2009 Environment and Natural Resources Trust Fund
M.L. 2009, Chapter 143, Sec. 2

The 2009 LCCMR recommendations were adopted by the legislature on May 17, 2009. On May 22, the Governor signed the bill into law (M.L. 2009, Chapter 143), with the exception of two projects that were line-item vetoed. $25.7 million*, primarily from Minnesota's Environment and Natural Resources Trust Fund, has been appropriated to 63 individual projects around the state. All work programs have been approved by the LCCMR in June and funding is available to projects on July 1, 2009.

Appropriations by Subdivision

Subd. 3 - Natural Resource Data and Information *(5 appropriations)*	**$5,995,000**
Subd. 4 - Land, Habitat, and Recreation *(10 appropriations*)*	**$13,227,000**
Subd. 5 - Water Resources *(5 appropriations**)*	**$1,788,000**
Subd. 6 - Aquatic and Terrestrial Invasive Species *(5 appropriations****)*	**$1,021,000**
Subd. 7 - Energy *(2 appropriations***)*	**$2,180,000**
Subd. 8 - Administration and Other *(2 appropriation)*	**$1,412,000**
Total	**$25,623,000**

*There are 10 appropriations in Subd. 4, which include 35 individual projects that are a part of Subd. 4e "Minnesota Habitat Conservation Partnership" (21) and Subd. 4f "Metropolitan Conservation Corridors" (14). Thus, Subd. 4 contains a total of 43 individual projects (35+8=43).
**Subd. 5 originally contained one additional appropriation that was approved by the legislature but vetoed by the governor: Subd. 5a "Removal of Endocrine Disruptors: Treatment and Education" for $275,000.
***Subd. 7 originally contained one additional appropriation that was approved by the legislature but vetoed by the governor: Subd. 7a "Options to De-carbonize Minnesota's Electrical Power System" for $143,000.
****Subd. 6 originally contained one additional appropriation that was approved by the legislature but was withdrawn: Subd. 6f "Native Plant Biodiversity, Invasive Plant Species, and Invertebrates" for $47,000.

Appropriations by Source of Funds

Environment & Natural Resources Trust Fund (TF)	**$25,157,000***
Great Lakes Protection Account (GLPA)	**$66,000**
State Land and Water Conservation Account (LAWCON)	**$400,000**
Total	**$25,623,000**

*$25,622,000 was available to be appropriated from the Environment and Natural Resources Trust Fund in fiscal year 2009. Due to governor vetoes and the one withdrawn project, all of the $465,000 that had been allocated for two vetoed projects and the one withdrawn project will remain within the Trust Fund.

Environment and Natural Resources Trust Fund
M.L. 2009, Chapter 143, Sec. 2

Subd	Project Title	Project Manager	Affiliation	LCCMR $ Rec. $25,622,000 from TF	LCCMR $ Rec. $66,000 from GLPA	LCCMR $ Rec. $400,000 from LAWCON	Region of Impact
Subd. 3 - Natural Resource Data and Information							
3a	Minnesota County Biological Survey	Carmen Converse	DNR	$2,100,000			NW, NE
3b	County Geologic Atlas and South-Central Minnesota Groundwater	Jim Berg	DNR	$1,875,000			NE, Central, Metro, SW
3b	County Geologic Atlas and South-Central Minnesota Groundwater	Dale Setterholm	Minnesota Geological Survey	$820,000			NE, Central
3c	Soil Survey	Greg Larson	BWSR	$400,000			NE, Central
3d	Springshed Mapping for Trout Stream Management	Jeff Green	DNR	$250,000			Metro, SE
3d	Springshed Mapping for Trout Stream Management	E. Calvin Alexander, Jr.	U of M	$250,000			Metro, SE
3e	Restorable Wetlands Inventory	Darin Blunck	Ducks Unlimited, Inc.	$300,000			NW, Central
			Subtotal =	**$5,995,000**	**$0**	**$0**	
Subd. 4 - Land, Habitat, and Recreation							
4a	State Parks Acquisition	Larry Peterson	DNR	$590,000			Statewide
4b	State Trail Acquisition	Stan Linnell	DNR	$1,000,000			NW, Central, SE
4c	Metropolitan Regional Park System Acquisition	Arne Stefferud	Metropolitan Council	$1,290,000			Metro
4d	Statewide Scientific and Natural Area Acquisition and Restoration	Peggy Booth	DNR	$590,000			Statewide
4e	Minnesota's Habitat Conservation Partnership (HCP) - Phase VI	Matt Holland	Pheasants Forever, Inc.	$3,375,000			Statewide
4e1a	HCP - Project Coordination, Mapping & Data Management (1a)	Matt Holland	Pheasants Forever, Inc.	$100,000			Statewide
4e2a	HCP - Melvin Slough Landscape Restoration (2a)	Joe Cannella	MN Deer Hunters Association	$50,000			Northwest
4e2b	HCP - Partners for Fish and Wildlife (2b)	Sheldon Myerchin	US Fish and Wildlife Service	$50,000			Statewide

Subd	Project Title	Project Manager	Affiliation	LCCMR $ Rec. $25,622,000 from TF	LCCMR $ Rec. $66,000 from GLPA	LCCMR $ Rec. $400,000 from LAWCON	Region of Impact
4e2c	HCP - Shallow Lake Enhancement (2c)	Jon Schneider	Ducks Unlimited, Inc.	$225,000			Statewide
4e2d	HCP - Shallow Lake Assessment & Management (2d)	Ray Norrgard	DNR	$145,000			Statewide
4e2g	HCP - Wildlife Areas Management (2g)	Suzann Willhite	DNR	$50,000			Statewide
4e2h	HCP - Fisheries Habitat Restoration (2h)	Linda Erickson-Eastwood	DNR	$100,000			Statewide
4e2i	HCP - Bluffland Restoration/Set Out Seedlings (2i)	Dave Neu	National Wild Turkey Federation	$85,000			SW, SE
4e2j	HCP - Lakescaping for Wildlife & Water Quality (2j)	Carrol Henderson	DNR	$75,000			Statewide
4e2k	HCP - Prairie Management (2k)	Jason Garms	DNR	$75,000			Statewide
4e2n/4f	HCP - Campaign for Conservation - Acquisition and Restoration (2n/4f)	Rich Johnson	The Nature Conservancy	$365,000			Statewide
4e2o	HCP - Prairie Landscape Restoration: Oak Savanna, Grasslands, and	Greg Hoch	Friends of the Detroit Lakes WMD	$50,000			NW
4e3a	HCP - Shoreland Protection Project - Conservation Easements (3a)	Jane Prohaska	Minnesota Land Trust	$210,000			Statewide
4e3c	HCP - Shallow Lake Easements (3c)	Jon Schneider	Ducks Unlimited, Inc.	$250,000			Statewide
4e3d	HCP - Wetlands Reserve Program (3d)	Jon Schneider	Ducks Unlimited, Inc.	$420,000			Statewide
4e4a	HCP - Critical Lands Conservation Initiative - Acquisition (4a)	Matt Holland	Pheasants Forever, Inc.	$350,000			Statewide
4e4b	HCP - Fisheries Land Acquisition (4b)	Mike Halverson	DNR	$300,000			Statewide
4e4c	HCP - Critical Lands Protection Program - Acquisition (4c)	Robert McGillivray	The Trust for Public Land	$350,000			Statewide
4e4h	HCP - Acquisition for Minnesota Valley Wetland Management District (4h)	Deborah Loon	Minnesota Valley National Wildlife Refuge Trust	$100,000			Southwest
4e4i	HCP - Professional Services (4i)	Kim Hennings	DNR	$25,000			Statewide
4f	Metro Conservation Corridors (MeCC) - Phase V	Wayne Sames	DNR	$3,375,000			Central

Subd	Project Title	Project Manager	Affiliation	LCCMR $ Rec. $25,622,000 from TF	LCCMR $ Rec. $66,000 from GLPA	LCCMR $ Rec. $400,000 from LAWCON	Region of Impact
4f1.1	MeCC - Mapping and Coordination (1.1)	Wayne Sames	DNR	$100,000			Central
4f2.3	MeCC - Restore & Enhance Significant Watershed Habitat (2.3)	Tom Lewanski	Friends of the Mississippi River	$90,000			Metro
4f2.4	MeCC - Lower Minnesota River Watershed Restoration & Enhancement	Joseph Pavelko	Friends of the Minnesota Valley	$90,000			Metro
4f2.5	MeCC - Restore & Enhance Significant Habitat (2.5)	Wiley Buck	Great River Greening	$155,000			Central, Metro
4f2.6/3.4/4.1	MeCC - Grants for Restoration, Acquisition, Easements, and Other	Marybeth Block	DNR	$1,175,000			Metro
4f2.7/3.6	MeCC - Metro SNA Acquisition, Restoration & Enhancement (2.7/3.6)	Peggy Booth	DNR	$410,000			Central
4f2.9	MeCC - Stream Habitat Restoration (2.9)	Mike Halverson	DNR	$150,000			Metro
4f3.1	MeCC - Critical Land Protection Program (3.1)	Becca Nash	The Trust for Public Land	$380,000			Central, Metro, SE
4f3.2	MeCC - Protect Significant Habitat by Acquiring Conservation Easements (3.2)	Jane Prohaska	Minnesota Land Trust	$250,000			Metro
4f3.3	MeCC - Fee Acquisition for Minnesota Valley NWR (3.3)	Deborah Loon	Minnesota Valley National Wildlife Refuge Trust	$225,000			Metro
4f3.5	MeCC - Fish & Wildlife Land Acquisition (3.5)	Mike Halverson	DNR	$350,000			Metro
4g	Statewide Ecological Ranking of Conservation Reserve Program (CRP)	Julie Klocker	Board of Water and Soil Resources (BWSR)	$107,000			Statewide
4h	Protection of Granite Rock Outcrop Ecosystem	Thomas Kalahar	Renville Soil and Water Conservation District	$1,500,000			Central, SW
4i	Minnesota Farm Bill Assistance Project	Tabor Hoek	Board of Water and Soil Resources (BWSR)	$1,000,000			Central, SW, SE
4j	Land and Water Conservation Fund (LAWCON) Federal Reimbursement	Wayne Sames	DNR	$0		$400,000	Statewide
			Subtotal =	**$12,827,000**	**$0**	**$400,000**	
Subd. 5 - Water Resources							
~~5a*~~	GOV. VETO - ~~Removal of Endocrine Disruptors: Treatment and Education~~	~~Paige Novak~~	~~U of M~~	~~$275,000~~			~~Statewide~~

Subd	Project Title	Project Manager	Affiliation	LCCMR $ Rec. $25,622,000 from TF	LCCMR $ Rec. $66,000 from GLPA	LCCMR $ Rec. $400,000 from LAWCON	Region of Impact
5b*	Vulnerability of Fish Populations in Lakes to Endocrine Disrupting Contaminants	Richard Kiesling	USGS	$297,000			Metro
5c*	Cooperative Habitat Research in Deep Lakes	Donald Pereira	DNR	$825,000			NW, NE, Central, Metro
5d*	Intensified Tile Drainage Evaluation	Shawn Schottler	Science Museum of Minnesota	$300,000			Central, Metro, SW, SE
5e	Citizen-Based Stormwater Management	Becky Rice	Metro Blooms	$279,000			Metro
5f	Minnesota Drainage Law Analysis and Evaluation	Louis Smith	Smith Partners PLLP	$87,000			Statewide
			Subtotal =	**$1,788,000**	**$0**	**$0**	
Subd. 6 - Aquatic and Terrestrial Invasive Species							
6a*	Ballast Water Sampling Method Development and Treatment Technology	Mary Jean Fenske	MPCA	$300,000	$66,000		NE
6b*	Emergency Delivery System Development for Disinfecting Ballast	Scott Smith	USGS	$125,000			NE
6c*	Improving Emerging Fish Disease Surveillance in Minnesota	Katharine Pelican	U of M	$80,000			Statewide
6d	Controlling the Movement of Invasive Fish Species	Vaughan Voller	U of M	$300,000			Statewide
6e	Prevention and Early Detection of Invasive Earthworms	Cindy Hale	U of M, NRRI	$150,000			Statewide
~~6f~~	WITHDRAWN - ~~Native Plant Biodiversity, Invasive Plant Species, and Invertebrates~~	~~Greg Hoch~~	~~Concordia College~~	~~$47,000~~			~~NW~~
			Subtotal =	**$955,000**	**$66,000**	**$0**	
Subd. 7 - Energy							
~~7a~~	GOV. VETO - ~~Options to De-carbonize Minnesota's Electrical Power System~~	~~Melisa Pollak~~	~~U of M~~	~~$143,000~~			~~Statewide~~
7b	Projecting Environmental Trajectories for Energy-Water-Habitat Planning	Peter Reich	U of M	$180,000			Statewide

Subd	Project Title	Project Manager	Affiliation	LCCMR $ Rec. $25,622,000 from TF	LCCMR $ Rec. $66,000 from GLPA	LCCMR $ Rec. $400,000 from LAWCON	Region of Impact
7c	Energy Efficient Cities	Carl Nelson	Center for Energy and Environment	$2,000,000			Metro, SE
			Subtotal =	**$2,180,000**	**$0**	**$0**	
Subd. 8 - Administration and Other							
8a	Contract Management	Wayne Sames	DNR	$158,000			Statewide
8b	Legislative-Citizen Commission on Minne	Susan Thornton	Legislative-Citizen Commission on Minnesota	$1,254,000			Statewide
			Subtotal =	**$1,412,000**	**$0**	**$0**	
			GRAND TOTAL =	**$25,157,000**	**$66,000**	**$400,000**	

*** Research Appropriation**

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Minnesota County Biological Survey
PROJECT MANAGER: Carmen Converse
AFFILIATION: Department of Natural Resources (DNR)
MAILING ADDRESS: Box 25, 500 Lafayette Road
CITY/STATE/ZIP: St. Paul, Minnesota 55155
PHONE: (651) 259-5083
E-MAIL: carmen.converse@.state.mn.us
WEBSITE: http://www.dnr.state.mn.us/eco/mcbs/index.html
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 3a

APPROPRIATION AMOUNT: $2, 100,000

Overall Project Outcome and Results

Since 1987 the Minnesota County Biological Survey (MCBS) has systematically collected, interpreted and delivered baseline data on the distribution and ecology of plants, animals, native plant communities, and functional landscapes in 81 of 87 counties. MCBS has added 19,089 new records to the Rare Features Database and contributed 4,544 of the 9,634 total database records to the Relevé (vegetation sampling) Database. Rare aquatic plant and vegetation surveys were completed for 1,764 lakes. Statewide 9,713 MCBS Sites of Biodiversity Significance and 58,957 polygons of native plant communities are now publically available on DNR's Data Deli.

During this project period, northeastern surveys documented features within large functional landscapes of fire-dependent forests, cliff and talus complexes, and undeveloped lakes. Surveys began in a portion of the northern patterned peatlands, one of the state's largest (about 2.5 million acres) and most inaccessible ecological systems. Surveys included successful collaboration with Red Lake Reservation DNR managers and University of Minnesota researchers.

New range distributional data were recorded for Braun's holly fern *(Polystichum braunii),* Laurentian tiger beetle (*Cicindela denikei*), Black-throated Blue Warblers (*Setophaga caerulescens*) and three species of mosses.

MCBS data on the locations of native prairie were a centerpiece of a plan: *Minnesota prairie conservation plan 2010: a habitat plan for native prairie, grassland, and wetlands in the Prairie Region of western Minnesota.* See also: *Minnesota's Remaining Native Prairie 100 Years After the Public Land Survey (http://files.dnr.state.mn.us/eco/mcbs/prairie_map.pdf)*

MCBS provided data and interpretation to inform management and monitoring activities in the Manitou and Sand Lake Seven Beavers Collaboratives- two large multi-jurisdictional landscapes.

DNR's Forest Certification implementation used a MCBS data access tool to assist in evaluation of data related to High Conservation Value Forests.

Maps of the Minnesota locations of 242 breeding birds based on observations by MCBS are on the web: Bird Distribution Maps (http://www.dnr.state.mn.us/eco/mcbs/birdmaps.html)

Project Results Use and Dissemination

Data delivery includes delivery of information to local units of government, presentations and field trips, publications and web products. Several examples of recipients of data during this period include: St Louis County, Becker County, State Parks, northeast Landscape Collaboratives, Potlatch, Hamden Slough National Wildlife Refuge, Voyageurs National Park, Heron Lake Watershed District, and private landowners near the Chandler MN, Chanarambie Creek Prairies.

Examples of presentations:
Staff made presentations and prepared posters related to rare aquatic plants as part of the Minnesota Native Plant Society Symposium in March 2011, *Minnesota's Lake Vegetation: Above and Below the Water Line.*

MCBS made a presentation and helped to lead field trips at Morton Outcrops SNA at a June 2010 meeting of the Commissioner's Advisory Committee and others in the Minnesota River corridor-including members of the Green Corridor project. A MCBS plant ecologist has been providing assistance to the Green Corridor project to identify priority sites for conservation action.

Examples of web delivery:
The Rare Features Guide www.mndnr.gov/rsg provides information on 439 state listed species for application in conservation and management planning. Many of the recent profiles were written by MCBS biologists.

The Native Plant Community Classification (http://www.dnr.state.mn.us/npc/classification.html) page was redesigned providing easier navigation and a link to the NPC classification methods (http://files.dnr.state.mn.us/natural_resources/npc/npc_methods_paper.pdf) description that provides background on how data were analyzed and interpreted utilizing vegetation plot data (relevés) to derive the DNR's current native plant community classification.

Updates including links to other web locations were completed related to the list of Minnesota's vascular plants MNTaxa: The State of Minnesota's Vascular Plant Checklist (http://www.dnr.state.mn.us/eco/mcbs/plant_lists.html).

Publications
An ecological evaluation for the La Salle Creek and Chain of Lakes corridor in Hubbard County contributed to proposed conservation of this landscape.

Web-based Minnesota's amphibian and reptile distribution maps (http://www.dnr.state.mn.us/eco/mcbs/amphibian&reptile_maps.html) will be used to update the book, *Amphibians and Reptiles Native to Minnesota.*

Updates were added for MCBS-related projects on the DNR's website:
News from the Field 2010 (http://www.dnr.state.mn.us/eco/mcbs/news2010.html), *News from the Field 2011 (http://www.dnr.state.mn.us/eco/mcbs/news2011.html)*

A manuscript entitled *Recent rediscovery of rare plants in temporary pools on Sioux Quartzite outcrops* was published in the proceedings of the 22nd North American Prairie conference that was held in Cedar Falls, Iowa in 2010.

New graphics, updated distribution maps, new photos of 35 orchid species and illustrations were completed as part of a new DNR book on Minnesota's orchids that nears publication. This will be an update to the presently out- of- print but very popular book, *Orchids of Minnesota.* Botanists and plant ecologists finalized the verification of identification of their most recent field updates on the state's orchids for inclusion in the new book.

Environment and Natural Resources Trust Fund 2009 Work Program
Final Report

Date of Report: September 26, 2011
Final Report: June 30, 2011
Date of Work Program Approval: June 16, 2009
Project Completion Date: This workprogram outlines activities and products to be completed during the two-year duration of this funding (ending June 30, 2011). This is a continuation project so data generated from activities of the Minnesota County Biological Survey (MCBS) in previous biennia will be applied to the proposed outcomes, and data and procedures derived from work this biennium will be applied to future surveys and products.

I. PROJECT TITLE: Minnesota County Biological Survey

Program Manager: Carmen Converse
Affiliation: Department of Natural Resources
Mailing Address: Box 25, 500 Lafayette Road
City/State/ Zip: St. Paul, Minnesota 55155
Telephone Number: (651) 259-5083
E-mail Address: carmen.converse@state.mn.us
FAX Number: (651) 259-1811
Web Page address: http://www.dnr.state.mn.us/eco/mcbs/index.html

Location: (see also map): Surveys will continue in Lake, Cook and St Louis counties. Surveys will begin in Clearwater and Beltrami counties.

Total Trust Fund Project Budget:	**Trust Fund Appropriation:**	**$ 2,100,000**
	Minus Amount Spent:	**$ 2,069,676**
	Equal Balance:	**$ 30,324**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 3a

Appropriation Language: Minnesota County Biological Survey
$2,100,000 is from the trust fund to the commissioner of natural resources for continuation of the Minnesota county biological survey to provide a foundation for conserving biological diversity by systematically collecting, interpreting and delivering data on plant and animal distribution and ecology, native plant communities, and functional landscapes.

II. and III. FINAL PROJECT SUMMARY:

Overall Project Outcome and Results

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IV. OUTLINE OF PROJECT RESULTS:

Result 1: Field Surveys (see also attached map)

Description: The status and distribution of rare resources will be identified, providing a basis for the maintenance of Minnesota's biological diversity and ecological systems through ecological management, planning, research, monitoring, and critical habitat acquisition.

Procedure: A multi-level survey process is followed.

Review and site identification: Plant ecologists, botanists and zoologists review existing relevant natural resource data and record information into electronic databases, using Geographic Information Systems and other DNR information systems to consolidate and organize data. Examples of these data include forest inventories, wetlands inventories, wildlife habitat inventories, park surveys, soil surveys, land use data, historical public land surveys, biophysical surveys, academic research, and records from museum collections. Using these data, supplemented by the interpretation of aerial photography or other imagery, staff identify MCBS sites and species habitats for targeted surveys.
Coordination: Staff notify and coordinate surveys when possible with other divisions within the DNR, universities, counties, municipalities, tribal governments, watershed districts, federal

natural resource agencies, conservation organizations, corporations, and individual landowners. This is critical to the success of data consolidation and field surveys.

Field Surveys: Ground surveys to assess MCBS site and native plant community quality and condition include the collection of vegetation samples in coordination with other sampling (soils, water chemistry etc.) when possible. Aerial surveys sometimes supplement ground surveys. Additional specialized techniques are used during field seasons to survey selected rare species or groups of species (e.g., plants, birds, mammals, reptiles, amphibians, insects, fishes).

Summary Budget Information for Result 1: **Trust Fund Budget:** **$ 750,000**
Amount Spent: **$ 817,339**
Balance: **$ (67,339)**

Deliverable	**Completion Date**	**Budget**	**Status (see below)**
Review and site identification	June 2010 Northeast August 2009 Beltrami/Clearwater	220,000	
Coordination	July 2009-June 2011	150,000	
Field surveys	July-Oct 2009; April-Oct 2010; April-June 2011	380,000	

Final Report Summary June 2011

Review and site identification

In the Border Lakes subsection, priorities for surveys were determined in 2009 and re-assessed after the 2010 field season. The Superior National Forest blow down data and M.L. Heinselman's stand origin data, along with more recent vegetation monitoring activities and procedures in progress in the Border Lakes, were also reviewed. This process resulted in a plan to complete the field surveys of sites, native plant communities, animals and plants in Cook County in 2010. Surveys in the Border Lakes subsection of Lake County were proposed for completion in the 2011 field season pending continuation of funding for MCBS.

In the Nashwauk Uplands and portions of the Tamarack Lowlands subsection, a plant ecologist and zoologists evaluated resources. Sites selected for 2010 survey focused on the Mesabi Range, Big Rice Moraine, and Whalsten Till Plain Land Type Associations. In addition, Bear Head Lake State Park and Lake Vermillion State Park were included for review at the request of the DNR Division of Parks and Trails for expedient surveys.

Clearwater County sites targeted for native plant community survey were identified in 2009 and rare plant and aquatic plant survey sites were added in 2010. Completion of surveys is anticipated by the end of the 2011 field season pending continuation of funding for MCBS.

Beltrami County sites were selected in 2009. In 2010 and 2011 surveys of sites, native plant communities, rare plants and rare animals were planned. Completion of field surveys in the vicinity of Upper Red Lake in coordination with the Red Lake Reservation Department of Natural Resources is anticipated by the end of the 2011 field season.

Coordination

Coordination with the US Forest Service continues. The results of 2009 surveys on Superior National Forest (SNF) were presented at a fall meeting of the SNF biologists, at a DNR regional meeting of Division of Ecological and Water Resources staff, and at another regional meeting organized by DNR Division of Wildlife that included DNR area wildlife managers and wildlife biologists from the Superior and Chippewa National Forests.

Areas selected for survey within the Superior National Forest, including the Boundary Waters Canoe Area Wilderness (BWCAW), were reviewed with Forest biologists, all required permits were obtained and ongoing monitoring activities in the SNF were discussed. Two SNF Wilderness staff assisted a MCBS plant ecologist on several Wilderness survey canoe-based trips of from four to eight days in duration, providing an excellent opportunity to share information on how MCBS data can be applied to SNF vegetation management and monitoring, most specifically as related to fire monitoring within the SNF and the BWCAW.

Surveys in St. Louis County included work in two State Parks: Bear Head Lake State Park and the new Lake Vermillion State Park. Agreements for species surveys and vegetation mapping within the two parks were developed with regional DNR Division of Parks and Trails staff.

Meetings with local agencies, private landowners and organizations in St Louis County were held to introduce them to the initiation of MCBS in the Nashwauk Uplands subsection. MCBS survey objectives and procedures were explained and input on areas of potential survey interest was requested. In March 2011, the St Louis County Land Department was updated on the status of work in the county and proposed plans for the 2011 field season. An additional meeting with the District One commissioner provided more detail on that area.

MCBS staff attended DNR Regional meetings in Grand Rapids and at Lake Itasca State Park to inform the newly formed division (Division of Ecological and Water Resources) about the procedures and status of MCBS and to further explore options for coordination.

Other DNR Divisions are now mapping lands they manage using the native plant community classification developed by the Division of Ecological and Water Resources and Division of Forestry ecologists. A project within the DNR to create a consolidated spatial data layer of native plant communities currently mapped on all DNR-managed lands is underway.

Related to the above activity, the Ecological Land Classification (ECS) program in DNR's Forestry Division is collecting data to inform mapping projects in a number of state forests with the goal of ultimately mapping native plant communities on all of the state DNR lands having forest management activities. A closer collaboration of mapping resulted in several field days that included field training of forestry staff and review of collected data. MCBS plant ecologists participated in sessions associated with the Nemadji State Forest, the Fond du Lac Reservation, and the Tower, Cloquet and Hibbing Forestry Areas. Plant ecologists also provided mapping suggestions to ECS forestry staff working in Smokey Hills and Paul Bunyan State Forests.

In Beltrami County, MCBS plant ecologists focused on the survey of peatland native plant communities and rare plants in the vicinity of Upper Red Lake. Communication with staff from the Big Bog Recreation Area, field visits with DNR Division of Wildlife staff at Red Lake WMA and Ecological and Water Resources northwest regional ecologists was an important part of survey planning. Reconnaissance of this vast area provided substantial information and prompted additional strategies for targeting further survey and efficient ways to coordinate with other ongoing survey and monitoring efforts in the area.

Red Lake Reservation in Beltrami and Clearwater counties contains significant natural areas. MCBS biologists and ecologists continued communication with the leadership and staff of the Red Lake Reservation Department of Natural Resources. Continuation of the successful procedures for native plant community, rare animal and rare plant surveys based on the logistical procedures developed in 2010 were extended into the 2011 field season.

Collaboration with scientists involved in long-term peatland research at the University of Minnesota resulted in a successful agreement to share resources for access and vegetation sampling in 2010 and in June 2011, specifically using helicopter transport that provides the best access to sample areas with the least amount of disturbance. Continuation of this agreement is anticipated for August 2011 to include additional sites and opportunities for rare plant and animal surveys at phenologically more optimal times.

Coordination continues with bryologist Jan Janssens in order to incorporate accurate moss identification into MCBS vegetation sampling, native plant community classification, and database organization. Building on a highly successful 2009 training session in the identification of bryophytes (mosses and liverworts) in northeastern Minnesota, Jan provided additional training sessions for botanists and ecologists working in the northwestern region. These organisms are especially prominent in the patterned peatlands landscape and in calcareous fens, both targeted resources for survey in northwestern Minnesota. Training sessions were centered out of Norris Camp (Red Lake Wildlife Management Area) in 2010 and at Itasca State Park in 2011. The MCBS information officer and MCBS ecologists helped to develop training materials.

The MCBS aquatic botanist provided ideas based on MCBS aquatic plant field work at a meeting to develop criteria for a Lake Index of Biotic Integrity (IBI), organized by the Minnesota Pollution Control Agency (MPCA) to consider the development of an aquatic plant indicator for Lake IBI.

Coordination with the wetland inventory and other resource assessment and monitoring efforts continues (National Wetlands Inventory, DNR MIS/GIS, Minnesota Pollution Control Agency wetland monitoring staff and Forestry Assessment). This includes updates on air photo production, joint field visits with MPCA monitoring staff, and exploration of potential ideas for acceleration of mapping through application of new mapping elements and software such as LiDAR and eCognition.

In spring of 2011 Forest Capital Partners, Inc. contacted MCBS about a potential for conducting surveys for rare features on some of their holdings in northern Minnesota. An agreement for a pilot project is being considered pending continued funding of MCBS.

Surveys for rare animals and animal species of greatest conservation need began in Lake County and St Louis counties largely due to funding from a State Wildlife Grant. (For a report on findings see *State Wildlife Grant Report* ***Project:*** *Minnesota's Wildlife Resources and Habitat Surveys and Information Management.* ***Grant Number:*** *T-5-R-2* ***Project Period:*** *July 1, 2007-August 31, 2010.*) Additional surveys in Lake, Beltrami and St Louis counties in the 2011 field season began in part funded by the State Wildlife Grant. Surveys beyond the 2011 field season are pending continued Federal funding associated with the State Wildlife Action Plans that have been developed in each state and coordinated nationally.

Coordination with the Bell Museum of Natural History especially as related to long-term curation and of museum collections is ongoing. In addition, the Science Museum of Minnesota also continues to provide logistical support for preparation of some museum collections.

MCBS prairie ecologists are participating in a multi-agency/organization prairie monitoring collaborative that includes The Nature Conservancy, Concordia College, DNR Division of Ecological Resources and Wildlife, the US Fish & Wildlife Service and others. Due to their extensive knowledge and experience in the prairie region, these MCBS ecologists have provided substantial advice related to prairie vegetation sampling protocol and have assisted with field training and sampling. Their experience with data analysis related to native plant community classification, observations of the influences of management on prairie quality and their ability to identify prairie plants even in vegetative condition has been valuable to the collaborative in the determination of best strategies for long-term monitoring of prairie condition as related to management. Clarification of procedures and quality control of data to ensure the most accurate results was one outcome of this coordination.

Two individuals from MCBS with extensive knowledge of Minnesota's native prairie participated in the development of a statewide grassland conservation plan. This multi-agency/organizational effort began in 2010 and was completed in 2011 (see also result #3). Mapped known locations of native prairie collected by MCBS formed the core data of this project that has spatially explicit targets for conservation.

Field surveys

Preparation for field surveys, especially in remote areas requires substantial logistical preparation and coordination. This included obtaining field housing, vehicles, maps, helicopter flights (peatlands), and organizing field gear, checking, repairing and updating equipment, updating GPS files and securing and updating safety items.

Field safety communications using SPOT were highly effective in remote areas such as the Boundary Waters Canoe Area Wilderness and the Red Lake Peatlands. This service provides a reliable means of communicating simple safety messages from a light-weight portable device that includes a GPS interface. This replaced the use of short range radios for safety applications since radios sometimes had poor reception and reporting times were inconvenient. Satellite phones were borrowed to explore their use but were found to be too expensive for more widespread use by field surveyors. Short range radios were beneficial in the peatlands where several biologists were working in relatively close proximity and needed to be in contact regarding coordination of helicopter transfer.

A safety wilderness training in May 2011 provided an update for all field staff from a previous training session. Due to the extensive work planned in remote areas, this was critical to survey outcomes. The value of wilderness training was demonstrated in 2010 when field surveyors working on a large wilderness lake during extreme weather made bivouac decisions consistent with their training.

In the Border Lakes portion of Cook County, the documentation of ecological data on rare plant and rare animal locations, native plant community and landscape condition in the survey areas was completed in 2010. Survey plant ecologists recorded data related to high quality targeted native plant communities including Red Pine-White Woodland (Canadian Shield), Red Pine-White Pine Woodland (Northeastern Bedrock) and Black Spruce-Jack Pine Woodlands. Records include notes on vegetation response to fire and wind events, past management, locations of legacy patches (serving as source areas), cold drainages and wetland complexes. Vegetation samples (relevés) were collected along with observations using GPS locations. Rare plant and animal searches also included the preparation of species lists for habitats such as cliff faces, lakes, small seepages and wetlands

Data collected included relevés, and information on soils, geomorphology, geology, hydrology, aquatic conditions, topography, landscape context, disturbance history, regeneration and community response to fire, micro-topography and structural components. Locations of rare species, species (animals) of greatest conservation need and records of common species that had no previous museum documentation in the area were priorities.

A major part of the survey effort during this period was accomplished during extended wilderness canoe trips to base camps in the BWCAW from where additional overland surveys were conducted. Examples of sites surveyed in 2010 are Misquah Hills, Omega Lake, Swan Lake, Caribou Lake, Eagle Mountain, Veggie, Bean, Esther Lake, Poplar Lake, Portage Brook Ridge, and Cascade Lake.

Surveys for rare animals and animal species of greatest conservation need began in Lake and St Louis counties in 2010 with funding from a State Wildlife Grant. Animal surveys were also conducted at the new Lake Vermillion State Park as a result of an agreement with the Division of Parks and Trails.

Surveys began in a portion of the northern patterned peatlands, one of the state's largest (about 2.5 million acres) and most inaccessible ecological systems. In the Red Lake Peatlands of Beltrami County, MCBS plant ecologists and botanists worked with Paul Glaser (University of Minnesota) to re-sample vegetation plots established over 20 years ago in the area, to collect additional data in new locations and to conduct aerial reconnaissance of the area for future surveys. Helicopter access in 2010 and in June 2011 was instrumental in accomplishing this survey.

In Clearwater County native plant community and rare plants surveys within the Red Lake Reservation were completed along with additional sites in other parts of the county, including a number of calcareous fens.

Surveys where rare aquatic plants were targeted were completed in a total of 77 lakes including locations in the Border Lakes portion of Cook County, and in selected lakes in St Louis and Cass counties. This included surveys in both Bear Head Lake and Lake Vermillion State Parks.

Field surveys in June 2011 were challenging due to the impending state of Minnesota government shutdown that required preparations to secure state vehicles and equipment and notify staff and contractors working in remote areas about procedures for potential termination of field work. This preparation reduced the amount of field work accomplished in June and required significant alteration of plans for the entire 2011field season.

Highlights Northeastern Surveys (Border Lakes, Nashwauk Uplands, Tamarack Lowlands)
The large functional landscapes of the Border Lakes Subsection portion of Cook County contain high quality fire-dependent forests and large areas recovering from a series of wildfires and wind storms, cliff and talus complexes, and associated groundwater seepage zones. Plant surveys included focused searches for rare aquatic plants that were successful on the numerous undeveloped lakes and associated sedge fens and mud flat communities. For example, Homer, Little Cascade, Little John, Two Island, and Wine lakes all contained more than one species of a rare aquatic plant and/or large populations of a rare species.

Rare plants and other plants of interest that were documented in the northeastern surveys include: maidenhair spleenwort *(Asplenium trichomanes),* matricary grapefern *(Botrychium matricariifolium),* least moonwort *(Botrychium simplex),* nodding sedge *(Carex gynandra),* intermediate sedge *(Carex media),* Michaux's sedge *(Carex michauxiana),* hoary whitlow grass *(Draba cana),* Robbins' spikerush *(Eleocharis robbinsi),* nahanni oak fern *(Gymnocarpium jessoense),* Appalachian fir moss *(Huperzia cf. appalachiana),* a species of clubmoss *(Huperzia appressa),* bog rush *(Juncus stygius),* American shore plantain *(Littorella uniflora var. americana),* small-flowered woodrush *(Luzula parviflora),* large-leaved sandwort *(Moehringia macrophylla),* one-flowered muhly (M*uhlenbergia uniflora)* ,blunt-fruited sweet cicely *(Osmorhiza depauperata),* small green wood orchid *(Platanthera clavellata),* small shinleaf *(Pyrola minor),* sooty-colored beak rush *(Rhynchospora fusca),* Lapland buttercup *(Ranunculus lapponicus),* cloudberry *(Rubus chamaemorus),*encrusted saxifrage *(Saxifraga paniculata),* soapberry *(Shepherdia canadensis),* awlwort (*Subularia aquatica* var. *americana),* Torrey's mannagrass *(Torreyochloa pallida* var. *fernaldii),* a species of lichen *(Usnea longissima),* hidden-fruit bladderwort *(Utricularia geminiscapa),* lavender bladderwort *(Utricularia resupinata),* alpine woodsia *(Woodsia alpina),* Oregon woodsia *(Woodsia oregana)* and Rocky Mountain woodsia *(Woodsia scopulina).* Several additional species of interest include: sago pondweed (*Stuckenia pectinata),* leafy pondweed (*Potamogeton foliosus),* Illinois pondweed *(Potamogeton illinoensis),* sticky groundsel *(Senecio viscosus),* and pellitory *(Parietaria pensylvanica).*

A more detailed count of the number of individuals of Braun's holly fern *(Polystichum braunii)* first recorded at a location in the BWCAW in 2009 was made in 2010 to more adequately document the most northwestern range extent of this species known in the US.

Animal surveys in 2009 and 2010 resulted in new locations for six targeted insects, including Nabokov's blue butterfly (*Plebejus idas nabokovi)* and the first Cook County report of the Laurentian tiger beetle (*Cicindela denikei*), a globally rare species. Mammal surveys resulted in records of Northern bog lemming *(Synaptomys borealis)*, Heather vole *(Phenacomys ungava)*, Rock vole *(Microtus chrotorrhinus)*, Smoky shrew *(Sorex fumeus)*, Northern myotis *(Myotis septentrionalis)*, and Gray wolf *(Canis lupus)*. In terms of amphibians and reptiles, Snapping turtle (*Chelydra serpentina*), and the Eastern red-backed salamander (*Plethodon cinereus*) were located in the study area. Forty-four species of nongame fish were documented. These included Shortjaw cisco (*Coregonus zenithicus*), Kiyi (*Coregonus kiyi*), Nipigon cisco (*Coregonus nipigon*), Bloater (*Coregonus hoyi*), Lake chub (*Couesius plumbeus*), Deepwater sculpin (*Myoxocephalus thompsonii*), and Spoonhead sculpin (*Cottus ricei*). Bird surveys were conducted the Border Lakes Subsection in Lake County in 2010 resulting in 40 locations of rare species. This is a significantly lower number of records than in the Border Lakes Subsection of Cook County in 2009 largely due to about100 fewer locations of Black-throated Blue Warblers (*Setophaga caerulescens*) recorded in 2010 than in 2009.

Animal surveys conducted in the spring of 2011 resulted in a Sturgeon River location of Northern brook lamprey *(Ichthyomyzon fossor)*, and three locations of Four toed salamanders *(Hemidactylium scutatum)* in southern St Louis County, including the first record on the east side of the St. Louis River.

June 2011 breeding bird surveys were focused in the Border Lakes and Tamarack Lowlands subsections of St Louis County with additional preliminary surveys in the Nashwauk Uplands. A total of 153 potential breeding bird species were recorded, including 35 records of rare species: Trumpeter Swan (*Cygnus buccinator*), American Bittern (*Botaurus lentiginosus*), Sandhill Crane (*Grus canadensis*), Upland Sandpiper (*Bartramia longicauda*) and Black-throated Blue Warblers (*Setophaga caerulescens*). Other species of interest that were recorded include Northern Hawk Owl (*Surnia ulula*), Great Gray Owl (*Strix nebulosa*), Eastern Whip-poor-will (*Caprimulgus vociferus*), Black-billed Magpie (*Pica hudsonia*), Tennessee Warbler (*Oreothlypis peregrina*), Bay-breasted Warbler (*Setophaga castanea*) and Wilson's Warbler (*Cardellina pusilla*).

Tennessee Warbler, Cape May Warbler (*Setophaga tigrina*), Bay-breasted Warbler, and Evening Grosbeak (*Coccothraustes vespertinus*) are bird species rarely observed in Minnesota except in isolated areas with spruce budworm outbreaks. Bay-breasted Warblers were recorded at six locations, a relatively high number for this species that is the rarest breeding warbler in Minnesota's boreal forest region. Black-throated Blue Warblers were found to be uncommon to rare in this area that is located near this species' northwestern range limit. It was recorded at two locations in the Nashwauk Uplands Subsection where there have been very few past records.

More detail on the results for surveys of rare animals and animal species of greatest conservation need are found in: ***State Wildlife Grant Project:*** *Minnesota's Wildlife Resources and Habitat Surveys and Information Management.* ***Grant Number:*** *T-5-R-2* ***Project Period: July 1, 2007-August 31, 2010****).* An additional State Wildlife Grant Project report on results of animal surveys will be available in December 2011.

Surveys of plants and native plant communities in the Border Lakes Subsection portion of Lake County continued in the field season of 2011. This included field surveys of rare plants, high quality communities and landscape conditions in places such as the Kawishiwi Triangle area, the vicinity of Fernberg Road east of Ely and the Isabella River watershed. Condition ranks of high quality white pine-red pine forests, upland white cedar forests, jack pine-black spruce and red pine-white pine woodlands and lakeshore communities were documented. Aquatic species were surveyed along rivers and in quiet bays of lakes. Landscape areas were assessed based on statewide biodiversity ranking.

Botanical surveys included wilderness canoe trips into places such as the Sagagana - Topaz Lake area of northeastern Lake County. Species of interest recorded during this time included: dragon's mouth *(Arethusa bulbosa)*, soapberry *(Shepherdia canadensis),* small-flowered woodrush *(Luzula parviflora),* Maidenhair spleenwort *(Asplenium trichomanes)*, Oregon woodsia *(Woodsia oregano),* smooth cliff brake *(Pellaea glabella),* Lapland buttercup *(Ranunculus lapponicus)*, small yellow water crowfoot *(R. gmelinii), and* least moonwort *(Botrychium simplex).*

In the Nashwauk Uplands Subsection, plant community and rare plant surveys were the primary focus of field work. Site surveys included the collection of 50 relevé plots and documentation of numerous rare plant locations in 2009 and 2010, including bog rush (*Juncus stygius* var. *americana*), montane yellow-eyed grass (*Xyris montana),* small green wood orchid *(Platanthera clavellata)*, coastal sedge (*Carex exilis*), cuckoo flower *(Cardamine pratensis* var. *palustris),* and discoid beggarticks (*Bidens discoidea)* The specimens of discoid beggerticks were collected from several lake shorelines were sent to the coauthor of the treatment of *Bidens* in *The Flora of North America* for annotation.

Also in the Nashwauk Uplands the plant ecologist completed native plant community mapping in Bear Head Lake State Park and provided this to Parks.

Highlights Clearwater and Beltrami counties

In Clearwater County surveys were focused in the northern portion of the county where good coordination with the Red Lake Reservation DNR resulted in the completion of surveys in the northern portion of the county. In addition, a number of calcareous fens, two old-growth pine sites and one outstanding peatland site were documented.

In Beltrami County the 2010 re-collection of relevés at 14 permanent plot locations in the patterned peatland where plot data were first recorded over 20 years ago is the beginning of potential long-term vegetation monitoring data collection project with plots selected statewide. In 2010 and June 2011 over 50 relevés were collected in Clearwater and Beltrami counties.

Rare plants and other plants of interest recorded in the region included: dragon’s mouth orchid *(Arethusa bulbosa)*, ram’s head orchid *(Cypripedium arietinum)*, barren strawberry *(Waldsteinia fragarioides),* beaked spikerush *(Eleocharis rostellata)*, twig rush (*Cladium mariscoides),* linear-leaved sundew *(Drosera linearis),* English sundew *(Drosera anglica)*, bog rush *(Juncus stygius var. americanus),* montane yellow-eyed grass *(Xyris montana),* sooty-colored beak rush *(Rhynchospora fusca),* small yellow water crowfoot *(Ranunculus gmelinii),* Cooper’s milk-vetch *(Astragalus neglectus),* white adder's mouth *(Malaxis monophyllos)*, small yellow water crowfoot *(Ranunculus gmelinii),* and matricary grapefern *(Botrychium* cf. *matricariifolium).*

***Bryophytes* (mosses and liverworts)**
Botanists have been collecting selected mosses and liverworts as an ongoing part of their survey work statewide. The recently completed identification of some of these collections by taxonomic expert, Jan Janssens revealed that three of the mosses collected are the first records of the species in Minnesota: *Philonotis yezoana, Tayloria serrata,* and *Fontinalis welchiana.*

Aquatic plants
Aquatic plant surveys were conducted in various parts of northern Minnesota in 2010 resulting in improved documentation of the distribution of several aquatic plant species. Examples follow: Several large populations of several hundred individuals of American awlwort *(Subularia aquatica var. americana)* were observed in several lakes in Cook County, yet no new locations were recorded during directed surveys for this species in Cass or St. Louis counties. American shore plantain *(Littorella uniflora),* recorded in large numbers in several Cook County lakes was also recorded at Larson Lake in Cass County, further documenting the known southwestern extent of its Minnesota range. Leafless water milfoil (*Myriophyllum tenellum)* was found growing in several lakes, often in large populations in Cook County, at Bear Head Lake in St. Louis County and a number of lakes farther south. Slender water naiad *(Najas gracillima),* Guadalupe naiad *(Najas guadalupensis var. olivacea)* and humped bladderwort (*Utricularia gibba)* are likely representative of a more southerly Minnesota flora, with no locations recorded in the northeast. Identification of collections from Cass County lakes were confirmed for Oakes’ pondweed *(Potamogeton oakesianus),* discoid beggar-tick (*Bidens discoidea*) and pedicelled bulrush (*Scirpus pedicellatus*).

Result 2: Information System Expansion

Description: MCBS will provide data and collections to information systems and museums, resulting in the long-term storage of biological collections and the distribution of information to individuals, organizations, and agencies with diverse natural resources goals.

Procedure:
Data collected by MCBS are entered into manual and computerized files in DNR’s information systems. Key databases include those tracking locations of plants and animals, rare features, relevé (vegetation plot samples), aquatic plant lists/lakes, MCBS sites, native plant community polygons (GIS), and animal aggregations. Locations of native plant communities are mapped at the scale of U.S.Geological Survey 1:24,000 topographic maps using ARC/GIS. Shape files of native plant communities and MCBS sites are available on the DNR’s Data Deli, accessible through the website. Rare species locations are entered into BIOTICS, an information system

developed by NatureServe, an international organization with a major focus on the storage, distribution and interpretation of rare features data. Photographic vouchers, color slides, digital images, and other digital media are stored at the DNR, St. Paul. Field data sheets are filed electronically or manually.

Information System Development: The collection and management of data continues to improve through the use of networks, GIS, relational databases, global positioning systems, and field data recorders. MCBS participates in DNR's efforts to maintain data standards and quality of data, to integrate databases, and to improve information delivery on the web. MCBS also coordinates with other state and national information system developments. Continued development of information systems is essential to achieve MCBS goals, and requires ongoing investment to satisfy the increasingly complex and diverse demands of users and the related needs for data standards, data security, metadata and other documentation. In order to effectively contribute to data synthesis, analysis, interpretation, and future natural resource monitoring needs, considerable effort is required to maintain data integrity as new technology in Information Systems continuously evolves.

Preparation of Collections: All plant and animal specimens are identified; collections are prepared for permanent storage and deposited in appropriate repositories at the J.F. Bell Museum of Natural History at the University of Minnesota and the Science Museum of Minnesota.

Summary Budget Information for Result 2: Trust Fund Budget: $ 700,000
Amount Spent: $ 766,351
Balance: $ (66,351)

Deliverable	**Completion Date**	**Budget**	**Status (see below)**
Data entered in DNR Information Systems	January 2010 # records added October 2010 #records added March 2011 #records added June 2011 #records added	575,000	
Information System Development	Updates with each status report	75,000	
Preparation of Collections	March 2010 #collections deposited June 2011 #collections deposited	50,000	

Final Report Summary June 2011

Data entered in DNR Information Systems

Since July 2009 new records of 1,069 rare features were added to the Rare Features Database. Since 1987, MCBS has added 19,089 new rare feature records. Since 1987, MCBS has contributed 4,544 of the 9,634 total database records to the Relevé (vegetation sampling) Database and has surveyed 1,764 lakes for rare aquatic plants and vegetation. Statewide, 9,713

MCBS Sites of Biodiversity Significance and 58,957 polygons of native plant communities are now publically available on DNR's Data Deli.

Information System Development

The NatureServe product, Biotics contains data standards for entry of observations that is shared by users in all NatureServe member programs in the Western hemisphere. During this time 104,871 records of Bird "observation" data were entered. This means that for the 12,835 locations of bird surveys conducted historically by MCBS there is an observation of each species (common or rare) recorded at individual locations. This includes observations from the standard point counts and from other techniques (playback calls for example). A similar effort is being pursued for all of the data collected on mammals by MCBS (inclusive of all species recorded). Over 29,000 species records of common and rare mammals representing over 1,200 locations were compiled. Data recorded by MCBS zoologists on common and rare fish is in the beginning stages of this process.

The first phase of an upgrade of the vegetation sampling database (Relevé Database) was completed that allowed for the entry of samples collected during recent field seasons. The project benefitted from coordinated effort of MCBS plant ecologists and botanists who provided programmers with technical input especially as related to plant taxonomy and related issues of synonymy. Two plant ecologists, located in St Paul, were especially critical to the database design and development. The departure of one of the plant ecologists for a fulltime position with a federal agency was disruptive to this project. A student worker was hired to assist with more routine tasks of the project and other aspects of the project were assigned to another plant ecologist.

The assistance of a computer programmer through a service level agreement with the DNR's Management Information System (MIS) was critical to the upgrade of this database. However, using a new DNR database development protocol, the first phase of this project was assigned through a service agreement to DNR MIS programming staff located in Grand Rapids while the ecological staff were located in St Paul, complicating communications. A second phase of the project was assigned to a MIS programmer in St Paul, who after receiving content-training by the ecologists and Divisional project management staff, worked on the project until departmental MIS staff were largely diverted to assist with the implementation of a new statewide financial system. This unexpected diversion of their time combined with the departure of the plant ecologist is one reason for the unexpended ENRTF funds.

A closely related project to upgrade a standard state database related to a comprehensive list of vascular plants continued to progress but was also disrupted due to the departure of a plant ecologist and other priorities of the MIS staff. Again, some of the DNR programming identified in a service level agreement resulted in unexpended ENRTF funds.

Closer coordination with herbarium database projects at the Bell Museum of Natural History progressed during this time due to effective communication between professional biologists who also have reasonable understanding of data management systems and national museum protocols (including a national software product, Specify 6.0). The project is intended to more closely coordinate the preparation of specimen information and specimen deposition in the museum repository. For example, when the botanist is preparing a label for a herbarium collection, the same data are simultaneously entered into the database of the Bell Museum thereby reducing data entry time and errors. The outcome will be improved data on plant distribution and phenology. Summaries and exchange of data and collections regionally and nationally that are critical to long-term vegetation monitoring and assessment of environmental changes will be more effective.

A MCBS plant ecologist is the project manager for a multi-divisional effort in the DNR to create a consolidated spatial data (GIS map) layer of native plant communities currently mapped on all DNR-managed lands using the same classification.

A pilot project using the image-processing tool eCognition was completed. Use of eCognition potentially could increase the speed of native plant community mapping that has been a time-consuming task of plant ecologists working especially in northern Minnesota. Test areas of native plant communities already mapped by plant ecologists in Cook and Aitkin counties were compared to results of mapping the same areas using a “trained” computerized mapping procedure utilizing eCognition and a number of related GIS layers. The outcome was that computer-generated native plant community maps seemed to be accurate enough to assist a plant ecologist in their interpretation of air photos before conducting field surveys in order to create a preliminary map of native plant communities. It also could assist in targeting areas to survey and provide validation of native plant community mapping after field surveys are completed. The expense of the software license and the eCognition training required to effectively operate the program are limitations. Future exploration of the potential to have a contractor or a DNR employee to provide this service is underway.

A new photographic image database is in progress for the Division to include imagery from MCBS. Staff contributed to some of the testing of the prototype and suggested further refinement of file transfer procedures.

As part of the Forest Certification process (all state of Minnesota forested lands are dual certified), DNR is responsible for identification of high conservation value forests (HCVF) and for monitoring of the elements that DNR considers as reasons for identifying those forests as containing high conservation value. MCBS Outstanding and High sites of biodiversity significance are being used to identify lands to satisfy these certification guidelines. In order to more quickly deliver information on these sites, MCBS GIS staff worked with MCBS ecologists and the Division of Forestry staff to develop a GIS “viewing tool” that presents data on those Outstanding and High sites on state land where data are currently available in the state. This tool has been successful and efforts to more widely apply this technology to display data on all MCBS sites on the web is in progress, requiring significant editing to the current site database, now in progress.

Preparation of collections

In collaboration with the Bell Museum of Natural History and the Science Museum of MN, progress continues on the curation of mammal, fishes and amphibian collections.

MCBS continues to provide staff one day per week to prepare museum specimens (mount pressed plants and labels on herbarium sheets) using standard herbarium procedures for collections contributed by MCBS for curation at the Bell Museum of Natural History.

The Bell Museum has acknowledged the following specimens received during this project period: Total= 5,031

June 1, 2010: 2205 specimens
June 15, 2011: 2826 specimens

Result 3: Guidance for Conservation and Management. Budget: $ 650,000

Description: MCBS will provide interpretation of results through products and technical assistance to guide private and public conservation and management of ecological systems, rare resources, and sites of biodiversity significance.

Summary Budget Information for Result 3: **Trust Fund Budget: $ 650,000**
Amount Spent: $ 485,986
Balance: $ 164,014

Deliverable	**Completion Date**	**Budget**	**Status (see below)**
MCBS data on website	Dec 2009 Shape files of sites and native plant communities on DNR's Data Deli for three counties. Oct 2010 Shape files of sites and native plant communities on DNR's Data Deli for three counties.	100,000	
Technical assistance, ecological evaluations, data interpretation	July 2009-June 2011 Updates with each status report.	200,000	
Publications, web products	June 2010 Vegetation plot data available on the web. Other updates with each status report July 2009-June 2011.	100,000	
Aspen Parkland-Red River Valley natural history/ guide book	Updates with each status report July 2009-June 2011. (Proposed publication 2013)	240,000	
Amphibians and reptiles native to Minnesota	Updates with each status report. (2^{nd} edition of book with revisions including new MCBS data. Publication proposed for 2012)	10,000	

Final Report Summary June 2011

MCBS data on website

Data related to the native plant communities and MCBS Sites of Biodiversity Significance for 15 counties were added as shape files (map files) to DNR's public geographic information system site, known as the Data Deli. Counties added were Becker, Carlton, Cottonwood, Dodge, Faribault, Freeborn, Lincoln, Lyon, Martin, Mower, Nobles, Pipestone, Steele, Waseca, and Watonwan. This exceeded the proposed completion target listed in the table above.

Technical assistance, ecological evaluations, data interpretation

Lake County Commissioners were provided examples of how MCBS data could be used in Lake County Land management: Examples of potential application of data: 1) Identification and prioritization of collaborative management projects (such as Manitou and Sand Lake Seven Beavers collaborative areas that each contains several MCBS Sites of Biodiversity Significance. 2) Use of maps of native plant communities and associated Ecological Classification System (ECS) tools in forest management (e.g. silvicultural interpretations by native plant community, and use of tree suitability tables). 3) Use of MCBS data to inform restoration and monitoring projects such as large patch management, hardwoods management, conifer restoration, Art Lake Ridges natural area project, invasive species monitoring. 4) Use of data to satisfy Forest Certification goals. Lake County lands within MCBS sites with Outstanding statewide biodiversity significance (~1,500 acres) could be considered as High Conservation Value Forests (HCVF) as related to Forest Stewardship Council (FSC) Certification standard -Principle #9. 5) Potential use in future modifications of the Lake County Forestry Department Working Management Plan (e.g., native plant community locations, wildlife management options for native plant community management, rare species guidance, etc.)

St Louis County Land Department received information on the potential applications of data (sites, rare species, vegetation plots, Ecological Evaluations) as related to management of their lands and to Sustainable Forest Initiatives (SFI) forest certification. Several meetings included discussions of the Sand Lake Seven Beavers Collaborative, "Special Sites" that are a category of land in the county and how MCBS data might be used. A subset of the MCBS site database (sites of biodiversity significance) was provided to the county to help inform them about some of the features in the sites that intersect the land managed by the county in these sites.

Becker County Board of Commissioners were given a presentation on survey results and provided a printed map of MCBS Sites of Biodiversity Significance to assist with their review of conservation and management goals on their county lands. A number of follow-up meetings related to site of biodiversity significance included assistance and ecological interpretations provided by MCBS staff.

Clearwater County Land Department were informed at a meeting how to interpret data provided in the Natural Heritage Database. This was followed by a letter to Clearwater County

detailing methods for how they might identify high conservation value forests in the county as related to forest certification that included potential examples.
Beltrami and Carlton Counties: As related to a five county cooperative Forest Certification audit, MCBS staff discussed ideas of how Carlton County might satisfy guidelines. In addition to state certification plant ecologists prepared preliminary materials for Beltrami County Natural Resource managers regarding potential HCVs on county managed land.

Hubbard County: MCBS ecologist worked with the Regional DNR ecologist to provide an update to the county's land management staff on how to use MCBS data.

White Iron Chain of Lakes Association (WICOLA) Kawishiwi Watershed Protection Project: MCBS information was shared with this association for joint Minnesota Pollution Control Agency, Lake County Soil and Water Conservation District regarding a project that encompasses a large portion of the Border Lakes subsection of Lake County. Since MCBS field surveys in the Border Lakes subsection over the next two field seasons include much of this area staff explained how data could be made available for project implementation.

Superior National Forest (SNF):
A presentation, *Results of 2009 MCBS Surveys on the Superior National Forest* was well-received at an annual review meeting related to the Superior National Forest (SNF) monitoring and research activities. This meeting included participation and presentations from researchers with active wilderness research permits.

MCBS information (site summaries, relevés reports, aquatic species lists for MCBS surveyed lakes, interpretation of native plant community data and existing condition, etc.) for several MCBS Sites were provided to the East Zone SNF biologist and hydrologist, to assist in their analysis of the *Windy* vegetation management project area on the Forest.

Staff interpreted data as related to proposed activities within the Superior National Forest's *Toohey*, *Twins*, and *Duncan Border Unit* (prescribed burn) vegetation management project areas. The northern coordinator conferred with biologists, foresters and fire management specialists to integrate MCBS data and interpretations, and provide technical assistance for project planning, resulting in some plan modifications.

A table of all plant species identified of interest to the Superior National Forest was delivered to the Forest botanist and updates on targeted plant searches were exchanged (such as species in the genera *Huperzia* and *Euphrasia).* New locations of USFS Region 9 Sensitive Plant Species recorded by MCBS botanists during the 2009 and 2010 field season were delivered. Assistance was also provided for projects related to non-native invasive worms on the Forest.

Staff provided comments on projects undergoing Regional environmental review (Superior National Forest scoping for BWCAW Non-native invasive species management Environmental Impact Statement, Lake County considerations for potential locations of communications towers, proposed trail bridge crossing related to a rare plant populations etc.)

Staff reviewed the SNF mountain bike trail proposed to cross state and federal lands, within the Onion River Hardwoods MCBS Site of Outstanding biodiversity significance.

The MCBS GIS specialist worked with staff ecologists to build a spatial query to deliver MCBS data for sites within the Lake Superior watershed that are located within the SNF.   Northern ecologists consulted with Forest biologists and foresters to provide interpretation of the resources found within the sites as part of a SNF Great Lakes Resource Initiative vegetation restoration project.

The **Chippewa National Forest** was provided a list of rare plants (including the Forest Service Region 9 sensitive species) located by MCBS botanists in 2009 in the Forest and in Beltrami County. They were also provided guidance related to phenology and habitat for a number of orchid species to assist in their surveys and monitoring [white adder's mouth *(Malaxis monophyllos),* bog adder's mouth *(M. paludosa),* small green wood orchid *(Platanthera clavellata),* and ram's head orchid *(Cypripedium arietinum)*].

Manitou Collaborative (NE MN): The MCBS northern coordinator continued to be the Division of Ecological and Water Resources representative on this collaborative. Recent contributions have been related to DNR Forest Certification and High Conservation Value Forest (HCVF), and discussions of the ecological significance of Art Lake Hardwood Ridges--an MCBS Site of Outstanding Biodiversity Significance. MCBS delivered and interpreted an Ecological Evaluation for Art Lake Hardwood Ridges Site and discussed possible conservation opportunities for this site. The collaborative proposed to extend monitoring in the Manitou Adaptive Forest Management (AFMP) patch project area and elsewhere in the Manitou collaborative area. The project includes vegetation and invasive species monitoring in control and treatment areas (funded by DNR AFMP program in 2011). MCBS staff worked with members of the collaborative and the UMN IonE Boreal Forest and Community Resilience Project to develop a proposal for a systems mapping workshop.

As part of the **Sand Lake Seven Beavers Collaborative (NE MN),** staff assisted the Scientific and Natural Area program with review and communications associated with request for access to SNF and The Nature Conservancy (TNC) harvest units along old winter road through Sand Lake Peatlands SNA that lies within the landscape. A plant ecologist provided a review, participated in an on-site visit, and helped prepare final prescriptions for stands proposed for treatment adjacent to Sand Lake Peatlands SNA that is within Sand Lake Seven Beavers Landscape.

North Shore Collaborative: The Forest Service has proposed a “north shore collaborative” that would involve a number of agencies and organizations. MCBS staff were contacted to participate and are willing to facilitate delivery of MCBS data should this group continue.

Subsection Forest Resource Management Planning: MCBS ecologists continue to assist with implementation of the state’s forest management plans including review of annual plan additions and participation in joint site visits as needed. Some examples: 1) staff participated in the annual DNR Cloquet Area coordination meeting between the divisions of Forestry, Wildlife, and Ecological and Water Resources where jack pine management on the Cloquet River was discussed. 2) Staff attended the State Forest Plan Annual Coordination meeting in Grand Marais and provided mapping guidance and field experience leading to creation of proposed treatments in the MCBS Swamp Lake Hardwoods site, which is also a High Conservation Value Forest. 3) The most current MCBS information for the Border Lakes Subsection was complied and delivered to the statewide SFRMP team as they prepare to update the northeast plan (four subsections combined). 4) Additional interpretation of MCBS data was provided for the North Shore Highlands and for the Nashwauk Uplands subsections that are also a part of a combined "four subsection" plan update.

Forest Certification: DNR Forestry and Wildlife forested lands are currently dual certified by the Forest Stewardship Council (FSC) and by the Sustainable Forest Initiatives (SFI). MCBS plant ecologists have provided substantial data interpretation over the past two years as related to the DNR's forest certification goals and Corrective Action Requests (CARs). The 2009 FSC/SFI Surveillance Audits included participation of selected staff in the audits within the Lake City Forestry Area (Whitewater WMA) and Little Falls Forestry Area (Mille Lacs WMA). A plant ecologist participated in a four-person interdisciplinary team that conducted two internal forest certification audits during this time in the Baudette Forestry Area and the Orr Forestry Area. The group prepared a report on what was learned from the internal auditing.

DNR is responsible for identification of high conservation value forests (HCVF) and for monitoring of the elements that DNR considers as reasons for identifying those forests as containing high conservation value. MCBS Outstanding and High sites of biodiversity significance are being used to identify lands to satisfy these certification guidelines. MCBS staff contributed to the development of a High Conservation Value Forests (HCVF) delivery tool now used in selected portions of the state by DNR land managers to streamline access to relevant MCBS data. This was featured at a training sessions at several regional workshops for managers responsible for implementing the plan to include management of HCVFs. MCBS also participated in the presentations and field visits with auditors as part of the 2010 October surveillance audits.

The outcome of the 2010 audit included Corrective Action Requests (CARs) that the DNR plans to address in part through the application of data collected by MCBS. MCBS sites of biodiversity significance provided a first source of data to enable the DNR to identify potential HCVFs in parts of the state where MCBS data are available. In 2011 staff began development of monitoring approaches to evaluate how to measure that HCVs are maintained or enhanced where identified. The forthcoming work plan being developed will inform Minnesota DNR's response to this CAR.

Heart of the Continent Partnership (HOCP): Staff participated in several meetings of HOCP. Approximate 50 people from the US and adjacent Canada participated in the most recent meeting, including key staff from public land agencies, conservation organizations, citizens groups, corporate land owners, universities, regional economic development agencies and local government representatives from around the HOC region. The meeting centered on a "systems mapping" workshop led by the UMN (Institute on the Environment) Boreal Forest and Community Resilience Project designed to engage public land managers and the private sector in addressing the issues associated with achieving economic and ecological sustainability in the HOC region. Information on MCBS Border Lakes surveys is included in their *Current Projects* and *Database of Research in the Region* located on the HOCP science committee pages on the HOCP website http://www.heartofthecontinent.org/science-committee

Quetico Provincial Park: Quetico Provincial Park recently decided to use the MN DNR's releve vegetation plot methodology for documenting native plant communities in the park. The northern coordinator worked with the Park biologist and MCBS data management staff to develop an agreement and process that enables Quetico to store relevé data.

Other technical assistance and data delivery

In the northeast DNR Region, staff met with the Division of Lands and Minerals (LAM) project coordinator, the statewide EWR Environmental Review coordinator and the Regional SNA specialist, to improve application of MCBS data to inform the LAM environmental review and internal coordination process with respect to mineral leases. Staff provided information on survey procedures and description of MCBS sites, biodiversity significance ranking guidelines, ecological evaluations, and how these could be considered in relationship to leases and mine development.

Plant ecologists provided land management recommendations to Potlatch for lands in high quality landscapes of the Nashwauk Uplands Subsection. Potlatch also receives annual **s**ummaries of MCBS field survey results as part of an agreement to conduct surveys on Potlatch lands. A letter of permission to conduct surveys on Potlatch lands for 2010 and 2011 and surveys results were exchanged.

Recent results of MCBS work in northern Minnesota were sent to Voyageurs National Park.

Plant ecologists coordinated with Grand Portage Monument (National Park Service) and NRCS staff to provide advice on rare species surveys needed for a Grand Portage Band project along Grand Portage Creek on the Grand Portage Reservation.

A plant ecologist provided ecological information in and around Hamden Slough National Wildlife Refuge to use in their update of a management plan.

In response to a request from the DNR Northwest Region, staff reviewed and created potential guidelines for management in areas where impacts could influence viability of ram's head orchid *(Cypripedium arietinum)* populations.

Staff contributed ideas related to an oak management project in a new DNR Wildlife Management Area in Crow Wing County that intersects an MCBS site of moderate biodiversity significance.

Information was provided to DNR's Nongame Wildlife staff related to the ecological quality of a portion of the Cloquet River that is highlighted in a recent MCBS ecological evaluation. This will be used in conservation planning along the St. Louis and/or Cloquet Rivers.

The Heron Lake Watershed District was provided spatial data (GIS files) of existing native prairie found within the district to include in an update of their watershed plan.

In southern Minnesota results from recently completed surveys on the Prairie Coteau and other southern counties was presented to the DNR southern region's Division of Ecological and Water Resources staff.

A prairie plant ecologist participated in a landowner workshop in Chandler MN to describe the significance of the Chanarambie Creek Prairies.

MCBS made a presentation and helped to lead field trips at Morton Outcrops SNA at a June 2010 meeting of the Commissioner's Advisory Committee and others in the Minnesota River corridor-including members of the Green Corridor project. A MCBS plant ecologist has been providing assistance to the Green Corridor project to identify priority sites for conservation action.

A plant ecologist participated in two of the annual Iron Range Earthfest events that included presentations on MCBS, the *Rare and common plants of the Iron Range Area* and an exhibit booth for the Division of Ecological and Water Resources.

Staff participated in the western Minnesota prairie/grassland/wetland planning process led by TNC that included other agency/organization staff with a particular interest and knowledge of prairie. MCBS data on the locations of native prairie were a centerpiece of the plan that was completed in June 2011entitiled, *Minnesota prairie conservation plan 2010: a habitat plan for native prairie, grassland, and wetlands in the Prairie Region of western Minnesota*. See also the MCBS map: Minnesota's Remaining Native Prairie 100 Years After the Public Land Survey.

Environment review issues frequently involve consultation with MCBS staff with specific knowledge of a particular area or resource. Recent mining projects adjacent to a number of calcareous fens and native prairies have involved several staff.

A botanist made a presentation in 2011 that provided a perspective on plants at a symposium on phenology at Wolf Ridge Environmental Learning Center (NE MN).

Staff made presentations and prepared posters related to rare aquatic plants as part of the Minnesota Native Plant Society Symposium in March 2011, *Minnesota's Lake Vegetation: Above and Below the Water Line.* Booklets generated from the web-based Rare Species Guide (see below) highlighting rare aquatic plant species were a popular item distributed at the symposium held at the Bell Museum of Natural History, a co-sponsor of the event.
The Montrose area DNR Fisheries Supervisor was sent photos and other information about the rare aquatic plants for his presentation at a conference about the Avon Hills Area--included were humped bladderwort *(Utricularia gibba),* and the olivaceous Guadalupe Island naiad *(Najas guadalupensis* ssp. *olivacea).*

Information related to rare aquatic plants was included in DNR's sensitive shoreland reports. For example: "A targeted search for rare aquatic [vascular] plants was conducted [by the Minnesota County Biological Survey] on July 7, 2008 (Myhre 2008). This survey focused on an undeveloped shoreline [or other area of the lake] that was most likely to contain rare species. A [brief] habitat description and a list of all plant taxa found in this area were recorded. Voucher specimens were made to document new locations of rare species and some common species.

Data for rare species were entered into the Rare Features Database of the MN DNR Natural Heritage Information System."

The aquatic plant botanist responded to a request for information about leafless water milfoil (*Myriophyllum tenellum)* for a consultant who was writing a stewardship plan for a private landowner in Kanabec County. They were provided information about the plant, why it is tracked and management ideas for the plant.

Ecological Evaluations provide detailed summaries of the resources found within selected sites of biodiversity significance (some examples follow).

An ecological evaluation for Rushford Bluffs in Fillmore County was updated for presentation to the Commissioner's Advisory Committee (CAC) in early October, 2010. The presentation to CAC was in response to the availability for purchase of a very significant portion of the site that contains barrens oak savanna and prairie supporting a number of rare plants including the only Minnesota location of a species of grass, *Agrostis hyemalis.*

An ecological evaluation for Horseshoe Bay Shore, located on the North Shore of Lake Superior was prepared and presented by a MCBS ecologist and approved at a CAC meeting.

An ecological evaluation was prepared for Fault Line Ridges, an area of about 6,200 acres located between Beaver Bay and Split Rock Lighthouse State Park in Lake County. Most of this area is a MCBS site of Outstanding Biodiversity Significance and the remainder a High Biodiversity Significance site. This was presented as a potential conservation area along with another site (Art Lake Ridges) to CAC in June 2010 and both were approved for SNA to pursue protection in the area.

An ecological evaluation was prepared for a proposed addition to an SNA in Clearwater County (Itasca 27).

An evaluation for a proposed Aquatic Management Area at Balm Lake in Beltrami County was submitted to the current landowner, the Area Fisheries Supervisor and regional DNR staff. The proposed AMA would consist of ~300 acres of upland mesic forest along an undeveloped portion of shoreline.

Information related to the Mission Creek site near Duluth was added to the larger Magney-Snively ecological evaluation at the request of the northeast DNR Region for discussion about conservation options for the entire area.

A MCBS plant ecologist prepared an ecological evaluation for the La Salle Creek and Chain of Lakes corridor in Hubbard County as part of a conservation effort for protection of a landscape level area of 3,200 acres that includes a potential acquisition of 1,200 acres surrounding the largely undeveloped La Salle Lake. A portion of this site was presented to the Commissioner's Advisory Committee (CAC) and was approved for continued consideration as a potential Scientific and Natural Area.

An ecological evaluation was prepared for Pike Mountain in northeastern Minnesota, which is proposed as a natural area registry site.

Other activities

Some staff attended the joint conference of the Minnesota chapters of the Society for Conservation Biology, The Wildlife Society, American Fisheries Society, and Society of American Foresters where a periodic review of recent scientific literature relevant to MCBS surveys in northeast Minnesota was distributed. In addition, a planning meeting for multi-agency/organizational prairie monitoring took place.

Staff provided technical consultation for wetland issues ranging from assisting in the evaluation of calcareous fens, providing ideas related to the Rapid Floristic Quality Assessment for wetlands, and attending meeting on aquatic plant issues.

A northwestern botanist collected and prepared 35 leaf samples of rose pogonia (*Pogonia ophioglossoides*) as a representative population from “extreme northwestern MN” for a spatial genetics research project conducted by Jyotsna Sharma of Texas Tech University.

A presentation – *Life on the Edge* (biodiversity at the edge of the boreal biome) was made by MCBS as part of a week-long field course sponsored by Forests of the Far North--the Appalachian Forest School (Forests of the Far North course), Vermilion Community College (Nature of the North Woods series), and the Ely Field Naturalists.
http://www.highlandssanctuary.org/WE/Minnesota/MN.htm

A presentation and field trip was conducted by a MCBS ecologist for the Brainerd chapter of the “Wild Ones”, to provide information on the native plant community classification. The field trip involved classifying a jack pine forest near the Brainerd Arboretum and discussing the challenges facing Jack Pine in central Minnesota.

MCBS biologists were on the steering committee to plan the 2011 Bioblitz event at Lake Vermillion and Soudan Underground Mine State Parks and were leaders of several of the biological surveys conducted in June 2011.

Staff familiar with rare aquatic resources provided data and attended a meeting to identify conservation quality lakes in Brainerd in the spring of 2011.

A number of field trips were led by staff in the Aspen Parklands, the Minnesota River Valley, Renville County, and Jackson County.

A plant ecologist made a presentation introducing students to MCBS as part of a University of Minnesota Duluth Biology Department seminar series. This included historical context, current status, recent accomplishments, and examples of applications of results. A plant ecologist made another presentation on MCBS in Beltrami County at Bemidji State University.

Publications, web products

A total of 62 plant species profiles were completed largely by MCBS botanists/plant ecologists during this project period so that the DNR's Rare Species Guide is up to date for all of the state's 439 listed species and available on DNR's website: www.mndnr.gov/rsg. The guide was featured on the DNR website's front page in late winter 2011. This rare species website provides easy access to information about all of the 439 endangered, threatened and special concern plant and animal species in the state. It synthesizes knowledge from years of research and management experience by biologists, managers and researchers and is the state's authoritative reference on state-listed species. It is written for a broad audience so it is valuable for natural resource professionals preparing conservation and management plans, and environmental review documents. Citizens, educators and students are also finding this site useful as a reliable reference for improved understanding of these resources.

Updates and improvements were made to the MCBS webpage displaying Bird Distribution Maps for the Minnesota locations of 242 breeding birds based on observations by MCBS throughout the state.

The Native Plant Community Classification page was redesigned providing easier navigation and a link to the NPC classification methods description that provides background on how data were analyzed and interpreted utilizing vegetation plot data (relevés) to derive the DNR's current native plant community classification.

A web page pertaining to the spread of White Nose Syndrome in bats was developed.

Updates including links to other web locations were completed related to the list of Minnesota's vascular plants MNTaxa: The State of Minnesota's Vascular Plant Checklist.

Aspen Parkland-Red River Valley natural history/guide book
A contract with the University of Minnesota Press was finalized, along with various administrative agreements needed due to State procedures. The project manager and selected staff ecologists and biologists created a detailed book outline and publication schedule and are currently writing two major portions of the book: native plant community descriptions and the historical accounts. Software specifically selected to organize maps, graphics and photos has helped the project manager to effectively consolidate MCBS data and historical data collected from the region.

Amphibians and reptiles native to Minnesota
As part of the project to update the book, *Amphibians and Reptiles Native to Minnesota*, the distribution maps are now available on the DNR website, Minnesota's amphibian and reptile distribution maps**.** Species accounts for six salamander, three toad and eleven frog species are being revised and new accounts are being prepared for three species of salamanders.

Orchids of Minnesota
New graphics, updated distribution maps, new photos of 35 orchid species and illustrations were completed as part of a new DNR book on Minnesota's orchids that will be published next year,

providing an update to the presently out- of- print but very popular book, *Orchids of Minnesota.* Botanists and plant ecologists finalized the verification of identification of their most recent field updates on the state's orchids for inclusion in the new book that is in the final publication stages of review.

Updates were added for MCBS-related projects on the DNR's website:
News from the Field 2010 , *News from the Field 2011*
Minnesota's Remaining Native Prairie 100 Years After the Public Land Survey

In association with the La Salle Lake project, a MCBS ecologist prepared a presentation and brochure for use at a tour of the area that included various regional DNR staff, Trust for Public Land, and the owner of La Salle Lake. The brochure was also used in a legislative bonding tour of the same area.

Three staff participated in a radio interview and field visits in northern Minnesota on August 5 with reporter, Stephanie Hemphill that were aired on Minnesota Public Radio and featured on MPR's related web page. "On the hunt for rare species".
http://minnesota.publicradio.org/display/web/2009/08/10/rare-species/).

An April 2011 MPR presentation featured spring frog calls with commentary by a MCBS herpetologist in a short piece, "The sounds of spring at Carlos Avery".

The MCBS website now includes an update related to the new 2009 MCBS location of weak Arctic sedge *(Carex supina).* This population represents the only U.S. extant population outside of Alaska. For a description of this discovery see:
http://www.dnr.state.mn.us/wildflowers/weak_arctic_sedge.html

Author/botanist, Welby Smith has been the featured speaker at over 10 well-attended seminars and meetings that were an outcome of the recent DNR publication (2008) *Trees and Shrubs of Minnesota.*

A Native Prairie Bank site in Lac Qui Parle County was featured in a recently distributed 2009 DNR Compact Disk entitled *Prairie treasure--A native prairie bank story*. MCBS staff provided some of the content and reviewed the product that features a site surveyed by MCBS in the 1980's.

A manuscript entitled *Recent rediscovery of rare plants in temporary pools on Sioux Quartzite outcrops* was published in the proceedings of the 22nd North American Prairie conference that was held in Cedar Falls, Iowa in 2010.

V. TOTAL TRUST FUND PROJECT BUDGET:
Personnel: $1,950,000= FTE's: 8.5 ecologists, 3 botanists, 2 data managers, 1 information officer
There are four classified positions that are working all of part of the time on this project (3FTE); 11.5 unclassified staff. (11.5 FTE with professional technical contracts used for a portion of the

salary of one ecologist and .5 information manager due to state hiring restrictions-see attachment A).

Field equipment, including data recorders	$30,000
Travel and Fleet	$100,000
Field supplies	$20,000

Use of classified staff: Robert Dana (.5 FTE ecologist) and Nancy Sather (1.0 FTE plant ecologist) are the two primary authors of the Aspen Parkland-Red River Valley natural history/ guide book that is specifically identified in Result #3. This book is an opportunity to publish and permanently archive knowledge and perspectives gained especially by these individuals due to decades of their field experience and investigation in the prairie and parkland region.

Robert's past funding has come from numerous sources. During FY10, he will continue to work on MCBS animal survey projects with temporary funding (Federal) provided by the State Wildlife Grants (as prioritized by the State Wildlife Action plan). The Landowner Incentive Program (LIP), a Federal Program proposed for discontinuation in December 2009, will provide a portion of his salary in early FY10 that enables him to complete a report for his recently completed LIP projects. Robert's expertise related to native prairie and insects will be utilized in Result 3 of the work program as related to management, conservation planning, local assistance and training. In terms of backfilling his position, other Divisional staff including regional staff primarily in the Scientific and Natural Area program, are performing some of the responsibilities once assigned to Robert.

Nancy Sather has been funded in the past by numerous state and federal sources as related to her work both with rare species and native plant communities. Recently much of her work on MCBS was funded by other sources that are no longer are available.

Jared Cruz (.5FTE), a GIS specialist, will manage the shape files developed by the project. He will be responsible for adding to and maintaining the polygons of native plant communities (now numbering over 45,000) and the MCBS sites of biodiversity significance, so that polygons are accessible to customers using DNR's "Data Deli." Interpretative products of data for project outcomes presented on the web, in publications and on maps frequently require GIS personnel. Since this .5FTE of work is specific to MCBS, there is no one else needed to backfill to accomplish other Divisional tasks.

Welby Smith (1.0 FTE) is currently assigned to plant collection in the northern regions identified in the project. The size and inaccessibility of the project area make the addition of this highly experienced botanist desirable. Welby's botanical expertise related to verification of collections, comments on issues such as forest management, conservation planning, local assistance and botanical training are utilized as part of Result 3 of this work program. Some of Welby's previous responsibilities have been assigned to others (the coordination of the state list of rare vascular plants for example), or included projects that have been completed or eliminated from Divisional priorities. As one example of a completed product, Welby authored the *Trees and shrubs of Minnesota* published in 2008.

Field equipment for work in remote areas (such as tents, tarps, packs, stoves, data recorders, tree corers, GPS units, plant specimen driers)

Travel and Fleet includes field season use of state vehicles ("summer loaners"), lodging and related expenses when not camping, and food while in travel status.

Field supplies include items such as plant presses, batteries, air photos, maps, water resistant note books.

TOTAL TRUST FUND PROJECT BUDGET: $2,100,000

Explanation of Capital Expenditures Greater Than $3,500 None

VI. PROJECT STRATEGY:

A. Project Partners: The University of Minnesota Bell Museum of Natural History and the Science Museum of Minnesota provide resources for the curation of specimens collected by MCBS. Surveys of Red Lake Reservation lands will be conducted pending approval by the Red Lake Tribal Council. This request does not include funding for these partners.

B. Project Impact and Long-term Strategy: The need to protect and manage functional ecological systems, including ecological processes and component organisms, continues to accelerate with increased demands for water and energy, continued habitat fragmentation, loss of species and genetic diversity, exotic species expansion, and climate change. Baseline data on the distribution and ecology of Minnesota's plants and animals, native plant communities, and functional landscapes are needed to prioritize actions to conserve and manage ecological systems and critical components of biological diversity. MCBS systematically collects, interprets, and delivers these baseline data to private and public users to help guide decision-making. MCBS prioritizes sites of biodiversity significance for conservation and as potential sites for monitoring of critical habitat and ecological functions. MCBS provides educational products and assists with training, planning, and environmental review. Funding will be requested from the Minnesota Legislature and other sources such as the State Wildlife Grants for an ongoing Minnesota Biological Survey that will extend beyond the completion of the first statewide assessment, proposed for completion in 2021.

Proposed future strategies for continuation of a Minnesota Biological Survey

1) Increase technical assistance from survey staff to interpret data (publications, web-products) and to train and deliver quality information to counties, municipalities, and managers making decisions that impact the state's ecological systems and rare resources.
2) Data Gaps: Survey areas where weather conditions, life-history cycles, lack of experts, etc. during the first survey left data gaps, and add areas once perceived as lower priority but threatened due to new issues (exotic species, climate change, disease, habitat fragmentation, demands for energy and genetic variability).
3) Aquatics: Expand upon MCBS aquatic surveys and integrate complementary surveys to identify outstanding aquatic landscapes and sites (lakeshed, watershed, etc.).

4) Establish long-term monitoring of ecological conditions in priority sites of outstanding and high biodiversity significance and other representative ecological systems (watersheds, ecological land type associations). Track the distribution of plants and animals, with more detailed monitoring of selected species. Monitoring also will be required for specific resource management issues (examples: prairie grazing, recreational impacts, groundwater/calcareous fens, forest certification, climate change).
5) Continue collaboration with other resource agencies and with universities, colleges, and museums that provide results of new research, innovative tools and new concepts, collection repositories, and educational opportunities for the public.
6) Continue information system development to enter, archive, manage, and deliver data and information.

C. Other Funds Proposed to be Spent during the Project Period:
All funds are pending:

Heritage Enhancement:	**$1,159,000**
General Fund	**$ 700,000**
State Wildlife Action grant	**$ 500,000 (federal-funds most of the animal surveys)**

D. Spending History: 2 –year time frame prior to July 1, 2009= $3,579,400 includes $1,500,000 Trust Fund. **Legal Citation:** ML 2007, Chap.30, Sec2, Subd. 6a.

VII. DISSEMINATION:

MCBS data are stored primarily in the Division of Ecological Resources information systems. In addition, MCBS procedures, updates, recent maps and links to related data are presented on the DNR website. Many GIS datasets are delivered to clients through the web and though agreements with the requesting agency and the DNR. For data on locations or rare features, a data request form is available via the web: http://www.dnr.state.mn.us/eco/nhnrp/nhis.html

MCBS invests considerable time in publishing and distributing survey results in a variety of formats for various audiences. The DNR and Legislative libraries and other local information repositories (such as libraries within counties) are sent published products, including books, maps, reports, field guides and digital media. Many products are available on the DNR website, including GIS shape files of native plant communities and MCBS sites, native plant community field guides, and guides to sampling techniques such as vegetation plot data collection using the relevé method. MCBS web pages are updated with new information and have links to associated resources. http://www.dnr.state.mn.us/eco/mcbs/index.html

As MCBS nears completion, the publication of natural history books based on MCBS data is consistent with user's demands. The second edition of *Amphibians and reptiles native to Minnesota* will include updated distribution data from MCBS. For example, the four-toed salamander first documented in the state in 1994 has been recorded by MCBS at 50 additional locations since that time. A new book will feature the Aspen Parkland landscape of northwestern Minnesota along with the northwestern prairie region and Red River valley. Based on local collaborator interest, this book will include a guide to selected natural areas of the region. Focus groups held in the northwestern region expressed strong interest in a book describing the natural history of the region and publication by a Minnesota publisher is planned.

Staff routinely make presentations that describe MCBS methodologies and results to a wide range of audiences including county boards, local planning groups, citizen advisory groups, other biologists, land managers and students. MCBS staff provide local planners with ecological interpretations describing important sites of biodiversity identified during the Survey to assist with management plans. Staff lead or participate in technical workshops and field trips to exchange ideas on survey methodology and provide training in the application and interpretation of the data.

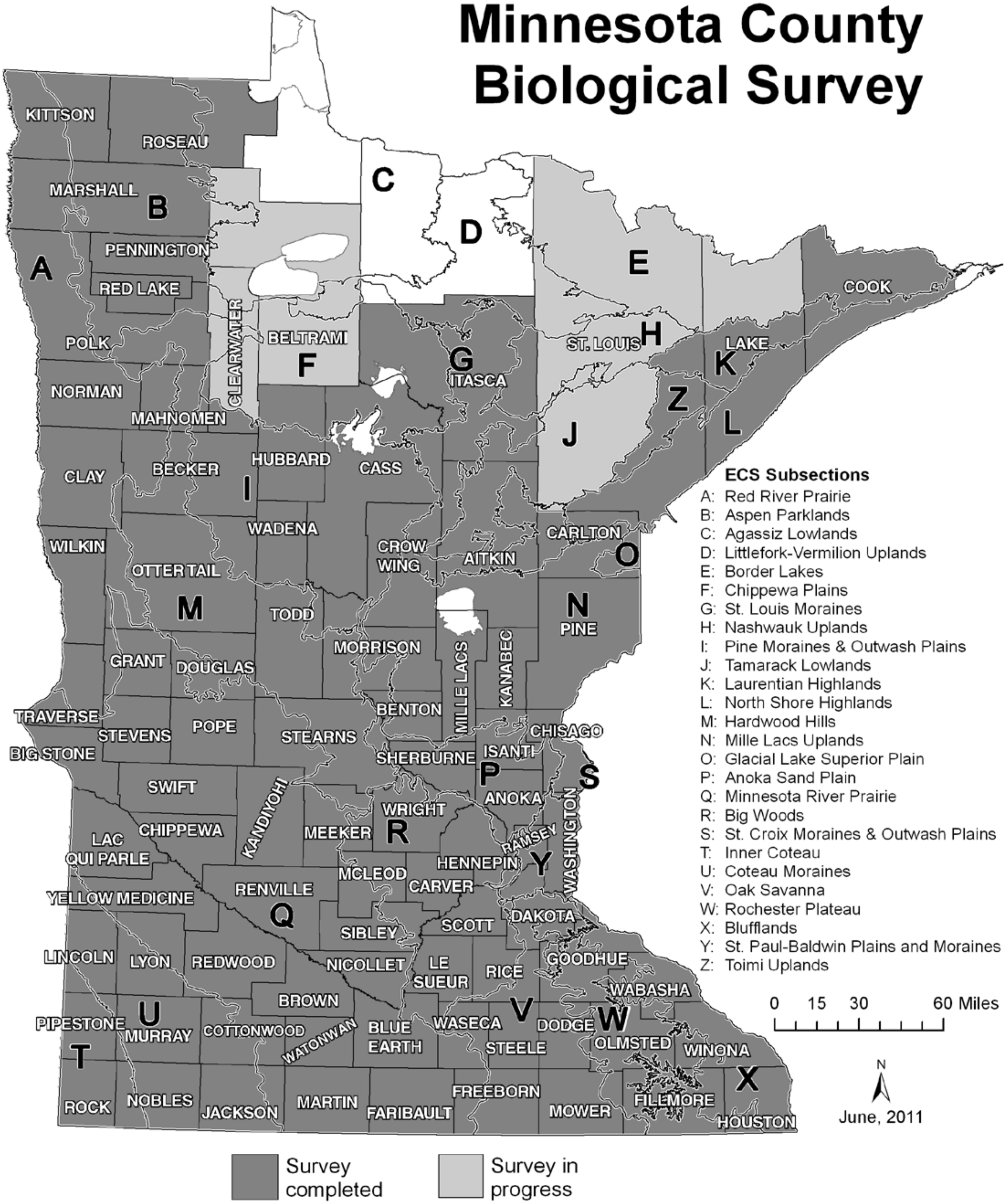
Physical collections are deposited at Minnesota repositories, primarily at the University of Minnesota's J.F. Bell Museum of Natural History and the Science Museum of Minnesota, St. Paul. As part of a larger network of museums and herbaria, these cooperators are essential to the documentation and sharing of MCBS results. MCBS and museum staff meet periodically to address curatorial, data management, and interpretive needs.

MCBS also delivers data through an international organization, NatureServe and also shares data with cooperators at colleges and universities and with others in ecological regions where surveys are ongoing or completed.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than January 2010, October 2010, and March 2011. A final workprogram report and associated products will be submitted between June 30 and August 1, 2011 as requested by LCCMR.

IX. RESEARCH PROPOSALS: N/A

Minnesota County Biological Survey



Attachment A: Budget Detail for 2009 Projects

Proposal Title: *Minnesota County Biological Survey*

Project Manager Name: Carmen Converse

Trust Fund Appropriation: $ *2,100,000*

2009 Trust Fund Budget	**Result 1 Budget:$750,000**	**Amount Spent**	**Balance**	**Result 2 Budget: $700,000**	**Amount Spent**	**Balance**	**Result 3 Budget: $650,000**	**Amount Spent**	**Balance**	**TOTAL FOR BUDGET ITEM**	**Amount Spent**
	Field Surveys			*Information System Expansion*			*Guidance Conservation Management*				
BUDGET ITEM											
PERSONNEL: Wages and benefits											
Botanist (Karen Myhre)	**50,000**	**37,492**	**12,508**	**60,000**	**64,242**	**-4,242**	**26,000**	**34,083**	**-8,083**	**136,000**	**135,817**
Botanist (Lynden Gerdes)	**60,000**	**66,196**	**-6,196**	**50,000**	**55,057**	**-5,057**	**26,000**	**11,286**	**14,714**	**136,000**	**132,539**
Botanist (Welby Smith)*	**70,000**	**58,212**	**11,788**	**40,000**	**11,658**	**28,342**	**56,000**	**71,947**	**-15,947**	**166,000**	**141,817**
Information Officer (Tom Klein)							**136,000**	**137,828**	**-1,828**	**136,000**	**137,828**
Information manager (Sharron Nelson)				**136,000**	**141,662**	**-5,662**				**136,000**	**141,662**
GIS (.5FTE Jared Cruz)* .5 FTE vacant				**124,000**	**109,390**	**14,610**				**124,000**	**109,390**
Plant ecologist (Chel Anderson)	**64,000**	**83,106**	**-19,106**	**40,000**	**48,273**	**-8,273**	**60,000**	**31,441**	**28,559**	**164,000**	**162,820**
Plant ecologist (Vacant)/or contracts	**50,000**	**89,216**	**-39,216**	**30,000**	**23,445**	**6,555**	**24,000**	**6,294**	**17,706**	**104,000**	**118,955**
Plant ecologist (Ethan Perry)	**60,000**	**38,162**	**21,838**	**40,000**	**59,527**	**-19,527**	**36,000**	**40,458**	**-4,458**	**136,000**	**138,147**
Plant ecologist (Erika Rowe)	**60,000**	**56,789**	**3,211**	**30,000**	**35,969**	**-5,969**	**30,000**	**27,668**	**2,332**	**120,000**	**120,426**
Plant ecologist (Jason Johnson)	**60,000**	**66,704**	**-6,704**	**40,000**	**33,063**	**6,937**	**20,000**	**19,486**	**514**	**120,000**	**119,253**
Plant ecologist (Rebecca Holmstrom)	**50,000**	**49,679**	**321**	**40,000**	**45,472**	**-5,472**	**30,000**	**18,156**	**11,844**	**120,000**	**113,307**
Plant ecologist (Stacey Olszneski)	**40,000**	**23,312**	**16,688**	**40,000**	**48,592**	**-8,592**	**20,000**	**8,191**	**11,809**	**100,000**	**80,095**
Plant ecologist (Nancy Sather)*	**26,000**	**13,786**	**12,214**	**30,000**	**66,063**	**-36,063**	**110,000**	**38,423**	**71,577**	**166,000**	**118,272**
Ecologist (.5 FTE Robert Dana)*	**10,000**	**26,104**	**-16,104**		**23,938**	**-23,938**	**76,000**	**40,725**	**35,275**	**86,000**	**90,767**
SALARIES	**600,000**	**608,758**	**-8,758**	**700,000**	**766,351**	**-66,351**	**650,000**	**485,986**	**164,014**	**1,950,000**	**1,861,095**
Field equipment (includes data recorders)*	**30,000**	**32,629**	**-2,629**							**30,000**	**32,629**
Travel expenses in Minnesota*	**100,000**	**163,290**	**-63,290**							**100,000**	**163,290**
field supplies*	**20,000**	**12,662**	**7,338**							**20,000**	**12,662**
COLUMN TOTAL	**750,000**	**817,339**	**-67,339**	**700,000**	**766,351**	**-66,351**	**650,000**	**485,986**	**164,014**	**2,100,000**	**2,069,676**

Result 1 :Travel expenses exceeded proposed due to use of helicopters in the patterned peatlands as the most cost-effective access. This reduced staff expenses and increased travel especially in this part of the state. In addition, the impending shutdown of state government required unanticipated transport of field vehicles from distant areas to secure DNR offices in June 2011. Results 2 and 3: More staff time was recorded for Result #2 largely due to the data management time required to prepare for the publications outlined in Result #3, including lead staff for the book publications. All expenditures are derived from DNR coding used in timesheet and expenditure records. A new accounting system introduced in late spring 2010 for use in FY2012 that included FY2011 reporting complicated generation and compilation of reports.

2009 Project Abstract
For the Period Ending June 30, 2012

PROJECT TITLE: County Geologic Atlas Acceleration
PROJECT MANAGER: Dale R. Setterholm
AFFILIATION: Minnesota Geological Survey, University of Minnesota
MAILING ADDRESS: MGS, 2642 University Ave, St. Paul, MN 55114-1057
Regents, 450 McNamara Center, 200 Oak Street SE, Minneapolis, MN 55455
PHONE: 612-627-4780
E-MAIL: sette001@umn.edu
WEBSITE: http://www.geo.umn.edu/mgs/
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chap.143, Sec.2, Subd.3(b)

APPROPRIATION AMOUNT: $820,000

Overall Project Outcome and Results

County geologic atlases support water and mineral resource management and education. An atlas provides maps and databases at scales appropriate for land use planning and water management decisions. An atlas greatly improves our ability to monitor the resource, to predict the effects of pumping, and to respond effectively to contamination. This project created atlases for Anoka and Wright counties in paper, digital, and web-accessible formats. Copies will be provided to LCCMR and the counties, and workshops will be held to train users.

Geologic maps describe the distribution of earth materials that determine where water can enter the ground (become ground water), where it can be taken from the ground (aquifers), and how aquifers connect to rivers, lakes, and wetlands. Each geologic atlas contains these parts-

Database map: shows the location of all well records, borings, scientific drilling, natural exposures, and geophysical measurements used to support the atlas. The databases are also provided.

Surficial Geology map: shows the earth materials immediately beneath the soil zone, and describes their composition and ability to convey water. The surface described by this map is the interface between human activities and ground water. Its character determines to a great degree the sensitivity of ground water to contamination.

Glacial Stratigraphy and Sand Distribution Model: A series of maps show the location, depth, and thickness of sand or gravel bodies (aquifers) in glacial materials. This map is useful in finding a water source, determining pumping effects, and in understanding the results of water monitoring.

Bedrock Geology map, bedrock topography map: These maps describe the location and type of bedrock present, and its ability to host and transmit groundwater. The contacts between layers of sedimentary rock are mapped as digital surfaces and this enables numerical simulations of the ground water system that can predict the effects of pumping before wells are drilled.

Project Results Use and Dissemination

Geologic atlases support informed decision-making. They are applied to wellhead protection, water appropriation decisions, well field design, onsite water treatment design, facility siting, monitoring, and remediation of contamination. The atlases are printed, and also provided in several digital formats for electronic use including geographic information systems. When the atlases are complete we hold workshops in the county to explain the products and their uses.

Environment and Natural Resources Trust Fund
2009 Work Program Final Report

Date of Report: 9/18/12
Final Report

Date of Work program Approval: June 16, 2009
Project Completion Date: June 30, 2012

I. PROJECT TITLE: County Geologic Atlas Acceleration

Project Manager: Dale Setterholm
Affiliation: Regents of the University of Minnesota; Dept: Minnesota Geological Survey
Mailing Address: Regents: 450 McNamara Center
200 Oak Street SE
City / State / Zip : Minneapolis MN 55455
Geological Survey: 2642 University Ave. W.
City / State / Zip : St. Paul MN 55114

Telephone Number: 612-627-4780
E-mail Address: sette001@umn.edu
FAX Number: 612-627-4778
Web Page address: http://www.geo.umn.edu/mgs/

Location: Anoka and Wright Counties

	M.L. 2009
Total Trust Fund Project Budget:	**$2,695,000**
DNR Total	*$1,875,000*
MGS Total	*$820,000*
MGS Trust Fund Appropriation	**$820,000**
Minus Amount Spent:	**$820,000**
MGS Equal Balance:	**$0**

Legal Citation: ML 2009, Chap.143, Sec.2, Subd.3(b)
Appropriation Language: $2,695,000 is from the trust fund for collection and interpretation of subsurface geological information and acceleration of the county geologic atlas program. $820,000 of this appropriation is to the Board of Regents of the University of Minnesota for the geological survey to continue and to initiate the production of county geologic atlases. $1,875,000 of this appropriation is to the commissioner of natural resources to investigate the physical and recharge characteristics of the Mt. Simon aquifer. This appropriation represents a continuing effort to complete the county geologic atlases throughout the state. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. and III. FINAL PROJECT SUMMARY:

County geologic atlases support water and mineral resource management and education. An atlas provides maps and databases at scales appropriate for land use planning and water management decisions. An atlas greatly improves our ability to monitor the resource, to predict the effects of pumping, and to respond effectively to contamination. This project created atlases for Anoka and Wright counties in paper, digital, and web-accessible formats. Copies will be provided to LCCMR and the counties, and workshops will be held to train users.

Geologic maps describe the distribution of earth materials that determine where water can enter the ground (become ground water), where it can be taken from the ground (aquifers), and how aquifers connect to rivers, lakes, and wetlands. Each geologic atlas contains these parts-

Database map: shows the location of all well records, borings, scientific drilling, natural exposures, and geophysical measurements used to support the atlas. The databases are also provided.

Surficial Geology map: shows the earth materials immediately beneath the soil zone, and describes their composition and ability to convey water. The surface described by this map is the interface between human activities and ground water. Its character determines to a great degree the sensitivity of ground water to contamination.

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Bedrock Geology map, bedrock topography map: These maps describe the location and type of bedrock present, and its ability to host and transmit groundwater. The contacts between layers of sedimentary rock are mapped as digital surfaces and this enables numerical simulations of the ground water system that can predict the effects of pumping before wells are drilled.

Project Results Use and Dissemination

Geologic atlases support informed decision-making. They are applied to wellhead protection, water appropriation decisions, well field design, onsite water treatment design, facility siting, monitoring, and remediation of contamination. The atlases are printed, and also provided in several digital formats for electronic use including geographic information systems. When the atlases are complete we hold workshops in the county to explain the products and their uses.

Amendment Request (9/6/2012): Amendment approved by LCCMR 9/18/12

An amendment is requested to show approval of budget changes. These changes do not affect the total project cost, but changes in the purposes of some spending. When the original project budget is designed the location of the study areas is not known. The project might take place in any Minnesota county that hasn't had an atlas already created, and these counties can be very close to our base of operations, or very far away. In this case we eventually found project partners in counties relatively near our facility (Wright and Anoka counties). This greatly reduced the magnitude of our travel and the need for overnight stays with meal costs. These counties also have very large subsurface databases which reduce our need for field work, particularly drilling, and the travel costs associated with that work. For these reasons we would like to amend the sum budgeted for travel expenses, and repurpose those funds. We would also like to amend the amount budgeted for supplies, and for capital equipment to reflect the true costs incurred in those categories rather than the estimates in the original budget. The final amendment requested is a redistribution of the funds not spent in the categories described above into a 2% increase in the wages and benefits category, a 7% increase in direct operating costs, and the remainder to a new category for the printing of the Sibley, Nicollet, and Blue Earth county atlases. That work was awarded on a competitive bid.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 3: Initiate County Geologic Atlases

Initiate Part A County Geologic Atlases for Anoka County and Wright County. Note: all components listed below may not be completed within the time frame and budget of this project, but substantial progress in both counties is anticipated.

Description:

- create geologic maps, illustrations, and databases in print and GIS formats.
- location, boundaries, size, and hydrologic characteristics of aquifers and the materials that confine them in these counties.
- these maps are essential information in efforts to protect and wisely allocate ground water and they support these related activities and programs:
    - ground water monitoring, wellhead protection, ground water allocation, well construction, wellfield design, facility siting, permitting, application of agricultural best management practices, remediation, and management of ground water dependent surface water features (springs, fens, lakes, rivers).
- products:
    - maps of bedrock geology, surficial geology, subsurface Quaternary geology, bedrock topography, and thickness of glacial deposits
    - database of well construction records to support the mapping, describe water use, and to help resolve well problems; scientific test drilling as necessary

Summary Budget Information for Result 3:

	M.L. 2009
Trust Fund Budget:	**$728,057**
Amount Spent:	**$728,057**
Balance:	**$0**

Deliverable	Completion Date	Budget	Status
3. M.L. 2009: CWI databases for 2 counties	6/30/10	$ 18,000	complete
4. M.L. 2009: geologic maps	6/30/12	$728,057	underway

M.L. 2009 Final Report Summary: All of the products for the Anoka and Wright county geologic atlases are complete with the exception of the subsurface Quaternary products (sand body aquifer models, stratigraphic column, cross-sections). These products are nearly complete and we anticipate printing the atlases later this year

.
These atlases were different from past projects in that there was so much more data available. A typical county atlas might have between 1,000 and 4,000 well records available to document the subsurface geology. The Anoka Atlas utilized 24,000 wells, and the Wright Atlas utilized 10,700 wells. This large body of data adds work in compiling and interpreting the data, but results in maps of higher resolution and greater accuracy.

The bedrock map of Anoka County http://conservancy.umn.edu/bitstream/116119/1/pl2_bg.pdf includes 9 map units, all of Paleozoic age. A map of the shape and elevation (topography) of the bedrock surface was prepared, as was a topography of the top of the Wonewoc Formation. Two cross-sections illustrate the vertical sequence of units. The bedrock map of Wright County includes 23 map units (2 Cretaceous age, 6 Paleozoic age, 15 Precambrian age). Six surfaces were mapped (2 Cretaceous, 3 Paleozoic, 1 Precambrian) and three cross-sections illustrate the vertical sequence of units. Both of these maps have been incorporated into a single map of the ten-county metro area, with additional contact surfaces mapped for all counties. This effort, co-funded by MGS and USGS, has created all the digital information necessary for the geologic framework of a new ground water model for the expanded metro area. This compilation includes new atlas data (Anoka, Wright, Sherburne, Chisago, Carver, Scott) and updates of previous atlas maps (Ramsey, Hennepin, Dakota, Washington).

The surficial geologic map of Anoka County is complete and available via the MGS web site http://conservancy.umn.edu/bitstream/116119/2/pl3_sg.pdf. It has 27 map units. It includes a simplified illustration of sand vs. clay at the land surface. The vertical sequence of glacial materials has been documented with 87 cross-sections created at a spacing of 500 meters. This is the most detailed and data-rich account of glacial stratigraphy in the state. Significant findings include the type of materials filling valleys cut into the bedrock surface. These valleys are common in the Paleozoic rocks of Minnesota and they can affect ground water flow patterns when the valleys cut through bedrock layers that would normally restrict vertical flow. In Anoka County the largest bedrock valley, which continues to the south and hosts several metro lakes, is filled mostly with sand. This may be a pathway for recharge to deeper aquifers. Water level measurements will determine if this is the case. Other smaller valleys have complex fills with thick aquifers in places, but also much clay-rich material. Digital surfaces representing glacial aquifer boundaries and the contacts between till deposits of various ages are currently under construction.

The surficial map of Wright County is deceptively simple in that it covers a complex sequence of glacial deposits representing many events and disparate materials. This sequence will be evident in the cross-sections and sand body maps that describe the subsurface.

About 40% of the closely-spaced (1 km) cross-sections that describe the subsurface distribution of glacial materials in the county are complete. There will be 51 east-west sections and we expect to complete them in October. Again, the density of data has improved our understanding, but increased the necessary effort. This work has changed our understanding of the limits of some glacial advances and their deposits, including multiple depositional phases of the Des Moines Lobe. Construction of digital surfaces representing glacial aquifer boundaries and the contacts between till deposits of various ages will follow when the cross-sections are complete.

The new Giddings drilling machine and truck were purchased and are used frequently on county geologic atlas projects. The borehole camera was purchased and is used on atlas projects and related research (such as the St. Lawrence Formation hydrogeologic characterization funded by M.L. 2010 Chp. 362, Sec. 2, Subd. 3a). The flowmeter was repaired and is in use on atlases and related hydrogeologic projects.

Printing of the Blue Earth, Nicollet, and Sibley county geologic atlases was funded by this project. This bidded contract cost $34,380 in total for 1,000 copies of each atlas. Each copy includes 6 printed plates with a map and other illustrative material on each plate.

Result 5: Production and Printing of the Benton and Chisago County Geologic Atlases

Description:

- o Take the geologic maps and databases from 2007 work program through the technical review, editing, production, and printing phases
- products:
  - o printed maps of bedrock geology, surficial geology, subsurface Quaternary geology, bedrock topography, and thickness of glacial deposits
  - o A CD or DVD package of digital versions of the products in several formats appropriate for the varying technology levels of users

Summary Budget Information for Result 5:

Trust Fund Budget:	**$91,944**
Amount Spent:	**$91,944**

Balance: **$0**

Deliverable	Completion Date	Budget	Status
1. printed maps and DVD	6/30/10	$91,944	complete

Final Report Summary: The Benton and Chisago County Geologic Atlases have been completed and delivered to the counties and to the LCCMR. The counties each received 1,000 copies of the printed atlases, and a DVD containing all the digital files and associated databases.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: approx. 6 fte from approx. 15 staff	$570,216
Contracts: drilling (approx. 6 or 7 holes $75,000) printing $22,000	$ 97,101
Equipment/Tools/Supplies ($86,000 capital equip below; $3500 core box, lab/field supplies $7000, copy/scan/plot $400, field maps $300, lab analyses $1600)	$ 98,883
Travel:	$ 54,000
Other:	$ 0
2009 TRUST FUND PROJECT BUDGET:	$820,000

Explanation of Capital Expenditures Greater Than $3,500:

Soil Probe and carrier truck: $62,000

The Minnesota Geological Survey relies primarily on water well records for subsurface geologic data. This is augmented by 1 to 3 rotasonic test borings approximately 250 feet deep, and 100 to 200 shallow borings less than 25 feet deep. The shallow borings are drilled with a truck mounted auger owned by MGS. This project will purchase a new auger and truck to augment our current equipment. The acceleration of the program requires a second set of equipment.

Repair of a downhole flow meter tool: $9,000

MGS lowers several types of measuring probes into water wells or test borings to record physical properties of the surrounding earth materials, or the water in the borehole and adjacent aquifers. Our flowmeter probe was damaged during previous use and these funds will repair it for use on this project and future atlases.

Downhole Video Camera and Recorder $15,000

A downhole video camera provides us with the ability to see geologic strata in uncased intervals of wells or test borings. This is useful in interpreting the geology, and also in assessing the suitability of the hole for deploying the downhole flow meter or other tools. Seeing the conditions in advance will help us avoid tool loss or damage in holes with obstructions or problematic construction.

VI. OTHER FUNDS & PARTNERS:

A. Project Partners:

Minnesota Geolgical Survey, total from 2009 appropriation	$820,000
Anoka County (well location verification)	in-kind contribution
Wright County (well location verification)	in-kind contribution

B. Project Impact and Long-Term Strategy:

County Geologic Atlases provide information essential to sustainable management of water resources. Atlases are completed or underway for 25 of Minnesota's 87 counties. The products also support and enhance the activities of other agencies such as ground water monitoring, wellhead protection, ground water allocation, well construction, wellfield design, facility siting, permitting, application of agricultural best management practices, remediation, and management of ground water dependent surface water features (springs, fens, lakes, rivers).

C. Other Funds Proposed to be Spent during the Project Period:

Proposals will be made for similar matches to selected products of the 2009 appropriation. Update: The USGS Statemap Program accepted the Anoka surficial and bedrock maps as projects and contributed $68,525 in additional funds. The Great Lakes Geologic Mapping Coalition co-funded the subsurface Quaternary products of Anoka County contributing an additional $36,736.

D. Spending History:

VII. DISSEMINATION:

Geologic maps and databases prepared by the Minnesota Geological Survey will be available in GIS and other electronic formats on the MGS website http://www.mngs.umn.edu/index.html, and in print.

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted not later than 12/1/08, 7/1/09, 12/1/09, 7/1/10, 12/1/10, 6/30/11, 12/1/11, 6/30/12 **A final work program report and associated products will be submitted between June 30 and August 1, 2009 and again between June 30 and August 1,2010 as requested by the LCCMR**

IX. RESEARCH PROJECTS:

Attachment A: Final Budget Detail for 2009 Project

Project Title: County Geologic Atlas Acceleration

Project Manager Name: Dale Setterholm

revised 9/18/12

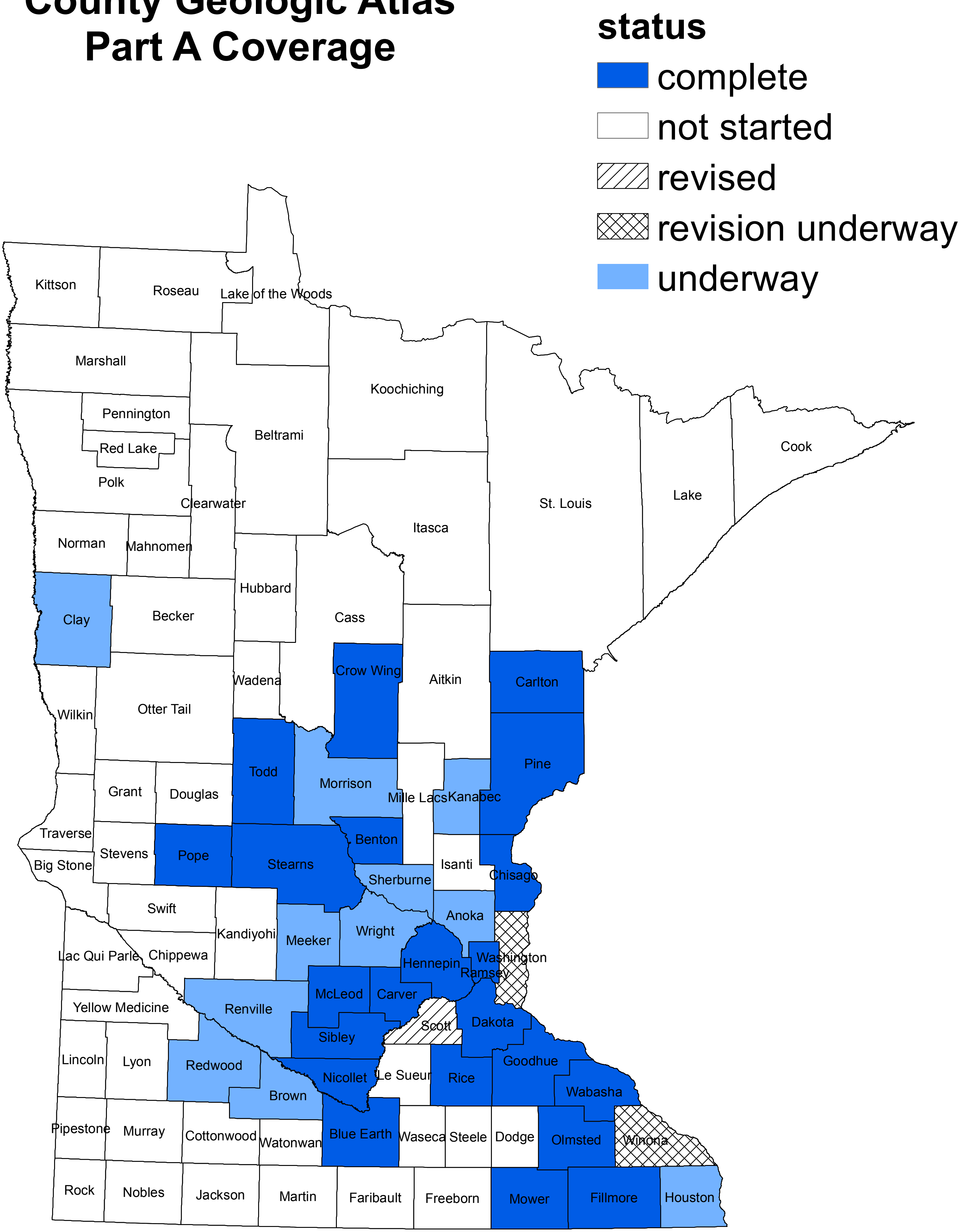
Trust Fund Appropriation: $ **820,000**

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

2009 Trust Fund Budget	**Revised Result 3B Budget:**	**Amount Spent (06/30/2012)**	**Balance (06/30/2012)**	**Result 5 Budget:**	**Amount Spent (06/30/2012)**	**Balance (06/30/2010)**	**TOTAL BUDGET**	**TOTAL BALANCE**
BUDGET ITEM	Initiate new CGAs in Anoka and Wright counties			Production and Printing of Benton and Chisago CGAs				
PERSONNEL: wages and benefits *(List individual names, amount budgeted and %FTE; add rows as needed)*	514,575	514,575	0	65,159	65,159	0	579,734	0
Contracts						0		0
Professional/technical *(test drilling, bid)*	75,000	75,000	0	0	0	0	75,000	0
Other direct operating costs *(repair flowmeter)*	9,683	9,683	0	0	0	0	9,683	0
Non-capital Equipment / Tools *(what equipment? Give a general description and cost)*	0	0	0	0	0	0	0	0
Capital equipment over $3,500 *(Giddings soil probe, truck, borehole camera)*	73,768	73,768	0	0	0	0	73,768	0
Printing (*competitive bid*) Sibley, Nicollet, and Blue Earth Atlases	34,380	34,380	0	26,785	26,785	0	61,165	0
Supplies *(xeroxing, maps and publications, kraft envelopes, sample bags, sieves, banding for core samples)*	11,252	11,252	0	0	0	0	11,252	0
Travel expenses in Minnesota	9,399	9,399	0	0	0	0	9,399	0
Other *(Describe the activity and cost) be specific*			0	0				
COLUMN TOTAL	**$728,057**	**$728,057**	0	**$91,944**	**$91,944**	**$0**	**$820,000**	**$0**

County Geologic Atlas Part A Coverage



2009 Project Abstract
For the Period Ending June 30, 2012

PROJECT TITLE: South-Central Minnesota Groundwater Monitoring of the Mt. Simon Aquifer
PROJECT MANAGER: James A. Berg
AFFILLITION: Minnesota Department of Natural Resources
MAILING ADDRESS: 500 Lafayette Road
CITY/STATE/ZIP: St. Paul, MN 55155
PHONE: 651-259-5680
E-MAIL: jim.a.berg@state.mn.us
WEBSITE: http://www.dnr.state.mn.us/index.html
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chap.143, Sec. 2, Subd. 3 (b)

APPROPRIATION AMOUNT: $1,875,000

Overall Project Outcome and Results

Most data collected for the Mt. Simon – Hinckley aquifer Phase 2 study were derived from 16 wells installed at 10 locations to depths of 100 to 695 feet in McLeod, Wright, Hennepin, Sherburne, Anoka, and Isanti counties. In the Phase 2 area chemical residence time indicators from the Mt. Simon aquifer indicate groundwater ages less than approximately 1,000 years in eastern Wright and Sherburne counties and northern Isanti County. These relatively young groundwater ages are consistent with water level and stratigraphic information that indicate both direct and indirect connection of surface water to the Mt. Simon- Hinckley aquifer through localized focused recharge.

This project has shown that the most critical recharge area for the Mt. Simon-Hinckley aquifer and Minneapolis-St. Paul metropolitan area water supply includes portions of Wright, Sherburne, and Isanti counties. Protection of this region from water pollution should be a high priority for all levels of government. Continued monitoring of wells installed for this investigation will create a long term record that can be used to interpret changes in local and regional water supply due to water use or climate changes.

The County Geologic Atlas, Part B, portion of this project supported the completion of three and the initiation of six Part B atlases in the County Geologic Atlas series that the DNR prepares in collaboration with the Minnesota Geological Survey. Each Part B atlas provides groundwater maps, data describing aquifer properties and use, analytical results of groundwater chemistry sampling including age-dating samples, and interpretation of pollution sensitivity. All of these maps and data are used to meet many environmental information and protection needs, including resource protection planning, water resource management, water appropriation permitting, contamination mitigation, education, among others. The Todd, Carlton, and Benton Part B atlases were completed and the Carver, McLeod, Chisago, Blue Earth, Nicollet, and Sibley Part B atlases were initiated.

Project Results Use and Dissemination

The reports from this project have been available on the DNR website since the summer of 2012. The Mt. Simon project was presented as a poster at the Midwest Groundwater Association meeting in Minneapolis in October 2012. We are currently producing a short (15 minute) video highlighting some of the results of the project for presentation at future meetings and for general viewing on the internet. In addition, a summary of the project will be submitted to the Minnesota Groundwater Association for inclusion in the quarterly newsletter.

The well log and well construction information is currently available in the project report and the Minnesota Department of Health County Well Index (http://mdh-agua.health.state.mn.us/cwi/cwiViewer.htm). The wells have become part of the DNR observation well network. Water level data is currently available at: http://climate.umn.edu/ground_water_level/

Publication of Part B atlas reports include preparation and printing of the County Geologic Atlases, Part B, and delivery of printed reports to the county; preparation and delivery of Part B materials to MGS for inclusion in a DVD version of each completed project that incorporates geographic information system (GIS) files, database files, pdfs, and additional digital products. When each atlas Part B is completed a training workshop for the county and local users is held to explain the results and how the maps, data, and other information can be used to assist local water resource programs. To reach other users and audiences program staff contributed newsletter articles and presented talks and posters at conferences. Completed digital products are posted on DNR webspace at http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html . Printed reports are available for sale through MGS Map Sales at http://www.mngs.umn.edu/mapsales.html .

Environment and Natural Resource Trust Fund 2008 and 2009 Work Program Final Report

Date of Report: 12/18/12
Final Report

	M.L. 2008	M.L. 2009
Date of Work program Approval:	June 10, 2008	June 16, 2009
Project Completion Date:	June, 30 2011	June 30, 2012

I. PROJECT TITLES: South-Central Minnesota Groundwater Monitoring and County Geologic Atlases (2008), County Geological Atlas and South-Central Minnesota Groundwater (2009)

Project Manager: Jim Berg
Affiliation: Minnesota Department of Natural Resources
Mailing Address: 500 Lafayette Road
City / State / Zip : St. Paul, MN 55155
Telephone Number: 651-259-5680
E-mail Address: jim.a.berg@state.mn.us
FAX Number: 651-296-0445
Web Page address: http://www.dnr.state.mn.us/index.html

Location: Martin, Watonwan, Brown, Nicollet, Blue Earth, and Sibley Counties (2008 project). McLeod, Wright, Sherburne, Isanti, Anoka, and Hennepin Counties (Mt. Simon aquifer monitoring - 2009 project); The Part B atlases that will be funded during the project period (2009 project) will include Todd, Carlton, McLeod, Carver, Benton, and Chisago counties.

	M.L. 2008	M.L. 2009	Total
Total Trust Fund Project Budget:	**$1,600,000**	**$2,695,000**	**$4,295,000**
DNR Total	*$894,000*	*$1,875,000*	*$2,769,000*
MGS Total	*$706,000*	*$820,000*	*$1,526,000*
DNR Trust Fund Appropriation	**$894,000**	**$1,875,000**	**$2,769,000**
Minus Amount Spent:	**$894,000**	**$1,697,259**	**$2,591,259**
DNR Equal Balance:	**$0**	**$177,741**	**$177,741**

Legal Citation:
ML 2008, Chap.367, Sec. 2, Subd. 4 (h).
Appropriation Language (2008):
$1,600,000 is from the trust fund for collection and interpretation of subsurface geological information and acceleration of the county geologic atlas program. $706,000 of this appropriation is to the Board of Regents of the University of Minnesota for the Geological Survey to begin county geologic atlases in three counties. $894,000 of this appropriation is to the commissioner of natural resources to investigate the physical and recharge characteristics of the Mt. Simon aquifer. This appropriation represents a continuing effort to complete the county geologic atlases throughout the state. This

appropriation is available until June 30, 2011, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

Legal Citation: ML 2009, Chap.143, Sec. 2, Subd. 3 (b)
Appropriation Language (2009):

$2,695,000 is from the trust fund for collection and interpretation of subsurface geological information and acceleration of the county geologic atlas program. $820,000 of this appropriation is to the Board of Regents of the University of Minnesota for the geological survey to continue and to initiate the production of county geologic atlases. $1,875,000 of this appropriation is to the commissioner of natural resources to investigate the physical and recharge characteristics of the Mt. Simon aquifer. This appropriation represents a continuing effort to complete the county geologic atlases throughout the state. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II and III 2008 AND 2009 FINAL PROJECT SUMMARY:

M.L. 2008

Abstract

To better understand the recharge dynamics of the Mt. Simon aquifer the western edge of this aquifer was investigated through observation well installations, water level monitoring, groundwater chemical analysis, and aquifer capacity testing. Most data collected for this study are derived from the 27 observation wells, drilled to depths of 70 to 718 feet, that were installed at 14 locations by contracted drilling companies.

The combination of chemical residence time indictors, continuous water level data from nested well locations, and a general knowledge of the regional hydrostratigraphy, shows the Mt. Simon aquifer in this region has a very slow recharge rate from a large source area located south of the Minnesota River, and a smaller source area located in the northern portion of the study area. The younger ^{14}C residence time values of Mt. Simon groundwater (7,000-8,000 years) from this project roughly correspond to a time after the last ice sheet had receded from southern Minnesota suggesting groundwater in the Mt. Simon aquifer in this region began as precipitation that infiltrated during the post-glacial period. The stable isotope data of oxygen and hydrogen support this conclusion. A recharge estimate of the Mt. Simon aquifer south of the Minnesota River based on these minimum residence time data suggest a rate of approximately 0.49 cm/year. The resulting 1.2 billion gallons/year of recharge from the southern source area is less than the approximately 2.2 billion gallons were pumped out of the Mt. Simon aquifer in this area in 2009. Continued monitoring of the observation wells in this region should help determine if more water is being used compared to recharge. A major accomplishment of this project is the creation of a network of observation well nests along the western margin of the Mt. Simon Sandstone that is considered an important recharge area for the aquifer. Long term water level and geochemistry data from these wells will enable future hydrologists to evaluate the local and regional effects of Mt. Simon aquifer groundwater pumping in the region.

(http://files.dnr.state.mn.us/publications/waters/south_central_mn_gw_monitoring.pdf).

A document titled “Minnesota Groundwater Level Monitoring Network-Guidance Document for network Development” was also completed as part of this project. The Guidance Document outlines how Minnesota’s current groundwater level monitoring network of approximately 750 wells should be expanded to meet monitoring needs. This expansion is necessary because large areas in Minnesota are not adequately monitored. Many areas of Minnesota are underlain by multiple aquifers, all of which must be considered in developing the long-term network that will provide adequate resource data
(http://files.dnr.state.mn.us/publications/waters/groundwater_network_guidance.pdf).

M.L. 2009

Most data collected for the Mt. Simon – Hinckley aquifer Phase 2 study were derived from 16 wells installed at 10 locations to depths of 100 to 695 feet in McLeod, Wright, Hennepin, Sherburne, Anoka, and Isanti counties. In the Phase 2 area chemical residence time indicators from the Mt. Simon aquifer indicate groundwater ages less than approximately 1,000 years in eastern Wright and Sherburne counties and northern Isanti County. These relatively young groundwater ages are consistent with water level and stratigraphic information that indicate both direct and indirect connection of surface water to the Mt. Simon- Hinckley aquifer through localized focused recharge.

This project has shown that the most critical recharge area for the Mt. Simon-Hinckley aquifer and Minneapolis-St. Paul metropolitan area water supply includes portions of Wright, Sherburne, and Isanti counties. Protection of this region from water pollution should be a high priority for all levels of government. Continued monitoring of wells installed for this investigation will create a long term record that can be used to interpret changes in local and regional water supply due to water use or climate changes.
The County Geologic Atlas, Part B, portion of this project supported the completion of three and the initiation of six Part B atlases in the County Geologic Atlas series that the DNR prepares in collaboration with the Minnesota Geological Survey. Each Part B atlas provides groundwater maps, data describing aquifer properties and use, analytical results of groundwater chemistry sampling including age-dating samples, and interpretation of pollution sensitivity. All of these maps and data are used to meet many environmental information and protection needs, including resource protection planning, water resource management, water appropriation permitting, contamination mitigation, education, among others. The Todd, Carlton, and Benton Part B atlases were completed and the Carver, McLeod, Chisago, Blue Earth, Nicollet, and Sibley Part B atlases were initiated.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Groundwater level monitoring guidance document
Description: The purpose of this document is to create a strategic plan for developing a statewide network of water level monitoring wells (observation wells). The document, created by DNR Waters, will review the current state of Minnesota's network, monitoring frequency, database protocols, costs, data uses, and limitations. The document will include a review of networks in other states or countries that may have advantageous approaches that the Minnesota DNR could consider. Finally, the document will make recommendations for how to evaluate the adequacy of the existing network and make recommendations for improving the existing network.

Summary Budget Information for Result 1:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$33,000**	**$0**	**$33,000**
Amount Spent:	**$33,000**	**$0**	**$33,000**
Balance:	**$0**	**$0**	**$0**

Deliverable	Completion Date	Budget	Status
1. Existing sources of information from other states and countries.	1/05/09	$1,000	complete
2. Information and status of the Minnesota observation well network.	7/1/09	$1,000	complete
3. Information and methods used by other government entities	12/1/09	$11,000	complete
4. Final Report: Information and recommendations for Minnesota groundwater monitoring	5/31/11	$20,000	complete

Completion Date: M.L. 2008: 5/31/11

Final Report Summary (guidance document):
Minnesota's environmental and economic future depends on a continued and available supply of groundwater that is managed sustainably. The Minnesota Department of Natural Resources is responsible for managing the quantity of groundwater use through appropriation permits and monitoring water levels. Groundwater quantity estimates for management purposes depend on a historical record of water level measurements. However, the state's current groundwater level monitoring network does not provide adequate statewide groundwater quantity information because many areas and groundwater resources are unmonitored.

This Guidance Document outlines how Minnesota's current groundwater level monitoring network of approximately 750 wells should be expanded to approximately 7000 groundwater level monitoring wells to meet monitoring needs. This expansion is necessary because large areas in Minnesota are not adequately monitored. Many areas of Minnesota are underlain by multiple aquifers, all of which must be considered in developing the long-term network that will provide adequate resource data. A more complete and integrated network of groundwater level monitoring wells will provide stakeholders, local government officials, and groundwater resource managers with the information needed to:

- Understand the status of groundwater quantity throughout the state
- Formulate management responses to changing water levels
- Plan for the future based on current scientific data

This document is intended to provide the DNR with a guide to build the backbone network that will support the state's current and future groundwater level monitoring information needs. Network wells will become long-term assets used to fully understand, manage, and assess Minnesota's groundwater resources. As described in this document, this is an unprecedented expansion project that will vastly improve the understanding of Minnesota's groundwater resources. The envisioned expansion is a very significant undertaking, estimated to require 30 years to complete and cost $94.7 million. The continued operation and maintenance of the network assets as the network expands is also a significant undertaking, requiring on-going support to acquire, analyze, and interpret groundwater level data and to make the data readily available to a wide variety of users.

The Minnesota groundwater level network as it develops into the future is intended to meet information needs for sustainable management of water resources. The existing network, while limited, provides invaluable data for resource managers; the expanded network will provide greatly improved data resource to understand groundwater system response to change and provide the groundwater quantity data needed to make informed decisions to protect Minnesota's groundwater resource for the future.

Result 2: Test drilling, monitoring well installation, sampling, laboratory analysis, water level measurement

Description: Monitoring wells (observation wells) will be drilled and completed at 14 locations in the 2008 project area and approximately 10 locations in the 2009 project area. The monitoring well installations will be completed with contracted drilling services hired and coordinated by the DNR. Each location will consist of a two-well nest with a deep well completed in the lowermost bedrock aquifer (Mt. Simon Formation), and another well completed in a shallower unconsolidated sand and gravel aquifer. The well nests will be located on public property and completed to depths of approximately 100 to 1000 feet. Drill cuttings (ground-up rock and sediment brought to the surface by the drilling process) will be collected at 5-foot intervals by DNR staff and archived for analysis by the Minnesota Geological Survey. DNR or MGS staff will complete downhole geophysical surveys after the full depth of the deep borehole has been drilled. A reverse circulation/dual rotary drilling method will be used as much as possible to generate high quality drill cuttings. These high quality samples will significantly improve stratigraphic interpretations of glacial and bedrock materials. This drilling method advances an 8 - inch diameter steel casing during the drilling process. The wells will be pumped prior to sampling providing some specific capacity information. The specific capacity test will provide some information regarding the aquifers producing capacity.

Most of the test holes will be completed as 4-inch diameter water level monitoring wells (observation wells) in the lowermost bedrock aquifer (Mt. Simon Sandstone) and shallower aquifers, to help track long-term groundwater level trends. The wells will be sampled by DNR staff for general chemistry, trace elements, tritium, carbon 14 and stable oxygen and deuterium isotopes to determine the residence time of the ground water in the formations. In addition, DNR staff will instrument the wells with continuous water level recording equipment to track short and long term changes in water levels. The chemistry and water level information will help determine the sustainable limitations for future use of this aquifer.

Summary Budget Information for Result 2:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$861,000**	**$990,325**	**$1,851,325**
Amount Spent:	**$861,000**	**$990,325**	**$1,851,325**
Balance:	**$0**	**$0**	**$0**

Deliverable	Completion Date	Budget	Status
1. All the drilling sites will have been chosen and several of the wells will have been installed, instrumented and sampled. The drilling logs, geophysical logs, flow logs, locations, well construction diagrams, and water level data from the wells that have been installed by this date will be available.	12/01/08	$250,000	complete
2. Same as above with several more sites completed (M.L. 2008)	7/1/09	$250,000	complete
3. Same as above with several more sites completed (M.L. 2008). Sites have been chosen for M.L. 2009 and contractor bidding, SHPO reviews and access permission requests are underway. Several of the wells will have been installed.	12/1/09	$250,000 (2008) $250,000 (2009)	complete
4. All the monitoring wells will have been installed, instrumented, and sampled. During the remaining one-year period The data loggers will downloaded and maintained on a regular basis. Remaining data compilation and interpretation will continue and creation of final report will begin (M.L. 2008). Several more well nests for the M.L. 2009 will have been completed and associated data loggers installed.	7/1/10	$37,000 (2008) $300,000 (2009)	complete
5. Same as above with more data compilation and progress toward completion of final report (M.L. 2008).	12/1/10	$37,000 (2008) $300,000	complete

All of the well nests will have been completed, associated data loggers installed, and water samples collected and submitted for lab analysis (M.L. 2009).		(2009)	
6. Project completion (M.L. 2008) and final report to include maps summarizing thickness and extent of Mt. Simon aquifer in project area. Interpretation of collected water level data and chemistry and implications for sustainable use of Mt. Simon aquifer. Recommendations for future investigations and/or monitoring. Routine downloading of data loggers, data compilation, interpretation and report preparation (M.L. 2009)	6/30/11	$37,000 (2008) $33,750 (2009)	complete
7. Routine downloading of data loggers, data compilation, interpretation and report preparation (M.L. 2009)	7/1/11	$33,750 (2009)	complete
8. Same as above (M.L. 2009)	12/1/11	$33,750 (2009)	complete
9. Project completion (M.L. 2009) and final report to include maps summarizing thickness and extent of Mt. Simon aquifer in project area integrated with 2008 project results. Report will include interpretation of collected water level data and chemistry and implications for sustainable use of Mt. Simon aquifer. Recommendations for future investigations and/or monitoring.	6/30/12	$39,075 (2009)	complete

Completion Date **M.L. 2008:** 6/30/11
M.L. 2009: 6/30/12

M.L. 2008 Final Report Summary:
Drilling, well installation, groundwater sampling, and data logger installations have been completed at all the 2008 project sites (Phase 1) for a total of 27 wells at 14 sites in 5 counties. All wells drilled have been mud logged and gamma logged. In addition, rock and sediment samples have been sent to the Minnesota Geological Survey for analysis. The wells were sampled for chemical constituents such as tritium and carbon-14 that helped determine the residence time or age of the groundwater in this aquifer and overlying aquifers. The wells were also instrumented with equipment to continuously record groundwater levels.

M.L. 2009 Final Report Summary:
A total of seven Mt. Simon Sandstone observation wells and nine wells in other geologic units were drilled and completed at 10 locations in five counties. Staff from the Minnesota DNR Ecological and Water Resource Division coordinated the installation of these wells. . All wells drilled have been mud logged and gamma logged. In addition, rock and sediment samples have been sent to the Minnesota Geological Survey for analysis. Drilling in the northern portion of the investigation area (Phase 2) began in the fall of 2009. The wells are completed in the Mt. Simon and Hinckley sandstones, the Fond du Lac Formation, and shallower units on public property in the project area to depths of 100 feet to 695 feet. The wells were sampled for chemical constituents such as tritium and carbon-14 that helped determine the residence time or age of the groundwater in this aquifer and overlying aquifers. The wells were also instrumented with equipment to continuously record groundwater levels.

Result 3 (to be completed by the MGS who will be providing separate work program updates): Initiate Part A County Geologic Atlases for Blue Earth, Nicollet, and Sibley Counties. Note: all components listed below may not be completed within the time frame and budget of this project, but substantial progress in all three counties is anticipated.

Result 4 (to be completed by the MGS): MGS support for DNR Drilling Program
Description: MGS will process, examine, interpret, and archive samples from the DNR test drilling. MGS will also conduct downhole geophysical logging of selected test holes to observe aquifer properties.

Result 5 (to be completed by the MGS): Production and Printing of the Benton and Chisago County Geologic Atlases

Result 6: Acceleration of County Geologic Atlas Part B reports.
Description: Initiate and complete the Benton and Chisago county geologic atlas Part B projects. Support initiation of three (Carlton, McLeod, Carver) and completion of four (Todd, Carlton, McLeod, Carver) county geologic atlas Part B projects. Progress on Part B atlas development includes ground water sample collection and analysis; geophysics field data collection and analysis; aquifer mapping and technical analysis of ground water systems. Publication of Part B atlas reports include preparation and printing of the County Geologic Atlases, Part B and delivery of printed reports to county; preparation and delivery of Part B materials to MGS for DVD version of each, along with geographic information system (GIS) files, database files, pdfs, and additional digital products. Digital products will be posted on DNR webspace.

Summary Budget Information for Result 6:

	M.L. 2008	**M.L. 2009**	**Total**
Trust Fund Budget:	**$0**	**$884,675**	**$884,675**
Amount Spent:	**$0**	**$706,934**	**$706,934**
Balance:	**$0**	**$177,741**	**$177,741**

Deliverable	**Completion Date**	**Budget**	**Status**
1. Additional staff hired (2 hydrologists; research analyst; half-time editor) to support additional atlas projects to be developed and completed during the project. Support continuation of ongoing projects: Todd County. Support publication of Todd County Part B.	12/01/09	$205,333	complete
2. Support continuation of ongoing work. Start Benton, and Chisago counties. Support start of Carlton, McLeod, and Carver Counties.	7/1/10	$153,333	complete
3. Continue ongoing projects.	12/1/10	$123,333	complete
4. Continue ongoing projects. Support publication of Carlton County Part B.	7/1/11	$147,333	complete
5. Continue ongoing projects. Support publication of Part B for McLeod and Carver counties	12/1/11	$133,334	complete
6. Publish Part B for Benton and Chisago counties.	6/30/12	$122,009	Benton published; Chisago 85-90% complete

Completion Date M.L. 2009: 6/30/12

M.L. 2009 Final Report Summary:
Four additional staff were hired to accelerate completion of County Geologic Atlases, Part B. These personnel included two hydrologist 2's, an Information Officer 2 (editor), and a Research Analyst (GIS). During the final six months of the project, a temporary hydrologist 1 was hired to assist water sample collection for three projects. By the end of the project three Part B atlases were published, including Todd, Carlton, and Benton. Six Part B atlases were initiated, including Chisago, McLeod, Carver, Blue Earth, Nicollet, and Sibley, substantially meeting the project acceleration goal. Each project includes ground water sample collection and analysis; geophysics field data collection and analysis (if needed); technical analysis of ground water systems and groundwater flow; assembly of available data describing aquifer properties and water use; and preparation of interpretive maps of aquifer pollution sensitivity. At the completion of each Part B project a report is published describing aquifers, groundwater conditions, natural water chemistry, groundwater age-dating, and pollution sensitivity.
A substantial balance for Result 6 is the result of delayed initial hires for three staff; in two cases, multiple interviews were required to identify viable candidates. One of the hydrologists that was hired was released from state service after six months and the vacancy could not be filled for nine months. This resulted in a delay in project and report preparation work, with the result that not all the planned publication budget could be used. The three-week state shut-down in July 2011 also contributed to the unspent balance.

V. TOTAL TRUST FUND PROJECT BUDGET:

<u>M.L. 2008</u>	
DNR Staff or Contract Services:	
Hydrologist 3, unclassified, 1.0 FTE x 2years (results 1 and 2)	$132,000
Drilling contractors	$694,474
Laboratory analysis of 30 ground water samples tritium, deuterium and 18 oxygen	$7,989
Archeological site assessment (SHPO)	$6,799
DNR Equipment:	
Down-hole geophysical logging tool (gamma, magnetic induction)	$0
Field computer	$4,267
Submersible sample pump, reel, tubing and cable (or contracted sampling services)	$8,645
Continuous water level monitoring equipment for 27 wells	$18,298
DNR Other:	
Overnight expenses	$9,253
Mileage	$9,835
Supplies	$2440
SUBTOTAL DNR PROJECT BUDGET:	$894,000
SUBTOTOTAL MGS (see MGS WP) **PROJECT BUDGET:**	$706,000
TOTAL TRUST FUND PROJECT BUDGET:	$1,600,000
<u>M.L. 2009</u>	
DNR Staff or Contract Services (Result 2):	
Hydrologist 3, unclassified, 1.0 FTE x 2years	$110,092
Drilling contractors	$812,151
Laboratory analysis of 17 ground water samples cations, anions, trace elements, tritium, stable isotopes, and 14 carbon	$33,236
Archeological site assessment (SHPO)	$5,325
Well pumping equipment for aquifer tests and sampling	$5,896
DNR Staff or Contract Services (Result 6):	
Hydrologist 2, unclassified. 2.0FTE x 2.5 years	$302,275
Hydrologist 1, unclassified, 1.0FTE x 0.5 years	$14,000
Rotosonic core drilling – MGS	$50,000
Research Analyst (GIS), unclassified 1.0 FTE x 2.5 years	$158,600
Information Officer 2, unclassified 1.0 FTE x 2.5 years	$160,600
GIS training for 3 new hires (2-Hydrogeologist 2's, 1-Research Analyst (GIS)	$763
Printing	$38,000

Laboratory analysis of 80 groundwater samples/county for cations, anions, trace elements, tritium and several 14 C	$133,000
DNR Equipment:	
(Result 2):	
Continuous water level monitoring equipment for 17 wells	$12,003
(Result 6):	
Three GIS Workstations	$5,672
DNR Other:	
(Result 2)	
Overnight expenses	$4,976
Mileage	$4,759
Supplies	$1,887
(Result 6)	
Overnight expenses (70 days @ $100/day)	$6,126
Mileage (4,167 miles @ $.48/mile)	$4,000
Supplies	$11,639
SUBTOTAL DNR PROJECT BUDGET:	$1,875,000
SUBTOTOTAL MGS (see MGS WP) **PROJECT BUDGET:**	$820,000
TOTAL TRUST FUND PROJECT BUDGET (2009):	$2,695,000

Explanation of Capital Expenditures Greater Than $3,500 (2008):

<u>Down-hole geophysical logging tool (gamma, magnetic induction)</u>
This tool is essential for any borehole subsurface investigation. The tool measures the natural gamma radiation and electrical conductivity (or resistivity) of the various downhole formations. A continuous profile of these downhole properties is created from this data that allows the geologist to determine what types of sediment (sand, silt, clay) or layers of bedrock sandstone, shale etc.) exist at that location. Formations have characteristic profiles that aid in their identification and correlation. The physical properties of the aquifers (porosity and permeability) can also be estimated from this data. The use of this tool requires supporting equipment (truck, winch, cable computer, software) that the DNR currently possesses. At the end of this project this equipment will continue to be used as part of the DNR ground water level monitoring program and other related activities.

<u>Field computer</u>
Downloading the data from the data loggers requires regular use of a portable computer that can be used under all types of weather conditions and can survive occasional drops and bumps. This is a special laptop computer that has been manufactured to withstand moisture and shocks that would destroy other laptops. The extra toughness increases the cost compared to a standard laptop but we consider it essential for protecting our priceless data.

Submersible sample pump, reel, tubing and cable
One of the objectives of this project is to characterize the ground water residence time of the Mt. Simon aquifer through laboratory analysis of ground water samples. This data will represent an essential component for understanding the recharge characteristics of this aquifer and limits for sustainable use. Many of the ground water samples will be collected from depths greater than 50 feet below ground surface, which requires the use of a submersible pump. At the end of this project this equipment will continue to be used as part of the DNR county geologic atlas program and other related activities.

Continuous water level monitoring equipment for project wells
Another method for understanding the recharge characteristics of this aquifer and limits for sustainable use is to track water levels continuously over an extended time period. Fluctuations in water levels not caused by nearby pumping might be evidence of aquifer recharge. Tracking water levels with dedicated equipment is efficient and creates scientifically valid information versus manually gathering this data on a much less frequent basis. At the end of this project this equipment will probably remain on all the wells for water level data acquisition as part of the DNR ground water level monitoring program.

Explanation of Capital Expenditures Greater Than $3,500 (2009):

GIS Workstations for three new atlas projects hires
Ordinary desktop computers do not have sufficient memory, hard drive, or graphics card capability to meet the intensive GIS needs of the hydrologist or GIS positions. The delayed hire will cover the costs. Software is departmental standard software. These computers will continue to be used as GIS workstations for future County Geologic Atlas projects.

VI. OTHER FUNDS & PARTNERS/ PROJECT STRATEGY:

A. Project Partners

M.L. 2008

Minnesota Geological Survey, total from appropriation	$706,000
Nicollet County (well location verification)	in-kind contribution
Blue Earth County (well location verification)	in-kind contribution
Sibley County (well location verification)	in-kind contribution

M.L. 2009

Minnesota Geological Survey, total from appropriation	$820,000
Anoka County (well location verification)	in-kind contribution
Wright County (well location verification)	in-kind contribution

B. Other Funds proposed to be spent during the Project Period (2008 and 2009):
The report from Result 1 (Groundwater level monitoring guidance document) will be reviewed and edited by several senior staff at the DNR and other state and federal agencies. The project will be managed by existing DNR staff with salary paid through the general fund.
Result 6 (Acceleration of county geologic atlas Part B reports) will be supported by existing DNR staff with salary paid through the general fund. The project will be managed by existing DNR staff with salary paid through the general fund.

C. Spending History (2008 and 2009): LCMR provided funds for the Mankato State University, Water Resource Center to create and publish geologic atlases in the project area covered by this work plan.

D. Time:

E. Project Impact and Long-term Strategy (2008 and 2009):
This project will create both short and long-term benefits for the people and natural resources of the region. The information generated by this project will be immediately useful to water management scientists, planners, drillers, consultants, industrial users, and municipal officials for understanding and assessing local ground water conditions for protection and wise use. Atlas acceleration funds are part of a long-term plan to complete country geologic atlases for the entire state.

VII. DISSEMINATION:
The reports from this project have been available on the DNR website since the summer of 2012. The Mt. Simon project was presented as a poster at the Midwest Groundwater Association meeting in Minneapolis in October 2012. We are currently producing a short (15 minute) video highlighting some of the results of the project for presentation at future meetings and for general viewing on the internet. In addition, a summary of the project will be submitted to the Minnesota Groundwater Association for inclusion in the quarterly newsletter.

The well log and well construction information is currently available in the project report and the Minnesota Department of Health County Well Index (http://mdh-agua.health.state.mn.us/cwi/cwiViewer.htm). The wells have become part of the DNR observation well network. Water level data is currently available at: http://climate.umn.edu/ground_water_level/

Publication of Part B atlas reports include preparation and printing of the County Geologic Atlases, Part B, and delivery of printed reports to the county; preparation and delivery of Part B materials to MGS for inclusion in a DVD version of each completed project that incorporates geographic information system (GIS) files, database files, pdfs, and additional digital products. When each atlas Part B is completed a training workshop for the county and local users is held to explain the results and how the maps, data, and other information can be used to assist local water resource programs. To reach other users and audiences program staff contributed newsletter articles and presented talks and posters at conferences. Completed digital products are posted on DNR webspace at http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html . Printed reports are available for sale through MGS Map Sales at http://www.mngs.umn.edu/mapsales.html .

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted not later than 12/1/08, 7/1/09, 12/1/09, 7/1/10, 12/1/10, 7/1/11, 12/1/11, 6/30/12

IX. RESEARCH PROJECTS:

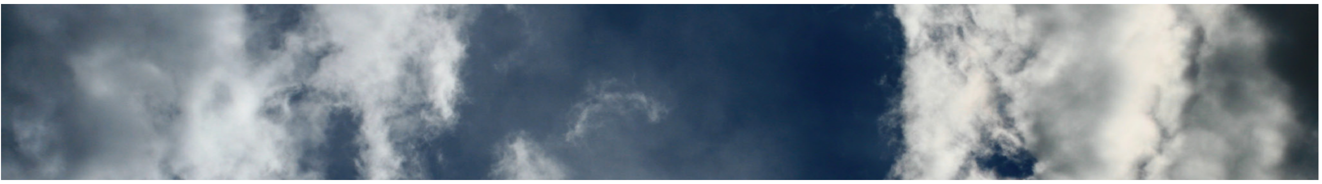
Attachment A: Final Budget Detail for 2009 Projects
Project Manager Name: Jim Berg, DNR Ecological and Water Resources

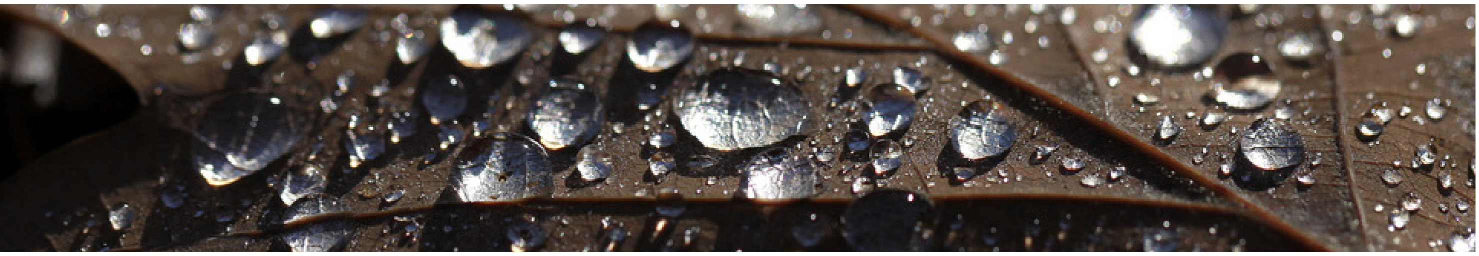
Trust Fund Appropriation: $ 1,875,000
Project Title: County Geological Atlases South-Central Minnesota Groundwater (2009)
Date: December 18, 2012

2009 Trust Fund Budget	**Result 2 DNR Budget**	**Amount Spent**	**Balance**	**Result 6 DNR Budget**	**Amount Spent**	**Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
	Test drilling, monitoring well installation, sampling, laboratory analysis, water level measurement			*Acceleration of County Geologic Atlas Part B reports*				
BUDGET ITEM								
PERSONNEL:								
wages and benefits	**110,092**	110,092	0	**635,475**	520,307	115,168	745,567	115,168
GIS training for new hires				**763**	700	63	763	63
Contracts								
Lab analysis of ground water samples	33,236	33,236	0	133,000	97,867	35,133	166,236	35,133
Drilling contracts	**812,151**	812,151	0	0	0	0	812,151	0
SHPO assessments	5,325	5,325	0	0	0	0	5,325	0
P/T contract MGS for rotosonic drilling				50,000	50,000	0	50,000	0
Equipment								
Well pumping supplies for aquifer test and sampling	**5,896**	5,896	0	0	0	0	5,896	0
Continuous water level monitoring equipment	**12,003**	12,003	0	0	0	0	12,003	0
(Three) GIS workstations				5,672	5,672	0	5,672	0
Travel expenses	**9,735**	9,735	0	**10,126**	10,126	0	19,861	0
Other								
Printing				38,000	10,623	27,377	38,000	27,377
Supplies	**1,887**	1,887	0	**11,639**	11,639	0	13,526	0
COLUMN TOTAL	**$990,325**	**$990,325**	**$0**	**$884,675**	**$706,934**	**$177,741**	**$1,875,000**	**$177,741**

South-Central Minnesota Groundwater Monitoring of the Mt. Simon Aquifer – Phase 2

James A. Berg and Scott R. Pearson
Minnesota Department of Natural Resources
Ecological and Water Resources Division
St. Paul, Minnesota





Minnesota Department of Natural Resources

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

August 2012

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative Commission on Minnesota Resources (LCCMR).

This is the final project report of Result 2 of the LCCMR project titled “County Geological Atlas and South-Central Minnesota Groundwater ” (ML 2009, Chap.143, Sec. 2, Subd. 3 (b))

Authors
James A. Berg, Minnesota Department of Natural Resources
Scott R. Pearson (DNR)

Contributors and Reviewers
Dr. Jeanette Leete (DNR)
Neil Cunningham (DNR)
Bob Tipping (Minnesota Geological Survey)
Terry Boerboom (MGS)
John Mossler (MGS)
Scott Alexander (University of Minnesota)
Jan Falteisek (DNR)

Version 1.0, August 2012

If you have questions or would like additional information, please contact James Berg at 651-259-5680.

Minnesota Department of Natural Resources
500 Layfayette Road North | Saint Paul, MN 55155-4040 | www.dnr.state.mn.us
651-296-6157 | Toll free 888-MINNDNR | TTY 651-296-5484

This report is available in additional formats upon request, and online at www.dnr.state.mn.us

Contents

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Abstract

This Phase 2 report is the final of two reports covering groundwater investigations for the Mt Simon and Mt. Simon-Hinckley aquifers in southern and central Minnesota. The Phase 1 report published in June 2011 reported on work accomplished in Martin, Watonwan, Brown, Nicollet, and Sibley counties. Both investigation phases included observation well installations, water level monitoring, groundwater chemical analysis, and aquifer capacity testing to determine recharge pathways and sustainable limits for this aquifer. Most data collected for this Phase 2 study are derived from 16 wells installed at 10 locations to depths of 100 to 695 feet in McLeod, Wright, Hennepin, Sherburne, Anoka, and Isanti counties.

In the southern part of the study area (Phase 1 area) hydrograph and geochemical residence time data (^{14}C and tritium) show relatively isolated conditions with groundwater ages ranging from 6,000 to 30,000 years for the Mt. Simon aquifer. In the northern portion of the study area (Phase 2 area) chemical residence time indicators from the Mt. Simon aquifer indicate groundwater ages less than approximately 1,000 years in eastern Wright and Sherburne counties and northern Isanti County. These relatively young groundwater ages are consistent with water level and stratigraphic information that indicate both direct and indirect connection of surface water to the Mt. Simon-Hinckley aquifer through localized focused recharge.

This project has shown that the most critical recharge area for the Mt. Simon-Hinckley aquifer and Minneapolis-St. Paul metropolitan area water supply includes portions of Wright, Sherburne, and Isanti counties. Protection of this region from water pollution should be a high priority for all levels of government. Continued monitoring of wells installed for this investigation will create a long term record that can be used to interpret changes in local and regional water supply due to water use or climate changes.

Acknowledgements

The 2008 and 2009 legislatures allocated funding from the Environment and Natural Resources Trust Fund for an aquifer investigation, mapping, and monitoring project in south-central and east-central Minnesota (Figure 1). The 2008/2009 allocations provided $4,295,000 for a 4-year project. The allocation is being shared by the Minnesota DNR ($2,769,000) and the Minnesota Geological Survey (MGS, $1,526,000) to evaluate the Mt. Simon-Hinckley aquifer and produce geologic atlases. The purpose of this report is to compile, summarize, and interpret data collected from the second phase of the Minnesota DNR portion of this project as required by the statute (ML 2009, Chap.143, Sec. 2, Subd. 3 (b)). The Phase 1 report (Berg and Pearson, 2011) was submitted to the Legislative-Citizen Commission on Minnesota Resources in July 2011 and is available online at the DNR website on the water publications web page.

Introduction and Purpose

The deepest bedrock aquifer of east central Minnesota, including the Minneapolis-St. Paul metropolitan area, is the thick (50 to 200 feet) Mt. Simon Sandstone of Cambrian age. In areas where the Mt. Simon Sandstone is underlain by the Hinckley Sandstone, the two formations together are called the Mt. Simon-Hinckley aquifer. This aquifer supplies all or some of the water used by over one million Minnesotans. Measurements of water levels in this aquifer are taken from groundwater level monitoring wells, which are also known as observation wells. The water level measurements that are available from this aquifer in the Minneapolis-St. Paul metropolitan area indicate declining water levels in areas where water is being withdrawn for municipal and industrial use.

To better understand the recharge dynamics of the Mt. Simon-Hinckley aquifer, the western and northern edges were investigated where it was not likely to be overlain by thick, relatively impermeable Paleozoic shale formations. A total of seven Mt. Simon Sandstone observation wells and nine wells in other geologic units were drilled. Staff from the Minnesota DNR Ecological and Water Resource Division coordinated the installation of these wells. Drilling in the northern portion of the investigation area (Phase 2) began in the fall of 2009. The wells are completed in the Mt. Simon and Hinckley sandstones, the Fond du Lac Formation, and shallower units on public property in the project area to depths of 100 feet to 695 feet (Table 1). The wells were sampled for chemical constituents such as tritium and carbon-14 that helped determine the residence time or age of the groundwater in this aquifer and overlying aquifers. The wells were also instrumented with equipment to continuously record groundwater levels.

Bedrock Geology of Investigation Area

The focus of this investigation was the Cambrian Mt. Simon Sandstone (Figure 2) which was deposited at the base of a thick sequence of Paleozoic marine carbonate, shale, and sandstone formations that underlie central and southeastern Minnesota in a broad structural basin known as the Hollandale embayment (Figure 3). The Mt. Simon Sandstone is generally a medium to coarse grained quartzose sandstone (Mossler, 2008). The Mt. Simon Sandstone cuttings observed from drill holes for this project generally indicated the unit is dominated by thick beds of gray and white, silty, very fine to medium-grained quartzose to feldspathic sandstones with thin white-grey, light green, and reddish shale layers. The basal portion of the Mt. Simon Sandstone has coarse yellowish quartz grains ranging from very coarse sand to medium pebble size.

Various Precambrian bedrock units underlie the Mt. Simon Sandstone due to a complicated geologic history prior to the deposition of the Paleozoic rocks. These older underlying rocks include Middle Proterozoic sedimentary rocks, such as the Hinckley Sandstone and the Fond du Lac Formation, Early Proterozoic igneous and metamorphic rocks, and in some southern areas the Lower Proterozoic Sioux Quartzite. Few of these underlying rocks, with the exception of the Hinckley Sandstone, have desirable aquifer properties for most purposes. Therefore, the Mt. Simon Sandstone and combined portions of the underlying Hinckley Sandstone is the deepest bedrock aquifer in the region. The only aquifer available for large capacity (i.e., municipal and industrial) use along the western edge of the Hollandale embayment (Figure 3) is the Mt. Simon aquifer in the Phase 1 area and the Mt. Simon-Hinckley aquifer in the Phase 2 area.

Following the deposition of sand and other sediments that would become the Mt. Simon Sandstone and overlying formations, there was a long period of exposure and non-deposition of rock materials. Marine and non-marine sedimentary rocks (mostly shale and sandstone) were deposited along the western edge of the Hollandale embayment in south-central Minnesota during the Late Cretaceous period. During this period, a shallow epicontinental (inland) sea covered the western interior of North America. Relatively thick sections (50-200 feet) of these types are rocks are common in the southern portion of the investigation area.

Surficial Geology of Investigation Area

Following another long period of exposure and non-deposition of rock materials after the Cretaceous period, the region was affected by repeated continental glaciations during the Quaternary period. These glaciations deposited thick alternating layers of glacial outwash (sand and gravel), glacial till (dense mixture of silt, sand, and clay), and other types of deposits. Thus, the depositional history for most of southeastern and south-central Minnesota left a legacy of both bedrock and glacial aquifer systems.

Recharge of the Mt. Simon-Hinckley aquifer depends not only on the absence of overlying impermeable bedrock layers, but also on the existence of a downward gradient and interconnected surficial and buried sand layers that create pathways for focused recharge (Figure 4). The portion of the investigation area south of the City of Buffalo in Wright County is generally characterized by fine grained glacial sediments at the surface that inhibit rapid groundwater recharge. Northeast of the City of Buffalo, sand or sand and gravel at the surface is very common which creates the potential for focused recharge to the Mt. Simon aquifer (Figure 5). Two recent MGS publications (Tipping and Meyer, 2007; and Tipping, 2011) have focused on the characteristics of glacial sediments in the Twin Cities area and evidence of bedrock aquifer recharge. Writing about this sandy area northwest of the Minneapolis-St. Paul metropolitan area, Tipping and Meyer (2007) observe: "Commonly perceived as sand over bedrock, the Quaternary stratigraphy of this area is actually a complex sequence of coarse and fine grained sediments, including multiple till layers, sand bodies and lacustrine deposits." Furthermore, due to these conditions they conclude that "recharge to bedrock aquifers in the northwest and west-central parts of the metropolitan area appears to be largely localized due to a combination of high permeability zones in unconsolidated sediments…" One of the major goals of this investigation is to help regionally define and characterize Mt. Simon-Hinckley aquifer recharge areas; however, due to the stratigraphic complexity of the glacial sediments overlying the aquifer, a more detailed and local definition will have to wait for the completion of county geologic atlases.

Investigation Methods

Site Selection

The wells for this investigation were drilled on publically owned land to help ensure the longevity of these monitoring locations. With the exception of two locations, all the wells are on state land managed by the Department of Natural Resources, either wildlife management areas (WMA) or water access (WA) locations. One well site in Wright County is owned by the county (Anderson County Park) and another at a National Wildlife Refuge (Sherburne NWR) is owned by the federal government. At these locations special access permission was obtained from the Wright County Board of Commissioners and the U.S. Fish and Wildlife Service, respectively.

Site locations were chosen in suspected recharge areas for the Mt. Simon-Hinckley aquifer near the western edge of the Hollandale embayment at locations where the Mt. Simon Sandstone was likely to be the uppermost bedrock found underlying the surficial glacial deposits or Cretaceous shale and sandstone. A shallow and a deep well were constructed at most locations to provide data on the vertical hydraulic head gradients, changes in groundwater chemistry, and residence time at depth. At the three locations in Isanti County only a Mt. Simon or Hinckley aquifer well was installed and not a shallower well in a nested situation. The Mt. Simon-Hinckley aquifer at these locations was generally overlain by sand and gravel to the surface. Wells and well nest sites were spaced as evenly as possible across the recharge area given the existing distribution of public land in the region. The well nest locations are typically near existing roads and parking lots for easy access and to minimize disturbance of undeveloped parts of these properties.

Drilling Methods and Well Construction

Two different kinds of drilling methods were used to install wells for this project (Table 1). Mud rotary (MR) is a commonly used and widely available method for drilling and completing water wells. Typically a hollow tricone drilling bit is attached to hollow drilling rods that are turned by the drilling rig. During the drilling process, a drilling mud mixture is pumped through the inside of the hollow rod and bit assembly which pushes the ground rock and sediment upward through the space between the drilling rods and the borehole to the surface. The drilling mud flows into an open tank at the surface and is recirculated back down the inside of the drill bit and rod assembly to the bottom of the borehole. The advantage of the MR method is that it is relatively fast and inexpensive. The disadvantage of this method is that the cuttings (ground-up bits of rock and sediment) that the driller and geologist need to find in the drilling mud so they can track drilling progress become difficult or impossible to identify below a certain depth because the cuttings are mixed and degraded as they are pushed to the surface.

Another type of drilling method called dual rotary/reverse circulation (DR/RC) was used in selected areas. During DR/RC drilling, the drill cuttings are returned to surface inside the rods. Air pressure at the drill bit creates suction that pulls the water and cuttings up the “inner tube” which is inside the rod. Once the water and cuttings reach the surface, the cuttings move through a sample hose and are collected in a sample pail. DR/RC drilling produces easily identifiable rock chips from all depths and is therefore ideal for drilling in unknown areas where the geologist does not know exactly what to expect at depth. However, DR/RC drilling is slower and more expensive than mud rotary.

Aquifer Interval Selection for Monitoring

Methods for well construction were somewhat different for boreholes drilled with the two methods. For the dual rotary holes, a 10-inch diameter temporary steel surface casing was driven simultaneously during drilling to the base of the unconsolidated or poorly consolidated Quaternary and Cretaceous layers. Once solid bedrock was reached, the remainder of the hole was drilled without casing because the hole was unlikely to collapse. Drilling continued until Precambrian bedrock was encountered beneath the Mt. Simon Sandstone. At three locations (Anderson County Park, Sherburne NWR, and Stanchfield WMA), the Mt. Simon Sandstone was not present so the deep well was constructed in the Precambrian Hinckley Sandstone or Fond du Lac Formation. After the borehole drilling was completed, a geophysical log of the hole was made by geologists from the Minnesota Geological Survey; at this time, the depth of the permanent 4-inch diameter casing was determined based on the gamma log characteristics of the target formation. For the Mt. Simon wells the relatively shale-free portions of the formation were typically left as open hole. The casing was then constructed by the drilling crew and grouted in place and the temporary casing was removed. The advantage of this procedure was that the depth of the permanent casing could be chosen based on the cuttings and the geophysical log ensuring that the open-hole portion of the well was in the correct depth range, such as the most transmissive portion of the Mt. Simon Sandstone.

Once the deep Mt. Simon Sandstone, Hinckley Sandstone, or Fond du Lac Formation well was completed and logged with geophysical tools, the aquifer for the shallower well in the nest was chosen based on gamma log and cuttings characteristics. In general, we were seeking the shallowest aquifer that might be used for domestic or larger capacity purposes. These shallow wells were generally completed in the discontinuous sand layers of the Quaternary units at a relatively wide range of depths; the shallower well at the Pickerel Lake location was completed in the Cambrian Wonewoc Sandstone.

At three locations wells were completed in buried sand and gravel aquifers using the mud rotary method. A seven-inch diameter borehole was drilled into the top of the buried sand and gravel aquifer and a four-inch steel casing and well screen were placed in the borehole. The casing was then grouted in place.

Geophysical Well Logging

Well logging is the practice of making a detailed record (a well log) of the geologic formations penetrated by a borehole. The geologic log is the geologists's interpretation of the samples brought to the surface. The geophysical well log is a record of formation physical properties measured with electrically powered instruments. The main geophysical log types collected for this project include passive measurements of natural gamma rays and resistivity. After the borehole has been completed, but before the permanent casing has been grouted in the borehole, the logging tool (or probe) is lowered into the open wellbore on a wire connected a reel at the surface. Once lowered to the bottom of the hole, measurements are taken as the probe is reeled up through the wellbore. Measurements are recorded continuously while the probe is ascending from the bottom of the hole.

Gamma ray logging is a method of measuring naturally occurring gamma radiation to characterize the rock or sediment in a borehole. Different types of rock emit different amounts of natural gamma radiation (Driscoll, 1986). Shale and clay usually emit more gamma rays than other sedimentary rocks, such as sandstone, or sand and gravel because radioactive potassium, uranium and thorium are common components in their clay content. This difference in radioactivity between shale and sandstone/carbonate rocks (or clay-rich and non-clay rich sediments) allows the geologist to distinguish between shale and non-clay-rich rock with the natural gamma log.

Resistivity is a property of all materials which represents how strongly a material opposes the flow of electric current. This log is recorded in boreholes containing electrically conductive fluid (drilling mud or water). Sand and sandstone tend to be insulators (high resistivity); clay and shale tend to be conductors (low resistivity). Similar to the gamma log, this difference in resistivity between shale (or clay-rich sediments) and sandstones/carbonate rocks (or non-clay rich sediments) allows the geologist to distinguish between the two general categories of sediments or sedimentary rocks using the resistivity log.

Generalized versions of the gamma logs completed by the staff of the Minnesota Geological Survey (MGS) are shown with the lithologic logs for each of the project well nests in the Appendix. The lithologic descriptions on each of these logs are summarized from MGS interpretations of cuttings. Detailed copies of these logs can be obtained from the MGS.

Well Development

After the borehole is drilled and the permanent well casing is grouted in the well, the well is purged for one to two hours to remove sediment that may have accumulated at the base of the well. This well development procedure is designed to ensure that all or most of the open hole portion of the well is unclogged and water level measurements from the well are representative of water levels in the aquifer at that location.

Groundwater Sample Collection

Protocols commonly employed for the collection of groundwater samples generally require the removal of much of the standing water in the borehole prior to the collection of groundwater samples. This is done so that the sample represents fresh groundwater and is representative of the resource. Removing groundwater from a well can be completed through the use of any of a number of mechanical methods including bailers, air injection and pumping. An electric submersible well pump was selected for this project because it is capable of removing hundreds of gallons of water from depths greater than 150 feet in a relatively short period of time in preparation for groundwater sampling. In addition, well performance testing can be conducted during the same pumping process. Therefore, the collection of water samples was organized to complete the following two tasks: the collection of groundwater samples and a short duration well performance test.

To accomplish these two tasks, a submersible water well pump was temporarily installed in each well to be sampled. An electric generator was used to provide power to the pump and a combination of piping and flexible hose were installed to deliver the groundwater to the surface. The pump used was capable of producing pumping rates of 15 to 31 gallons per minute. Table 2 presents the basic information collected during the performance test procedures.

Groundwater was pumped through a hose from the flow meter to a clean, white five-gallon bucket that allowed field observations of color and odor. The bucket was also used as a flow through chamber into which the probes of several instruments were suspended. Sequential measurements of temperature, pH and specific conductance were made. The wells were pumped until constant values of pH, temperature and specific conductance were observed. The groundwater sample was collected after the values of these parameters remained stable and at least one well volume of water had been removed from the well.

The sampling consisted of filling prepared and labeled containers with groundwater from the hose discharge at the stabilization bucket. The carbon-14 (^{14}C) sample size was approximately 30 gallons and required special handling and containers. Analytes and sampling protocol are summarized in Table 3. Samples were sent to the University of Minnesota Hydrochemistry Laboratory (U of M) and the University of Waterloo Isotope Laboratory (Waterloo) for analysis. Alkalinity was measured with field titration equipment onsite or within 24 hours.

Specific Capacity Procedures and Results

A specific capacity test provides an estimate of the potential yield from a water well. Specific capacity can be calculated from the results of a short duration pumping test. Specific capacity is the pumping rate (gallons per minute) divided by the measured drawdown (feet) and is reported in units of gallons per minute per foot of drawdown (gpm/ft). In Minnesota's principal aquifers, the observed specific capacities range from less than 1.0 gpm/ft to values greater than 100 gpm/ft (Minnesota DNR, 2004). Specific capacities for the Mt. Simon-Hinckley aquifer wells typically range from 1 to 33 gpm/ft; specific capacities for glacial drift wells show greater variability from less than 1 to greater than 50 gpm/ft. As shown in Table 2, the observed specific capacities for the Mt. Simon wells ranged from approximately 1 gpm/ft at Crooked Road WMA to 9 gpm/ft at Robina WMA.

The depths to groundwater were measured from dedicated measuring points located at the top of the well casings. For this project the measuring point elevations were measured using engineering grade global positioning systems that use the Minnesota Department of Transportation Continuously Operating Reference Station network. The measuring point at each well is on the north side of the top of the four-inch diameter steel well casing (top of casing). Groundwater depth measurements were collected before, during, and after pumping using electronic water level measuring tapes and electronic pressure transducer instruments.

A flow meter was used to measure rate and a flow totalizer was used to measure total water discharge in gallons. The flow rate from the well was controlled with the well head check valve. At the start of each pumping test the valve was opened to allow the full pumping rate. Some of the wells were pumped at rates lower than the capacity of the pump to maintain water levels above the pump intake.

Continuous Water Level Measurements

Unattended continuous water level measurements can be made with pressure transducers which are instruments that respond to changes in pressure created by the water column above the instrument. A data logger can record the measurements taken by a pressure transducer at specific intervals set by the user. Improvements in technology over the last decade have resulted in combined data logger and pressure transducer units that are about the size of a small flashlight.

Sealed data logger and pressure transducer units were submerged in each well to a depth of 20 to 25 feet below the water surface. Sealed units record changes in total pressure including barometric pressure. To discriminate changes in pressure reading that are related to barometric pressure change from real water level changes, a record of barometric pressure must also be made. Three data logger and barometer units were deployed across the study area for this purpose. All of the instruments were programmed to collect and store hourly readings.

Data are stored in the data logger until downloaded during site visits that were scheduled quarterly. Communication cables connected to the instruments are accessible from the top of each well. At each location the data are downloaded from the instruments and a water level measurement is taken with a measuring tape. After the data are downloaded, computer software is used to calibrate the data series to the actual measurements and adjust for changes in barometric pressure.

Thickness of the Mt. Simon Sandstone Near the Western Subcrop

One of the objectives of the project was to better define the physical characteristics, including extent and thickness, of the Mt. Simon Sandstone in the study area to help with future water resource evaluations. All the Mt. Simon aquifer wells drilled for the Phase 2 project were drilled to the base of the formation. Most existing wells in this area (Figure 6) provide a minimum thickness value since most of the wells are only drilled into the top of the aquifer to provide water for domestic and irrigation users. Across the study area the thicknesses of the Mt. Simon Sandstone gradually increase toward the southeast to thicknesses of 200 feet and greater in the Minneapolis-St. Paul metropolitan area. Most Mt. Simon aquifer users in the northwestern metropolitan area are pumping water from the portion of the aquifer that ranges from 50 to 125 feet thick.

Groundwater Movement and Potentiometric Surface of the Mt. Simon-Hinckley Aquifer

A key aspect of understanding the hydrogeology of any area is to develop a basic understanding of the groundwater flow pathways. Aquifers and systems of aquifers are rarely static or unchanging. Water is usually moving into the aquifers (recharge), through the aquifers, and out of the aquifers (discharge) in complicated but definable patterns. Three primary types of data are used by investigators to understand these relationships: chemical data from collected samples, aquifer test data gathered by pumping wells under controlled conditions, and static (non-pumping) data measured from wells and surface water bodies. Static water-level data and potentiometric surfaces are the primary focus of this section.

A potentiometric surface is defined as “a surface that represents the level to which water will rise in a tightly cased well” (Fetter, 1988). The potentiometric surface of a confined aquifer (aquifer under pressure) occurs above the top of an aquifer where an overlying confining (low-permeability) layer exists. Static (non-pumping) water-level data from the County Well Index, measurements from the project wells, and data from a U.S. Geological Survey synoptic water level measurement project (Sanocki and others, 2009) were combined and contoured to create the potentiometric contour map (Figure 7). Additional wells in fractured Precambrian crystalline aquifers beyond the extent of the Mt. Simon-Hinckley aquifer are included to show the hydraulic head conditions near the boundary of the aquifer. The contour lines illustrate the potentiometric surface much like the contour lines of a topographic map represent a visual model of the ground surface. The potentiometric surface is not the same as the water table, which is the physical surface of the saturated zone. The potentiometric surface is an imagined representation of the potential energy that is available to move the groundwater in a confined aquifer. Low-elevation areas on the potentiometric surface that could be above the coincident surface-water bodies may indicate discharge areas; when combined with other information sources, high-elevation areas on the potentiometric surface can be identified as important recharge areas. Groundwater moves from higher to lower potentiometric elevations perpendicular to the potentiometric elevation contours (flow directions are shown as arrows). Groundwater flow pathways from recharge areas through the aquifer to discharge locations occur over a wide continuum of depth, distance, and time. Flow into, through, and out of shallow aquifers can occur relatively quickly in days or weeks over short distances of less than a mile, whereas flow through deeper aquifers across dozens of miles may take centuries or millennia.

Figure 7 shows generally, southeasterly groundwater flow directions toward the Minneapolis-St. Paul metropolitan area, and with some local flow toward the Mississippi and Rum Rivers. On cross section Y-Y' (Figure 8) the Mt. Simon-Hinckley aquifer potentiometric surface is relatively shallow across much of the cross section. Near the right (southeastern) portion of the cross section, however, the potentiometric surface becomes much deeper due to the long term effects of high capacity pumping from the aquifer in the Minneapolis-St. Paul metropolitan area. This roughly circular area of depressed water levels is often referred to as a "cone of depression" because the amount of depression gradually lessens as the distance from the centers of pumping increases, resulting in a cone-shaped depression.

Geochemistry

All the wells constructed for this project and one existing well in the area were sampled for analysis of common ions, trace constituents, residence time indicators (tritium and ^{14}C), and stable isotopes (^{18}O and deuterium). The results of all these analyses (Tables 4 and 5) assist in the interpretation of the recharge characteristics of the Mt. Simon-Hinckley aquifer.

Groundwater Residence Time

Two residence time indicators were used in this project: tritium and carbon-14 (^{14}C). Residence time is the approximate time that has elapsed from when the water infiltrated the land surface to when it was pumped from the aquifer for this investigation. In general, short residence time suggests high recharge rates or short travel paths; whereas long residence time suggests low recharge rates or long travel paths.

Tritium (^{3}H) is a naturally occurring isotope of hydrogen. Concentrations of this isotope in the atmosphere were greatly increased from 1953 through 1963 by above ground detonation of hydrogen bombs (Alexander and Alexander, 1989). This isotope decays at a known rate, with a half-life of 12.32 years. Groundwater samples with concentrations of tritium equal to or greater than 8 tritium units (TU) are considered recent water (mostly recharged in the past 60 years). Concentrations equal to or less than 1 TU are considered vintage water (recharged prior to 1953). Concentrations between these two limits are considered a mixture of recent and vintage water and are referred to as mixed water.

The carbon-14 (^{14}C) isotope, which also occurs naturally, has a much longer half-life than tritium (5730 years). Carbon-14 is used to estimate groundwater residence in a time span from about 100 years to 40,000 years (Alexander and Alexander, 1989).

Two shallow groundwater samples in Sherburne County contained detectable tritium concentrations (Table 4 and Figure 9). The sample to the north in this county was collected from a well in the Sherburne National Wildlife Refuge (NWR) from a buried sand and gravel aquifer at a depth of 161 feet. The mixed tritium value and ^{14}C age of 1,300 years could be considered typical of groundwater at this general depth beneath a thick extensive surficial sand layer (Figure 5). The other detectable tritium occurrence from a shallow well, located at the Sand Dunes State Forest, is unusual as the sample contained a high tritium concentration (19.6) indicting recharge within the past 60 years. Both tritium detections from shallow wells were from the sandy area of the Mt. Simon Sandstone subcrop shown on Figure 5. This limited data set supports the idea that this sandy area is a potential Mt. Simon-Hinckley aquifer recharge area.

Tritium data from the Mt. Simon-Hinckley aquifer are shown in Figure 10 including data produced by this project (labeled symbols) and data acquired from the Minnesota Department of Health (James Walsh, unpublished data). Sixteen occurences of recent and mixed tritium have been found within or near the Mt. Simon Sandstone subcrop and within the area of laterally extensive surficial sand. These data represent an important starting point for beginning to understand the distribution of rapid recharge areas within Wright, Sherburne, and Isanti counties.

Figure 11 shows the distribution of ^{14}C residence time values from the Mt. Simon Sandstone, Hinckley Sandstone, and Fond du Lac Formation wells for this project. One additional Mt. Simon-Hinckley aquifer well was sampled for this project from an existing well near Glencoe in McLeod County. Other Mt. Simon-Hinckley aquifer data (Scott Alexander, unpublished data; Lively and others, 1992; Todd Petersen, unpublished data) are also shown on Figure 11 for comparison.

Samples collected from Mt. Simon wells in southern Wright and eastern McLeod counties along the Mt. Simon subcrop mostly did not contain detectable tritium and had old ^{14}C residence time values (6,000 to 20,000 years) indicating hydraulically isolated conditions and very slow recharge similar to values and conditions found in the Phase 1 project area (Berg and Pearson, 2011). The sample collected from the existing well near Glencoe did contain detectable tritium (2.7 TU). This relatively old well, constructed in 1971, may have a corroded casing that allows leakage of recent surficial water into the aquifer. This value may not represent tritium conditions in the aquifer. The 2,000 year old water located in north-central Carver County is along a north–northwest fault trend that may have created a fracture-enhanced flow zone within the Mt. Simon aquifer. Groundwater flow directions suggest the relatively young water at this location was recharged from northeastern Wright County.

In the northern portion of the Phase 2 study area along the Mt. Simon Sandstone subcrop, tritium was detected only at the Sand Dunes State Forest location (4.6 TU). At the other locations, tritium was not detected, but ^{14}C residence time values within or near the Mt. Simon Sandstone subcrop were generally young and ranged from recent to 2,000 years. A somewhat older ^{14}C value of 3,000 years from the Mt. Simon aquifer well at Spectacle WMA in western Isanti County seems anomalous and may be due to local isolated conditions or an upward gradient in the Rum River valley that may be bringing deeper and older water upward.

Stable Isotopes, ¹⁸O and Deuterium

All groundwater samples collected from the study area were analyzed for stable isotopes of oxygen and hydrogen, the two elements found in water. Analysis of the results provides an additional tool for characterizing the area groundwater. Isotopes of a particular element have the same number of protons but different numbers of neutrons. Stable isotopes are not involved in any natural radioactive decay; they are used to understand water sources or the processes affecting them (Kendall and Doctor, 2003). Commonly used isotopes for these purposes include oxygen isotopes ^{16}O and ^{18}O and hydrogen isotopes ^{1}H and ^{2}H. The heavy hydrogen (^{2}H) is called deuterium. The mass differences between ^{16}O and ^{18}O or ^{1}H and ^{2}H result in water molecules that evaporate or condense at different rates. Thus, the concentrations of these isotopes in water changes (fractionates) during evaporation and precipitation, resulting in different $^{18}O/^{16}O$ and $^{2}H/^{1}H$ ratios in rain, snow, rivers, and lakes. The values are expressed as $\delta^{2}H$ and ^{18}O. The symbol "δ" (i.e., delta) denotes the relative difference from standard mean ocean water (Vienna standard mean ocean water - VSMOW) and expresses the relative abundance of the rarer heavy isotopes, $\delta^{2}H$ and $\delta^{18}O$. These values from precipitation water generally plot close to a straight line known as the meteoric water line (Figure 12). The departure of ^{18}O and ^{2}H values from the meteoric water line can indicate evaporation or mixing of water from different sources.

Figure 12 shows a plot of $\delta^{18}O$ and $\delta^{2}H$ values from groundwater samples collected in the study area compared to the meteoric water line. Two types of information regarding the origin and history of these water samples can be interpreted from this graph: relative atmospheric temperature during source water precipitation and relative mixing of water from cold and warm sources.

Source Water Temperature and Mixing

For the samples that plot along the same slope as the meteoric water line, the samples more depleted in heavy isotopes (samples that plot closer to the bottom left of the graph) suggest water that precipitated from a colder atmosphere (Siegel, 1989). Person and others (2007) provided a compilation of paleohydrological studies of groundwater systems in North America that were affected by the advance and retreat of the Laurentide ice sheet. He concluded that the range of $\delta^{18}O$ groundwater values from cold ice or snow melt sources ranges from -25‰ to -9‰. Studies of glacial waters, as evidenced by ostracodes in Lake Agassiz sediments, however, shows ranges of $\delta^{18}O$ from -25‰ to -20‰ (Birks and others, 2007; Breckenridge and Johnson, 2009). Most $\delta^{18}O$ values of groundwater samples from the south central Minnesota Phase 1 and Phase 2 projects (Berg and Pearson, 2011) ranged from approximately -10‰ to -8‰; these values suggest this water is derived from post-glacial precipitation.

In the Phase 1 area in every well nest, the sample from the shallower well had less negative (warmer) $\delta^{18}O$ values than the sample from the associated Mt. Simon aquifer sample. An example of this typical situation is shown in the lower left corner of Figure 13 from the Phase 1 area in northern Sibley County (Severance Lake). This typical pattern may be due to more seepage of meteoric water with warmer isotope values into the shallower aquifer replacing more of the relict older and colder water. Less of this seepage and relict cold water replacement has occurred in the Mt. Simon aquifer of the Phase 1 area and therefore the stable isotope values are slightly colder.

Another possibility (Scott Alexander, personal communication) relates to the timing of the main recharge events for prairie versus woodland areas. Climate changes over geologic time scales are well documented in the geologic literature (Dean, 1999). As climates change, ecosystems shift as well. Regions of Minnesota that were once woodland would now be a prairie type and vice versa. The prairies would develop a larger water demand earlier in the season than the woodlands, and create a slight difference in the stable isotopes of the recharge waters.

At two locations in the Phase 2 area, and possibly a third, this pattern has been reversed. These locations include Anderson County Park in central Wright County, Pickerel Lake WA in western Anoka County and possibly the Robina WMA location in western Hennepin County. This reversal of the typical stratification pattern found in south central Minnesota may be due to the much greater volume of groundwater usage in the Minneapolis-St. Paul metropolitan area. The huge volume of groundwater pumped from the Mt. Simon-Hinckley aquifer over many years that created the cone of depression shown in Figure 7 has increased the hydraulic gradient in the aquifer; this has accelerated the influx of meteoric water from the Mt. Simon Sandstone and Hinckley Sandstone subcrop areas or nearby fracture zones, thereby flushing relict cold water at a faster rate compared to the overlying less-used aquifer. At the Robina WMA location only the Mt. Simon aquifer wells had been completed when all the project wells were sampled in the fall of 2010 so there is no shallow aquifer data for comparison. However, the Robina WMA sample has the warmest stable isotope values of the data set and may represent the same kind of flushed conditions found at the other two locations.

Major Ions

Some evidence of distinct source water types and mixing of these waters can be understood by considering the relative abundances of some common cations and anions as ion concentrations plotted as percentages from area groundwater samples. Figure 14 shows the relative abundances of these common ions plotted on a ternary graph (Piper diagram). Table 5 also shows the concentrations of these constituents in mg/l. The most common type of water in this area has Ca and Mg (Ca+Mg) as the predominant cation and bicarbonate as the most common anion. The bicarbonate type of water is common in glacial aquifers of the upper Midwest (Freeze and Cherry, 1979, p. 284) and is derived from dissolution of calcite and dolomite minerals in soil and glacial sediments by infiltrating precipitation. Higher sulfate concentrations (greater than 100mg/l) in the Mt. Simon aquifer tend to occur in the Phase 1 study area (Berg and Pearson, 2011) where infiltrating water passed through Cretaceous sandstone and shale layers that contain sulfide minerals that are oxidized to sulfate.

The data from five Phase 2 samples plotted on the center of the cation ternary plot show that some slightly elevated Na+K waters are also present in the area (Figure 14). These slightly Na+K type waters (McLeod County Highway building, Mt. Simon Sandstone well; Clouster Lake WMA Mt. Simon Sandstone and buried sand and gravel wells; and Anderson County Park, Hinckley Sandstone well) are more characteristic of water in the Phase 1 area where the Mt. Simon sandstone subcrop is not overlain by a thick extensive surficial sand layer that is present in northeastern Wright, eastern Sherburne, and southwestern Isanti counties (Figure 5). None of the samples from that sandy area contained elevated concentrations of sulfate or Na+K due to a general lack of Cretaceous bedrock and greater flushing of the aquifers with recharging meteoric water.

Trace Elements

Analysis of groundwater samples for a suite of trace element constituents reveals exceedences of the drinking water standard for arsenic (10 ug/l) in two samples. These samples were collected from the buried sand and gravel aquifer at the Lake Ann WA site and the Wonewoc aquifer at the Pickeral Lake WA site (Table 4). Naturally occurring elevated arsenic values are common in aquifers in western and central Minnesota that are hydraulically connected to Des Moines lobe glacial till (Erickson and Barnes, 2005).

Hydrogeology Illustrated by Cross Sections and Hydrographs from Observation Well Nests

A set of seven geologic cross sections were created for this report to provide location-specific representations of the stratigraphy and geologic structure for each well nest and to provide a hydrogeologic context for the hydrograph and geochemical data. The cross sections were constructed by projecting lithologic, stratigraphic, and well construction information onto the trace of each cross section (Figure 3) from within a one kilometer zone on either side of the cross section.

Water level data from each well constructed for this project were plotted to create hydrographs illustrating water elevation changes over time. Hydrographs provide a method of representing large amounts of data from one or more wells. The water elevation hydrographs are provided for each corresponding cross section. Each hydrograph displays the water levels recorded in one or two wells nested at the same site with the Mt. Simon Sandstone, Hinckley Sandstone, or Fond du Lac Formation wells shown in blue and the shallower depth well shown in red. Nested wells are located at the same site within a few feet of each other. On several hydrographs the difference in water elevation is large enough to require the use of a secondary axis. The shallower well information is set on the secondary axis and the corresponding units are indicated on the right side of the hydrograph.

Most of the water level data cover the time period between early 2011 through the spring of 2012. In general, the precipitation pattern for that time period consisted of a relatively wet summer and fall for 2011 (Figure 15) followed by a dry 2012 winter (Figure 16) and early 2012 spring. The following hydrographs follow this pattern and suggest at least some direct hydraulic connection to the surface:

Observation wells completed in aquifers with direct hydraulic connections to the surface

Site	Aquifer(s)	Figures
Stanchfield WMA	PMHN	17
Spectacle Lake WMA	CMTS	18 and 19
Crooked Road WMA	CMTS	20 and 21
Sherburne NWR	QBAA and PMFL	22 and 23
Pickerel Lake WA	CWOC	22 and 24
Sand Dunes SF	QBAA and CMTS	25 and 26
Anderson County Park	QBAA	27 and 28
Lake Ann WA	QBAA	30 and 31
Clouster Lake WMA	QBAA	32 and 33

The relatively old ^{14}C residence time values from the Mt Simon-Hinckley aquifer in the southern portion of the Phase 2 area indicate very slow recharge and hydraulically isolated conditions. The limited range of water level fluctuations shown on the hydrographs reflects this relative hydraulic isolation. Water level fluctuations shown on these hydrographs are not caused by rapid downward flow of precipitation (recharge), but a pressure response to the increased volume and weight of additional groundwater in the overlying water table aquifer and shallow buried aquifers (Maliva and others, 2011). The following wells appear to be in the category:

Observation wells completed in aquifers with very limited hydraulic connections to the surface

Site	Aquifer(s)	Figures
Pickerel Lake WA	CMTS	22 and 24
Anderson County Park	PMHN	27 and 28
Robina WMA	CMTS	27 and 29
Lake Ann WA	CMTS	30 and 31
Clouster Lake WMA	CMTS	32 and 33
McLeod County Hwy Dept	CMTS	34

Comparisons of hydrographs of deep wells with nearby shallow wells can reveal vertical gradients. A downward gradient exists where the groundwater elevation in the shallower well is higher than the groundwater elevation in the deeper well. This condition indicates that groundwater will move downward if a flow pathway is available. All hydrograph pairs show generally downward gradients (Figures 23, 24, 26, 28, 31, and 33). Hydrograph pairs at four locations (Sherburne NWR, Sand Dunes SF, Anderson County Park, and Pickerel Lake WA) follow similar although offset patterns. At the Sherburne NWR (Figure 23) and Sand Dunes (Figure 26) sites these similar patterns are probably because both the shallow and deeper aquifers at each site are separated only by very leaky confining layers; therefore, they are connected partially to the same overlying recharging aquifers (Figures 22 and 25). At the Pickerel Lake WA (Figure 22) and Anderson County Park (Figure 27) sites the hydrograph patterns are less similar (Figures 24 and 28, respectively), with the deeper aquifer having a smaller fluctuation range and a subdued pattern compared to the shallower aquifer. This type of relationship suggests fluctuations within Mt. Simon aquifer wells are due to pressure effects of changes in the overlying water weight of the water table aquifer.

Finally, the hydrograph patterns between the well pairs at Lake Ann WA (Figure 31) and Clouster Lake WMA (Figure 33) do not suggest similarity. Also, the hydrographs of the Mt. Simon aquifers wells at the Robina WMA (Figure 29) or the McLeod County Highway Department (Figure 34) sites do not appear to follow the precipitation pattern for the area during 2011 and early 2012. These hydrograph data along with the old ^{14}C age data and stratigraphic relationships shown on the corresponding cross sections indicate the Mt. Simon-Hinckley aquifer at these locations is the most isolated within the Phase 2 study area. These data have been collected over a relatively short time, and these analyses should be considered preliminary. Longer periods of record will reveal additional insights.

Mt. Simon and Mt. Simon-Hinckley and Aquifer Carbon-14 Residence Time Distribution and Conceptual Recharge Models

Figure 35 shows a simplified distribution of ^{14}C ages of samples collected from the Mt. Simon and Mt. Simon-Hinckley aquifers along the western and northern boundaries of the aquifers. The areas colored in dark blue (^{14}C age < 1,000 years), light blue (1,000 to 2,000), and gray (2,000 to 10,000 years) represent a significant portion of post-glacial recharge in this aquifer in Minnesota.

The two main factors influencing the distribution of this post-glacial recharge are the three major river valleys (Minnesota, Mississippi, and St. Croix) that are Mt. Simon-Hinckley groundwater discharge features and a relatively thin and sandy Quaternary layer in the northern portion of the Phase 2 study area (eastern Wright, Sherburne, and Isanti counties) that enhanced recharge in that area (Figure 5). Another factor may be the Mt. Simon aquifer cone of depression that has been acting over such a short time, but has significantly changed the magnitude of the vertical gradient.

The influence of the Minnesota River valley is apparent by the elongated shapes of three zones of younger (less than 10,000 year) groundwater in Watonwan and Brown counties, Sibley County, and eastern Wright and Carver counties. All of these zones are elongated toward the Minnesota River valley. The two southerly zones were created by slow dispersed downward migration of recharge water through fine-grained glacial sediment and Cretaceous sand and shale (Figure 36, Z-Z') that is described in more detail in the Phase 1 report (Berg and Pearson, 2011).
The lobe of relatively young groundwater in Wright and Carver counties is also migrating toward the Minnesota River valley, but the core of this zone may be comprised of much younger water (<2000 years) that originated in a stratigraphic setting similar to eastern Sherburne County shown on cross section Y-Y' (Figure 36). Instead of the slow dispersed recharge characteristic of the Mt. Simon subcrop south of northeastern Wright County, recharge in eastern Wright County

that created this lobe is characterized by areas of local and focused recharge through interconnected sand and gravel layers. Detailed mapping of these focused recharge areas was beyond the scope of this project, but some progress identifying these areas has been made by GIS modeling of vertical travel time from the water table to the top of bedrock (Tipping 2011) and will continue with geologic atlases that are currently in progress for Wright and Sherburne counties.

Figure 37 shows a comparison of Mt. Simon-Hinckley aquifer ^{14}C age values and modeled vertical travel time to the top of the Mt. Simon aquifer. Vertical travel time values should be similar but not the same as ^{14}C ages. The residence time data always represent mixtures of younger and older water and vertical travel time models do not account for the effects of mixing and horizontal groundwater flow.

The remainder of the large area of younger groundwater northeast and east of Wright County also likely originated in the type of setting shown on cross section Y-Y' (Figure 36) because the sandy and thin overlying Quaternary sediments extend into southern Isanti County. Most of the migration of this relatively young body of groundwater would have been controlled by the natural gradients created by the Mississippi and St. Croix rivers prior to human settlement of the Twin Cities metropolitan area.

Summary and Conclusions

- Beginning in the fall of 2009, a total of seven Mt. Simon Sandstone wells and nine wells in other geologic units were drilled in the northern portion of the investigation area (Phase 2). The wells are completed in the Mt. Simon Sandstone, the Hinckley Sandstone, the Fond du Lac Formation, and shallower units on public property in the project area to depths of 100 feet to 695 feet.

- The wells were sampled for chemical constituents, tritium, and carbon-14 that helped determine the residence time or age of the groundwater in this aquifer and overlying aquifers. The wells were also instrumented with equipment to record groundwater levels hourly.

- As the wells were purged prior to sampling, the pumping rate and water level drawdown data showed specific capacities for the Mt. Simon wells ranged from approximately 1 gpm/ft at Crooked Road WMA to 9 gpm/ft at Robina WMA.

- Most Mt. Simon aquifer users in the northwestern metropolitan area are pumping water from the portion of the aquifer that ranges from 50 to 125 feet thick.

- Tritium detections from the project well groundwater samples were somewhat rare with four detections: two from buried sand and gravel aquifers in Sherburne County and two from Mt. Simon aquifer wells in McLeod and Sherburne counties.

- In the southern part of the Phase 2 area (southern Wright and eastern McLeod counties) samples collected from the Mt. Simon aquifer wells had old ^{14}C residence time values of 6,000 to 20,000 years indicating hydraulically isolated conditions and very slow recharge similar to values and conditions found in the Phase 1 project area.

- In the northern portion of the Phase 2 study area ^{14}C residence time values from the Mt. Simon aquifer wells were generally young, typically less than 1,000 years. These values indicate this is an important recharge area.

- Most $\delta^{18}O$ values of groundwater samples from both project phases ranged from approximately -10‰ to -8‰ suggesting small variations of post-glacial climate and/or regional vegetation types.

- Four Mt. Simon-Hinckley or Hinckley groundwater samples in the southern portion of the Phase 2 area contained slightly elevated Na+K water similar to some groundwater in the Phase 1 area where the Mt. Simon Sandstone subcrop is not overlain by a thick extensive surficial sand layers typical of the northern portion of the Phase 2 area.

- Two groundwater samples exceeded the drinking water standard for arsenic (10 ug/l). These samples were collected from the buried sand and gravel aquifer at the Lake Ann WA site (Wright County) and the Wonewoc aquifer at the Pickerel Lake WA site (Anoka County).

- Hydrographs of Mt. Simon-Hinckley, Hinckley, and Fond du Lac aquifer wells in the northern portion of the Phase 2 area from early 2011 through the spring of 2012 correlate well with the precipitation pattern during that period. These data along with local stratigraphic information and residence time data indicate at least some direct hydraulic connection to the surface.

- Four zones of younger (less than 10,000 years) Mt. Simon aquifer groundwater were defined by this project. Three of these zones are elongated toward the Minnesota River valley. The two southerly zones were created by slow dispersed downward migra tion of recharge water through fine-grained glacial sediment and Cretaceous sand and shale. The northern two zones comprised of younger water were created by recharge from areas of local and focused recharge through interconnected sand and gravel layers.

A major accomplishment of this project is the creation of a network of observation well nests along the western margin of the Mt. Simon Sandstone that is considered an important recharge area for the aquifer. Long term water level and geochemistry data from these wells will enable future hydrologists to evaluate the local and regional effects of continuing future Mt. Simon aquifer groundwater pumping in the region. In addition, this project demonstrated the value of high frequency, nested water level measurements, groundwater chemistry, and residence time data in constructing conceptual models of groundwater flow and recharge.

Recommendations

The observation wells installed for this project have become part of the DNR observation well network. Continued monitoring of these wells will create a long term record that can be used to interpret changes in local and regional water supply due to water use or climate changes. In general, observation well record data become increasingly valuable as the length of record increases over time.

This project and Tipping (2011) have shown that the most critical recharge area for the Mt. Simon-Hinckley aquifer and Minneapolis-St. Paul metropolitan area water supply includes northeastern Wright County, eastern Sherburne County, and southern Isanti County. Protection of this region from water pollution should be a high priority for all levels of government. One of the primary purposes of the DNR and MGS County Geologic Atlas program is to create maps of pollution sensitivity for important aquifers. Atlases for Wright and Sherburne counties are currently in progress and will provide information for the next step in defining sensitive areas of the Mt. Simon-Hinckley aquifer. Unfortunately, there are no current plans for an Isanti County geologic atlas. This study has shown that protection of water resources in the Buffalo to Cambridge area has not only local implications but also is of significant importance for one of the major aquifers in the Minneapolis-St. Paul metropolitan area.

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Tables

Table 1 - Well summary

DNR OB#	MN Unique	County	Site Name	Formation	Drilling Method	Depth	UTM Easting	UTM Northing	Top casing elevation (ft above msl)	Ground elevation (ft above msl)	Depths of open hole or screened interval (ft)	Depth to Water (ft)
43000	210308	McLeod	McLeod Co Hwy Dept*	CMTS	unknown	500	408846	4959611	1020.9	1018.1	446-500	143
43005	773241	McLeod	Clouster Lake WMA	CMTS	DR/RC	580	411577	4973105	1033.1	1031.0	491-580	137.67
43006	773242	McLeod	Clouster Lake WMA	QBAA	DR/RC	120	411575	4973104	1033.2	1030.8	112-120	17.01
86011	773244	Wright	Lake Ann WA	CMTS	DR/RC	530	416903	4986009	1000.0	997.9	456-476	87.76
86012	773243	Wright	Lake Ann WA	QBAA	DR/RC	118	416904	4986010	1000.3	998.4	110-118	12.08
86013	777348	Wright	Anderson County Park	PMHN	DR/RC	450	418750	4997277	1004.4	1002.2	393-450	77.38
86014	777349	Wright	Anderson County Park	QBAA	MR	138	418750	4997276	1004.2	1002.2	130-138	65.54
27058	779945	Henn	Robina WMA	CMTS	DR/RC	695	441275	4987241	991.3	989.1	595-695	79.33
71027	777350	Sherburne	Sand Dunes State Forest	CMTS	DR/RC	208	448200	5026886	973.7	971.7	140-208	28.02
71028	777351	Sherburne	Sand Dunes State Forest	QBAA	MR	100	448202	5026888	973.8	971.9	90-98	27.66
71029	777352	Sherburne	Sherburne Nat WLR	PMFL	DR/RC	355	450173	5035011	981.9	979.8	215-355	31.04
71030	777353	Sherburne	Sherburne Nat WLR	QBAA	MR	161	450174	5035014	981.9	979.9	145-155	30.86
30015	779949	Isanti	Crooked Road WMA	CMTS	DR/RC	311.5	463566	5037109	973.6	971.4	270-310	26.81
30016	779947	Isanti	Spectacle Lake WMA	CMTS	DR/RC	262	467925	5045052	963.5	961.3	221-261	35.38
30017	779944	Isanti	Stanchfield WMA	PMHN	DR/RC	185	476144	5062969	962.5	960.5	164-184	12.06
2031	779942	Anoka	Pickerel Lake WMA	CMTS	DR/RC	410	465172	5020025	930.9	928.9	310-410	19.94
2032	779941	Anoka	Pickerel Lake WMA	CWOC	DR/RC	195	465172	5020027	931.0	929.0	170-195	14.14

Drilling methods:
MR = mud rotary
DR/RC = dual rotary/reverse circulation

QBAA = Quaternary buried aquifer
CWOC= Cambrian Wonowoc
CMTS = Cambrian Mt. Simon Sandstone

PMHN = Precambrian Hinckley Sandstone
PMFL = Precambrian Fond du Lac Formation

* Existing well, completed 1971

Table 2 Well pumping data summary

Date Sampled	MN Unique	County	Site Name	Formation	Depth to static water from top Casing (ft.)	Static water water elevation (ft. above msl)	Pumping Minutes	Volume (gallons)	Pumping Rate (gpm)	Drawdown (feet)	Specific Capacity (gpm/drawdown)
10/11/2010	210308	McLeod	McLeod Co Hwy Dept	CMTS	146.02	874.88	56	890	16	11.17	1.4
10/12/2010	773241	McLeod	Clouster Lake WMA	CMTS	137.62	895.43	74	1145	15	1.83	8.5
10/11/2010	773242	McLeod	Clouster Lake WMA	QBAA	16.69	1016.47	26	560	22	3.57	6.1
10/12/2010	773244	Wright	Lake Ann WA	CMTS	87.83	912.13	40	865	22	28.98	0.7
10/12/2010	773243	Wright	Lake Ann WA	QBAA	11.76	988.54	24	600	25	2.25	11.2
10/12/2010	777348	Wright	Anderson County Park	PMHN	77.31	927.04	46	715	16	43.36	0.4
10/12/2010	777349	Wright	Anderson County Park	QBAA	64.54	939.68	20	295	15	39.20	0.4
10/13/2010	777350	Sherburne	Sand Dunes State Forest	CMTS	27.61	946.04	41	1260	31	5.53	5.6
10/13/2010	777351	Sherburne	Sand Dunes State Forest	QBAA	27.34	946.48	40	1192	30	22.17	1.4
10/13/2010	777352	Sherburne	Sherburne National Wildlife Refuge	PMFL	30.73	951.21	45	1180	26	14.86	1.8
10/13/2010	777353	Sherburne	Sherburne National Wildlife Refuge	QBAA	30.44	951.46	37	670	18	64.91	0.3
10/13/2010	779949	Isanti	Crooked Road WMA	CMTS	26.99	946.57	40	1190	30	24.5	1.2
10/14/2010	779947	Isanti	Spectacle Lake WMA	CMTS	35.83	927.62	52	1590	31	9.06	3.4
10/14/2010	779944	Isanti	Stanchfield WMA	PMHN	12.39	950.14	40	1040	26	47.38	0.55
12/2/2010	779942	Anoka	Pickerel WA	CMTS	20.54	910.34	63	1040	17	3.88	4.3
12/2/2010	779941	Anoka	Pickerel WA	CWOC	14.6	916.28	39	1020	26	6.7	3.9
10/12/2010	779945	Hennepin	Robina WMA	CMTS	79.33	911.97	57	1745	31	3.33	9.3

QBAA = Quaternary buried aquifer
CWOC= Cambrian Wonowoc
CMTS = Cambrian Mt. Simon Sandstone

PMHN = Precambrian Hinckley Sandstone
PMFL = Precambrian Fond du Lac Formation

Table 3 Field sample collection and handling

Parameter	Lab	Sample container	Head space	Rinse	Filter	Preservative	Refrigeration	Shelf life	Field duplicate	Field blank	Storage duplicate
Tritium	Waterloo	500 ml, HDPE	yes	**NO**	no	no	no	long	1 for every 20	none	yes
18O, Deuterium	Waterloo	60 ml, HDPE	yes	**NO**	no	no	no	long	1 for every 20	none	yes
Cations	U of M	15 ml, Fisherbrand BLUE cap	yes	yes *	yes	1 drop 6N HCl	yes	2-3 weeks	1 for every 20	1 for every 20 ****	no
Anions	U of M	50 ml, Argos BLACK ***	yes	yes *	yes	no	yes	2-3 weeks	1 for every 20	1 for every 20 ****	no
Trace constituents	U of M	15 ml, Sarstedt RED cap	yes	yes *	yes	5 drops 15N HNO_3	yes	2-3 weeks	1 for every 20	1 for every 20 ****	no
Alkalinity	onsite	500 ml, plastic	**NO**	yes **	no	no	Yes, if not analyzed onsite	24-48 hours	none	none	no
14C	U of M	30 gallon barrel	yes	no	yes	NH_4OH to pH 8.5	no	years	none	none	no

* Rinse the bottle once with FILTERED sample water prior to collecting the sample. Rinsing means fill the bottle with sample water (FILTERED if sample is filtered) and then pour the contents out over the cap.

** Rinse the bottle three times with sample water prior to collecting the sample. Fill bottle submerged with cap in hand. Seal bottle submerged ensuring no remnant bubbles.

*** Fill 50 ml anion bottle unless filtering is very difficult. Bottle must be at least 1/3 full.

**** Use DI water from small bottle for field blanks (NOT THE CARBOY). Pour DI water into the back of the syringe when the plunger is removed. Fill bottles through filter.

Table 4 Residence time indicators, stable isotopes, and selected trace elements

						Trace elements**		Residence time indicators		Stable isotopes****	
MN unique	**Site name**	**County**	**Formation**	**Depth (ft)**	**Date sampled**	As	B	^{14}C (years)	Tritium***	Deuterium	^{18}O
210308	McLeod Co Hwy Dept	McLeod	CMTS	500	10/11/2010	<0.66	500	11,000	2.7	-63.58	-9.5
773241	Clouster Lake WMA	McLeod	CMTS	580	10/12/2010	<2.3	150	14,000	<0.8	-68.45	-10.24
773242	Clouster Lake WMA	McLeod	QBAA	120	10/11/2010	9.66	200	6,000	<0.8	-64.86	-9.97
773243	Lake Ann WA	Wright	QBAA	118	10/12/2010	11.63	100	60	<0.8	-58.96	-9.38
773244	Lake Ann WA	Wright	CMTS	530	10/12/2010	<0.66	300	20,000	<0.8	-64.49	-9.59
777348	Anderson County Park	Wright	PMHN	450	10/12/2010	<2.3	500	6,000	<0.8	-62.97	-8.26
777349	Anderson County Park	Wright	QBAA	138	10/12/2010	<2.3	270	2,000	<0.8	-60.07	-8.82
777350	Sand Dunes State Forest	Sherburne	CMTS	208	10/13/2010	<0.66	<45	1,400	4.6	-72.42	-10.44
777351	Sand Dunes State Forest	Sherburne	QBAA	100	10/13/2010	<2.3	<45	60	19.6	-72.15	-10.37
777352	Sherburne Nat NWR	Sherburne	PMFL	355	10/13/2010	<0.66	<45	8,000	<0.8	-65.99	-8.83
777353	Sherburne Nat NWR	Sherburne	QBAA	161	10/13/2010	3.29	<45	1,300	4.1	-61.91	-8.44
779941	Pickerel Lake WMA	Anoka	CWOC	195	12/2/2010	14.4	46	2,000	<0.8	-67.18	-9.79
779942	Pickerel Lake WMA	Anoka	CMTS	410	12/2/2010	6.4	<45	2,000	<0.8	-60.01	-8.08
779944	Stanchfield WMA	Isanti	PMHN	185	10/14/2010	<0.66	60	300	<0.8	-57.09	-8.13
779945	Robina WMA	Hennepin	CMTS	695	10/12/2010	<2.3	100	15,000	<0.8	-53.97	-7.67
779947	Spectacle Lake WMA	Isanti	CMTS	262	10/14/2010	<0.66	<45	3,000	<0.8	-67.05	-9.85
779949	Crooked Road WMA	Isanti	CMTS	311.5	10/13/2010	4.62	<45	600	<0.8	-62.87	-9.02

** ug/l (parts per billion)
*** tritium units (TU), < means not detected

**** delta values reported in units per thousand relative to standard
NA = not analyzed

QBAA = Quaternary buried aquifer
CWOC = Cambrian Wonewoc Sandstone

CMTS = Cambrian Mt. Simon Sandstone
PMHN = Precambrian Hinckley Sandstone
PMFL = Fond du Lac Formation

Table 5 Selected anion and cation data

						Anions mg/l				Cations mg/l					
MN unique	Site name	County	Formation	Depth (ft)	Date sampled	Cl	SO4	Br	Cl/Br	Ca	Mg	Na	K	Fe	Mn
210308	McLeod Co Hwy Dept	McLeod	CMTS	500	10/11/2010	11.3	8.03	0.050	226	39.9	15.3	76.9	2.69	1.15	0.066
773241	Clouster Lake WMA	McLeod	CMTS	580	10/12/2010	2.08	95.2	0.034	61	83.1	38.7	57.5	4.92	1.80	0.026
773242	Clouster Lake WMA	McLeod	QBAA	120	10/11/2010	0.88	62.1	0.022	40	86.4	38.9	47.3	4.84	1.06	0.094
773243	Lake Ann WA	Wright	QBAA	118	10/12/2010	0.79	16.1	0.024	33	100.5	38.5	22.1	6.32	0.952	0.232
773244	Lake Ann WA	Wright	CMTS	530	10/12/2010	3.45	75.8	0.027	128	42.1	19.1	75.5	5.13	0.585	0.075
777348	Anderson County Park	Wright	PMHN	450	10/12/2010	1.97	122	0.025	79	73.6	37.7	90.6	7.05	2.82	0.051
777349	Anderson County Park	Wright	QBAA	138	10/12/2010	1.68	64.9	0.025	67	83.1	39.8	47.7	5.71	0.527	0.376
777350	Sand Dunes State Forest	Sherburne	CMTS	208	10/13/2010	0.65	13.4	0.005	130	47.1	11.3	2.68	1.35	0.581	0.182
777351	Sand D unes State Forest	Sherburne	QBAA	100	10/13/2010	0.70	16.1	0.006	117	49.7	11.9	3.42	1.11	0.185	0.134
777352	Sherburne Nat NWR	Sherburne	PMFL	355	10/13/2010	1.80	2.61	0.011	164	45.4	12.8	9.73	2.91	0.685	0.034
777353	Sherburne Nat NWR	Sherburne	QBAA	161	10/13/2010	0.93	2.30	0.008	116	43.8	13.4	9.29	1.79	1.082	0.263
779941	Pickerel Lake WMA	Anoka	CWOC	195	12/2/2010	2.13	12.6	0.008	266	49.4	20.0	7.93	6.46	0.006	0.083
779942	Pickerel Lake WMA	Anoka	CMTS	410	12/2/2010	1.04	1.17	0.005	208	57.6	21.0	6.24	2.27	1.364	0.113
779944	Stanch□eld WMA	Isanti	PMHN	185	10/14/2010	1.31	0.63	0.008	164	69.2	30.3	5.47	1.98	1.990	0.421
779945	Robina WMA	Hennepin	CMTS	695	10/12/2010	0.98	61.1	0.016	61	97.9	29.1	10.5	7.73	1.660	0.072
779947	Spectacle Lake WMA	Isanti	CMTS	262	10/14/2010	0.52	3.09	0.005	104	36.9	13.4	6.44	2.96	0.029	0.125
779949	Cr ooked Road WMA	Isanti	CMTS	311.5	10/13/2010	0.48	1.67	0.006	80	48.2	14.2	4.08	1.48	0.029	0.102

QBAA = Quaternary buried aquifer
CWOC = Cambrian Wonewoc Sandstone
CMTS = Cambrian Mt. Simon Sandstone
PMHN = Precambrian Hinckley Sandstone
PMFL = Fond du Lac Formation

Figures

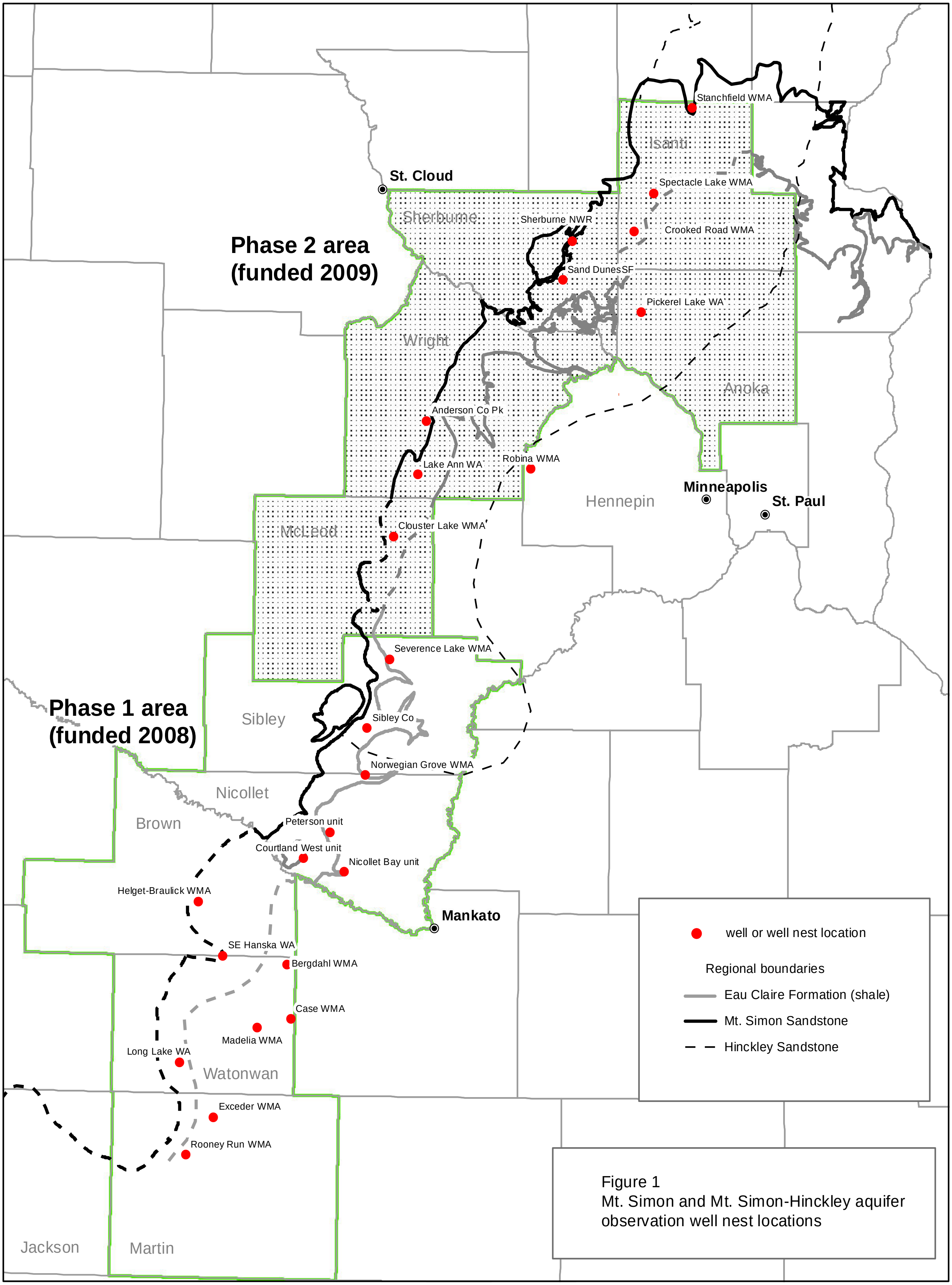


Figure 1
Mt. Simon and Mt. Simon-Hinckley aquifer observation well nest locations

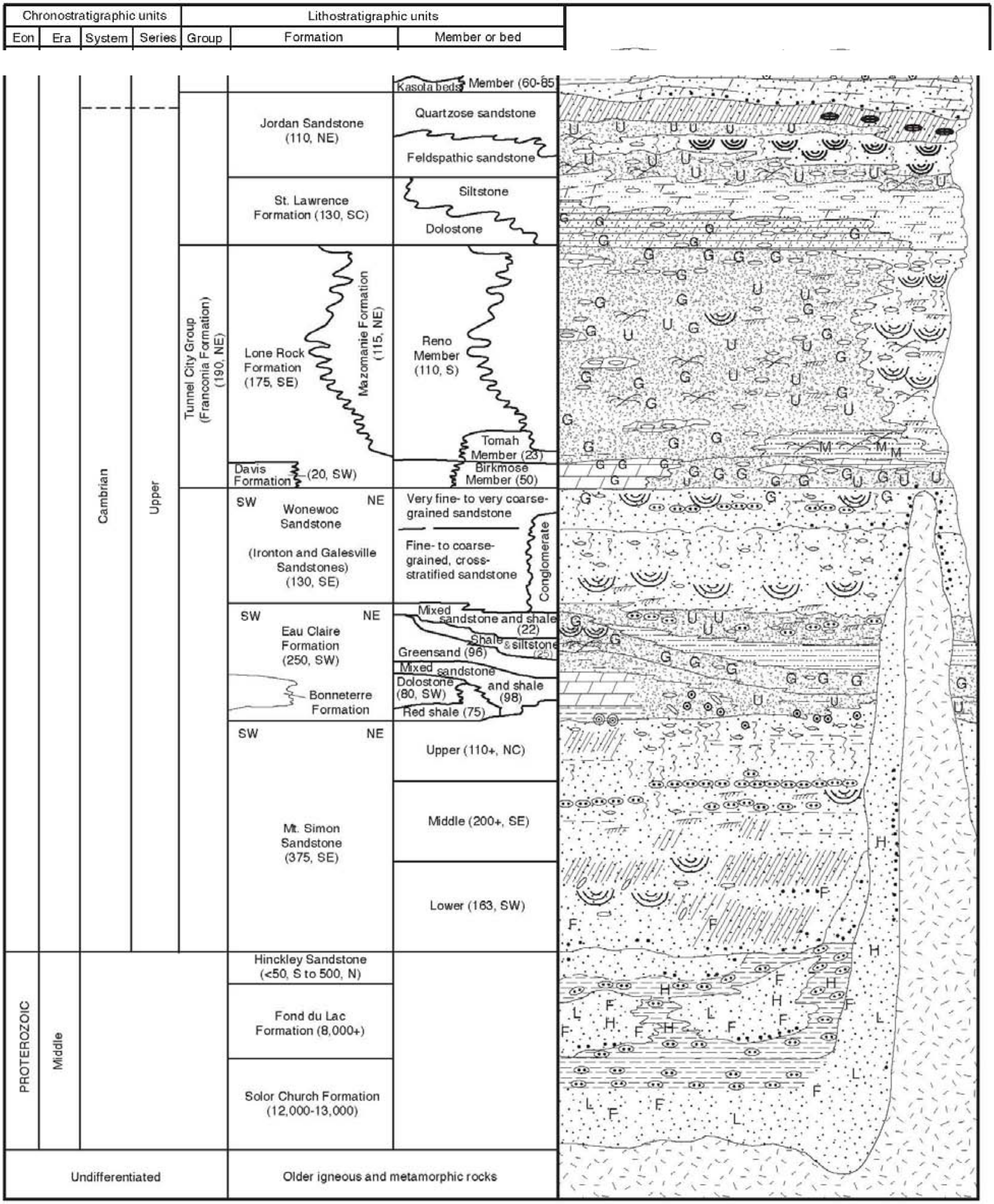


Figure 2 Cambrian and older stratigraphy in study area (Modified from Mossler 2008)

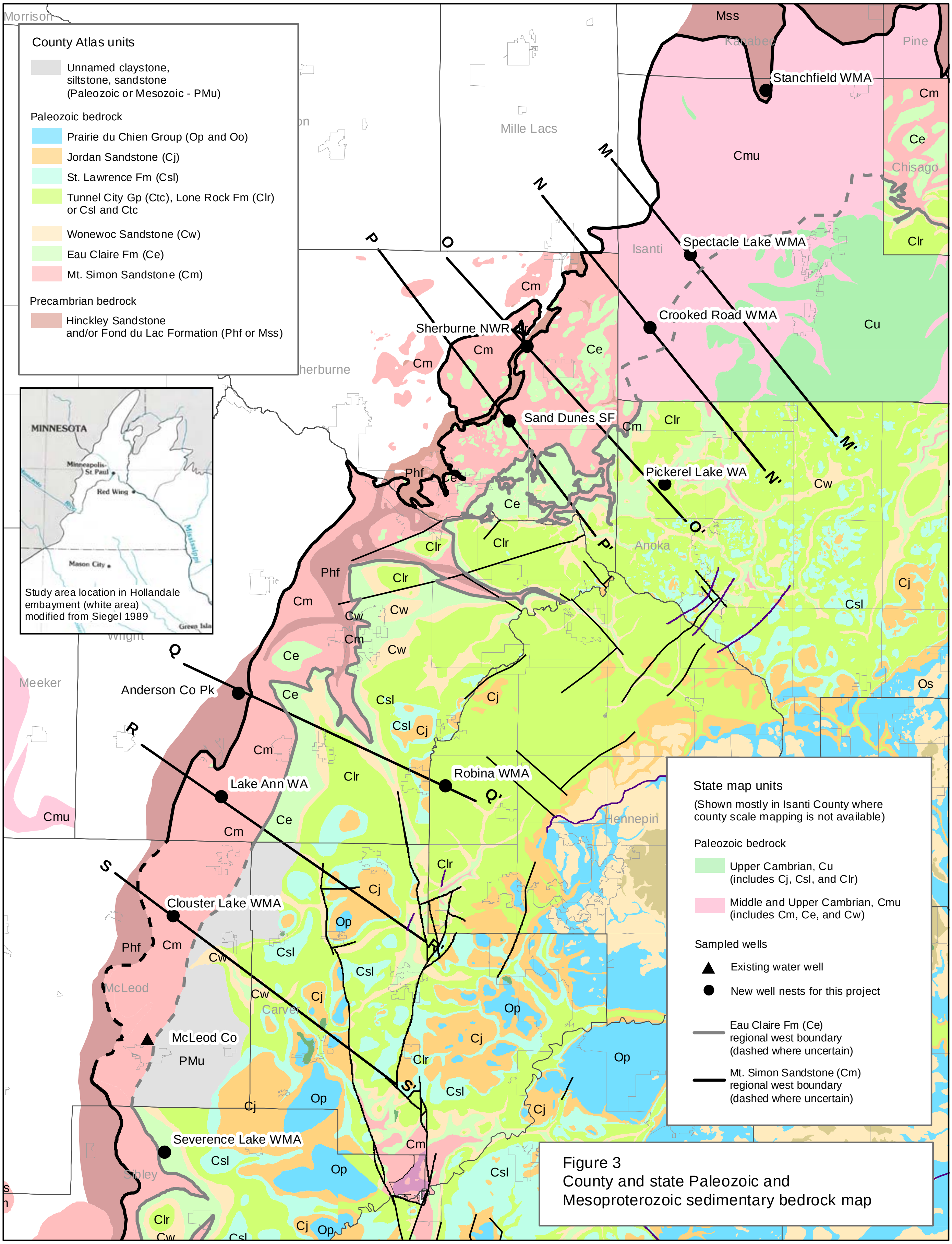


Figure 3
County and state Paleozoic and Mesoproterozoic sedimentary bedrock map

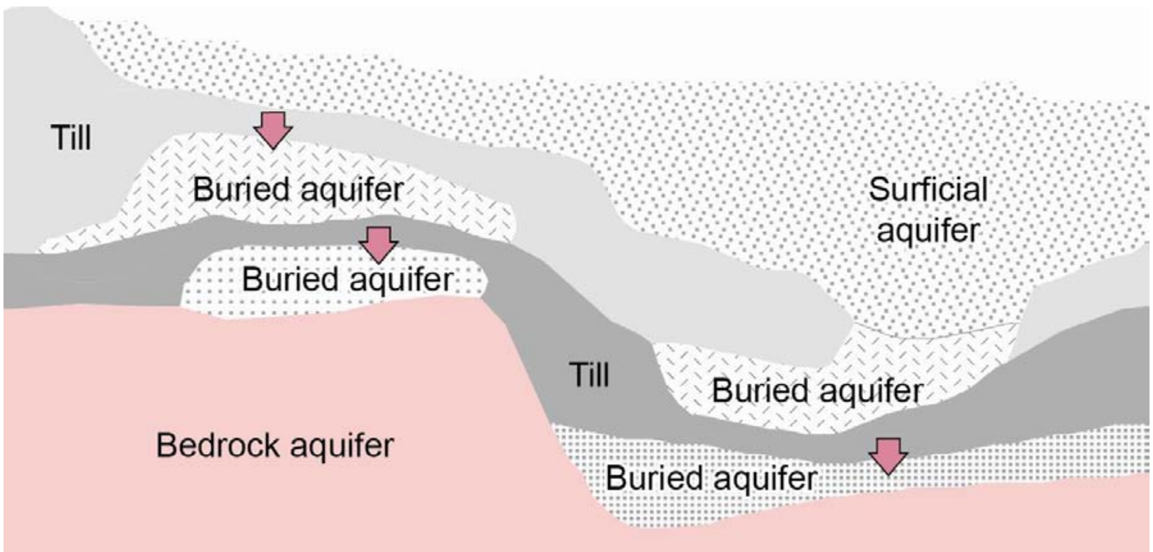


Figure 4

Schematic cross section of focused recharge to a bedrock aquifer through connected buried sand and gravel aquifers

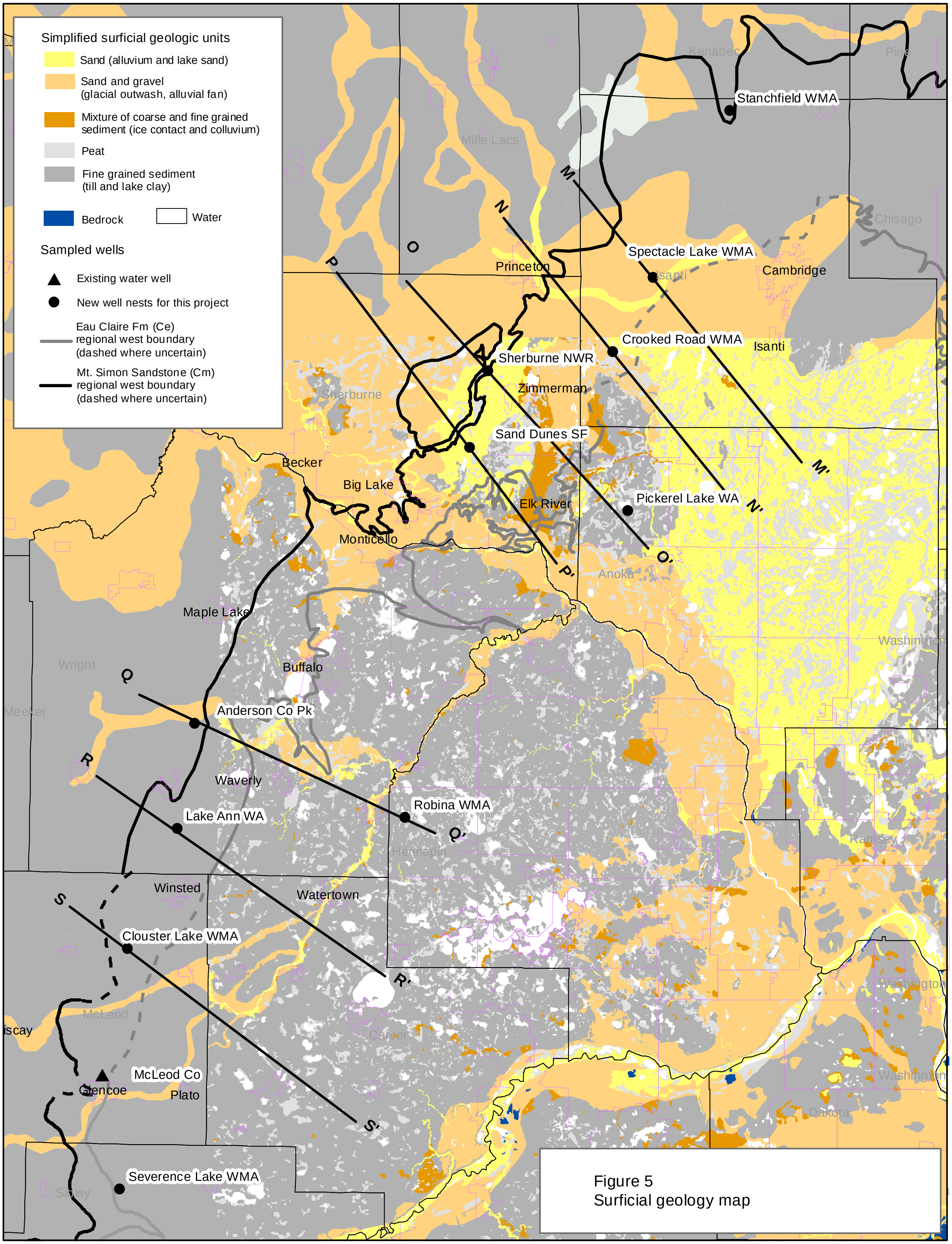


Figure 5
Surficial geology map

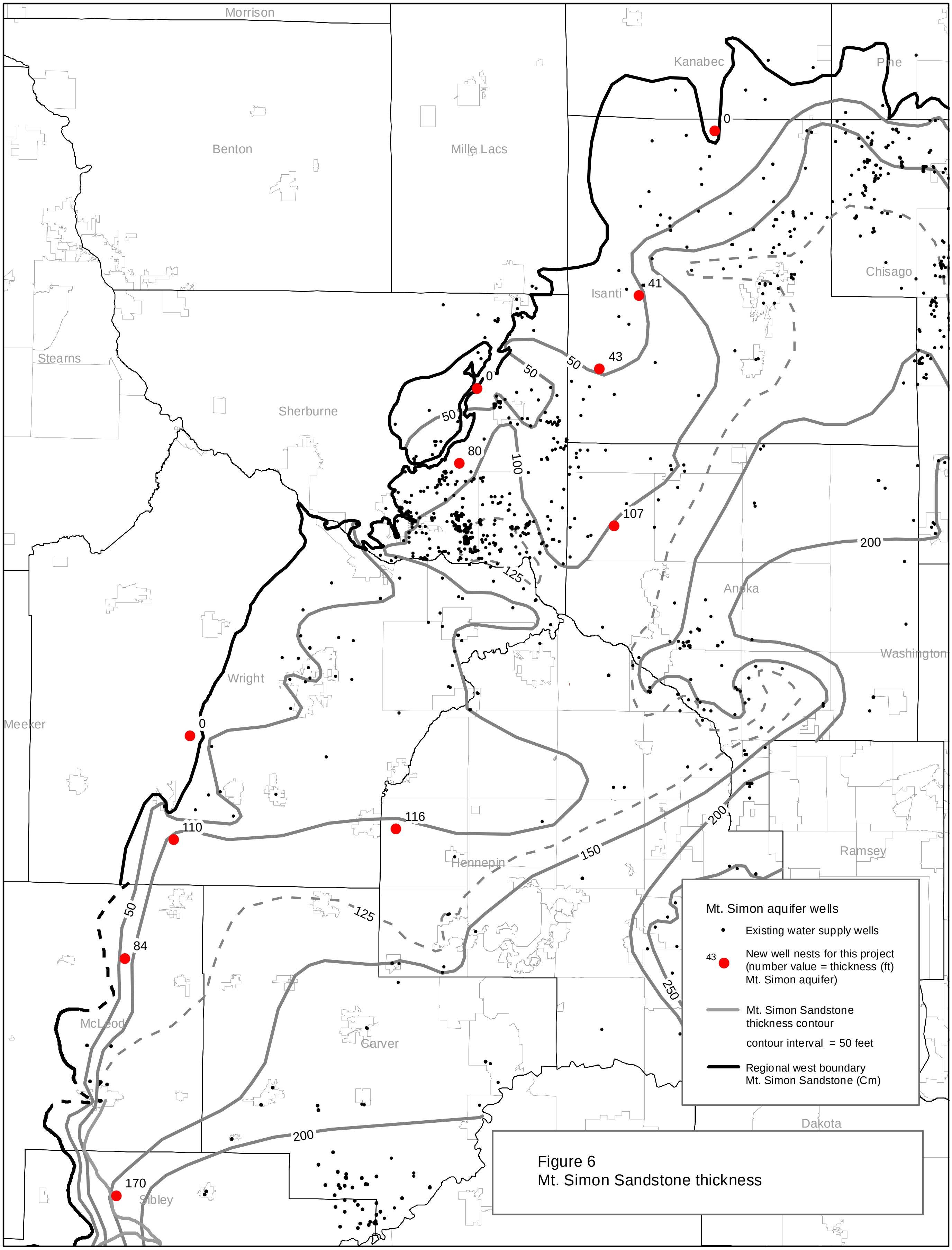


Figure 6
Mt. Simon Sandstone thickness

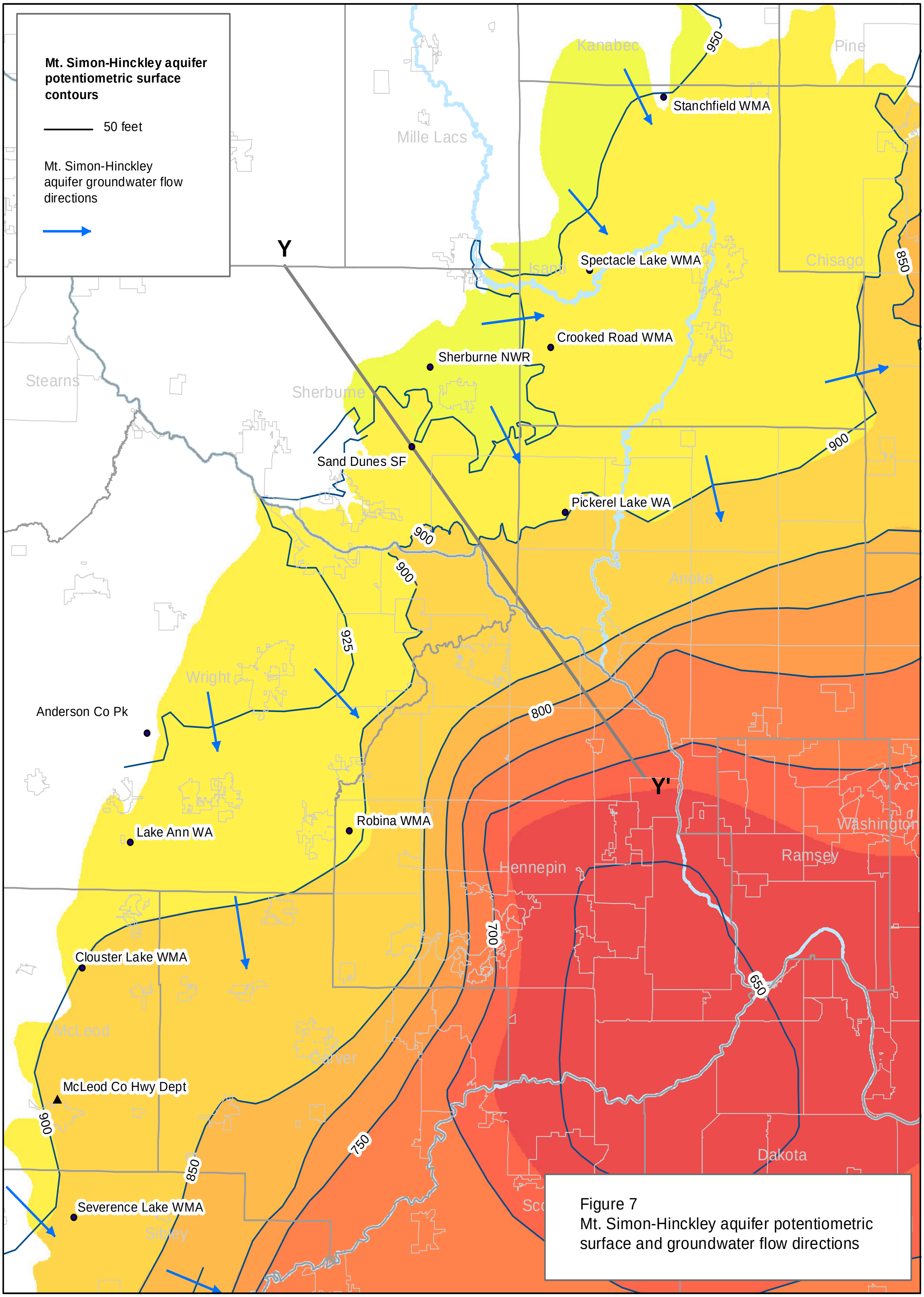


Figure 7
Mt. Simon-Hinckley aquifer potentiometric surface and groundwater flow directions

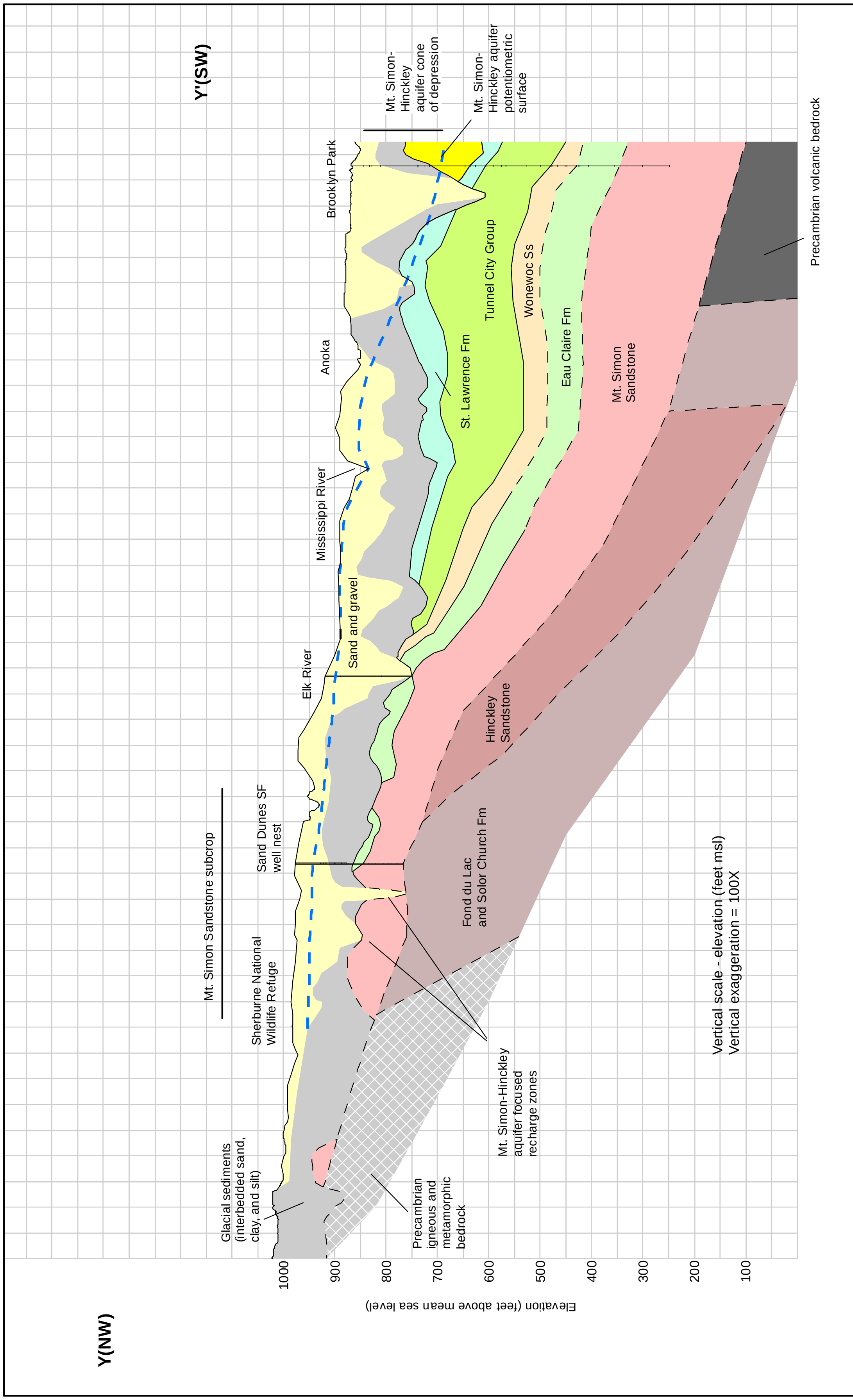


Figure 8
Cross section Y-Y'
Mt. Simon-Hinckley aquifer
potentiometric surface

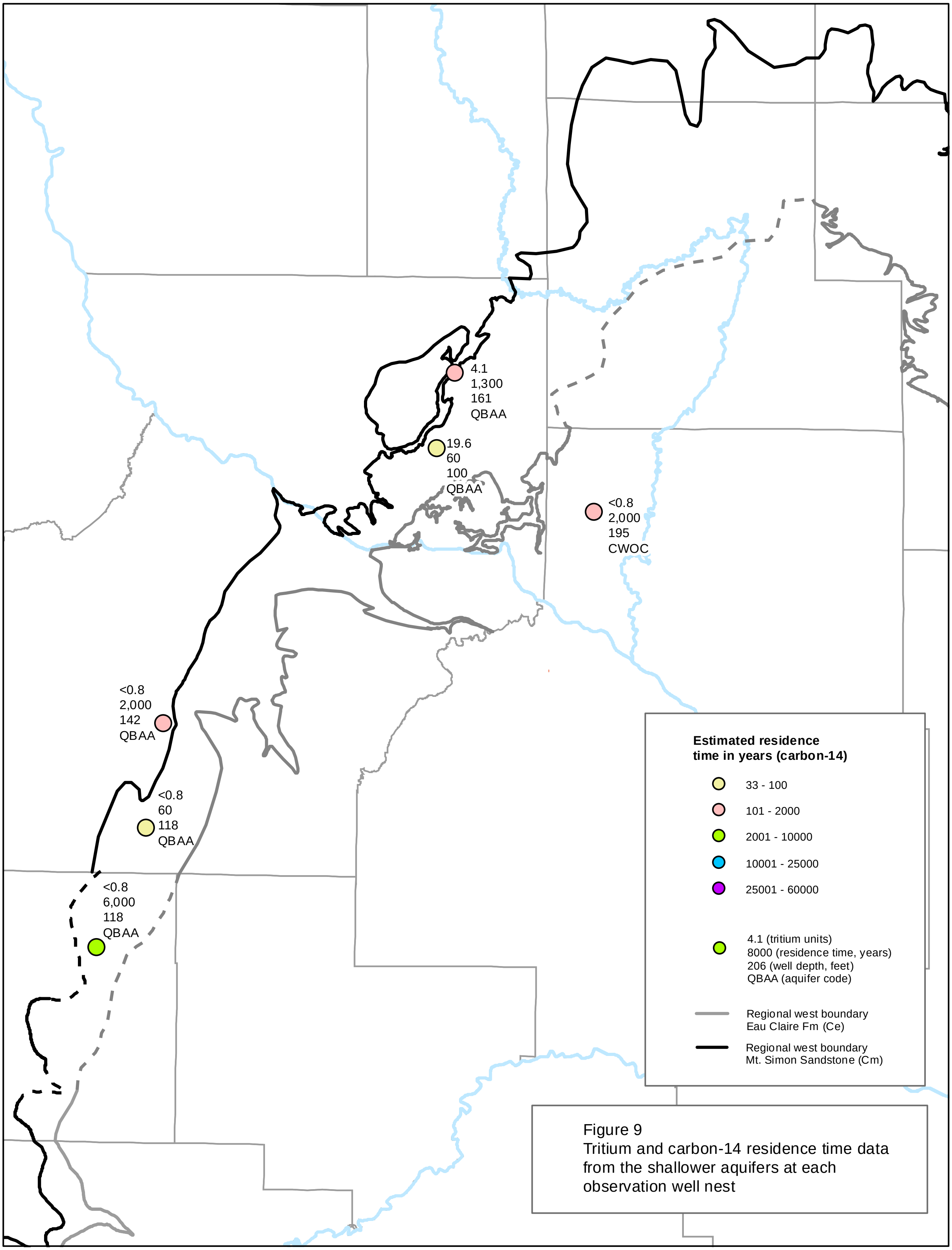


Figure 9
Tritium and carbon-14 residence time data from the shallower aquifers at each observation well nest

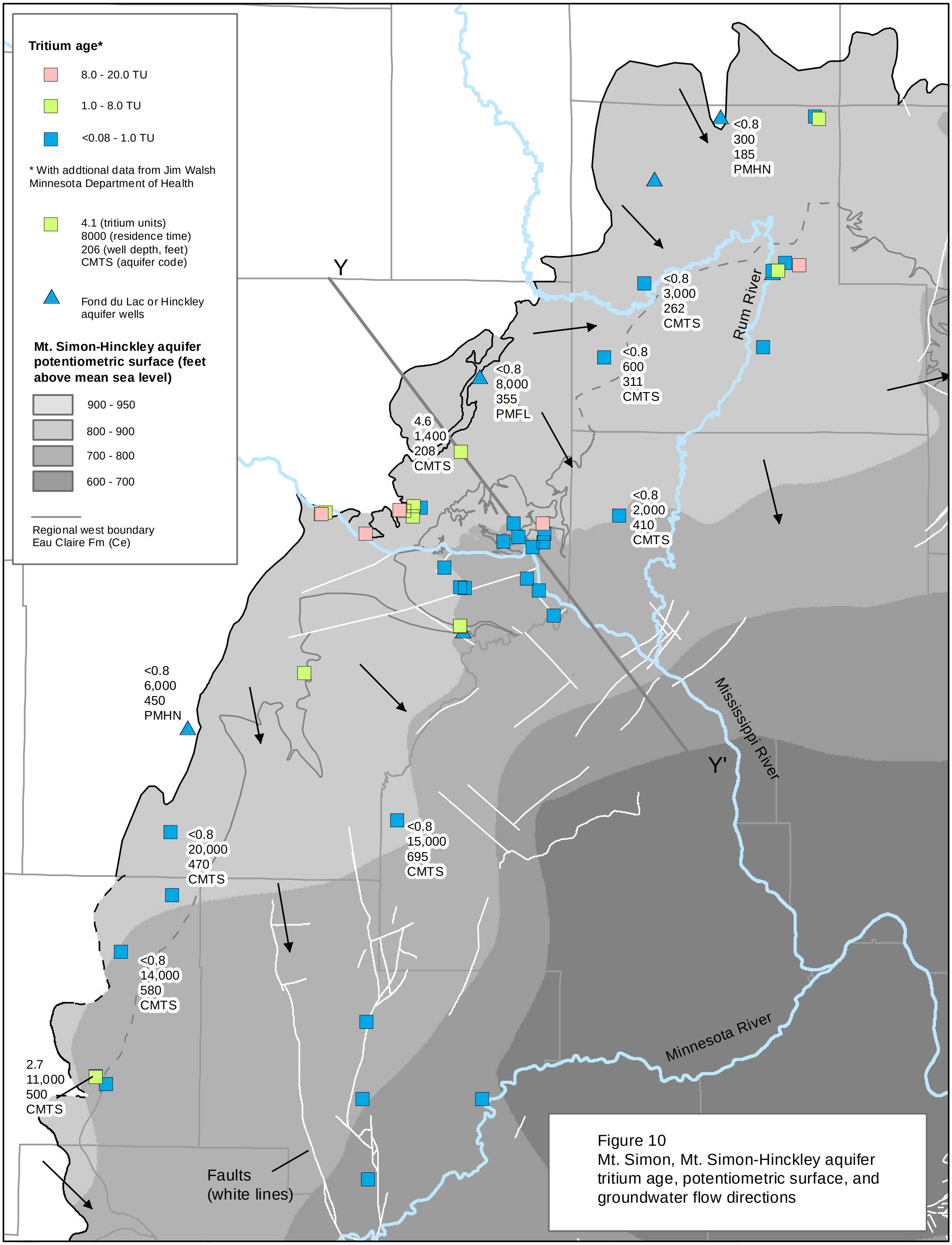


Figure 10
Mt. Simon, Mt. Simon-Hinckley aquifer tritium age, potentiometric surface, and groundwater flow directions

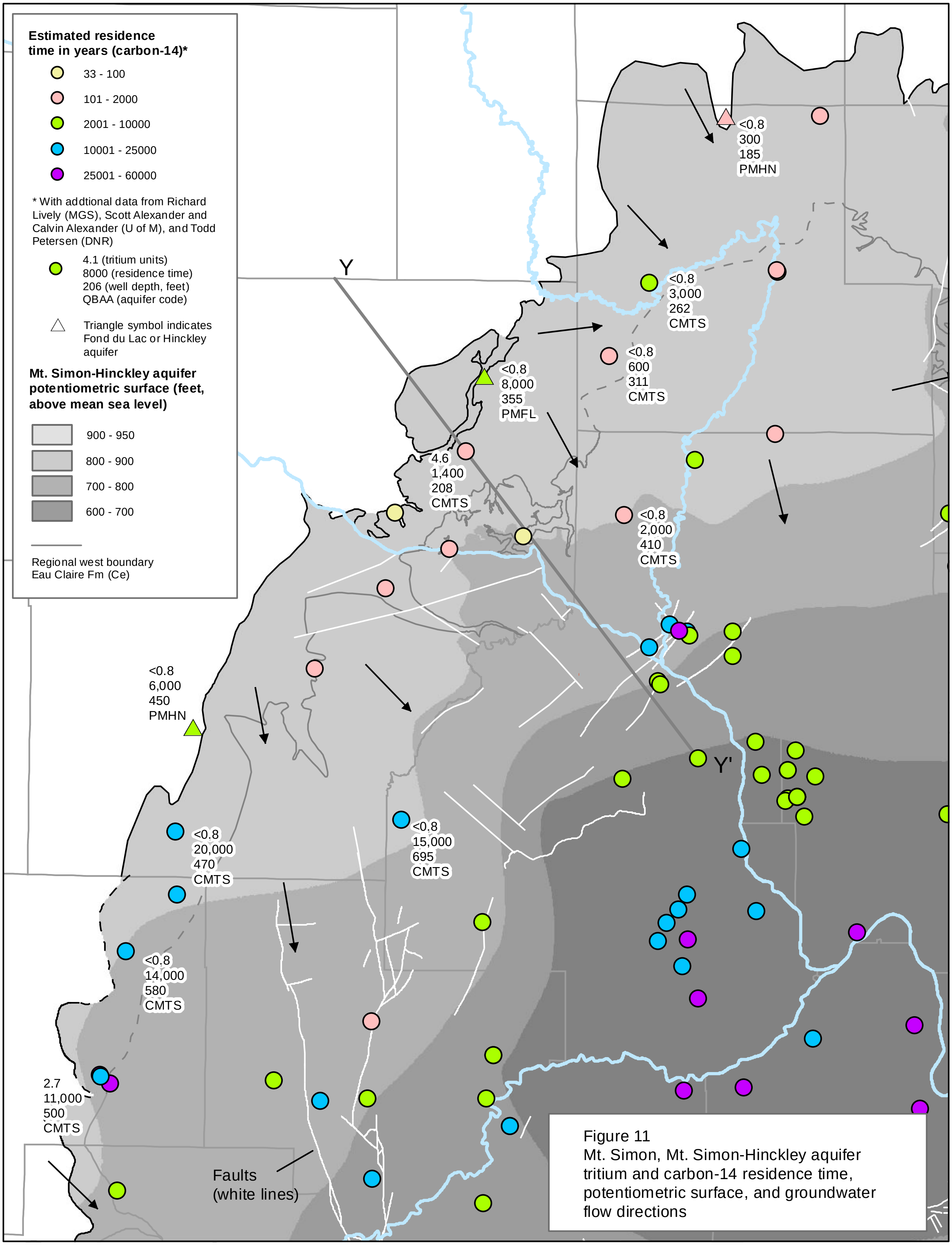
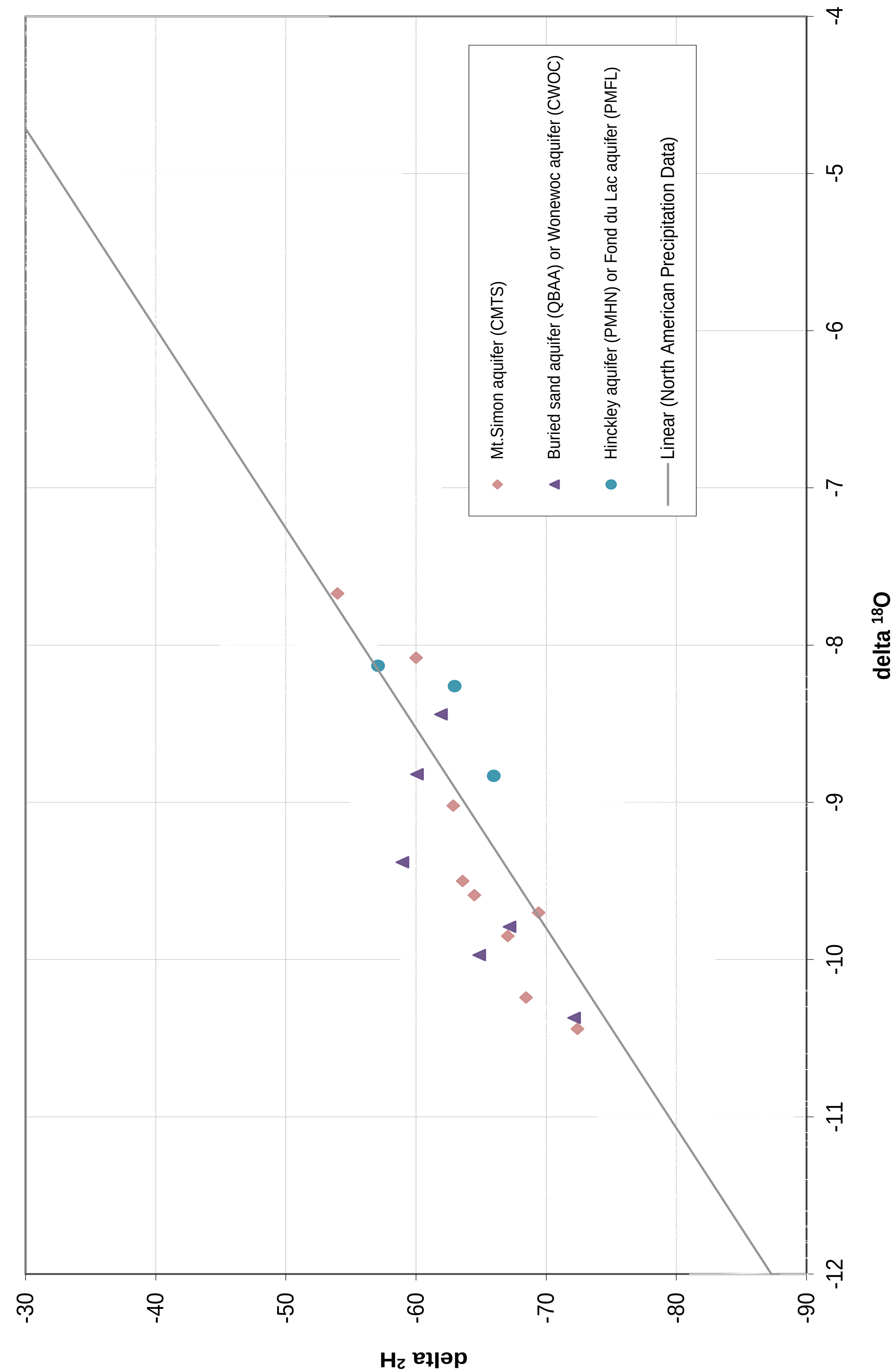


Figure 11
Mt. Simon, Mt. Simon-Hinckley aquifer tritium and carbon-14 residence time, potentiometric surface, and groundwater flow directions

Figure 12 Stable isotope data compared with North American meteoric line



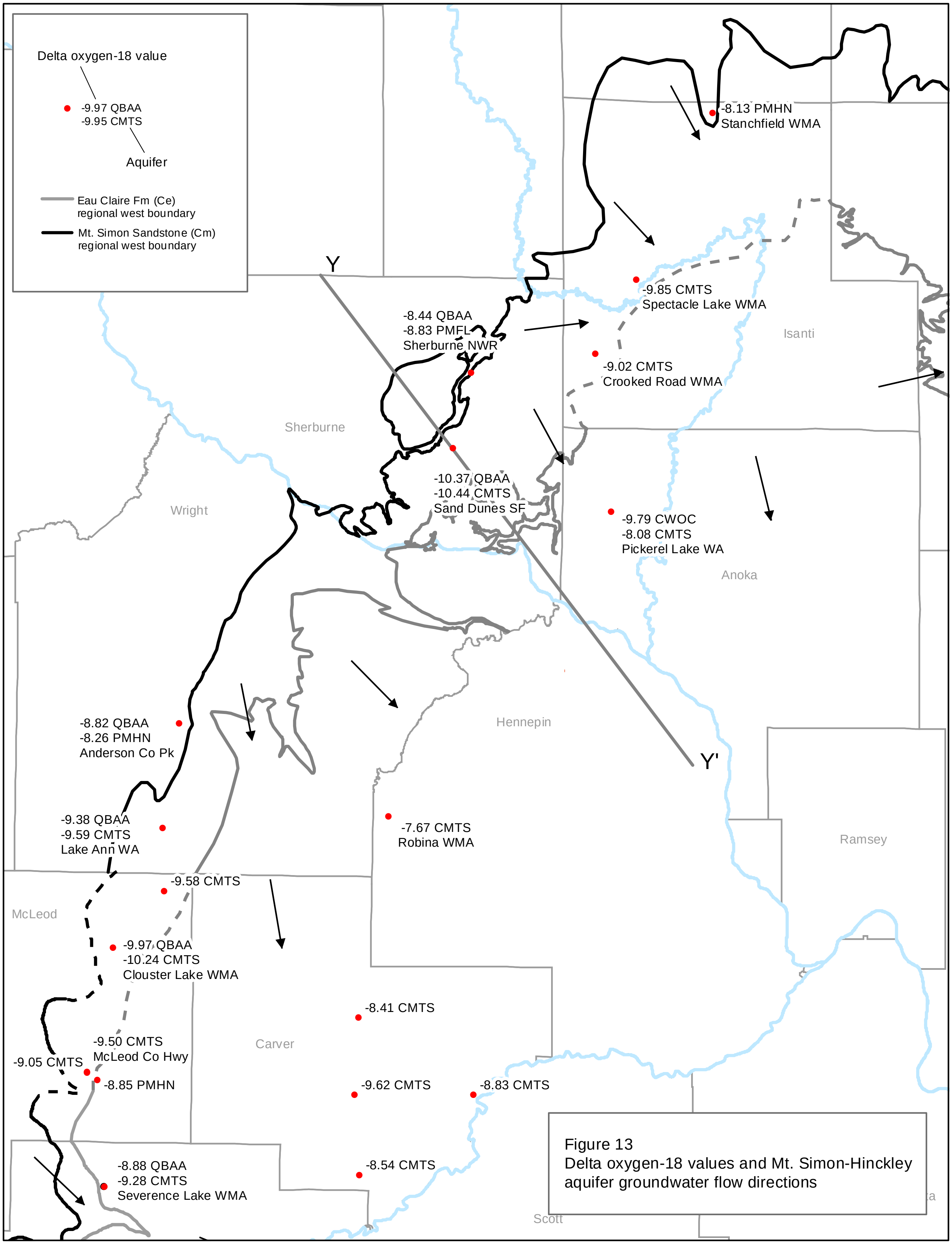


Figure 13
Delta oxygen-18 values and Mt. Simon-Hinckley aquifer groundwater flow directions

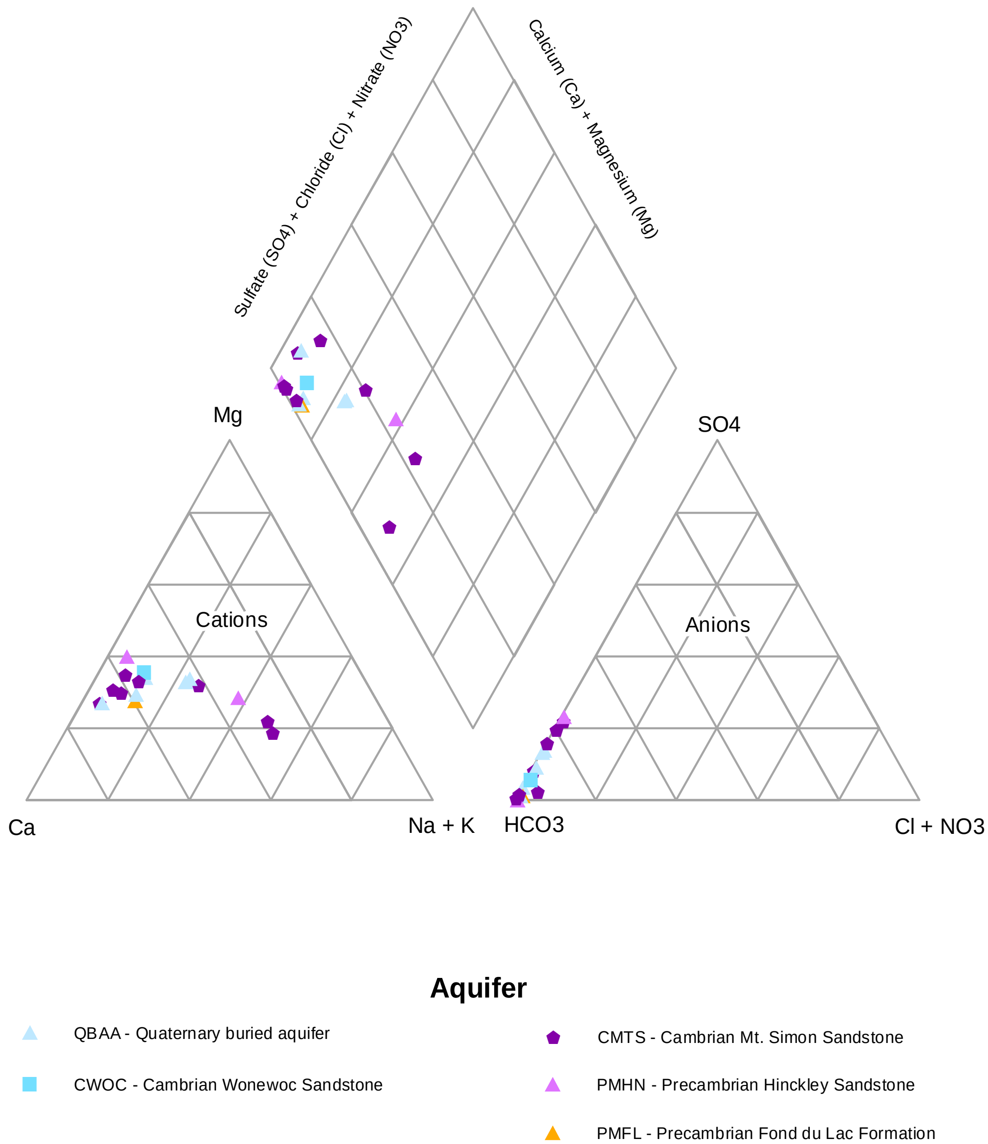
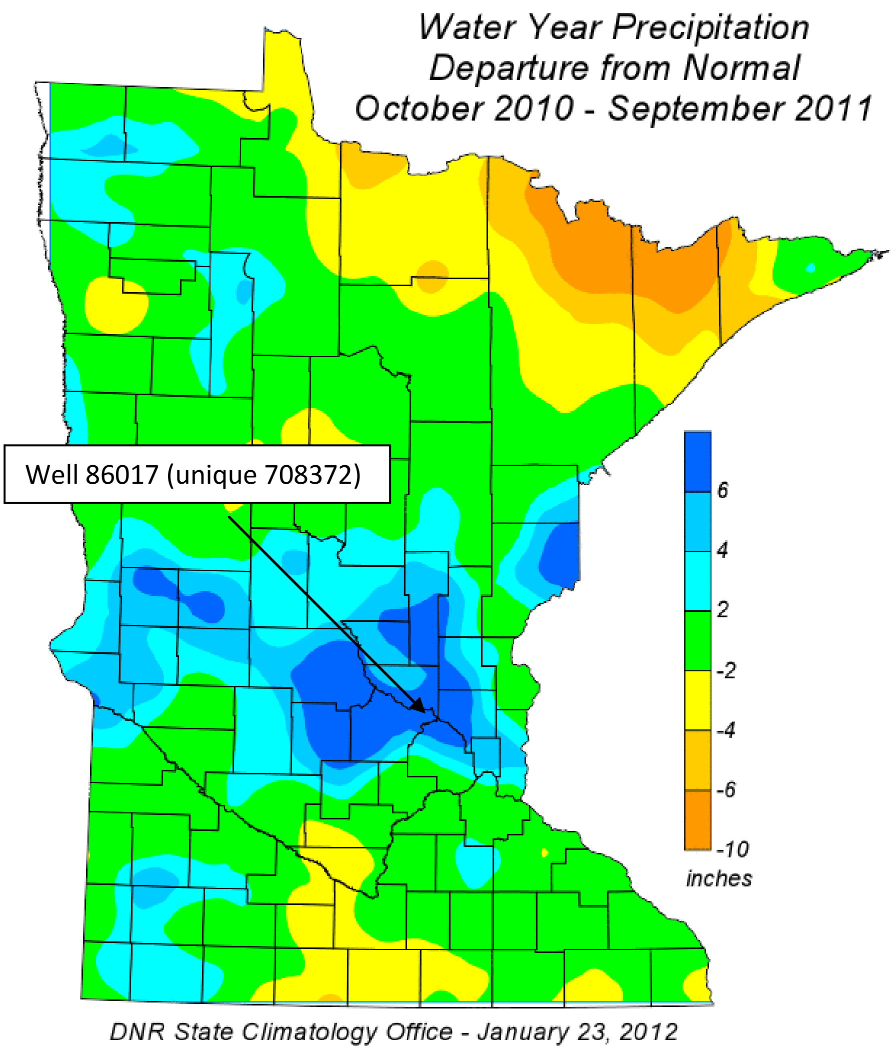


Figure 14
Ternary diagram showing relative abundances of major cations and anions



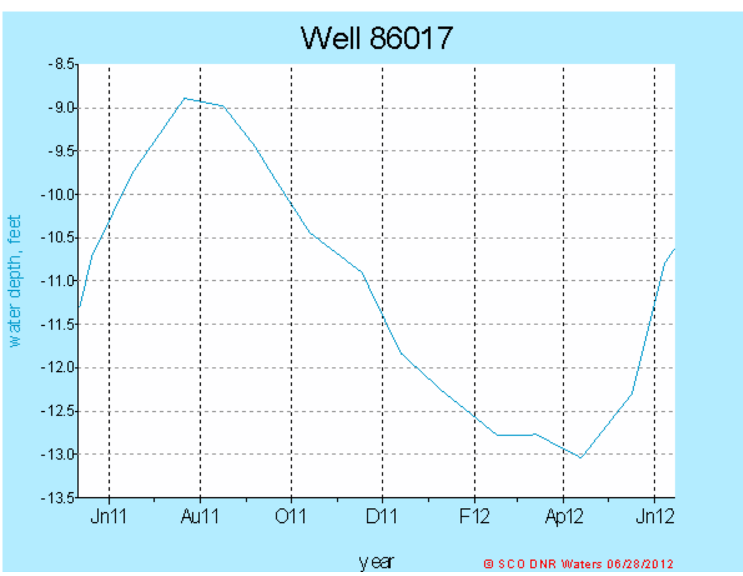


Figure 15

Precipitation departure from normal October 2010 - September 2011 and hydrograph of typical water table observation well in the Phase 2 study area

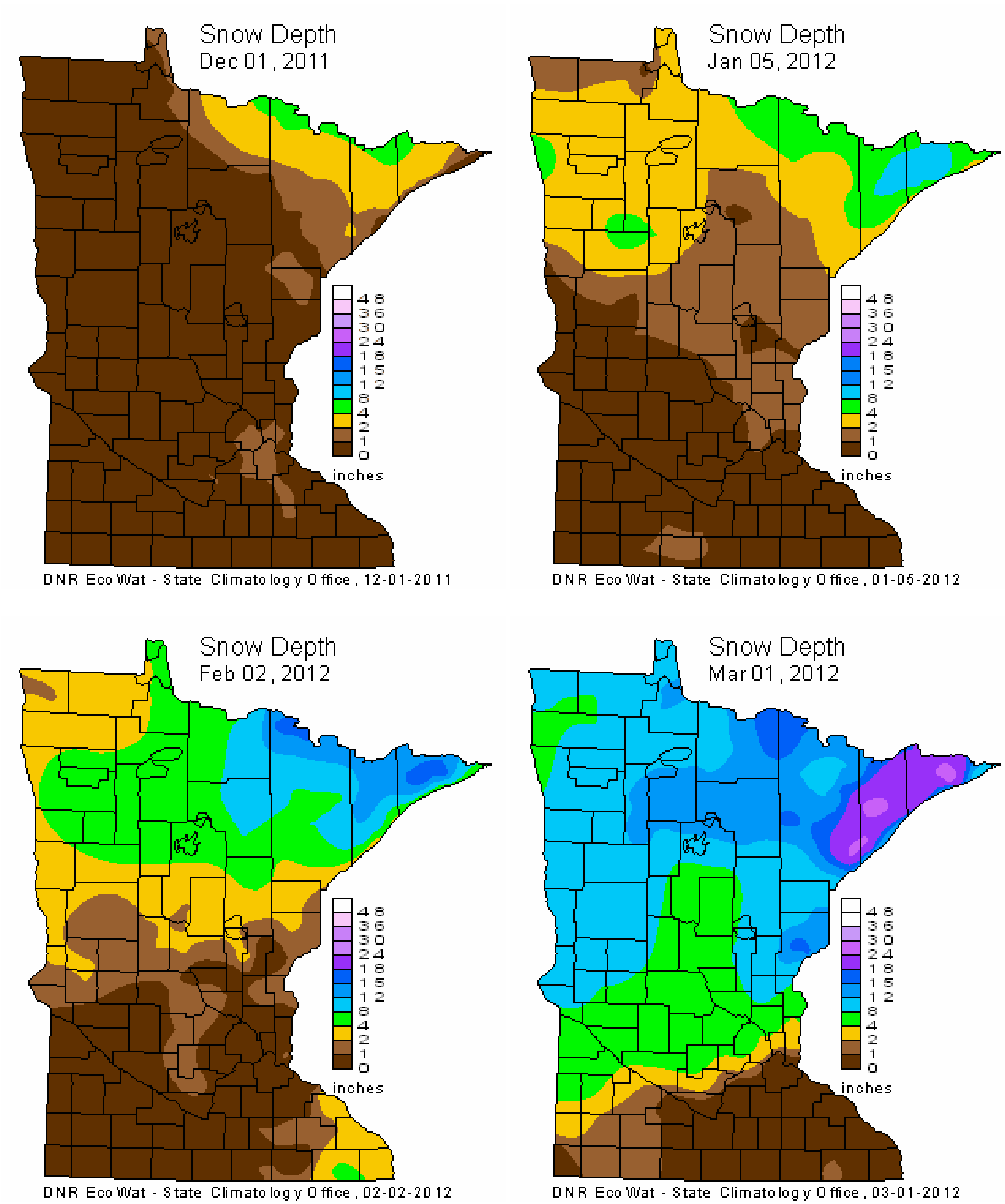


Figure 16

Snow depth December 2011 - March 2012

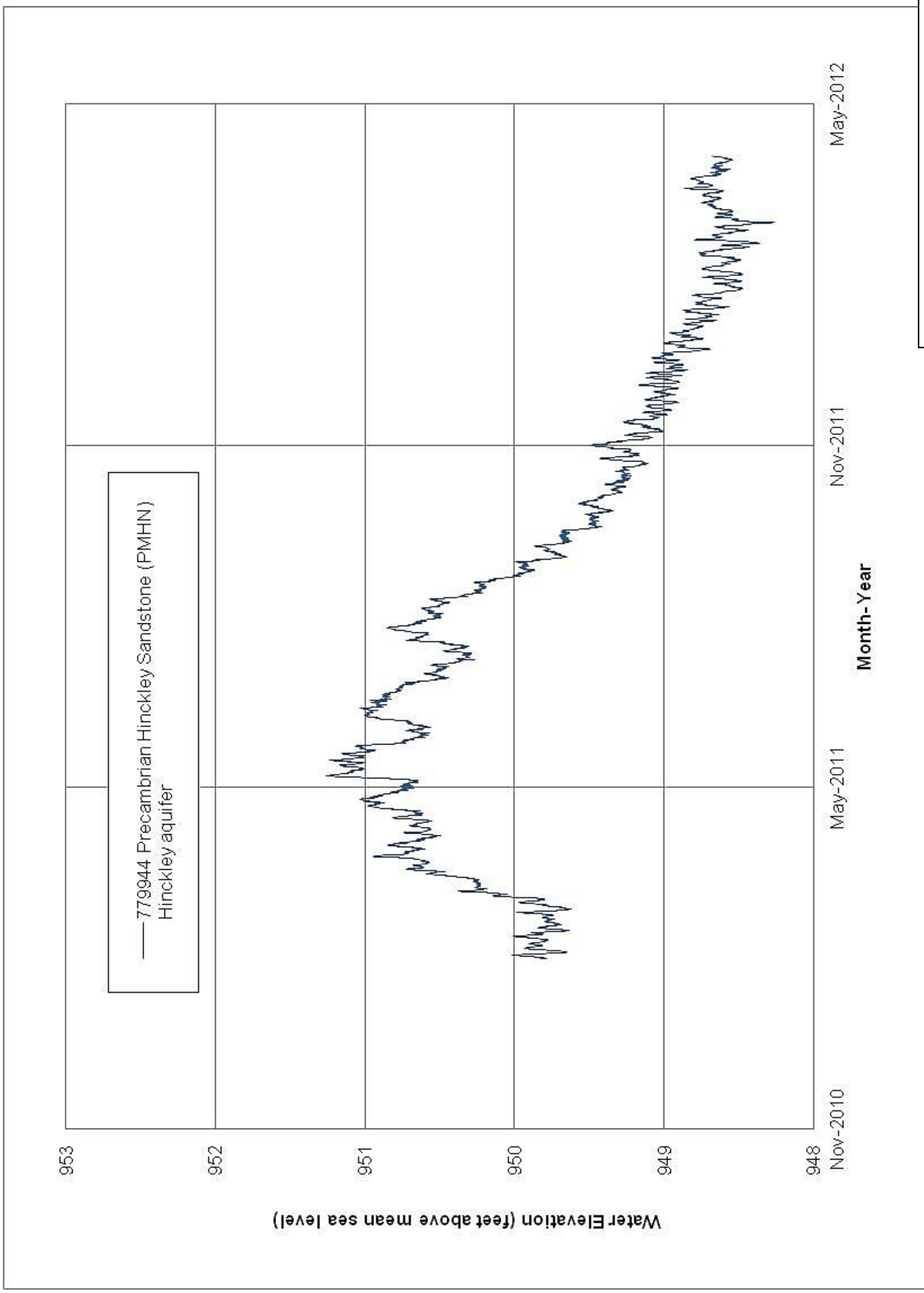


Figure 17
Stanchfield WMA
hydrograph

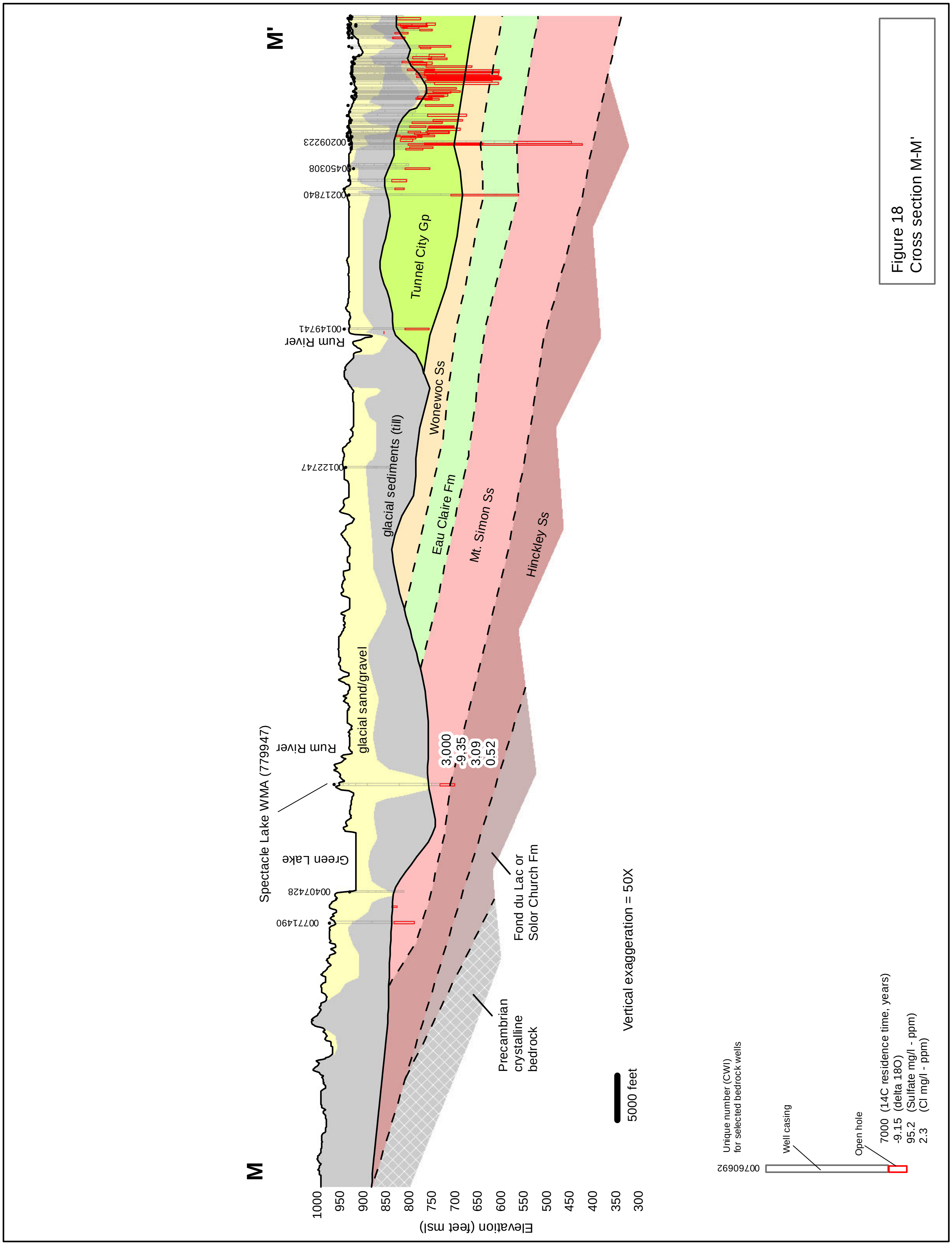


Figure 18
Cross section M-M'

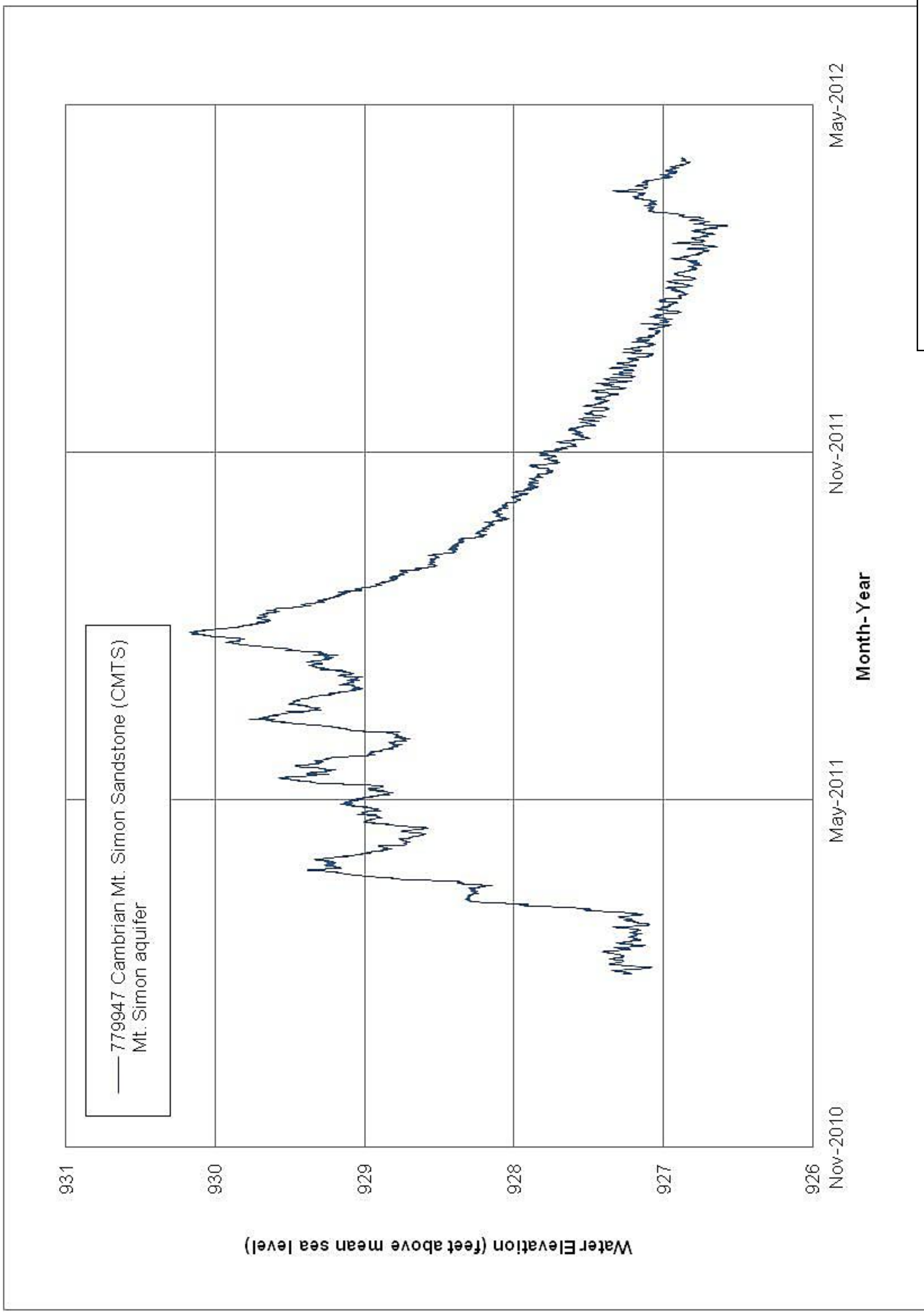


Figure 19
Spectacle Lake WMA
hydrograph

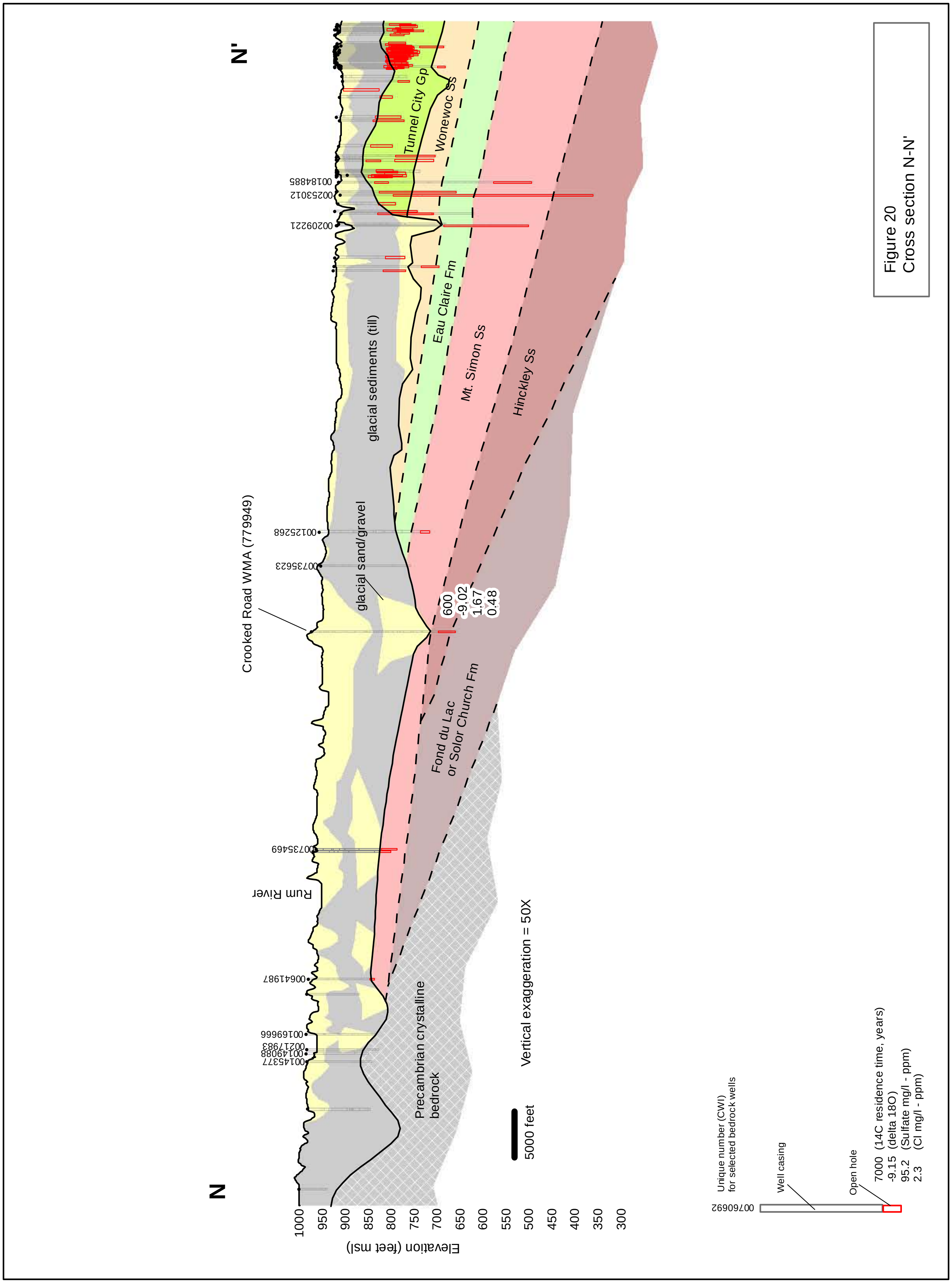


Figure 20
Cross section N-N'

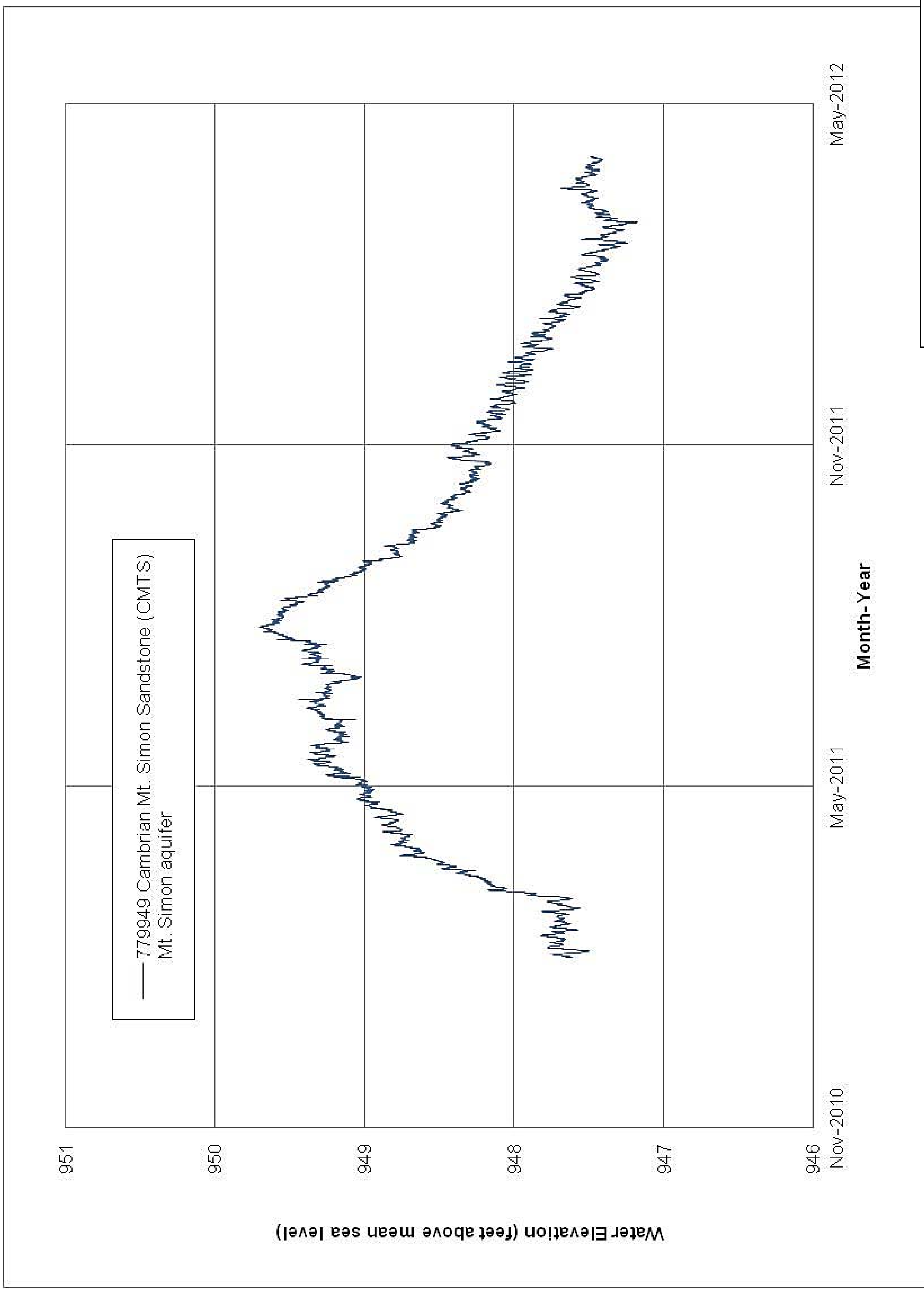


Figure 21
Crooked Road WMA
hydrograph

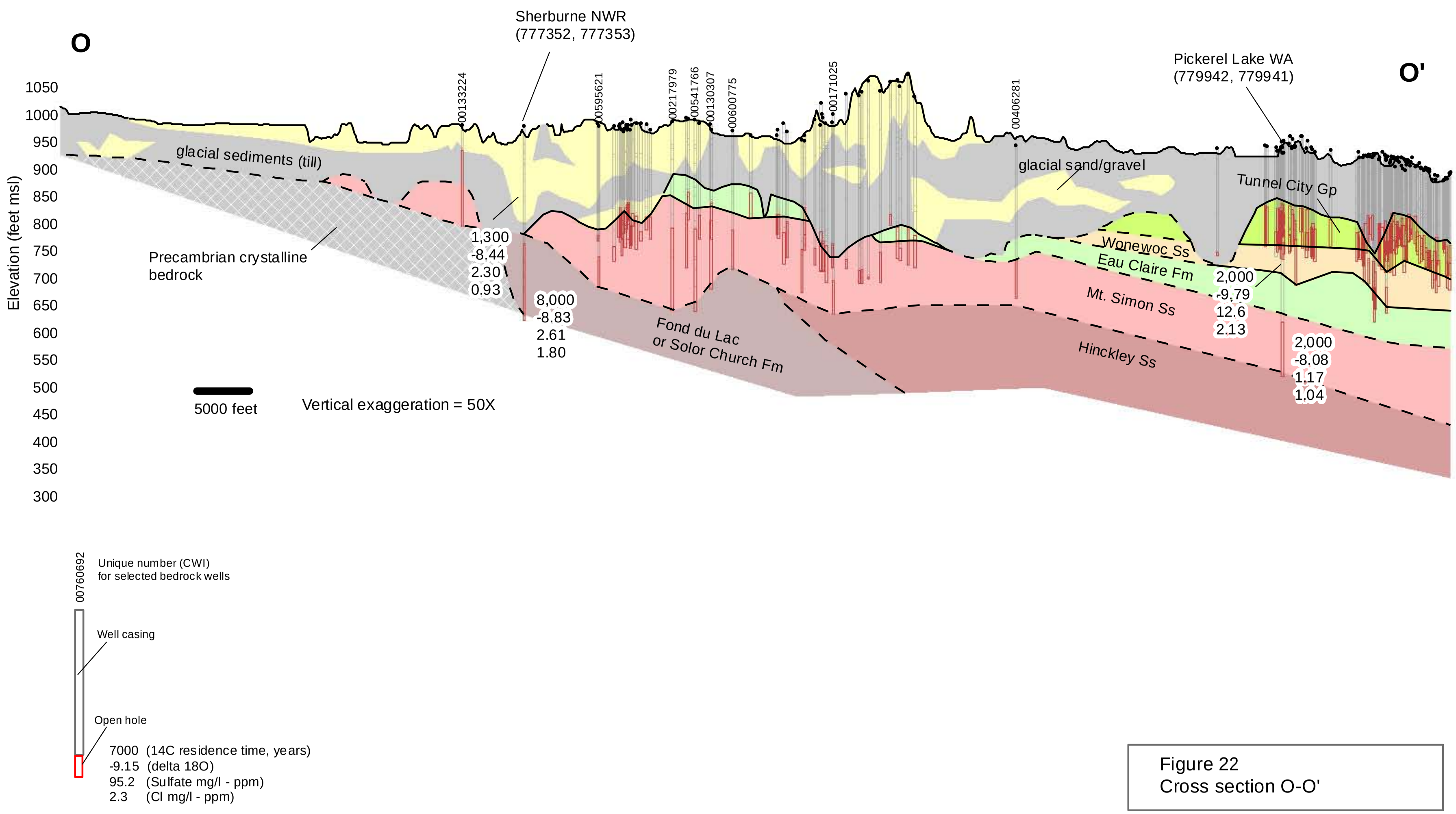


Figure 22
Cross section O-O'

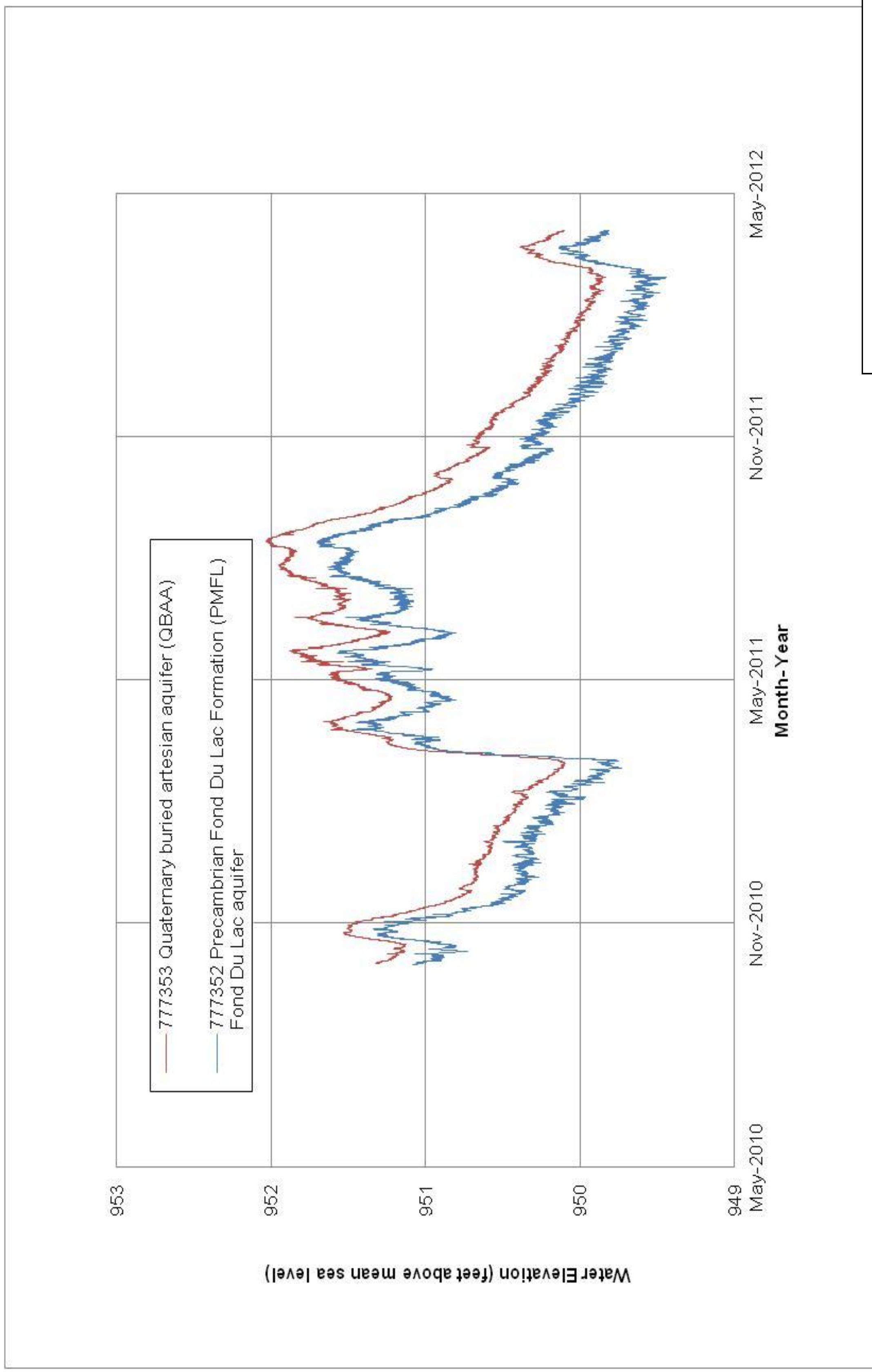


Figure 23
Sherburne National Wildlife Refuge
hydrograph

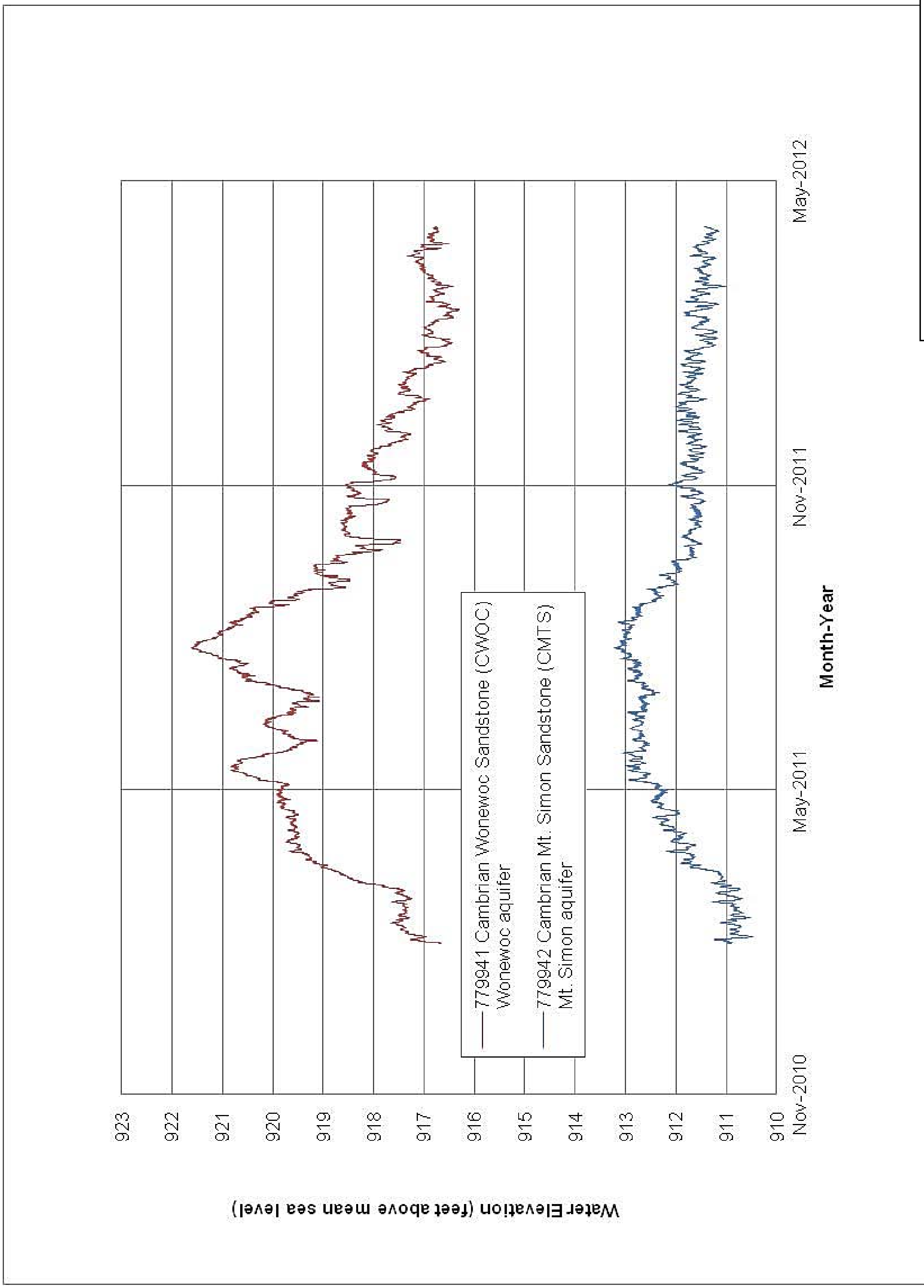


Figure 24
Pickerel Lake WA
hydrograph

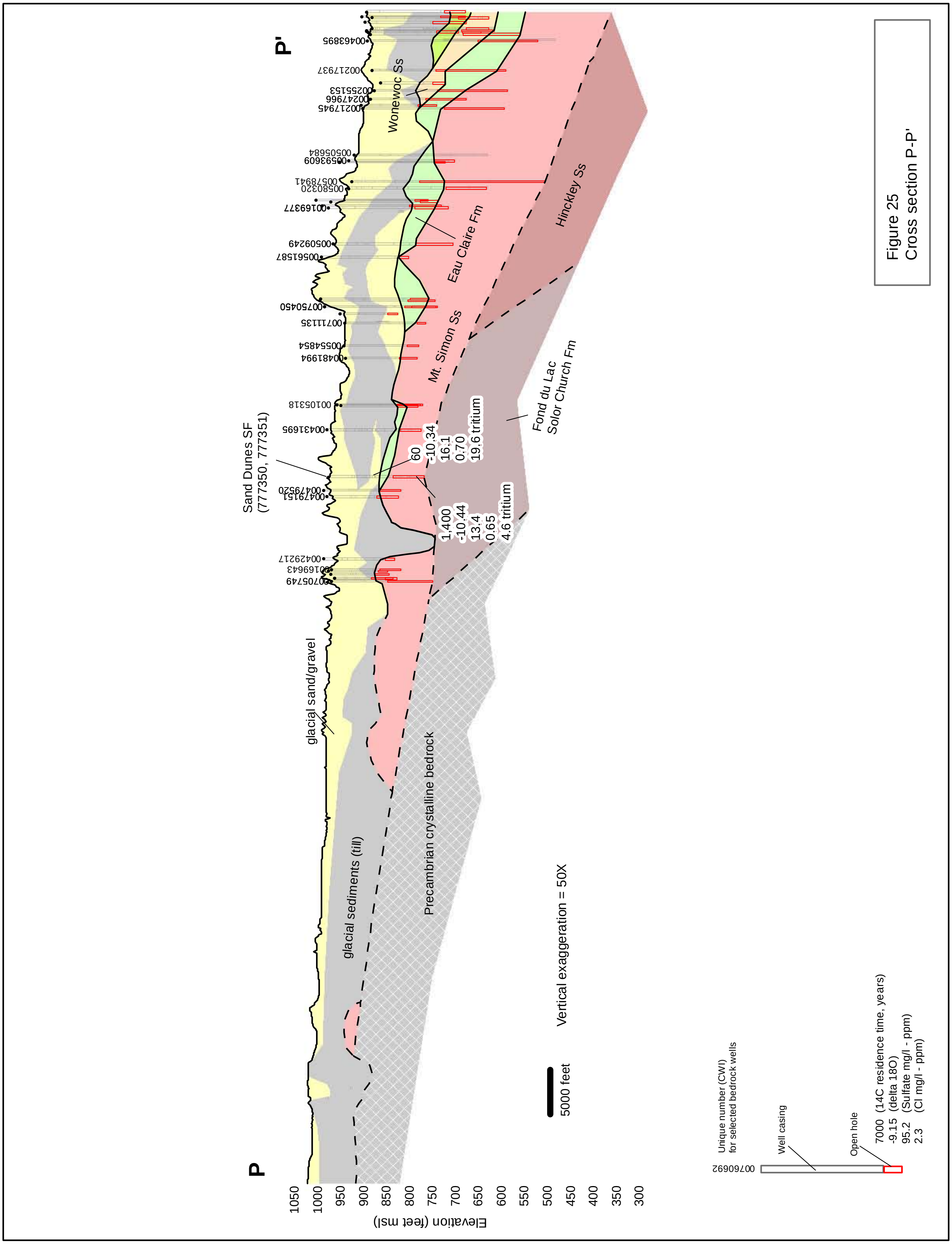


Figure 25
Cross section P-P'

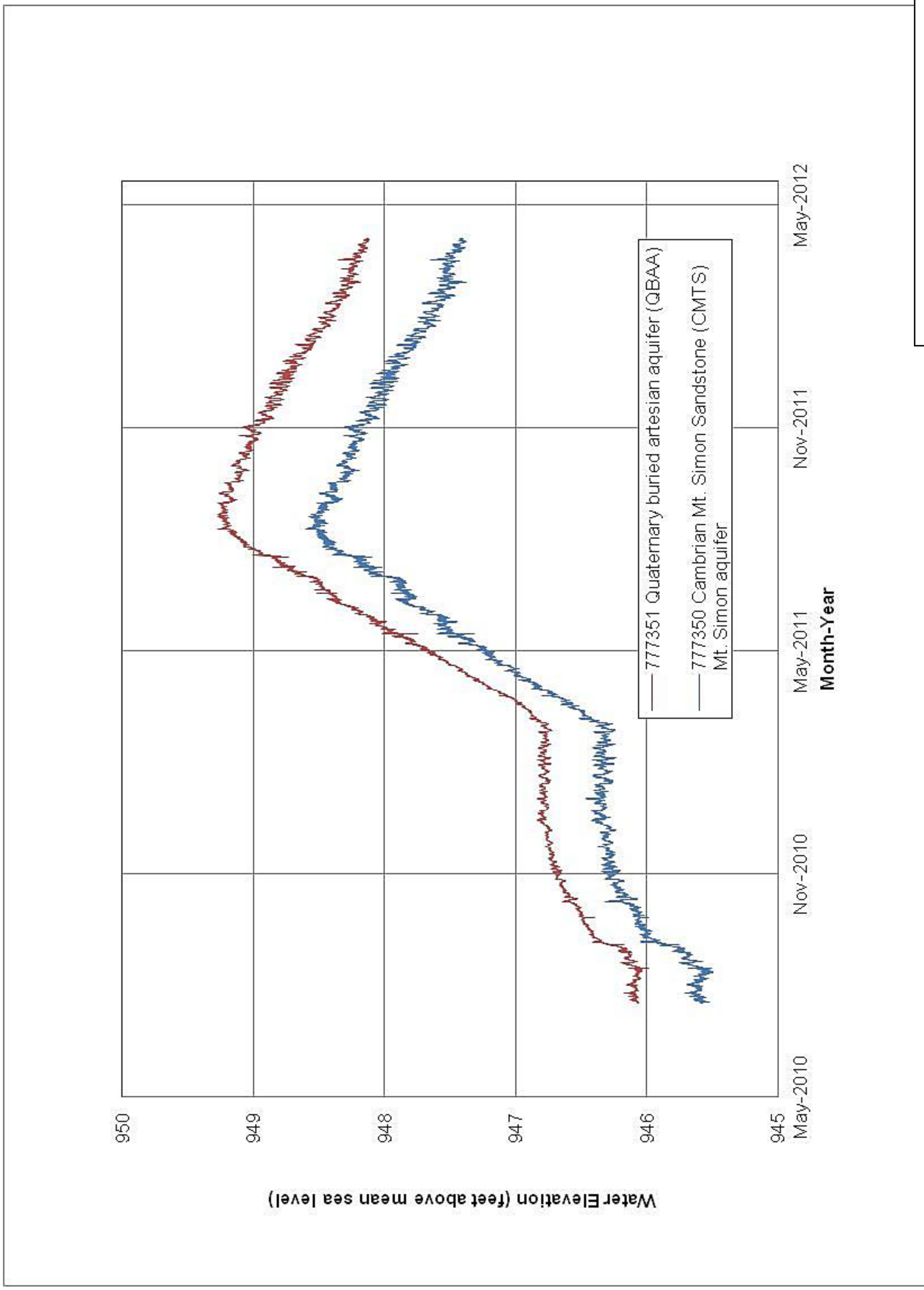


Figure 26
Sand Dunes State Forest
hydrograph

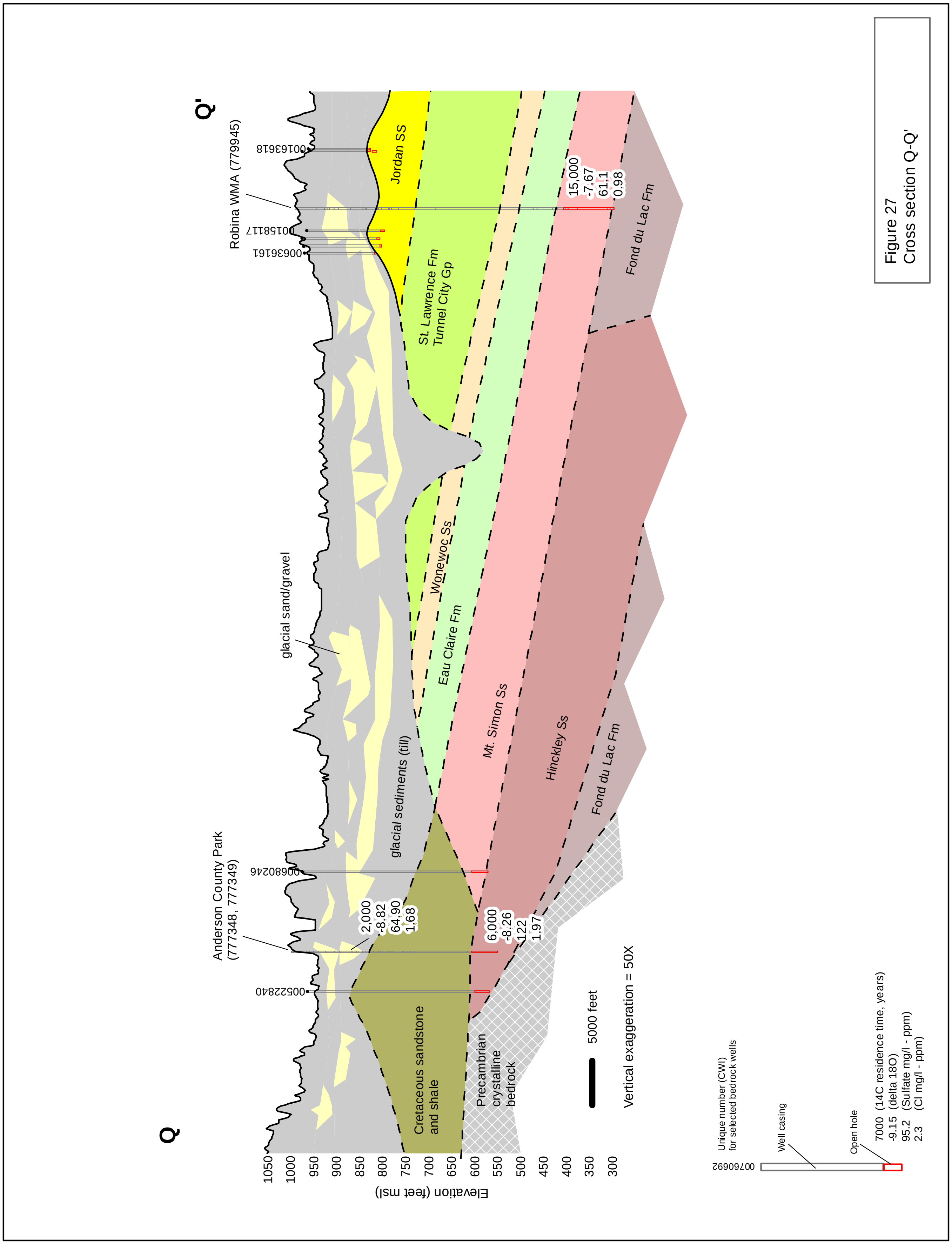


Figure 27
Cross section Q-Q'

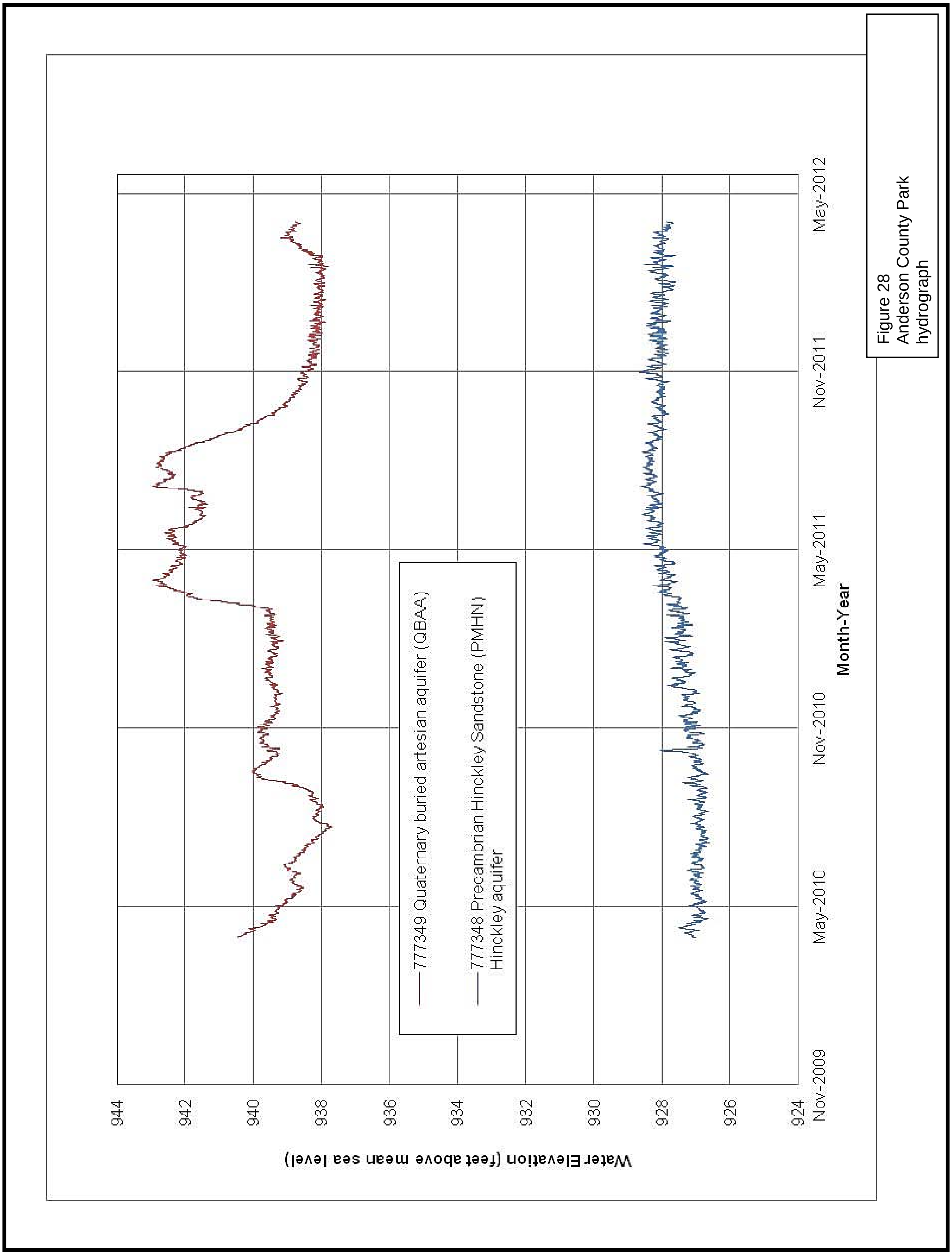


Figure 28
Anderson County Park hydrograph

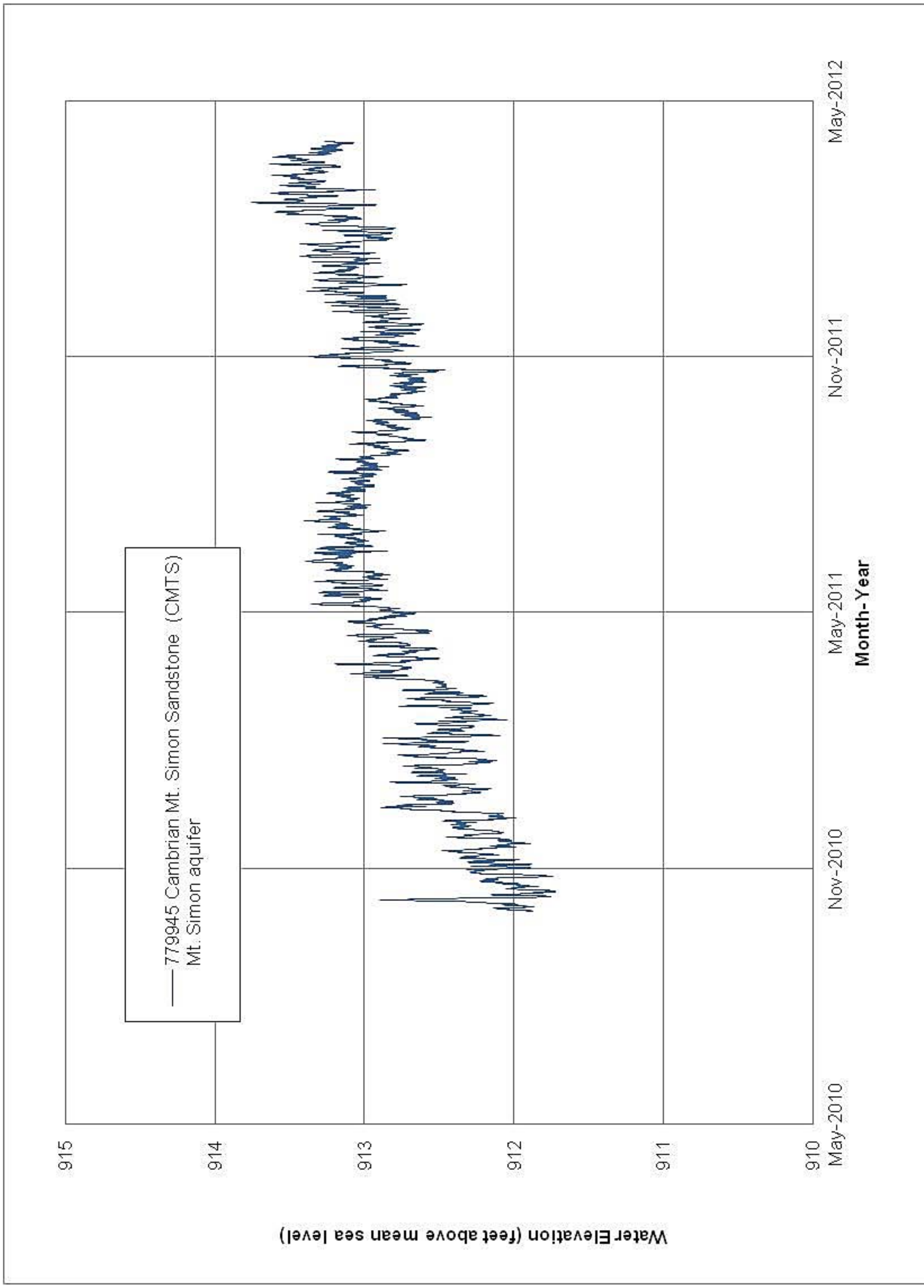


Figure 29
Robina WMA
hydrograph

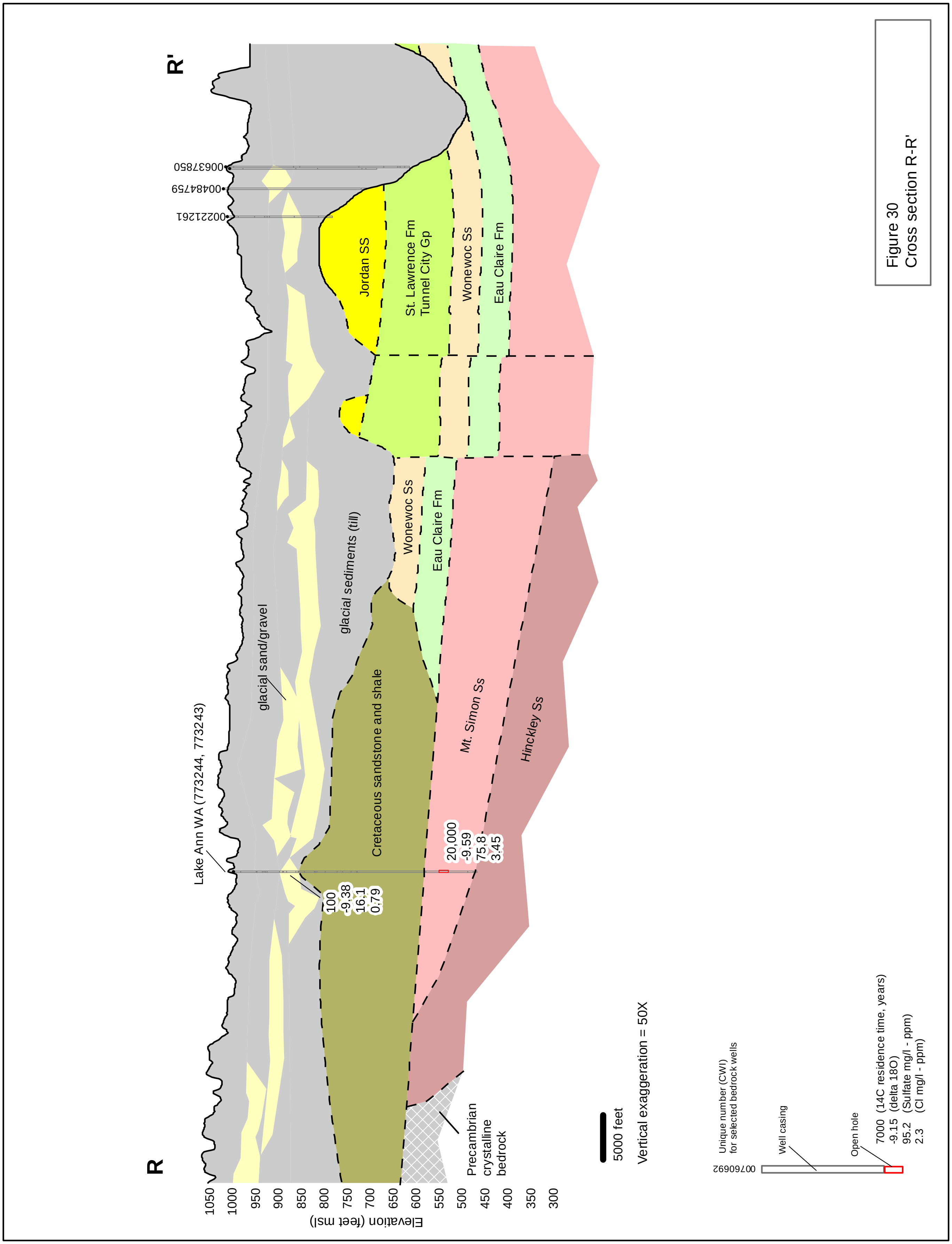


Figure 30
Cross section R-R'

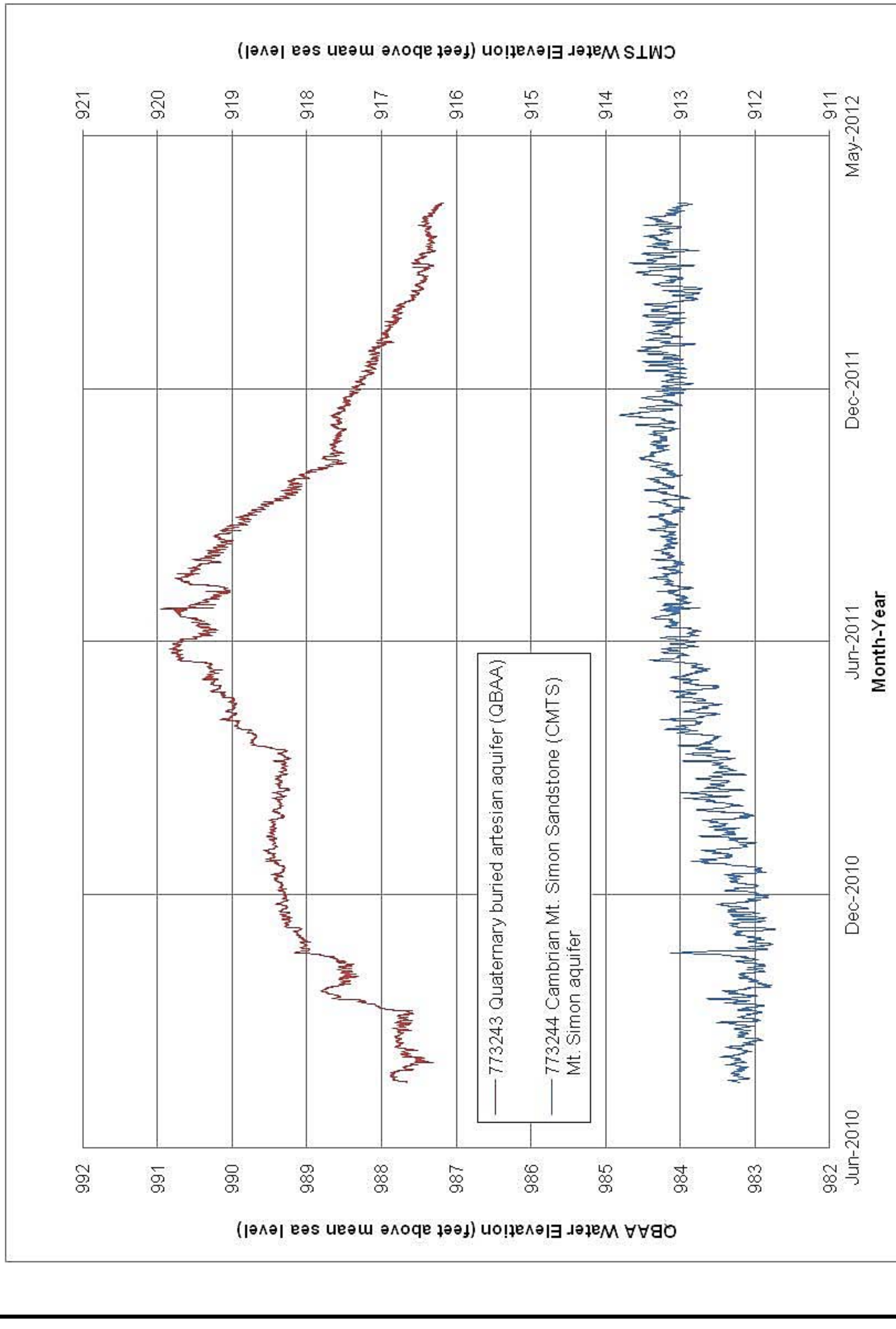


Figure 31
Lake Ann WA
hydrograph

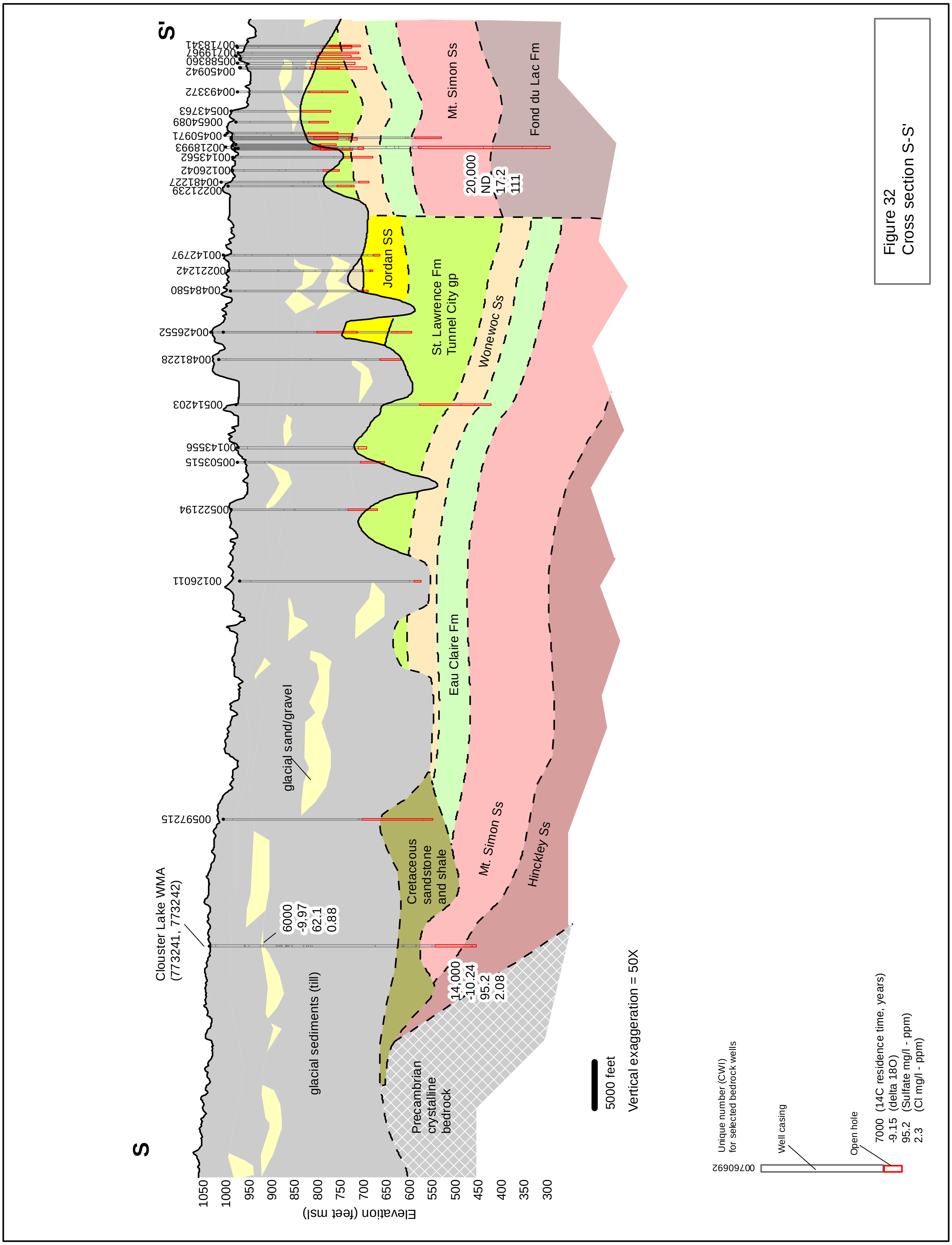


Figure 32
Cross section S-S'

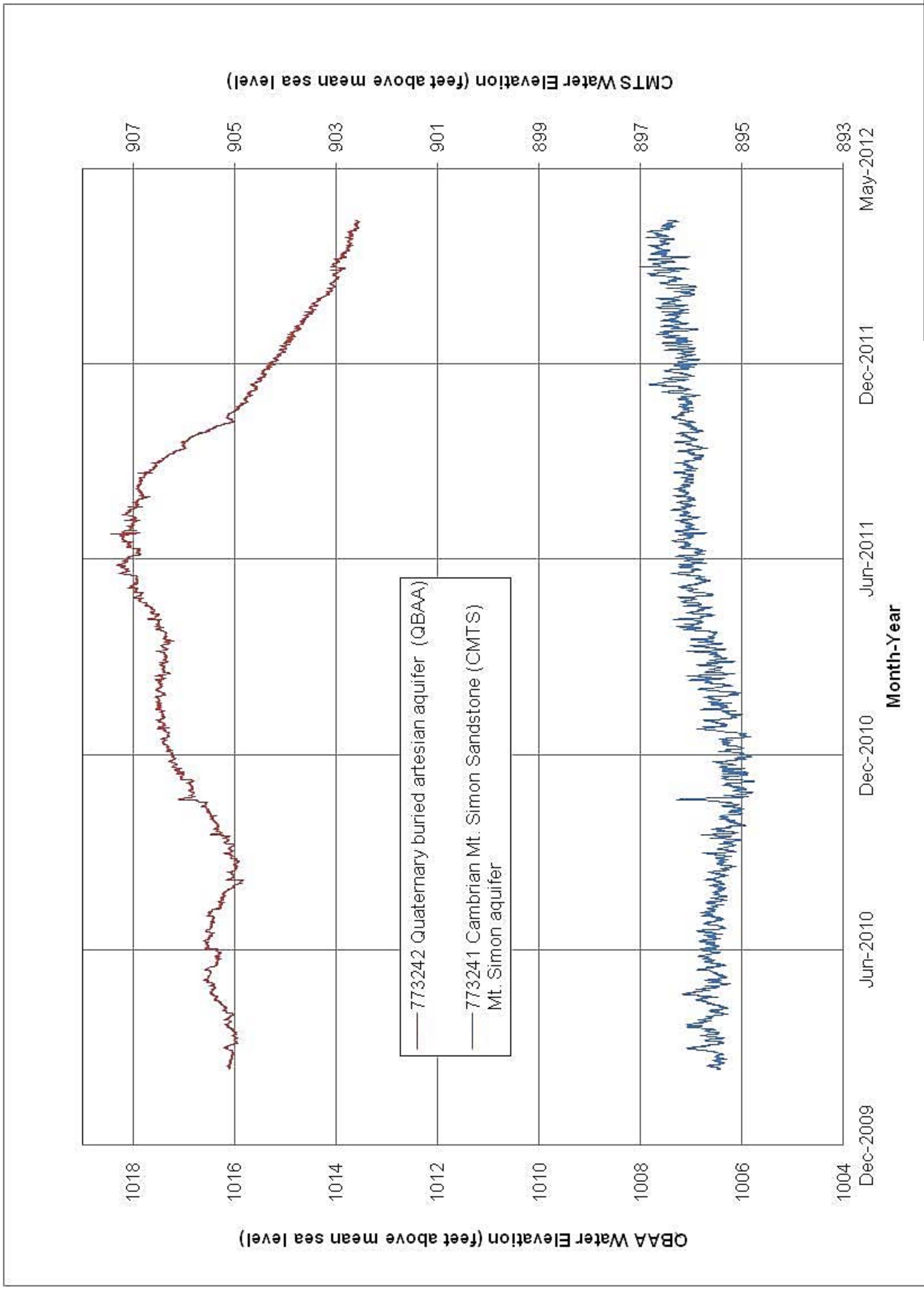


Figure 33
Clouster Lake WMA
hydrograph

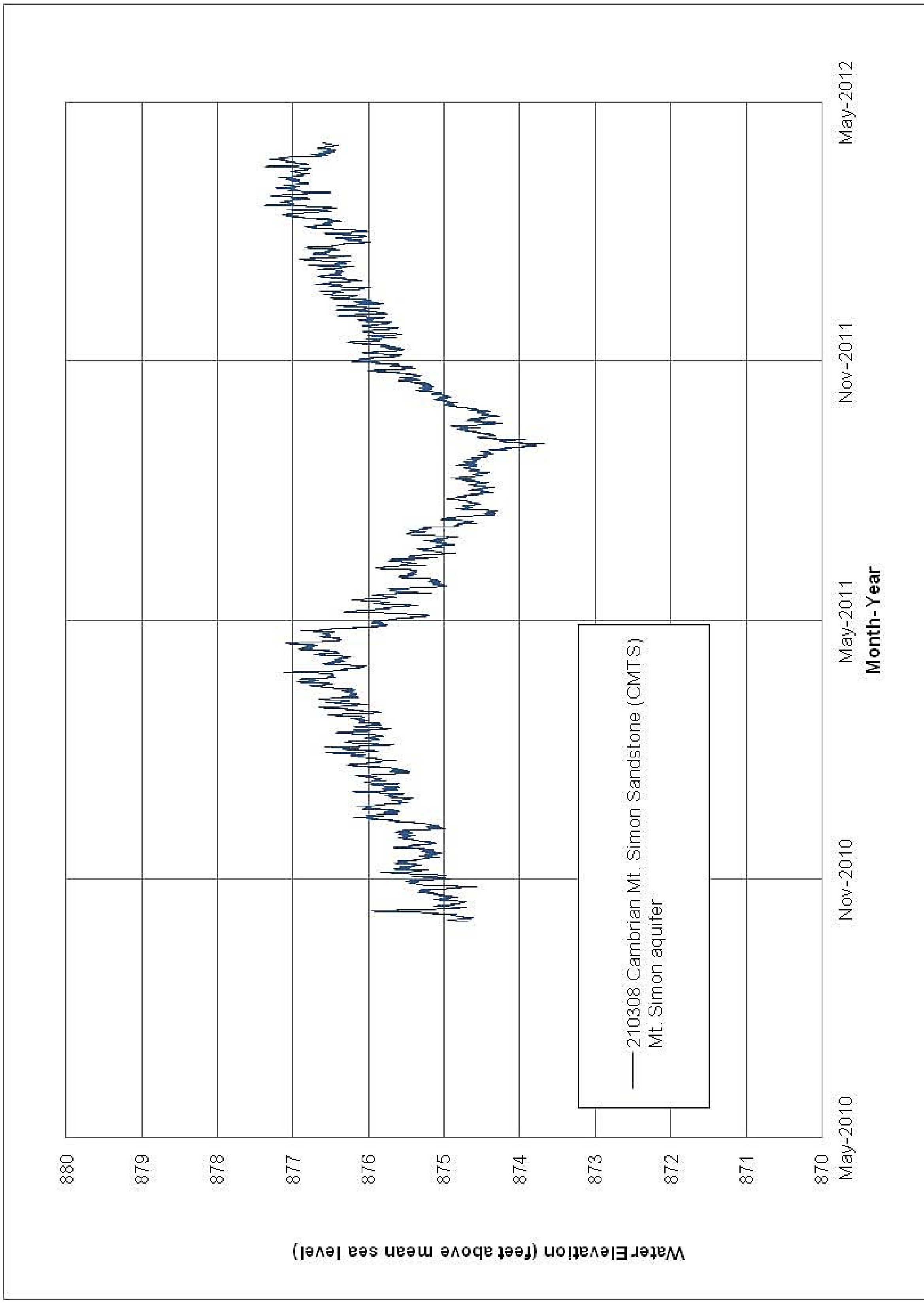


Figure 34
McLeod County Highway Department
hydrograph

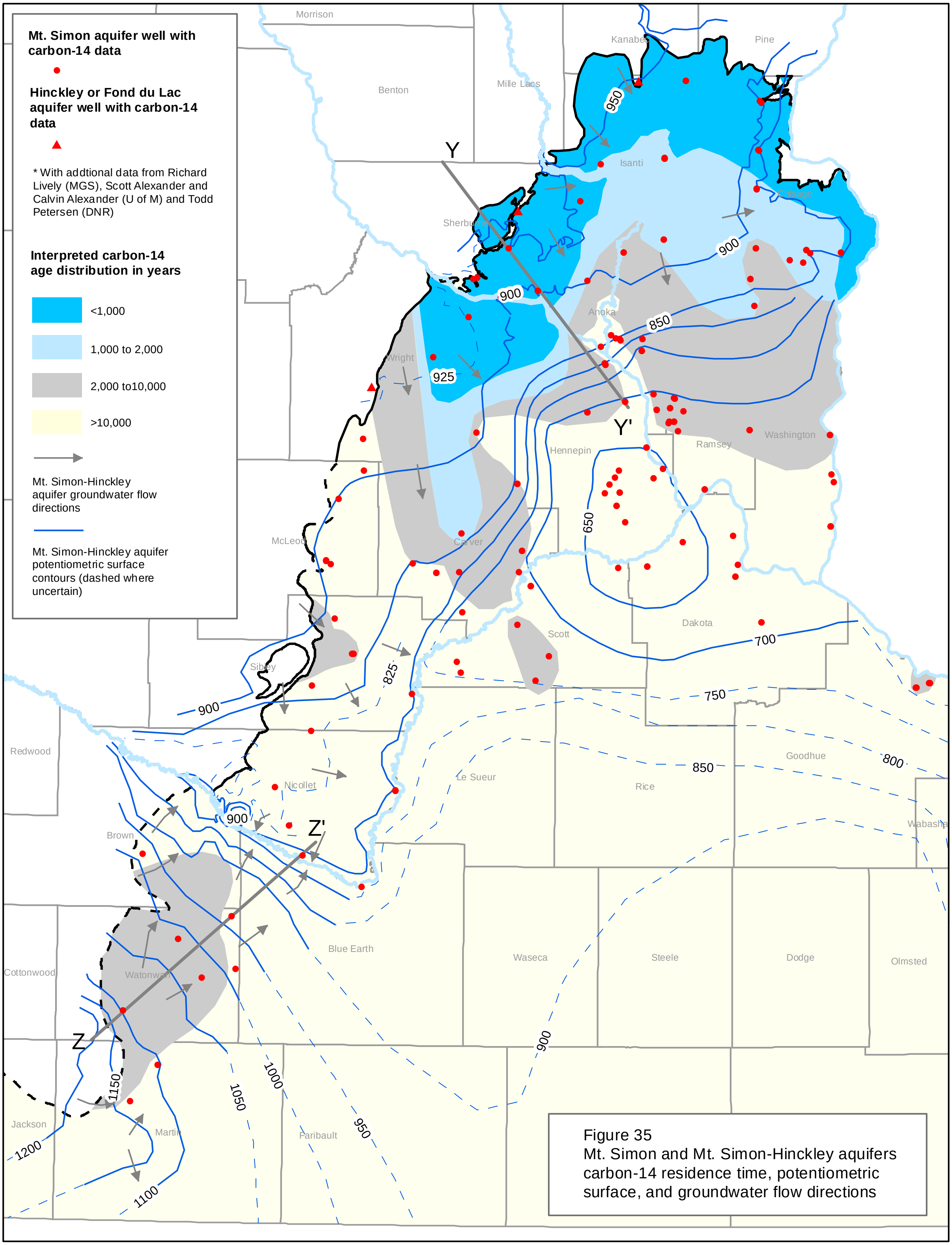


Figure 35
Mt. Simon and Mt. Simon-Hinckley aquifers carbon-14 residence time, potentiometric surface, and groundwater flow directions

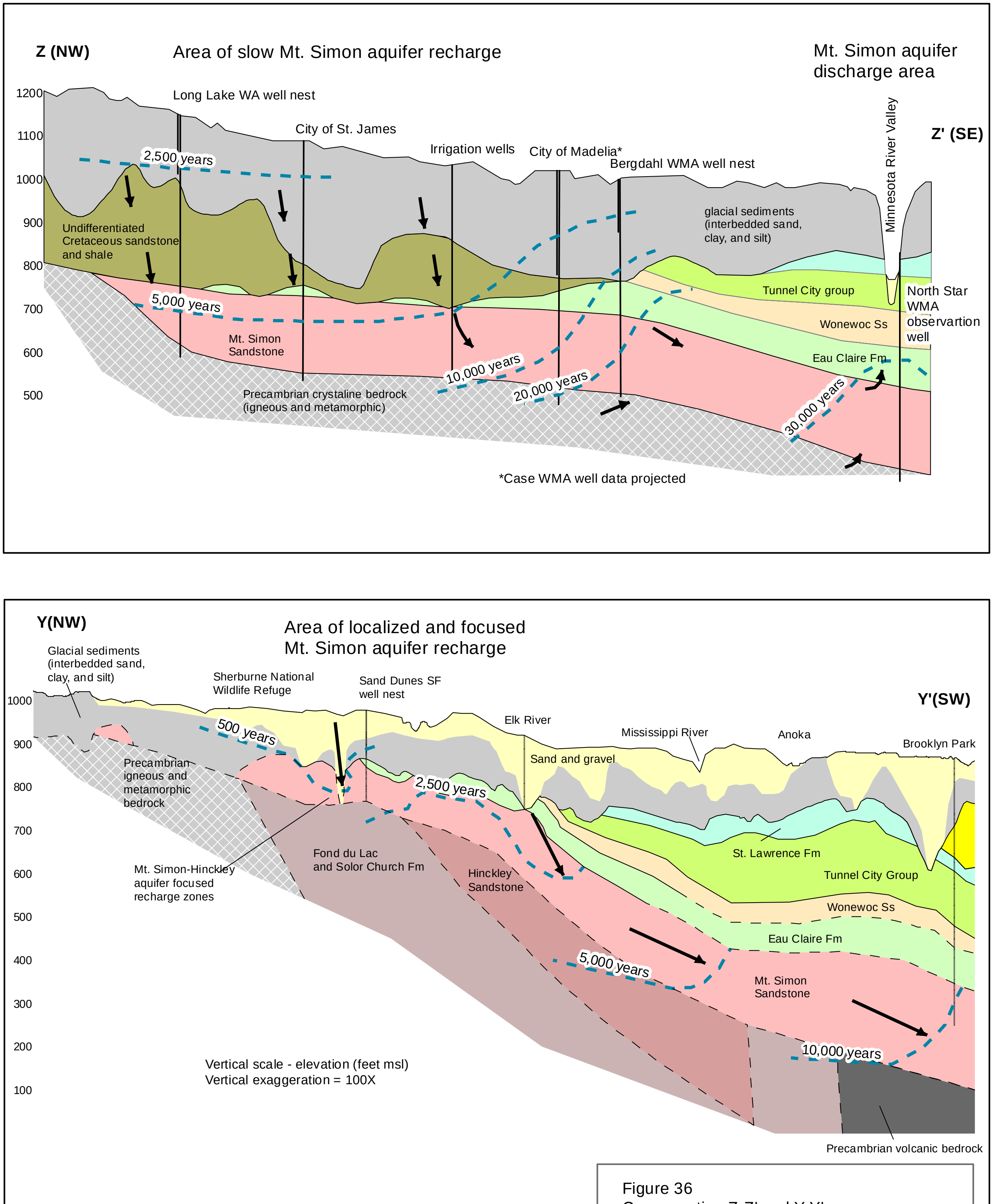


Figure 36
Cross section Z-Z' and Y-Y'
Mt. Simon and Mt. Simon-Hinckley aquifers recharge and discharge

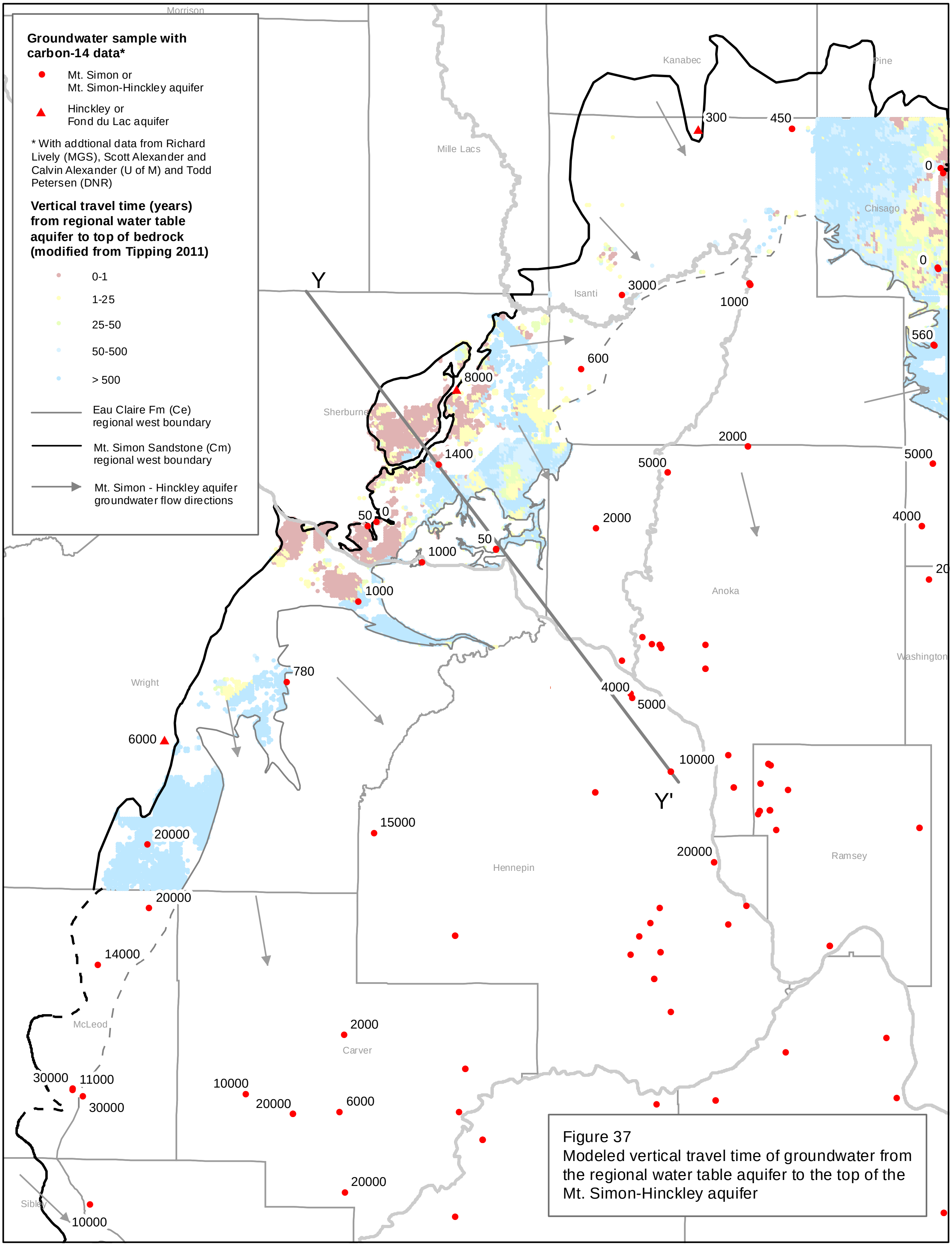
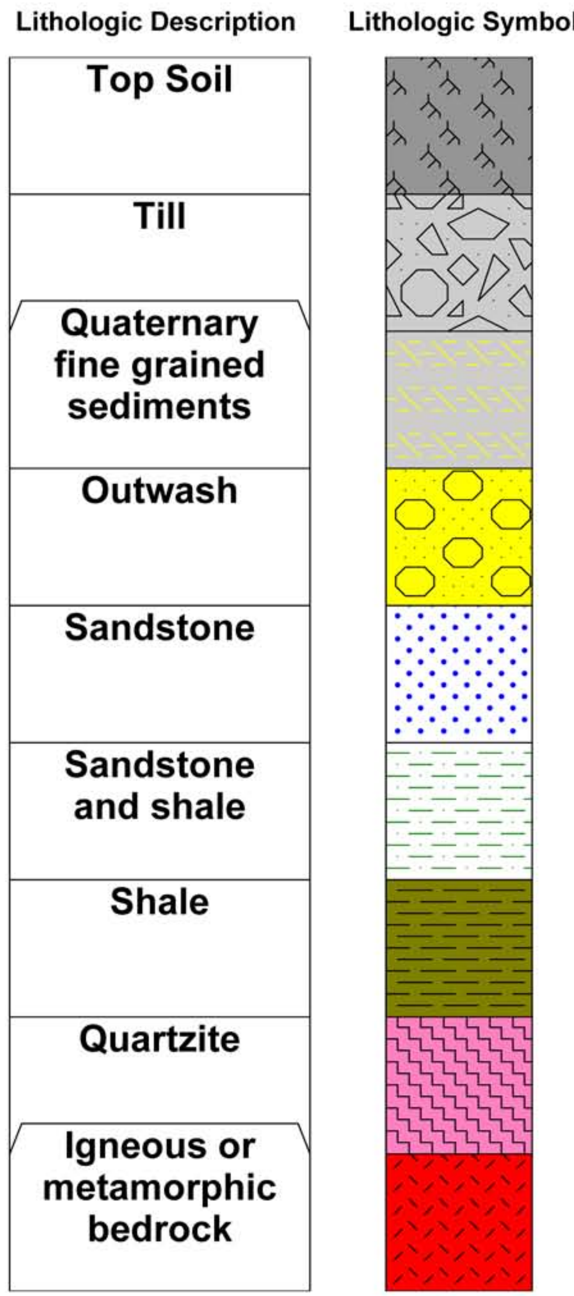


Figure 37
Modeled vertical travel time of groundwater from the regional water table aquifer to the top of the Mt. Simon-Hinckley aquifer

Appendix

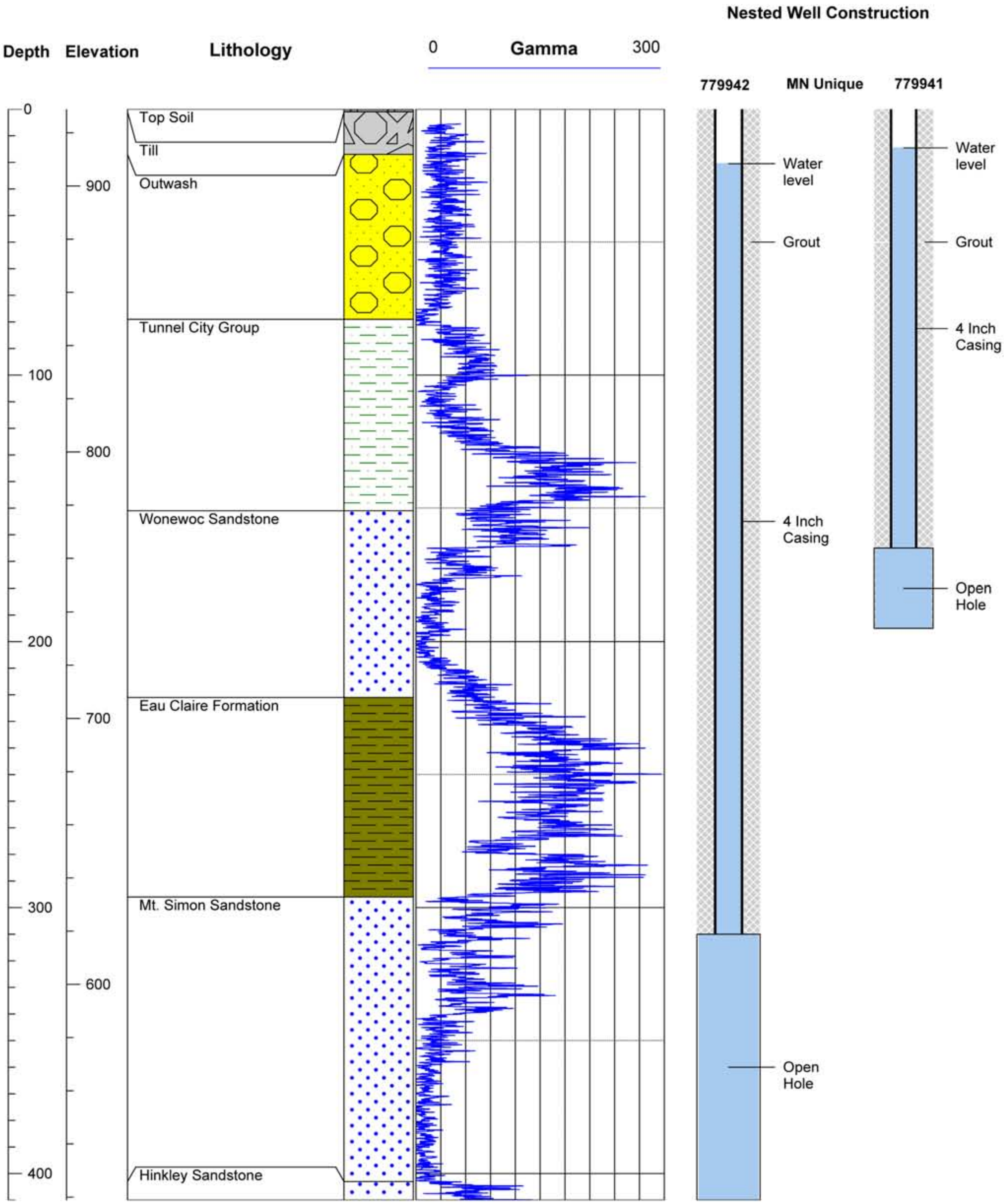
Geologic Log Legend



Geological / Geophysical Logs and Well Construction Diagrams

Site Name Pickerel Lake WA

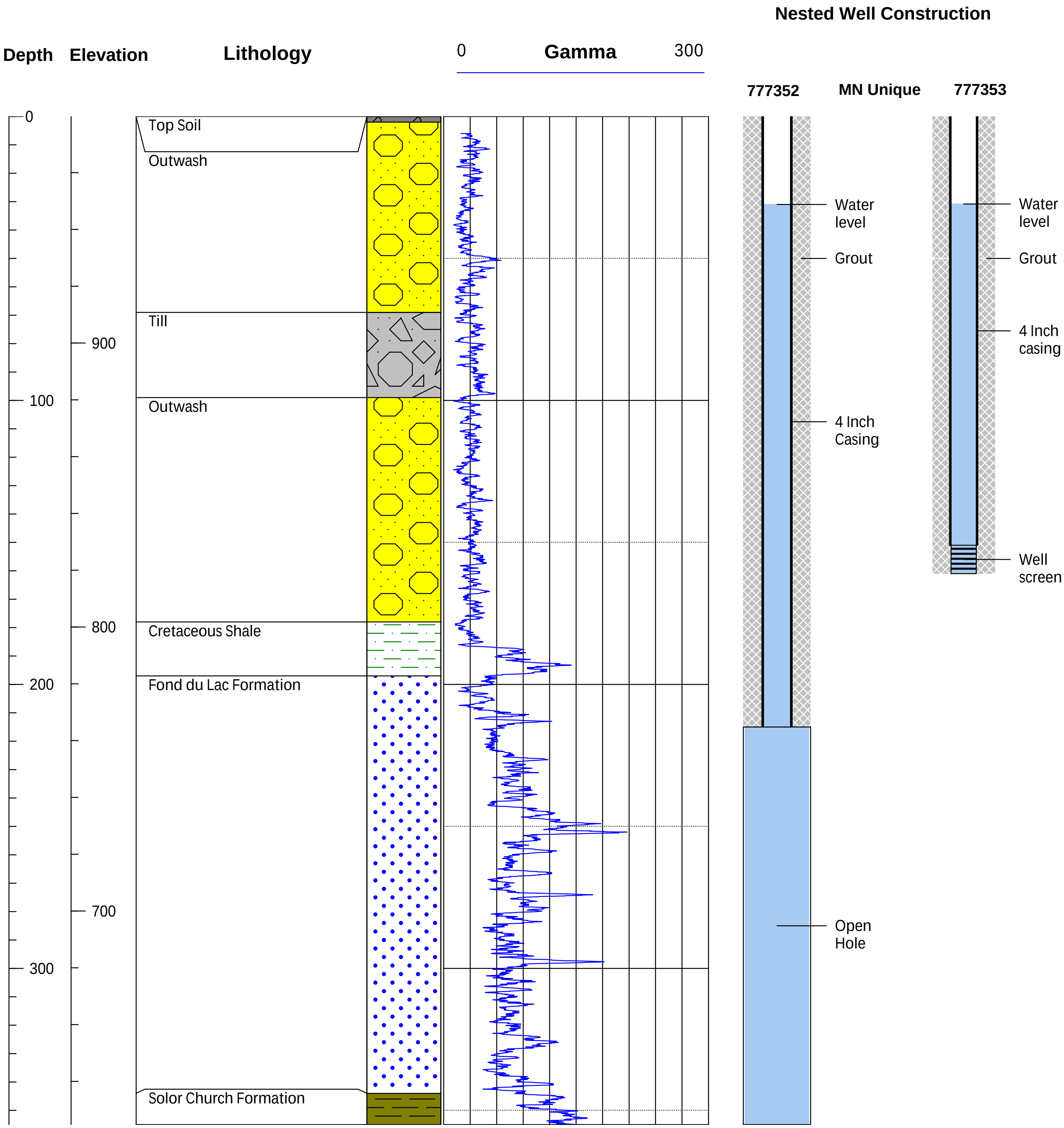
County Anoka

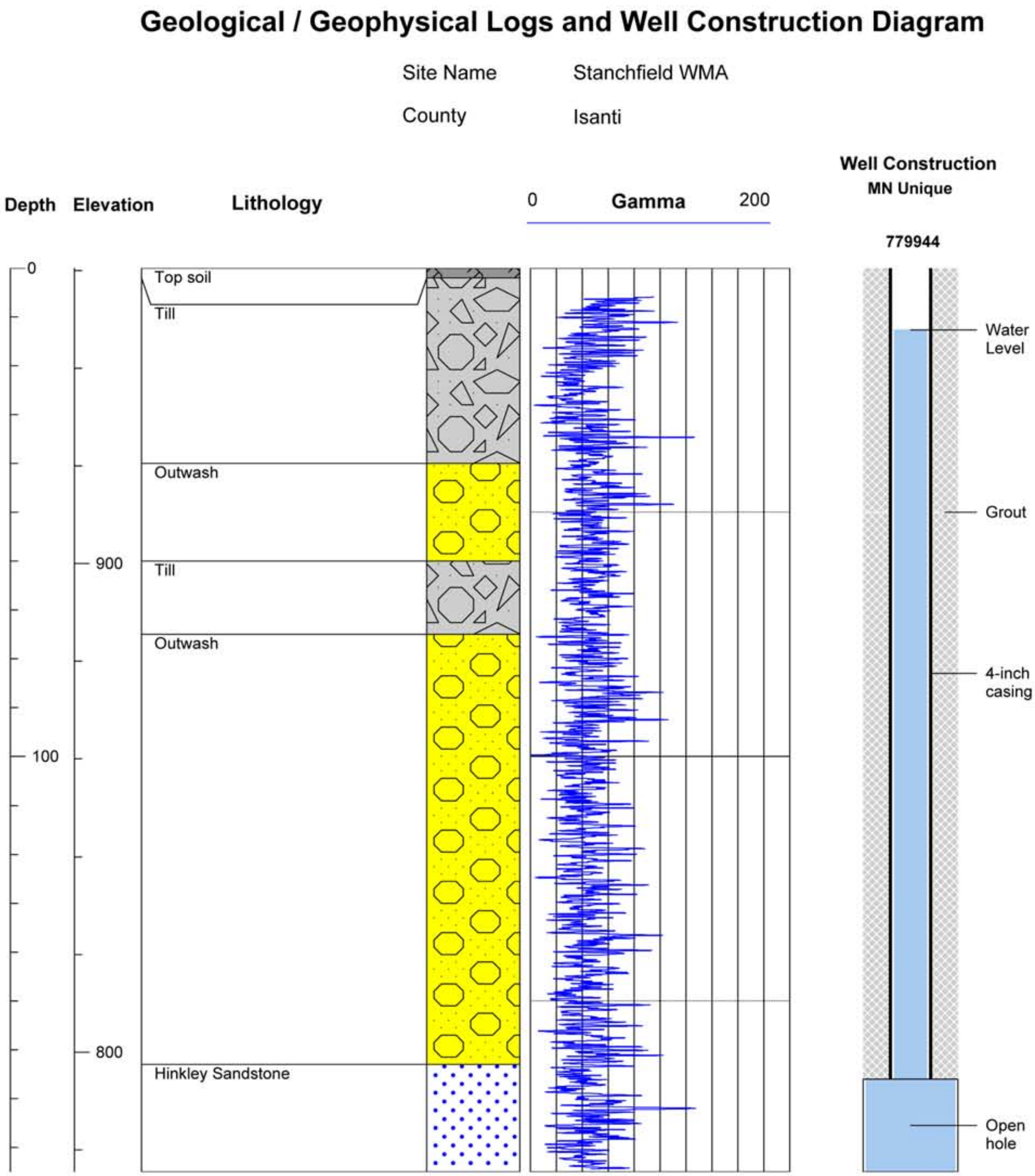


Geological / Geophysical Logs and Well Construction Diagrams

Site Name Sherburne National Wildlife Refuge

County Sherburne

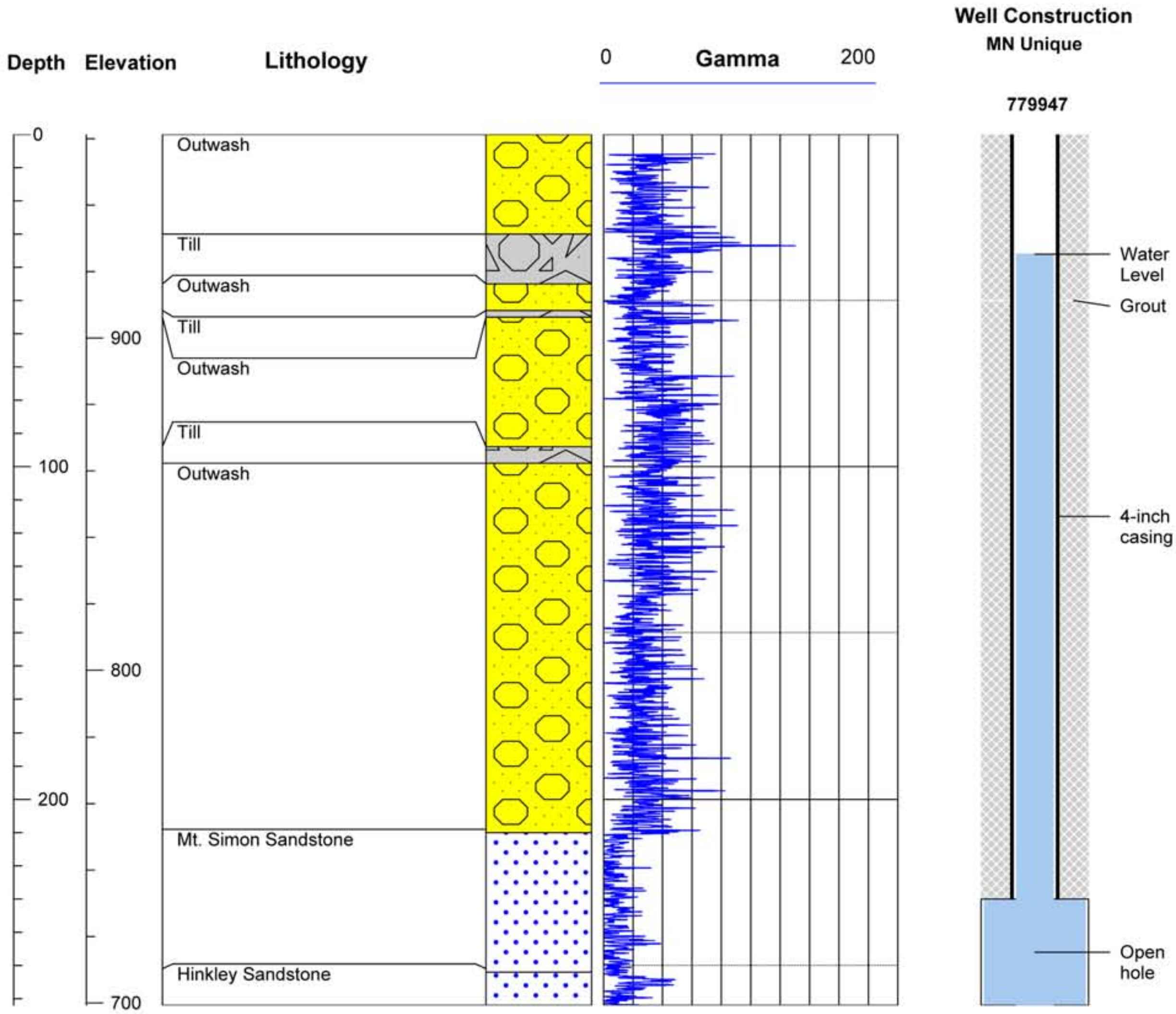



Geological / Geophysical Logs and Well Construction Diagram
Site Name
Stanchfield WMA
County
Isanti
Well Construction
MN Unique
779944
Depth
Elevation
Lithology
0
Gamma
200
0
100
900
800
Top soil
Till
Outwash
Till
Outwash
Hinkley Sandstone
Water Level
Grout
4-inch casing
Open hole

Geological / Geophysical Logs and Well Construction Diagram

Site Name Spectacle Lake WMA

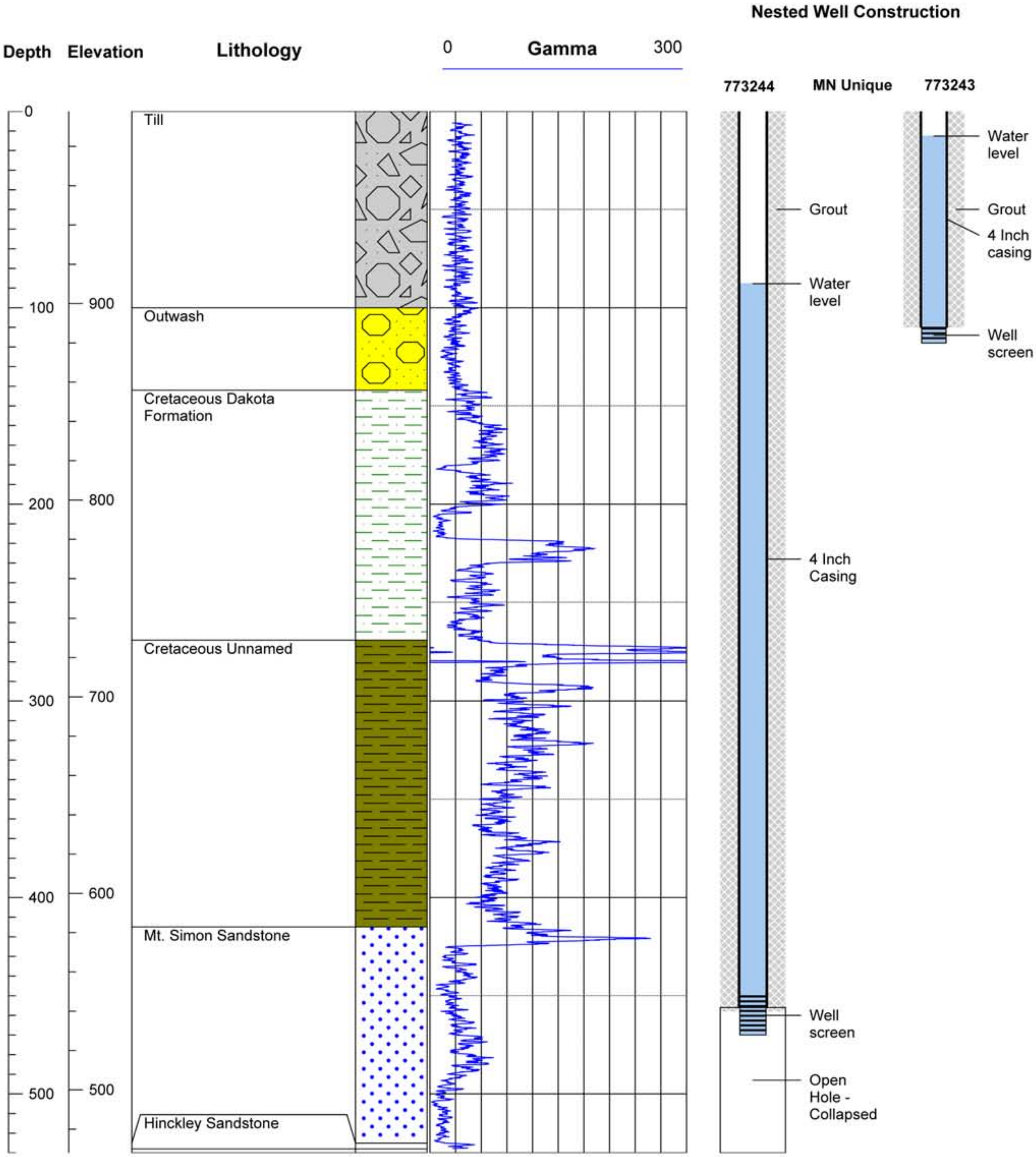
County Isanti



Geological / Geophysical Logs and Well Construction Diagrams

Site Name Lake Ann WA

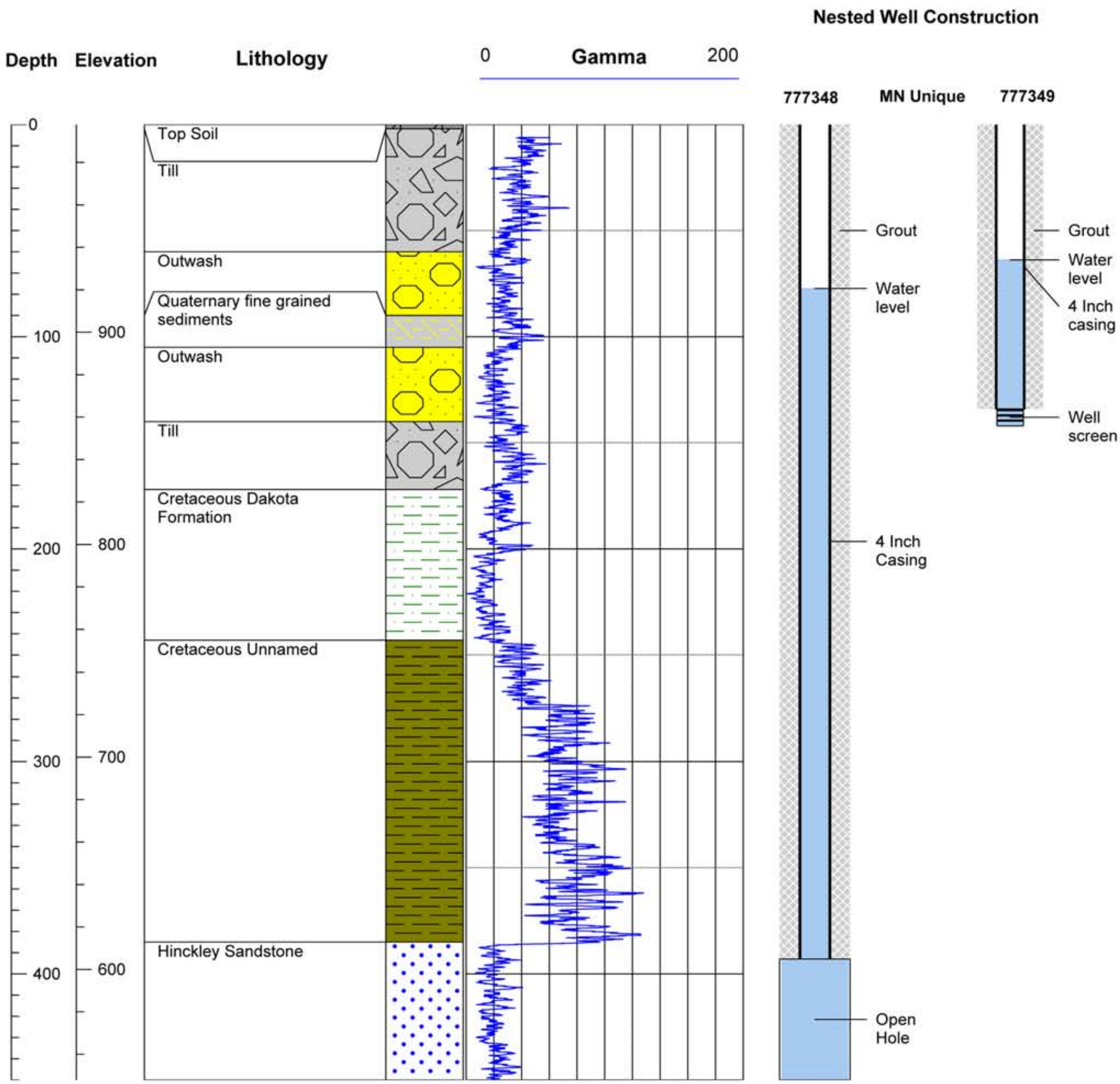
County Wright



Geological / Geophysical Logs and Well Construction Diagrams

Site Name Anderson County Park

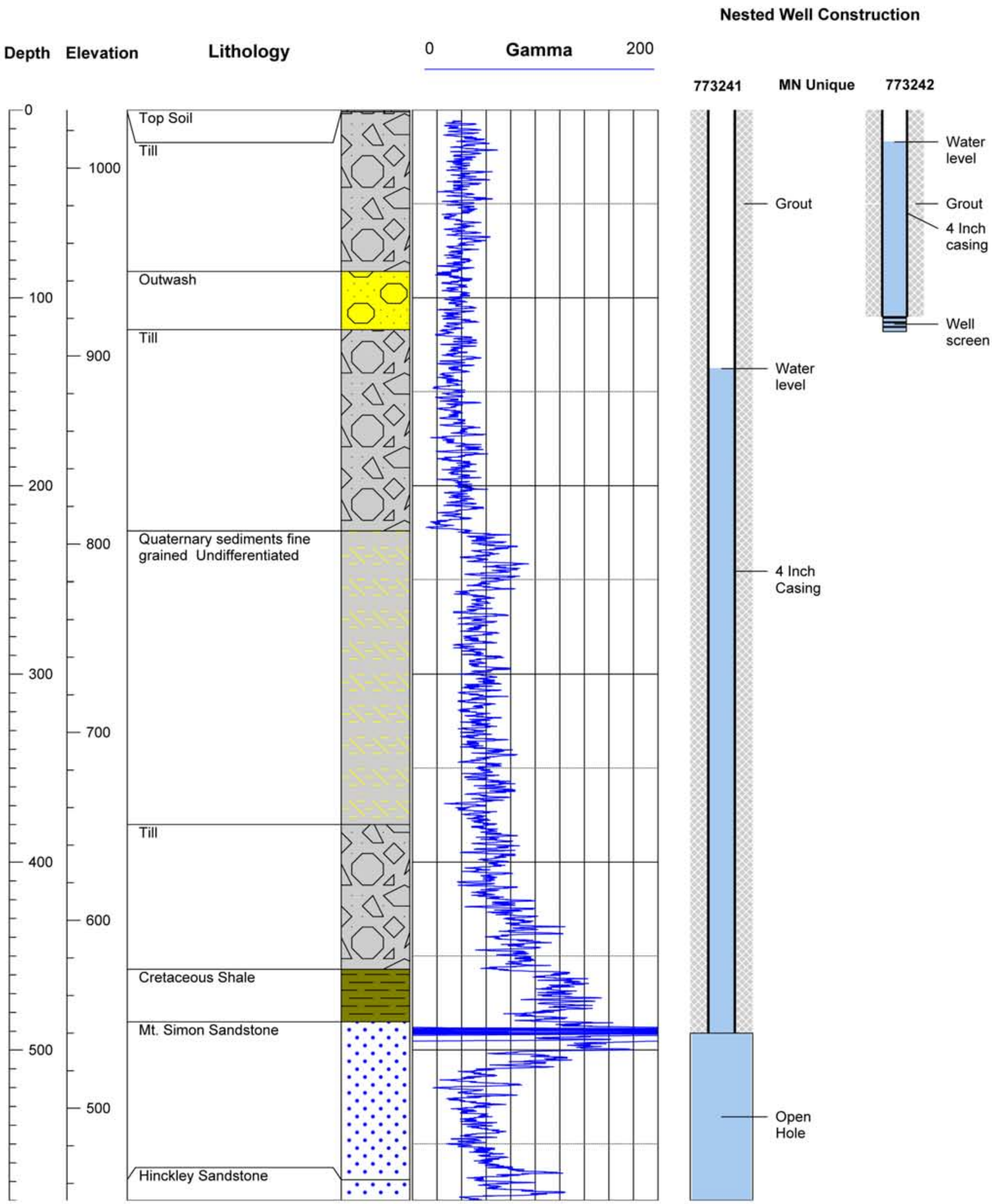
County Wright



Geological / Geophysical Logs and Well Construction Diagrams

Site Name Clouster Lake WMA

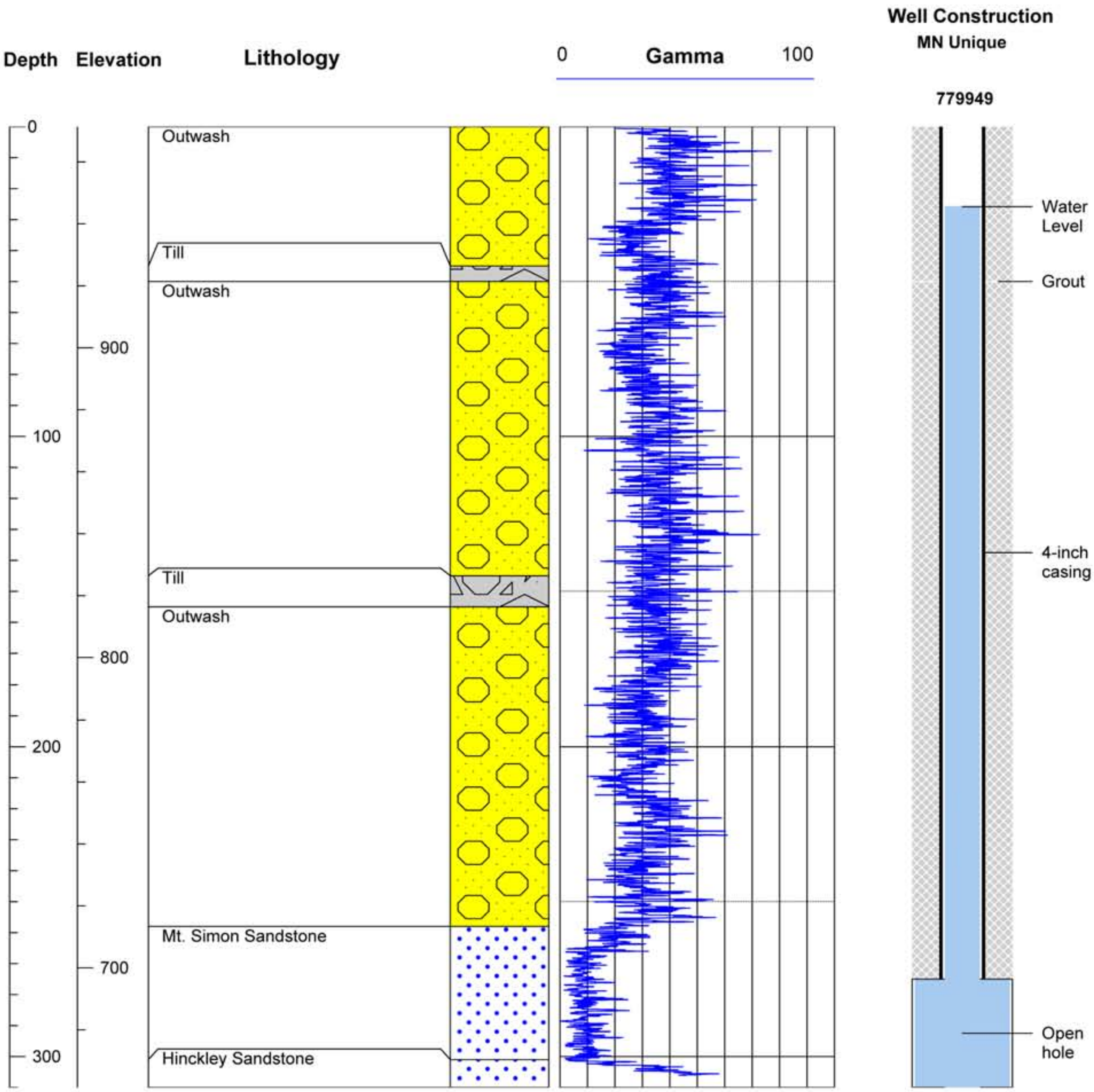
County McLeod



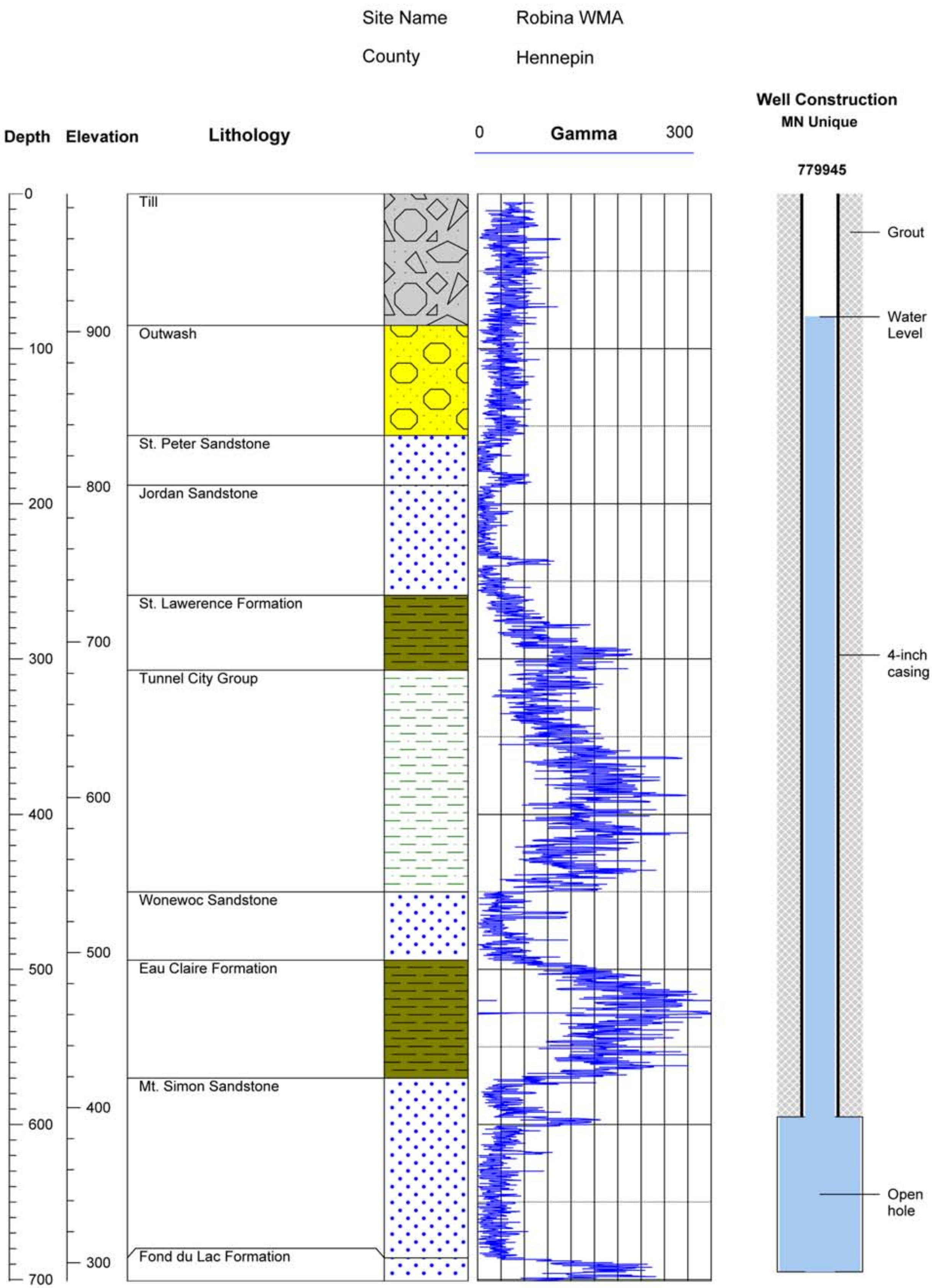
Geological / Geophysical Logs and Well Construction Diagram

Site Name Crooked Road WMA

County Isanti



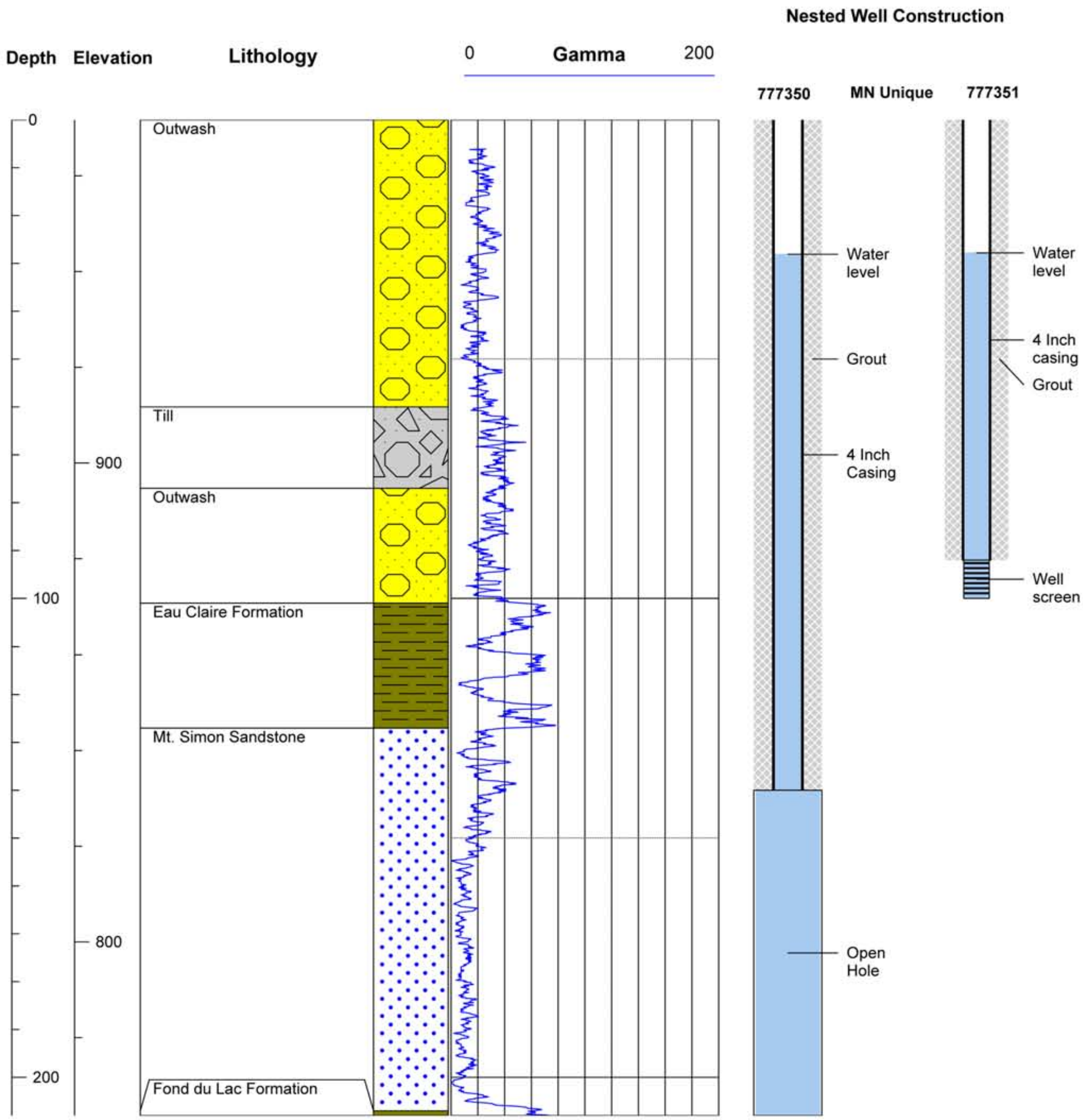
Geological / Geophysical Logs and Well Construction Diagram



Geological / Geophysical Logs and Well Construction Diagrams

Site Name Sand Dunes State Forest

County Sherburne



2008 and 2009 Project Abstract
For the Period Ending June 30, 2010

PROJECT TITLE: Soil Survey
PROJECT MANAGER: Megan Lennon
AFFILIATION: Minnesota Board of Water and Soil Resources
MAILING ADDRESS: 520 Lafayette Road N
CITY/STATE/ZIP: St. Paul, MN 55155
PHONE: (651) 296-1285
E-MAIL: megan.lennon@state.mn.us
WEBSITE: www. bwsr.state.mn.us
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: $400,000 is from the trust fund to the Board of Water and Soil Resources for soil survey mapping and interpretation efforts in areas of the state, including Crow Wing, Pine, Cook, Lake, and Isanti Counties, and to accelerate the delivery of soils data through the Internet as a Web-based soil survey. The new soil surveys must be done on a cost-share basis with local and federal funds.

APPROPRIATION AMOUNT: $400,000

Overall Project Outcome and Results

Accurate soils information is essential for evaluating the potential for land to support development, crop and forest production, and for identifying the most suitable locations for conservation practices and other land uses. Readily accessible local soil information is critical to informing conservation decisions and provides a foundation for sustainable land use planning. The soil survey is the mechanism for how this basic natural resource information is made available to land use authorities and landowners to make the best land use decisions.

In the ongoing, multi-year project to map, classify, interpret and Web-publish an inventory of the soils of Minnesota, this two-year phase of the project focused on accelerating the completion of a Statewide soil survey, increase soil mapping in targeted areas, and enhancing soils data through increased sample collection, availability and interpretation. Specifically: (a) 330,000 acres mapped in Crow Wing County; (b) 32,000 acres mapped in Pine County; (c) 85,000 acres mapped in Koochiching County; (d) 80,000 acres mapped in the Crane Lake subset of St. Louis County; (e) 219,000 acres mapped in Lake County; (f) 114,000 acres mapped in Cook County; (g) Data from 1,000 soil samples (some dating back to the 1970's) were interpreted for the first time and incorporated into Soil Surveys for many Minnesota counties; (h) Land use effects on soil carbon were determined on 122 sites in 14 counties throughout the State, this data can be used to develop soil carbon management guidance.

The soil survey project was extremely successful and many of the mapping goals were exceeded. Mapping surpassed initial acreage goals in both Crow Wing, Lake, Cook and Pine Counties, and the soil surveys for Koochiching and St. Louis Counties were completed 1 year ahead of schedule. A report detailing the results of re-analysis of lab samples from the 1970's highlighting land use impacts on soil carbon is available on BWSR's State Soil Office website.

Project Results Use and Dissemination

The Soil Survey project funded by the Minnesota Environment and Natural Resources Trust Fund is highlighted as a BWSR feature project (www.bwsr.state.mn.us/projects/soil_survey.pdf) on the Agency's homepage. All the data, mapping information, and interpretations are available on the Web Soil Survey as a user-friendly, GIS-based application. Web Soil Survey provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world.

Environment and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report:	August 15, 2011	
Final Report		
	M.L. 2008	**M.L. 2009**
Date of Work Program Approval:	June 10, 2008	June 16, 2009
Project Completion Date:	June 30, 2010	June 30, 2011

I. PROJECT TITLE: Soil Survey

Project Manager: Megan Lennon
Affiliation: Board of Water and Soil Resources
Mailing Address: 520 Lafayette Road North
Saint Paul, MN 55155
Telephone Number: (651) 296-1285
E-mail Address: megan.lennon@state.mn.us
Fax Number: (651) 297-5615
Web Page Address: www.bwsr.state.mn.us

Location: Crow Wing, Koochiching, Lake, Cook and Saint Louis Counties. Web-based delivery has statewide applicability.

Total Trust Fund Project Budget:	**M.L. 2008**	**M.L. 2009**	**Total**
Trust Fund Appropriation:	**$400,000**	**$400,000**	**$800,000**
Minus Amount Spent:	**$400,000**	**$393,693.50**	**$793,693.50**
Equal Balance:	**$0**	**$6,306.50**	**$6,306.50**

Legal Citation:
M.L. 2008, Chap. 367. Sec. 20, Subd. 5(b)
2008 Appropriation Language:
$400,000 is from the trust fund to the Board of Water and Soil Resources for soil survey mapping and interpretation efforts in areas of the state, including Crow Wing, Pine, Cook, Lake, and Isanti Counties, and to accelerate the delivery of soils data through the Internet as a Web-based soil survey. The new soil surveys must be done on a cost-share basis with local and federal funds.

Legal Citation: M.L. 2009, Chap. 143, Sec. 2, Subd. 3c
2009 Appropriation Language:
$400,000 is from the trust fund to the Board of Water and Soil Resources to accelerate the county soil survey and mapping and Web-based data delivery. This appropriation represents a continuing effort to complete the mapping. The soil surveys must be done on a cost-share basis with local and federal funds.

II. and III. FINAL 2008 and 2009 PROJECT SUMMARY

Overall Project Outcome and Results

Accurate soils information is essential for evaluating the potential for land to support development, crop and forest production, and for identifying the most suitable locations for conservation practices and other land uses. Readily accessible local soil information is critical to informing conservation decisions and provides a foundation for sustainable land use planning. The soil survey is the mechanism for how this basic natural resource information is made available to land use authorities and landowners to make the best land use decisions.

In the ongoing, multi-year project to map, classify, interpret and Web-publish an inventory of the soils of Minnesota, this two-year phase of the project focused on accelerating the completion of a Statewide soil survey, increase soil mapping in targeted areas, and enhancing soils data through increased sample collection, availability and interpretation.   Specifically: (a) 330,000 acres mapped in Crow Wing County; (b) 32,000 acres mapped in Pine County; (c) 85,000 acres mapped in Koochiching County; (d) 80,000 acres mapped in the Crane Lake subset of St. Louis County; (e) 219,000 acres mapped in Lake County; (f) 114,000 acres mapped in Cook County; (g) Data from 1,000 soil samples (some dating back to the 1970's) were interpreted for the first time and incorporated into Soil Surveys for many Minnesota counties; (h) Land use effects on soil carbon were determined on 122 sites in 14 counties throughout the State, this data can be used to develop soil carbon management guidance.

The soil survey project was extremely successful and many of the mapping goals were exceeded. Mapping surpassed initial acreage goals in both Crow Wing, Lake, Cook and Pine Counties, and the soil surveys for Koochiching and St. Louis Counties were completed 1 year ahead of schedule.   A report detailing the results of re-analysis of lab samples from the 1970's highlighting land use impacts on soil carbon is available on BWSR's State Soil Office website.

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IV. OUTLINE OF PROJECT RESULTS:

Soil surveys contain information essential to the management of natural resources. Many of the technical specifications for the protection and restoration of soil, water, wetlands and habitats require the consideration of soils data. For many years, the State of Minnesota has supported the efforts of the USDA Natural Resources Conservation Service to map the soils of this state. During the last three years, soils data have become available through the Internet (Web Soil Survey). Before soils data can be delivered through the Internet, soils must be mapped and digitized. Progress is being made to complete this task. (Lake and Cook, the last two counties, have signed agreements with NRCS to complete their soil survey.) However, the NRCS estimates that at current staffing levels, ten or more years are needed to complete the state. This proposal will accelerate the completion and includes funding to continue county government support for soil mapping and digitizing, accelerate soil mapping and update and reinterpret older soils data. To accomplish these tasks, efficient and timely use will be made of former and current NRCS soil scientists. Soils data, some of it older, will be updated for modern interpretations and delivered through the Web Soil Survey.

Result 1: <u>"Support county government efforts to complete the soil survey for the state".</u> Crow Wing, Pine, Cook and Lake Counties are the final counties in the plan to complete a soil survey for the State. For Crow Wing and Pine Counties, the cost of completing the soil survey is borne by the USDA, state and county in (approximately) a 70/20/10 distribution, respectively. (Contributions to soil survey costs in Isanti and the survey areas in the NE are varied and include LCMR, USDA and county cost-sharing arrangements.) Result 1 will generate about $100,000 per year of local cost-share in the form of cash, office space and soil survey-related equipment and products.

Summary Budget Information for Result 1:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$150,000**	**$235,000**	**$385,000**
Amount Spent:	**$150,000**	**$228,693.50**	**$378,693.50**
Balance:	**$ 0**	**$6,306.50**	**$6306.50**

Deliverable	Completion Date	Budget	General Status (See details below)
1. 2008: About 70,000 acres will be addressed in Crow Wing County by existing NRCS staff. The NRCS has now fully staffed this survey with three soil scientists.	June 30, 2010	$75,000	Acreage goals were met and budget was spent.
2. 2008: About 15,000 acres per year will be addressed in Pine County by existing NRCS staff. The NRCS intends to add two or more soil scientists to this survey. The state supported accelerated program is ending: no additional state funded soil scientists will be added for 2009.	June 30, 2010	$75,000	Although county and state participation has ended, NRCS exceeded acreage goals. The budget was spent.
3. 2009: About 150,000 acres will be addressed in Crow Wing County by existing NRCS staff.	June 30, 2011	$75,000	About 263,000 acres were addressed with ENTRF

			LCCMR funds and NRCS cost-share. The entire budget was spent.
4. 2009: About 85,000 acres will be addressed in Lake County by existing NRCS staff and soil scientists contracted by the county. The NRCS currently has one soil scientist assigned to this survey who will also assist with quality control. **Amendment approved: 5/7/2010**	June 30, 2011	$107,000	About 76,000 acres were addressed. $100,776.50 spent was spent.
5. 2009: About 42,000 acres will be addressed in Cook County by existing NRCS staff and soil scientists contracted by the county. The NRCS currently has one soil scientist assigned to this survey who will also assist with quality control. **Amendment approved: 5/7/2010**	June 30, 2011	$53,000	About 42,000 acres were addressed. $52,917 was spent.

Final Report Summary

M.L. 2008: The NRCS addressed 71,000 acres in Crow Wing County and 32,000 in Pine County (despite Pine County's withdrawal from the program). Portions of both Crow Wing and Pine Counties are available on the Web Soil Survey.

M.L. 2009: The NRCS and its contract soil mappers exceeding mapping goals. A total of 390,000 acres were mapped in Crow Wing, Lake and Cook Counties. The Glacial Lake Brainerd region of Crow Wing County (83,000 acres) is available on Web Soil Survey. Crow Wing, Lake and Cook Counties contributed $30,000, $10,000 of in-kind services annually to the soil survey effort. The Lake County survey effort came in under budget by $6,223.50 due to an initial over estimate of work load (mapping acreage) for contract soil mappers. By the time this was discovered it was too late in the fiscal year to amend the work plan and shift funds to another Result. After mapping approximately 42,000 acres in Cook County, $83 remained unspent.

Result 2: "Increase soil mapping. Experience has shown that soil mapping can be accelerated by augmenting existing NRCS staff with experienced soil scientists familiar with NRCS mapping procedures and the soil landscape. For 2008, an additional 40,000 acres will be addressed by current NRCS soil scientists (detailees) brought to

Minnesota on work assignments. For 2009, an additional 28,000 acres will be addressed**. Amendment approved: 6/24/2010**

Summary Budget Information for Result 2:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$100,000**	**$140,000**	**$240,000**
Amount Spent:	**$100,000**	**$140,000**	**$240,000**
Balance:	**$0**	**$0**	**$240,000**

Deliverable	Completion Date	Budget	General Status (See details below)
1. M.L. 2008: 40,000 acres addressed in several project areas including Pine, Saint Louis (Crane Lake), Lake, Cook and Koochiching. This deliverable will be completed by June 30, 2010. (Note: "New" surveys -Lake and Cook- received only federal funds.) Pine terminated the project July 7, 2009; funds, if any, to shift to NRCS in 2009.	June 30, 2010	$100,000	Acreage goals were met and budgeted amount was spent.
2. M.L. 2009: 28,000 acres addressed in several project areas including Saint Louis (Crane Lake), Koochiching, Lake and Cook Counties. Decreased acreage goal by NRCS due to increased acreage by private sector soil scientists working under NRCS direction. This deliverable will be completed by June 30, 2011. **Amendment approved: 6/24/2010**	June 30, 2011	$140,000	Acreage goals were exceed with 215,000 acres addressed with ENTRF LCCMR funds and NRCS cost-share. The budget was spent.

Final Report Summary

M.L. 2008: NRCS-employed soil scientists, assigned to Minnesota ("detailees"), addressed 85,000 acres in Koochiching County and 80,000 acres in the Crane Lake subset of Saint Louis County. As a result of these significant accomplishments, the surveys of Koochiching and the Crane Lake subset were completed one year ahead of schedule and will be posted on the WEB Soil Survey. Lake and Cook Counties received only Federal funds and the 'new' soil surveys are prioritized for mapping with 2009 Soil Survey Project appropriation.

M.L. 2009: NRCS soil scientists exceeded acreage goals and mapped 226,000 acres in Lake, St. Louis and Cook Counties. Soils data for Koochiching County and St. Louis County is available on Web Soil Survey. NRCS matched $2,000,000 to complete soil mapping and digitizing in remaining project areas.

Result 3: "**Accelerate data collection, availability and interpretation."**
By providing additional personnel (including professional/technical contracts) to update and interpret soils data, modern interpretations will be developed, some from older data. All data will be available for delivery on the Internet (Web Soil Survey). The USDA NRCS has committed $8,000 cash and an equal amount of in-kind services to this effort. **Amendment approved 6/24/2010**

Summary Budget Information for Result 3:

	M.L. 2008	**M.L. 2009**	**Total**
Trust Fund Budget:	**$150,000**	**$25,000**	**$175,000**
Amount Spent:	**$150,000**	**$25,000**	**175,000**
Balance:	**$0**	**$0**	**$0**

Deliverable	**Completion Date**	**Budget**	**Status**
1. M.L. 2008: A county-based soil productivity index for agricultural crops and forests will be developed for statewide use by June1, 2009. This project will be done in consultation with the NRCS who is responsible for posting the product on the WEB Soil Survey.	June 1, 2009	No 2008 funds were used for this deliverable. 2007 funds were used.	Crop productivity and forest productivity indices have been prepared for 85 and 20 soil survey areas, respectively.
2. M.L.2008 and M.L. 2009: Data from several hundred lab samples dating back to the 1970's will be interpreted and made Web-available.	June 30, 2011	$175,000 (150,000 '08 and 25,000 '09)	1,000 soil pedon samples were

Amendment approved 6/24/2010			evaluated and entered into Web Soil Survey. The entire budget was spent.

Final Report Summary

M.L. 2008: Inventorying and cataloging the over 10,000 soil samples collected over a 30 year period beginning in the mid-1970's has began. Using many of these same sampling sites, contemporary samples will be taken to determine what, if any, trends exist regarding soil carbon and nitrogen. Data for 122 sites has been collected and is being interpreted. A report detailing the results is available on the BWSR State Soils Office webpage. Results show long-term land use and management influence soil organic carbon levels in Minnesota soils.

M.L. 2009: A retired NRCS soil scientist completed interpretation, correlation and reclassification of 1,000 previously untested soil samples from the 1970's. The new data was entered into the National Soil Survey database and is available on Web Soil Survey.

VII. Total Trust Fund Project Budget:

M.L. 2008

Staff or Contract Services: $ 400,000. $150,000 --$75,000 each for contracts with Crow Wing and Pine Counties—for ongoing soil survey activities. Due to their withdrawal, Pine County will receive a pro-rated final payment and may not earn the entire $75,000 [result 1]; $100,000 contract with USDA-NRCS to increase soil mapping and data availability [result 2] The balance—if any-- of the Pine County agreement will be awarded to USDA-NRCS; $150,000 contract with the UM to accelerate data collection, availability and interpretation [result 3].
Equipment: $ None anticipated to be procured with LCCMR funds.
Development: $ N/A
Restoration: $ N/A
Acquisition, including easements: $ N/A
TOTAL 2008 TRUST FUND PROJECT BUDGET: $ 400,000

M.L. 2009

Contracts: $400,000 USDA NRCS $140,000; Counties $235,000: Crow Wing County $75,000; Lake County $107,000; and Cook County, $53,000; Retired NRCS soil scientist, $25,000.

Equipment/Tools/Supplies: N/A
Acquisition, including Easements: N/A
Travel: N/A
Other: N/A
TOTAL 2009 TRUST FUND PROJECT BUDGET: $400,000

IIX. OTHER FUNDS & PARTNERS/ PROJECT STRATEGY:

A. Project Partners:
M.L. 2008
The project team includes Joe McCloskey, State Soil Scientist, USDA NRCS; Greg Larson, State Soil Specialist, BWSR, and Professor Ed Nater, UM Department of Soil, Water and Climate. The NRCS will receive $100,000 plus the balance of the terminated agreement with Pine County and the UM will receive $150,000.

M.L. 2009 **Amendment Approved: 5/7/2010**
The project team includes Caryl Radatz, State Soil Scientist, USDA NRCS; Megan Lennon, Soil Scientist, BWSR and Greg Larson, State Soil Specialist. The NRCS will receive $140,000.

B. Other Funds Proposed to be Spent during 2008 and 2009:
Each year, the Minnesota Office of the NRCS has or will commit(s) about $2.5 Million to their soils program, with about $2.0 Million spent on completing soil mapping and digitizing activities in the remaining project areas. The Board of Water and Soil Resources provides in-kind contributions of about $20,000 annually.

C. Spending History:
The LCMR contributed $500,000 funding for the biennium ending June 30, 2007. Crow Wing County has contributed about $30,000 annually. Pine County has contributed about $10,000 annually. Lake and Cook Counties will each contribute about $10,000 annually.

D. Time for 2008 and 2009 funds:
2008 funds are for the biennium beginning July 1, 2008.
2009 funds are for the biennium beginning July 1, 2009.

E. Project Impact and Long-term Strategy:
As stated previously, soils data are critical to the use and management of soils and other natural resources. Work remains in five survey areas (of 91) before WEB-published soil survey is available statewide. A county by county assessment of the completion schedule is provided, followed by a table that summarizes which year(s) of LCCMR funding was used.
Koochiching: Field work is done. WEB-publication is complete.

Saint Louis County (Crane Lake subset): Field work is done. WEB-publication is complete.
Pine: Work is no longer on schedule. The termination of the project by the county creates an uncertain future. To meet federal mandates, USDA-NRCS will continue to work in the county but at a much slower pace. However, as reported earlier, the NRCS has made significant progress.
Crow Wing County: Work is on schedule to complete the entire county by late 2013. WEB-publication of the 83,000 acre Glacial Lake Brainerd geomorphic area is complete.
Lake County: As reported earlier, work is beginning to complete the entire county by late 2013. Much of the county is part of the Superior National Forest. Soils mapping therein has been completed by the US Forest Service.
Cook County: As reported earlier, work is beginning to complete the entire county by late 2013. Much of the county is part of the Superior National Forest. Soils mapping therein has been completed by the US Forest Service.

Survey Area	**LCCMR 07**	**LCCMR 08**	**LCCMR 09**
Koochiching	X	X	
Saint Louis (Crane Lake)	X	X	
Pine County		X	
Crow Wing County	X	X	X
Lake County			X
Cook County			X

IX. DISSEMINATION: As the projects described herein are developed and approved by the NRCS, they may be used without restriction.

IX. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than January 2009; June 30, 2009; January 2010, June 30, 2010, and January 2011. A final work program report and associated products for the 2008 appropriation will be submitted between June 30 and August 1, 2010 as requested by the LCCMR and a final work program report and associated products for the 2009 appropriation will be submitted no later than August 1, 2011.

X. RESEARCH PROJECTS: Not applicable.

Attachment A: Final Budget Detail for 2009 Project

Project Title: Soil Survey

Project Manager Name: Megan Lennon

Trust Fund Appropriation: $400,000

2009 Trust Fund Budget	**Results 1 Budget 4/15/2010 Amendment approved: 5/7/2010**	**Amount Spent** *(6/30/2011)*	**Balance** *(6/30/2011)*	**Revised Result 2 Budget July 11, 2010**	**Amount Spent** *(6/30/2011)*	**Balance** *(6/30/2011)*	**Revised Result 3 Budget 7/11/2010**	**Amount Spent** *(6/30/2011)*	**Balance** *(6/30/2011)*	**Revised TOTAL Budget BUDGET**	**Revised TOTAL BALANCE**
	Support county government efforts to complete the soil survey			*Increase soil mapping*			*Accelerate data collection, availability and interpretation*				
BUDGET ITEM											
Contracts											
Cook County	53,000	52,917	83							53,000	0
Crow Wing County	75,000	75,000	0							75,000	0
Lake County	107,000	100,776.50	6,223.50							107,000	6,223.50
Retired Soil Scientist 6/24/2010 (Al Giencke, work is to interpet and make web available 1,000 soil samples)							25,000	25,000	0	25,000	0
USDA NRCS				140,000	140,000	0		0		140,000	0
COLUMN TOTAL	**$235,000**	**$228,693.50**	**$6,306.50**	**$140,000**	**$140,000**	**$0**	**$25,000**	**$25,000**	**$0**	**$400,000**	**$6,306.50**

Final Report

Historical C Project

Deborah Allan, Karina Fabrizzi, and Keith Piotrowski

March 2011

This project was funded by the Minnesota Environment and Natural Resources Trust Fund.

This report summarizes the results of this research project and gives a detailed accounting of the activities undertaken from Summer 2010 to the present. The overall findings of the project show that for 102 sites so far analyzed, there were significant increases in carbon concentration for forest soils (38%) and a small but significant decrease in cropped soils (-13%) over mean depths of 24-30 inches (60-75 cm). Grassland soil C increases were not significant due to small sample numbers (n=9). Carbon accumulation increased significantly for the top two horizons (0-4" and 4-13") at forest sites, while grassland sites had significant increases only in the second horizon (8-16"). Cropland sites had significant decreases of 24% in the surface horizon. When management changed from cropland to grassland, C concentration increased 53% (from 12.2 to 18.8 g C kg^{-1} soil for 12 sites), but site numbers were too small to see C differences for other management conversions. Regional differences in C changes reflect the predominant managements sampled in each area.

During the final reporting period, our activities were focused on:

1. Processing and analyzing soil samples taken during Summer and Fall of 2010 in the following counties: Brown, Nobles, Rock, Houston, Beltrami, Wilkin and Pennington.

2. Analyzing the original soil samples for each county that had been sampled in 2010.

3. Summarizing the results.

1. Processing and analysis of soil samples Summer-Fall 2010.

Soil samples were taken in the Summer and Fall of 2010 in the following counties: Brown, Nobles, Rock, Houston, Beltrami, Wilkin, and Pennington. Table 1 summarizes all the counties that were sampled for the duration of the study.

During Summer-Fall 2010 sampling, approximate locations of the sites were identified using latitude and longitude information. A GPS unit was used to verify the exact location. Soil samples were taken using a hand-probe. An average of 3-4 cores were taken to match the increment depths already recorded in the Soil Survey notes for each sample. Some extra cores were taken for the shallow surface soil samples. Samples were transported to the laboratory, sieved to 2mm, air-dried and stored until analysis.

Soil samples were analyzed for C and N using a Vario Max C/N analyzer. Data summaries for each county are presented in the Appendix and a summary of the results is presented later in this report.

In some cases, soil samples had very high C values because of high carbonate content. We selected those samples that had a pH of 7.5 or greater and re-ran them using an adjustment for carbonates on the Vario Max C/N analyzer. This adjustment was not always successful, so we also attempted to neutralize the carbonates using a HCl-fumigation technique. Some samples were still very high in C, so we are planning to treat the soil samples with a solution of hydrochloric acid and then rinse them with distilled water to eliminate all the carbonates present. There were samples from 20 sites with questionable C values which are not reported here; the final data will be presented shortly in a revised final report.

2. Analysis of the original soil samples for each county.

Total C and N of the original soil samples were determined by dry combustion using a Vario Max C/N analyzer, so that we could compare the original reported C values with values obtained using the present methodology. We obtained a high correlation between the original data and the reanalyzed measurements for the archived samples (r=0.943, n=225) with the Vario Max C/N analyzer procedure (Figure 1), which gave us confidence that we could use the re-ran values as “original” soil sample data to compare with the values for the soils sampled in 2009 and 2010. Some of the original data for the lowest depths were not reported but we were able to analyze them because we had access to the archived samples.

3. Summary of the preliminary results

In total, there were 492 sites for which labeled, archived samples exist. These sites occur in the following regions of MN:

- **North Central**: 18 sites in Aitkin, Morrison, and Todd Counties.
- **Northeast**: 67 sites in St Louis, Itasca and Koochiching Counties.
- **Southwest**: 48 sites in Rock, Nobles, Jackson, and Murray Counties.
- **Red River North Basin**: 121 sites in Beltrami, Clearwater, Clay, Mahnomen, Pennington, Red Lake, Wilkin and Traverse Counties.
- **Southeast**: 80 sites in Houston, Mower and Winona Counties.
- **Minnesota River Basin**: 158 sites in Kandiyohi, Chippewa, Yellow Medicine, Redwood, Meeker, Brown, Le Sueur, and Martin Counties.

After collecting information about the landowners for each experimental site, the counties that were considered for resampling were:

- **North Central Region of MN**: Todd (11).
- **North East Region of MN:** St Louis North and South and Itasca (65).
- **Southwestern Region of MN**: Rock and Nobles (16).
- **Red River North Basin**: Beltrami, Pennington, and Wilkin (98).
- **Southeastern Region of MN:** Winona and Houston (48).
- **Minnesota River Basin:** Kandiyohi, Yellow Medicine, Redwood, and Brown (92).

Thus, the potential number of sites to be sampled was reduced to 330 for the 15 counties (Table 1). We sent 244 letters to those landowners we could identify requesting permission to obtain soil samples, and received positive replies for a total of 135 sites to sample. Some of the sites could not be sampled because the actual location was no longer suitable (middle of road, disturbed sites, and construction areas).

Data presented in this report correspond to 102 sites, since we will be repeating soil samples that have high carbonates. To summarize the results presented in this report, data for each site was averaged over the whole profile. Individual information for each site and county are presented in the Appendix.

Changes in carbon concentrations for each type of management practice are presented in Figures 2 and 3. Figure 2 shows changes in C concentration for those sites that had the same management at the initial sampling time (T=0) as when we sampled in 2009-10 (T=1). For 24 sites with forest vegetation, C concentrations increased significantly by 5.1 g C kg^{-1} soil (38% increase) to a mean depth of 24 inches (61 cm). Sites under grassland (n=9) averaged a similar increase (5.2 g C kg^{-1} soil) to 30 inches (76 cm), but it was not significant due to the small number of samples. Those sites that were in cropland (n=51) had a significant but smaller decrease of 2.3 g C kg^{-1} soil in C concentration (-13%) after 31 yrs to a mean depth of 27 inches (69 cm).

Changes in C concentrations at different depths are presented in Table 2 and Figure 3. For each management, soil sampling depths were averaged for each of 3 horizons. Carbon concentrations were significantly higher in the top two horizons for forest sites and in the second horizon only for grassland sites. For cropland sites, C losses were only observed in the surface horizon (24%).

Figure 4 shows how C concentrations have changed for sites where the vegetation is different from what it was when the soils were originally sampled (T=0). The number of sites for each category is low, so the only significant differences were observed for sites where cropland changed to grassland. Over a mean depth of 27 inches (69 cm), C concentrations increased by 6.5 g C kg^{-1} soil (53 %).

When the data was averaged across the six Minnesota regions where we sampled (Table 3, Figure 5), most of the areas showed no changes or slight increases in C concentrations across all managements. Comparing differences in C concentrations among regions should be done with caution, since each region encompasses different managements and soil types, and the number of sites per region varies greatly. For example, the increase observed in the Northeast can be attributed to the fact that all these sites were under forest (21 sites). In the North Central region, changes in C are related to management since 4 of the 5 sites sampled are in grassland, but such small sample numbers do not allow us to generalize for the whole region. The relatively small changes in the Minnesota River Basin, Southwest and Red River North Basin reflect mostly cropland sites. In the Southeast, about half the sites are under grassland or forest and the other half are in cropland.

Table 1. Detailed information for the sampled sites:

Region	County	Potential sites	Sent letters	Approved answer for sampling	Sampled Sept 2009 to October 2010
Northeast	**Itasca**	18	10	8	3 [†] (September 16th 2009)
	St . Louis North	30	15	13	11 (September 16th 2009)
	St. Louis South	17	5 (and by email contact)[‡]	12	8 (September 2nd 2009)
North Central	**Todd**	11	10	5	5 (September 9th 2009)
Red River North Basin	**Pennington**	52	52	14	14 (September 28th and 29th 2010)
	Beltrami	17	12	7	7 (September 28th and 29th))
	Wilkin	29	19	12ʃ	15 (September 21st 2010)
Minnesota River Basin	**Redwood**	11	10	6	6 (November 10th 2009)
	Yellow Medicine	9	8	3	2 (November 10th 2009)
	Kandiyohi	26	14	8[ʃ]	13 (November 17th 2009)
	Brown	46	40	17[ʃ]	14 (July 21st and 27th 2010)
Southeastern	**Winona**	19	14	10	8 (October 28th 2009)
	Houston	29	19	11	7(October 20th 2010)
Southwestern	**Rock**	14	14	7	7 (June 24th 2010)
	Nobles	2	2	2	2 (June 24th 2010)
Total	**15**	330	244	135	122

[†] For proximity, we only sampled the sites from Itasca Co. that were close to St. Louis North Co.
[‡] For some of the sites, permission was obtained by email contact.
[ʃ] There were more than two sites for some landowners.

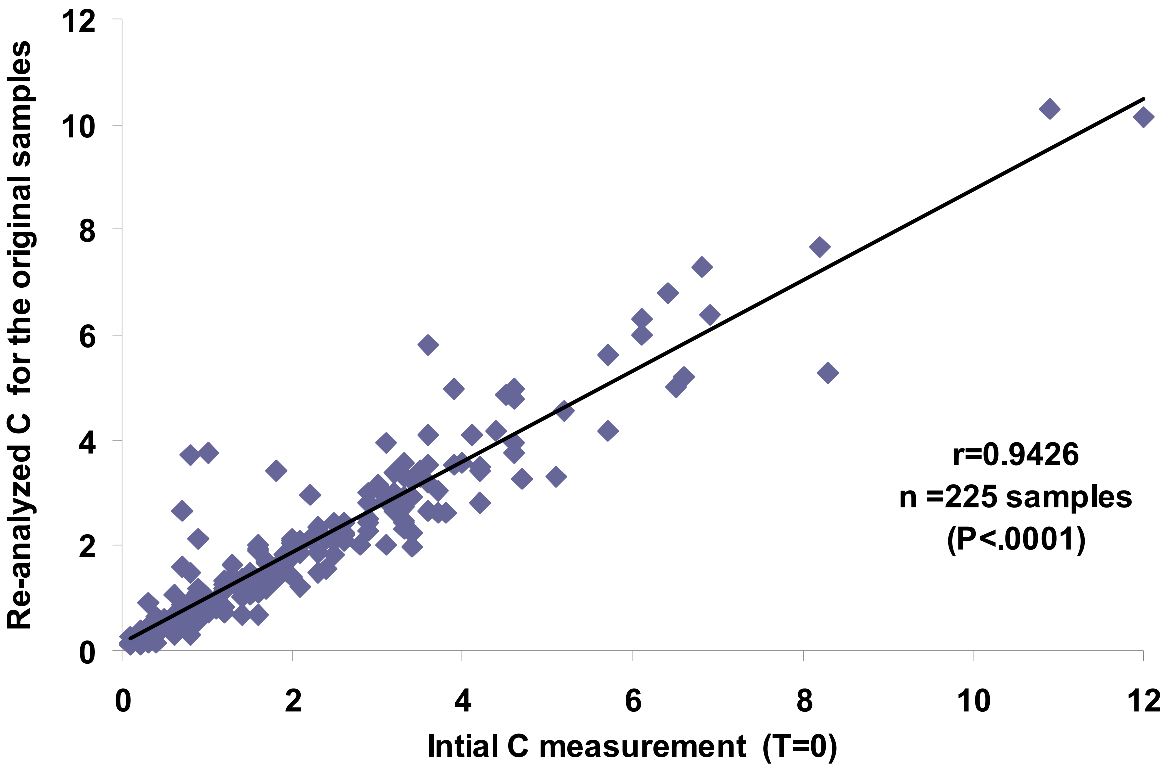


Figure 1. Comparison between initial C measurement (T=0) and the re-analyzed C measurement in 2009-2010 of the original samples using the Vario Max C/N analyzer at different sampling depths.

Management	C at initial sampling (T=0)	C at present	Increment in C concentration	Number of sites	Mean time since T=0	Mean depth of sampling
	.... g C kg^{-1} soil				yrs	inches
Forest	13.4	18.5	5.1 (*P*=0.0068)	24	30	24
Cropland	16.9	14.6	- 2.3 (*P*=0.0280)	51	31	27
Grassland	10.5	15.7	5.2 (*P*=0.1330)	9	30	30

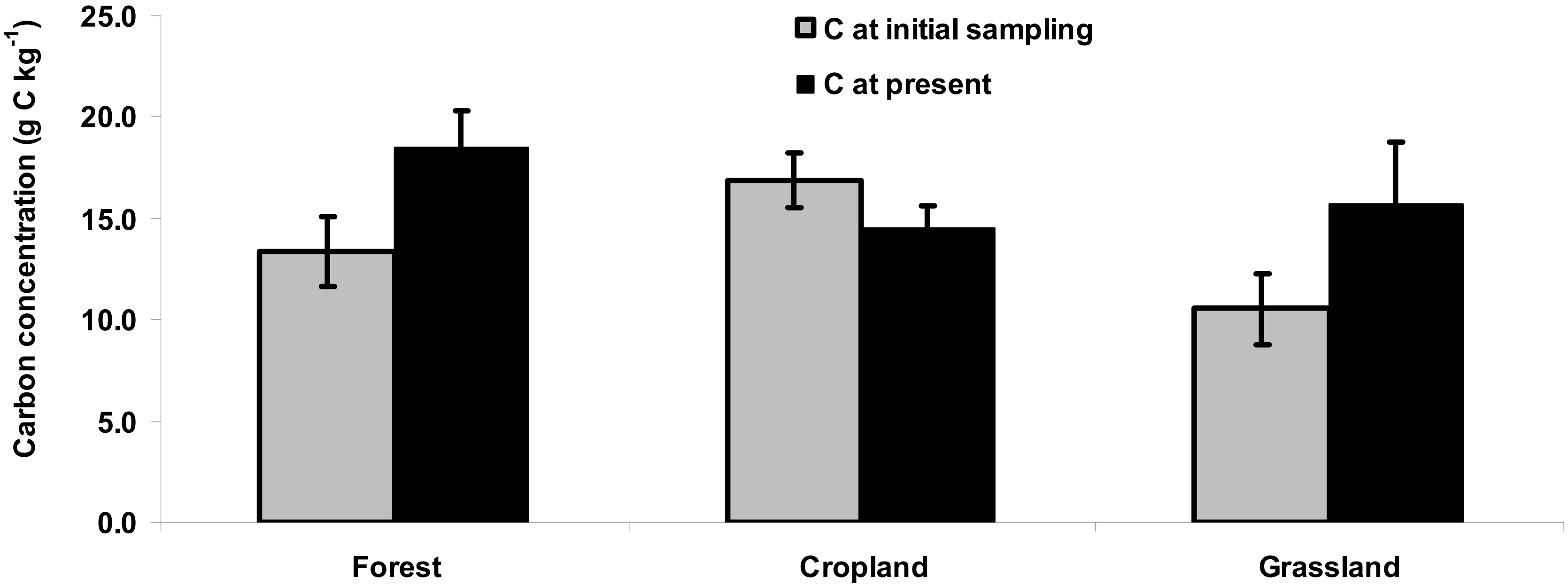


Figure 2. Changes in carbon concentrations after 30 years for sites that remained in the same management.

Table 2. Changes in carbon concentrations after 30 years for sites that remained in the same management at different depth increments.

	Forest[1]			Grassland[2]			Cropland[3]		
Horizon	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Initial C ($g\ C\ kg^{-1}$ soil)	41.7	10.2	4.4	20.6	5.9	6.2	28.8	14.4	6.7
C at present ($g\ C\ kg^{-1}$ soil)	56.5	16.3	6.2	23.5	13.2	10.3	22.1	13.3	8.2
C increment or decrease ($g\ C\ kg^{-1}$ soil)	14.9*	6.0**	2.1	2.9	7.3*	4.2	-6.7**	-1.1	1.4
% increment or decrease from Initial C	36	59	48	14	124	68	-24	-8	22

* Indicates significant differences at $P<0.05$

** Indicates significant differences at $P<0.01$

1. For forest, mean horizon depths are 1=0-4", 2=4-13", 3=13-31"
2. For grassland, mean horizon depths are 1=0-8", 2=8-16", 3=16-32"
3. For cropland, mean horizon depths are 1=0-9", 2=9-16", 3=16-28"

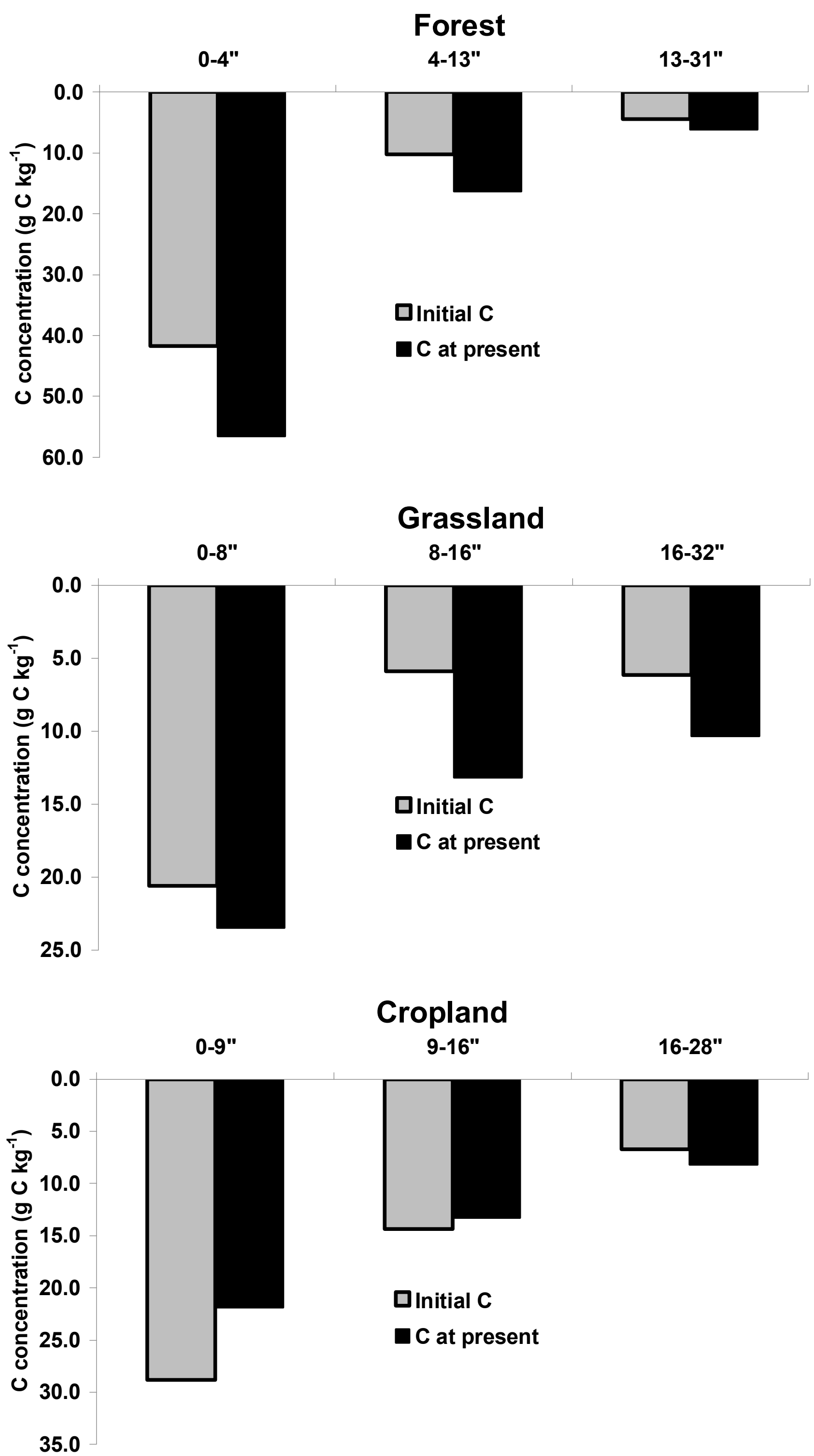


Figure 3. Changes in carbon concentrations after 30 years for sites that remained in the same management at different depth increments.

Management	C at initial sampling (T=0)	C at present	Increment in C concentration	Number of sites	Mean time since T=0	Mean depth of sampling
	.... g C kg^{-1} soil				yrs	inches
Forest to Grassland	13.6	14.1	0.5 (*P*=0.8787)	3	30	29
Cropland to Forest	4.5	13.2	8.7 (*P*=0.0753)	3	31	33
Cropland to Grassland	12.2	18.8	6.5 (*P*=0.0299)	12	30	27

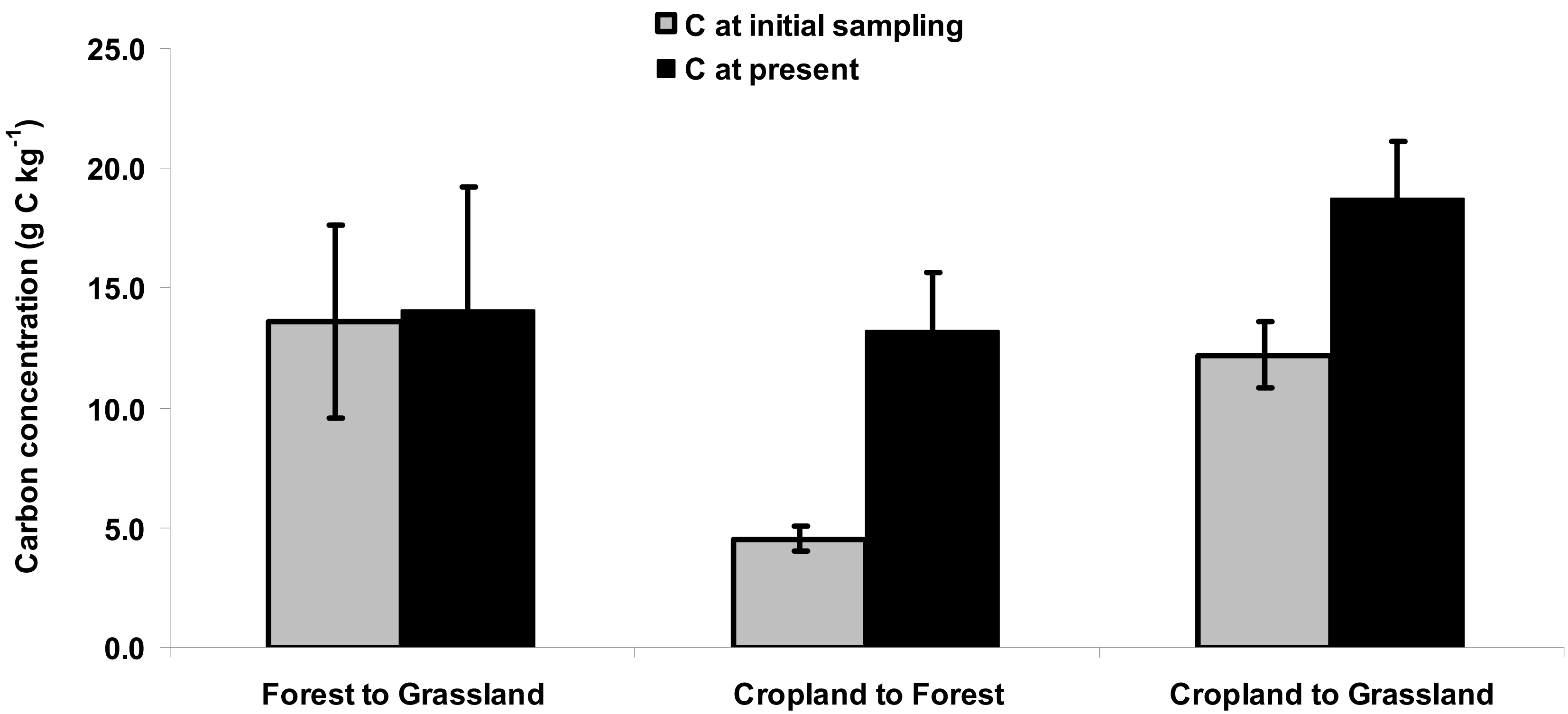


Figure 4. Changes in carbon concentration after 30 years at sites that changed management.

Table 3. Average changes in carbon concentration in 6 different regions of Minnesota after 30 yrs.

Management	C at initial sampling (T=0)	C at present	Increment in C concentration	Number of sites
	…………. g C kg^{-1} soil ………….			
Northeast	13.6	19.0	5.4 (*P*=0.0056)	21
Red River North Basin	12.5	12.7	0.2 (*P*=0.8581)	26
North Central	8.6	17.4	8.9 (*P*=0.2322)	5
Minnesota River Basin	18.9	18.4	-0.5 (*P*=0.8161)	30
Southwest	17.2	16.9	-0.3 (*P*=0.9032)	8
Southeast	9.6	12.7	3.1 (*P*=0.1352)	13

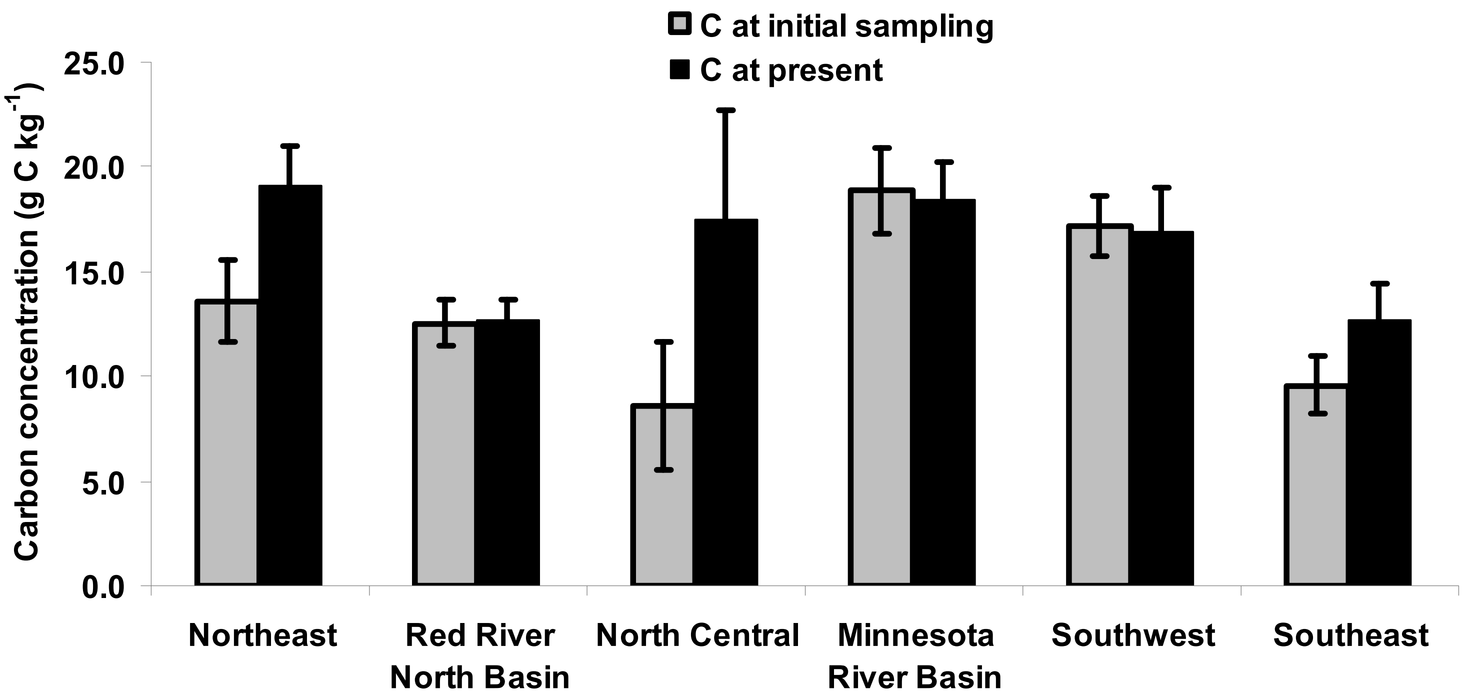


Figure 5. Average changes in carbon concentration in 6 different regions of Minnesota after 30 yrs.

APPENDIX
Individual information for each sampling site.

Region	County	N of sites	Management	Average depth	C at initial (T=0)	C at present (T=1)	C-Increment	Time since T=0
				inches	.... g C kg^{-1} soil		....	yrs.
Northeast	**Itasca**	1	Forest	**22**	3.92	21.20	17.28	31
Northeast	**Itasca**	2	Forest	**24**	5.26	20.82	15.56	31
Northeast	**Itasca**	3	Forest	**23**	7.32	10.31	2.99	29
Northeast	**St. Louis N**	4	Forest	**15**	16.97	24.81	7.84	31
Northeast	**St. Louis N**	5	Forest	**23**	16.11	16.79	0.67	30
Northeast	**St. Louis N**	6	Forest	**15**	16.07	21.27	5.20	30
Northeast	**St. Louis N**	7	Forest	**14**	11.41	17.37	5.96	30
Northeast	**St. Louis N**	8	Forest	**8**	27.37	29.43	2.06	30
Northeast	**St. Louis N**	9	Forest	**26**	10.17	28.13	17.96	30
Northeast	**St. Louis N**	10	Forest	**18**	19.28	9.59	-9.69	30
Northeast	**St. Louis N**	11	Forest	**60**	1.86	12.00	10.14	29
Northeast	**St. Louis N**	12	Forest	**44**	3.85	17.76	13.91	29
Northeast	**St. Louis N**	13	Forest	**60**	2.80	6.65	3.85	29
Northeast	**St. Louis N**	14	Forest to Grassland	**30**	18.60	23.92	5.32	30
Northeast	**St. Louis S**	15	Forest	**36**	2.07	5.55	3.48	31
Northeast	**St. Louis S**	16	Forest	**16**	4.27	3.76	-0.50	30
Northeast	**St. Louis S**	17	Forest	**16**	17.55	26.63	9.09	30
Northeast	**St. Louis S**	18	Forest	**15**	28.93	33.30	4.37	30
Northeast	**St. Louis S**	19	Forest	**14**	20.89	35.77	14.88	30
Northeast	**St. Louis S**	20	Forest	**13**	23.66	18.52	-5.14	30
Northeast	**St. Louis S**	21	Forest	**25**	27.02	16.21	-10.80	30
Red River North Basin	**Beltrami**	1	Forest	**24**	10.69	9.55	-1.14	30
Red River North Basin	**Beltrami**	2	Forest	**23**	15.90	10.86	-5.04	30
Red River North Basin	**Beltrami**	3	Grassland	**18**	13.25	9.84	-3.41	30
Red River North Basin	**Beltrami**	4	Grassland	**21**	9.37	9.78	0.41	30
Red River North Basin	**Beltrami**	5	Grassland	**34**	16.63	16.61	-0.02	31
Red River North Basin	**Beltrami**	6	Cropland to Grassland	**22**	20.58	17.08	-3.51	30
Red River North Basin	**Beltrami**	7	Cropland to Grassland	**24**	17.21	20.39	3.18	30
Red River North Basin	**Pennington**	8	Forest	**18**	14.63	16.01	1.37	30
Red River North Basin	**Pennington**	9	Cropland	**17**	27.17	23.49	-3.68	32
Red River North Basin	**Pennington**	10	Cropland	**18**	16.03	15.76	-0.27	31
Red River North Basin	**Pennington**	11	Cropland	**22**	6.21	9.48	3.27	30
Red River North Basin	**Pennington**	12	Cropland	**27**	12.38	9.95	-2.43	30
Red River North Basin	**Pennington**	13	Cropland to Forest	**23**	3.72	16.16	12.44	32
Red River North Basin	**Pennington**	14	Cropland to Forest	**24**	5.48	15.19	9.71	32
Red River North Basin	**Pennington**	15	Cropland to Grassland	**25**	10.67	18.08	7.40	-
Red River North Basin	**Pennington**	16	Cropland to Grassland	**16**	7.83	10.49	2.66	32
Red River North Basin	**Wilkin**	17	Cropland	**21**	17.03	7.17	-9.86	31
Red River North Basin	**Wilkin**	18	Cropland	**35**	6.85	5.22	-1.63	31
Red River North Basin	**Wilkin**	19	Cropland	**30**	5.51	6.33	0.81	31
Red River North Basin	**Wilkin**	20	Cropland	**31**	5.21	11.63	6.42	31
Red River North Basin	**Wilkin**	21	Cropland	**32**	11.94	10.02	-1.91	31
Red River North Basin	**Wilkin**	22	Cropland	**37**	12.56	7.94	-4.62	31
Red River North Basin	**Wilkin**	23	Cropland	**30**	13.56	8.79	-4.77	30
Red River North Basin	**Wilkin**	24	Cropland	**24**	14.23	13.82	-0.41	30
Red River North Basin	**Wilkin**	25	Cropland	**26**	11.13	11.81	0.68	30
Red River North Basin	**Wilkin**	26	Cropland	**18**	19.86	18.62	-1.24	30

Region	County	N of sites	Management	Average depth	C at initial (T=0)	C at present (T=1)	C-Increment	Time since T=0
				inches	....	g C kg^{-1} soil	....	yrs.
Northcentral	**Todd**	1	Cropland	**26**	20.62	14.68	-5.94	29
Northcentral	**Todd**	2	Grassland	**15**	6.44	26.72	20.28	29
Northcentral	**Todd**	3	Grassland	**36**	4.99	6.87	1.88	31
Northcentral	**Todd**	4	Forest to Grassland	**36**	5.55	6.48	0.93	29
Northcentral	**Todd**	5	Cropland to Grassland	**15**	5.33	32.49	27.16	29
Minnesota River Basin	**Brown**	1	Cropland	**15**	17.55	13.16	-4.40	32
Minnesota River Basin	**Brown**	2	Cropland	**17**	18.77	22.06	3.28	32
Minnesota River Basin	**Brown**	3	Cropland	**26**	13.19	16.15	2.96	32
Minnesota River Basin	**Brown**	4	Cropland	**33**	9.79	11.25	1.46	32
Minnesota River Basin	**Brown**	5	Cropland	**35**	12.31	9.81	-2.50	32
Minnesota River Basin	**Brown**	6	Cropland	**30**	51.78	33.97	-17.81	32
Minnesota River Basin	**Brown**	7	Cropland	**33**	46.46	26.78	-19.68	32
Minnesota River Basin	**Brown**	8	Cropland	**24**	6.13	4.64	-1.49	32
Minnesota River Basin	**Brown**	9	Cropland	**20**	24.26	23.01	-1.25	31
Minnesota River Basin	**Brown**	10	Cropland	**24**	13.76	12.72	-1.04	31
Minnesota River Basin	**Brown**	11	Cropland	**25**	7.68	5.75	-1.93	31
Minnesota River Basin	**Brown**	12	Cropland	**38**	14.85	15.74	0.89	31
Minnesota River Basin	**Brown**	13	Cropland	**18**	24.08	18.82	-5.26	30
Minnesota River Basin	**Kandiyohi**	14	Cropland	**31**	19.66	11.54	-8.11	31
Minnesota River Basin	**Kandiyohi**	15	Cropland	**24**	34.73	6.19	-28.54	30
Minnesota River Basin	**Kandiyohi**	16	Grassland	**31**	5.82	33.68	27.86	31
Minnesota River Basin	**Kandiyohi**	17	Grassland	**23**	17.90	32.74	14.84	29
Minnesota River Basin	**Kandiyohi**	18	Grassland	**60**	5.41	21.15	15.74	29
Minnesota River Basin	**Kandiyohi**	19	Grassland	**34**	15.09	9.42	-5.67	29
Minnesota River Basin	**Kandiyohi**	20	Cropland to Grassland	**60**	6.50	8.79	2.29	31
Minnesota River Basin	**Kandiyohi**	21	Cropland to Grassland	**19**	17.79	15.33	-2.46	31
Minnesota River Basin	**Kandiyohi**	22	Cropland to Grassland	**17**	13.30	33.79	20.48	28
Minnesota River Basin	**Kandiyohi**	23	Cropland to Grassland	**30**	11.73	16.61	4.88	29
Minnesota River Basin	**Redwood**	24	Cropland	**23**	18.74	19.48	0.74	33
Minnesota River Basin	**Redwood**	25	Cropland	**25**	23.39	16.85	-6.54	33
Minnesota River Basin	**Redwood**	26	Cropland	**25**	16.03	13.44	-2.59	33
Minnesota River Basin	**Redwood**	27	Cropland	**28**	27.54	43.63	16.10	32
Minnesota River Basin	**Redwood**	28	Cropland	**28**	36.09	30.47	-5.61	32
Minnesota River Basin	**Y. Medicine**	29	Cropland	29	18.63	8.29	-10.34	33
Minnesota River Basin	**Y. Medicine**	30	Cropland	21	17.28	16.26	-1.01	33

Region	County	N of sites	Management	Average depth	C at initial (T=0)	C at present (T=1)	C-Increment	Time since T=0
				inches	…………………………	g C kg^{-1} soil	………………………	yrs.
Southwestern	**Nobles**	1	Cropland	**22**	14.78	17.80	3.01	31
Southwestern	**Nobles**	2	Cropland to Grassland	**20**	15.65	27.33	11.67	31
Southwestern	**Rock**	3	Cropland	**18**	15.54	12.24	-3.29	32
Southwestern	**Rock**	4	Cropland	**16**	13.05	8.36	-4.68	32
Southwestern	**Rock**	5	Cropland	**16**	23.84	13.05	-10.79	32
Southwestern	**Rock**	6	Cropland	**26**	16.52	13.92	-2.60	32
Southwestern	**Rock**	7	Cropland	**30**	14.43	20.82	6.39	32
Southwestern	**Rock**	8	Cropland	**18**	23.56	21.35	-2.21	32
Southeastern	**Houston**	1	Cropland	**34**	13.09	13.55	0.46	-
Southeastern	**Houston**	2	Cropland	**42**	8.85	7.66	-1.19	-
Southeastern	**Houston**	3	Cropland	**39**	6.17	13.71	7.54	31
Southeastern	**Houston**	4	Grassland	**32**	5.70	8.29	2.58	34
Southeastern	**Houston**	5	Forest to Grassland	**21**	16.60	11.89	-4.71	31
Southeastern	**Houston**	6	Cropland to Grassland	**42**	9.92	11.99	2.07	-
Southeastern	**Houston**	7	Cropland to Grassland	**28**	9.93	12.63	2.70	-
Southeastern	**Winona**	8	Forest	**33**	12.58	31.25	18.68	30
Southeastern	**Winona**	9	Cropland	**35**	3.25	7.67	4.43	31
Southeastern	**Winona**	10	Cropland	**28**	20.44	9.48	-10.96	31
Southeastern	**Winona**	11	Cropland	**35**	5.66	11.10	5.44	29
Southeastern	**Winona**	12	Cropland	**27**	7.86	17.34	9.48	29
Southeastern	**Winona**	13	Cropland to Forest	**53**	4.39	8.30	3.91	30

2009 Project Abstract
For the Period Ending June 30, 2011

I. PROJECT TITLE: Innovative Springshed Mapping for Trout Stream Management-Continuation

Project Manager: E. Calvin Alexander, Jr.
Affiliation: Geology & Geophysics Dept, University of Minnesota
Mailing Address: 310 Pillsbury Dr. SE
City / State / Zip: Minneapolis, MN 55455
Telephone Number: (612) 624-3517
E-mail Address: alexa001@umn.edu
FAX Number: (612) 625-3819
E-MAIL: jeff.green@state.mn.us
WEBSITE: http://www.geo.umn.edu/people/profs/ALEXANDER.html
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chap.[143], Sec.[2], Subd.3D.

APPROPRIATION AMOUNT: $250,000

Overall Project Outcome and Results

Springshed delineation provides critical information for the protection and management of the springs that form the coldwater streams of southeast Minnesota. Our primary tool is fluorescent dye tracing. During the two-year period of Phase II, the U of M in collaboration with the DNR conducted 26 traces in Fillmore, Houston, Winona and Wabasha counties that mapped over 12,000 acres. Each individual trace typically has involved two or more different tracers with up to five different tracers employed in one trace. These traces are expanding the tools available for the springshed mapping, while defining new springsheds and refining the boundaries of known springsheds. These traces have been conducted in the Galena, Prairie du Chien and St. Lawrence springshed areas

The Fillmore County traces were in the Galena Formation. We discovered three previously unmapped springsheds and expanded the boundaries of five known springsheds. The expanded boundary springsheds were in the Watson Creek and South Fork Root watersheds, target areas for the local, state and federal Root River Initiative. The new springsheds are in the Crystal Creek watershed. These traces enhanced MDA watershed research and education efforts.

The traces in Houston, Winona and Wabasha were in the St. Lawrence Formation. This work expanded the geographic range of St. Lawrence traces and demonstrated that conduit flow in the St. Lawrence (a confining unit in the state well code) is a regional phenomenon. Four new springsheds were located in the St. Lawrence. Two of the traces in Houston County were run from streams that do not disappear into the St. Lawrence but flow continually across it. Both of those traces were detected at springs and one was detected in a private well. This indicates that St. Lawrence groundwater across southeast Minnesota could be impacted by the surface water quality of streams crossing the formation in shallow conditions.

Solinst level-temperature-conductivity loggers were purchased in the second year of the project. The data from them has shown that Prairie du Chien formation springs can be monitored for minor temperature fluctuations. Detecting these fluctuations has allowed us to conclude that the monitored springs are affected by snowmelt runoff. This network has identified four distinct thermal patterns which are related to the types of flow systems connecting each spring with its surface recharge. Temperature monitoring can be applied to a large number of springshed faster and more economically than can be dye traced. The combination of temperature monitoring and dye tracing is providing more information than either can provide alone. Work progressed on theoretical and modeling efforts to extract more information from the data generated by the tracer measurements. Base flow spring flow measurements are being collected to define Normalized Base Flow (NBF) Curves that will allow quick estimates of the size of springsheds. This information will be used for spring assessment protocol development.

The availability of new, high resolution LiDAR data for seven of the counties provided an important new tool that is being utilized to locate sinkholes, sinking streams and spring as part of the springshed mapping effort. This information was tabulated in the Minnesota Karst Features Data Base (KFDB), which is being updated and modernized to facilitate public accessibility to the springshed maps.

MGS staff visited numerous springs and stream sinks to identify their stratigraphic position to allow for more accurate spring data interpretation and to enhance dye trace planning. New higher resolution structural contour maps, that resulted from their work have shown that the locations of about half of the Galena springs can be related to the structural features in the bedrock.

We coordinated our efforts with other LCCMR funded programs is SE Minnesota and with ongoing resource management efforts by the DNR, MPCA and Ag Department State agencies. Six of the dye traces were done in coordination with local governmental staff in order to support the Root River pilot project of the Mississippi River Basin Initiative (MRBI) in Minnesota. We are working with the MPCA's TMDL efforts in SE Minnesota.

Project Results Use and Dissemination

The dissemination of the results of this project proceeded at several levels. We provided interim results to local landowners and to local, county, regional and state agency staff and resource managers. MPCA staff, for example, routinely contact us with questions about karst features in SE Minn. We worked synergistically with other LCCMR funded research projects and with a range of resource management efforts. The generation and dissemination of the maps and written reports was part student educational projects – from local High School students through University students in classes and interns, graduate student theses, post Doctoral researchers and colleagues. We lead and participated in fieldtrips sponsored by LCCMR, the MGWA and other groups focused on protecting SE MN trout streams and water resources. We worked collaboratively with MPCA, DNR, Department of Agriculture and other agencies to expand and complement the LCCMR funded work. A dozen reports on the interim results of this project were presented at state and national scientific meetings.

Trust Fund 2009 Work Program

Date of Report: 31 January 2012
Date of Next Progress Report:
Date of Work Program Approval: 16 June 2009
Project Completion Date: 30 June 2011

I. PROJECT TITLE: Innovative Springshed Mapping for Trout Stream Management-Continuation

Project Manager: E. Calvin Alexander, Jr.
Affiliation: Geology & Geophysics Dept, University of Minnesota
Mailing Address: 310 Pillsbury Dr. SE
City / State / Zip: Minneapolis, MN 55455
Telephone Number: (612) 624-3517
E-mail Address: alexa001@umn.edu
FAX Number: (612) 625-3819
Web Site Address: http://www.geo.umn.edu/people/profs/ALEXANDER.html

Location: Dakota, Dodge, Goodhue, Houston, Fillmore, Mower, Olmsted, Winona, Wabasha, and Washington Counties.

Total Trust Fund Project Budget:	U of Mn	Mn DNR	**Total**
Trust Fund Appropriation	$ 250,000	$ 250,000	**$ 500,000**
Minus Amount Spent:	$ 187,421	$	**$**
Equal Balance:	$ 62,579		**$**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 3d.

Appropriation Language: Springshed Mapping for Trout Stream Management. $500,000 is from the trust fund to continue to identify and delineate supply areas and springsheds for springs serving as coldwater sources for modern and historic trout streams and to assess the impacts from development and water appropriations. Of this appropriation, $250,000 is to the Board of Regents of the University of Minnesota and $250,000 is to the commissioner of natural resources.

II and III. FINAL PROJECT SUMMARY AND RESULTS: Springshed delineation provides critical information for the protection and management of the springs that form the coldwater streams of southeast Minnesota. Our primary tool is fluorescent dye tracing. During the two-year period of Phase II, the U of M in collaboration with the DNR conducted 26 traces in Fillmore, Houston, Winona and Wabasha counties that mapped over 12,000 acres. Each individual trace typically has involved two or more different tracers with up to five different tracers employed in one trace. These traces are expanding the tools available for the springshed mapping, while defining new springsheds and refining the boundaries of known springsheds. These traces have been conducted in the Galena, Prairie du Chien and St. Lawrence springshed areas

The Fillmore County traces were in the Galena Formation. We discovered three previously unmapped springsheds and expanded the boundaries of five known springsheds. The expanded boundary springsheds were in the Watson Creek and South Fork Root watersheds, target areas for the local, state and federal Root River Initiative. The new springsheds are in the Crystal Creek watershed. These traces enhanced MDA watershed research and education efforts.

The traces in Houston, Winona and Wabasha were in the St. Lawrence Formation. This work expanded the geographic range of St. Lawrence traces and demonstrated that conduit flow in the St. Lawrence (a confining unit in the state well code) is a regional phenomenon. Four new springsheds were located in the St. Lawrence. Two of the traces in Houston County were run from streams that do not disappear into the St. Lawrence but flow continually across it. Both of those traces were detected at springs and one was detected in a private well. This indicates that St. Lawrence groundwater across southeast Minnesota could be impacted by the surface water quality of streams crossing the formation in shallow conditions.

Solinst level-temperature-conductivity loggers were purchased in the second year of the project. The data from them has shown that Prairie du Chien formation springs can be monitored for minor temperature fluctuations. Detecting these fluctuations has allowed us to conclude that the monitored springs are affected by snowmelt runoff. This network has identified four distinct thermal patterns which are related to the types of flow systems connecting each spring with its surface recharge. Temperature monitoring can be applied to a large number of springshed faster and more economically than can be dye traced. The combination of temperature monitoring and dye tracing is providing more information than either can provide alone. Work progressed on theoretical and modeling efforts to extract more information from the data generated by the tracer measurements. Base flow spring flow measurements are being collected to define Normalized Base Flow (NBF) Curves that will allow quick estimates of the size of springsheds. This information will be used for spring assessment protocol development.

The availability of new, high resolution LiDAR data for seven of the counties provided an important new tool that is being utilized to locate sinkholes, sinking streams and spring as part of the springshed mapping effort. This information was tabulated in the Minnesota Karst Features Data Base (KFDB), which is being updated and modernized to facilitate public accessibility to the springshed maps.

MGS staff visited numerous springs and stream sinks to identify their stratigraphic position to allow for more accurate spring data interpretation and to enhance dye trace planning. New higher resolution structural contour maps, that resulted from their work have shown that the locations of about half of the Galena springs can be related to the structural features in the bedrock.

We coordinated our efforts with other LCCMR funded programs is SE Minnesota and with ongoing resource management efforts by the DNR, MPCA and Ag Department State agencies. Six of the dye traces were done in coordination with local governmental staff in order to support the Root River pilot project of the

Mississippi River Basin Initiative (MRBI) in Minnesota. We are working with the MPCA's TMDL efforts in SE Minnesota.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: <u>Innovative Trout Springshed Maps and Reports</u>

Description: Springsheds that feed source springs of trout streams will be delineated in the Galena, Prairie du Chien, and St. Lawrence karst lands. Dye tracing will be expanded in the Prairie du Chien and Galena karsts. We will also conduct dye traces in the St. Lawrence Formation as karst features are located in this newly recognized karst unit. Maps of the springsheds will be made available via a GIS-based website allowing regular updates. The temperature monitoring network will be maintained and expanded as equipment and sites become available. High resolution structural contour maps, fluorescence data on the dissolved organic compounds in the springs and stable isotope results will be included in the springshed maps and reports as they become available and useful.

Summary Budget Information for Result 1:

Trust Fund Budget:	U of Mn	Mn DNR	**Total**
Trust Fund Appropriation	$ 190,211	$ 250,000	**$ 440,211**
Minus Amount Spent:	$ 130,740	$ ______	**$** ______
Equal Balance:	$ 59,472	$	**$**

Deliverable	Completion Date	Budget
1. Innovative Trout Springshed Maps and Reports U of Mn. These reports and maps will present the results of the dye traces and other data that help to define the trout spring springsheds.	**30 June 2011**	**$ 190,211**

Final Results

Extensive GIS and field reconnaissance work identified many promising areas for dye tracing. These areas are in Fillmore, Houston, Wabasha and Winona, Dakota and Goodhue Counties. Twenty-six traces were conducted in Fillmore, Houston and Winona Counties. These traces typically involved two or more tracers and one recent trace involved five different tracers.

In the Galena karst of Fillmore County the traces have been coordinated with the Root River pilot project of the Mississippi River Basin Initiative (MRBI) in Minnesota with the MPCA's TMDL work and with Department of Ag's ongoing research efforts. These traces have: 1) defined new springsheds, 2) refined the boundaries of previously mapped springsheds, 3) provided information on the relative responses of different tracers in the same systems, 4) provided calibration points for the NBF curve effort, and 5) involved local staff and citizens including High School Students from Harmony and U of Mn students, interns and Post Docs in the trout stream protection effort. The traces in the well-developed karst of the Galena are typically through well-integrated conduit drainage systems and are relatively quick (days to weeks) and easy to conduct.

A successful quintuple trace at Freiheit Spring in the Galena karst of Fillmore County compared the behavior of a flow pulse, turbidity, fluorescent dye, salt conductivity, stable isotopes and heat as tracers. The differing responses of the traces yield significant new information on the geometry and behavior of the conduits through which the ground water flows to the trout springs. This is an important new tool in classifying the trout stream springs.

In the Prairie du Chien karst of Fillmore, Houston and Winona Counties many of the traces have also contributed to the Root River MRBI effort. Traces in the less well integrated Prairie du Chien karst were slower (weeks to months) and more expensive to conduct, but the Prairie du Chien hosts important trout streams and major trout hatcheries with significant environmental threats. We have had successful traces in some cases and frustrating "lost" traces in other cases.

Our discovery, in the previous biennium's project, that the St. Lawrence "aquitard" is actually a conduit karst aquifer north of Rushford, MN (northeastern Fillmore and southern Winona Counties) was confirmed by traces from sinking and losing streams in the St. Lawrence Formation to trout stream springs in five locations from the Kieffer Valley of northern Winona County to central Houston County. These traces have revealed a new type of tracer breakthrough curves – characterized by relatively quick (days to a week) initial breakthroughs followed by very long tails of tracers at the springs. These traces take up to a year or more to complete. These results have major implications for the management of the many trout streams with St. Lawrence source springs. These traces have dramatically changed our understanding of the hydrology of St. Lawrence springs and have demonstrated that these springs are significantly more vulnerable then we had previously believed. These traces emphasize that losing reaches of surface streams (which are much less obvious than stream sinks) are significant threats to trout springs.

In the previous biennium we demonstrated that temperature logging of trout springs could provide an economical screening tool to identify trout springs with rapid connections to their recharge areas. We maintained and expanded the temperature monitoring efforts. We started with a mixture of small, very economical Hobo temperature loggers and a collection of pre-existing, more expensive Campbell temperature/conductivity/water level loggers. The Hobos proved to provide a useful initial screening but lacked the temperature resolution of the Campbell systems. The conductivity and water level data provided by the Campbells provided critical additional information. During this project we have added five Solinst temperature/ conductivity/stage loggers to our temperature array. They proved to be effective complements to the Campbell loggers for temperature monitoring but yielded disappointing results for level and conductivity logging.

The results from the temperature monitoring array revealed four different temperature responses in trout springs. Spring in the well-integrated Galena karsts typically show numerous hour-to-day temperature events. These are produced by individual recharge events. The winter and spring snow melt events are relatively cold water. The late spring, summer and early fall events are warm events. Springs fed by perennial sinking streams show large seasonal temperature variations that are in phase with the surface temperatures. We see a few springs whose temperature is constant. The fourth pattern, seen in some of the St. Lawrence springs are seasonal temperature variations (of up to a couple of degrees) that are four to eight months out of phase with the surface temperature. These springs have the property that they are warmer in the winter than they are in the summer. This phenomenon has not been reported previously and may have a very significant impact on trout ecology.

Tony Runkel and Julia Steinberg of the MGS used their contract time to assist both the U of M and DNR staff in determining the stratigraphic position of springs of interest. This work is vital as we are finding more and more evidence that there is a significant element of stratigraphic control on where the springs occur on the landscape. The characterization work is being used to plan dye traces, interpret temperature monitoring, and to develop a conceptual model of spring occurrence and vulnerability. This work is being used in conjunction with spring flow measurements to apply a methodology (originally developed in Kentucky) for determining springshed area by base flow measurements. The data are gathered at springsheds of known size and geology and then plotted to develop a regression equation that will give you basin size.

The number of well-defined springsheds has grown, allowing the area of those springsheds plotted against the base flow of the springs is yielding increasingly accurate NBF curves. These curves provide a rapid way of estimating the size – but not the shape or location) of a trout stream's springshed.

The unexpended balance on Result 1 was due to three changes that resulted in savings to the grant: 1) the largest savings was in salaries. The advanced graduate students who worked on this project have smaller fringe benefit costs than do the beginning graduate students on which the budget was based. The P.I. only drew one of the two months of salary budgeted. 2) The capital equipment budget of $20,000 was to purchase a piece of equipment whose cost had tripled to $60,000 by the time the LCCMR funds were available, leaving insufficient funds to purchase the equipment. 3) The travel expenses in state proved to be significantly cheaper that estimated at in the proposal.

Result 2 **Web Accessible Trout Springshed Maps and KFDB**

Description: The springshed maps as they are produced and updated will be useful to resource managers. They need to be accessible in a user-friendly web site. The MN Karst Features Data Base (KFDB) exists and is and will continue to be an integral part of the springshed mapping project. The KFDB will be updated, made more web accessible and user friendly. Web sites will be designed to facilitate user access to the springshed maps and the data in the KFDB. The most appropriate location for the long term web host for the Springshed Maps and web accessible KFDB is being investigated. Whatever host is most appropriate, the site will be linked to the Mn DNR, MGS and U of Mn and any other relevant web pages.

Summary Budget Information for Result 2:

Trust Fund Budget:	U of Mn	Mn DNR	**Total**
Trust Fund Appropriation	$ 59,789	$ 000	**$ 59,789**
Minus Amount Spent:	$ 56,681	$ 000	**$ 56,681**
Equal Balance:	$ 3,108	$ 000	**$ 3,108**

Deliverable	**Completion Date**	**Budget**
1. Web site for user friendly posting of GIS based springshed maps & updated access to KFDB for on-line data entry & management.	**30 June 2011**	**$ 59,789**

Final Results

Bob Tipping of the MGS has been using his contract time to maintain the KFDB and to assist Yongli Gao modernize and update the systems. Yongli Gao, a contract worker, was in residence at the University of Minnesota from the summer of 2010 through May 2011. The data base has been significantly improved. Gao also worked on the web-based accessibility of the springshed maps. The availability of the 2008 high resolution LiDAR data for SE Minnesota were utilized at all levels in this project. Summer interns and graduate students have conducted initial photo interpretation of the LiDAR data sets from Houston, Winona, Wabasha and Fillmore Counties and those new data sets are being entered into the KFDB. A full integration of this important new data set is an important part of the effort to develop and demonstrate new springshed mapping tool.

A major challenge for the KFDB and associated web site is the where the data base and web site should be. Versions of the data base are accessible via the DNR Data Deli and the MGS web site. We currently hope that the data base will be maintained at the MGS and the resulting maps and data will be available on the DNR and MGS web sites.

V. TOTAL TRUST FUND PROJECT BUDGET:

	U of Mn	Mn DNR	**Total**
Personnel:	$ 171,291	$ 202,500	**$ 373,791**
Contracts:	$ 28,000	$ 000	**$ 28,000**
Equipment/Tools/Supplies:	$ 30,000	$ 16,000	**$ 46,000**
Travel:	$ 20,709	$ 29,000	**$ 49,709**
Other:	$ 000	$ 2,500	**$ 2,500**

(See explanation of the capitol equipment, equipment/tools/supplies and the in- and out of state travel below.)

TOTAL TRUST FUND PROJECT BUDGET: $ 500,000

Explanation of Capital Expenditures Greater Than $3,500:
The $20,000 Capital Equipment item in the U of Mn portion of this project is to purchase a new, fast, high capacity Laser Cavity Liquid Water Isotope Analyzer to measure the stable isotope composition of oxygen and hydrogen in water. The $20,000 from the LCCMR will be matched by funds from other sources to purchase an Analysis System that will cost about $40,000. The current high cost of mass spectrometric water isotope measurements limits the application of isotope measurements to Trout Springshed mapping. This new technology decreases the cost by a factor of 10.

Of the remaining $10,000 of the U of Mn Equipment/Tool/Supplies budget, $2,000 will be spent purchasing non-capital equipment and tools such as field meters, electrodes for field meters, sensors, and replacement parts for existing equipment. $8,000 will be spent on expendable supplies such as fluorescent dye, charcoal, labels, bottles, lab supplies, etc.

Explanation of Travel Costs:
The U of Mn's $17,709 item for instate travel is to cover the cost of the extensive field work involved in this project. Most of that will cover the mileage costs of the field vehicles. A few overnight trips will include lodging and food charges for the project partners.

The $3,000 item for travel outside of Minnesota is to partially defray the costs of the Project Manager, Scientist and Graduate Research Assistant to attend to learn from colleagues in other states who are working on karst hydrogeology. Possible meetings include the 12th Sinkhole Conference in 2010 or the Annual Geological Society of America Meetings.

VI. PROJECT STRATEGY:

A. Project Partners:

Dr. E. Calvin Alexander, Jr. will be the project manager of the overall Trout Springshed Mapping Project and the manager of the U of MN portion of the project. He is a tenured Professor in the Geology & Geophysics Department at the University of Minnesota

Jeff Green will be project manager of the DNR portion of this project and will be responsible for carrying out the DNR share of project activities. He is a classified state employee. His current position of Ground Water Specialist will be backfilled.

Dr. Yongli Gao will be a contractor who was responsible for developing the GIS based web site for public access to the springshed maps and updating the KFDB to make it more user friendly and accessible. Gao designed and implemented the current MN KFDB and is currently working with the USGS on a National Karst Features Data System. He is an Assistant Professor at East Tennessee State University in Johnson City, TN.

Dr. Anthony C. Runkel will be contributing stratigraphic information to Results 1 of this project. Tony is the Minnesota State Geologist with the Minnesota Geological

Survey. He has done extensive work on the karst hydrostratigraphy of southeastern Minnesota.
Robert G. Tipping is a Senior Scientist with the Minnesota Geological Survey. Bob currently maintains the MN KFDB. He has also done pioneering work on the karst hydrostratigraphy of southeastern Minnesota.

B. Project Impact and Long-term Strategy: By delineating springsheds and making web-based maps available, this project will provide critical information for the protection and management of the springs that form the coldwater streams of southeast Minnesota. This information is critical for Total Maximum Daily Load (TMDL) implementation strategies, impaired waters remediation, ground water protection and allocation issues, and local land and water management decisions.

Karst ground water flow is the most complex hydrogeologic environment in Minnesota. Springs are the natural features that return groundwater to surface waters. Karst springs respond much faster to surface recharge than is expected from conventional hydrology theory. Karst springs exhibit a wide range of rapid responses to recharge events. Springs integrate all of the natural and anthropogenic processes that occur in their recharge areas – in their individual springsheds. Springshed mapping is critical component of karst aquifer characterization. Long-term resources are needed to gather and maintain the parameters necessary to realistically, effectively manage karst springs in Minnesota and to train staff and resource managers in the use of the available karst data. LCMR and LCCMR have played a leading role in the effort to understand and manage Minnesota's karst springs
The availability of high-resolution LiDAR maps, beginning July 2009, produced a flood of new information showing the locations of karst features. That new information has had a major impact on the springshed mapping project.

C. Other Funds Proposed to be Spent during the Project Period:

A NSF Summer Intern in both the summers of 2009, 2010 and 2011 worked on projects contributing directly to this project. Their $4,700 summer stipends, each paid by the NSF, contributed significant information this effort.

Two University of Minnesota Undergraduate Research Opportunity Projects (UROP) students have conducted dye traces in SE Minn which contribute directly and significantly to this project. They each received $1,400 from University of Minnesota funds.

Dr. Matt Covington, on a NSF Post-Doctoral Fellowship, made major theoretical and experimental contributions to this project – at no cost to the LCCMR – estimated $25,000.

D. Spending HIstory*:* $ 250,000 from the trust fund to a joint project between the U of MN and the DNR, 1 July 2007 to 30 June 2009.

VII. DISSEMINATION: GIS based maps and written reports of the springsheds will be prepared and disseminated to the LCCMR and interested residents and to local, regional and state resource managers and regulators interested in specific targeted areas. Interim dye trace results will be available as GIS shape files and derived products on a dye trace by dye trace basis. Data tables of discharge and chemistry will be available as developed.

Final

The dissemination of the results of this project proceeded at several levels. We provided interim results to local landowners and to local, county, regional and state agency staff and resource managers. MPCA staff, for example, routinely contact us with questions about karst features in SE Minn. We worked synergistically with other LCCMR funded research projects and with a range of resource management efforts. The generation and dissemination of the maps and written reports was part student educational projects – from local High School students through University students in classes and interns, graduate student theses, post Doctoral researchers and colleagues. We lead and participated in fieldtrips sponsored by LCCMR, the MGWA and other groups focused on protecting SE MN trout streams and water resources. We worked collaboratively with MPCA, DNR, Department of Agriculture and other agencies to expand and complement the LCCMR funded work. A dozen reports on the interim results of this project were presented at state and national scientific meetings.

Formal Publications:

Luhmann, Andrew J., Matthew D. Covington, Scott C. Alexander, Su Yi Chai, Benjamin F. Schwartz, Joel T. Groten and E. Calvin Alexander, Jr. (2012) Comparing Conservative and Nonconservative Tracers and Using Them to Estimate Flow Path Geometry. In review, Journal of Hydrology.

Alexander, E. Calvin, Jr., Jeffrey A. Green, Anthony Runkel and Katherine J. Logan (2011) Southeastern Minnesota karst hydrogeology: New insights from data loggers, tracing, LiDAR and hydrophysics. *in* Miller, J.D., Jr., Hudak, G.J., Wittkop, C. and McLoughlin, P.I. eds., Archean to Anthropocene: Field Guides to the Geology of the MidContinent of North America: Geological Society of America Field Guide 24, p. 243-257.

Tipping, R., Alexander, Scott C. Alexander and E.C. Alexander Jr. (2011) Groundwater Policy at State and Local Levels: The Science-Policy Linkage, (K. William Easter and Jim Perry, *eds.*) **Water Policy in Minnesota Issues, Incentives, and Action**. RFF Press, Earthscan, London, p. 122-133. ISBN: 978-1-61726-086-5.

Andrew J. Luhmann, Matthew D. Covington, Andrew J. Peters, Scott C. Alexander, Cale T. Anger, Jeffrey A. Green, Anthony C. Runkel and E. Calvin Alexander, Jr. (2011) Classification of Thermal Patterns at Karst Springs and Cave Streams, Ground Water, Vol 49, no.3, p 324-334.

Alexander, E. Calvin, Jr., Greg A. Brick, Arthur N. Palmer (2009) Ch. 4: Glaciated Central Lowlands, Minnesota, p. 146-150. *In:* Palmer, Arthur N., and Palmer, Margaret V., 2009, Caves and Karst of the USA: Huntsville, AL., National Speleological Society, 446 p. ISBN 9781879961289.

Anderson, Julia, Runkel, Anthony, Tipping, Robert G., Barr, Kelton D., and Alexander, E. Calvin, Jr. (2011) Hydrostratigraphy of a fractured, urban aquitards. Abstract 110-4, 2011 Geological Society of America Meeting, *Abstracts with Programs*, Vol. 43, No. 5.

Brick, Greg, Alexander, E. Calvin, Jr., Watkins, Justin and Lundy, James R. (2011) Surface and groundwater nitrate databases for southeastern Minnesota, USA. Poster 108-3, 2011 Geological Society of America Meeting, *Abstracts with Programs*, Vol. 43, No. 5.

Ladd, Bethany S., and Alexander, E. Calvin, Jr. (2011) Dye tracing in the Jordan Sandstone near the Crystal Springs State Fish Hatchery, Winona County, Minnesota. Poster 108-4, 2011 Geological Society of America Meeting, *Abstracts with Programs*, Vol. 43, No. 5.

Luhmann, Andrew J., Covington, Matthew D., and Alexander, E. Calvin, Jr. (2011) Using a multi-tracer experiment to estimate flow path geometry. Abstract 135-7, 2011 Geological Society of America Meeting, *Abstracts with Programs*, Vol. 43, No. 5.

Green, Jeffrey A., and Alexander, E. Calvin, Jr. (2011) Dye tracing observations from the Prairie du Chien Group in Minnesota, Abstract 60-11, 2011 Geological Society of America Meeting, *Abstracts with Programs*, Vol. 43, No. 5.

Talbot, Michael T. and Alexander, E. Calvin, Jr. (2011) The impact of karst on agriculture. (*eds.: Engel, Annette Summers, Engel, Scott, Moore, Paul J., DuChene, Harvey)* Carbonate Geochemistry: Reactions and Processes in Aquifers and Reservoirs, Billing, MT, 6-9 August 2011, Karst Waters Institute Special Publication 16, KWI, P.O. Box 1442, Leesburg, VA 20177, p. 69.

Rahimi, Mina and Alexander, E. Calvin Alexander, Jr. (2011) Three decades of sinkhole mapping in Winona County, MN, Poster presented at The 12th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst 10-14 January 2011, St. Louis, MO.

Anger, Cale T. and Alexander, E. Calvin, Jr. (2011) Bench scale models of dye breakthrough curves. Poster presented at The 12th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst. Program with Abstracts, 10-14 January 2011, St. Louis, MO, p 36.

Green, Jeffrey A., Runkel, Anthony C. and Alexander, E. Calvin, Jr. (2011) Karst conduit flow in the Cambrian St. Lawrence confining unit, southeast Minnesota, U.S.A. Abstract presented at The 12th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst. Program with Abstracts, 10-14 January 2011, St. Louis, MO, p 36.

Luhmann, Andrew J., Covington, Matthew D., Alexander, Scott C., Chai, Su Yi and Alexander, E. Calvin, Jr. (2011) Comparison of discharge, conductivity, temperature, dye, deuterium and turbidity responses from a multiple tracer test in karst. Abstract presented at The 12th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst. Program with Abstracts, 10-14 January 2011, St. Louis, MO, p 34.

Luhmann, Andrew J., Covington, Matthew D. and Alexander, E. C., Jr. (2010) Thermograph Recessions, Abstract 129-7, GSA 2010 Abstracts with Programs, Annual Meeting, Denver, CO, Vol. 42, No. 5, p. 329.

Mina Rahimi Kazerooni, Scott C. Alexander and E. Calvin Alexander, Jr. (2010) LiDAR Mapping of Sinkholes: Winona County, MN (poster). Abstract 47-3, GSA 2010 Abstracts with Programs, Joint Meeting North-Central/South-Central Sections, Vol. 42, No. 2, p. 107-108.

Cale T. Anger and E. Calvin Alexander, Jr. (2010) Bench-Scale Models of Dye Breakthrough Curves. Abstract 40-3, GSA 2010 Abstracts with Programs, Joint Meeting North-Central/South-Central Sections, Vol. 42, No. 2, p. 98.

Andrew J. Luhmann, Cale T. Anger, Julie Greene, Erik B. Larson, Scott C. Alexander, Matthew D. Covington, Jeffrey A. Green and E. Calvin Alexander, Jr. (2010) Simultaneous Fluorescent Dye, Conductivity and Thermal Traces in a Karst Springshed. Abstract 26-5, GSA 2010 Abstracts with Programs, Joint Meeting North-Central/South-Central Sections, Vol. 42, No. 2, p. 77.

M.D. Covington, A. J. Luhmann, E. C. Alexander, Jr., S. C. Alexander, M. O. Saar, C. M. Wicks (2009) Thermal Signals as a Means of Characterizing Karst Aquifers. Eos Trans. AGU, 90 (52), Fall Meet. Suppl., Abstract H14A-04.

Cale T. Anger, Andrew J. Luhmann, Scott C. Alexander and E. Calvin Alexander, Jr. (2009) Delineating End-member Tracer Breakthrough Curve Geometries: Quantitative Field and Modeling Applications in Southeastern Minnesota. Abstract 176-15, Geological Society of America *Abstracts with Programs*, Vol. 41, No. 7, p. 467.

Erik B. Larson, Scott C. Alexander, Jeffrey A. Green and E. Calvin Alexander, Jr. (2009) Advances in Sinkhole Mapping: A LiDAR Survey of Houston County, Minnesota. Abstract 261-8, Geological Society of America *Abstracts with Programs*, Vol. 41, No. 7, p. 678.

Andrew J. Luhmann, Matthew D. Covington, Andrew J. Peters, Scott C. Alexander Cale T. Anger, Jeffery A. Green and E. Calvin Alexander, Jr. (2009) Thermal Patterns of Karst Springs and Cave Streams in Southeastern Minnesota. Abstract 127-6, Geological Society of America *Abstracts with Programs*, Vol. 41, No. 7, p. 346.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than 31December 2009, 30 June 2010, 31 December 2010. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS:

Attachment A: Budget Detail for 2009 Projects - **Summary and a Budget page for each partner (if applicable)**								
Project Title: Innovative Springshed Mapping for Trout Stream Management-Continuation								
Project Manager Name: E. Calvin Alexander, Jr.								
Trust Fund Appropriation: $ 250,000								
2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent**	**Balance** *(date)*	**Result 2 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Innovative Trout Springshed Maps and Reports	*1/31/2012*	*1/31/2012*	*Web Accessable Trout Springsheds and KFDB*	*1/31/2012*	*1/31/2012*		
BUDGET ITEM								
PERSONNEL: wages and benefits (Total)	**139,502**	**116,625**	**22,877**	**31,789**	**28,681**	**3,108**	**171,291**	**25,985**
UM Prof. E. Calvin Alexander, Jr. (1 month/yr - 8% FTE - $23,884)		4,829						
UM Scientist Scott Alexander (50% FTE - $59,540)		47,588						
UM Graduate Research Assistant (50% FTE - $53,300)		60,617			13,850			
MGS Scientist Anthony Runkel (1 month/yr - 8% FTE - $14,444)					11,741			
MGS Scientist Robert Tipping (1 month/yr - 8% FTE - $13,787) + Julia Steenberg					3,091			
UM Undergrad Res. Assist. (8 hr/wk, 9 m/yr - 15% FTE - $6,336)		3,591						
Contracts								
Professional/technical								
Yongli Gao (Web page & Data Base design)				28,000	28,000	0	28,000	0
Non-capital Equipment / Tools								
meters, electrodes, sensors, etc.	2,000	1,030	970				2,000	970
Capital equipment over $3,500								
Equipment such as Los Gatos Research Liquid Water Isotope Analyzer	20,000	0	20,000				20,000	20,000
Supplies								
Fluorescent dye, charcoal, labels, bottles, etc.	8,000	3,696	4,304				8,000	4,304
Travel expenses in Minnesota								
(see explanation in section V of work plan)	17,709	6,775	10,934				17,709	10,934
Travel outside Minnesota								
(see explanation in section V or work plan)	3,000	2,613	387				3,000	387
COLUMN TOTAL	**$190,211**	**$130,740**	**$59,472**	**$59,789**	**$56,681**	**$3,108**	**$250,000**	**$62,579**

2009 Project Abstract
For the Period Ending June 30, 2011

I. PROJECT TITLE: Innovative Springshed Mapping for Trout Stream Management-Continuation

Project Manager: Jeff Green
Affiliation: Minnesota DNR-Division of Waters
Mailing Address: 2300 Silver Creek Rd NE
City / State / Zip: Rochester, MN 55906
Telephone Number: 507-206-2853
E-mail Address: jeff.green@state.mn.us
FAX Number: 507-285-7144
E-MAIL: jeff.green@state.mn.us
WEBSITE:
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chap.[143], Sec.[2], Subd.3D.

APPROPRIATION AMOUNT: $250,000

<u>Overall Project Outcome and Results</u>

Springshed delineation provides critical information for the protection and management of the springs that form the coldwater streams of southeast Minnesota. Our primary tool is fluorescent dye tracing. During the two-year period of Phase II, DNR (in cooperation with the U of M) conducted 26 traces in Fillmore, Houston, Winona and Wabasha counties that mapped over 12,000 acres.

The Fillmore County traces were in the Galena Formation. We discovered three previously unmapped springsheds and expanded the boundaries of five known springsheds. The expanded boundary springsheds were in the Watson Creek and South Fork Root watersheds, target areas for the local, state and federal Root River Initiative. The new springsheds are in the Crystal Creek watershed. These traces enhanced MDA watershed research and education efforts.

The traces in Houston, Winona and Wabasha were in the St. Lawrence Formation. This work expanded the geographic range of St. Lawrence traces and demonstrated that conduit flow in the St. Lawrence (a confining unit in the state well code) is a regional phenomenon. Four new springsheds were located in the St. Lawrence. Two of the traces in Houston County were run from streams that do not disappear into the St. Lawrence but flow continually across it. Both of those traces were detected at springs and one was detected in a private well. This indicates that St. Lawrence groundwater across southeast Minnesota could be impacted by the surface water quality of streams crossing the formation in shallow conditions.

Solinst level-temperature-conductivity loggers were purchased in the second year of the project. The data from them has shown that Prairie du Chien formation springs can be monitored for minor temperature fluctuations. Detecting these fluctuations has allowed us to conclude that the monitored springs are affected by snowmelt runoff. This information will be used for spring assessment protocol development.

Project Results Use and Dissemination

The project manager has spoken about the project and its results to local, state and federal officials, citizen groups, anglers, local, state and federal agency staff, and met one-on-one with numerous landowners. Project results are part of the base data for Root River Initiative watershed management efforts in the Watson Creek and Rush Pine watersheds. MPCA staff are using the maps as part of their nitrate-TMDL development. MDA staff are using the springshed maps to modify their watershed research in the Crystal Creek watershed. The project was featured on MPR when a reporter accompanied the project manager on a spring snowmelt runoff dye trace near Canton, MN. Two traces were conducted in cooperation with the earth science class at Fillmore Central High School in Harmony. The students assisted with dye input and sampling.

Environment and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report: 15 Sept. 2011
Final Report
Date of Work Program Approval: 16 June 2009
Project Completion Date: 30 June 2011

I. PROJECT TITLE: Innovative Springshed Mapping for Trout Stream Management-Continuation

Project Manager: Jeff Green
Affiliation: Minnesota DNR-Division of Waters
Mailing Address: 2300 Silver Creek Rd NE
City / State / Zip: Rochester, MN 55906
Telephone Number: 507-206-2853
E-mail Address: jeff.green@state.mn.us
FAX Number: 507-285-7144
Web Site Address:

Location: Houston, Fillmore, Mower, Olmsted, Winona, Wabasha, Goodhue, Dodge, Dakota and Washington Counties.

Total Trust Fund Project Budget:	U of MN	MN DNR	**Total**
Trust Fund Appropriation	$ 250,000	$ 250,000	**$ 500,000**
Minus Amount Spent:	$ 000	$ 246,930	**$ 000**
Equal Balance:	$ 250,000	$ 3,070	**$ 500,000**

Legal Citation: ML 2009, Chap.[143], Sec.[2], Subd.3D.

Appropriation Language: Springshed Mapping for Trout Stream Management. $500,000 is from the trust fund to continue to identify and delineate supply areas and springsheds for springs serving as coldwater sources for modern and historic trout streams and to assess the impacts from development and water appropriations. Of this appropriation, $250,000 is to the Board of Regents of the University of Minnesota and $250,000 is to the commissioner of natural resources.

II. and III. FINAL PROJECT SUMMARY AND RESULTS:

Springshed delineation provides critical information for the protection and management of the springs that form the coldwater streams of southeast Minnesota. Our primary tool is fluorescent dye tracing. During the two-year period of Phase II, DNR (in cooperation with the U of M) conducted 26 traces in Fillmore, Houston, Winona and Wabasha counties that mapped over 12,000 acres.

The Fillmore County traces were in the Galena Formation. We discovered three previously unmapped springsheds and expanded the boundaries of five known springsheds. The expanded boundary springsheds were in the Watson Creek and South Fork Root watersheds, target areas for the local, state and federal Root River Initiative. The new springsheds are in the Crystal Creek watershed. These traces enhanced MDA watershed research and education efforts.

The traces in Houston, Winona and Wabasha were in the St. Lawrence Formation. This work expanded the geographic range of St. Lawrence traces and demonstrated that conduit flow in the St. Lawrence (a confining unit in the state well code) is a regional phenomenon. Four new springsheds were located in the St. Lawrence. Two of the traces in Houston County were run from streams that do not disappear into the St. Lawrence but flow continually across it. Both of those traces were detected at springs and one was detected in a private well. This indicates that St. Lawrence groundwater across southeast Minnesota could be impacted by the surface water quality of streams crossing the formation in shallow conditions.

Solinst level-temperature-conductivity loggers were purchased in the second year of the project. The data from them has shown that Prairie du Chien formation springs can be monitored for minor temperature fluctuations. Detecting these fluctuations has allowed us to conclude that the monitored springs are affected by snowmelt runoff. This information will be used for spring assessment protocol development.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: <u>Innovative Trout Springshed Maps and Reports</u>

Description: Springsheds that feed source springs of trout streams will be delineated in the Galena, Prairie du Chien, and St. Lawrence karst lands. Dye tracing will be expanded in the Prairie du Chien and Galena karsts. We will also do dye tracing in the St. Lawrence Formation which has been viewed as a confining unit. During the first two years of this project, we have run several dye traces through it and will do more as suitable locations are found. Maps of the springsheds will be transferred to the U of M for web posting and will be linked to the DNR web site. The existing temperature-monitoring network will be maintained and expanded as equipment and sites are available.

Summary Budget Information for Result 1: **Trust Fund Budget: $ 440,211.00**
(to U of MN.) **$** (190,211)
(to MNDNR) **$** (250,000)
Amount Spent (MNDNR): $ 246,930
Balance (MNDNR): $ 3,070

Deliverable	**Completion Date**	**Budget**
1. Innovative Trout Springshed Maps and Reports (Conduct dye traces and field investigations for springshed map production for counties listed under	30 June 2011	$250000

Location on page 1, maps and reports of completed traces and spring parameter monitoring)		

(See also the companion U of M project work program Result 1)

Results

Galena limestone tracing:

Frego Creek at Canton (Fillmore County) - The traces at Canton, a mix of dry sinkhole (water from a tanker truck is poured into the sinkhole to flush the dye) and spring snowmelt traces, expanded the boundaries of two known springsheds and refined the boundary between them.

Harmony area (Fillmore County) - We expanded the boundary of one known springshed.

Crystal Creek (Fillmore County) - Discovered three previously unmapped springsheds. The subsurface boundaries of two of them are different from the surface water boundaries. In one case, water sinking in sinkholes inside the surface watershed emanates from a spring outside of the watershed. In the other case, water sinking in sinkholes outside of the watershed flows into the surface watershed underground to discharge from a spring.

Watson Creek (Fillmore County) - The traces at Watson, a mix of dry sinkhole and spring snowmelt traces, expanded the boundaries of two known springsheds and refined the boundary between them.

St. Lawrence Formation tracing. Tracing in the St. Lawrence is an innovative use of tracer dyes.

Sullivan Creek (Houston County) - The first detected trace from a sinking point in the east headwater tributary of the creek was detected at four different springs. The pattern resembles a river delta and is similar to the Ahrensfeld Creek St. Lawrence dye trace site. A dye trace from the west headwater tributary, a perennial stream, was detected at one of the springs connected to the sinking east tributary. The west tributary dye was also detected in a private well. This is the first documented instance of a non-disappearing stream crossing the St. Lawrence and losing flow to the subsurface.

Indian Springs (Houston County) - This trace from a non-disappearing stream was detected at a spring complex further downstream along the creek. This is the second instance of a perennial stream losing flow to the subsurface and affecting groundwater quality.

Borson Northeast (Winona County) - This trace was from a disappearing stream in a tributary valley to Rush Creek. It is northeast of Borson Spring, one of the three springs that were found to have dye in them during the first St. Lawrence dye trace. The sinking point was located using the new LiDAR imagery. The points of the first traces from Ahrensfeld Creek were examined on the LiDAR image. The stream channel literally disappears at the sinking point. When the LiDAR image for the Borson NE valley was examined, it had a similar morphology. Discussions with the landowner revealed that a stream did in fact sink there. This breakthrough is being used to locate other potential St. Lawrence sinking streams. The dye trace from this sink connected to Borson spring, one of the three that had dye from the Ahrensfeld Creek trace. Dye was also detected at another spring near Borson that also forms a coldwater tributary to Rush Creek.

Gorman Creek (Wabasha County) - This trace was an attempt to further expand the type of St. Lawrence stream used for tracing. Gorman Creek rises from two springs. One is in the middle of the St. Lawrence and the other emanates from the base of the formation. Upstream of the mid-St. Lawrence spring are two valleys that only have flow during runoff events. In an attempt to determine if these types of streams lose flow into the subsurface, a dye trace was run from one of the valleys during spring snowmelt. The conditions were less than optimal as the runoff was quite high. No dye was detected from this trace. It would be reasonable to repeat the experiment later.

GIS reconnaissance has identified a number of additional sites that could have streams sinking in the St. Lawrence. Field checks of these have resulted in four more St. Lawrence sinking streams being identified. A perennial stream crossing the St. Lawrence has also been located.

Solinst level-temperature-conductivity loggers were purchased and deployed as part of this project. They provided tantalizing and perplexing results. Temperature can be accurately measured in .01-degree increments. This allowed us to identify subtle snowmelt pulses in two Prairie du Chien springs. We have also continued to record St. Lawrence spring temperature changes. The conductivity data are more problematic. The loggers show wide fluctuations that are unlikely to be real. We are investigating this matter.

Final Report Summary: 15 July 2011

Result 2: <u>Web Accessible Trout Springshed Maps and KFDB (to be completed by the U of M who will be providing separate work program updates)</u>:

Description: The springshed maps as they are produced and updated will be useful to resource managers. They need to be accessible in a user-friendly web site. The MN Karst Features Data Base (KFDB) exists and is and will continue to be an integral part of the springshed mapping project. The KFDB will be updated, made more web accessible and user friendly. Web sites will be designed to facilitate user access to the springshed maps and the data in the KFDB.

Summary Budget Information for Result 2 (updates will be provided by the U of M):

Trust Fund Budget:	**$**	**59,789**
Amount Spent:	**$**	**000**
Balance:	**$**	**59,789**

V. TOTAL TRUST FUND PROJECT BUDGET:

	MNDNR	U of MN	Total
Personnel:	$ 202,500	$ 171,291	**$ 373,791**
Contracts:	000	$ 28,000	**$ 28,000**
Equipment/Tools/Supplies:	$ 16,000	$ 30,000	**$ 46,000**
Travel:	$ 29,000	$ 20,709	**$ 49,709**
Other:	$ 2,500	000	**$ 2,500**
Totals:	$250000	$250000	**$ 500000**

(ARCGIS Training & Out-of-State Travel to National meetings to present results and to learn from colleagues in other states.)

TOTAL TRUST FUND PROJECT BUDGET: $ 500,000

Explanation of Capital Expenditures Greater Than $3,500: n/a

VI. PROJECT STRATEGY:

A. Project Partners:

Jeff Green will be DNR project manager and will be responsible for carrying out the DNR share of project activities. He is a classified state employee. His current position of Regional Ground Water Specialist will be backfilled.
Dr. E. Calvin Alexander, Jr. will be the project manager of the companion U of M project and will be responsible for carrying out the U of M share of project activities.
Dr. Yongli Gao will be a contractor who is responsible for developing the GIS-based web site for public access to the springshed maps and updating the Minnesota Karst Features Database (MN KFDB) to make it more user friendly and accessible (Result 2 of the companion U of M study). Gao designed and implemented the current MN KFDB and is currently working with the USGS on a National Karst Features Data System. He is an Assistant Professor at East Tennessee State University in Johnson City, TN.
Dr. Anthony C. Runkel will be contributing stratigraphic information to Result 1 of this project. Tony is the Minnesota State Geologist with the Minnesota Geological Survey. He has done extensive work on the karst hydrostratigraphy of southeastern Minnesota.
Robert G. Tipping is a Senior Scientist with the Minnesota Geological Survey. Bob currently maintains the MN KFDB. He has also done pioneering work on the karst hydrostratigraphy of southeastern Minnesota.

B. Project Impact and Long-term Strategy: By delineating springsheds and making web-based maps available, this project will provide critical information for the protection and management of the springs that form the coldwater streams of southeast Minnesota. This information is critical for Total Maximum Daily Load

(TMDL) implementation strategies, impaired waters remediation, ground water protection and allocation issues, and local land and water management decisions.

Karst ground water flow is the most complex hydrogeologic environment in Minnesota. Springs are the natural features that return groundwater to surface waters. Karst springs respond much faster to surface recharge than is expected from conventional hydrology theory. Karst springs exhibit a wide range of rapid responses to recharge events. Springs integrate all of the natural and anthropogenic processes that occur in their recharge areas – in their individual springsheds. Springshed mapping is critical component of karst aquifer characterization. Long-term resources are needed to gather and maintain the parameters necessary to realistically, effectively manage karst springs in Minnesota and to train staff and resource managers in the use of the available karst data. LCMR and LCCMR have played a leading role in the effort to understand and manage Minnesota's karst springs
The availability of high-resolution LiDAR maps, scheduled for July 2009, will produce a flood of new information showing the locations of karst features. We anticipate that new information will have a major impact on the springshed mapping project.

C. Project Partners: University of Minnesota, total from appropriation $25000

D. Other Funds Proposed to be spent during the Project Period: DNR Waters staff project support $10822 (0.05 FTE General Fund).

E. Spending HIstory*:* $125,000 from the trust fund via a contract between the U of M and the DNR, 1 July 2007 to 30 June 2009.

VII. DISSEMINATION: GIS-based maps and written reports of the springsheds will be prepared and disseminated to the LCCMR, interested residents and to local, regional and state resource managers and regulators interested in specific targeted areas. Interim dye trace results will be available as GIS shape files and derived products on a dye trace by dye trace basis. Data tables of discharge and chemistry will be available as developed.

31 December 2010

In October 2009, project information and results were presented to MPCA and DNR staff at a karst training day and to a Rochester Community Education Learning is Forever class. The temperature monitoring data were used to develop a presentation on spring variability for the American Geophysical Union meeting in San Francisco (U of M lead).

15 July 2010

In March, an MPR reporter accompanied me on a snow-melt runoff dye trace near Frego Creek in Fillmore County. The reporter (Stephanie Hemphill) went with me to change background samplers; we then crossed some very muddy fields to three different sinkholes where I poured dye. The report she produced is on-line at http://minnesota.publicradio.org/display/web/2010/03/29/karst-hydrology/. In May, I spent the day with Federal agency managers from the Midwest. I went with them on their tour of the Root River basin and explained about the karstlands of southeast Minnesota. I took considerable time to discuss springs and their importance to the streams and fish populations of the southeast.

15 January 2011

In September, I attended and spoke at a Rush-Pine watershed meeting and met with the Houston County board to discuss this project and voice support for their involvement in a geologic atlas for the county. January 10-14 I attended the 12th Sinkhole conference and presented our St. Lawrence work. The 16 November dye tracing efforts at Harmony were done in cooperation with Fillmore central High School. I gave the students an overview of karst and what we are doing for this project. They assisted with the dye inputs and the subsequent spring monitoring.

30 June 2011

Presentation on southeast Minnesota, karst and springshed mapping to the Whitewater Watershed Project.
Presentation on our St. Lawrence work to DNR EcoWaters and Fisheries staff in Lake City.
Brownbag seminar presentation of the project at the Edward's Aquifer Authority in San Antonio, TX.
Presentation on springshed mapping at the Wisconsin Geological and Natural History Survey for University and state agency staff.
Presentation on springshed mapping at the EcoWaters Environmental Review coordinators meeting.
Presented the St. Lawrence dye tracing work at the 12th Karst Conference in St. Louis and prepared a manuscript for publication in the conference proceedings.
Presented the St. Lawrence work at a brown bag seminar at the MGS.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than 31December 2009, 15 July 2010, 15 January 2011. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS:

Attachment A: updated 11/8/11 (using ***Revised Budget***)
Project Title: Innovative Springshed Mapping for Trout Stream Management-Continuation
Project Manager Name: Jeff Green (DNR)
Trust Fund Appropriation: **$**250,000 (DNR only)

2010-2011 Trust Fund Budget (FY11)	Result 1 Budget:	**Result 1 Revised Budget 3/11/11**	Amount Spent FY10 7/1/09 - 6/30/10	Balance FY10	Amount Spent FY11 7/1/10 - 6/30/11	**ENDING BALANCE**
	Innovative Trout Springshed Maps and Reports	Innovative Trout Springshed Maps and Reports				
BUDGET ITEM						
Personnel (wages and benefits): Hydrologist 3 (Jeff Green) 100%	$202,500	**$211,000**	$104,639	**$106,361**	$106,516	**-$155**
Contracts	$0	**$0**	$0	**$0**	$0	**$0**
Professional/Technical	$0	**$0**	$0	**$0**	$0	**$0**
Other Contracts	$0	**$0**	$0	**$0**	$0	**$0**
Other Direct Operating Costs:	$0	**$0**	$0	**$0**	$0	**$0**
Non-capital Equipment / Tools: (field equipment such as auto-samplers (1-3 @ approx. $3,200 each), flume/weir for spring flow measurement (1 @ approx. $1,500), dataloggers to measure spring parameters (2-3 @ approx. $1,400), netbook computer for datalogger download (approx. $350), temperature loggers (10 @ $60), and other misc. items less than $600 each (ex. waders for spring flow measurement)	$14,000	**$20,550**	$11,886	**$8,664**	$6,684	**$1,980**
Office Equipment & Computers:	$0	**$0**	$0	**$0**	$0	**$0**
Capital Equipment Over $3,500	$0	**$0**	$0	**$0**	$0	**$0**
Land Acquisition	$0	**$0**	$0	**$0**	$0	**$0**
Easement Acquisition	$0	**$0**	$0	**$0**	$0	**$0**
Professional Services for Acquisition	$0	**$0**	$0	**$0**	$0	**$0**
Printing	$0	**$0**	$0	**$0**	$0	**$0**
Supplies: (dye, charcoal, labels, bottles, etc.) 3 dyes (minimum order is approx. $850 each) (dye trace uses .25-2.0 Kg., plan to do 24 dye traces)	$2,000	**$2,000**	$270	**$1,730**	$1,780	**-$50**
Travel Expenses in Minnesota						
DNR Fleet Vehicle Costs**	$28,000	**$13,850**	$7,715	**$6,135**	$5,109	**$1,025**
Meals & Lodging for Fieldwork	$1,000	**$800**	$362	**$438**	$1,045	**-$607**
Travel Outside Minnesota: (travel & meals, registration) 12th Multidisciplinary Conference on Sinkholes and the Engineering & Environmental Impacts of Karst registration fee, St. Louis, MO, in 2011.	$1,250	**$1,250**	$0	**$1,250**	$623	**$627**
Other (in-state): (employee development, i.e., travel & meals, registration) ARCGIS training and other hydrogeology & karst training in Minnesota such as the Driftless Area Symposium, Southeast Minnesota Water Resources Board workshops, and LIDAR data training.	$1,250	**$550**	$300	**$250**	$0	**$250**
COLUMN TOTALS	$250,000	**$250,000**	$125,172	**$124,828**	$121,757	**$3,070**

Total Spent FY10-11 **$246,929.72**

2009 Project Abstract
For the Period Ending June 30, 2012

PROJECT TITLE: Restorable Wetlands Inventory
PROJECT MANAGER: Darin R. Blunck
AFFILIATION: Ducks Unlimited, Inc.
MAILING ADDRESS: 1 Waterfowl Way
CITY/STATE/ZIP: Memphis, TN 38103
PHONE: (901) 758-3788
E-MAIL: dblunck@ducks.org
WEBSITE: http://www.ducks.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 3(e)
APPROPRIATION AMOUNT: $300,000

<u>Overall Project Outcome and Results</u>

The Restorable Wetlands Inventory (RWI) is a complement to the National Wetlands Inventory (NWI) completed in late-1980s by the U.S. Fish & Wildlife Service. An administrative decision was made developing the original NWI not to map wetland basins in Minnesota identified as completely drained. The number and acreage of completely drained wetlands that were not mapped by the NWI process is significant. In Pope County alone, 25,000 acres of completely drained wetland acres were missed in the NWI mapping process—nearly 19% of the total wetland resources in that county. The RWI project identifies and digitizes the completely-drained depressional wetlands that were not mapped by the NWI process. Restorable wetlands mapping is based upon protocols established for NWI allowing seamless integration of the two datasets.

The 2009 Environment and Natural Resources Trust Fund appropriation provided the last project funding needed to complete, remaining RWI mapping for the glaciated, tallgrass prairie region of Minnesota – an additional 6,120 mi^2. The mapping occurred in approximately 178 townships in Clay, Mahnomen, McLeod, Meeker, Nicollet, Norman, Renville, Sibley, Wilkin, and Wright Counties.

In the Red River Valley Complex, over 132,000 individual restorable wetland basins were identified and mapped. In the Prairie-Hardwood Complex, almost 131,000 individual restorable wetland basins were identified and mapped.

As in previous phase of the mapping project, partners included the LCCMR, Ducks Unlimited, Inc., and the U.S. Fish and Wildlife Service. The photo-interpretation and digitization work was contracted to the GIS Lab at South Dakota State University.

The attached "Restorable Wetlands Inventory: Final Status Map" displays the counties and townships that were completed under the M.L. 2008, M.L. 2009, and prior appropriations.

Data will be distributed on the web via the Minnesota GIS Data Deli (http://deli.dnr.state.mn.us) and the Ducks Unlimited, Inc. (http://www.ducks.org) websites.

Trust Fund 2008 Work Program and
Trust Fund 2009 Work Program

Date of Report:	August 15, 2012	
Date of Next Status Report:	n/a	
	M.L. 2008	**M.L. 2009**
Date of Work program Approval:	June 10, 2008	June 16, 2009
Project Completion Date:	June, 30 2010	June 30, 2012

I. PROJECT TITLE: Restorable Wetlands Inventory

Project Manager: Darin R. Blunck
Affiliation: Ducks Unlimited, Inc.
Mailing Address: 1 Waterfowl Way
City / State / Zip : Memphis, TN 38103
Telephone Number: (901) 758-3788
E-mail Address: dblunck@ducks.org
Fax Number:
Web Page address: http://www.ducks.org

Location: Under the 2008 Appropriation, mapping will occur in 154 townships in Brown, Cottonwood, Lincoln, Lyon, Martin, Murray, Nobles, Pipestone, Redwood, Rock, and Watonwan Counties (See Status Map).

Under the 2009 Appropriation, mapping will occur in 170 townships in Clay, Mahnomen, McLeod, Meeker, Nicollet, Norman, Renville, Sibley, Wilkin, and Wright Counties (See Status Map).

Total Trust Fund Project Budget:	**M.L. 2008**	**M.L. 2009**	**Total**
Trust Fund Appropriation:	**$245,000.00**	**$300,000**	**$545,000**
Minus Amount Spent:	**$243,870.50**	**$300,000**	**$543,870.50**
Equal Balance:	**$1129.50***	**$0**	**$1,129.50**

*M.L. 2008 not used will cancel.

Legal Citation:
M.L. 2008, Chp. 367, Sec. 2, Subd. 5(e)
2008 Appropriation Language:
$245,000 is from the trust fund to the commissioner of natural resources for an agreement with Ducks Unlimited, Inc., to continue the inventory, mapping, and digitizing of drained restorable wetlands in the southwest prairie region of Minnesota. This appropriation is available until June 30, 2011, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

M.L. 2009, Chp. 143, Sec. 2, Subd. 3(e)
2009 Appropriation Language:
$300,000 is from the trust fund to the commissioner of natural resources for an agreement with Ducks Unlimited, Inc., to complete the inventory, mapping, and digitizing of drained restorable wetlands in Minnesota. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. PROJECT SUMMARY AND RESULTS:

The Restorable Wetlands Inventory (RWI) is a complement to the National Wetlands Inventory (NWI) completed in late-1980s by the U.S. Fish & Wildlife Service. An administrative decision was made developing the original NWI not to map wetland basins in Minnesota identified as completely drained. The number and acreage of completely drained wetlands that were not mapped by the NWI process is significant. In Pope County alone, 25,000 acres of completely drained wetland acres were missed in the NWI mapping process—nearly 19% of the total wetland resources in that county. RWI project identifies and digitizes the completely-drained depressional wetlands that were not mapped by the NWI process. Restorable wetlands mapping is based upon protocols established for NWI allowing seamless integration of the two datasets.

<u>M.L. 2008 FINAL PROJECT SUMMARY</u>
The Restorable Wetlands Inventory (RWI) is a complement to the National Wetlands Inventory (NWI) completed in late-1980s by the U.S. Fish & Wildlife Service. An administrative decision was made developing the original NWI not to map wetland basins in Minnesota identified as completely drained. The number and acreage of completely drained wetlands that were not mapped by the NWI process is significant

RWI project identifies and digitizes the completely-drained depressional wetlands that were not mapped by the NWI process. Restorable wetlands mapping is based upon protocols established for NWI allowing seamless integration of the two datasets.

In the Southwest Prairie Complex, over 300,000 individual restorable wetland basins were identified and mapped. Upon completing the Southwest Prairie Complex mapping, townships in 42 western and south-central counties in the prairie and transition zone eco-regions of Minnesota have been mapped, adding an important component to the State's spatial data infrastructure that informs environmental planning and research. Through this investment in RWI – combined with the National Wetlands Inventory, landcover classifications, and a growing catalogue of high-resolution elevation data – our capacity to understand (and importantly, restore and manage) Minnesota's wetland resources is continuing to improve.

Project Partners were the LCCMR, Ducks Unlimited, Inc., and the U.S. Fish and Wildlife Service. The photo-interpretation and digitization work was contracted to the GIS Lab at South Dakota State University.

M.L. 2009 FINAL PROJECT SUMMARY

The 2009 LCCMR appropriation provided the last project funding needed to complete, remaining RWI mapping for the glaciated, tallgrass prairie region of Minnesota – an additional 6,120 mi^2. The mapping occurred in approximately 178 townships in Clay, Mahnomen, McLeod, Meeker, Nicollet, Norman, Renville, Sibley, Wilkin, and Wright Counties.

In the Red River Valley Complex, over 132,000 individual restorable wetland basins were identified and mapped. In the Prairie-Hardwood Complex, almost 131,000 individual restorable wetland basins were identified and mapped.

As in previous phase of the mapping project, partners included the LCCMR, Ducks Unlimited, Inc., and the U.S. Fish and Wildlife Service. The photo-interpretation and digitization work was contracted to the GIS Lab at South Dakota State University.

The attached "Restorable Wetlands Inventory: Final Status Map" displays the counties and townships that were completed under the M.L. 2008, M.L. 2009, and prior appropriations.

III. PROGRESS SUMMARY AS OF:

M.L. 2008
Completed (see "M.L. 2008 Final Project Summary" in Section II above)

December 31, 2008
M.L. 2009
N/A

June 30, 2009:
M.L. 2009
N/A

December 31, 2009:
M.L. 2009
Agreement has been signed with GIS lab at South Dakota State University to continue working on the project through the final phase of counties.

June 30, 2010:
M.L. 2009
NAPP imagery has been acquired and prepared for the Red River Valley Complex and Farm Service Agency compliance slides have been obtained for Clay and Wilkin Counties. Deviating from the schedule outlined in the workplan, Clay and Wilkin Counties will be completed prior to Mahnomen and Norman Counties due to the timing of the compliance slide acquisitions.

December 31, 2010:
M.L. 2009
Clay County has been photo-interpreted and digitized and is under final QA/QC by the USFWS project partner. Wilkin County photo-interpretation is finished with digitization underway. Photo-interpretation of Mahnomen and Norman Counties is partly completed. NAPP imagery has been acquired and prepared for the Prairie-Hardwood Complex.

June 30, 2011:
M.L. 2009
Clay County has been completed. Mahnomen County has been photo-interpreted and digitized and is under final QA/QC by the USFWS project partner. Wilkin County digitization is complete; errors were found during initial QA/QC and is being revisited by the contractor. Photo-interpretation and digitization of Meeker and Norman Counties is completed and awaiting QA/QC.

December 31, 2011:
M.L. 2009
Mahnomen and Meeker Counties are under final QA/QC by the USFWS project partner. Wilkin County is near finalization and ready for QA/QC. QA/QC is also underway for Meeker and Norman Counties. Photo-interpretation of Renville County is complete with 12 of 27 townships digitized.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Southwest Prairie Complex Mapping
Description:
In **Brown, Cottonwood, Lincoln, Lyon, Martin, Murray, Nobles, Pipestone, Redwood, Rock, and Watonwan Counties**, RWI product will be mapped for **154 Townships**. National Aerial Photography Program (NAPP) (1:40,000 scale) color infrared (CIR) photographs will be viewed in stereo pairs at 5x magnification using a cartographic engineering stereoscope. Drained depressional wetlands will be delineated on a Mylar overlay using a 6X0 (0.13mm diameter) rapidograph pen and indelible ink. Collateral data will be consulted during the digitization process consisting of published county soil surveys and descriptions of hydric soils, USDA Farm Service Agency compliance slides (aerial 35-mm slides) acquired in 1993 (immediately after a period of intense precipitation), USGS 7.5-minute topographic maps, and National Wetlands Inventory (NWI) maps. Mylar overlays will be scanned to create draft digital data. The final deliverable consists of distributing the final GIS products on the Minnesota DNR Data Deli and Ducks Unlimited websites.

Summary Budget Information for Result 1:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$245,000.00**	**$0**	**$245,000.00**
Amount Spent:	**$243,870.50**	**$0**	**$243,870.50**

Balance:	**$1129.50**	**$0**	**$1129.50**

Deliverable	Completion Date	Budget	Status
1. Acquisition of Imagery	July 2008	$2,500	n/a
2. SDSU Photointerpretation/Digitization • Brown County (~17 townships) • Cottonwood (9 townships) • Lincoln County (13 townships) • Lyon County (12 townships) • Martin County (20 townships) • Murray County (6 townships) • Nobles County (16 townships) • Pipestone County (~12 townships) • Redwood County ~(24 townships) • Rock County (~13 townships) • Watonwan County (12 townships)	n/a September 2008 December 2008 February 2008 April 2009 July 2009 September 2009 December 2009 February 2010 April 2010 May 2010 June 2010	$242,500	n/a
3. Product Distribution	July 2010	$0	n/a

[a] SDSU GIS Lab will receive a one-time payment upon delivery of product for all Counties. Ducks Unlimited, Inc. will request LCCMR reimbursement after product has been delivered by SDSU and Ducks Unlimited, Inc. has paid SDSU for their work. Completion dates reflect anticipated digitization timeframes for each county.

Completion Date: M.L. 2008 = July 31, 2010

Final Report Summary (July 2010):

The Restorable Wetlands Inventory (RWI) is a complement to the National Wetlands Inventory (NWI) completed in late-1980s by the U.S. Fish & Wildlife Service. An administrative decision was made developing the original NWI not to map wetland basins in Minnesota identified as completely drained. The number and acreage of completely drained wetlands that were not mapped by the NWI process is significant

RWI project identifies and digitizes the completely-drained depressional wetlands that were not mapped by the NWI process. Restorable wetlands mapping is based upon protocols established for NWI allowing seamless integration of the two datasets.

In the Southwest Prairie Complex, over 300,000 individual restorable wetland basins were identified and mapped. Upon completing the Southwest Prairie Complex mapping, townships in 42 western and south-central counties in the prairie and transition zone eco-regions of Minnesota have been mapped, adding an important component to the State's spatial data infrastructure that informs environmental planning and research. Through this investment in RWI – combined with the National Wetlands Inventory, landcover classifications, and a growing catalogue of high-resolution elevation data – our capacity to understand (and importantly, restore and manage) Minnesota's wetland resources is continuing to improve.

The Restorable Wetlands Inventory mapping product for the Southwest Prairie Complex is complete and will be distributed on the Minnesota Data Deli and Ducks Unlimited, Inc. websites by the end of August 2010 in GIS-compatible formats.

Result 2: Red River Valley Complex Mapping
Description:
Within **Clay, Mahnomen, Norman, and Wilkin Counties**, RWI product will be mapped for **72 Townships** (see Work Plan Map #1). The protocols, procedures, and deliverables will be the same as described under Result 1, but for the different geographic extent.

Summary Budget Information for Result 2:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$0**	**$125,000**	**$125,000**
Amount Spent:	**$0**	**$125,000**	**$125,000**
Balance:	**$0**	**$0**	**$0**

Deliverable	Completion Date	Budget	Status
1. Acquisition of Imagery	January 2010	$2,500	n/a
2. SDSU Photointerpretation/Digitization • Mahnomen County (16 townships) • Norman County (24 townships) • Clay County (12 townships) • Wilkin County (~21 townships)	n/a June 2010 September 2010 December 2010 April 2011	$122,500	n/a
3. Product Distribution	April 2011	$0	n/a

[a] SDSU GIS Lab will receive a one-time payment upon delivery of product for all Counties. Ducks Unlimited, Inc. will request LCCMR reimbursement after product has been delivered by SDSU and Ducks Unlimited, Inc. has paid SDSU for their work. Completion dates reflect anticipated digitization timeframes for each county.

Completion Date: M.L. 2009 = April 30, 2011

Result Status as of December 31, 2009:
M.L. 2009
Agreement has been signed with the GIS lab at South Dakota State University to continue photo-interpretation and digitization work on the final, remaining counties in the RWI project.

Result Status as of June 30, 2010:
M.L. 2009
NAPP imagery has been acquired and prepared for the Red River Valley Complex and Farm Service Agency compliance slides have been obtained for Clay and Wilkin Counties. Deviating from the schedule outlined in the workplan, Clay and Wilkin

Counties will be completed prior to Mahnomen and Norman Counties due to the timing of the compliance slide acquisitions.

Result Status as of December 31, 2010:
M.L. 2009
Clay County has been photo-interpreted and digitized and is under final QA/QC by the USFWS project partner. Wilkin County photo-interpretation is finished with digitization underway. Photo-interpretation of Mahnomen and Norman Counties is partly completed.

Result Status as of June 30, 2011:
Clay County has been completed. Mahnomen County has been photo-interpreted and digitized and is under final QA/QC by the USFWS project partner. Wilkin County digitization is complete; errors were found during initial QA/QC and is being revisited by the contractor. Photo-interpretation and digitization of Norman County is completed and awaiting QA/QC.

Result Status as of December 31, 2011:
Mahnomen and Meeker Counties are under final QA/QC by the USFWS project partner. Wilkin and Norman Counties are near finalization and ready for QA/QC.

Final Report Summary (July 2012):

In the Red River Valley Complex, over 132,000 individual restorable wetland basins were identified and mapped. Upon completing the Southwest Prairie Complex mapping, townships in 72 western in the prairie and transition zone eco-regions of Minnesota have been mapped, adding an important component to the State's spatial data infrastructure that informs environmental planning and research. Through this investment in RWI – combined with the National Wetlands Inventory, landcover classifications, and a growing catalogue of high-resolution elevation data – our capacity to understand (and importantly, restore and manage) Minnesota's wetland resources is continuing to improve.

Result 3: Prairie-Hardwood Complex Mapping
Description:
In **Meeker, McLeod, Wright, Renville, Sibley, and Nicollet Counties**, RWI product will be mapped for **106 Townships**. The protocols, procedures, and deliverables will be the same as described under Result 1, but for the different geographic extent.

Summary Budget Information for Result 3:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$0**	**$175,000**	**$175,000**
Amount Spent:	**$0**	**$175,000**	**$175,000**
Balance:	**$0**	**$0**	**$0**

Deliverable	Completion Date	Budget	Status

1. Acquisition of Imagery	June 2011	$2,500	n/a
2. SDSU Photointerpretation/Digitization • Meeker County (18 townships) • Wright County (~22 townships) • McLeod County (14 townships) • Sibley County (16 townships) • Nicollet County (~5 townships) • Renville County (~27 townships)	n/a August 2011 October 2011 December 2011 February 2012 February 2012 June 2012	$172,500	n/a
3. Product Distribution	June 2012	$0	n/a

[a] SDSU GIS Lab will receive a one-time payment upon delivery of product for all Counties. Ducks Unlimited, Inc. will request LCCMR reimbursement after product has been delivered by SDSU and Ducks Unlimited, Inc. has paid SDSU for their work. Completion dates reflect anticipated digitization timeframes for each county.

Completion Date: M.L. 2009: June 30, 2012

Result Status as of December 31, 2009:
M.L. 2009
Agreement has been signed with the GIS lab at South Dakota State University to continue photo-interpretation and digitization work on the final, remaining counties in the RWI project.

Result Status as of June 30, 2010:
M.L. 2009
N/A

Result Status as of December 31, 2010:
M.L. 2009
NAPP imagery has been acquired and prepared for the Prairie-Hardwood Complex and Farm Service Agency compliance slides have been obtained for Meeker, McLeod, Wright, Renville, Sibley, and Nicollet Counties.

Result Status as of June 30, 2011:
M.L. 2009
Photo-interpretation and digitization of Meeker County is completed and awaiting QA/QC

Result Status as of December 31, 2011:
M.L. 2009
QA/QC underway for Meeker County. Photo-interpretation of Renville County is complete with 12 of 27 townships digitized.

Final Report Summary (July 2012):

In the Prairie-Hardwood Complex, close to 131,000 individual restorable wetland basins were identified and mapped. Upon completing the Prairie Hardwood

Complex mapping, townships in 106 western and south-central counties in the prairie and transition zone eco-regions of Minnesota have been mapped, adding an important component to the State's spatial data infrastructure that informs environmental planning and research. Through this investment in RWI – combined with the National Wetlands Inventory, landcover classifications, and a growing catalogue of high-resolution elevation data – our capacity to understand (and importantly, restore and manage) Minnesota's wetland resources is continuing to improve.

V. TOTAL TRUST FUND PROJECT BUDGET:

M.L. 2008

Staff or Contract Services: $ 245,000

• Contract - South Dakota State University, NWI Laboratory	$ 242,500
• 2.5% FTE - Project Manager Ducks Unlimited, Inc.	$ 2,500
TOTAL 2008 TRUST FUND PROJECT BUDGET:	**$ 245,000**

M.L. 2009

Staff or Contract Services: $ 300,000

• Contract - South Dakota State University, NWI Laboratory	$ 296,000
• 5% FTE - Project Manager Ducks Unlimited, Inc.	$ 4,000
TOTAL 2009 TRUST FUND PROJECT BUDGET:	**$ 300,000**

VI. OTHER FUNDS AND PARTNERS

A. Project Partners

M.L. 2008 and M.L. 2009

Dr. Rex Johnson, HAPET Team Leader, U.S. Fish & Wildlife Service – Region 3
Darin R. Blunck, Director of Conservation Programs, Ducks Unlimited, Inc.
Brian Huberty, Regional NWI Coordinator, U.S. Fish & Wildlife Service – Region 3

B. Other Funds Proposed to be Spent during the Project Period

M.L. 2008

U.S. Fish & Wildlife Service	$45,000 Cash/In-kind	Imagery Acquisition and QA/QC
Ducks Unlimited, Inc.	$4,500 In-kind	Project Management

M.L. 2009

U.S. Fish & Wildlife Service	$50,000 Cash/In-kind	Imagery Acquisition and QA/QC
Ducks Unlimited, Inc.	$6,000 In-kind	Project Management

C. Spending History

U.S. Fish & Wildlife Service	$ 10,000 Cash/In-kind
Ducks Unlimited, Inc.	$ 6,000 In-kind
Habitat Corridors Partnership (LCCMR)	$ 98,000 Cash

D. Time:

M.L. 2008
Grant funds will be used predominantly for contract services with timeframes established for deliverables based on approximations of when the contractor estimates feasible delivery of products. Reimbursement for the Southwest Prairie Complex Result will be requested from LCCMR in July 2010 upon completion and delivery of the mapping product.
M.L. 2009
Reimbursement for the Red River Valley mapping result will be requested from LCCMR in April 2011 upon completion and delivery of the mapping product. Reimbursement will be requested in June 2012 upon completion and delivery of the mapping product for the Prairie-Hardwood Complex.

E. Project Impact and Long-term Strategy

The completion of the Restorable Wetlands Inventory is an important component of the State's spatial data infrastructure. Once completed, the dataset will provide seamless data on wetland restoration potential in the glaciated regions of Minnesota. The dataset is a baseline dataset that requires no periodic updates.

VII. DISSEMINATION:
Data will be distributed on the web via the Minnesota GIS Data Deli (http://deli.dnr.state.mn.us) and the Ducks Unlimited, Inc. (http://www.ducks.org) websites.

VIII. REPORTING REQUIREMENTS:
M.L. 2008
Periodic work program progress reports will be submitted not later than December 2008, June 2009, and December 2009 for the 2008 appropriation. A final work program report and associated products for the 2008 appropriation will be submitted between June 2010 and July 2010.

M.L. 2009
Periodic work program progress reports will be submitted not later than December 2009, June 2010, December 2010, June 2011, December 2011, and June 2012. A final work program report and associated products for the 2009 appropriation will be submitted no later than August 1, 2012.

IX. RESEARCH PROJECTS:

Attachment A: Budget Detail for 2009 Projects - Summary and a Budget page for each partner (if applicable)

Project Title: *Restorable Wetland Inventory*

Project Manager Name: *Darin R. Blunck - Ducks Unlimited, Inc.*

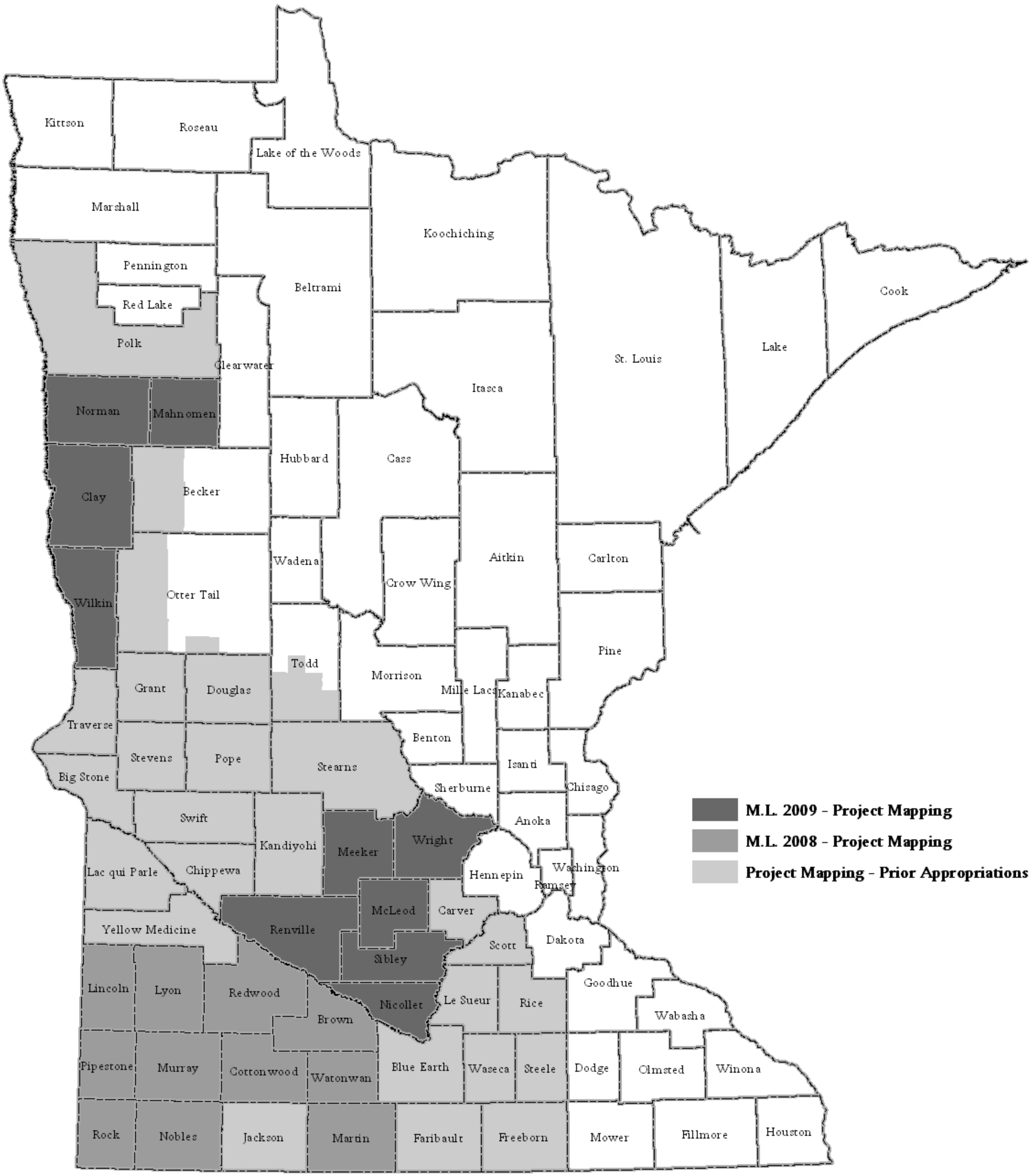
Trust Fund Appropriation: $ 300,000

1) See list of non-eligible expenses, do not include any of these items in your budget sheet
2) Remove any budget item lines not applicable

2009 Trust Fund Budget	Result 2 Budget:	Amount Spent	Balance 8/15/2012	Result 3 Budget:	Amount Spent	Balance 8/15/2012	TOTAL BUDGET	TOTAL BALANCE
	Red River Valley Complex			*Prairie Hardwood Complex*				
BUDGET ITEM			0			0	0	0
Contracts			0			0	0	0
Professional/technical: Ducks Unlimited, Inc., Project Management	2,500	2,500	0	2,500	2,500	0	5,000	0
Professional/technical: GIS Laboratory, Department of Fish and Wildlife Sciences, South Dakota State University	122,500	122,500	0	172,500	172,500	0	295,000	0
COLUMN TOTAL	**$125,000**	**$125,000**	**$0**	**$175,000**	**$175,000**	**$0**	**$300,000**	**$0**

Restorable Wetland Inventory - LCCMR

Final Status Map - 2012



2009 Project Abstract
For the Period Ending June 30, 2012

PROJECT TITLE:	**State Parks Acquisitions (4a)**
PROJECT MANAGER:	Jennifer Christie
AFFILIATION:	DNR Division of Parks and Trails
MAILING ADDRESS:	500 Lafayette Rd
CITY/STATE/ZIP:	St Paul, MN 55155
PHONE:	651-259-5633
E-MAIL:	jennifer.christie@state.mn.us
WEBSITE: [If applicable]	www.dnr.state.mn.us/
FUNDING SOURCE:	Environment and Natural Resources Trust Fund
LEGAL CITATION:	M.L. 2009, Chap. 143, Sec. 2, Subd. 4(a)

APPROPRIATION AMOUNT: $590,000

Overall Project Outcome and Results
The Environment and Natural Resources Trust Fund funding allowed for the following:

- Ownership of approximately 87 acres in the Cuyuna Country State Recreation Area. Acquisition of this parcel provides for unified ownership of park-managed land and includes a key access point into the recreation area. This parcel also has over one mile of water frontage on three lakes within the recreation area.

- Ownership of a 17-acre parcel in Whitewater State Park. Acquisition of this parcel provides protection on the Whitewater River and adjacent to the park visitor center. The current trail system lies close to the boundary and could now be extended for additional river resource interpretation. The parcel also provides a natural buffer between the visitor center and private development.

- Ownership of approximately 20 acres of land in Nerstrand Big Woods State Park due to partially funding from the Trust Fund. This property is identified by Minnesota County Biological Survey as having outstanding biodiversity significance and has not been logged in over 100 years. The spring ephemerals prevalent in this area of the park are now protected. The site is also key to maintaining the closed canopy and diverse understory characteristic of 'big woods' in Nerstrand Big Woods State Park.

All acquisitions are from willing sellers, and located within the statutory boundary of state parks.

Trust Fund 2009 Work Program Final Report

Date of Report: August 1, 2012
Date of Work program Approval: June 16, 2009
Date of Work program Extension Approval: July 1, 2011
Project Completion Date: June 30, 2012

I. PROJECT TITLE: State Parks Acquisition

Project Manager: Jennifer Christie
Affiliation: Department of Natural Resources, Division of Parks and Trails
Mailing Address: 500 Lafayette Road
City / State / Zip: St. Paul, MN 55155
Telephone Number: 651-259-5633
E-mail Address: Jennifer.Christie@state.mn.us
FAX Number: 651-297-5475
Web Page address: www.dnr.state.mn.us

Location: Acquisitions include, but not limited to, 1) Central- Cuyuna Country State Recreation Area near Ironton in Crow Wing County and 2) Southeast– Whitewater SPK near Altura in Winona County and 3) Southern-Nerstrand State Park in Rice County. See attached map for locations.

Total Trust Fund Project Budget:	**Trust Fund Appropriation:**	**$ 590,000**
	Minus Amount Spent:	**$ 590,000**
	Equal Balance:	**$ -0-**

Legal Citation: ML 2009, Chap.143, Sec. 2, Subd. 4A
Legal Citation: Carry forward ML 2011, Chap. 2, Sec.2, Subd.18a.

Appropriation Language: State Parks Acquisition has been extended to June 30, 2012

$590,000 is from the trust fund to the commissioner of natural resources to acquire in-holdings for state parks. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. A list of proposed acquisitions must be provided as part of the required work program.

II. FINAL PROJECT SUMMARY AND RESULTS: Trust Fund funding allowed for the following:

- Ownership of approximately 87 acres in the Cuyuna Country State Recreation Area. Acquisition of this parcel provides for unified ownership of park-managed land and includes a key access point into the recreation area. This parcel also has over one mile of water frontage on three lakes within the recreation area.

- Ownership of a 17-acre parcel in Whitewater State Park. Acquisition of this parcel provides protection on the Whitewater River and adjacent to the park visitor center. The current trail system lies close to the boundary and could now be extended for additional river resource interpretation. The parcel also provides a natural buffer between the visitor center and private development.

- Ownership of approximately 20 acres of land in Nerstrand Big Woods State Park due to partially funding from the Trust Fund. This property is identified by Minnesota County Biological Survey as having outstanding biodiversity significance and has not been logged in over 100 years. The spring ephemerals prevalent in this area of the park are now protected. The site is also key to maintaining the closed canopy and diverse understory characteristic of 'big woods' in Nerstrand Big Woods State Park.

  See attached map for locations.

All acquisitions are from willing sellers, and located within the statutory boundary of state parks.

III. FINAL REPORT SUMMARY:

In December 30, 2009, the 87 acre parcel at Cuyuna Country State Recreation Area was appraised and anticipated to be acquired by February 2010. The 87 acre parcel at Cuyuna Country State Recreation Area was acquired on March 12, 2010.

In December 30, 2009, the 17 acre parcel at Whitewater State Park was in the acquisition process of being appraised with an anticipated completion date within the next 60 days. In October 22, 2010, the 17-acre parcel at Whitewater State Park appraisal was completed and an offer was made in April 2010. In December 30, 2010, on-going discussions between the MnDNR and Parks & Trails Council of Minnesota were occurring regarding the offer to purchase the property. The 17-acre parcel at Whitewater State Park was acquired on June 6, 2010.

On January 25, 2012, due to declining property values, MnDNR requested a workplan amendment to add the partial funding of Nerstrand State Park acquisition. On January 31, 2012, the workplan amendment was approved. On July 1, 2011, the Work program Extension Approval was given to extend the completion date to June 30, 2012. The 20 acre parcel at Nerstrand State Park was acquired on December 28, 2011.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Ownership of approximately 87 acres within the statutory boundary of Cuyuna Country State Recreation Area.

Description: The Department of Natural Resources, Division of Parks and Trails will appraise, negotiate and acquire this parcel. This 87 acre parcel is completely surrounded by park-managed land and includes a key access point into the recreation area. This parcel also has over one mile of water frontage on three lakes within the recreation area.

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$280,000**
	Amount Spent:	**$280,000**
	Balance:	**$ -0-**

Deliverable	Completion Date	Budget	Status
1. 87 Acres Acquired	June 30, 2012	$280,000	Completed

Final Report Summary:
This acquisition was completed on March 12, 2010.

In December 30, 2009, the 87 acre parcel at Cuyuna Country State Recreation Area was appraised and anticipated to be acquired by February 2010. The 87 acre parcel at Cuyuna Country State Recreation Area was acquired on March 12, 2010.

Result 2: Ownership of a 17-acre parcel within the statutory boundary of Whitewater State Park

Description: The Department of Natural Resources, Division of Parks and Trails will appraise, negotiate and acquire this parcel. This 17 acre parcel straddles the Whitewater River and lies adjacent to the park visitor center. The current trail system lies close to the boundary and this property may be used to extended the trail for additional river resource interpretation. The parcel also provides a natural buffer between our visitor center and private development.

Summary Budget Information for Result 2:	**Trust Fund Budget:**	**$279,418**
	Amount Spent:	**$279,418**
	Balance:	**$ -0-**

Deliverable	Completion Date	Budget	Status
1. 17 acres acquired	June 30, 2012	$279,418	Completed

Final Report Summary:
This acquisition was completed on June 6, 2010

In December 30, 2009, the 17 acre parcel at Whitewater State Park was in the acquisition process of being appraised with an anticipated completion date within the next 60 days. In October 22, 2010, the 17-acre parcel at Whitewater State Park appraisal was completed and an offer was made in April 2010. In December 30, 2010, on-going discussions between the MnDNR and Parks & Trails Council of Minnesota were occurring regarding the offer to purchase the property. The 17-acre parcel at Whitewater State Park was acquired on June 6, 2010.

Result 3: Ownership of approximately 20 acres within the statutory boundary of Nerstrand State Park.

Description: Partially fund the acquisition of approximately 20 acres of land in Nerstrand Big Woods State Park located in Rice County. This property was identified as outstanding biodiversity significance by Minnesota County Biological Survey and has not been logged in over 100 years. The spring ephemerals are prevalent in this area of the park and the site is important to maintaining the closed canopy and diverse understory characteristic of 'big woods' in Nerstrand Big Woods State Park.

Summary Budget Information for Result 3:	Trust Fund Budget:	$30,582
	Amount Spent:	$30,582
	Balance:	$ -0-

Deliverable	**Completion Date**	**Budget**	**Status**
1. 20 Acres Acquired	**June 30, 2012**	**$30,582**	**Completed**

Final Report Summary:
This acquisition was completed on December 28, 2011.

On January 25, 2012, due to declining property values, MnDNR requested a workplan amendment to add the partial funding of Nerstrand State Park acquisition. On January 31, 2012, the workplan amendment was approved on January 31, 2012. On July 1, 2011, the Work program Extension Approval was given to extend the completion date to June 30, 2012.

V. TOTAL TRUST FUND PROJECT BUDGET:

Staff or Contract Services: **$15,000 (Appraisal Services and Professional Services from DNR, Division of Lands and Minerals and the Attorney General's Office)**
Acquisition, including easements: 125 Acres, The State of Minnesota (DNR)

TOTAL TRUST FUND PROJECT BUDGET: $590,000

VI. OTHER FUNDS & PARTNERS:

A. **Project Partners**: Local state park support groups and the Parks and Trails Council of Minnesota. Project partners will only receive market value of project sites

in their ownership. Project partner may receive up to $1,500 reimbursement for appraisal costs.
B. Other Funds Proposed to be Spent during the Project Period: Bonding 2006 and 2008 funds, RIM Match funds when appropriate

C. Past Spending:

Land Acquisition for the Division of Parks and Recreation

M.L. 2008 $ 750,000
M.L. 2007 $ 750,000
M.L. 2005 $2,000,000
M.L. 2003 $1,500,000
M.L. 2001 $1,726,000

D. Time: To acquire by June 2012

VII. DISSEMINATION: Update state park maps and website as land becomes available for public use.

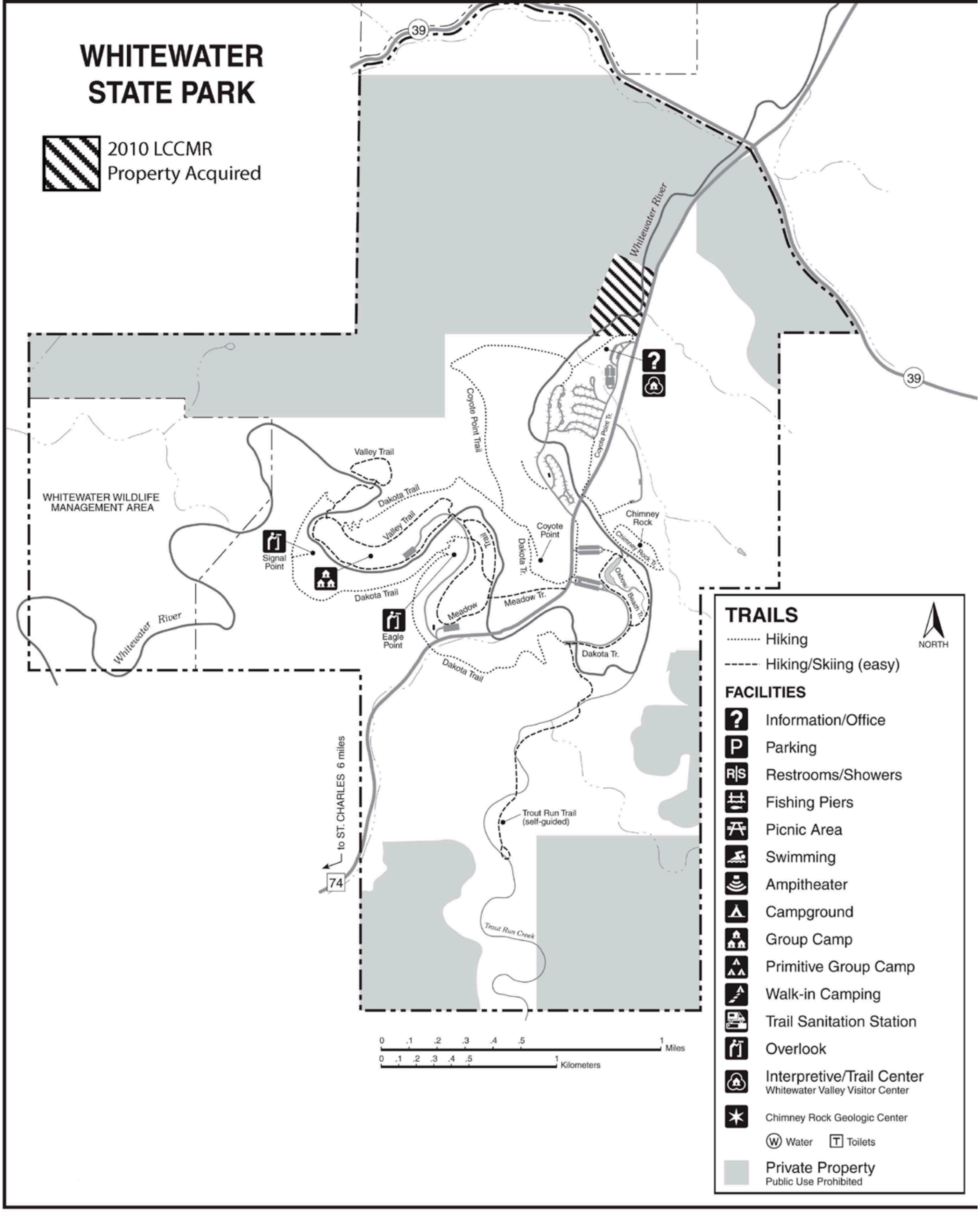
VIII. REPORTING REQUIREMENTS:
Periodic work program progress reports will be submitted no later than December 31, 2009, June 30, 2010 and December 30, 2010 . A final work program report and associated products will be submitted by June 30, 2012 as requested by the LCCMR

IX. RESEARCH PROJECTS: NA

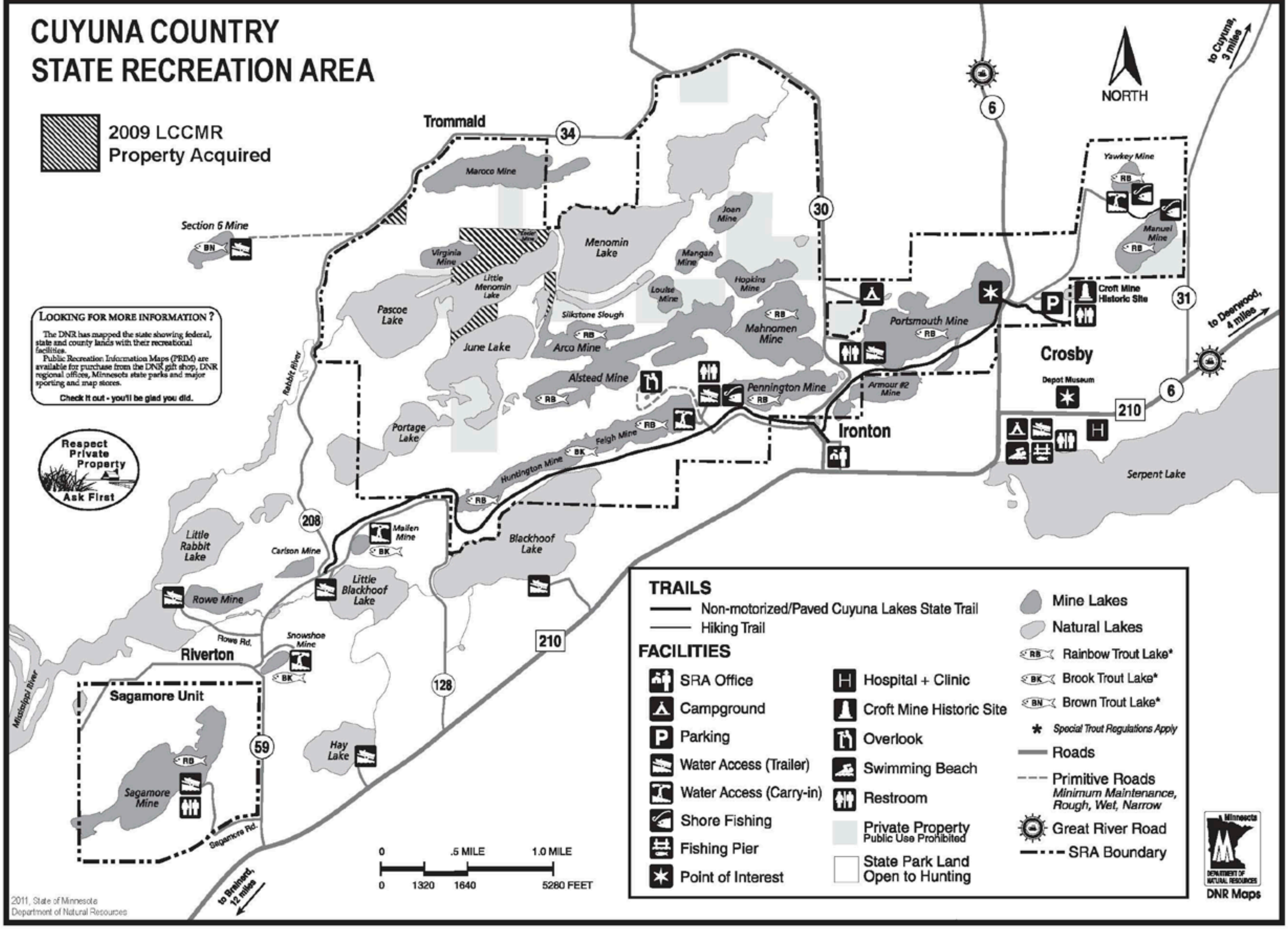
SEE ATTACHMENT A - LCCMR 2009 Budget Detail

2009 LCCMR Acquired Property

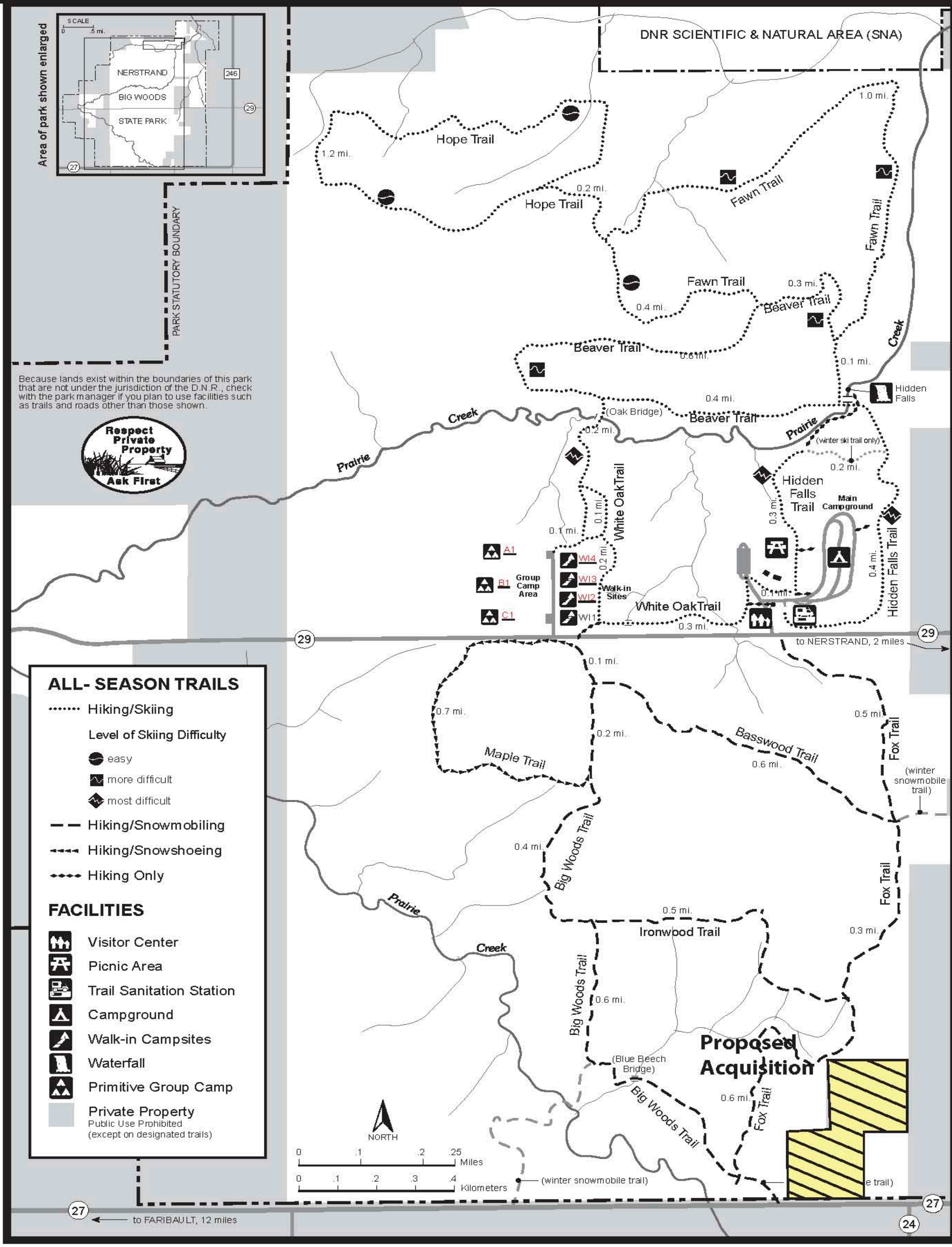
State Parks Land Acquisition



2009 LCCMR Acquired Property
State Parks Land Acquisition



Nerstrand State Park Proposed Acquisition
2009 and 2010 LCCMR Funds



Attachment A: Budget Detail for 2009 Projects - **Summary and a Budget page for each partner (if applicable)**

1-Aug-12

Project Title: State Park Acquisition

Project Manager Name: Jennifer Christie

Trust Fund Appropriation: $590,000

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *3/12/10*	**Balance** 7/25/12	**Result 2 Budget:**	**Amount Spent** *6/6/10*	**Balance** 7/25/12	**Result 3 Budget:**	**Amount Spent** *6/30/12*	**Balance** 1/25/12	**TOTAL BUDGET**	**TOTAL BALANCE**
	Ownership of 87 acres in Cuyuna Country SRA			Ownership of 17 acre parcel in Whitewater SPK			Ownership of 20 acre parcel in Nerstrand SPK				
BUDGET ITEM											
Land acquisition	280,000	280,000	0	275,000	275,000	0	30,582	30,582	0	$585,582	$0
Professional Services for Acq. Such as Appraisal, Survey, Title Work and Progessional Services	0			4,418	4,418	0			0	4,418	$0
COLUMN TOTAL	**$280,000**	**$280,000**	**$0**	**$279,418**	**$279,418**	**$0**	**$30,582**	**$30,582**	**$0**	**$590,000**	**$0**

2009 Project Abstract
For the Period Ending June 30, 2012

PROJECT TITLE:	**State Trail Acquisitions (4a)**
PROJECT MANAGER:	Jennifer Christie
AFFILIATION:	DNR Division of Parks and Trails
MAILING ADDRESS:	500 Lafayette Rd
CITY/STATE/ZIP:	St Paul, MN 55155
PHONE:	651-259-5633
E-MAIL:	jennifer.christie@state.mn.us
WEBSITE: [If applicable]	www.dnr.state.mn.us/
FUNDING SOURCE:	Environment and Natural Resources Trust Fund
LEGAL CITATION:	M.L. 2009, Chap. 143, Sec. 2, Subd. 4(a)

APPROPRIATION AMOUNT: $590,000

Overall Project Outcome and Results
The Environment and Natural Resources Trust Fund funding allowed for the following:

- Ownership of approximately 1.25 miles of the Paul Bunyan State Trail. Acquisition of this property provided for the necessary connection to the Paul Bunyan State Trailhead on the southeastern corner of Lake Bemidji. The property is comprised entirely of former industrial property, located adjacent to the shoreline of Lake Bemidji. The 2009 Trust Fund appropriation amount partially funded this acquisition.
- Ownership of approximately 6 miles of the Browns Creek Segment of Munger State Trail. The property is comprised entirely of the right-of-way of the former Minnesota Zephyr Dinner Trail and traverses the margins of the St. Croix River floodplain adjacent to T.H. 95, the gently to steeply sloping bluffs of the river valley and gently rolling uplands that are interspersed with residential and commercial development. The 2009 Trust Fund appropriation amount partially funded this acquisition.

Trust Fund 2009 Work Program Final Report

Date of Report: August 1, 2012
Date of Work program Approval: June 16, 2009
Date of Work program Extension Approval: July 1, 2011
Project Completion Date: June 30, 2012

I. PROJECT TITLE: State Trail Acquisition

Project Manager: Jennifer Christie
Affiliation: Department of Natural Resources, Division of Parks and Trails
Mailing Address: 500 Lafayette Road
City / State / Zip: St. Paul, MN 55155
Telephone Number: 651-259-5633
E-mail Address: Jennifer.Christie@state.mn.us
FAX Number: 651-297-5475
Web Page address: www.dnr.state.mn.us

Location: Acquisitions include, but not limited to: (1) Northwest – Paul Bunyan State Trail – in the City of Bemidji. (2) Central – Browns Creek Segment of the Munger State Trail. See attached map for locations.

Total Trust Fund Project Budget:	**Trust Fund Appropriation:**	**$ 1,000,000**
	Minus Amount Spent:	**$ 1,000,000**
	Equal Balance:	**$ -0-**

Legal Citation: Carry forward ML 2011, Chap. 2, Sec. 2, Subd.18a.
Legal Citation: ML 2009, Chap.143, Sec.2, Subd.4b.

Appropriation Language: State Trail Acquisition

State Trails Acquisition has been extended to June 30, 2012

$1,000,000 is from the trust fund to the commissioner of natural resources to assist in the acquisition of the Brown's Creek *s*egment of the Willard Munger Trail in Washington County and Paul Bunyan State Trail in the City of Bemidji.

II. PROJECT SUMMARY AND RESULTS: Trust Fund funding allowed for the following:

- Ownership of approximately 1.25 miles of the Paul Bunyan State Trail. Acquisition of this property provided for the necessary connection to the Paul Bunyan State Trailhead on the southeastern corner of Lake Bemidji. The property is comprised entirely of former industrial property, located adjacent to the shoreline of Lake Bemidji. The 2009 Trust Fund appropriation amount partially funded this acquisition.

- Ownership of approximately 6 miles of the Browns Creek Segment of Munger State Trail. The property is comprised entirely of the right-of-way of the former Minnesota Zephyr Dinner Trail and traverses the margins of the St. Croix River floodplain adjacent to T.H. 95, the gently to steeply sloping bluffs of the river valley and gently rolling uplands that are interspersed with residential and commercial development. The 2009 Trust Fund appropriation amount partially funded this acquisition.

Parcels in this work program may be revised during the course of this funding cycle due to an inability to complete the negotiations or other factors.

III. FINAL REPORT SUMMARY:

The 1.25 miles of the Paul Bunyan State Trail was acquired on January 7, 2010.

The 64-acre, approximately 6 miles of Browns Creek Segment of Munger State Trail was acquired on February 16, 2012.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Acquire approximately 1.25 miles of the Paul Bunyan State Trail.

Description: The DNR proposed to acquire a single narrow linear parcel located along the southeastern shoreline of Lake Bemidji, and which containing 13.5 acres extending over approximately 1.25 miles. The property to be acquired is comprised entirely of former industrial property, located adjacent to the shoreline of Lake Bemidji. This proposed acquisition will provide partial funding for the necessary connection Paul Bunyan State Trailhead on the southeastern corner of Lake Bemidji and the segment of the State Trail currently beginning acquired through the City of Bemidji. Funding provided through Capital Bonding (2005 and 2008) will also be used for this project.

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$300,000**
	Amount Spent:	**$300,000**
	Balance:	**$ -0-**

Deliverable	**Completion Date**	**Budget**	**Status**
1. 1.25 miles Acquired	**June 30, 2010**	**$300,000**	**Completed**

Final Report Summary:
In December 30, 2009, the approximately 1.25 miles of the Paul Bunyan State Trail purchase option was encumbered on December 30, 2009. Closing date was

scheduled for the first week of January. Professional services costs were provided under other funding sources.

The approximately 1.25 miles of the Paul Bunyan State Trail was acquired on January 7, 2010.

Result 2: Acquire approximately 6 miles of the Browns Creek Segment of Munger State Trail.

Description: The DNR proposed to acquire 64 acres, 6 miles, of the Browns Creek Segment of the Willard Munger State Trail. This funding partially funded the acquisition of approximately 64 acres, 6 miles, of the Brown's Creek Segment of the Willard Munger State Trail located in Washington County. The acquisition is of a single narrow linear property between the existing Gateway State Trail Corridor and Downtown Stillwater. The property is comprised entirely of the right-of-way of the former Minnesota Zephyr Dinner Trail and traverses the margins of the St. Croix River floodplain adjacent to T.H. 95, the gently to steeply sloping bluffs of the river valley and gently rolling uplands that are interspersed with residential and commercial development. Once developed, this will become a heavily travelled trail corridor in the Minneapolis/St. Paul metropolitan area. The acquisition contains the entire Browns Creek Trail corridor as Legislatively Authorized. No additional acquisition would be required to complete the entire Browns Creek Segment of Willard Munger State Trail. The allocated funds will require an extension request to supplement the 2011-2012 LCCMR funding amount of $1,500,000 and funds offered by Washington County. Approximately $1 million additional funds will be sought from other sources.

DNR Option Agreement	2009 LCCMR Work Plan Amount (Extension Required)	2011-2012 LCCMR Proposal Amount	Washington Co. Offered Amount	Total Funding Amount	Amount of Funding -TBD
$4,235,000	$700,000	$1,500,000	$1,000,000	$3,300,000	$1,035,000

Summary Budget Information for Result 2: **Trust Fund Budget: $ 700,000**
Amount Spent: $ 700,000
Balance: $ -0-

Deliverable	Completion Date	Budget
1. 6 miles of trail corridor acquired	**June 30, 2012**	**$700,000**

Final Report Summary:
In December 2009, the 6 miles of the Browns Creek Segment of the Munger State Trail was in the acquisition process. The appraisal's anticipated to be completed

within the next 60 days. Current funding amount expended was for professional services.

In February 2010, the 6 miles of the Browns Creek segment of the Willard Munger State Trail was in the acquisition process. The appraisal was anticipated to be completed within the next 60 days. Current amount expended was for professional services. The total amount of the acquisition is anticipated to exceed the ENTRF budget and the DNR is working on securing additional funding sources.

In October 2010, an appraisal was completed and an option was signed with the landowner to acquire 6 miles of the Browns Creek Segment of Munger State Trail.

In December 2010, the landowner had entered into an option agreement with the DNR for the acquisition of the 6 miles of the Browns Creek segment of the Willard Munger State Trail.

In January 2012, the DNR elected to purchase the option agreement and encumbered the funds for this project on September 30, 2011. The title review is in progress and we are awaiting the title opinion.

The approximately 6 miles of the Browns Creek Segment of the Munger State Trail was acquired on February 16, 2012.

V. TOTAL TRUST FUND PROJECT BUDGET:

Staff or Contract Services: Appraisal Services and Professional Services from DNR, Division of Lands and Minerals and the Attorney General’s Office
Equipment: None
Development: $ -0-
Restoration: $ -0-
Acquisition, including easements: 7.25 Miles, The State of Minnesota (DNR)

TOTAL TRUST FUND PROJECT BUDGET: $1,000,000.00

Explanation of Capital Expenditures Greater Than $3,500:

VI. OTHER FUNDS & PARTNERS:

A. **Project Partners:** The City of Bemidji will assist the DNR in trail corridor acquisition planning for the Paul Bunyan State Trail. It is currently anticipated that both the City of Stillwater and Washington County will assist the DNR, Division of Parks and Trails in the acquisition of former Minnesota Zephyr railroad corridor. It is anticipated that the Parks and Trails Council of Minnesota will play a critical role in the negotiation and timely acquisition of many of the individual properties prior to State acquisition.

B. Other Funds: Proposed to be spent during the Project Period: Washington County has committed up to $1,000,000 for the acquisition of the former Minnesota Zephyr railroad corridor for use as the Browns Creek Segment of the Willard Munger State Trail.

C. Past Spending:
Land Acquisition for the Division of Parks and Trails State Trail property acquisition efforts have been supported by legislative appropriations through Capital Bonding, Dedicated User Accounts, the General Fund, the Legislative Commission of Minnesota Resources and Federal appropriations through the Federal Highway Administration.

D. Time: To acquire by June 2012

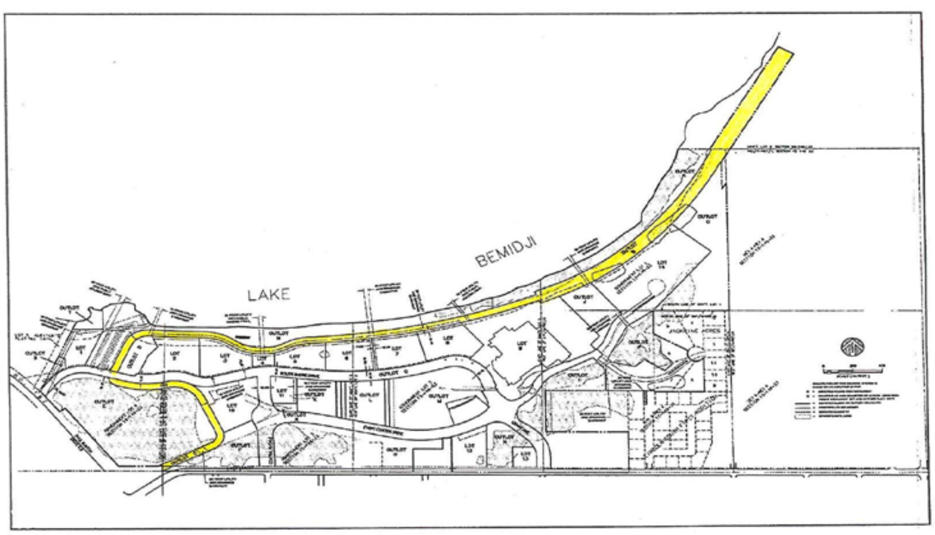
VII. DISSEMINATION: No projected news releases at this time

VIII. REPORTING REQUIREMENTS:
Periodic work program progress reports will be submitted not later than September 30, 2009, April 30, 2010, and September 2010. A final work program report and associated products will be submitted on April 30, 2011 as requested by the LCCMR

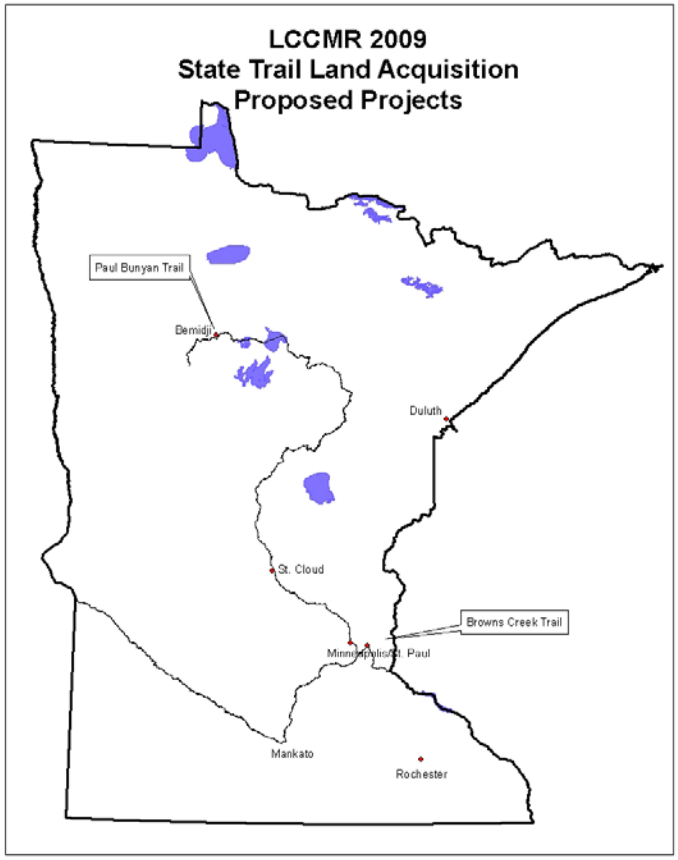
IX. RESEARCH PROJECTS: NA

2009 Proposed Trail Acquisition
Paul Bunyan State Trail - Corridor through Bemidji

Locator



Willard Munger State Trail-Browns Creek Segment



Attachment A: Budget Detail for 2009 Projects - **Summary and a Budget page for each partner (if applicable)**

1-Aug-12

Project Title: State Trails Acquisition

Project Manager Name: Jennifer Christie

Trust Fund Appropriation: $1,000,000

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *1/7/10*	**Balance** 8/1/12	**Result 2 Budget:**	**Amount Spent** *2/16/12*	**Balance** 8/1/12	**TOTAL BUDGET**	**TOTAL BALANCE**
	Ownership of 1.25 miles of the Paul Bunyan State Trail			Ownership of 6 miles of Browns Creek segment				
BUDGET ITEM								
Land acquisition	300,000	300,000	0	650,562	650,562	0	$950,562	$0
Professional Services for Acq. Such as Appraisal, Survey, Title Work and Progessional Services				49,438	49,438	0	49,438	$0
COLUMN TOTAL	**$300,000**	**$300,000**	**$0**	**$700,000**	**$700,000**	**$0**	**$1,000,000**	**$0**
						h		

2009 Project Abstract
For the Period Ending June 30, 2012

PROJECT TITLE:	**Statewide Scientific and Natural Area Acquisition and Restoration (4d)**
PROJECT MANAGER:	Margaret (Peggy) Booth
AFFILIATION:	DNR Division of Ecological & Water Resources
MAILING ADDRESS:	500 Lafayette Rd, Box 25
CITY/STATE/ZIP:	St Paul, MN 55155-4025
PHONE:	651-259-5088
E-MAIL:	peggy.booth@state.mn.us
WEBSITE: [If applicable]	www.dnr.state.mn.us/snas
FUNDING SOURCE:	Environment and Natural Resources Trust Fund
LEGAL CITATION:	M.L. 2009, Chap. 143, Sec. 2, Subd. 4(d)

APPROPRIATION AMOUNT: $590,000

Overall Project Outcome and Results

Acquisition and SNA designation of five properties at three SNAs was completed permanently protecting and providing for public use of 207.32 acres (pro-rated as 106.4 acres with this appropriation). First, a new SNA was established with acquisition of the 14.72-acre **Morton Outcrops SNA** – the heart of a 65-acre exceptional and geologically significant Minnesota River valley rock outcrop site with seven rare species – located in Redwood County. Second, two additions totaling 105.7 acres (pro-rated as 50.3 acres for this appropriation) to the **Hastings Sand Coulee SNA** were acquired; along with a 78-acre adjoining tract transferred from DNR Wildlife, these acquisitions mean that 267 acres is now protected as SNA out of the ~500-acre sand coulee area which is the largest remaining sand prairie complex in Dakota County and is home to 14 rare species including three snakes and two butterflies. Third, two native prairie sites were added to **Blanket Flower Prairie SNA** in Clay County which now protects about 430 acres of habitat for 106 bird species including the greater prairie chicken: a 14-acre addition was acquired with this appropriation; and the 135.9-acre Ole Huseby Homestead addition to Blanket Flower Prairie SNA was acquired in part with this funding (pro-rated as 27.4 acres for this appropriation).

A total of 563 acres at 27 SNAs across the state received restoration and enhancement work, plus development projects were completed at 17 SNAs, thus increasing the native habitat quality and public use of these SNAs. In summary: one 11-acre prairie reconstruction project was completed; woody invasive/non-native species were removed on 202 acres at 11 SNAs and herbaceous or seedling invasive species were removed at another 44 acres at four SNAs; prescribed burning was completed on 317 acres at nine SNAs. New Adaptive Management Plans were completed for two+ sites. Conservation Corps Minnesota (CCM) was involved in these projects at ten SNAs.

Project Results Use and Dissemination

Information about Scientific and Natural Area (SNA) sites, including those SNAs with new acquisition, restoration, enhancement and development activities through this appropriation, is available on the DNR website (www.mndnr.gov/snas). DNR-sponsored volunteer events are regularly posted at: www.dnr.state.mn.us/volunteering/sna/index. The Hastings Sand Coulee SNA acquisition was referenced in articles in the *Hastings Gazette* and the Friends of the Mississippi River website.

Environment and Natural Resources Trust Fund
2009 Work Program Final Report
Statewide Scientific and Natural Area Acquisition and Restoration (4d)

Date of Report: December 3, 2012
Final Report

Date of Work program Approval:	June 16, 2009
Project Completion Date:	June 30, 2011 for Result 2; June, 30 2012 for Result 1.

I. PROJECT TITLE: **Statewide Scientific and Natural Area Acquisition and Restoration (4d)**

Project Manager:	Margaret (Peggy) Booth
Affiliation:	DNR Division of Ecological & Water Resources
Mailing Address:	500 Lafayette Rd, Box 25
City / State / Zip :	St Paul, MN 55155-4025
Telephone Number:	651-259-5088
E-mail Address:	peggy.booth@state.mn.us
FAX Number:	651-296-1811
Web Page address:	www.dnr.state.mn.us/snas

Location: statewide (See Figure 1)

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**590,000**
	Minus Amount Spent:	**$**	**588,969**
	Equal Balance:	**$**	**1,031**

Legal Citation:
M.L. 2009, Chap. 143, Sec. 2, Subd. 4(d)
Appropriation Language:
$590,000 is from the trust fund to the commissioner of natural resources to acquire high quality native plant communities and rare features and restore parts of scientific and natural areas as provided in Minnesota Statutes, section 86A.05, subdivision 5. A list of proposed acquisitions must be provided as part of the required work program.

II & III. FINAL PROJECT SUMMARY
Acquisition and SNA designation of five properties at three SNAs was completed permanently protecting and providing for public use of 207.32 acres (pro-rated as 106.4 acres with this appropriation). First, a new SNA was established with acquisition of the 14.72-acre **Morton Outcrops SNA** – the heart of a 65-acre exceptional and geologically significant Minnesota River valley rock outcrop site with seven rare species – located in Redwood County. Second, two additions totaling 105.7 acres (pro-rated as 50.3 acres for this appropriation) to the **Hastings Sand Coulee SNA** were acquired; along with a 78-acre adjoining tract transferred from DNR Wildlife, these acquisitions mean that 267 acres is now protected as SNA out of the ~500-acre sand coulee area which is the largest remaining sand prairie

complex in Dakota County and is home to 14 rare species including three snakes and two butterflies. Third, two native prairie sites were added to **Blanket Flower Prairie SNA** in Clay County which now protects about 430 acres of habitat for 106 bird species including the greater prairie chicken: a 14-acre addition was acquired with this appropriation; and the 135.9-acre Ole Huseby Homestead addition to Blanket Flower Prairie SNA was acquired in part with this funding (pro-rated as 27.4 acres for this appropriation).

A total of 563 acres at 27 SNAs across the state received restoration and enhancement work, plus development projects were completed at 17 SNAs, thus increasing the native habitat quality and public use of these SNAs. In summary: one 11-acre prairie reconstruction project was completed; woody invasive/non-native species were removed on 202 acres at 11 SNAs and herbaceous or seedling invasive species were removed at another 44 acres at four SNAs; prescribed burning was completed on 317 acres at nine SNAs. New Adaptive Management Plans were completed for two+ sites. Conservation Corps Minnesota (CCM) was involved in these projects at ten SNAs.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: SNA Acquisition
Description:
The SNA program will acquire and designate as SNA approximately 280 acres of high quality native habitat in order to protect elements of natural diversity of state importance such as rare and endangered plant and animal species, undisturbed plant communities, and geological features (180 acres using M.L. 2008 appropriation and 100 acres using M.L. 2009 appropriation). The SNA goal is to preserve and perpetuate the ecological diversity of Minnesota's heritage for scientific study, education, and nature observation. Furthermore, SNA acquisition is an important strategy of the State Wildlife Action Plan in protecting key habitats for Species of Greatest Conservation Need. Sites acquired are designated and managed as provided in MN Statute 86A.05 and MN Rules 6136. Presently, 147 SNAs encompassing over 182,000 acres have been designated in Minnesota.

Sites to be acquired under this appropriation have been identified as priorities for protection by the Minnesota County Biological Survey (MCBS) with Ecological Evaluations approved for SNA acquisition by the Commissioner's Advisory Committee. Land acquired with this appropriation will be sufficiently improved to meet at least minimum management standards as determined by the commissioner. All required Trust Fund acquisition reports will be submitted for each acquisition.

Through this funding (M.L. 2008 and M.L. 2009), all or part of about 4-10 sites would be protected at estimated costs of $2,000 to $12,000/acre depending on appraised land values in the locations being acquired. These funds would be targeted at sites that will not be protected through other currently available ENRTF and bonding funds. Specifically, to date the sites have been identified as conservation priorities for potential acquisition under this grant are listed in Table 1 and shown in Figure 1.

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$434,649**
	Amount Spent:	**$434,649**
	Balance:	**$ 0**

Deliverable	Completion Date	Budget	Status
100 acres acquired & designated SNA	November 17, 2011	$434,649	5 sites (106 acres prorated)

Completion Date: June 30, 2012

Final Report Summary:
The new **Morton Outcrops SNA** was established through acquisition and designation of a 14.72-acre parcel. The 65-acre Morton Outcrops is one of the best remaining examples of a rock outcrop flora in Minnesota with 150 to 200 species of plants and 7 rare plant and animal including the Federally Threatened species prairie bush clover (*Lespedeza leptostachya)* and the state-listed Endangered lichen *Buellia nigra*. The Morton Outcrop is the type locality from which the rock type "Morton Gneiss" was first described. Classified as Morton Quartz Monzonite Gneiss, this rock type is one of the oldest known rocks in the world, dating to over 3 billion years before present.

A pair of acquisitions were funded in part through this appropriation to add over 105 acres to the **Hastings Sand Coulee SNA**. First, a 25.64 acre addition was acquired with this appropriation and designated as SNA that features outstanding quality dry sand gravel prairie and rare species including records of the bull snake. This acquisition, done with assistance of Friends of the Mississippi River. permanently protected rare species habitat previously owned by the City of Hastings for storm-water management purposes. Second, this funding contributed towards acquisition of an 80-acre Holst property that also was funded in part in ENRTF 2009 Metro Corridors funding reallocated from Metro Greenways to the SNA Program, $50,000 from Dakota County, and with SNA prairie bonding (see budget table below summarizing landowner payments). These two parcels are part of the sinuous 500+ acre Hastings Sand Coulee area that is the largest remaining prairie complex in Dakota County and is home to 14 rare species including 3 snakes and 2 butterflies. The 80-acre Holst tract immediately adjoins a 78-acre parcel transferred from DNR Fish and Wildlife Division (Hastings WMA) to DNR Ecological and Water Resources Division that was concurrently added to the Hastings Sand Coulee SNA. The 25.64-acre parcel also immediately adjoins the WMA parcel and is kitty-corner to the Holst property. Having these 3 contiguous parcels added to the SNA has greatly increased the ability of DNR and FMR to ecologically manage these sites for their phenomenal ensemble of rare species and unique plant communities.

Hastings Sand Coulee SNA - Holst addition				
Total acres acquired as SNA:		80		
Funding Source		**Landowner Payment**	**%**	**Pro-Rated Acres**
Dakota County - FNAP	$	50,000.00	10.4%	8.3
Non-State Subtotal	**$**	**50,000.00**		
Bonding - SNA 2008 Prairie	$	61,800.00	12.9%	10.3
ENRTF- SNA MeCC 2009	$	220,000.00	45.8%	36.7
ENRTF- SNA 2009	**$**	**148,200.00**	**30.9%**	**24.7**
DNR Subtotal	**$**	**430,000.00**		
TOTAL	**$**	**480,000.00**	**100.0%**	**80.0**

Two additions were acquired and designated at **Blanket Flower Prairie SNA** (Clay County). A 14-acre parcel was fully acquired with this funding that is part of a high biodiversity area and needed to buffer the adjoining higher quality native prairie to the southwest that is already SNA; DNR ownership of this parcel will increase prairie management effectiveness on the existing SNA. The 135.9-acre Ole Huseby Homestead addition (pro-rated as 27.4 acres for this appropriation) features high quality dry sand-gravel prairie (providing habitat for regal fritillary and Nuttal's ground rose) as well as woodland and lakeshore; this site is one of the few ownerships in this area with high quality prairie that has not sold a wind lease to a wind farm developer. These two parcels added significant acreage to the SNA which harbors 106 bird species including greater prairie chicken.

Blanket Flower SNA – Ole Huseby Homestead addition				
Total acres to be acquired:		135.9		
Funding Source		**Landowner Payment**	**%**	**Pro-Rated Acres**
Bonding - SNA 2008 prairie	$	137,880.00	46.3%	62.9
ENRTF- SNA 2009	**$**	**60,000.00**	**20.1%**	**27.4**
ENRTF- SNA 2010	$	100,000.00	33.6%	45.6
DNR Subtotal	**$**	**297,880.00**		
TOTAL	**$**	**297,880.00**	**100.0%**	**135.9**

Several other projects were initiated under this appropriation, but were subsequently halted for various reasons. These projects include the following; a) a proposed 240-acre new SNA called **Dinner Creek** in Hubbard County was determined to have no legal access, landowner was asked to obtain legal access, but this did not happen so its acquisition was put on indefinite hold; b) a 17-acre addition to **Cold Spring Heron Colony SNA** (Stearns County) was put on hold after determining that the landowner had an unacceptable deed; c) an 10-acre addition to the new **Boltuck-Rice Forever Wild SNA** was postponed at the landowners request; d) the proposed new 52-acre **Rushford Bluffs SNA** was delayed because of landowner deed issues; and e) a proposed 62-acre addition to **Iron Springs Bog SNA** (Clearwater County) was optioned with the landowner, but the county board declined to approve the acquisition because of no-net-loss of private land concerns, so the project was halted.

Result 2: Restoration and Development of SNAs
Description:
Restoration, enhancement, and development activities on about 600 acres at approximately 25 Scientific and Natural Areas (SNAs) statewide will improve the health and sustainability of native biodiversity of native prairie, savanna, old growth forest, and other native plant communities. This work will directly contribute towards achievement of restoration of degraded and rare land features (particularly native prairie, savanna, and forest) needed to support Species of Greatest Conservation Need (SGCN) and thereby helps achieve Habitat Recommendation 5 of the SCPP.

Activities for restoration, development, and native habitat enhancement purposes and to bring sites acquired up to minimum standards will be carried out by SNA program or other Department crews, Minnesota Conservation Corps (MCC), Sentence to Service personnel, volunteers, and/or contractors on SNAs across the state (outside of the Metro Conservation Corridors partnership mapped corridors). This includes activities, such as seed collection, site preparation, planting, establishment period maintenance, removal and treatment of exotics, control of woody encroachment, site clean-up, signing, deer exclosures and other fencing, prescribed burns, and updating of management plans or completion of new adaptive management plans for targeted sites. Results will be reported for all non-duplicated acres with activities accomplished through these funds (e.g. acres of exotics removed or treated, miles of burn breaks installed or acres of prescribed burns, acres of seed harvest, acres planted, etc). All restoration will use seeds or plants of a local ecotype, collected whenever possible from onsite or within 25 miles.

All SNAs are candidates for restoration, enhancement, and development work, with the highest priority sites (not including sites with prairie work targeted through other funding) are listed in Table 2 and highlighted in Figure 1.

Summary Budget Information for Result 1: Trust Fund Budget: $155,351
Amount Spent: $154,320
Balance: $ 1,031

Deliverable	**Completion Date**	**Budget**	**Status**
1. ~30 acres restoration/reconstruction	June 30, 2011	$25,000	11 acres completed
2. ~140 acres invasive species control & woody encroachment removal	June 30, 2011	$48,000	246 acres treated
3. ~430 acres prescribed burning	June 30, 2011	$50,000	317 acres burned

4. site development at ~ 10 SNAs	June 30, 2011	$13,000	projects completed at 15 sites
5. ~ 5 management plan (updates or new)	March 1, 2011	$24,000	2+ new mgmt plan completed

Completion Date: June 30, 2011

Final Report Summary: A total of 563 acres at 27 SNAs across the state received restoration and enhancement work, plus development projects were completed at 17 SNAs. In summary: one 11-acre prairie reconstruction project was completed at Zumbro Falls Woods SNA, including collection of seed on site, mechanical seeding, and follow-up prescribed burning; woody invasive/non-native species were removed on 202 acres at 11 SNAs and herbaceous or seedling invasive species were removed at another 44 acres at four SNAs; 11 miles of burn breaks were installed at nine SNAs and prescribed burning was completed on 317 acres at nine SNAs. New Adaptive Management Plans (natural resource management plans using new approach and format developed by the SNA Program) were completed for three sites (two paid predominantly with this funding) and prescribed burn plans were completed and approved for 14 sites. Development projects included installation of signs, gates, and culverts, improvements to exclosure and boundary fencing, parking lot construction, trail repair, and site cleanup. Conservation Corps Minnesota (CCM) was involved in these projects at ten SNAs. See Table 2 for details.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $111,245 (for classified and unclassified SNA program & other DNR staff paid almost exclusively with special project funds: ~ 0.1 FTE acquisition specialist; up to ~0.1 FTE management plan writer & contract coordinator – new position; up to ~ 0.5 FTE specialists and technicians; and ~ 0.6 FTE laborers and seasonal crews).
Contracts: $29,978 (MCC and contractors selected through bid process as needed to complete restoration and development projects).
Equipment/Tools/Supplies: $10,052 (truck & equipment fleet charges & incidental parts; materials and supplies, such as fencing, signs, gloves, PPE, chemical, etc.)
Acquisition, including easements: $424,582 (towards fee acquisition of about 100 acres to be owned by DNR & designated SNA; including related real estate transaction costs)
Travel: $1,299 (instate travel as needed by land acquisition specialists evaluating site & negotiating with landowners & as needed by project staff for restoration & development work.)

Other: $2,957(for DNR professional services needed to complete a restoration/enhancement project)
TOTAL TRUST FUND PROJECT BUDGET: $590,000

Explanation of Capital Expenditures Greater Than $3,500: NA

VI. OTHER FUNDS & PARTNERS / PROJECT STRATEGY:

A. Project Partners:

SNA developed and implemented its projects in cooperation with Friends of the Mississippi River, Dakota County and other partners.

B. Other Funds Proposed to be Spent during the Project Period:

These Environmental Trust fund appropriations were supplemented by other state funding (e.g. bonding and potentially other LCCMR recommended funding) and non-state funds (e.g. federal SWG, private funds, and partial landowner donations) as needed to complete priority acquisitions and restoration and development projects. Funding sources used for acquisition projects done through these appropriations and pro-rated acreages are reported above.

C. Spending History:

SNA acquisition, restoration and development project appropriations received in CY 2005-2008 (not counting those targeted exclusively to Metro Corridors, HCP, or private prairie stewardship): 2005 SNA Statewide $134K; 2008 SNA Statewide $1M; Accelerated Prairie (Results 4 & 6 only) $775K. FY06-08 Bonding appropriations: 2006 SNA $2M; 2008 SNA $1M; 2008 Native Prairie $4M. Federal funds spent as of 4/1/09 in FY06-09: State Wildlife Grants $94K. Other funds spent: partner contributions & landowner donations. The SNA program general fund includes approximately $400,000 annually for statewide operations and crew.

D. Time: July 1, 2009 – June 30, 2012.

E. Project Impact and Long-term Strategy:

This project will help protect and perpetuate rare species, SGCNs, and natural features of state significance at approximately 25-35 SNA sites across the state selected because of their importance and strategic value in protecting these rare resources. As a part of the State Outdoor Recreation system, all of these sites are managed as state SNAs that provide public access and opportunities to the public for nature observation and study.

The SNA Long Range Plan has a goal of protection through SNA designation within each ecological subsection of five occurrences of each native plant community (NPC) and three occurrences of each natural heritage element found in that subsection. The Division of Ecological Resources is in the process of using the recently revised Native Plant Community Classification system to assess the extent of protection for each NPC per subsection – looking at both numbers of occurrences (NPC polygons) and acreage protected. This demonstrates a substantial need for more SNA land acquisition and native habitat restoration/development for at least the next 2 decades. Towards this end, the Division could readily utilize support from the Environment and Natural Resources Trust fund and/or the Lessard Outdoor Heritage Council of $2M to $8M per biennium over this timeframe.

VII. DISSEMINATION: Site tours have been held for various groups at each acquired site during which funding approved by LCCMR was acknowledged

VIII. REPORTING REQUIREMENTS:
Periodic work program progress reports will be submitted not later than March 1st and September 1st of each year. A final work program report and associated products for the 2008 appropriation will be submitted no later than August 1, 2010 as requested by the LCCMR and a final work program report and associated products for the 2009 appropriation will be submitted no later than August 1, 2012.

IX. RESEARCH PROJECTS: NA

Attachment A: FINAL Budget Detail for 2009 Project

Project Title: Statewide Scientific & Natural Area Acquisition and Restoration

Project Manager Name: Margaret (Peggy) Booth

Trust Fund Appropriation: $ 590,000

2009 Trust Fund Budget	Result 1 Budget:	Amount Spent (12/1/11)	Balance (12/1/11)	Result 2 Budget:	Amount Spent (6/30/11)	Balance (6/30/11)	TOTAL BUDGET	TOTAL BALANCE
	Acquisition & Designation			Restoration & Development				
BUDGET ITEM								
PERSONNEL: wages and benefits for classified and unclassified SNA program & other DNR staff paid almost exclusively with special project funds: ~ 0.1 FTE acquisition specialist; up to ~0.1 FTE management plan writer & contract coordinator – new position; up to ~ 0.5 FTE specialists and technicians; and ~ 0.6 FTE laborers and seasonal crews	10,067	10,067	-	101,178	100,147	1,031	111,245	1,031
Contracts (								
Other contracts: MCC and contractors selected through bid process as needed to complete restoration and development projects	-		-	29,978	29,978	-	29,978	-
Non-capital Equipment / Tools: truck & equipment fleet charges & incidental parts	-	-	-	10,052	10,052	-	10,052	-
Land acquisition	390,000	390,000	-			-	390,000	-
Professional Services	34,582	34,582	-	2,957	2,957	-	37,539	-
Supplies: restoration & development materials and supplies, such as fencing, signs, gloves, PPE, chemical, etc.			-	9,887	9,887	-	9,887	-
Travel expenses in Minnesota	-	-	-	1,299	1,299	-	1,299	-
COLUMN TOTAL	**434,649**	**434,649**	**-**	**155,351**	**154,320**	**1,031**	**590,000**	**1,031**

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Table 2. Potential SNA -STATEWIDE - Restoration & Development Activities - FY10-11

FINAL — **updated September 13, 2011**

SNA Name	County	Updated or New Management Plan	Acres Completed (bold X if other)					Comments & Accomplishments Not Measured in Acres
			Native Plant Community Reconstruction	Woody Encroachment-Invasives Removal	Prescribed Burning	Non-Woody or Seedling Invasives Control	Development	
DNR REGION 1 (NORTHWEST)								
Felton Prairie				5				
Lester Lake	Hubbard	X					X	partial funding towards sign and parking area installation & mgmt plan
Pembina Trail	Polk	X					X	culverts and repair approach/gates; mgmt plan completed for Foxboro unit
Prairie Smoke Dunes	Norman		X	1	X		X	2 culverts and gate installed; 1.1 miles of burn break; building removal-site clean up in preparation for future 1.1 ac restoration project
Santee Prairie	Mahnomen						X	gate installed
Two Rivers Aspen Parkland	Roseau				X			1.24 miles burn break; rxburn plan developed; conditions too wet to conduct burn
DNR REGION 2 (NORTHEAST)								
Chisholm Point Island	Itasca					2	X	.35 miles of exclosure repair - work by CCM
Hemlock Ravine	Carlton						X	.22 miles of exclosure reinforcement
Lost 40		X						new natural resource management plan completed
Moose Mountain	St. Louis						X	boundary brushing
Myhr Creek Ridge	Cook						X	parking lot contructed
Sugarloaf Point	Cook					2		work by CCM
DNR REGION 3 (CENTRAL)								
Boot Lake	Anoka						X	.08 miles boundary fencing completed
Falls Creek	Washington						X	site cleanup - 1 dump completed
Franconia Bluffs	Washington			1			X	2975 ft of boundary signing completed & site cleanup initiated
Harry Cater					3			
N. Fork Zumbro Woods	Goodhue						X	signing completed
Oronoco Prairie	Olmsted				X			0.42 miles burn break; not burned due to other priorities
Quarry Park	Stearns				X			1.22 miles burn break; not burned - conditions too wet then too green
Seminary Fen	Carver						X	site cleanup completed
Spring Creek Prairie				1				
St. Croix Savanna	Washington				37		X	site cleanup completed; 1.62 miles burn break
Uncas Dunes	Sherburne			X	77			assisted contractor with woody (timber) removal
Wolsfeld Woods	Hennepin					24	X	trail repair completed
Wood-Rill	Hennepin					16	X	.64 miles trail repair completed
Zumbro Falls Woods	Wabasha		11	X	11			biomass project completed; 1.14 miles burn break; RxB part of reconstruction aftercare (same acres)
DNR REGION 4 (SOUTH)								
Blue Devil Valley	Yellow Medicine			1				work by CCM
Butternut Valley Prairie	Blue Earth			12			X	signs installed
Des Moines River Prairie	Jackson				18			1.14 miles burn break; work by CCM
Holthe Prairie	Jackson			95				
Iron Horse Prairie				8	21			incl work by CCM
Lundblad Prairie	Murray				46			.83 miles burn break; incl. work by CCM
Mound Spring Prairie					X			2.29 miles burn break; not burned due to logistics issues
Prairie Coteau	Pipestone				71			incl, work by CCM
Racine Prairie	Mower			4				work by CCM
Rock Ridge	Cottonwood				33			work by CCM
Swede's Forest	Yellow Medicine-Redwood			4				
Wild Indigo Prairie	Mower			70				work by CCM
TOTAL acres			**11**	**202**	**317**	**44**		

Minnesota's Habitat Conservation Partnership

2011 – Phase VI Habitat Conservation Partnership Final Report – November 16, 2011
ML 2009, Chapter 143, Section 2, Subd. 4(e)

The mission of the Minnesota Habitat Corridors Partnership is to restore, enhance and conserve habitat corridors for the purpose of sustaining fish, wildlife and native plant communities for all generations.

This unique Partnership is funded in part by the Minnesota Legislature, as recommended by the Legislative Commission on Minnesota Resources. Funding is provided by the Environment & Natural Resources Trust Fund and the participating partners. The Partnership provides for statewide coordination of existing federal, state, and private land and water conservation programs and focuses resources on identified habitat corridors.

Partner Organizations

Ducks Unlimited ☼ Fond du Lac Reservation ☼ Leech Lake Band of Ojibwe ☼ Minnesota Board of Water and Soil Resources ☼ Minnesota Deer Hunters Association
Minnesota Department of Natural Resources ☼ Minnesota Land Trust ☼ Minnesota Valley National Wildlife Refuge Trust, Inc. ☼ National Wild Turkey Federation
Pheasants Forever ☼ Friends of the Detroit Lakes Wetland Management District☼ The Nature Conservancy ☼ Trust for Public Land ☼ U.S. Fish and Wildlife Service
U.S. Natural Resources Conservation Service

Table of Contents

Restoring Minnesota's Fish and Wildlife Habitat Corridors

A Brief History

The general concept of focusing conservation efforts in geographic areas with the greatest need and opportunity is intuitively attractive. Applying this approach to the problem of habitat fragmentation makes sense to most conservationists. It was this approach that formed the basis for the project proposal Restoring Minnesota's Fish and Wildlife Habitat Corridors submitted to LCMR in 2000. It was heralded as a fresh approach to bringing together conservation partners, differing restoration and protection strategies, and consolidated funding to a new level of coordination. Even before the project was officially approved, members of LCMR wanted to know more about where the corridors would be and what kinds of activities would be funded.

In response, a group of partners led by the Minnesota Waterfowl Association and in consult with the Citizens Advisory Committee to the LCMR was convened to identify target areas, or "corridors", to form the backbone of the proposal. The complexity of the issue became immediately apparent. The state of Minnesota is highly variable in terms of natural resources, threats to these resources, loss of the resources, potential for protection and restoration, and the agencies and nongovernmental organizations committed to sound resource management.
The first step was to apply a geographic information system to map important aspects of the existing resource base. The basic elements were forests, grasslands, water, and land use. Data layers included mapped information from state and federal agencies. Examples included: Wildlife Management Areas, RIM easements, the Minnesota Natural Heritage Database, rivers, and shallow lakes.

More information about important resources areas was gathered through regional meetings with Department of Natural Resources and U. S. Fish and Wildlife Service field staff throughout the state. The information was further refined through meetings with individual partners. The meetings with partners also served to identify information related to partner specific priorities and restrictions.

The three basic geographic concepts created through these meetings were: Spatial Corridors, Linear Corridors and Project Areas.

Project Areas: These areas were the actual areas identified for focusing projects within the LCMR proposal and work plans. Project areas included spatial and linear corridors but were modified by political, cultural, and practical considerations. While the two types of corridors were driven primarily by natural resource considerations, the project areas were driven by organization resource considerations. There were spirited discussions concerning the appropriate size and configuration of the project areas as they were identified on maps. Some partners wanted to limit the size of the areas in order to concentrate project dollars in specific areas of high priority to their organization. Others favored larger areas toallow flexibility in identification of projects for funding and completion. Meetings were held with the 14 Restoring Minnesota's Fish and Wildlife Corridors Project Partners to determine which spatial or linear corridors in the State projects will be performed for the LCMR grant. Each Project Partner selected a combination of 3 linear and/or 3 spatial corridors throughout the State where they will perform restoration & management programs, conservation easement programs, or habitat acquisition programs for the grant. Those corridors that were selected became the boundaries for the Corridor Project Areas theme. Community GIS Services then on-screen digitized the polygons.

In the end, eleven project areas were identified that sought to balance opportunities for all the partners while focusing the habitat protection and restoration efforts on key areas of Minnesota. Phase I of the Minnesota Habitat Corridors Partnership completed work within the eleven identified project areas. In Phase II & III, only minor changes were made to the some project areas. Future Phases may change the project area boundaries when justified, but it has been agreed that the total project area acreage would not increase.

Spatial corridors: Spatial corridors are broad areas that include resources of interest to the partners. An example is the headwaters of the Minnesota River valley. This area includes a relative abundance of wetlands and native prairie as well as major state and federal management areas. Meetings were held at Community GIS Services offices with resource managers from MN DNR wildlife and the Minnesota Waterfowl Association Staff. At these meetings, corridor delineations were on-screen digitized based upon the spatial corridor criteria including: 1) Clusters of shallow lakes that provide important production and migration benefits to waterfowl, 2) Concentrations of 500 acre of larger shallow lakes that provide greater security and resources , areas of historical significance to waterfowl, other migratory birds, and wetland wildlife, 3) Relationships to high density waterfowl production areas 4) Recommendations of resource managers and project partners. The associated data and spatial corridors were printed on large format paper and brought to project partner meetings and resource manager meetings with USFWS and MN DNR wildlife staff where corrections and additions were made. The spatial corridors were then clipped to project areas.

Linear Corridors: Linear corridors are relatively narrow bands of resources that generally follow distinct geologic features or river corridors and often occurred within one or more spatial corridors. An example is the riparian area along the Cannon River in southeastern Minnesota. Meetings were held at each MN DNR Regional Office throughout the state where approximately 35-40 maps with mylar overlays containing the information listed below was presented to resource managers from MN DNR wildlife, forestry and fisheries staff. At these meetings corridor delineations were made on mylar overlays that contained important habitat and protected land linkages by the resource managers. The maps and mylar overlays were brought back to the Community GIS Services offices. There, with the oversight of Corridors Partners, linear corridors were delineated either based upon ArcView Shapefile buffers of rivers/streams or by selecting groups of sections from the MN DNR Section Level Public Land Survey and creating ArcView Shapefiles. These ArcView Shapefiles of linear corridors ere merged in ArcView and clipped to the 11 project area polygons.

LCCMR FINAL REPORT
Restoring Minnesota's Fish and Wildlife Habitat Corridors - Phase 6
Habitat Conservation Partnership

Project Manager: Joe Pavelko
Affiliation: Pheasants Forever
Address: 7975 Acorn Circle
Victoria, MN 55386
Phone: 612-532-3800
Email: jpavelko@pheasantsforever.org
Website: www.mnhabitatcorridors.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4e

Appropriation Language: Minnesota Habitat Corridors Partnership - Phase 6

$3,375,000 is from the trust fund to the commissioner of natural resources for the sixth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $770,000 is for the Department of Natural Resources agency programs and $2,605,000 is for agreements as follows: $450,000 with Pheasants Forever; $50,000 with Minnesota Deer Hunters Association; $895,000 with Ducks Unlimited, Inc.; $85,000 with National Wild Turkey Federation; $365,000 with the Nature Conservancy; $210,000 with Minnesota Land Trust; $350,000 with the Trust for Public Land; $100,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; $50,000 with the United States Fish and Wildlife Service; and $50,000 with Friends of Detroit Lakes Watershed Management District to plan, restore, and acquire fragmented landscape corridors that connect areas of quality habitat to sustain fish, wildlife, and plants. The United States Department of Agriculture-Natural Resources Conservation Service is a cooperating partner in the appropriation. Expenditures are limited to the project corridor areas as defined in the work program. Land acquired with this appropriation must be sufficiently improved to meet at least minimum habitat and facility management standards as determined by the commissioner of natural resources. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

Total Project Budget

Result	Environmental Trust Allocation	Environmental Trust Funds Spent	Environmental Trust Balance	Other Funds Spent
Coordination/Mapping	$100,000	$38,277	$61,723	-
Restoration	$1,220,000	$1,158,226	$61,774	$603,700
Easement	$880,000	$880,000	$0	$4,044,853
Acquisition	$1,175,000	$897,368	$277,632	$568,517
Total	**$3,375,000**	$2,973,871	$401,129	$5,217,069

*The above table reflects Habitat Corridors Partnership expenditures by result. Please note that the expenditures for restoration, easement acquisition and fee-title acquisition reflected here will not exactly match the subtotals for those categories reflected in Table 2. Also note that the total expenditures are identical. The reason for this is that some work programs expend dollars on both acquisition and restoration. Also, some partners expend funds on both easement and fee title acquisition, depending on the wishes of the landoowner they are working with. For example, a partner working under the 4a work program to acquire a state wildlife management area (acquisition) is also responsible to ensure that the initial habitat is developed (restoration) on that acquired

Overall Work Program Summary

During the period between July 1st, 2009 and June 30th, 2011, Minnesota's Habitat Conservation Partnership (HCP) collectively expended $10,849,598 of funds to restore, enhance or protect a total of 10,350 acres of habitat and 32,957 feet of shoreline and riparian areas within the defined HCP project areas. More specifically, 5,732 acres of habitat and 16,461 feet of shoreline and riparian areas were restored, enhanced or protected with $2,973,871 of Environment and Natural Resources Trust Funds (ENRTF) that leveraged an additional $5,217,069 of other non-state funds to restore, enhance, or protect 3,896 acres of habitat and 1,415 feet of shoreline and riparian areas.

In total, partners expended $1,913,371 ($1,158,226 ENRTF) to restore/enhance a total 6,100 acres (4,874acres ENRTF). Work included 4,805 acres of grassland restoration/enhancement, 578 acres of wetland restoration/enhancement, 125 acres of woodland restoration, and 4,740 feet of shoreline restoration. Other accomplishments included 71 shallow lake surveys and designs, dam modifications, and site access/development.

Partners acquired a total of 3,463 acres (649 acres ENRTF) of perpetual conservation easements. Grassland/wetlands continued to be a priority for HCP partners working on easements, with 3,071.7 acres protected. Shoreline/riparian areas were also a priority with 13,216 feet protected. In addition, 335.6 acres of woodland was also permanently protected.

Partners permanently protected 787.6 acres in fee-title acquisition with total funding of $2,499,610 ($897,368 ENRTF and $568,517 of other non-state funds). In total, HCP partners permanently protected 600.5 acres of new WMAs, 56.3 acres of AMAs, 52.3 acres of TNC preserve, and 78.5 acres of WPAs.

For complete information, go to http://www.mnhabitatcorridors.org.

HCP Partners include: Ducks Unlimited, Friends of the Detroit Lakes Wetland Management District, MN Deer Hunters Association, MN Department of Natural Resources, MN Land Trust, MN Valley National Wildlife Refuge Trust, Inc, National Wild Turkey Federation, Pheasants Forever, The Nature Conservancy, Trust for Public Land, U.S. Fish and Wildlife Service, U.S. Natural Resources Conservation Service

Project Results Use and Dissemination

The partnership acknowledges funding from the Minnesota Environment and Natural Resources Trust Fund. Accomplishment report information, mapping products, and project information can be found at www.mnhabitatcorridors.org <http://www.mnhabitatcorridors.org>. Other forms of information can be obtained by contacting Joe Pavelko, the HCP Coordinator, at (612) 532-3800.

	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS			STATE FUNDS			PARTNERS STATE LEVERGED FUNDS			OTHER		
Activity(Results)	ENTF Allocation	ENTF Expenditure	Balance	Acres	Shoreline /Riparian (feet)	Expenditure	Acres	Shoreline /Riparian (feet)	Expenditure	Acres	Shoreline /Riparian (feet)	Expenditure	Acres	Shoreline /Riparian (feet)	Expenditure	Acres	Shoreline /Riparian (feet)
1. Project Coordination and Mapping																	
1A - Project Coordination and Mapping - Pheasants Forev - Pheasants Forever	$100,000	$38,277	$61,723	0	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0
SubTotal:	$100,000	$38,277	$61,723	0	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0
2. Restoration & Management																	
2A - Hides for Habitat - Restoration - MDHA	$50,000	$49,969	$31	35	0	$1,000	0	0	$0	0	0	$14,196	0	0	$0	0	0
2B - Partners for Wildlife - U.S. Fish & Wildlife Service	$50,000	$50,000	$0	396	0	$46,538	98	0	$0	0	0	$0	0	0	$0	0	0
2C - Shallow Lake Enhancement - Ducks Unlimited	$225,000	$225,000	$0	158	0	$299,977	295	0	$1,249	0	0	$0	0	0	$0	0	0
2D - Shallow Lake Assessment and Management - MN DNR - Division of Wildlife	$145,000	$140,689	$4,311	0	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0
2G - Wildlife Areas Management - DNR-Division of Fish & Wildlife	$50,000	$6,128	$43,872	0	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0
2H - Fisheries Habitat Restoration - MN DNR - Division of Fisheries	$100,000	$100,000	$0	367	1,460	$18,000	0	0	$51,000	287	0	$85,000	0	1,740	$0	0	0
2I - Set Out Seedlings/Bluffland Restoration - NWTF	$85,000	$74,330	$10,670	72	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0
2J - Lakescaping - MN DNR - Division of Ecological Services	$75,000	$72,458	$2,542	9	1,540	$0	0	0	$0	0	0	$0	0	0	$0	0	0
2K - Prairie Management - MN DNR - Scientific and Natural Areas Program	$75,000	$74,990	$10	679	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0
2N - Campaign for Conservation - Restoration - The Nature Conservancy	$315,000	$314,662	$338	3,118	0	$238,185	546	0	$0	0	0	$0	0	0	$0	0	0
2O - Working Lands Partnership - Friends of the Detroit Lakes Wetland Managment Dis	$50,000	$50,000	$0	40	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0
SubTotal:	$1,220,000	$1,158,226	$61,774	4,874	3,000	$603,700	939	0	$52,249	287	0	$99,196	0	1,740	$0	0	0
3. Conservation Easement Programs																	
3A - Shoreland Protection Program - Minnesota Land Trust	$210,000	$210,000	$0	508	10,389	$18,000	48	1,412	$61,120	1	150	$0	0	0	$515,000	9	1,265
3C - Shallow Lake Easements - Ducks Unlimited	$250,000	$250,000	$0	141	0	$103,532	34	0	$0	0	0	$0	0	0	$0	0	0
3D - Wetlands Reserve Program - DU and NRCS	$420,000	$420,000	$0	0	0	$3,923,321	2,721	0	$0	0	0	$0	0	0	$0	0	0
SubTotal:	$880,000	$880,000	$0	649	10,389	$4,044,853	2,804	1,412	$61,120	1	150	$0	0	0	$515,000	9	1,265

Activity(Results)	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS			STATE FUNDS			PARTNERS STATE LEVERGED FUNDS			OTHER		
	ENTF Allocation	ENTF Expenditure	Balance	Acres	Shoreline /Riparian (feet)	Expenditure	Acres	Shoreline /Riparian (feet)	Expenditure	Acres	Shoreline /Riparian (feet)	Expenditure	Acres	Shoreline /Riparian (feet)	Expenditure	Acres	Shoreline /Riparian (feet)
4. Habitat Acquisition Programs																	
4A - Critical Lands Conservation Initiative - Pheasants Forever	$350,000	$72,987	$277,013	36	0	$56,000	55	0	$0	0	0	$0	0	0	$0	0	0
4B - Fisheries Land Acquisition - MNDNR - Fisheries	$300,000	$300,000	$0	37	1,310	$0	0	0	$165,000	4	989	$0	0	0	$396,600	15	4,041
4C - Critical Lands Protection Program - The Trust for Public Land	$350,000	$350,000	$0	104	1,762	$507	0	3	$1,369,493	406	6,895	$0	0	0	$0	0	0
4F - Campaign for Conservation - The Nature Conservancy	$50,000	$50,000	$0	12	0	$235,755	40	0	$0	0	0	$0	0	0	$0	0	0
4H - MN Valley Refuge Expansion - MN Valley Trust	$100,000	$100,000	$0	21	0	$276,255	58	0	$0	0	0	$0	0	0	$0	0	0
4I - Professional Services - MNDNR - Fisheries	$25,000	$24,381	$619	0	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0
SubTotal:	$1,175,000	$897,368	$277,632	209	3,072	$568,517	153	3	$1,534,493	410	7,884	$0	0	0	$396,600	15	4,041
Grand Total:	$3,375,000	$2,973,871	$401,129	5,732	16,461	$5,217,069	3,896	1,415	$1,647,862	698	8,034	$99,196	0	1,740	$911,600	24	5,307

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Table 3 - Accomplishments by Project Area - Phase 6 **Minnesota Habitat Conservation Partnership**

	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS					STATE FUNDS					PARTNERS STATE LEVERGED FUNDS					OTHER				
Activity(Results)	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian
1 - Aspen Parklands																									
Restoration																									
2A -Hides for Habitat - Restoration	$49,969	0	0	35	0	$1,000	0	0	0	0	$0	0	0	0	0	$14,196	0	0	0	0	$0	0	0	0	0
2C -Shallow Lake Enhancement	$52,396	0	0	16	0	$80,747	0	0	6	0	$1,249	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2N -Campaign for Conservation - Restoration	$153,687	0	0	970	0	$220,217	0	0	364	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$256,052	0	0	1,022	0	$165,708	0	0	369	0	$1,249	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition																									
4C -Critical Lands Protection Program	$350,000	0	0	0	1,762	$507	0	0	0	3	$1,369,493	406	0	0	6,895	$0	0	0	0	0	$0	0	0	0	0
Acquisition Subtotal	$350,000	104	0	0	1,762	$507	0	0	0	3	$1,369,493	406	0	0	6,895	$0	0	0	0	0	$0	0	0	0	0
1 - Aspen Parklands Subtotal	$606,052	104	0	1,022	3,524	$166,215	0	0	369	5	$1,370,742	406	0	1,022	13,790	$0	406	0	0	0	$0	0	0	0	0
2 - Mississippi Headwaters																									
Restoration																									
2H -Fisheries Habitat Restoration	$3,416	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$3,416	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement																									
3C -Shallow Lake Easements	$92,757	0	79	0	0	$70,322	0	20	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement Subtotal	$92,757	0	79	0	0	$26,257	0	20	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition																									
4B -Fisheries Land Acquisition	$81,216	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition Subtotal	$81,216	6	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2 - Mississippi Headwaters Subtotal	$177,389	6	79	0	3,524	$26,257	0	20	0	0	$0	0	79	0	0	$0	0	0	0	0	$0	0	0	0	0

	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS					STATE FUNDS					PARTNERS STATE LEVERGED FUNDS					OTHER				
Activity(Results)	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian
3 - Border Prairie																									
Restoration																									
2J -Lakescaping	$41,544	0	0	5	840	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2K -Prairie Management	$30,970	0	0	511	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2N -Campaign for Conservation - Restoration	$86,610	0	0	1,932	0	$110,493	0	0	159	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$159,124	0	0	2,448	840	$7,115	0	0	159	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement																									
3D -Wetlands Reserve Program	$0	0	0	0	0	$1,452,736	0	1,295	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement Subtotal	$0	0	0	0	0	$1,398,341	0	1,295	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition																									
4B -Fisheries Land Acquisition	$209,797	0	0	0	1,310	$0	0	0	0	0	$165,000	4	0	0	989	$0	0	0	0	0	$349,000	9	0	0	2,091
Acquisition Subtotal	$209,797	30	0	0	1,310	$0	0	0	0	0	$165,000	4	0	0	989	$0	9	0	0	0	$349,000	9	0	0	2,091
3 - Border Prairie Subtotal	$368,921	30	0	2,448	5,674	$1,405,456	0	1,295	159	0	$165,000	4	0	2,448	989	$0	4	0	0	0	$349,000	9	0	0	2,091
4 - Central Lakes																									
Restoration																									
2J -Lakescaping	$20,914	0	0	3	300	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$20,914	0	0	3	300	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement																									
3A -Shoreland Protection Program	$15,000	0	171	0	169	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement Subtotal	$15,000	0	171	0	169	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition																									
4B -Fisheries Land Acquisition	$46	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition Subtotal	$46	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
4 - Central Lakes Subtotal	$35,960	0	171	3	3,993	$0	0	0	0	0	$0	0	171	3	0	$0	0	0	0	0	$0	0	0	0	0

	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS					STATE FUNDS					PARTNERS STATE LEVERGED FUNDS					OTHER				
Activity(Results)	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian
5 - Lower St. Louis River																									
Restoration																									
2N -Campaign for Conservation - Restoration	$27,174	0	0	114	0	$103,378	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$27,174	0	0	114	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement																									
3A -Shoreland Protection Program	$108,780	0	289	0	7,058	$18,000	0	48	0	1,412	$61,120	0	1	0	150	$0	0	0	0	0	$515,000	0	9	0	1,265
Easement Subtotal	$108,780	0	289	0	7,058	$18,000	0	48	0	1,412	$61,120	0	1	0	150	$0	0	0	0	0	$515,000	0	9	0	1,265
Acquisition																									
4B -Fisheries Land Acquisition	$1,627	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition Subtotal	$1,627	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
5 - Lower St. Louis River Subtotal	$137,581	0	289	114	3,718	$18,000	0	48	0	0	$61,120	0	289	114	150	$0	0	0	0	0	$515,000	0	9	0	1,265
6 - Upper Minnesota River																									
Easement																									
3D -Wetlands Reserve Program	$0	0	0	0	0	$436,404	0	217	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement Subtotal	$0	0	0	0	0	$382,009	0	217	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition																									
4A -Critical Lands Conservation Initiative	$69,370	0	0	0	0	$56,000	55	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
4B -Fisheries Land Acquisition	$3,915	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition Subtotal	$73,285	36	0	0	0	$56,000	55	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
6 - Upper Minnesota River Subtotal	$73,285	36	0	0	3,524	$438,009	55	217	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
7 - Alexandria Moraine																									
Restoration																									
2J -Lakescaping	$10,000	0	0	1	400	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$10,000	0	0	1	400	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement																									
3D -Wetlands Reserve Program	$0	0	0	0	0	$1,411,181	0	877	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement Subtotal	$0	0	0	0	0	$1,356,786	0	877	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
7 - Alexandria Moraine Subtotal	$10,000	0	0	1	3,924	$1,356,786	0	877	0	0	$0	0	0	1	0	$0	0	0	0	0	$0	0	0	0	0

	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS					STATE FUNDS					PARTNERS STATE LEVERGED FUNDS					OTHER				
Activity(Results)	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian
9 - Des Moines River Valley																									
Restoration																									
2C -Shallow Lake Enhancement	$110,001	0	0	104	0	$65,029	0	0	17	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2I -Set Out Seedlings/Bluffland Restoration	$5,170	0	0	11	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2K -Prairie Management	$22,560	0	0	84	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$137,731	0	0	199	0	$33,151	0	0	17	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
9 - Des Moines River Valley Subtotal	$137,731	0	0	199	3,524	$33,151	0	0	17	0	$0	0	0	199	0	$0	0	0	0	0	$0	0	0	0	0
10 - Southern Lakes																									
Restoration																									
2C -Shallow Lake Enhancement	$10,000	0	0	38	0	$188,932	0	0	272	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2H -Fisheries Habitat Restoration	$25,305	0	0	367	0	$0	0	0	0	0	$51,000	0	0	287	0	$0	0	0	0	0	$0	0	0	0	0
2K -Prairie Management	$8,550	0	0	43	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$43,855	0	0	448	0	$157,054	0	0	272	0	$51,000	0	0	287	0	$0	0	0	0	0	$0	0	0	0	0
Easement																									
3A -Shoreland Protection Program	$15,000	0	48	0	3,162	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
3D -Wetlands Reserve Program	$0	0	0	0	0	$786,186	0	333	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement Subtotal	$15,000	0	48	0	3,162	$731,791	0	333	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition																									
4H -MN Valley Refuge Expansion	$100,000	0	0	0	0	$276,255	58	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition Subtotal	$100,000	21	0	0	0	$276,255	58	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
10 - Southern Lakes Subtotal	$158,855	21	48	448	6,686	$1,165,100	58	333	272	0	$51,000	0	48	448	0	$0	0	0	0	0	$0	0	0	0	0

	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS					STATE FUNDS					PARTNERS STATE LEVERGED FUNDS					OTHER				
Activity(Results)	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian
11 - Mississippi Bluff Lands																									
Restoration																									
2H -Fisheries Habitat Restoration	$71,279	0	0	0	1,460	$18,000	0	0	0	0	$0	0	0	0	0	$85,000	0	0	0	1,740	$0	0	0	0	0
2I -Set Out Seedlings/Bluffland Restoration	$60,260	0	0	61	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2K -Prairie Management	$12,910	0	0	41	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2N -Campaign for Conservation - Restoration	$47,191	0	0	102	0	$114,231	0	0	23	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$191,639	0	0	203	1,460	$28,853	0	0	23	0	$0	0	0	0	0	$85,000	0	0	0	1,740	$0	0	0	0	0
Acquisition																									
4B -Fisheries Land Acquisition	$3,399	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$47,600	7	0	0	1,950
4F -Campaign for Conservation	$50,000	0	0	0	0	$235,755	40	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Acquisition Subtotal	$53,399	12	0	0	0	$235,755	40	0	0	0	$0	0	0	0	0	$0	7	0	0	0	$47,600	7	0	0	1,950
11 - Mississippi Bluff Lands Subtotal	$245,039	12	0	203	4,984	$264,607	40	0	23	0	$0	0	0	203	0	$85,000	0	0	0	1,740	$47,600	7	0	0	3,900
3-7-8 - Border Prairie Transition Zon																									
Restoration																									
2B -Partners for Wildlife	$50,000	0	0	396	0	$46,538	0	0	98	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2C -Shallow Lake Enhancement	$22,183	0	0	0	0	$60,903	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2O -Working Lands Partnership	$50,000	0	0	40	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration Subtotal	$122,183	0	0	436	0	$75,563	0	0	98	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement																									
3C -Shallow Lake Easements	$118,793	0	62	0	0	$77,275	0	14	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Easement Subtotal	$118,793	0	62	0	0	$33,210	0	14	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
3-7-8 - Border Prairie Transition Zone Subtotal	$240,976	0	62	436	3,524	$108,773	0	14	98	0	$0	0	62	436	0	$0	0	0	0	0	$0	0	0	0	0

	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS					STATE FUNDS					PARTNERS STATE LEVERGED FUNDS					OTHER				
Activity(Results)	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian
Expenditures not Attributable to Specific Projects	$786,393	-	-	-	-	$234,716	-	-	-	-	$0	-	-	-	-	$14,196	-	-	-	-	$0	-	-	-	-
Grand Total:	$2,978,182	209	649	4,874	16,461	$5,217,069	153	2,804	939	1,415	$1,647,862	410	1	287	8,034	$99,196	0	0	0	1,740	$911,600	15	9	0	

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS					OTHER FUNDS					STATE FUNDS					PARTNERS STATE LEVERGED FUNDS					OTHER				
Activity(Results)	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	Expenditure	Acq. Acres	Easement Acres	Rest. Acres	Shoreline/ Riparian	Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian
Project Coordination/Mapping																									
1A -Project Coordination and Mapping - Pheasants Forev	$38,277	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
SubTotal:	$38,277	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
Restoration																									
2A -Hides for Habitat - Restoration	$49,969	0	0	35	0	$1,000	0	0	0	0	$0	0	0	0	0	$14,196	0	0	0	0	$0	0	0	0	0
2B -Partners for Wildlife	$50,000	0	0	396	0	$46,538	0	0	98	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2C -Shallow Lake Enhancement	$225,000	0	0	158	0	$299,977	0	0	295	0	$1,249	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2D -Shallow Lake Assessment and Management	$145,000	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2G -Wildlife Areas Management	$6,128	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2H -Fisheries Habitat Restoration	$100,000	0	0	367	1,460	$18,000	0	0	0	0	$51,000	0	0	287	0	$85,000	0	0	0	1,740	$0	0	0	0	0
2I -Set Out Seedlings/Bluffland Restoration	$74,330	0	0	72	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2J -Lakescaping	$72,458	0	0	9	1,540	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2K -Prairie Management	$74,990	0	0	679	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2N -Campaign for Conservation - Restoration	$314,662	0	0	3,118	0	$238,185	0	0	546	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
2O -Working Lands Partnership	$50,000	0	0	40	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
SubTotal:	1,162,537	0	0	4,874	3,000	$603,700	0	0	939	0	$52,249	0	0	287	0	$99,196	0	0	0	1,740	$0	0	0	0	0
Easement																									
3A -Shoreland Protection Program	$210,000	0	508	0	10,389	$18,000	0	48	0	1,412	$61,120	0	1	0	150	$0	0	0	0	0	$515,000	0	9	0	1,265
3C -Shallow Lake Easements	$250,000	0	141	0	0	$103,532	0	34	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
3D -Wetlands Reserve Program	$420,000	0	0	0	0	$3,923,321	0	2,721	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
SubTotal:	$880,000	0	649	0	10,389	$4,044,853	0	2,804	0	1,412	$61,120	0	1	0	150	$0	0	0	0	0	$515,000	0	9	0	1,265
Acquisition																									
4A -Critical Lands Conservation Initiative	$72,987	36	0	0	0	$56,000	55	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
4B -Fisheries Land Acquisition	$300,000	37	0	0	1,310	$0	0	0	0	0	$165,000	4	0	0	989	$0	0	0	0	0	$396,600	15	0	0	4,041
4C -Critical Lands Protection Program	$350,000	104	0	0	1,762	$507	0	0	0	3	$1,369,493	406	0	0	6,895	$0	0	0	0	0	$0	0	0	0	0
4F -Campaign for Conservation	$50,000	12	0	0	0	$235,755	40	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
4H -MN Valley Refuge Expansion	$100,000	21	0	0	0	$276,255	58	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
4I -Professional Services	$24,381	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0	$0	0	0	0	0
SubTotal:	$897,368	209	0	0	3,072	$568,517	153	0	0	3	$1,534,493	410	0	0	7,884	$0	15	0	0	0	$396,600	15	0	0	4,041

Activity(Results)	ENVIRONMENTAL AND NATURAL RESOURCES TRUST FUNDS Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	OTHER FUNDS Expenditure	Acquisition Acres	Ease ment Acres	Restoration Acres	Shoreline/ Riparian	STATE FUNDS Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian	PARTNERS STATE LEVERGED FUNDS Expenditure	Acq. Acres	Easement Acres	Rest. Acres	Shoreline/ Riparian	OTHER Expenditure	Acquisition Acres	Easement Acres	Restoration Acres	Shoreline/ Riparian
Grand Total:	2,978,182	209	649	4,874	16,461	$5,217,069	153	2,804	939	1,415	$1,647,862	410	1	287	8,034	$99,196	0	0	0	1,740	$911,600	15	9	0	6,572

*Table 4 reflects Habitat Conservation Partnership expenditures by result. Please note that the expenditures for restoration, easement acquisition and fee-title acquisition reflected here will not exactly match the subtotals for those categories reflected in Table 2. Also note that the total expenditures are identical. The reason for this is that some work programs expend dollars on both acquisition and restoration. For example, a partner working under the 4a work program to acquire a state wildlife management area (acquisition) is also responsible to ensure that the initial habitat is developed (restoration) on that acquired parcel.

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Other:	Any other expenditures (e.g. grant income funds)

Restoration Expenditures and Accomplishments by Funding Type, Activity, Land Type, and Owner

Minnesota's Habitat Conservation Partnership - Phase 6

The table below reflects expenditures attributable to specific restoration projects. Please note that the expenditures here will not match the subtotals for those categories reflected in Table 2 and Table 4. Also note that the total accomplishments(acres and shoreline) are identical. The reason for this is that some work programs expend dollars not attributable to a specific projects. For example Ducks Unlimited expends funds on technical assistance by DU biologists to DNR, US Fish & Wildlife Service, local units of goverment, and private landowners regarding shallow lake assesment, improvment, and managment. These personal expenditures are not reflected in the table below.

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Other:	Any other expenditures (e.g. grant income funds)

			ENTF			Other Funds			Partners State Leveraged Funds			State Funds			Total		
			Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline
Dam Modification	Public	Lake	$28,721	367	0	$0	0	0	$0	0	0	$51,000	287	0	$79,721	654	0
		Total	**$28,721**	**367**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$51,000**	**287**	**0**	**$79,721**	**654**	**0**
	Total		**$28,721**	**367**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$51,000**	**287**	**0**	**$79,721**	**654**	**0**
Grassland Enhancement	Private	Land	$97,620	479	0	$21,310	63	0	$0	0	0	$0	0	0	$118,930	542	0
		Total	**$97,620**	**479**	**0**	**$21,310**	**63**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$118,930**	**542**	**0**
	Public	SNA	$40,655	363	0	$0	0	0	$0	0	0	$0	0	0	$40,655	363	0
		WPA	$99,969	75	0	$0	0	0	$0	0	0	$0	0	0	$99,969	75	0
		Total	**$140,624**	**438**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$140,624**	**438**	**0**
	Total		**$238,244**	**917**	**0**	**$21,310**	**63**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$259,554**	**980**	**0**
Grassland Restoration	Private	Lake	$6,597	52	0	$228	2	0	$0	0	0	$0	0	0	$6,825	54	0
		Land	$300,116	3,192	0	$134,807	546	0	$0	0	0	$0	0	0	$434,922	3,738	0

Restoration Expenditures and Accomplishments by Funding Type, Activity, Land Type, and Owner

Minnesota's Habitat Conservation Partnership - Phase 6

The table below reflects expenditures attributable to specific restoration projects. Please note that the expenditures here will not match the subtotals for those categories reflected in Table 2 and Table 4. Also note that the total accomplishments(acres and shoreline) are identical. The reason for this is that some work programs expend dollars not attributable to a specific projects. For example Ducks Unlimited expends funds on technical assistance by DU biologists to DNR, US Fish & Wildlife Service, local units of goverment, and private landowners regarding shallow lake assesment, improvment, and managment. These personal expenditures are not reflected in the table below.

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Other:	Any other expenditures (e.g. grant income funds)

			ENTF			Other Funds			Partners State Leveraged Funds			State Funds			Total		
			Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline
Grassland Restoration	Private	**Total**	**$306,713**	**3,244**	**0**	**$135,035**	**547**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$441,747**	**3,792**	**0**
	Public	SNA	$2,750	3	0	$0	0	0	$0	0	0	$0	0	0	$2,750	3	0
		WMA	$10,000	30	0	$0	0	0	$0	0	0	$0	0	0	$10,000	30	0
		Total	**$12,750**	**33**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$12,750**	**33**	**0**
	Total		**$319,463**	**3,277**	**0**	**$135,035**	**547**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$454,497**	**3,825**	**0**
Shallow Lake Survey / Design / Wetland	Public	Lake	$10,316	0	0	$10,538	0	0	$0	0	0	$1,249	0	0	$22,103	0	0
		WMA	$16,526	0	0	$17,824	0	0	$0	0	0	$0	0	0	$34,350	0	0
		WPA	$33,263	0	0	$40,109	0	0	$0	0	0	$0	0	0	$73,372	0	0
		Total	**$60,105**	**0**	**0**	**$68,471**	**0**	**0**	**$0**	**0**	**0**	**$1,249**	**0**	**0**	**$129,825**	**0**	**0**
	Total		**$60,105**	**0**	**0**	**$68,471**	**0**	**0**	**$0**	**0**	**0**	**$1,249**	**0**	**0**	**$129,825**	**0**	**0**
Shoreline	Private	Lake	$72,458	9	1,540	$0	0	0	$0	0	0	$0	0	0	$72,458	9	1,540

Restoration Expenditures and Accomplishments by Funding Type, Activity, Land Type, and Owner

Minnesota's Habitat Conservation Partnership - Phase 6

The table below reflects expenditures attributable to specific restoration projects. Please note that the expenditures here will not match the subtotals for those categories reflected in Table 2 and Table 4. Also note that the total accomplishments(acres and shoreline) are identical. The reason for this is that some work programs expend dollars not attributable to a specific projects. For example Ducks Unlimited expends funds on technical assistance by DU biologists to DNR, US Fish & Wildlife Service, local units of goverment, and private landowners regarding shallow lake assesment, improvment, and managment. These personal expenditures are not reflected in the table below.

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Other:	Any other expenditures (e.g. grant income funds)

			ENTF			Other Funds			Partners State Leveraged Funds			State Funds			Total		
			Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline
Shoreline Habitat Restoration / Stabilization	Private	**Total**	**$72,458**	**9**	**1,540**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$72,458**	**9**	**1,540**
	Public	River	$71,279	0	1,460	$18,000	0	0	$85,000	0	1,740	$0	0	0	$174,279	0	3,200
		Total	**$71,279**	**0**	**1,460**	**$18,000**	**0**	**0**	**$85,000**	**0**	**1,740**	**$0**	**0**	**0**	**$174,279**	**0**	**3,200**
	Total		**$143,737**	**9**	**3,000**	**$18,000**	**0**	**0**	**$85,000**	**0**	**1,740**	**$0**	**0**	**0**	**$246,737**	**9**	**4,740**
Wetland Enhancement	Public	Lake	$10,000	38	0	$157,054	272	0	$0	0	0	$0	0	0	$167,054	310	0
		NWR	$98,655	104	0	$21,171	17	0	$0	0	0	$0	0	0	$119,826	121	0
		WPA	$25,820	16	0	$21,403	6	0	$0	0	0	$0	0	0	$47,223	22	0
		Total	**$134,475**	**158**	**0**	**$199,628**	**295**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$334,103**	**453**	**0**
	Total		**$134,475**	**158**	**0**	**$199,628**	**295**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$334,103**	**453**	**0**
Wetland Restoration	Private	Land	$15,000	20	0	$25,000	34	0	$0	0	0	$0	0	0	$40,000	54	0
		Total	**$15,000**	**20**	**0**	**$25,000**	**34**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$40,000**	**54**	**0**

Restoration Expenditures and Accomplishments by Funding Type, Activity, Land Type, and Owner

Minnesota's Habitat Conservation Partnership - Phase 6

The table below reflects expenditures attributable to specific restoration projects. Please note that the expenditures here will not match the subtotals for those categories reflected in Table 2 and Table 4. Also note that the total accomplishments(acres and shoreline) are identical. The reason for this is that some work programs expend dollars not attributable to a specific projects. For example Ducks Unlimited expends funds on technical assistance by DU biologists to DNR, US Fish & Wildlife Service, local units of goverment, and private landowners regarding shallow lake assesment, improvment, and managment. These personal expenditures are not reflected in the table below.

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Other:	Any other expenditures (e.g. grant income funds)

			ENTF			Other Funds			Partners State Leveraged Funds			State Funds			Total		
			Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline	Expenditures	Acres	Shoreline
Wetland	**Total**		**$15,000**	**20**	**0**	**$25,000**	**34**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$40,000**	**54**	**0**
Woodland Restoration	Public	State	$27,174	114	0	$0	0	0	$0	0	0	$0	0	0	$27,174	114	0
		WMA	$5,170	11	0	$0	0	0	$0	0	0	$0	0	0	$5,170	11	0
		Total	**$32,344**	**125**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$32,344**	**125**	**0**
	Total		**$32,344**	**125**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$0**	**0**	**0**	**$32,344**	**125**	**0**
Total			**$972,089**	**4,873**	**3,000**	**$467,444**	**939**	**0**	**$85,000**	**0**	**1,740**	**$52,249**	**287**	**0**	**$1,576,781**	**6,099**	**4,740**

Easement Expenditures and Accomplishments by Funding Type and Easement Holder

Minnesota's Habitat Conservation Partnership - Phase 6

The table below reflects expenditures attributable to specific easement projects. Please note that the expenditures here may not match the subtotals for those categories reflected in Table 2 and Table 4. Also note that the total accomplishments(acres and shoreline) are identical. The reason for this is that some work programs expend dollars not attributable to a specific project or a project that was not completed. For example Pheasants Forever expended funds on a appraisal fee for the desired acquisition of Hands Marsh WMA in which the offer was made and rejected by the potential seller. Therefore, this expenditure is not reflected in the table below.

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Other:	Any other expenditures (e.g. grant income funds)

		ENTF	Other Funds	State Funds	Other	Total
Ducks Unlimited	Expenditures	$211,550	$59,467	$0	$0	$271,017
	Shoreline	0.0	0.0	0.0	0.0	0.0
	Riparian	0.0	0.0	0.0	0.0	0.0
	Grassland Acres	57.0	13.0	0.0	0.0	70.0
	Woodland Acres	25.2	6.5	0.0	0.0	31.6
	Wetland Acres	58.4	14.9	0.0	0.0	73.2
	Acres	140.5	34.4	0.0	0.0	174.9
Minnesota Land Trust	Expenditures	$138,780	$18,000	$61,120	$515,000	$732,900
	Shoreline	3,524.0	0.0	150.0	1,265.0	4,940.0
	Riparian	6,865.0	1,412.0	0.0	0.0	8,276.7
	Grassland Acres	29.0	0.0	0.0	0.3	29.3
	Woodland Acres	254.3	40.9	0.9	7.9	304.0
	Wetland Acres	171.5	6.5	0.0	0.0	178.0
	Acres	508.3	48.0	1.0	8.6	566.0
USDA - Natural Resource Conservation Service	Expenditures	$0	$3,868,926	$0	$0	$3,868,926
	Shoreline	0.0	0.0	0.0	0.0	0.0
	Riparian	0.0	0.0	0.0	0.0	0.0
	Grassland Acres	0.0	1,690.1	0.0	0.0	1,690.1
	Woodland Acres	0.0	0.0	0.0	0.0	0.0
	Wetland Acres	0.0	1,031.1	0.0	0.0	1,031.1
	Acres	0.0	2,721.2	0.0	0.0	2,721.2

Easement Expenditures and Accomplishments by Funding Type and Easement Holder

Minnesota's Habitat Conservation Partnership - Phase 6

The table below reflects expenditures attributable to specific easement projects. Please note that the expenditures here may not match the subtotals for those categories reflected in Table 2 and Table 4. Also note that the total accomplishments(acres and shoreline) are identical. The reason for this is that some work programs expend dollars not attributable to a specific project or a project that was not completed. For example Pheasants Forever expended funds on a appraisal fee for the desired acquisition of Hands Marsh WMA in which the offer was made and rejected by the potential seller. Therefore, this expenditure is not reflected in the table below.

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Other:	Any other expenditures (e.g. grant income funds)

		ENTF	Other Funds	State Funds	Other	Total
Total	Expenditures	$350,330	$3,946,393	$61,120	$515,000	$4,872,843
	Shoreline	3,524.4	0.0	150.1	1,265.2	4,939.7
	Riparian	6,864.7	1,412.0	0.0	0.0	8,276.7
	Grassland Acres	86.0	1,703.1	0.0	0.3	1,789.4
	Woodland Acres	279.5	47.4	0.9	7.9	335.6
	Wetland Acres	229.8	1,052.5	0.0	0.0	1,282.3
	Acres	648.8	2,803.6	1.0	8.6	3,462.1

Acquisition Expenditures and Accomplishments by Funding Type and Acquisition Holder

Minnesota's Habitat Conservation Partnership - Phase 6

The table below reflects expenditures attributable to acquisition projects. Please note that the expenditures here will not match the subtotals for those categories reflected in Table 2 and Table 4. Also note that the total accomplishments(acres and shoreline) are identical. The reason for this is that some work programs expend dollars not attributable to a specific project. For example the Minnesota Land Trust works on a large number of potential conservation projects and because many projects initiated or worked on under the grant are not actually completed in this phase of the project, the Land Trust does not allocate salaries to specific conservation easement projects. Therefore, salaries and benefits for staff working on contacing lanowners, negotiating conservation easements and completing all aspects of easement projects are not

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Partners State Levereged Funds:	Non state funds that have leveraged state funds as part of an HCP project (not eligible for use as other funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

		ENTF	Other	Other Funds	State Funds	Total
DNR-AMA	Expenditures	$300,000	$396,600	$0	$165,000	$861,600
	Shoreline	1,309.6	2,091.5	0.0	988.6	4,389.7
	Riparian	0.0	1,950.0	0.0	0.0	1,950.0
	Grassland Acres	20.0	2.0	0.0	0.0	22.0
	Woodland Acres	9.0	13.0	0.0	4.0	26.4
	Wetland Acres	7.6	1.3	0.0	0.2	9.0
	Acres	36.7	15.5	0.0	4.1	56.3
DNR-WMA	Expenditures	$419,370	$0	$56,507	$1,369,493	$1,845,370
	Shoreline	0.0	0.0	0.0	0.0	0.0
	Riparian	1,761.0	0.0	2.0	6,895.0	8,658.3
	Grassland Acres	70.0	0.0	23.0	175.0	268.1
	Woodland Acres	8.0	0.0	0.0	32.0	40.0
	Wetland Acres	51.0	0.0	32.2	159.2	242.4
	Acres	139.3	0.0	55.2	406.1	600.5
TNC-Preserve	Expenditures	$50,000	$0	$235,755	$0	$285,755
	Shoreline	0.0	0.0	0.0	0.0	0.0
	Riparian	0.0	0.0	0.0	0.0	0.0
	Grassland Acres	12.0	0.0	40.0	0.0	52.3
	Woodland Acres	0.0	0.0	0.0	0.0	0.0
	Wetland Acres	0.0	0.0	0.0	0.0	0.0
	Acres	12.0	0.0	40.3	0.0	52.3

Acquisition Expenditures and Accomplishments by Funding Type and Acquisition Holder

Minnesota's Habitat Conservation Partnership - Phase 6

The table below reflects expenditures attributable to acquisition projects. Please note that the expenditures here will not match the subtotals for those categories reflected in Table 2 and Table 4. Also note that the total accomplishments(acres and shoreline) are identical. The reason for this is that some work programs expend dollars not attributable to a specific project. For example the Minnesota Land Trust works on a large number of potential conservation projects and because many projects initiated or worked on under the grant are not actually completed in this phase of the project, the Land Trust does not allocate salaries to specific conservation easement projects. Therefore, salaries and benefits for staff working on contacing lanowners, negotiating conservation easements and completing all aspects of easement projects are not

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (If partner funds are leveraging state funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as other funds commitment)
Partners State Levereged Funds:	Non state funds that have leveraged state funds as part of an HCP project (not eligible for use as other funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

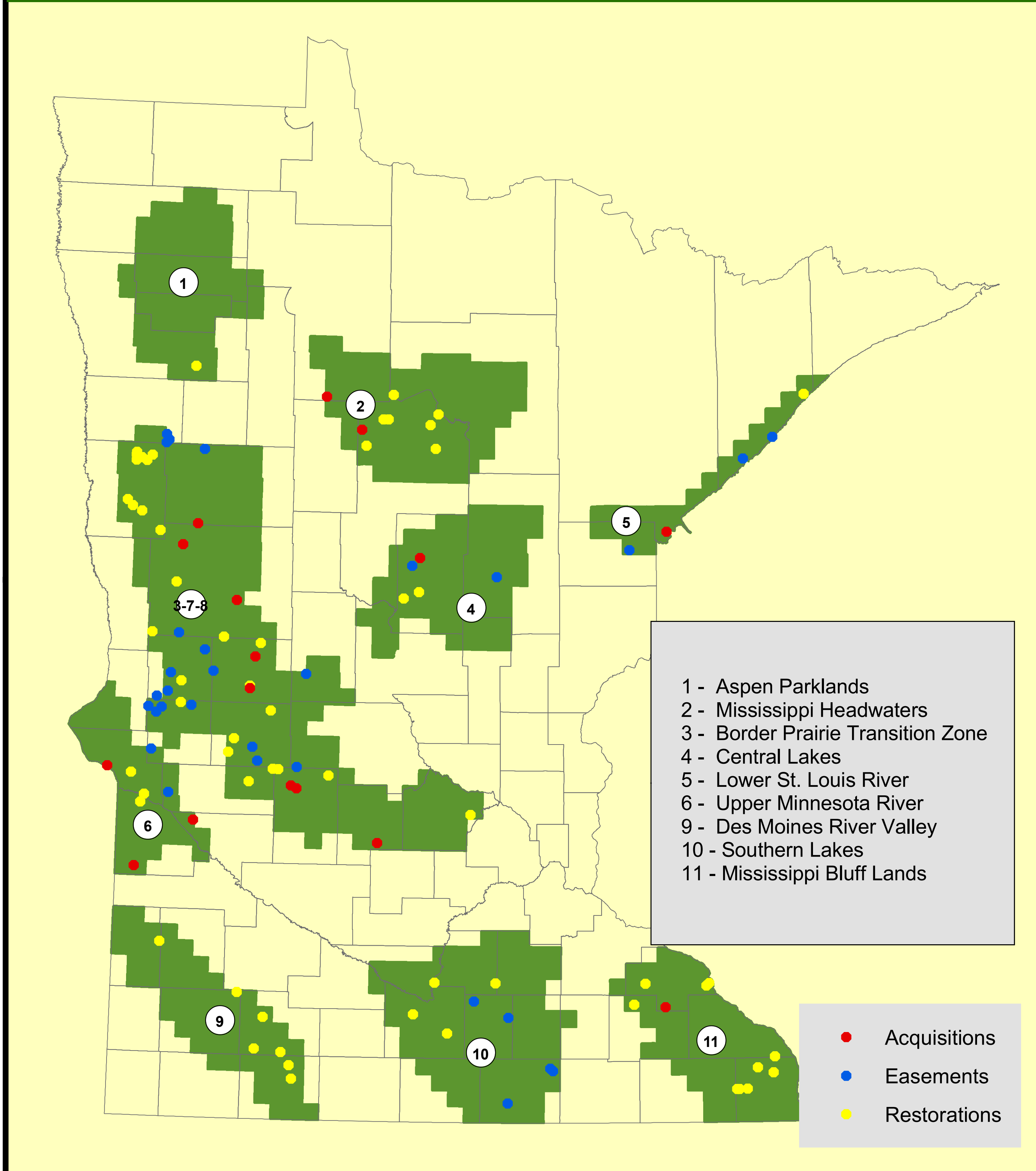
		ENTF	Other	Other Funds	State Funds	Total
USFWS-WPA	Expenditures	$100,000	$0	$276,255	$0	$376,255
	Shoreline	0.0	0.0	0.0	0.0	0.0
	Riparian	0.0	0.0	0.0	0.0	0.0
	Grassland Acres	17.0	0.0	47.0	0.0	63.5
	Woodland Acres	0.0	0.0	0.0	0.0	0.0
	Wetland Acres	4.0	0.0	11.0	0.0	15.0
	Acres	20.9	0.0	57.6	0.0	78.5
Total	Expenditures	$869,370	$396,600	$568,517	$1,534,493	$3,368,980
	Shoreline	1,309.6	2,091.5	0.0	988.6	4,389.7
	Riparian	1,761.4	1,950.0	1.7	6,895.1	10,608.3
	Grassland Acres	118.8	2.0	109.9	175.2	405.9
	Woodland Acres	17.3	13.3	0.0	35.8	66.3
	Wetland Acres	62.6	1.3	43.2	159.4	266.5
	Acres	208.9	15.5	153.1	410.1	787.6

	ENTF			Other Funds		
	FundingAmoun	ProRatedAcres	ProRatedShorel	FundingAmoun	ProRatedAcres	ProRatedShorel
2A	**$49,969.00**	**35.00**	**0.00**	**$0.00**	**0.00**	**0.00**
2B	**$50,000.00**	**395.61**	**0.00**	**$46,537.84**	**98.37**	**0.00**
2C	**$194,580.00**	**157.64**	**0.00**	**$268,099.00**	**295.32**	**0.00**
2H	**$100,000.00**	**367.40**	**1,459.52**	**$18,000.00**	**0.00**	**0.00**
2I	**$65,429.73**	**71.75**	**0.00**	**$0.00**	**0.00**	**0.00**
2J	**$72,458.00**	**9.00**	**1,540.00**	**$0.00**	**0.00**	**0.00**
2K	**$74,990.00**	**679.00**	**0.00**	**$0.00**	**0.00**	**0.00**
2N	**$314,661.92**	**3,118.09**	**0.00**	**$134,806.89**	**545.56**	**0.00**
2O	**$50,000.00**	**40.00**	**0.00**	**$0.00**	**0.00**	**0.00**
Total	**$972,088.65**	**4,873.48**	**2,999.52**	**$467,443.73**	**939.26**	**0.00**

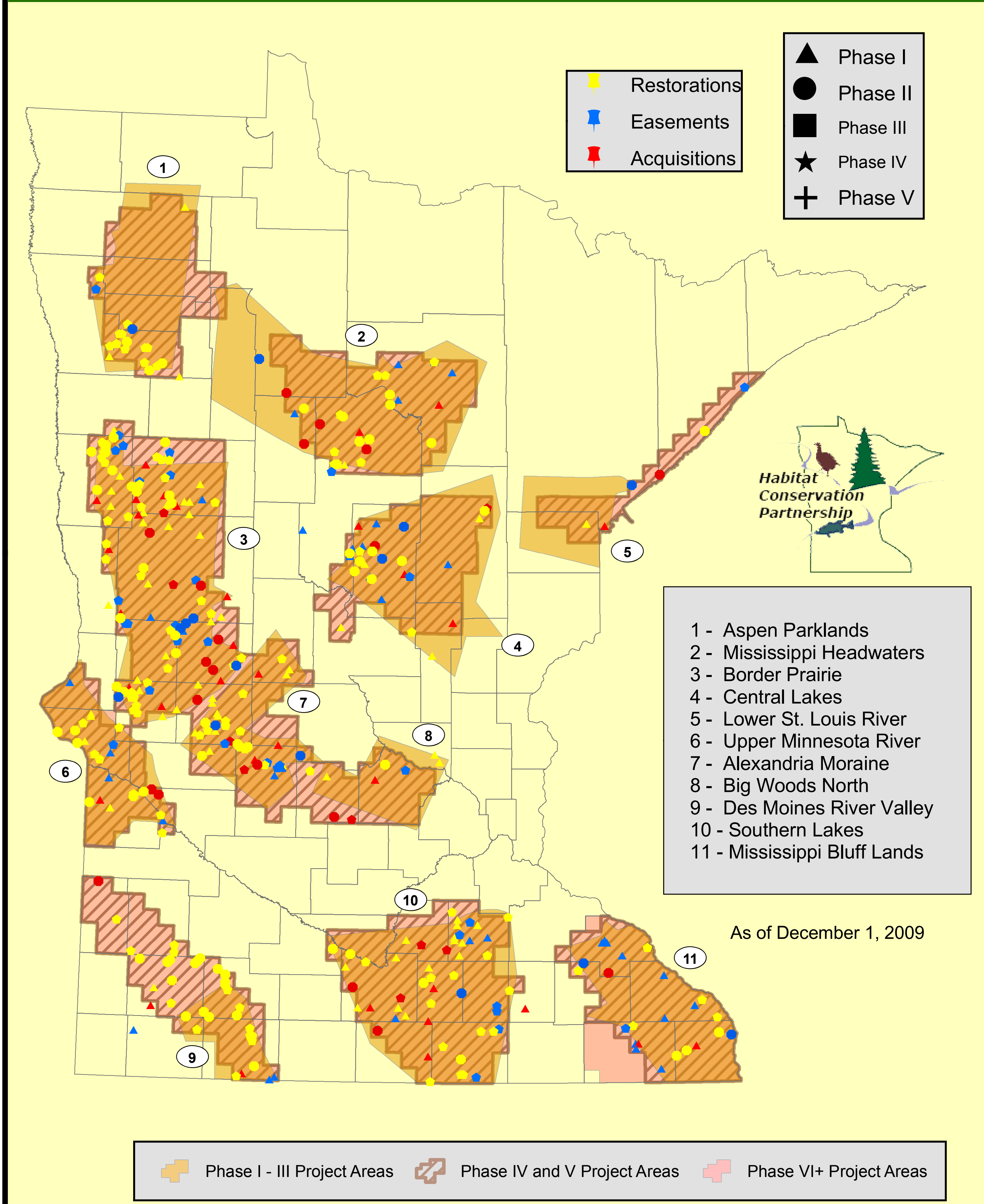
Partners State Leveraged Funds			State Funds		
FundingAmoun	ProRatedAcres	ProRatedShorel	FundingAmoun	ProRatedAcres	ProRatedShorel
$0.00	**0.00**	**0.00**	**$0.00**	**0.00**	**0.00**
$0.00	**0.00**	**0.00**	**$0.00**	**0.00**	**0.00**
$0.00	**0.00**	**0.00**	**$1,249.00**	**0.00**	**0.00**
$85,000.00	**0.00**	**1,740.16**	**$51,000.00**	**286.56**	**0.00**
$0.00	**0.00**	**0.00**	**$0.00**	**0.00**	**0.00**
$0.00	**0.00**	**0.00**	**$0.00**	**0.00**	**0.00**
$0.00	**0.00**	**0.00**	**$0.00**	**0.00**	**0.00**
$0.00	**0.00**	**0.00**	**$0.00**	**0.00**	**0.00**
$0.00	**0.00**	**0.00**	**$0.00**	**0.00**	**0.00**
$85,000.00	**0.00**	**1,740.16**	**$52,249.00**	**286.56**	**0.00**

Total		
FundingAmoun	ProRatedAcres	ProRatedShorel
$49,969.00	**35.00**	**0.00**
$96,537.84	**493.98**	**0.00**
$463,928.00	**452.95**	**0.00**
$254,000.00	**653.96**	**3,199.68**
$65,429.73	**71.75**	**0.00**
$72,458.00	**9.00**	**1,540.00**
$74,990.00	**679.00**	**0.00**
$449,468.81	**3,663.65**	**0.00**
$50,000.00	**40.00**	**0.00**
$1,576,781.38	**6,099.30**	**4,739.68**

Habitat Conservation Partnership
Phase VI Accomplishments
Restoring Minnesota' Fish and Wildlife Habitat Corridors



Habitat Conservation Partnership
Accomplishments
Restoring Minnesota' Fish and Wildlife Habitat Corridors



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: HCP - Project Coordination, Mapping & Data Management (1a)
PROJECT MANAGER: Joe Pavelko
AFFILIATION: Pheasants Forever, Inc.
MAILING ADDRESS: 7975 Acorn Circle
CITY/STATE/ZIP: Victoria, MN 55386
PHONE: 612-532-3800
E-MAIL: jpavelko@pheasantsforever.org
WEBSITE: www.pheasantsforever.org www.minnesotapf.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4e1a

APPROPRIATION AMOUNT: $100,000

Overall Project Outcome and Results
Duties assigned to the project coordinator under this work program and as outlined and approved by the Habitat Conservation Partnership were to:
1. Coordinate partners, projects and cultivate partnerships,
2. Manage project data and contract/coordinate mapping service,
3. Solicit & compile partner information & provide reports to LCCMR and partners,
4. Schedule, coordinate, and chair meetings & provide meeting minutes,
5. Coordinate public relations outreach to media,
6. Serve as primary contact for LCCMR,
7. Facilitate executive & full committee meetings & coordinate subcommittee meetings, and
8. Manage contract for administration and mapping components of the Partnership.

We expended a total of $38,267 of Environment and Natural Resources Trust Fund (ENRTF) funds. Pheasants Forever, Inc. completed the above-referenced tasks successfully so that the outstanding habitat work detailed in this report could be completed, reported, and promoted. Work included full partnership meetings, executive committee meetings, and the required full partnership update reports which included coordination between all funded partners, LCCMR, and Community GIS Services. Promotion of individual partnership accomplishments and overall accomplishments was encouraged and several positive articles and events occurred and were shared as a result. ENRTF expenditures for personnel (Project Coordinator and accounting staff) and project coordinator travel totaled $2,242. A total of $25,758 within the personnel budget item was not needed to achieve our results and remains unspent. In addition, $36,025 of ENRTF funds were expended to manage data, operate the online reporting system from which all partner reports are generated, and map all partner projects. Pheasants Forever, Inc. contracted the mapping and data management services for the Phase VI Habitat Conservation Partnership with Community GIS Services of Duluth, Minnesota.

Community GIS has made several improvements to the operability of the reporting and mapping system. These updates include identifying free-text fields from the reporting website, and creating pre-populated drop down lists for them. As part of this exercise, all mapping fields were inspected to ensure minimal data duplication within the geodatabase. Metadata was created for the geodatabase at this time as well, which helps to define the fields being used. All HCP project accomplishments and expenditures are accounted for and fully described within the online reporting system and report generation. Anyone can access the Phase VI data electronically from the HCP website.

Project Results Use and Dissemination

The partnership acknowledges funding from the Minnesota Environment and Natural Resources Trust Fund. Accomplishment report information, mapping products, and project information can be found at www.mnhabitatcorridors.org. Other forms of information can be obtained by contacting Joe Pavelko, the HCP Coordinator, at (612) 532-3800.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

1A: Project Coordination and Mapping - Pheasants Forev - Pheasants Forever

Project Manager: Joe Pavelko

Affiliation: Pheasants Forever

Address: 7975 Acorn Circle
Victoria, MN 55,386

Phone: 612-532-3800

Fax:

E-mail: jpavelko@pheasantsforever.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation: ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Work Program Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Project Coord./ Mapping	$100,000	$ 38,277	$61,723	$0	$0
Total	$100,000	$ 38,277	$61,723	$0	$0

Work Program Summary

Overall Project Outcome and Results

Duties assigned to the project coordinator under this work program and as outlined and approved by the Habitat Conservation Partnership were to: 1. Coordinate partners, projects and cultivate partnerships, 2. Manage project data and contract/coordinate mapping service, 3. Solicit & compile partner information & provide reports to LCCMR and partners, 4. Schedule, coordinate, and chair meetings & provide meeting minutes, 5. Coordinate public relations outreach to media, 6. Serve as primary contact for LCCMR, 7. Facilitate executive & full committee meetings & coordinate subcommittee meetings, and 8. Manage contract for administration and mapping components of the Partnership.

We expended a total of $38,267 of ENTF funds. Pheasants Forever, Inc. completed the above-referenced tasks successfully so that the outstanding habitat work detailed in this report could be completed, reported, and promoted. Work included full partnership meetings, executive committee meetings, and the required full partnership update reports which included coordination between all funded partners, LCCMR and Community GIS Services. Promotion of individual partnership accomplishments and overall accomplishments was encouraged and several positive articles and events occurred and were shared as a result. ENTF expenditures for personnel (Project Coordinator and accounting staff) and project coordinator travel totaled $2,242. A total of $25,758 within the personnel budget item was not needed to achieve our results and remains unspent. In addition, $36,025 of ENTF funds were expended to manage data, operate the online reporting system from which all partner reports are generated, and map all partner projects. Pheasants Forever, Inc. contracted the mapping and data management services for the Phase VI Habitat Conservation Partnership with Community GIS Services of Duluth, Minnesota.

Community GIS has made several improvements to the operability of the reporting and mapping system. These updates include identifying free-text fields from the reporting website, and creating pre-populated drop down lists for them. As part of this exercise, all mapping fields were inspected to ensure minimal data duplication within the geodatabase. Metadata was created for the geodatabase at this time as well which helps to define the fields being used. All HCP project accomplishments and expenditures are accounted for and fully described within the online reporting system and report generation. Anyone can access the Phase VI data electronically from the HCP website.

Project Results Use and Dissemination

The partnership acknowledges funding from the Minnesota Environment and Natural Resources Trust Fund. Accomplishment report information, mapping products, and project information can be found at www.mnhabitatcorridors.org.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

1A: Project Coordination and Mapping - Pheasants Forev - Pheasants Forever

Other forms of information can be obtained by contacting Joe Pavelko, the HCP Coordinator, at (612) 532-3800

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

1A: Project Coordination and Mapping - Pheasants Forev - Pheasants Forever

Work Program Expenditures

FundingType	*Funding Category*	*Amount*	*Description*
ENTF	Professional Services	$36,025.00	GIS/Mapping - Community GIS
ENTF	Personnel Expenditures	$2,252.00	Personnel Direct bill hours
	Total:	**$38,277.00**	

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects - **Summary and a Budget page**

Project Title: Project Coordination and Mapping – 1a - Pheasants Forever, Inc.

Project Manager Name: Joe Pavelko

Trust Fund Appropriation: $ 100,000

2009 Trust Fund Budget	Result 1 Budget:	Amount Spent June 30, 2011	Balance June 30, 2011	TOTAL BUDGET	TOTAL BALANCE
	Project Coordination & Mapping				
BUDGET ITEM					
PERSONNEL: wages and benefits (0.25 FTE For projece coordinator direct to project 0.05 FTE for grants coordinator nad 0.05 FTE for grant assisant), and travel direct to project	28,000	2,242	25,758	28,000	25,758
Contracts: Community GIS Services, Duluth, MN	42,000	36,025	5,975	42,000	5,975
Contracts: HCP Evaluation (contractor to be seleted June 2010)	30,000	0	30,000	30,000	30,000
COLUMN TOTAL	$100,000	$38,267	$61,733	$100,000	$61,733

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: HCP VI – Melvin Slough Landscape Restoration 2a
PROJECT MANAGER: Kim Hanson
AFFILIATION: Minnesota Deer Hunters Association
MAILING ADDRESS: 460 Peterson Road
CITY/STATE/ZIP: Grand Rapids, MN 55744
PHONE: 218-327-1103 Ext. 16
FAX: 218-327-1349
E-MAIL: kimhanson@mndeerhunters.com
WEBSITE: www.mndeerhunters.com
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4e2a
APPROPRIATION AMOUNT: $ 50,000.00

Overall Project Outcome and Results

Project Summary and Results

MDHA funding restored a total of 2 oak savannahs (grassland enhancement) consisting of 35 acres on the Winger WPA. Federal WPA's are managed for waterfowl production and are open to public hunting and other recreation consistent with the National Wildlife Refuge System. This restoration to the oak savannahs will create suitable habitat for deer, turkey, ruffed grouse, and other cavity nesting birds.

Specifically, on the Winger WPA (Polk County Winger Township 147, Range 42, Section 2) we restored 2 oak savannahs for 35 acres by shearing and piling undesirable trees such as boxelder, cottonwood, willow, and aspen which opened the landscape to promote savannah habitat. Large and small oak trees were not cut and the seedlings were flagged to prevent accidental damage.

All work was done in partnership with the USFWS Detroit Lakes Wetland Management District and other funds were secured and provided by the Minnesota Deer Hunters Association Hides for Habitat funds.

Project Results Use and Dissemination

MDHA has restored a total of 2 oak savannahs (35 acres total) on public land that is permanently protected and open to public hunting. These restored oak savannahs provide upland habitat for a variety of wildlife with a large scale benefit to hundreds of acres on the Winger WPA as well as the surrounding private land habitats. Future management of grasslands will be conducted by the USFWS Detroit Lakes Wetland Management District.

Since this initial project was submitted, MDHA changed project managers from Phase IV. In phase V our funds from matching came mostly from the Hides for Habitat funds through MDHA which is why there are less "other funds" contributed to this Phase V work plan. MDHA strives to identify projects that capitalize on our chapter system and will improve on this into the future.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2A:Hides for Habitat - Restoration - MDHA

Project Manager: Kim Hanson

Affiliation: MDHA

Address: 460 Peterson Road
Grand Rapids, MN 55744

Phone: 218-327-1103 ext. 16

Fax: 218-327-1349

E-mail: kimhanson@mndeerhunters.com

Fund: Environment and Natural Resources Trust Fund

Legal Citation: ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds * Proposed	Other Funds * Spent
Restoration	$50,000	$49,969	$31	$37,500	$1,000
Total	$50,000	$49,969	$31	$37,500	$1,000

*Other Funds are classified as non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds). Please note, however, that this work program has spent the following amounts not shown in the above table:

Partners State Levereged Funds: $14,196.28

See the tables and funding type definitions at the end of this report for further explanation.

Work Program Summary

Overall Project Outcome and Results

MDHA and USFWS funding restored a total of 8 oak savannahs (grassland enhancement) consisting of 35 acres on the Winger WPA. Federal WPA's are managed for waterfowl production and are open to public hunting and other recreation consistent with the National Wildlife Refuge System. This restoration to the oak savannahs will create suitable habitat for deer, turkey, ruffed grouse, and other cavity nesting birds.

Specifically, on the Winger WPA (Polk County Winger Township 147, Range 42, Section 2) we restored 35 acres of oak savannah by shearing and piling undesirable trees such as boxelder, cottonwood, willow, and aspen which opened the landscape to promote savannah habitat. Large and small oak trees were not cut and the seedlings were flagged to prevent accidental damage.

All work was done in partnership with the USFWS Detroit Lakes Wetland Management District and other funds were secured and provided by the Minnesota Deer Hunters Association Hides for Habitat funds.

Project Results Use and Dissemination

MDHA has restored a total of 8 oak savannahs (35 acres total) on public land that is permanently protected and open to public hunting. These restored oak savannahs provide upland habitat for a variety of wildlife with a large scale benefit to hundreds of acres on the Winger WPA as well as the surrounding private land habitats. Future management of grasslands will be conducted by the USFWS Detroit Lakes Wetland Management District.

MDHA strives to identify projects that capitalize on our chapter system and will improve on this into the future.

USFWS funds that were proposed as match were far less than pledged due to work that wasn't available to be completed due to wet conditions on the Winger WPS. The work in the amount of $27,000 that was pledged will be completed when the conditions are favorable.

There was a remaining $31 from ENTF that can be returned.

2A:Hides for Habitat - Restoration - MDHA

Restoration Activities

Project Area - 1 - Aspen Parklands

Project Name: Melvin Slough Restoration - Winger WPA
Township: 147, Range: 42, Section: 2

Activity: Grassland Enhancement
Landtype: Public - WPA
Description: As identified by Habitat and Population Evaluation Team through the Working Lands Initiative priority areas, this project will restore approximately 10 prairie wetland basins (approximately 13 acres). Work will take place on designated locations and utilize low ground pressure D-4 and D-6 Dozers that will remove fill/silt from wetland basins and fill-in existing drainage ditches with fill from wetlands. Seeding will also be done to restore the native plant communities.

November 1st, 2010 Amendment Request

The Phase VI wetland restorations will not be able to be completed by the deadline of June, 2011 due to the wet conditions on the Winger WPA. We are requesting an Amendment to this work program to continue Oak Savannah restoration efforts on the Winger WPA in approximately 20 acres. Work to be completed under the amendment will be removing unwanted vegetation in the area.

Amendment Approved November 19, 2010.

The work was completed on the Winger WPA as described in the approved amendment request. There were a total of 6 sites (S-1, S-2, S-3, S-5, S-7 and S-8) that had 20 acres that were treated for unwanted species. Work also included flagging smaller oak species and leaving behind larger oaks. Work was completed on these sites in mid February and entailed 134.5 hours on the Skidster, 31 hours on the Trackhoe and 34 hours on the skidder. The entire invoiced amount was $29,937.96 of which the USFWS paid the overage amount of $9,937.96 as match.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$20,000.00	20.00	0.00
ENTF	Restoration	$29,969.00	15.00	0.00
Grassland Enhancement Total		$49,969.00	35.00	0.00
Melvin Slough Restoration - Winger WPA Total		**$49,969.00**	**35.00**	**0.00**

Restoration Project Totals (By Funding Type)

Funding Type	Funding Amount	Acres	Shoreline Feet
ENTF:	$49,969.00	35.00	0.00
Total:	**$49,969.00**	**35.00**	**0.00**

2A:Hides for Habitat - Restoration - MDHA

Work Program Expenditures - Not Attributable to Specific Projects

FundingType	*Category*	*Amount*	*Description*
Other Funds	Personnel Expenditures	$1,000.00	Grant administration costs for MDHA staff.
Partners State Leveraged Funds	Personnel Expenditures	$14,196.28	USFWS Matching Funds spent on Winger WPA.
	Total:	**$15,196.28**	

Work Program Expenditures (Not Attributable to Specific Projects) By Funding Type

Funding Type	**Amount**
Other Funds	$1,000.00
State Funds	$0.00
Total	**$15,196.28**

Work Program Expenditures Breakdown

Funding Type:	**Restoration Projects**	**Not Attributable to Specific Projects**	**Total**
ENTF	$49,969.00	$0.00	$49,969.00
Other Funds	$0.00	$1,000.00	$1,000.00
Total	$49,969.00	$15,196.28	$65,165.28

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Project

Project Title: *Winger WPA, Polk County, Savannas Restoration Site S-4 & S-6*

Project Manager Name: *Kim Hanson*

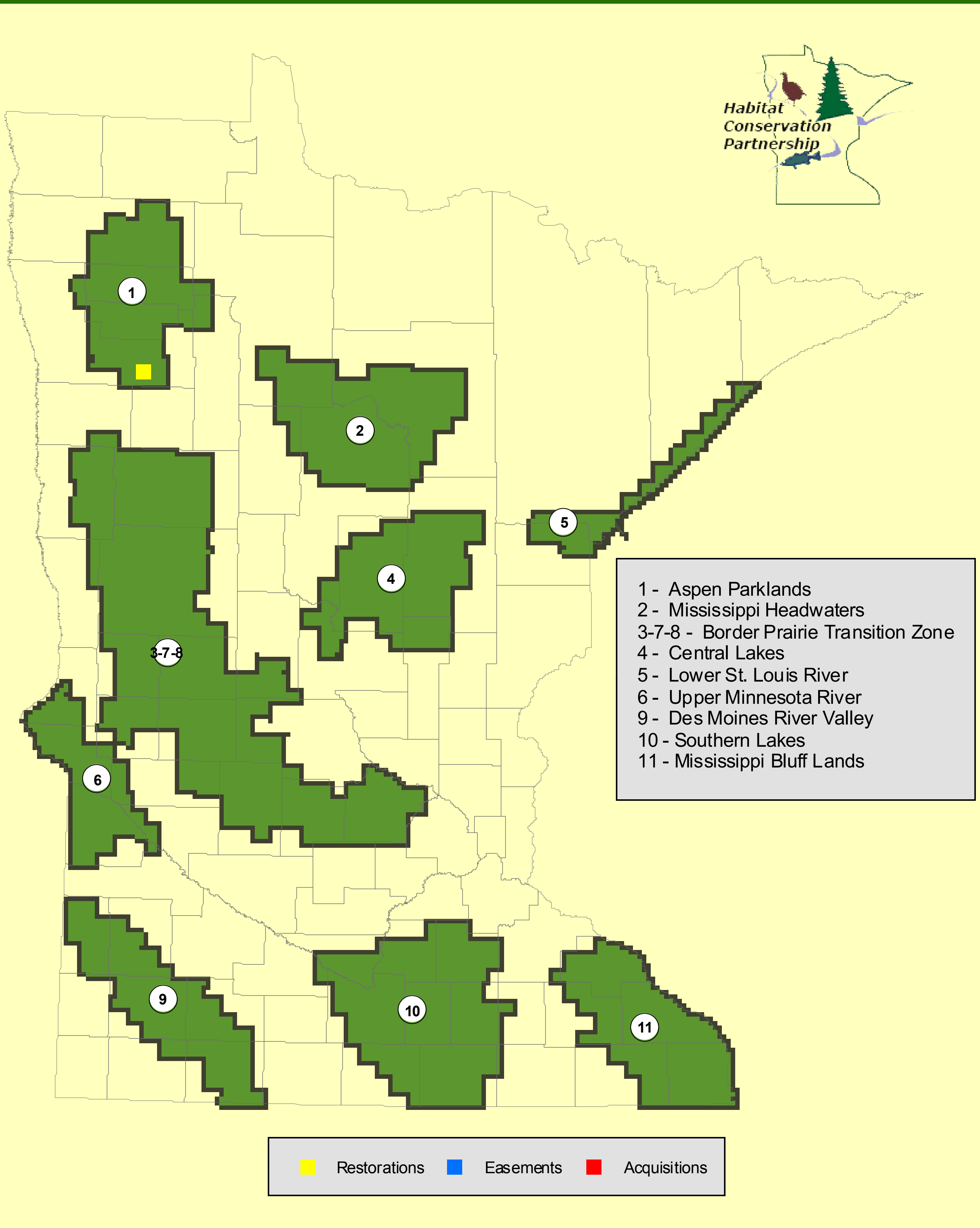
Trust Fund Appropriation: $ *50,000*

2009 Trust Fund Budget	Result 1 Budget:	Result 1 Budget REVISED 11/1/2010	Amount Spent (11/1/10)	Balance (11/1/10)	Result 2 Budget:	Amount Spent (date)	Balance (date)	TOTAL BUDGET	TOTAL BALANCE
	~~*Wetland Restoration*~~	*Oak Savannah Restoration*	*$20,000*		*Oak Savanna Restoration*		*$50,000.00*	**50,000**	
BUDGET ITEM							.		
PERSONNEL: wages and benefits									
Contracts	~~20,000~~	20,000	20,000		30,000	29,969	31	50,000	
Professional/technical									
Other contracts - Strom Construction Inc.	~~D-4, D-6 Low Ground Pressure Dozers, Excavators for removal & replacement of ditches~~	Tree Shears, Back Hoe and skidder for Removal of Vegetation			Tree Shears, Back Hoe for Removal of Vegetation				
COLUMN TOTAL	~~**$20,000**~~	**$20,000**	**$20,000**	**$0**	**$30,000**	**$29,969**	**$31**	**$49,969**	**$31**

Habitat Conservation Partnership

Hides for Habitat - Restoration

2A



Winger WPA
LCCMR Funded Sites

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Restoring Minnesota's Fish and Wildlife Habitat Corridors – Phase 6, Habitat Corridors Partnership - Partners for Fish and Wildlife Program (2b)
PROJECT MANAGER: Sheldon Myerchin
AFFILIATION: U.S. Fish and Wildlife Service
MAILING ADDRESS: 434 Great Oak Drive
CITY/STATE/ZIP: Waite Park, MN 56387
PHONE: (320) 253-4682
E-MAIL: Sheldon_Myerchin@fws.gov
WEBSITE: http://midwest.fws.gov
FUNDING SOURCE: Minnesota Environmental and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chapter 143, Section 2, subd.4(e)

APPROPRIATION AMOUNT: $50,000

Overall Project Outcome and Results
Since 1987, the USFWS' Partners for Fish and Wildlife (Partners) Program has restored more than 16,280 drained wetlands (74,300 acres) and more than 1,240 upland sites (54,100 acres) to native grasses and forbs, on private lands in Minnesota. Through its Partners Program, the USFWS works with other federal and state agencies, local units of government, tribal entities, conservation organizations, and individual landowners to restore or enhance fish and wildlife habitats on private land. This program emphasizes restoring habitats and native vegetation for fish and wildlife in concert with the goals of individual private landowners. These projects also benefit the general public by providing habitat for fish, wildlife and plants, improving water quality and watershed health, reducing non-point source pollution, and creating opportunities for outdoor recreation and education.

The $50,000.00 of Minnesota Environment and Natural Resources Trust Fund (Trust Fund) funding obtained through this work program, accelerated the USFWS' existing Partners Program with an additional voluntary restoration or enhancement of 38 wetland basins covering 54 acres of wetland habitat and five grassland sites covering 491 acres of upland habitat. With this funding, a total of 6 projects were completed on private land within HCP Project Area 12. The Trust Funds were expended from July 2009 through June 2011. The USFWS Partners Program provided $33,138.00 of Other Funds cost-sharing to complete these projects.

The USFWS Partners Program also provided $13,400.00 of Other Funds to complete two additional upland enhancement projects totaling 43 acres.

Under the Partners Program, wetlands are restored or enhanced by; plugging or filling drainage ditches, removing excess sediment, breaking up sub-surface tile systems, embankment construction, and/or installing water control structures. Upland grassland areas are restored or enhanced by removing invasive woody vegetation and re-seeding former cropland to a native prairie seed mixture. All seeded areas complied with requirements to utilize local native ecotype seed as available.

Project selection for Trust Fund cost-share via the Partners Program is based on the project's contribution to building wetland and upland habitat complexes or corridors and/or restoring or enhancing native habitats in the focus project areas.

Project Results Use and Dissemination

These projects were completed within the nine HCP Project Areas across the state of Minnesota. Without the willingness of the landowners involved, and the variety of other partners, this important wetland, upland and river/riparian wildlife habitat would not be restored. Numerous presentations including the Trust Fund habitat restoration information have been made over the past ten years at various meetings i.e. Minnesota State Private Lands Meeting, the Wetland Summit, the Shallow Lakes Forum, MNDNR Roundtable, and at Kiwanis, Rotary, and Lion's Club presentations. One project completed with Trust Fund dollars was also featured on the Minnesota Bound television program hosted by Ron Schara.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2B:Partners for Wildlife - U.S. Fish & Wildlife Service

Project Manager: Sheldon Myerchin

Affiliation: U.S. Fish & Wildlife Service

Address: 434 Great Oak Drive
Waite Park, MN 56387

Phone: (320)253-4682

Fax: (320) 253-0710

E-mail: sheldon_myerchin@fws.gov

Fund: Environment and Natural Resources Trust Fund

Legal Citation:

ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Restoration	$50,000	$50,000	$0	$50,000	$46,538
Total	$50,000	$50,000	$0	$50,000	$46,538

Work Program Summary

Overall Project Outcome and Results

Since 1987, the USFWS' Partners for Fish and Wildlife (Partners) Program has restored more than 16,280 drained wetlands (74,300 acres) and more than 1,240 upland sites (54,100 acres) to native grasses and forbs, on private lands in Minnesota. Through its Partners Program, the USFWS works with other federal and state agencies, local units of government, tribal entities, conservation organizations, and individual landowners to restore or enhance fish and wildlife habitats on private land. This program emphasizes restoring habitats and native vegetation for fish and wildlife in concert with the goals of individual private landowners. These projects also benefit the general public by providing habitat for fish, wildlife and plants, improving water quality and watershed health, reducing non-point source pollution, and creating opportunities for outdoor recreation and education.

The $50,000.00 of Minnesota Environment and Natural Resources Trust Fund (Trust Fund) funding obtained through this work program, accelerated the USFWS' existing Partners Program with an additional voluntary restoration or enhancement of 38 wetland basins covering 54 acres of wetland habitat and five grassland sites covering 491 acres of upland habitat. With this funding, a total of 6 projects were completed on private land within HCP Project Area 12. The Trust Funds were expended from July 2009 through June 2011. The USFWS Partners Program provided $33,138.00 of Other Funds cost-sharing to complete these projects.

The USFWS Partners Program also provided $13,400.00 of Other Funds to complete two additional upland enhancement projects totaling 43 acres.

Under the Partners Program, wetlands are restored or enhanced by; plugging or filling drainage ditches, removing excess sediment, breaking up sub-surface tile systems, embankment construction, and/or installing water control structures. Upland grassland areas are restored or enhanced by removing invasive woody vegetation and re-seeding former cropland to a native prairie seed mixture. All seeded areas complied with requirements to utilize local native ecotype seed as available.

Project selection for Trust Fund cost-share via the Partners Program is based on the project's contribution to building wetland and upland habitat complexes or corridors and/or restoring or enhancing native habitats in the focus project areas.

Project Results Use and Dissemination

These projects were completed within the nine HCP Project Areas across the state of Minnesota. Without the willingness of the landowners involved, and the variety of other partners, this important wetland, upland and river/riparian wildlife habitat would not be restored.
Numerous presentations including the Trust Fund habitat restoration information have been made over the past ten years at various meetings i.e. Minnesota State Private Lands Meeting, the Wetland Summit, the Shallow Lakes Forum, MNDNR

2B:Partners for Wildlife - U.S. Fish & Wildlife Service

Roundtable, and at Kiwanis, Rotary, and Lion's Club presentations. One project completed with Trust Fund dollars was also featured on the Minnesota Bound television program hosted by Ron Schara.

2B:Partners for Wildlife - U.S. Fish & Wildlife Service

Restoration Activities

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2B:Partners for Wildlife - U.S. Fish & Wildlife Service

Project Area - 3-7-8 - Border Prairie Transition Zone

Project Name: PLDusJ-Upland enhancement-Clay Co.
Township: 138, Range: 45, Section: 10

Activity: Grassland Enhancement
Landtype: Private - Land
Description: This project enhanced 33 acres of native prairie habitat by removing invasive woody vegetation to provide quality grassland nesting habitat for migratory birds and resident wildlife. The project is located on a USFWS habitat easement that is protected in perpetuity. Siberian elm trees as well as boxelder, Russian olive, ponderosa pine, and wild plum were cut and piled near a road access. The cut trees will be removed and the site is planned to be burned under a prescribed fire in the spring of 2010.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$10,000.00	18.71	0.00
Other Funds	Restoration	$7,635.00	14.29	0.00
PLDusJ-Upland enhancement-Clay Co. Total		**$17,635.00**	**33.00**	**0.00**

Project Name: PLReeK-Upland enhancement-Pope Co.
Township: 123, Range: 39, Section: 6

Activity: Grassland Restoration
Landtype: Private - Land
Description: This project enhanced 131 acres of native prairie habitat by removing invasive woody vegetation to provide quality grassland nesting habitat for migratory birds and resident wildlife. The project is located on a USFWS habitat easement that is protected in perpetuity. Siberian elm trees as well as boxelder, cottonwood, red cedar, and willow were cut and piled. The cut trees will be removed or burned and the whole site is planned to be burned under a prescribed fire in the near future.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$7,600.34	131.00	0.00

Project Name: PLSweD-Upland enhancement-Swift Co.
Township: 122, Range: 37, Section: 1

Activity: Grassland Restoration
Landtype: Private - Lake
Description: This project enhanced 54 acres of native prairie and grassland habitat by removing invasive woody vegetation to provide quality grassland nesting habitat for migratory birds and resident wildlife. The project is located on a MN RIM easement that is protected in perpetuity. Siberian elm trees as well as boxelder, cottonwood, red cedar, and willow were cut and piled. The cut trees will be removed or burned and the whole site is planned to be burned under a prescribed fire in the near future.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$6,597.16	52.20	0.00
Other Funds	Restoration	$227.84	1.80	0.00
PLSweD-Upland enhancement-Swift Co. Total		**$6,825.00**	**54.00**	**0.00**

2B:Partners for Wildlife - U.S. Fish & Wildlife Service

Project Name: PLAhrJ-Upland enhancement-Swift Co.
Township: 122, Range: 38, Section: 33

Activity: Grassland Restoration
Landtype: Private - Land
Description: This project enhanced 57 acres of native prairie and grassland habitat by removing invasive woody vegetation to provide quality grassland nesting habitat for migratory birds and resident wildlife. The project is located on a USFWS habitat easement that is protected in perpetuity. Siberian elm trees were cut and piled. The cut trees will be removed or burned and the whole site is planned to be burned under a prescribed fire in the near future.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$5,027.50	57.00	0.00

Project Name: PLQuiS - Upland enhancement - Big Stone Co.
Township: 122, Range: 45, Section: 19

Activity: Grassland Enhancement
Landtype: Private - Land
Description: This project enhanced 122 acres of native prairie and grassland habitat by removing invasive woody vegetation to provide quality grassland nesting habitat for migratory birds and resident wildlife. The project is located on a USFWS habitat easement that is protected in perpetuity. Siberian elm trees were cut and piled. The cut trees will be removed or burned and the whole site is planned to be burned under a prescribed fire in the near future.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$5,775.00	116.45	0.00
Other Funds	Restoration	$275.00	5.55	0.00
PLQuiS - Upland enhancement - Big Stone Co. Total		**$6,050.00**	**122.00**	**0.00**

Project Name: PLDouP - Wetland restoration - Otter Tail Co.
Township: 131, Range: 44, Section: 29

Activity: Wetland Restoration
Landtype: Private - Land
Description: This project restored 38 wetland basins covering 54 acres to high quality wetland habitat by plugging drainage ditches and removing excess sediment to provide quality wetland habitat for migratory birds and resident wildlife. The project is located on a USFWS habitat easement that is protected in perpetuity. Drainage ditches were filled or embankments constructed to restore the hydrology of the wetlands that had been previously drained for agriculture production. Rock weirs were also placed on two wetlands due to their larger size and the significant watershed into these basins. The surrounding uplands on the tract, which totals 325 acres, were previously seeded to native grass mixture to provide high quality nesting cover.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$15,000.00	20.25	0.00
Other Funds	Restoration	$25,000.00	33.75	0.00
PLDouP - Wetland restoration - Otter Tail Co. Total		**$40,000.00**	**54.00**	**0.00**

2B:Partners for Wildlife - U.S. Fish & Wildlife Service

Project Name: PLSchJ - Upland enhancement - Big Stone Co.
Township: 121, Range: 45, Section: 36

Activity: Grassland Enhancement
Landtype: Private - Land
Description: This project enhanced 33 acres of native prairie and grassland habitat by removing invasive woody vegetation to provide quality grassland nesting habitat for migratory birds and resident wildlife. The project is located on a USFWS habitat easement that is protected in perpetuity. Siberian elm trees were cut and piled. The cut trees will be removed or burned and the whole site is planned to be burned under a prescribed fire in the near future.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
Other Funds	Restoration	$3,400.00	33.00	0.00

Project Name: PLWebD - Upland enhancement - Clay Co.
Township: 142, Range: 45, Section: 34

Activity: Grassland Enhancement
Landtype: Private - Land
Description: This project enhanced 10 acres of grassland habitat by removing invasive woody vegetation to provide quality grassland nesting habitat for migratory birds and resident wildlife. Siberian elm trees were cut and piled. The cut trees will be removed or burned and the whole site is planned to be burned under a prescribed fire in the near future.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
Other Funds	Restoration	$10,000.00	10.00	0.00

Restoration Project Totals (By Funding Type)

Funding Type	Funding Amount	Acres	Shoreline Feet
ENTF:	$50,000.00	395.61	0.00
Other Funds:	$46,537.84	98.39	0.00
Total:	**$96,537.84**	**494.00**	**0.00**

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects - **Summary and a Budget page for each partner (if applicable)**

Project Title: Partners for Fish and Wildlife (2b) Minnesota's Habitat Conservation Partnership

Project Manager Name: *Sheldon Myerchin*

Trust Fund Appropriation: $ *50,000*

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

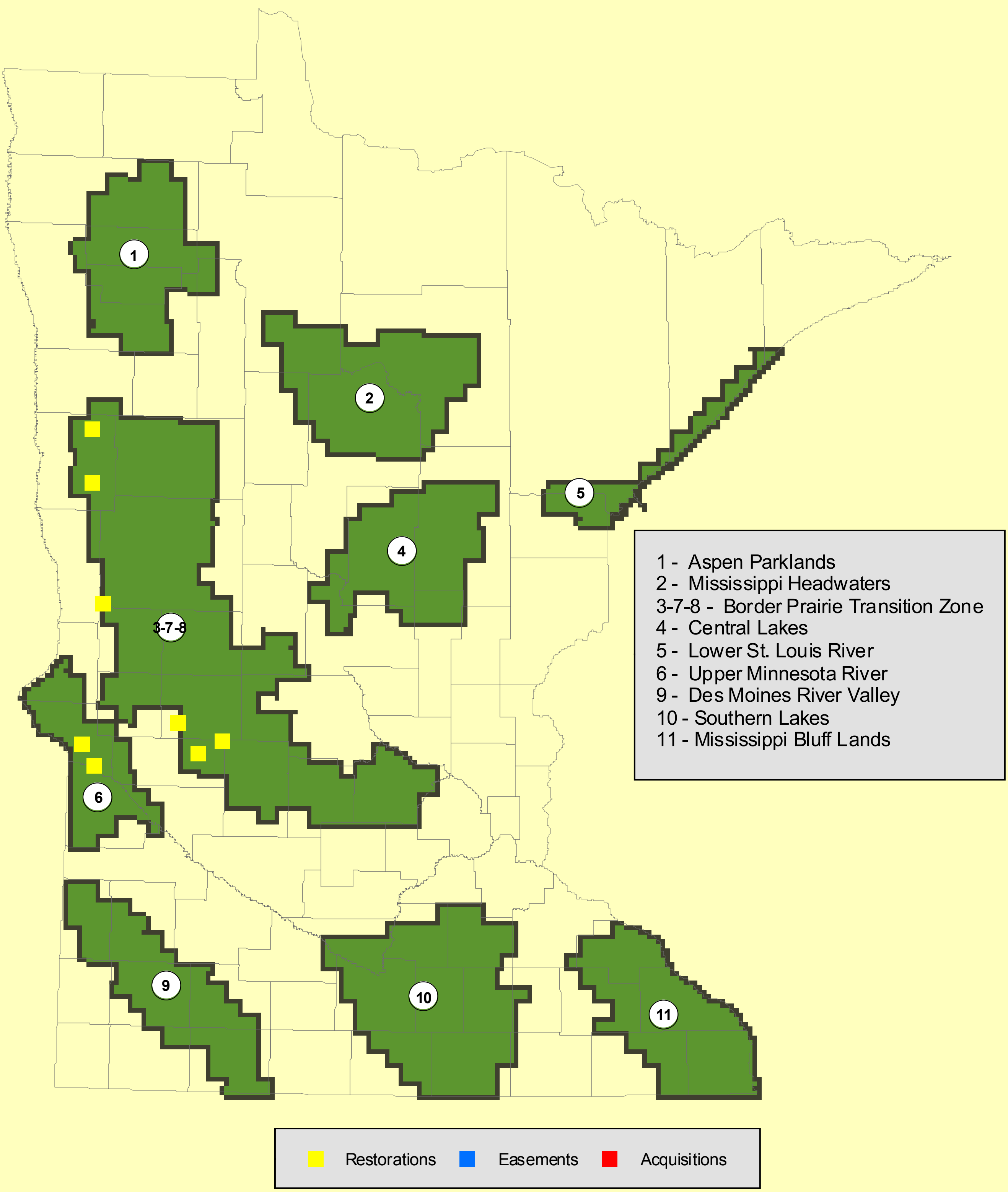
2) Remove any budget item lines not applicable

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(date)*	**Balance** *(6/30/11)*
	Restoration		
BUDGET ITEM		0	
Contracts			
Professional/technical *(with whom?, for what?)*			
Other contracts *($50,000 (110 acres) ETF funds will be used to: hire contractors to perform wetland restoration construction work, perform seedbed preparation and/or seeding on upland grassland restorations, or conduct invasive species removal; purchase water control structure materials for wetland restorations if needed; purchase local genotype prairie seed and herbicides if needed for prairie restoration projects.*	50,000	50,000	0
COLUMN TOTAL	**$50,000**	**$50,000**	**$0**

Habitat Conservation Partnership

Partners for Wildlife

2B



LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2C:Shallow Lake Enhancement - Ducks Unlimited

Project Manager: Jon Schneider

Affiliation: Ducks Unlimited

Address: 311 East Lake Geneva Road
Alexandria, MN 56308

Phone: (320)762-9916

Fax: (320)759-1567

E-mail: jschneider@ducks.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation: ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds * Proposed	Other Funds * Spent
Restoration	$225,000	$225,000	$0	$100,000	$299,977
Total	$225,000	$225,000	$0	$100,000	$299,977

*Other Funds are classified as non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds). Please note, however, that this work program has spent the following amounts not shown in the above table:

State Funds: $1,249.00

See the tables and funding type definitions at the end of this report for further explanation.

Work Program Summary

Overall Project Outcome and Results

The objective of this project was to accelerate Ducks Unlimited (DU) bio-engineering assistance to help agencies design and construct enhancement projects on shallow lakes for waterfowl using water control structures. DU biologists and engineers provided technical assistance to Minnesota DNR, U.S. Fish & Wildlife Service, and private landowners around shallow lakes with a goal of enhancing at least one shallow lake totaling 100 wetland acres with a new water control structure and/or fish barrier, engineering at least four new shallow lake enhancement structure projects for DNR on designated shallow lakes or basins within state Wildlife Management Areas (WMAs) and for the Service on federal Waterfowl Production Areas (WPA), and providing technical assistance to agency field staff on other shallow lake projects throughout HCP project areas.

Through this grant project, DU biologists and engineers surveyed and designed six new water control structures for the Minnesota DNR and US Fish & Wildlife Service, including Sandborn Lake in LeSueur County, Lindsey Lake in Becker County, Everglade WMA in Stevens County, Harder Lake and Wolf Lake WPAs in Cottonwood County, and Henjum WPA in Kandiyohi County. These six bio-engineering projects will be implemented in the future as permits and easements are secured. In addition, DU enhanced 453 wetland acres by constructing previously designed water control structures on the outlets of three shallow lakes, including Block WPA in Grant County, Perch Lake in Blue Earth County on Perch Lake WPA, and Gislason Lake in Lincoln County on the Northern Tallgrass Prairie National Wildlife Refuge. This far surpasses our target goal of enhancing at least one shallow lake totaling 100 wetland acres or more. Finally, DU shallow lakes field biologist provided ongoing technical assistance to Minnesota DNR and the Service on 30 shallow lake projects in HCP Project Areas to help assess and develop new projects for future possible bio-engineering, implementation, and management by those conservation agencies.

DU’s total cost to provide these bio-engineering services to enhance shallow lakes was $526,225, and included reimbursement of $225,000 from the Environment & Natural Resources Trust Fund through this grant, and the expenditure of $1,249 in Other State Funds and $299,977 in Other Funds (DU and federal funds) that far exceeds the $100,000 in Other Funds that we originally proposed to spend.

Project Results Use and Dissemination

This grant helped DU, DNR, and the Service accelerate the assessment and enhancement of shallow lakes throughout

2C:Shallow Lake Enhancement - Ducks Unlimited

southern, central and western Minnesota. DU provided six detailed engineering design plans to state and federal agency staff, and informed the public of shallow lake improvement projects through public meetings, news releases sent to the media, and in articles in DU publications. Shallow lake assessment data collected by DU biologists was provided to DNR's shallow lake program and area wildlife managers, and shared with MPCA to aid in their impaired waters assessment.

2C:Shallow Lake Enhancement - Ducks Unlimited

Restoration Activities

2C:Shallow Lake Enhancement - Ducks Unlimited

Project Area - 1 - Aspen Parklands

Project Name: Sandborn Lake
Township: 112, Range: 23, Section: 35

Activity: Shallow Lake Survey / Design / Wetland Mapping
Landtype: Public - Lake
Description: DU bio-engineering staff surveyed and designed a new water control structure for the outlet of Sandborn Lake in LeSueur County, which is one of DNR's 44 designated wildlife management lakes. The project will be constructed in the future once DNR obtains all the necessary land rights needed for structure placement and management.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Personnel Expenditures	$10,316.00	0.00	0.00
Other Funds	Personnel Expenditures	$10,538.00	0.00	0.00
State Funds	Personnel Expenditures	$1,249.00	0.00	0.00
Sandborn Lake Total		**$22,103.00**	**0.00**	**0.00**

Project Name: Lindsey Lake WPA
Township: 141, Range: 42, Section: 33

Activity: Shallow Lake Survey / Design / Wetland Mapping
Landtype: Public - WPA
Description: DU bio-engineering staff surveyed and designed a new water control structure for the outlet of Lindsey Lake in Becker County. The project will be implemented in the future once the U.S. Fish & Wildlife Service obtains the necessary permits and funding is secured.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Personnel Expenditures	$7,694.00	0.00	0.00
Other Funds	Personnel Expenditures	$11,429.00	0.00	0.00
Lindsey Lake WPA Total		**$19,123.00**	**0.00**	**0.00**

Project Name: Harder Lake WPA
Township: 106, Range: 36, Section: 14

Activity: Shallow Lake Survey / Design / Wetland Mapping
Landtype: Public - WPA
Description: DU bio-engineering staff surveyed and designed a new water control structure for the outlet of a large wetland on Harder Lake WPA in Cottonwood County. The project will be implemented in the future once permits and funding is secured.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Personnel Expenditures	$8,566.00	0.00	0.00
Other Funds	Personnel Expenditures	$5,499.00	0.00	0.00
Harder Lake WPA Total		**$14,065.00**	**0.00**	**0.00**

2C:Shallow Lake Enhancement - Ducks Unlimited

Project Name: Block WPA
Township: 128, Range: 42, Section: 30

Activity: Wetland Enhancement
Landtype: Public - WPA
Description: DU bio-engineering staff surveyed and designed a water control structure for the outlet of a 22-acre degraded semi-permanent wetland on Block WPA in Grant County for the US Fish & Wildlife Service. DU contracted the construction of the project in fall 2009, and the Service used the structure to conduct a temporary draw-down to rejuvenate the aquatic ecology and improve water clarity of the basin.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Personnel Expenditures	$1,784.00	0.00	0.00
ENTF	Restoration	$24,036.00	16.13	0.00
Other Funds	Personnel Expenditures	$12,664.00	0.00	0.00
Other Funds	Restoration	$8,739.00	5.87	0.00
Block WPA Total		**$47,223.00**	**22.00**	**0.00**

Project Area - 9 - Des Moines River Valley

Project Name: Gislason Lake
Township: 111, Range: 44, Section: 1

Activity: Wetland Enhancement
Landtype: Public - NWR
Description: DU constructed a water control structure for the outlet of Gislason Lake in Lincolon County. The construction work began in fall 2009 and was completed in May 2010. The structure was used US Fish & Wildlife Service biologists from Big Stone NWR to conduct a temporary draw-down of the basin in fall and winter 2009-10 to rejuvenate it's aquatic ecology and improve water quality, and rid the basin of invasive fish. This enhancement will take place in 2010 and the basin will be reflooded in 2011 or 2012 by the Service, depending on the resulting aquatic vegetative response.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Personnel Expenditures	$17,691.00	0.00	0.00
ENTF	Restoration	$80,964.00	103.75	0.00
Other Funds	Personnel Expenditures	$7,707.00	0.00	0.00
Other Funds	Restoration	$13,464.00	17.25	0.00
Gislason Lake Total		**$119,826.00**	**121.00**	**0.00**

Project Name: Wolf Lake WPA
Township: 105, Range: 35, Section: 31

Activity: Shallow Lake Survey / Design / Wetland Mapping
Landtype: Public - WPA
Description: DU bio-engineering staff surveyed and designed a new water control structure for the outlet of Wolf Lake and associated wetlands Cottonwood County. The project will be implemented in the future once project funding and permits have been secured.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Personnel Expenditures	$11,346.00	0.00	0.00
Other Funds	Personnel Expenditures	$11,291.00	0.00	0.00
Other Funds	Professional Services	$689.00	0.00	0.00
Wolf Lake WPA Total		**$23,326.00**	**0.00**	**0.00**

2C:Shallow Lake Enhancement - Ducks Unlimited

Project Area - 10 - Southern Lakes

Project Name: Perch Lake
Township: 106, Range: 26, Section: 13

Activity: Wetland Enhancement
Landtype: Public - Lake
Description: DU engineered a new water control structure for the outlet of Perch Lake in Blue Earth County under our 2008 LCCMR Grant for HCP 2c, and constructed the new structure under this 2009 LCCMR Grant for HCP 3c. The old structure on the outlet of the lake that was constructed in the early 1970s failed and the DNR no longer had water level management control. DNR is now using the new structure built by DU to restore water levels in Perch Lake, which is one of DNR's 44 shallow lakes legally designated for wildlife management purposes, and will use the structure to conduct temporary water level draw-downs as needed to enhance the lake in the future.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$10,000.00	37.77	0.00
Other Funds	Personnel Expenditures	$84,987.00	0.00	0.00
Other Funds	Restoration	$72,067.00	272.23	0.00
Perch Lake Total		**$167,054.00**	**310.00**	**0.00**

Project Area - 3-7-8 - Border Prairie Transition Zone

Project Name: Henjum Lake WPA
Township: 121, Range: 36, Section: 22

Activity: Shallow Lake Survey / Design / Wetland Mapping
Landtype: Public - WPA
Description: DU bio-engineering staff surveyed and designed a water control structure for the outlet of a large wetland on Henjum WPA in Kandiyohi County for the US Fish & Wildlife Service. The project will be implemented in the future once the Service obtains all the necessary flowage easements requeired, and secures project construction funding.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Personnel Expenditures	$5,657.00	0.00	0.00
Other Funds	Personnel Expenditures	$10,511.00	0.00	0.00
Other Funds	Professional Services	$690.00	0.00	0.00
Henjum Lake WPA Total		**$16,858.00**	**0.00**	**0.00**

Project Name: Everglade WMA - Fish Lake WPA
Township: 126, Range: 44, Section: 36

Activity: Shallow Lake Survey / Design / Wetland Mapping
Landtype: Public - WMA
Description: DU bio-engineering staff surveyed and designed a new water control structure and invasive fish barrier for the outlet of the Everglade WMA and Fish Lake WPA complex in Stevens County. The project will be implemented in the future once DNR obtains all the necessary flowage rights and structure easements requeired.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Personnel Expenditures	$16,526.00	0.00	0.00
Other Funds	Personnel Expenditures	$17,824.00	0.00	0.00
Everglade WMA - Fish Lake WPA Total		**$34,350.00**	**0.00**	**0.00**

Restoration Project Totals (By Funding Type)

Funding Type	Funding Amount	Acres	Shoreline Feet
ENTF:	$194,580.00	157.66	0.00

2C:Shallow Lake Enhancement - Ducks Unlimited

Other Funds:	$268,099.00	295.34	0.00
State Funds:	$1,249.00	0.00	0.00
Total:	**$463,928.00**	**453.00**	**0.00**

2C:Shallow Lake Enhancement - Ducks Unlimited

Work Program Expenditures - Not Attributable to Specific Projects

FundingType	*Category*	*Amount*	*Description*
ENTF	Personnel Expenditures	$714.00	DU biologists provide technical assistance to DNR and FWS agency staff and private landowners regarding shallow lakes in HCP Project Area #6.
ENTF	Personnel Expenditures	$16,958.00	DU biologists provide technical assistance to DNR and FWS agency staff and private landowners regarding shallow lakes in HCP Project Area #3-7-8.
ENTF	Personnel Expenditures	$3,707.00	DU biologists provide technical assistance to DNR and FWS agency staff and private landowners regarding shallow lakes in HCP Project Area #10.
ENTF	Personnel Expenditures	$4,638.00	DU biologists provide technical assistance to DNR and FWS agency staff and private landowners regarding shallow lakes in HCP Project Area #9.
ENTF	Personnel Expenditures	$4,403.00	DU conservation program manager coordinates activities of DU engineers and biologists, and administers this grant.
Other Funds	Personnel Expenditures	$459.00	DU biologists will provide technical assistance to DNR and FWS agency staff and private landowners regarding shallow lakes in HCP Project Area #6.
Other Funds	Personnel Expenditures	$14,193.00	DU biologists will provide technical assistance to DNR and FWS agency staff and private landowners regarding shallow lakes in HCP Project Area #3-7-8.
Other Funds	Personnel Expenditures	$3,173.00	DU biologists will provide technical assistance to DNR and FWS agency staff and private landowners regarding shallow lakes in HCP Project Area #10.
Other Funds	Personnel Expenditures	$3,429.00	DU biologists will provide technical assistance to DNR and FWS agency staff and private landowners regarding shallow lakes in HCP Project Area #9.
Other Funds	Personnel Expenditures	$10,624.00	DU conservation program manager coordinates activities of DU engineers and biologists, and administers this grant.
	Total:	**$62,298.00**	

Work Program Expenditures (Not Attributable to Specific Projects) By Funding Type

Funding Type	**Amount**
ENTF	$30,420.00
Other Funds	$31,878.00
Total	**$62,298.00**

Work Program Expenditures Breakdown

Funding Type:	**Restoration Projects**	**Not Attributable to Specific Projects**	**Total**
ENTF	$194,580.00	$30,420.00	$225,000.00
Other Funds	$268,099.00	$31,878.00	$299,977.00

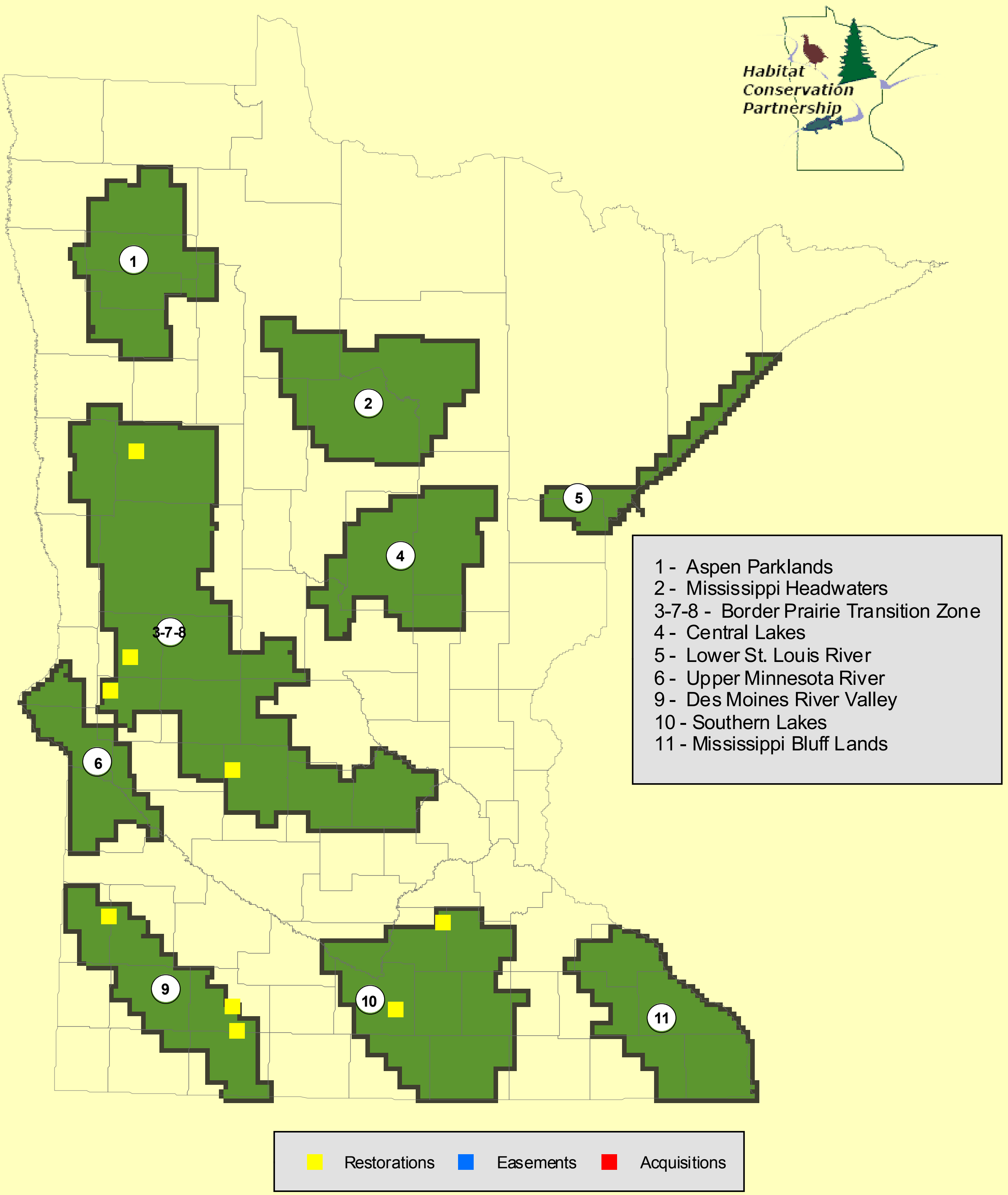
2C:Shallow Lake Enhancement - Ducks Unlimited

State Funds	$0.00	$0.00	$1,249.00
Total	$463,928.00	$62,298.00	$526,226.00

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Habitat Conservation Partnership
Shallow Lake Enhancement
2C



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Minnesota's Habitat Conservation Partnership Phase VI – Shallow Lake Assessment (2d), DNR – Section of Wildlife

PROJECT MANAGER: Ray Norrgard
AFFILIATION: DNR – Division of Fish and Wildlife
MAILING ADDRESS: 500 Lafayette Rd, Box 20
CITY/STATE/ZIP: St Paul, 55155-4020
PHONE: 651-259-5227
E-MAIL: ray.norrgard@state.mn.us
FAX: 651-297-4961
WEBSITE: www.dnr.state.mn.us

PROJECT TITLE:

FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4(e)2d

APPROPRIATION AMOUNT: $ 145,000

Overall Project Outcome and Results

DNR spent $140,689 to continue on-site field investigations to accelerate management of shallow lakes and adjacent wetland complexes and support the accomplishments of Ducks Unlimited through HCP 2c and 3c. Temporary field personnel (1 full time and up to 6 temporary) documented shallow lake habitat occurrence and quality. Habitat surveys were conducted on 171 lakes within seven HCP project areas. The lakes surveyed totaled over 82,831acres. The surveys were distributed more broadly than in the past with:

- 9 surveys conducted within Area 1,
- 9 surveys conducted within Area 2,
- 71 surveys conducted within Area 3,
- 15 surveys conducted within Area 4,
- 11 surveys conducted within Area 6,
- 30 surveys conducted within Area 9, and
- 26 surveys conducted within Area 10.

Data was entered into the DNR Shallow Lake Database, checked and verified.

Project Results Use and Dissemination

The habitat survey information was used to support DNR's shallow lake management efforts identified in the 2006 Duck Recovery Plan and Ducks Unlimited's efforts under Restoring Minnesota's Fish and Wildlife Habitat Corridors IV – Wildlife Shallow Lakes Enhancement 2(c). Dissemination of project accomplishments will be through the LCCMR reporting process and normal DNR budgeting and accomplishment reporting. Data collected on the habitat quality of shallow lakes will be available as part of the DNR shallow lakes database managed by Division of Fish and Wildlife staff in Brainerd.

Environment and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report: August 31, 2011
Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Minnesota's Habitat Conservation Partnership Phase VI – Shallow Lake Assessment (2d), DNR – Section of Wildlife

Project Manager: Ray Norrgard
Affiliation: DNR – Division of Fish and Wildlife
Mailing Address: 500 Lafayette Rd, Box 20
City / State / Zip: St Paul, 55155-4020
Telephone Number: 651-259-5227
E-mail Address: ray.norrgard@state.mn.us
FAX Number: 651-297-4961
Web Site Address: www.dnr.state.mn.us

Location: The primary emphasis will be in Habitat Conservation Partnership project areas 1, 2, 3, 4, 6, 9, 10 although some minor assessment work may occur in areas 5 and 11.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	$	145,000
	Minus Amount Spent:	$	140,689
	Equal Balance:	$	4,311

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4(e)2d

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the sixth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $770,000 is for the Department of Natural Resources agency programs and $2,605,000 is for agreements as follows: $450,000 with Pheasants Forever; $50,000 with Minnesota Deer Hunters Association; $895,000 with Ducks Unlimited, Inc.; $85,000 with National Wild Turkey Federation; $365,000 with the Nature Conservancy; $210,000 with Minnesota Land Trust; $350,000 with the Trust for Public Land; $100,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; $50,000 with the United States Fish and Wildlife Service; and $50,000 with Friends of Detroit Lakes Watershed Management District to plan, restore, and acquire fragmented landscape corridors that connect areas of quality habitat to sustain fish, wildlife, and plants. The United States Department of Agriculture-Natural Resources Conservation Service is a cooperating partner in the appropriation. Expenditures are limited to the project corridor areas as defined in the work program. Land acquired with this appropriation must be sufficiently

improved to meet at least minimum habitat and facility management standards as determined by the commissioner of natural resources. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY

Overall Project Outcome and Results

DNR spent $140,689 to continue on-site field investigations to accelerate management of shallow lakes and adjacent wetland complexes and support the accomplishments of Ducks Unlimited through HCP 2c and 3c. Temporary field personnel (1 full time and up to 6 temporary) documented shallow lake habitat occurrence and quality. Habitat surveys were conducted on 171 lakes within seven HCP project areas. The lakes surveyed totaled over 82,831acres. The surveys were distributed more broadly than in the past with:

- 9 surveys conducted within Area 1,
- 9 surveys conducted within Area 2,
- 71 surveys conducted within Area 3,
- 15 surveys conducted within Area 4,
- 11 surveys conducted within Area 6,
- 30 surveys conducted within Area 9, and
- 26 surveys conducted within Area 10.

Data was entered into the DNR Shallow Lake Database, checked and verified.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Complete 100 shallow lake surveys

DESCRIPTION: 171 shallow lake assessments, including both pre and post project lake monitoring, were completed to provide the information necessary to design and implement lake management strategies including DU lake structure enhancements and DNR accelerated management activities.

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$ 145,000**
	Amount Spent:	**$ 140,689**
	Balance:	**$ 4,311**

Deliverable	**Completion Date**	**Budget**	**Status**

1.171 lake surveys	June 30, 2011	$145,000	Completed

Completion Date: June 30, 2011
Final Report Summary: Habitat surveys were conducted on 171 lakes within seven HCP project areas. The lakes surveyed totaled 82,831 acres. The surveys were distributed more broadly than in the past with 9 surveys conducted within Area 1, 9 surveys conducted within Area 2, 71 surveys conducted within Area 3, 15 surveys conducted within Area 4, 11 surveys conducted within Area 6, 30 surveys conducted within Area 9, and 9 surveys conducted within Area 10. Data was entered into the DNR Shallow Lake Database, checked and verified.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $ 121,730 (actual $125,707)
Equipment/Tools/Supplies: $ 3,000 (actual $38)
Travel: $ 5,000 (actual $1,720)
Other (fleet and survey supplies): $ 16,000 (actual $1,322)

TOTAL TRUST FUND PROJECT BUDGET: $ 145,000
Salaries were shifted from interns to full-time temporary to accommodate workloads. Fleet payments were slightly more than predicted but were more than offset by savings in equipment and travel. Although actual accomplishments were 71% higher than the result objective there was an overall savings of $4,311.

Explanation of Capital Expenditures Greater Than $3,500: Not applicable

VI. PROJECT STRATEGY:

A. Project Partners:
This proposal is part of the Habitat Conservation Partnership Phase VI Proposal. Please see the main proposal for a complete list of partners involved.

B. Project Impact and Long-term Strategy:
This proposal is directly tied to the Shallow lakes that are a critical component of the wetland habitat complexes once common to Minnesota. These lakes provide the migration, brood rearing, and hibernacula critical for shorebirds, waterfowl, water birds, turtles and amphibians. Although these lakes physically remain on the landscape their ecological condition has been degraded by watershed changes and invasive species. However, many of these lakes can be restored with management investments. The shallow lake assessments completed with this grant are the first step towards restoration and meet the requirements for post project monitoring.

C. Other Funds Proposed to be Spent during the Project Period: The Section of Wildlife spends approximately $300,000 from Game and Fish Fund annually to provide technical assistance and assessment to support shallow lake management projects around the state.

D. Spending HIstory: Past ETF Spending**:** Phase I /2004: $350,000; Phase II/2005: $98,300; Phase III/2006: $98,000; Phase IV/2007: $98,000; Phase V/2008: 73,339.

VII. DISSEMINATION: Accomplishment Reports and press releases will be made available at http://www.mnhabitatcorridors.org

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted not later than December 1 and June 1 of each year. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS: N/A

Attachment A: Final Budget Detail for 2009 Projects

Project Title: Shallow Lake Assessment (2d)

Project Manager Name: Ray Norrgard

Trust Fund Appropriation: $ 145,000

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent**	**Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
	Shallow Lake Assessments				
BUDGET ITEM					
PERSONNEL: wages and benefits					
1 fte fulltime temporary specialist	45,730	62,744	-16,776	45,730	-16,776
3 fte (8) seasonal interns	75,270	62,963	15,428	75,270	15,428
Other direct operating costs: Vehicle fleet payments	12,000	13,040	-1,040	12,000	-1,040
Non-capital Equipment: Repair and replacement of lake suvey equipment as needed	3,000	38	2,962	3,000	2,962
Survey supplies	4,000	184	3,816	4,000	3,816
Travel expenses in Minnesota	5,000	1,720	3,280	5,000	3,280
COLUMN TOTAL	**$145,000**	**$140,689**	**$4,311**	**$145,000**	**$4,311**

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: HCP6-2g-Wildlife Areas Management
PROJECT MANAGER: Suzann Willhite
AFFILIATION: MN-DNR, Division of Fish & Wildlife
MAILING ADDRESS: 500 Lafayette Road,
CITY/STATE/ZIP: St Paul, MN 55155
PHONE: 651-259-5235
FAX: 651-297-4961
E-MAIL: Suzann.willhite@state.mn.us
WEBSITE: http://www.mnhabitatcorridors.org/
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Ch 143, Sec 2, Subd 4(e)

APPROPRIATION AMOUNT: $50,000

Overall Project Outcome and Results

Through this project DNR-Wildlife provides oversight for infrastructure management and habitat restoration on lands acquired by Habitat Conservation Partners (HCP). Partners acquire priority land and transfer it to the DNR for long term management as Wildlife Management Areas. This funding source ensures DNR will not incur a significant short-term liability for initial site development from these acquired lands. Temporary project staff or intermittent labor is hired as needed to implement development on lands acquired. Infrastructure management may include but is not limited to boundary surveys, boundary signing, professional services, public access, parking lots and user facilities, and clean up of old buildings or wells. Habitat restoration may include but is not limited to grassland development or improvement, wetland restoration or impoundment development, forest or woody cover development or improvement, brush land management, professional services, and food plot development. Digital boundary, habitat inventory and facilities files will be developed as part of the management plans. DNR cannot start work until the Partners have completed acquisition on each parcel. Once the new acquisitions are transferred to the DNR site development and habitat restoration work can occur.

Specifically in this phase, $6,128 was expended on habitat and development work at Benderberg WMA, including thirty acres of former cropland that were site prepped, seeded, and mowed. $43,872 went unspent due to when acquisitions were transferred to DNR, season for habitat work, and field staff availability.

Citizens of the state of Minnesota benefit from this project by having more public hunting and recreation land available in high priority landscapes throughout the state. These new public lands are managed as State Wildlife Management Areas (WMAs) by the Minnesota Department of Natural Resources (DNR) - Section of Wildlife for wildlife habitat.

Project Results Use and Dissemination

Information on HCP project results have been shared and disseminated through all partner organizations. Signs are posted on completed project sites identifying the ENRTF funding source. These signs provide information to the general public on how the lottery funds are spent for natural resource activities.

Environment and Natural Resources Trust Fund 2009 Work Program

Date of Report: August 30, 2011
Final Report
Date of Work Program Approval:
Project Completion Date:

I. PROJECT TITLE: Minnesota's Habitat Conservation Partnership Phase VI - Wildlife Areas Management (2g), DNR –FAW Section of Wildlife

Project Manager: Suzann Willhite
Affiliation: DNR – Division of Fish and Wildlife
Mailing Address: 500 Lafayette Rd, Box 20
City / State / Zip: St Paul, 55155-4020
Telephone Number: 651-259-5235
E-mail Address: suzann.willhite@dnr.state.mn.us
FAX Number: 651-297-4961
Web Site Address: www.dnr.state.mn.us

Location: All Habitat Conservation Partnership (HCP) work will be completed within the nine Project Area boundaries identified in the attached map (Habitat Conservation Partnership Wildlife Areas Management -2g Map).

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	$ 50,000
	Minus Amount Spent:	$ 6,127.79
	Equal Balance:	$ 43,872.21

Legal Citation: ML 2009, Chap. 143, Sec. 2, Subd. 4(e).

Appropriation Language:

(e) Minnesota's Habitat Conservation Partnership (HCP) – Phase VI

$3,375,000 is from the trust fund to the commissioner of natural resources for the sixth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $770,000 is for the Department of Natural Resources agency programs and $2,605,000 is for agreements as follows: $450,000 with Pheasants Forever; $50,000 with Minnesota Deer Hunters Association; $895,000 with Ducks Unlimited, Inc.; $85,000 with National Wild Turkey Federation; $365,000 with the Nature Conservancy; $210,000 with Minnesota Land Trust; $350,000 with the Trust for Public Land; $100,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; $50,000 with the United States Fish and Wildlife Service; and $50,000 with Friends of Detroit Lakes Watershed Management District to plan, restore, and acquire fragmented landscape corridors that connect areas of quality habitat to sustain fish, wildlife, and plants. The United States Department of Agriculture-Natural Resources Conservation Service is a cooperating partner in the appropriation. Expenditures are limited to the project corridor areas as defined in the work program. Land acquired with this appropriation must be sufficiently improved to meet at least minimum habitat and facility management standards as determined by the commissioner of natural resources. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY:

Overall Project Outcome and Results

Through this project DNR-Wildlife provides oversight for infrastructure management and habitat restoration on lands acquired by Habitat Conservation Partners (HCP). Partners acquire priority land and transfer it to the DNR for long term management as Wildlife Management Areas. This funding source ensures DNR will not incur a significant short-term liability for initial site development from these acquired lands. Temporary project staff or intermittent labor is hired as needed to implement development on lands acquired. Infrastructure management may include but is not limited to boundary surveys, boundary signing, professional services, public access, parking lots and user facilities, and clean up of old buildings or wells. Habitat restoration may include but is not limited to grassland development or improvement, wetland restoration or impoundment development, forest or woody cover development or improvement, brush land management, professional services, and food plot development. Digital boundary, habitat inventory and facilities files will be developed as part of the management plans. DNR cannot start work until the Partners have completed acquisition on each parcel. Once the new acquisitions are transferred to the DNR site development and habitat restoration work can occur.

Specifically in this phase, $6,128 was expended on habitat and development work at Benderberg WMA, including thirty acres of former cropland that were site prepped, seeded, and mowed. $43,872 went unspent due to when acquisitions were transferred to DNR, season for habitat work, and field staff availability.

Citizens of the state of Minnesota benefit from this project by having more public hunting and recreation land available in high priority landscapes throughout the state. These new public lands are managed as State Wildlife Management Areas (WMAs) by the Minnesota Department of Natural Resources (DNR) - Section of Wildlife for wildlife habitat.

Project Results Use and Dissemination

Information on HCP project results have been shared and disseminated through all partner organizations. Signs are posted on completed project sites identifying the ENRTF funding source.

These signs provide information to the general public on how the lottery funds are spent for natural resource activities.

IV. OUTLINE OF PROJECT RESULTS:

Result 1: Wildlife Areas Management

Description: DNR, Section of Wildlife staff will administer and manage habitat restoration and development of infrastructure necessary for public access on lands acquired by partners for State Wildlife Management Areas (WMA).

Summary Budget Information for Result 1: **Trust Fund Budget: $ 50,000**
Amount Spent: $ 6,127.79
Balance: $ 43,872.21

Deliverable	**Completion Date**	**Budget**
1. Initial site development on 200+ acres of partner acquired lands	June 30, 2011	$43,872.21

Result Completion Date: June 30, 2011.

Final Report Summary: Not all the funding was expended due to several reasons such as acquisition transfer time, season for habitat work, and field staff availability. Acquisition transfer from partner organizations to the DNR often takes a substantial amount of time. There are still WMA partner acquisitions in the transfer process that would qualify for this habitat and initial development funding. A second reason is the limited seasonal time and multiple year phases for some habitat work to be completed, for example, prairie establishment can take 3 to 5 years. And a third reason for not expending all the funds is the limited DNR field staff time available to coordinate or complete the habitat and development work. The $6,128 expended was for partner organization Pheasants Forever's acquisition at Benderberg WMA habitat and development work. Thirty acres of former cropland were site prepped, seeded and mowed. Development work consisted of boundary sign posting and parking lot construction. This project was originally approved for $10,000 of habitat and development work, but the work was not able to be completed before the funding expiration date. It would be helpful if future ENRTF funding for habitat and development work would have three years before expiring to allow more work to be completed over several seasons.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $ 5,000
Contracts: $ 15,000
Equipment/Tools/Supplies: $ 8,000
Acquisition, including easements: $ 0
Travel: $ 2,000

Other: $ 20,000

TOTAL TRUST FUND PROJECT BUDGET: $ 50,000

Explanation of Capital Expenditures Greater Than $3,500:
Infrastructure facility development and restoration of an estimated 200 acres.

VI. PROJECT STRATEGY:

A. Project Partners:
This proposal is part of the Habitat Conservation Partnership Phase VI Proposal. Please see the main proposal for a complete list of partners involved.

B. Project Impact and Long-term Strategy:
The mission of the Habitat Conservation Partnership is to restore, enhance and conserve habitat for the purpose of sustaining fish, wildlife and plant communities for all generations. Minnesota's Habitat Conservation Partnership (Partnership), formerly the Habitat Corridors Partnership, was formed in 2000 to provide a framework for statewide land conservation in partnership with the Environmental Trust Fund. The work of the Partnership has three main objectives: 1) **Partnership**: working together to accelerate existing programs and identify new opportunities that build upon our existing investments in habitat. 2) **Focus**: The Phase VI proposal will work in nine project areas encompassing 27,442 mi^2. All work proposed will occur within the identified project areas. These areas were identified as focus areas where resource conservation priorities and opportunity overlap 3) **Leverage**: the objective of this partnership is to bring more resources to bear on Minnesota's conservation need by identifying non-state contributions to accelerate habitat conservation by maximizing the results from limited funding through the Environmental Trust Fund.

This proposal is directly tied to the land acquisition efforts of the Partners, and ensures the timely restoration and development of newly acquired lands to benefit wildlife and provide public access.

C. Other Funds Proposed to be Spent during the Project Period: The Section of Wildlife spends approximately 8 million from Game and Fish and Heritage funds to do wildlife management and habitat improvement projects around the state.

D. Spending HIstory: Past ETF Spending**:** Phase I - 2004: $611,043; Phase II - 2005: $43,350; Phase III - 2006: $103,278; Phase IV - 2007: $11,944; Phase V - 2008: $29,102.

VII. DISSEMINATION: Accomplishment Reports and press releases will be made available at http://www.mnhabitatcorridors.org. Final reports will be available on the LCCMR website at: http://www.lccmr.leg.mn/lccmr.htm

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than December 1 and May 1 of each year. **A final work program report**

and associated products will be submitted between June 30 and August 31, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS: N/A

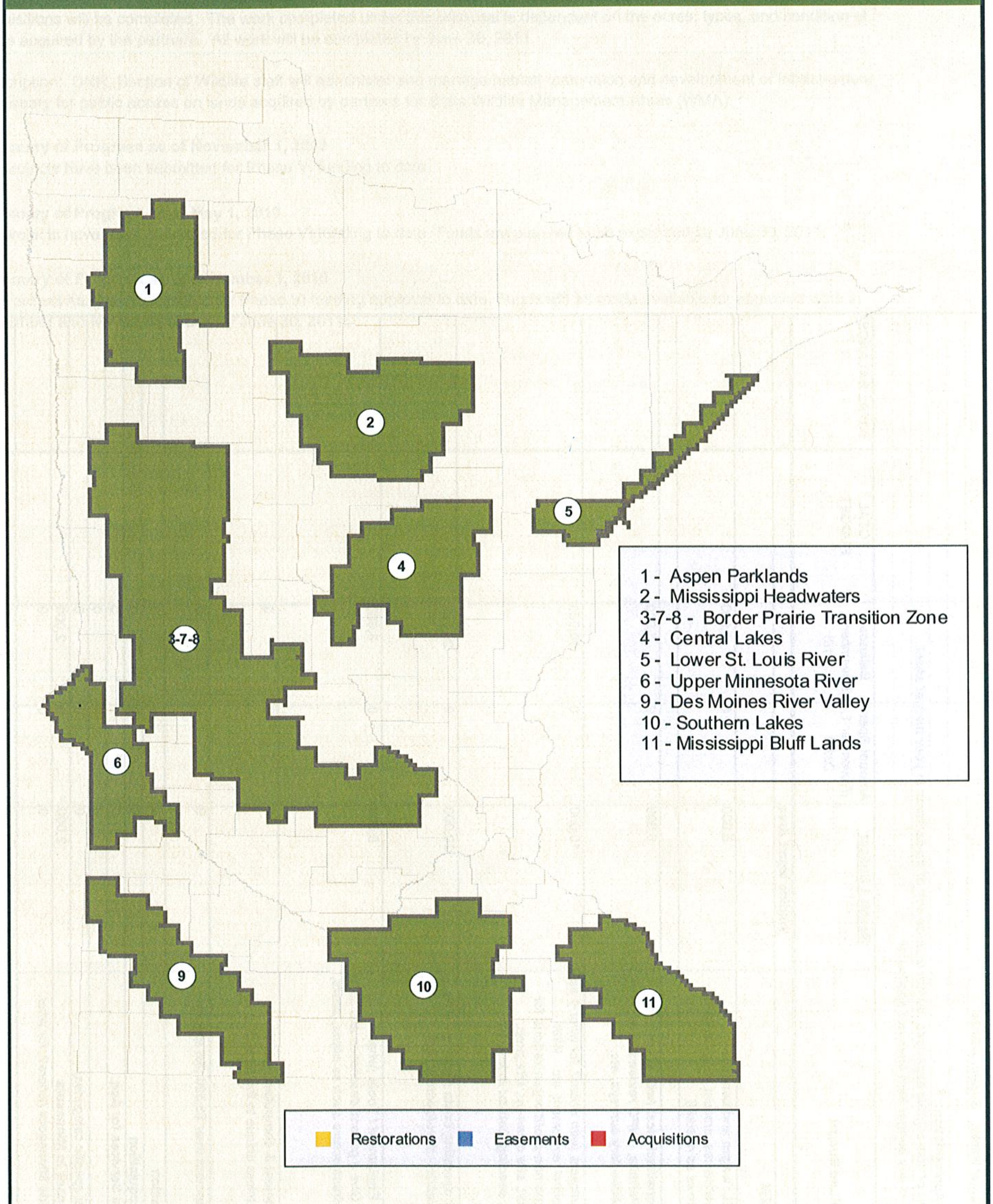
Attachment A: Final Budget Detail for 2009 Project
Updated: August 30, 2011
Project Title: *Wildlife Areas Management (2g), DNR – Section of Wildlife*

Project Manager Name: *Suzann Willhite*

Trust Fund Appropriation: $ *50,000*

2009 Trust Fund Budget	Result 1 Budget:	Amount Spent (June 30, 2011)	TOTAL BUDGET	TOTAL BALANCE (August 30, 2011)
	Wildlife Mgmt Area			
BUDGET ITEM				
PERSONNEL: wages and benefits	5,000	0	5,000	5,000
Contracts				
Professional/technical - ***Permits, SHPO reviews, well sealing, boundary surveys, etc.***	5,000	0	5,000	5,000
Other contracts - ***With private and non-profit organizations for land mgmt, site clean-up, site prep, planting, seeding, habitat mgmt, etc***	10,000	0	10,000	10,000
Other direct operating costs - ***Habitat development and restoration.***	20,000	0	20,000	20,000
Non-capital Equipment / Tools -***Fleet and Infrastructure such as signs, posts, gravel, etc.***	8,000	6,128	8,000	1,872
Travel expenses in Minnesota	2,000	0	2,000	2,000
COLUMN TOTAL	**$50,000**	**$6,128**	**$50,000**	**$43,872**

Habitat Conservation Partnership
Wildlife Areas Management
2G



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: HCP6 - Fish Habitat
PROJECT MANAGER: Linda Erickson-Eastwood
AFFILIATION: MN-DNR, Division of Fish & Wildlife
MAILING ADDRESS: 500 Lafayette Road,
CITY/STATE/ZIP: St Paul, MN 55155
PHONE: 651-259-5206
FAX: 651-297-4916
E-MAIL: **linda.erickson-eastwood**@state.mn.us
WEBSITE: http://www.mnhabitatcorridors.org/
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chapter 143, Section 2, Subd. 4e2h

APPROPRIATION AMOUNT: $100,000

Overall Project Outcome and Results

Citizens of the state of Minnesota benefit from this project by having a better fish community structure in Mills Lake, Blue Earth Co, and Horseshoe Lake, Rice County. They also benefit from improved stream habitat for trout on Winnebago Creek, Houston Co. This then creates better fishing and recreation available in high priority waterbodies. The portions of the work that the DNR was responsible for was completed on June 30, 2011. Design and planning for two barriers to prevent carp migration was the basis for these two projects. The projects were installed with the assistance of partners. The Horseshoe Lake barrier is completed while high water resulted in the Mills Lake installation being delayed until this fall. Once both are completed, we will have enhanced approximately 654 acres total. Another project done was plans, designs, and purchase of materials to restore 3,200 feet of trout waters on Winnebago Creek. Due to high waters, the partners will finish the installation this fall. Long term maintenance of these projects is going to be shared with the partners. These funds were also used to get the designs done for the Hartley Lake fish passage project.

Project Results Use and Dissemination

Information on HCP project results have been shared and disseminated through all partner organizations. The Environmental Trust Fund provides information to the general public on how the lottery funds are spent for natural resource activities.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2H:Fisheries Habitat Restoration - MN DNR - Division of Fisheries

Project Manager: Linda Erickson-Eastwood

Affiliation: MN DNR - Division of Fisheries

Address: 500 Lafayette Rd.
St. Paul, MN 55155

Phone: (651) 259-5206

Fax: (651) 297-4916

E-mail: linda.erickson-eastwood@dnr.state.mn.us

Fund: Environment and Natural Resources Trust Fund

Legal Citation:

ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds * Proposed	Other Funds * Spent
Restoration	$100,000	$100,000	$0	$0	$18,000
Total	$100,000	$100,000	$0	$0	$18,000

*Other Funds are classified as non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds). Please note, however, that this work program has spent the following amounts not shown in the above table:

State Funds: $51,000.00
Partners State Levereged Funds: $85,000.00

See the tables and funding type definitions at the end of this report for further explanation.

Work Program Summary

Overall Project Outcome and Results

Citizens of the state of Minnesota benefit from this project by having a better fish community structure in Mills Lake, Blue Earth Co, and Horseshoe Lake, Rice County. They also benefit from improved stream habitat for trout on Winnebago Creek, Houston Co. This then creates better fishing and recreation available in high priority waterbodies. The portions of the work that the DNR was responsible for was completed on June 30, 2011. Design and planning for two barriers to prevent carp migration was the basis for these two projects. The projects were installed with the assistance of partners. The Horseshoe Lake barrier is completed while high water resulted in the Mills Lake installation being delayed until this fall. Once both are completed, we will have enhanced approximately 654 acres total. Another project done was plans, designs, and purchase of
are completed, we will have enhanced approximately 654 acres total. Another project done was plans, designs, and purchase of
materials to restore 3,200 feet of trout waters on Winnebago Creek. Due to high waters, the partners will finish the installation this fall. Long term maintenance of these projects is going to be shared with the partners. These funds were also used to get the designs done for the Hartley Lake fish passage project.

Project Results Use and Dissemination

Information on HCP project results have been shared and disseminated through all partner organizations. The Environmental Trust Fund provides information to the general public on how the lottery funds are spent for natural resource activities.

2H:Fisheries Habitat Restoration - MN DNR - Division of Fisheries

Restoration Activities

Project Area - 2 - Mississippi Headwaters

Project Name: Hartley Lake Outlet
Township: 59, Range: 23, Section: 32

Activity: Dam Modification
Landtype: Public - Lake
Description: This was the engineering phase of modifiying the area and dam for fish passage.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$3,416.00	0.00	0.00

Project Area - 10 - Southern Lakes

Project Name: Horseshoe Lake AMA
Tract: 2
Township: 109, Range: 23, Section: 12

Activity: Dam Modification
Landtype: Public - Lake
Description: A high velocity culvert to to prevent carp passage was installed at the intersection of Twp. Road 24 and an unnamed lake. The culvert slope was raised by 6% to create a barrier to the carp movement upstream. This project was done with the assistance of Morristown Township.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$23,205.00	130.40	0.00
State Funds	Restoration	$51,000.00	286.60	0.00
Horseshoe Lake AMA 2 Total		**$74,205.00**	**417.00**	**0.00**

Project Name: Mills Lake Barrier
Township: 107, Range: 28, Section: 11

Activity: Dam Modification
Landtype: Public - Lake
Description: This project is putting in a fish barrier at the inlet of Mills Lake to ensure that unwanted fish do not enter the lake. By preventing the movement of unwanted fish, like carp, we can better maintain the habitat in the lake and produce a naturally sustaining fish community. This is a cooperative project with the Blue Earth County. We paid for design, plans and permits. Blue Earth will install the barrier sometime in the Fall of 2011.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$2,100.00	237.00	0.00

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2H:Fisheries Habitat Restoration - MN DNR - Division of Fisheries

Project Area - 11 - Mississippi Bluff Lands

Project Name: Winnebago Cree
Township: 101, Range: 5, Section: 15

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Public - River
Description: This project is being done in cooperation with Trout Unlimited. This project will restore instream habitat and correct eroding banks. The work will enhance the trout fishing in that part of the state. Due to flood in the spring of 2011 the completion of the project will be in the fall of 2011.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$71,279.00	0.00	1,459.52
Other Funds	Personnel Expenditures	$18,000.00	0.00	0.00
Partners State Leveraged Funds	Restoration	$85,000.00	0.00	1,740.48
Winnebago Cree Total		**$174,279.00**	**0.00**	**3,200.00**

Restoration Project Totals (By Funding Type)

Funding Type	Funding Amount	Acres	Shoreline Feet
ENTF:	$100,000.00	367.40	1,459.52
Other Funds:	$18,000.00	0.00	0.00
Partner's State Leveraged Funds	$85,000.00	0.00	1,740.48
State Funds:	$51,000.00	286.60	0.00
Total:	**$254,000.00**	**654.00**	**3,200.00**

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects Final

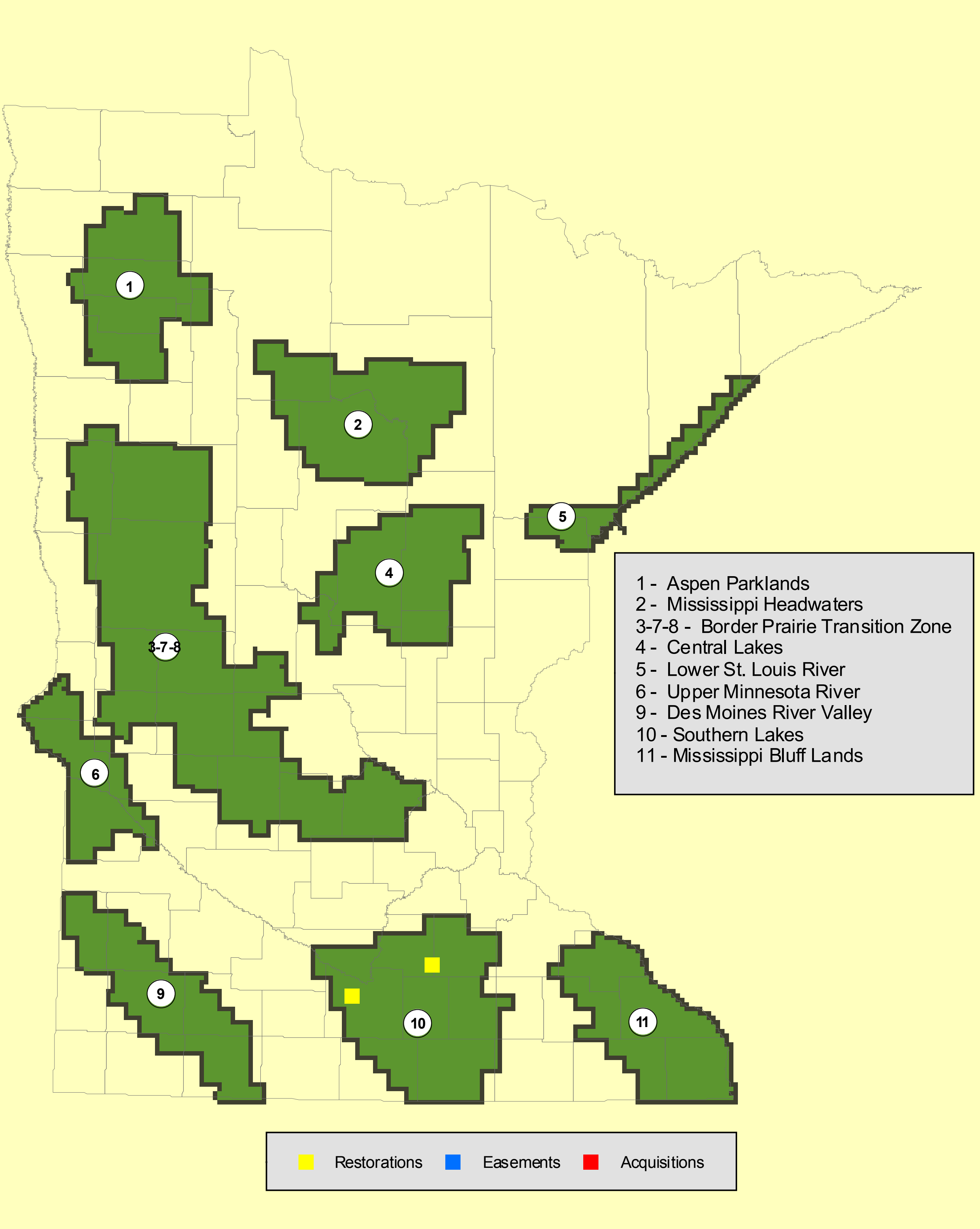
Project Title: Phase VI - Fish Habitat Improvement (2H)
Minnesota's Habitat Conservation Partnership

Project Manager Name: Linda Erickson-Eastwood

Trust Fund Appropriation: $ *100,000 (VERSION Sept 2011)*
1) See list of non-eligible expenses, do not include any of these items in your budget sheet
2) Remove any budget item lines not applicable

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(Sept 2011)*	**Balance** *(Sept 2011)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Habitat Improvement				
BUDGET ITEM					
PERSONNEL: *for seasonal staff to be hired as needed (approx. .25 FTE): Note that we did not use all of the funds allotted to this item.*	20,000	10,000	10,000	20,000	10,000
Contracts					
Professional/technical? *legal services, engineering, signage*	15,000	15,000	0	15,000	0
Other contracts; *low bid for habitat design or installation work being done or materials needed for fish habitat work*	65,000	75,000	0	65,000	-10,000
Other direct operating costs *(for what? – be specific)*					
Non-capital Equipment / Tools *(what equipment? Give a general description and cost)*					
Office equipment & computers - NOT ALLOWED unless unique to the project					
Capital equipment over $3,500 *(list specific items)*					
Land acquisition					
Easement acquisition					
Professional Services for Acq.					
Printing					
Supplies *(list specific categories)*					
Travel expenses in Minnesota					
Travel outside Minnesota *(where?, for what purpose?)*					
Other *(Describe the activity and cost) be specific*					
COLUMN TOTAL	**$100,000**	**$100,000**	**$0**	**$100,000**	**$0**

Habitat Conservation Partnership
Fisheries Habitat Restoration
2H



Attachment A: Budget Detail for Projects					
Project Title: Phase VI - Fish Habitat Improvement (2H) final Minnesota's Habitat Conservation Partnership					
Project Manager Name: Linda Erickson-Eastwood					
Trust Fund Appropriation: $ *100,000 (VERSION Sept 2011)*					
1) See list of non-eligible expenses, do not include any of these items in your budget sheet					
2) Remove any budget item lines not applicable					
2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Habitat Improvement				
BUDGET ITEM					
PERSONNEL: *for seasonal staff to be hired as needed (approx. .25 FTE)*					
Contracts					
Professional/technical? *legal services, engineering, signage*	15,000	15,000	0	15,000	0
Other contracts; *low bid for habitat design or installation work being done or materials needed for fish habitat work*	85,000	85,000	0	85,000	0
Other direct operating costs *(for what? – be specific)*					
Non-capital Equipment / Tools *(what equipment? Give a general description and cost)*					
Office equipment & computers - NOT ALLOWED unless unique to the project					
Capital equipment over $3,500 *(list specific items)*					
Land acquisition					
Easement acquisition					
Professional Services for Acq.					
Printing					
Supplies *(list specific categories)*					
Travel expenses in Minnesota					
Travel outside Minnesota *(where?, for what purpose?)*					
Other *(Describe the activity and cost) be specific*					
COLUMN TOTAL	**$100,000**	**$100,000**	**$0**	**$100,000**	**$0**


Hancock


DAHLE
DNR CULVERT REPLACEMENT
8 X 4 CL 2
HANCOCK - CF
05-18-11
CAST


DAHLE
DNR CULVERT REPLACEMENT
8 X 4 CL 2
HANCOCK - CF
05-18-11
Q
CAST


CULVERT REPLACEMENT

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Set Out Seedlings/ Bluffland Restoration
PROJECT MANAGER: Rick Horton (formerly Dave Neu)
AFFILIATION: National Wild Turkey Federation
MAILING ADDRESS: 37305 Deer Lake Way
CITY/STATE/ZIP: Grand Rapids, MN 55744
PHONE: 218-326-8800
E-MAIL: rhorton@nwtf.net
WEBSITE: www.nwtf.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chapter 143, Section 2, Subd. 4(e), para. 2i

APPROPRIATION AMOUNT: $85,000

Overall Project Outcome and Results

This project contained two types of habitat enhancement that resulted in the enhancement of a total of 72 acres of habitat.

In Habitat Corridor Area 11 in southeastern Minnesota, we contracted to have invasive eastern red cedar and buckthorn removed and controlled on south-facing blufftops on 60.75 acres of private land (5 parcels). These “goat prairies” were historically maintained by wind, freeze/thaw cycles, thin soils, and frequent wildfires. Fire suppression has allowed trees, shrubs, and exotic species to encroach upon the prairies. The contractor hand cut, piled, and burned trees and shrubs, and treated invasive species to ensure they would not resprout. This project enhanced prairie and outcrop habitat for state-threatened timber rattlesnakes, as well as three other at-risk snake species and numerous at-risk plant species found in this unique habitat. The resulting open grasslands will also be used as nesting and brood-rearing habitat for wild turkeys and other birds. Participating landowners have signed a 10-year maintenance agreement. Project cost was $67,259.50.

In Habitat Corridor 9, we purchased seedlings to plant 150 bur oak, 150 black walnut, and 175 hackberry trees on 11 acres on the Talcot Lake WMA. These trees were protected from herbivory by tree shelters and weed mats. In addition, we purchased 475 seedlings of each of the following fruiting shrubs – chokecherry, red osier dogwood, elderberry, and American plum. All seedlings were planted by DNR staff. This project restored oak savanna and lowland hardwood forest to provide roosting sites for wild turkeys along southwestern Minnesota river corridors, and provided natural winter food resources by planting fruit-bearing shrubs. Project cost was $7,070.23. We had hoped to accomplish more tree planting, but a staff change near the end of the project prevented us from finding a suitable location and order materials before the project deadline.

Project Results Use and Dissemination

Our intention is to make NWTF Chapters and volunteers aware of the accomplishments of this Environmental Trust Fund project by posting an article on our website and Facebook page. In addition, we plan to release a press statement announcing the completion of the project to the general public.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2I:Set Out Seedlings/Bluffland Restoration - NWTF

Project Manager: Rick Horton

Affiliation: NWTF

Address: 37305 Deer Lk Way
Grand Rapids, MN 55744

Phone: 2183268800

Fax:

E-mail: rickhorton

Fund: Environment and Natural Resources Trust Fund

Legal Citation: ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Restoration	$85,000	$74,330	$10,670	$73,000	$0
Total	$85,000	$74,330	$10,670	$73,000	$0

Work Program Summary

Overall Project Outcome and Results

This project contained two types of habitat enhancement. In Habitat Corridor Area 11 in southeastern Minnesota, we contracted to have invasive eastern red cedar and buckthorn removed from south-facing blufftops on 60.75 acres of private land (5 parcels). These “goat prairies” were historically maintained by frequent wildfires, but fire suppression allowed for tree encroachment. This work enhanced prairie and outcrop habitat for state-threatened timber rattlesnakes, as well as three other at-risk snake species and numerous at-risk plant species found in this unique habitat. The resulting open grasslands will also be used as nesting and brood-rearing habitat for wild turkeys and other birds. Participating landowners have signed a 10-year maintenance agreement. Project cost was $67,259.50.

In Habitat Corridor 9, we purchased seedlings to plant 150 bur oak, 150 black walnut, and 175 hackberry trees on 11 acres on the Talcot Lake WMA. These trees were protected from herbivory by tree shelters and weed mats. In addition, we purchased 475 seedlings of each of the following fruiting shrubs – chokecherry, red osier dogwood, elderberry, and American plum. All seedlings were planted by DNR staff. This project restored oak savanna and lowland hardwood forest to provide roosting sites for wild turkeys along southwestern Minnesota river corridors, and provided natural winter food resources by planting fruit-bearing shrubs. Project cost was $7,070.23. We had hoped to accomplish more tree planting, but a staff change near the end of the project prevented us from finding a suitable location and order materials before the project deadline.

Project Results Use and Dissemination

Due to the staff transition, I am unaware of what outreach my predecessor accomplished on this project. My intention is to make NWTF Chapters and volunteers aware of the accomplishments of this Environmental Trust Fund project by posting an article on our website and Facebook page. In addition, I plan to release a press statement announcing the completion of the project to the general public.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6

Habitat Conservation Partnership

2I:Set Out Seedlings/Bluffland Restoration - NWTF

Restoration Activities

Project Area - 9 - Des Moines River Valley

Project Name: Talcot Lake WMA
Township: 105, Range: 38, Section: 24

Activity: Woodland Restoration
Landtype: Public - WMA
Description: Eleven acres of native trees were planted on Talcot Lake WMA. Tree tubes, stakes, and weed mats were utilized to enhance this planting.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*	*ProratedTrees Planted*
ENTF	Restoration	$5,170.23	11.00	0.00	

2I:Set Out Seedlings/Bluffland Restoration - NWTF

Project Area - 11 - Mississippi Bluff Lands

Project Name: Laschenski
Tract: 2
Township: 103, Range: 7, Section: 35
Activity: Grassland Enhancement
Landtype: Private - Land
Description: will be updated

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline	ProratedTrees Planted
ENTF	Restoration	$19,110.00	21.00	0.00	

Project Name: Knutson
Tract: 1
Township: 103, Range: 7, Section: 31
Activity: Grassland Enhancement
Landtype: Private - Land
Description: will be updated

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline	ProratedTrees Planted
ENTF	Restoration	$11,042.00	14.00	0.00	

Project Name: Frauenkron
Tract: 1
Township: 104, Range: 6, Section: 21
Activity: Grassland Enhancement
Landtype: Private - Land
Description: will be updated

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline	ProratedTrees Planted
ENTF	Restoration	$13,837.50	10.25	0.00	

Project Name: Ferris
Tract: 1
Township: 103, Range: 7, Section: 32
Activity: Grassland Enhancement
Landtype: Private - Land
Description: will be updated

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline	ProratedTrees Planted
ENTF	Restoration	$9,715.00	9.25	0.00	

Project Name: Peters
Tract: 1
Township: 105, Range: 5, Section: 33
Activity: Grassland Enhancement
Landtype: Private - Land
Description: will be updated

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline	ProratedTrees Planted
ENTF	Restoration	$6,555.00	6.25	0.00	

Restoration Project Totals (By Funding Type)

Funding Type	Funding Amount	Acres	Shoreline Feet	# Trees Planted
ENTF:	$65,429.73	71.75	0.00	
Total:	**$65,429.73**	**71.75**	**0.00**	

2I:Set Out Seedlings/Bluffland Restoration - NWTF

Work Program Expenditures - Not Attributable to Specific Projects

FundingType	*Category*	*Amount*	*Description*
ENTF	Personnel Expenditures	$850.00	Staff time working on Result 2 while attempting to locate an appropriate tree planting project site, plan a project, amend the Workplan, and bid materials. Unfortunately we could not pull together a successful project due to staff transition and short dealine before the project expired.
ENTF	Personnel Expenditures	$7,000.00	Staff time while administering projects under Result 1. This included selecting sites, developing bid specifications, soliciting and reviewing bids, selecting contractors, visiting sites, filing reports and processing invoices.
ENTF	Personnel Expenditures	$1,050.00	Staff time administering project under Result 2. This involved selecting planting sites, ordering materials, filing reports, processing invoices and visiting site.
	Total:	**$8,900.00**	

Work Program Expenditures (Not Attributable to Specific Projects) By Funding Type

Funding Type	**Amount**
ENTF	$8,900.00
Total	**$8,900.00**

Work Program Expenditures Breakdown

Funding Type:	**Restoration Projects**	**Not Attributable to Specific Projects**	**Total**
ENTF	$65,429.73	$8,900.00	$74,329.73
State Funds	$0.00	$0.00	$0.00
Total	$65,429.73	$8,900.00	$74,329.73

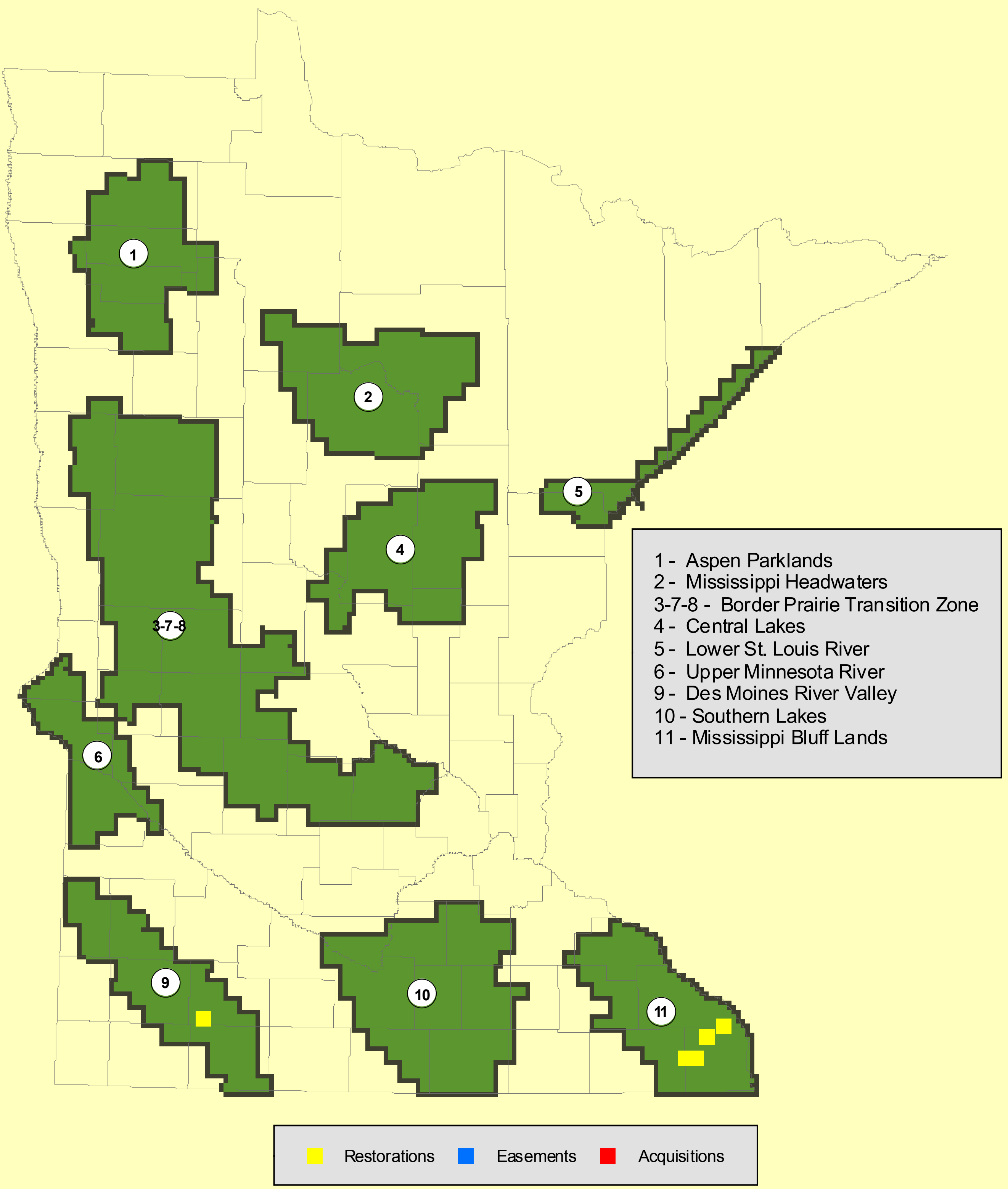
Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Habitat Conservation Partnership

Set Out Seedlings/Bluffland Restoration

2I



Attachment A: Budget Detail for 2009 Projects - Summary and a Budget page for each partner

Project Title: Bluffland Restoration and Set Out Seedlings - 2i

Minnesota's Habitat Conservation Partnership (VI)

Project Manager Name: *Rick Horton - NWTF Regional Biologist*

Trust Fund Appropriation: $ *85,000*

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

2008 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(June 30, 2011)*	**Balance** *(June 30, 2011)*	**TOTAL BUDGET**	**Result 2 Budget:**	**Amount Spent** *(June 30, 2011)*	**Balance** *(June 30, 2011)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Restore up to 120 acres of bluffland habitat				*Direct seed and plant seedlings on up to 60 acres*				
BUDGET ITEM			0				0		
PERSONNEL: wages and benefits and travel	7,000	7,000	0	7,000	2,000	1,900	100	2,000	100
Contracts			0				0		
Professional/technical *(with whom?, for what?)*	63,000	60,260	2,741	63,000			0		2,741
Other land improvement *(seedlings, stakes, mats, tubes))*		0			13,000	5,170	7,830	13,000	7,830
Other *(Describe the activity and cost) be specific*			0				0		

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Phase VI – Lakescaping for Wildlife and Water Quality (2J)
Minnesota's Habitat Conservation Partnership

Project Manager: Carrol Henderson
Affiliation: DNR Division of Ecological and Water Resources
Mailing Address: 500 Lafayette Road, Box 25
City / State / Zip: St. Paul, MN 55155-4020
PHONE: 651-259-5104
E-MAIL: Carrol.Henderson@dnr.state.mn.us
WEBSITE: www.mndnr.gov
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chapter 143, Section 2, Subd. 4e2j

APPROPRIATION AMOUNT: $75,000

Overall Project Outcome and Results
For Phase 6 of the Habitat Corridors Partnership project a total of eight lakescaping buffer zones were proposed for selection, planning, and installation in habitat corridors 3, 4, 7, and 9. This project exceeded that goal for a total of nine buffer zones, which were completed on schedule and under budget, totaling 1298 frontage feet of shoreline. This equates to an average cost of $55.82 per foot for planning, installing, and maintaining these shoreline buffer zones which are designed to improve water quality and fish and wildlife habitat.

In addition to the buffer zones, two field days were provided for the public in 2010 to view buffer zones that had previously been installed. One field day was held near Grand Rapids and one was held in the Alexandria vicinity.

The final component of this activity was to collect native origin plant seeds and propagules in 2009 and 2010 for propagation and subsequent planting on buffer zone sites. The goal was to collect seeds for a total of 80 plant species. However, a total of 92 species of native plant seeds and propagules were collected and subsequently used in the plantings.

This has been a very successful effort and an excellent partnership between the DNR's Division of Ecological and Water Resources and the Division of Fish and Wildlife to carry out this effort to promote stewardship of lakeshore habitat on private shorelands.

Project Results Use and Dissemination
Completion of Phase 6 brings to 73 the total number of lakescaping buffer zone demonstration areas that have been installed in 7 habitat corridors in 22 Minnesota counties since May of 2000 with LCMR and LCCMR support provided from the Minnesota Environment and Natural Resources Trust Fund. This initiative has been instrumental in promoting this concept of lakeshore stewardship not only throughout Minnesota but also in adjacent states and as far off as Washington state and South Carolina. The book Lakescaping for Wildlife and Water Quality and the new on-line version of Restore Your Shore provide a continuing source of information for people to learn how to plan and install their own buffer zones. Also, the DNR Shoreland Habitat Program continues to offer on-the-ground assistance to local lakeshore

associations, landowners, and local and county units of government to initiate lakeshore buffer zones throughout the state. The LCCMR deserves considerable credit for providing funding to help promote this essential concept for stewardship of privately owned lakeshore in Minnesota.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2J:Lakescaping - MN DNR - Division of Ecological Services

Project Manager: Carrol Henderson

Affiliation: MN DNR - Division of Ecological Services

Address: 500 Lafayette Rd.
St. Paul, MN 55155

Phone: (651) 259-5104

Fax: (651) 297-4961

E-mail: carrol.henderson@state.mn.us

Fund: Environment and Natural Resources Trust Fund

Legal Citation:

ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Restoration	$75,000	$72,458	$2,542	$0	$0
Total	$75,000	$72,458	$2,542	$0	$0

Work Program Summary

Overall Project Outcome and Results

Please Input a Overall Project Outcome and ResultsPhase 6 of the lakescaping projects was completed by June 30, 2011. A total of eight lakescaping buffer zones were proposed for selection, planning, and installation in habitat corridors 3, 4, 7, and 9. A total of nine buffer zones were completed on schedule and under budget, totaling 1298 frontage feet of shoreline. This equates to an average cost of $55.82 per foot for planning, installing, and maintaining these shoreline buffer zones which are designed to improve water quality and fish and wildlife habitat.

In addition to the buffer zones, two field days were provided for the public in 2010 to view buffer zones that had previously been installed. One field day was held near Grand Rapids and one was held in the Alexandria vicinity.

The final component of this activity was to collect native origin plant seeds and propagules in 2009 and 2010 for propagation and subsequent planting on buffer zone sites. The goal was to collect seeds for a total of 80 plant species. However, a total of 92 species of native plant seeds and propagules were collected and subsequently used in the plantings.

This has been a very successful effort and an excellent partnership between the DNR's Division of Ecological and Water Resources and the Division of Fish and Wildlife to carry out this effort to promote stewardship of lakeshore habitat on private shorelands.

Project Results Use and Dissemination

Completion of Phase 6 brings to 73 the total number of lakescaping buffer zone demonstration areas that have been installed in 7 habitat corridors in 22 Minnesota counties since May of 2000 with LCMR and LCCMR funds from the Minnesota Environment and Natural Resources Trust Fund. This initiative has been instrumental in promoting this concept of lakeshore stewardship not only throughout Minnesota but also in adjacent states and as far off as Washington State and South Carolina. The book Lakescaping for Wildlife and Water Quality and the new on-line version of Restore Your Shore provide a continuing source of information for people to learn how to plan and install their own buffer zones. Also, the DNR Shoreland Habitat Program continues to offer on-the-ground assistance to local lakeshore associations, landowners, and local and county units of government to initiate lakeshore buffer zones throughout the state.
The LCCMR deserves considerable credit for providing funding to help promote this essential concept for stewardship of privately owned lakeshore in Minnesota.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6

Habitat Conservation Partnership

2J:Lakescaping - MN DNR - Division of Ecological Services

Restoration Activities

Project Area - 3 - Border Prairie

Project Name: Jewett Lake
Tract: 1
Township: 134, Range: 43, Section: 23

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: This site on Jewett Lake has been selected, planned, and was installed on June 9-10, 2010.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$7,867.00	1.00	140.00

Project Name: Lake Vermont
Tract: 1
Township: 130, Range: 37, Section: 7

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: This lakescaping site has been selected, planned, and was planted on June 17-18, 2010.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$7,477.00	1.00	100.00

Project Name: Lake Mary
Tract: 1
Township: 128, Range: 38, Section: 33

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: Three hundred feet of shoreline on Lake Mary were planned,prepared, and planted with local origin native plants to create a shoreline buffer zone demonstration area.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$12,000.00	1.00	300.00

Project Name: Beebe Lake
Tract: # 1
Township: 120, Range: 24, Section: 29

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: A total of 150 feet of shoreline was planned, prepared, and planted with local origin native plants on June 25-26, 2011. This site is near St. Michael in Wright County.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$7,050.00	1.00	150.00

Project Name: Beebe Lake
Tract: # 2
Township: 120, Range: 24, Section: 29

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: A total of 150 of shoreline was selected on this property in fall of 2010. It was planned, prepared, and planted with local origin native plants on June 25-26, 2011.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$7,150.00	1.00	150.00

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2J:Lakescaping - MN DNR - Division of Ecological Services

Project Area - 4 - Central Lakes

Project Name: Rice Lake
Tract: 1
Township: 45, Range: 30, Section: 17

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: This project was installed on May 4, 2010.

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline
ENTF	Restoration	$8,596.00	1.00	125.00

Project Name: Lake Alexander
Tract: 1
Township: 132, Range: 25, Section: 30

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: One hundred feet of shoreline were planted to native plants to create a buffer zone on June 14, 2010.

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline
ENTF	Restoration	$7,476.00	1.00	100.00

Project Name: White Sand Lake
Tract: # 1
Township: 133, Range: 29, Section: 12

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: A total of 75 frontage feet of shoreline was selected on this property in fall of 2010. It was planned, prepared, and planted on June 28, 2011 wit local origin native plants.

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline
ENTF	Restoration	$4,842.00	1.00	75.00

Project Area - 7 - Alexandria Moraine

Project Name: Lake Villard
Tract: 1
Township: 126, Range: 37, Section: 14

Activity: Shoreline Habitat Restoration / Stabilization
Landtype: Private - Lake
Description: Four hundred feet of shoreline were planned, prepared, and planted with local origin native plants to create a buffer zone along the shoreline.

Funding Type	Funds Use	Funding Amount	Prorated Acres	Prorated Shoreline
ENTF	Restoration	$10,000.00	1.00	400.00

Restoration Project Totals (By Funding Type)

Funding Type	Funding Amount	Acres	Shoreline Feet
ENTF:	$72,458.00	9.00	1,540.00
Total:	**$72,458.00**	**9.00**	**1,540.00**

Attachment A: Budget Detail for Phase 6 Projects - Summary and a Budget page for each partner

Project Title: Lakescaping 2j — **Minnesota's Habitat Corridors Partnership (VI)**

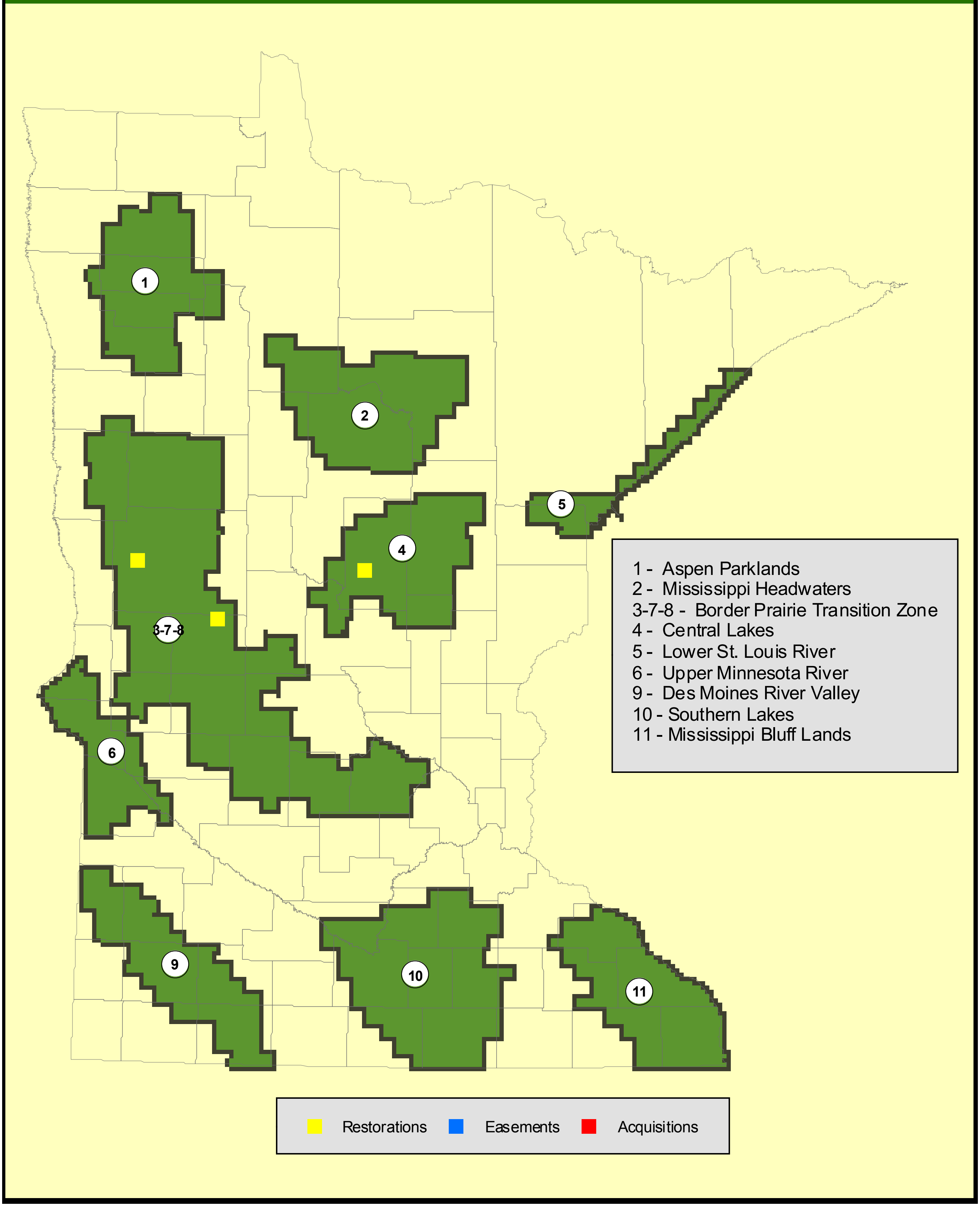
Final. Sept. 12, 2011.

Project Manager Name: Carrol Henderson

Trust Fund Appropriation: $75,000

2008 Trust Fund Budget	Result 1 Budget:	Amount Spent *(date)*	Balance	Result 2 Budget:	Amount Spent *(date)*	Balance *(date)*	Result 3 Budget:	Amount Spent *(date)*	Balance *(date)*	TOTAL BUDGET	TOTAL BALANCE
	Demo sites			Field Trips			Seed collection				
BUDGET ITEM											
PERSONNEL: wages and benefits 100% fisheries specialist Lindy Ekola, $60,000 & 2 10% wildlife techs @ $5000 = $70,000	52,000	53,340	-1,340	500	192	308	1,000	409	591	53,500	-441
Other Supplies. Plants; bioengineering materials;meals for volunteers	20,000	17,467	2,533	500	0	500	0	0	0	20,500	3,033
Travel/fleet expenses in Minnesota	1,000	1,051	-51	0	0	0	0	0	0	1,000	-51
COLUMN TOTAL	**$73,000**	**$71,858**	**$1,142**	**$1,000**	**$192**	**$808**	**$1,000**	**$409**	**$591**	**$75,000**	$2,541

Habitat Conservation Partnership
Lakescaping
2J



Attachment A: Budget Detail for Phase 6 Projects - **Summary and a Budget page for each partner**											
Project Title: Lakescaping 2j	**Minnesota's Habitat Corridors Partnership (VI)**										
	Final. Sept. 12, 2011.										
Project Manager Name: Carrol Henderson											
Trust Fund Appropriation: $75,000											
2008 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(date)*	**Balance**	**Result 2 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**Result 3 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Demo sites			**Field Trips**			**Seed collection**				
BUDGET ITEM											
PERSONNEL: wages and benefits 100% fisheries specialist Lindy Ekola, $60,000 & 2 10% wildlife techs @ $5000 = $70,000	52,000	53,340	-1,340	500	192	308	1,000	409	591	53,500	-441
Other Supplies. Plants; bioengineering materials;meals for volunteers	20,000	17,467	2,533	500	0	500	0	0	0	20,500	3,033
Travel/fleet expenses in Minnesota	1,000	1,051	-51	0	0	0	0	0	0	1,000	-51
COLUMN TOTAL	**$73,000**	**$71,858**	**$1,142**	**$1,000**	**$192**	**$808**	**$1,000**	**$409**	**$591**	**$75,000**	$2,541

Lakescaping Demo Sites

Year	Phase	Project #	Corridor Name	Corridor	HCP project #	County	Lake or site name	Nearest city	Zip	Date Installed	GPS Corridinates	Front	Twsp	Rng	S	DOW#
00-01	0	FPR05000	N/A			Cass	Ada	Pine River	56474	1-Jun-01	396249 5186399	120	139	29	28	11-0250-00
00-01	0	FPR01000	Alexandria Moraine	7		Pope	Barsness Park	Glenwood	56334	3-Jun-02	314219 5056772	1650	125	37	18	
00-01	0	FPR04000	Border Prairie	3		Becker	Beseau	Lake Park	56554	7-Jul-00	259764 5190557	140	139	43	29	03-0638-00
00-01	0	FPR06000	Ms Headwaters	2		Hubbard	Kabekona	Laporte	56461	12-Jun-00	368834 5225023	139	143	32	28	29-0075-00
00-01	0	FPR14000	N/A			Dakota	Marion	Lakeville	55044	12-Jun-00	477766 4946545	315	114	21	24	19-0026-00
00-01	0	FPR09000	Central Lakes	4		Crow Wing	North Long	Brainerd	56401	3-Aug-00	402626 5144118	175	134	29	1	18-0372-00
00-01	0	FPR07000	Ms Headwaters	2		Itasca	Siseebakwet	Cohasset	55721	19-Jun-00	447884 5223587	150	54	26	18	31-0554-00
00-01	0	FPR03000	N/A			Becker	Two Inlets	Park Rapids	56470	5-Jun-00	333295 5211502	315	141	36	14	03-0017-00
00-01	0	FPR02000	Border Prairie	3		Ottertail	Wall	Fergus Falls	56537	1-May-00	270920 5129354	130	132	42	4	56-0658-00
00-01	0	FPR10000	Border Prairie	3		Meeker	Washington	Darwin	55324	26-Jun-00	392200 4990124	120	118	29	6	47-0046-00
00-01	0	FPR13000	Mississippi Bluff Lands	11		Winona	Winona	Winona	55987	9-Aug-00	608292 4877378	121	107	7	27	85-0011-00
02-03	0	FPR15000	N/A			Hennepin	Fish	Maple Grove	55311	8-Jul-04	463684 4993343	85	119	22	27	27-0118-00
02-03	1	FPR16000	N/A			Washington	Big Carnelian	Stillwater	55082	22-May-01	545431 4998574	50	31	20	26	82-0049-00
02-03	I	FPR19000	Border Prairie	3		Ottertail	Clitherall	Battle Lake	56515	28-May-02	292756 5124565	180	132	40	15	56-0238-00
02-03	I	FPR25000	Border Prairie	3		Ottertail	Stalker	Dalton	56501	15-May-03	279890 5121571	150	132	41	29	56-0437-00
02-03	I	FPR20000	Border Prairie	3		Grant	Elk	Hoffman	56339	10-Jun-02	282907 5082571	285	128	41	26	26-0040-00
02-03	I	FPR21000	Central Lakes	4		Cass	Roosevelt	Baxter	56425	24-Jun-02	427985 5185447	350	139	26	27	11-0043-00
02-03		FPR24000	Border Prairie	3		Becker	Curfman	Detroit Lakes	56501	28-May-03	282247 5184727	140	138	41	10	03-0363-00
02-03	I	FPR26000	Central Lakes	4		Cass	Hardy	Pillager	56473	15-Jun-03	397487 5128586	240	133	29	28	11-0209-00
02-03	I	FPR28000	Southern Lakes	10		Waseca	Reeds	Medford	55049	15-Jun-03	450615 4892372	110	108	23	5	81-0055-00
02-03	I	FPR17000	Ms Headwaters	2		Cass	Leech	Walker	56484	15-Jul-02	380816 5213043	123	141	31	2	11-0203-00
02-03	I	FPR18000	Ms Headwaters	2		Itasca	Little Jay Gould	Cohasset	55721	17-Jun-02	453436 5232073	128	55	26	14	31-0566-00
02-03	I	FPR23000	Ms Headwaters	2		Beltrami	Stump	Bemidji	56601	15-Jun-03	368707 5260702	240	146	32	4	04-0130-01
2004	1	FPR32000	Border Prairie	3		Ottertail	Buchanan	Ottertail	56571	19-Jun-04	303668 5146119	90	134N	39W	11	56-0209-00
2004	1	FPR31000	Central Lakes	4	5143	Crow Wing	Gilbert	Brainerd	56401	2-Jun-04	408867 5137643	175	134N	28W	28	18-0320-00
2004	1	FPR30000	Alexandria Moraine	7	5881	Kandiyohi	Andrew	Spicer	56288	7-Jun-04	341194 5019999	185	121N	35W	12	34-0206-00
2004	1	FPR33000	Ms Headwaters	2	5141	Beltrami	Movil	Bemidji	56601	24-Jun-04	359349 5273093	66	148N	33W	33	04-0152-00
2005	2	FPR38000	Border Prairie	3		Douglas	Red Rock	Hoffman	56339	15-May-05	288809 5082922	104	128	40	29	21-0291-00
2005	2	FPR36000	Border Prairie	3		Ottertail	Franklin	Pelican Rapids	56572	21-May-05	272605 5167501	125	136	42	4	56-0759-00
2005	2	FPR41000	Border Prairie	3		Becker	Sallie	Detroit Lakes	56501	6-Jun-05	278815 5182456	150	138	41	20	03-0359-00
2005	2	FPR37000	Central Lakes	4		Crow Wing	Serpent	Deerwood	56444	10-Jun-05	429255 5147671	110	46	28	7	18-0090-00
2005	2	FPR39000	Alexandria Moraine	7	5882	Kandiyohi	Middle Fork-Crow R	New London	56273	27-Jun-05	347999 5017916	100	121	34	10	34-0158-00
2005	2	FPR40000	Ms Headwaters	2		Beltrami	Julia	Bemidji	56601	27-Jun-05	358448 5280828	200	148	33	4	04-0166-00
2006	3	ELKS1000	Ms Headwaters	2		Hubbard	Plantagenet	Bemidji	56601	1-Jun-06	353406 5249245	100	145	34	13	29-0156-00
2006	3	ELKS2000	Border Prairie	3		Ottertail	Long	Erhard	56534	14-Jun-06	266093 5147004	140	134	43	12	56-0784-00
2006	3	ELKS2000	Border Prairie	3		Ottertail	Long	Erhard	56534	7-Jun-06	265767 5147040	160	134	43	12	56-0784-00
2006	3	ELKS2000	Border Prairie	3		Ottertail	Little MacDonald	Ramsey	55303	12-Jun-06	291015 5165141	160	136	40	9	56-0328-00
2006	3	ELKS2000	Border Prairie	3		Douglas	Brophy	Alexandria	56308	25-May-06	311182 5086452	82	128	38	10	21-0102-00
2006	3	ELKS2000	Border Prairie	3		Becker	Floyd	Detroit Lakes	56501	30-May-06	281188 5193398	100	139	41	16	03-0387-00
2006	3	ELKS3000	Central Lakes	4		Crow Wing	Perch	Baxter	56425	30-May-06	402477 5132613	90	133	29	13	18-0371-00
2007	3	ELKS3000	Central Lakes	4		Crow Wing	White Sand	Baxter		16-May-07	401520 5134669	100	137	27	29	18-0310-00
2007	3	ELKS2000	Border Prairie	3		Becker	Big Cormorant	Audubon	56511	7-Jun-07		91	138	42	19	03-0576-00

Lakescaping Demo Sites

Year	Phase	Project #	Corridor Name	Corridor	HCP project #	County	Lake or site name	Nearest city	Zip	Date Installed	GPS Corridinates	Front	Twsp	Rng	S	DOW#	
2007	3	ELKS1000	Ms Headwaters	2		Cass	Upper Gull	Nisswa		14-Jun-07	397500 5153942	74	135	29	4	11-0218-00	
2008	3	ELKS2000	Border Prairie	3		Ottertail	Ottertail	Battle Lake	56515	3-Jul-07	291922 5141861	65	134	40	22	56-0242-00	
2008	3	ELKS2000	Border Prairie	3		Douglas	Darling	Alexandria	56308	9-Aug-07	313969 5086671	79	128	38	12	21-0080-00	
2008	4		Central Lakes	3		Crow Wing	Lower Hay Lake	Pequot Lakes	56003	Aug 6-7, 2007	401703 5170052	75	137	29	13		
2008	4		Central Lakes	3	6783	Crow Wing	Upper Hay Lake	Pequot Lakes	50662	July 9-11, 2007	401063 5165825	70	137	29	36		
2008	4	ELKS2000	Border Prairie	3		Stevens	Charlotte	Cyrus	56323	June 11-12, 2008	284723 5055462	80	125	41	24	75-0046-00	
2008	4	ELKS2000	Border Prairie	8	6375	Meeker	Lake Jennie			June 23-24, 2008	393612 4983417	120	118	29	29	47-0015-00	
2008	4		Central Lakes	4		Crow Wing	Nisswa Lake	Nisswa	56468	June 11-13, 08		135	135	29	15		
2009	4	ELKS3000	Central Lakes	4		Crow Wing	Lower Whitefish	Cross Lake		Aug 12-13, 2008	408149 5172450	200	137	27	29	18-0310-00	
2009	4	ELKS3000	Central Lakes	4		Crow Wing	Sibley	Pequot Lakes		Sept. 9-10, 2008	398630 5160546	75	136	29	15	18-0404-00	
2009	4	ELKS2000	Border Prairie	3		Ottertail	Round	Ottertail	56571	Aug 13-15, 2008	302010 5151737	120	135	36	22	56-0214-00	
2009	4	ELKS2000	Border Prairie	3	6849	Becker	Middle Cormorant	Lake Park	56554	June 1-5, 2009	263650 5183039	480	138	43	22	03-0602-00	
2009	4		Border Prairie	3	6852	Douglas	Lake Andrew	Alexandria	56308	May 20-21, 2009	0313486 5077484	100	127	38	12	21-0085-00	
2009	4		Border Prairie	3	6853	Grant	Pelican Lake	Ashby	56309	June 11-13, 2009	2800978 5104072	100	130	41	22	26-0002-00	
2009	4		Central Lakes	4	6850	Crow Wing	Lower Cullen			June 10-11,2009	E4019970 N 5454658	100	135	29	1		
2009	4		Central Lakes	4	6851	Crow Wing	Lower Cullen			June 10-11,2009	E 401967 N 544640	100	135	29	1		
2009	5		Des Moines	9	6855	Murray	Fulda	Fulda	56131	June -- 2009	E291424 N4858795	120	105	40	36	51-0021	
	5		Des Moines	9	6949	Murray	Sarah # 1	Garvin	56132	10-Aug-09	E280291 N4892560	100	108	41	15	51-0063	
	5		Des Moines	9	6950	Murray	Sarah # 2	Garvin	56132	10-Aug-09	E280309 N4892551	100	108	41	15	51-0063	
2009	5		Ms Headwaters	2	6856	Itasca	Sugar Lake	Grand Rapids	55744	15-16 July, 2009	E774810 N52223609	85	54	26	18	31-0554-00	
2009	5		Des Moines	9	6857	Jackson	Fish Lake	Windom	56101	June 7-9, 2010	E335272 N4856956	110	104	35	4	32-0018	
	5		Central Lakes	4	6951	Crow Wing	Hartley	Brainerd	56401	July 21-22, 2009	399213 5141438	180	134	29	15	18-0392	done
2010	6		Central Lakes	4	7022	Crow Wing	Rice Lake	Brainerd	56401	4-May-10	410810 5136611	125	45	30	17	18-145	
2010	6		Central Lakes	4	7034	Morrison	Lake Alexander	Pillager	56473	14-Jun-10	383642 5154961	100	132	25	30	49-79	
2010	6		Border Prairie	3	7014	Ottertail	Jewett Lake	Fergus Falls	56537	June 9-10, 2010	E264784 N5143816	140	134	43	23	56-0877-00	
2010	6		Border Prairie	3	7015	Douglas	Lake Vermont	Parkers Prairie	56361	June 17-18, 2010	E316353 N5106906	100	130	37	7	21-0073-00	
	6		Alexandria Moraine	7		Pope	Lake Villard	Villard	56385	15-Apr-11	E321600 N5065442	400	126	37	14	61-0067-00	
	6		Border Prairie	3		Wright	Beebe Lake	St. Michael	55376	June 25-26, 2011	E442440 N5003046	150	120	24	29	86-0023-00	
2010	6		Des Moines	9		Wright	Beebe Lake	St. Michael	55376	June 25-26, 2011	E335272 N4856956	150	120	24	29	86-0023-00	
			Central Lakes	4		Crow Wing	White Sand Lake	Baxter	56425	28-Jun-11	E401822 N513409		133	29	12	18-0379-00	
2010	6		Border Prairie	3		Douglas	Lake Mary	Alexandria	56308	May 19-21, 2011	E308653 N5079943	300	128	38	33	21-0092-00	

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: 2K:Prairie Management - MN DNR - Scientific and Natural Areas Program, part of the Overall Habitat Conservation Partnership
PROJECT MANAGER: Jason Garms
AFFILIATION: MN DNR – Ecological and Water Resources
MAILING ADDRESS: 500 Lafayette Rd
CITY/STATE/ZIP: Saint Paul, MN 55155
PHONE: 651-259-5130
E-MAIL: jason.garms@state.mn.us
WEBSITE: www.dnr.state.mn.us
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chapter 143, Section 2, Subd. 4(e)

APPROPRIATION AMOUNT: $75,000

Overall Project Outcome and Results

A total of 536 acres of native and reconstructed prairie (largely native) were prescribed burned. This includes 318 acres on Scientific and Natural Areas (SNA) and 218 acres on perpetual Native Prairie Bank (NPB) easements. Due to a lack of qualified prescribed burn vendors, most burns were implemented by agency crews. Invasive species control treatments were completed on a total of 113 acres, including 48 acres on SNAs and 65 acres on NPB lands. Invasive species treated include buckthorn, siberian elm, red cedar, knapweed, leafy spurge, and cow-vetch. Due to the availability of qualified contractors, many woody invasive species projects were contracted. One reconstruction project totaling 30 acres was completed on the Zilmer WMA, which part of the larger Felton Prairie Complex. Seed for the reconstruction was collected from surrounding lands. In total, 679 acres of prairie habitat was improved during this project.

Project Results Use and Dissemination

Ecological and Water Resources invests considerable time in publishing and distributing results in a variety of formats for various audiences. SNA Program staff make presentations that describe prairie management methodologies and results to a wide range of audiences including county boards, local planning groups, land managers, citizen and technical advisory groups, and at professional meetings.

Environmental and Natural Resource Trust Fund 2009 Work Program Final Report

Date of Report: August 31, 2011
Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2010

I. PROJECT TITLE: 2K – Prairie Management, MN DNR
Minnesota's Habitat Conservation Partnership Phase VI
www.mnhabitatcorridors.org

Project Manager: Jason Garms
Affiliation: MN DNR – Ecological Resources
Mailing Address: 500 Lafayette Rd Box 25
City / State / Zip: Saint Paul, MN 55155
Telephone Number: 651-259-5130
E-mail Address: jason.garms@state.mn.us
FAX Number: 651-296-1811
Web Site Address: www.dnr.state.mn.us

Location: Areas of native prairie and associated grasslands on public and private land within Project Areas 1, 3, 6, 9, 10, & 11. See map of Scientific & Natural Areas and Native Prairie Bank easements in the project areas.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**75,000**
	Minus Amount Spent:	**$**	**74,990**
	Equal Balance:	**$**	**10**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4e(2k)

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the sixth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $770,000 is for the Department of Natural Resources agency programs and $2,605,000 is for agreements as follows: $450,000 with Pheasants Forever; $50,000 with Minnesota Deer Hunters Association; $895,000 with Ducks Unlimited, Inc.; $85,000 with National Wild Turkey Federation; $365,000 with the Nature Conservancy; $210,000 with Minnesota Land Trust; $350,000 with the Trust for Public Land; $100,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; $50,000 with the United States Fish and Wildlife Service; and $50,000 with Friends of Detroit Lakes Watershed Management District to plan, restore, and acquire fragmented landscape corridors that connect areas of quality habitat to sustain fish, wildlife, and plants. The United States Department of Agriculture-Natural Resources Conservation Service is a cooperating partner in the appropriation. Expenditures are limited to the project corridor areas as defined in the work program. Land acquired with this appropriation must be sufficiently improved to meet at least minimum habitat and facility management standards as determined by the commissioner of natural resources. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program.

All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY:
A total of 536 acres of native and reconstructed prairie (largely native) were prescribed burned. This includes 318 acres on Scientific and Natural Areas (SNA) and 218 acres on perpetual Native Prairie Bank (NPB) easements. Due to a lack of qualified prescribed burn vendors, most burns were implemented by agency crews. Invasive species control treatments were completed on a total of 113 acres, including 48 acres on SNAs and 65 acres on NPB lands. Invasive species treated include buckthorn, siberian elm, red cedar, knapweed, leafy spurge, and cow-vetch. Due to the availability of qualified contractors, many woody invasive species projects were contracted. One reconstruction project totaling 30 acres was completed on the Zilmer WMA, which part of the larger Felton Prairie Complex. Seed for the reconstruction was collected from surrounding lands. In total, 679 acres of prairie habitat was improved during this project.

IV. OUTLINE OF PROJECT RESULTS:

Result 1: Prairie Management and Restoration

Description:
The following prairie management and restoration activities will be targeted at Scientific and Natural Areas and Native Prairie Bank conservation easements as shown on the attached map.

<u>Woody encroachment</u> – ($29,000/up to 200 acres of surrounding grassland/prairie benefited). Invasive woody species have invaded a significant number of native prairie tracts over the past 60+ years and is accelerating. Cutting scattered trees, fencerows, or small groves in prairies and grasslands can substantial improve areas of habitat for open grassland flora and fauna. Woody encroachment removal projects will be implemented by private contractors and DNR management crews.

<u>Prescribed burning</u> – ($24,000/up to 250 acres burned). The importance of fire for keeping prairies healthy is widely recognized. However, limited spring and fall burn seasons, and the need for specialized training and equipment, make it challenging to

meet all fire management needs. This activity builds on the success of past LCCMR accelerated prairie burning projects. DNR trained burn crews will implement prescribed fire projects, or certified private contractors when available.

Invasive species control – ($12,000/up to 35 acres treated) Herbaceous invasive species threaten many of the few remaining native prairies, and new invasive species continue to emerge. Species such as Spotted Knapweed, Birdsfoot Trefoil, Leafy Spurge, and Crown Vetch quickly invade grassland, reducing diversity and habitat quality. Funds will be used to implement 'best management practices' for control and elimination of exotic species on remnant prairies and other priority grasslands.

Restoration/reconstruction – ($10,000/up to 15 acres reconstructed) Today prairie remnants and other grasslands existing as fragments. Reconstruction efforts are needed to expand functionality of existing habitat, and buffer native plant communities from surrounding activities. Funds will be used to harvest and process seed, and plant native prairie species. Restoration projects will use only local ecotype seeds and plants.

Summary Budget Information for Result 1: **Trust Fund Budget: $75,000**
Amount Spent: $74,990
Balance: $10

Deliverable	Completion Date	Budget
1. 200 acres of woody encroachment control	June 30, 2010	$29,000
2. 250 acres prescribed burning	June 30, 2010	$24,000
3. 35 acres of invasive species control	June 30, 2010	$12,000
4. 15 acres of restoration/reconstruction	June 30, 2010	$10,000

Final Report Summary:
Woody encroachment – (58 acres of trees removed, 232 acres of prairie benefited): Buckthorn, Siberian elm, Red cedar were cleared from 58 acres, benefitting and improving 232 acres of prairie habitat. The acres listed above represents both the actual acres physically covered with trees that were removed, and the acres of habitat that are now more functional as prairie habitat. Costs varied greatly between individual projects based on the cutting techniques applied. Hand cutting on slopes can cost 10 times more per acre than projects that could support some mechanical removal. Private contractors remain very interested in this kind of work, bidding remains competitive.

Prescribed burning – (536 acres burned): The spring of 2010 was a good burn season and we were able to surpass our rxburn goals for this project. Weather is a huge variable that can substantially impact a burn season. It remains difficult to find qualified rxburn contractors that perform this kind of work – we continue to rely heavy on DNR crews to complete this work.

Invasive species control – (55 acres treated): Knapweed, Leafy Spurge, and Cow-vetch were treated using control techniques that are target specific and not harmful to surround resources, such as hand pulling and spot spraying individual plants with selective herbicides. Developing contracts for small dispersed invasive populations that emerge quickly have not proven cost effective, although contracts for removal of woody invasive species have been easier to manage and cost effective.

Restoration/reconstruction – (30 acres reconstructed): SNA Program staff members who manage lands within the Felton Prairie Complex did not find that Prairie Bank or SNA lands within the complex had restoration needs, but adjacent lands did. It was decided that the greatest reconstruction need for SNA's in the Felton Complex is to expand the surrounding habitat and buffer the SNA's from row crop land uses. A partnership between the County, DNR-SNA, and DNR-Wildlife yielded a harvest from adjacent County lands and a seeding on the Zilmer WMA. It remains very difficult to find local origin seed on the market.

V. TOTAL TRUST FUND PROJECT BUDGET:

Budget Item	
***Personnel:** DNR staff: NR Specialists, NR Technicians, NR laborers	$37,500
Contracts: Competitive bid contracts with private vendors and cost-share grants to landowners for prescribed burning, prairie reconstructions, woody encroachment, etc	$26,500
Equipment/Tools/Supplies: project supplies, vehicle fleet costs (e.g. ATV, Pick-up, ASV tracked vehicle)	$11,000
Acquisition: *none*	$0
Travel: *none*	$0
Other: *none*	$0
TOTAL TRUST FUND PROJECT BUDGET:	**$75,000**

***Explanation of Personnel costs:**

- For classified and unclassified SNA program & other DNR staff paid almost exclusively with special project funds: up to ~ 0.4 FTE specialists and technicians; and ~ 0.3 FTE laborers and seasonal crews
- Only time spent on approved projects will be charged to these funds. Without these funds, none of the projects in this work program would be completed. They are an acceleration of related initiatives.
- To implement projects in the work program, specialized skills (prescribed burning, knowledge of sites and management implications) are often required. DNR employees with the training, experience and certifications required to do these specialized tasks are used to directly implement these projects, and work with landowners and contractors to design, direct and certify completion of projects they carry out.
- Contracts with outside vendors are used when possible, but contractors are not available for some projects.

TOTAL TRUST FUND PROJECT BUDGET: $ 75,000

Explanation of Capital Expenditures Greater Than $3,500: *none*

VI. PROJECT STRATEGY:

A. Project Partners: We are part of the Habitat Conservation Partnership Phase V proposal. Please see main proposal for complete partner list.

B. Project Impact and Long-term Strategy: Please see main proposal for Habitat Conservation Partnerships impacts and long-term strategy. Project impact and long-term strategy for Prairie Management will be included in the December 1, 2009 Work Program Progress Report.

C. Other Funds Proposed to be Spent during the Project Period:

D. Spending HIstory: Past HCP spending; 2001: $36,250 / 2003: $0 / 2005: $133,000 / 2007: $75,000

VII. DISSEMINATION: Accomplishment Reports and press releases will be made available at http://www.mnhabitatcorridors.org

VIII. REPORTING REQUIREMENTS:

Periodic progress reports are due December 1, 2009, June 1, 2010, and December 1, 2010 and the final work program report is due between June 30 and August 1, 2011. All reports will be generated using the HCP online reporting system.

IX. RESEARCH PROJECTS: NA

Attachment A: Final Budget Detail for 2009 Projects

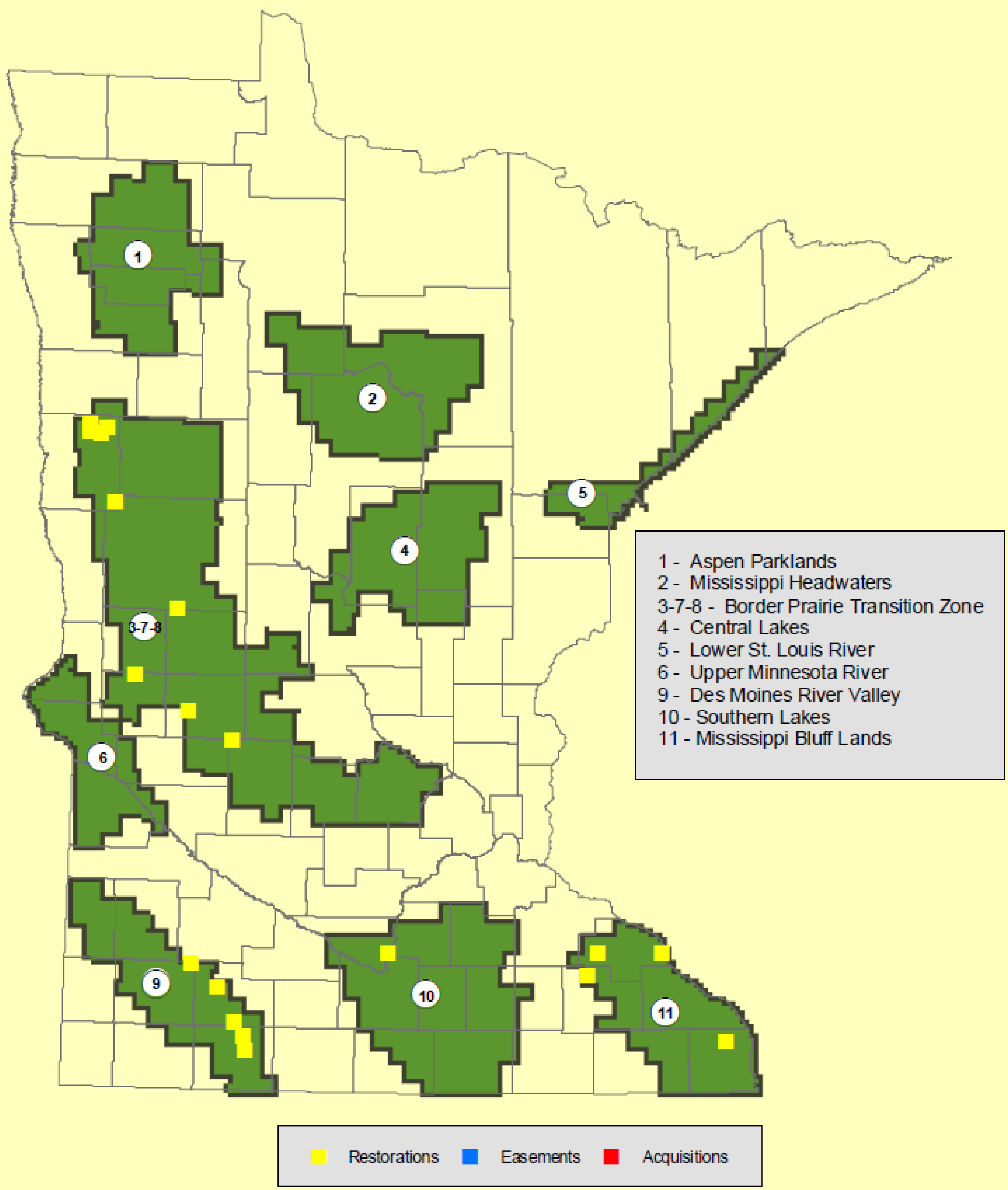
Project Title: 2K – Prairie Management

Project Manager Name: Jason Garms

Trust Fund Appropriation: $75,000

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent**	**Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
	Prairie Management and restoration				
BUDGET ITEM					
PERSONNEL: wages and benefits DNR NR Specialists, NR Technicians, NR laborers	37,500	37,490	10		10
Contracts					
Professional/technical					
Other contracts: (contracts for prescribed burning, prairie reconstructions, woody encroachment, etc. Also includes cost-share agreements for private land projects)	26,500	26,500	0		0
Other direct operating costs: vehicle fleet costs (e.g. ATV, Pick-up, ASV tracked vehicle)	7,500	7,500	0		0
Supplies: herbicide, safety supplies, etc	3,500	3,500	0		0
COLUMN TOTAL	**$75,000**	**$74,990**	**$10**	**$0**	**$10**

Habitat Conservation Partnership
Prairie Management
2K



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Minnesota's Habitat Conservation Partnership (HCP) - Phase VI 2N:Campaign for Conservation - Restoration - The Nature Conservancy
PROJECT MANAGER: Rich Johnson
AFFILIATION: The Nature Conservancy
MAILING ADDRESS: 1101 West River Parkway
CITY/STATE/ZIP: Minneapolis, MN 55415
PHONE: 612-331-0790
E-MAIL: rich_johnson@tnc.org
WEBSITE: http://www.mnhabitatcorridors.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chapter 143, Section 2, Subd. 4(e)
APPROPRIATION AMOUNT: $315,000

Overall Project Outcome and Results

The Nature Conservancy's (TNC) 2009 work program focused on 6 habitat restoration projects totaling 3,664 acres (3,118-ENRTF funds; 546-other funds). Additional details, beyond the short summary below, are found in the more detailed reporting provided for each project.

Northern Tallgrass Prairie: Prairie was restored on 183 acres (88 acres-ENRTF; 95 acres-other funds) of TNC land on this key parcel for building connections within the Bluestem Prairie complex. Project activities included seed collection, site preparation, sowing, and follow work to control invasives in the restoration area.

Western MN Invasives Control & Prescribed Fire: TNC accelerated management activities on 1,067 acres (798 acres-ENRTF; 269 acres-other funds) of TNC lands. Activities included planning/implementing prescribed fire on 1,060 acres, buckthorn removal, and a focused effort on controlling leafy spurge

Prairie Coteau Restoration: Prairie was restored on 84 acres (all acres-ENRTF) of TNC land in a key parcel for connecting remaining areas of native prairie in the Lac qui Parle complex. Completed work included preparing and seeding 71 acres, clearing trees, buckthorn removal, and fence removal.

Prairie Forest Border Restoration: This project accelerated prescribed fire and invasives management on 2,091 acres (1,932 acres-ENRTF; 159 acres-other funds) of TNC and public grassland, wetland and forest at 7 sites in Central and Southeastern Minnesota. Individual activities included planning/implementing prescribed fire on 1,392 acres, invasive surveys/treatment on 560 acres, brush removal on 135 acres, and buckthorn removal on 19 acres.

NE MN Conifer Restoration: 114 acres (all acres-ENRTF) of TNC and public land was managed to encourage the regeneration of conifers in Northeast Minnesota. Project tasks included installing exclosures and budcaps to prevent browsing and using brush saws, grass mats, and grubbing to control competing vegetation.

Sand Prairie Restoration: Prairie was restored on 90 acres and existing habitat was enhanced on an additional 35 acres of TNC land buffering the outstanding native prairie on the adjoining Weaver Dunes SNA (102 acres-ENRTF; 23 acres-other funds). Project activities included seed collection, site preparation, three rounds of sowing with a high-diversity 115-species mix, brush clearing, and surveying/treating invasive species.

One thing to note when reviewing detailed information on the individual projects: the completed acres shown for each project may be lower than the number of acres listed for the separate restoration activities. The lower total reflects the fact that multiple activities may have been done on the same acres.

Project Results Use and Dissemination

All restored lands are open to the public. TNC continues to coordinate with public and private partners to apply lessons learned from this project to work at these and other sites.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2N:Campaign for Conservation - Restoration - The Nature Conservancy

Project Manager: Rich Johnson

Affiliation: The Nature Conservancy

Address: 1101 West River Parkway
Minneapolis, MN 55415

Phone: 612-331-0790

Fax: 612-331-0770

E-mail: rich_johnson@tnc.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation:

ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Restoration	$315,000	$314,662	$338	$72,450	$238,185
Total	$315,000	$314,662	$338	$72,450	$238,185

Work Program Summary

Overall Project Outcome and Results

The Nature Conservancy's (TNC) 2009 work program focused on 6 habitat restoration projects. Additional details, beyond the short summary below, are found in the more detailed reporting provided for each project.

Northern Tallgrass Prairie - Prairie was restored on 183 acres of TNC land on this key parcel for building connections within the Bluestem Prairie complex. Project activities included seed collection, site preparation, sowing, and follow work to control invasives in the restoration area.

Western MN Invasives Control & Prescribed Fire - TNC accelerated management activities on 1,067 acres of TNC lands. Activities included planning/implementing prescribed fire on 1,060 acres, buckthorn removal, and a focused effort on controlling leafy spurge.

Prairie Coteau Restoration - Prairie was restored on 84 acres of TNC land in a key parcel for connecting remaining areas of native prairie in the Lac qui Parle complex. Completed work included preparing and seeding 71 acres, clearing trees, buckthorn removal, and fence removal.

Prairie Forest Border Restoration - This project accelerated prescribed fire and invasives management on 2,091 acres of TNC and public grassland, wetland and forest at 7 sites in Central and Southeastern Minnesota. Individual activities included planning/implementing prescribed fire on 1,392 acres, invasive surveys/treatment on 560 acres, brush removal on 135 acres, and buckthorn removal on 19 acres.

NE MN Conifer Restoration - 114 acres of TNC and public land was managed to encourage the regeneration of conifers in Northeast Minnesota. Project tasks included installing exclosures and budcaps to prevent browsing and using brush saws, grass mats, and grubbing to control competing vegetation.

Sand Prairie Restoration - Prairie was restored on 90 acres and existing habitat was enhanced on an additional 35 acres of TNC land buffering the outstanding native prairie on the adjoining Weaver Dunes SNA. Project activities included seed collection, site preparation, three rounds of sowing with a high-diversity 115-species mix, brush clearing, and surveying/treating invasive species.

One thing to note when reviewing detailed information on the individual projects... The completed acres shown for each project may be lower than the number of acres listed for the separate restoration activities. The lower total reflects the fact that multiple activities may have been done on the same acres.

2N:Campaign for Conservation - Restoration - The Nature Conservancy

Project Results Use and Dissemination

All restored lands are open to the public. TNC continues to coordinate with public and private partners to apply lessons learned from this project to work at these and other sites.

2N:Campaign for Conservation - Restoration - The Nature Conservancy

Restoration Activities

2N:Campaign for Conservation - Restoration - The Nature Conservancy

Project Area - 1 - Aspen Parklands

Project Name: Northern Tallgrass Prairie Restoration
Tract: Williams
Township: 139, Range: 46, Section: 36

Activity: Grassland Restoration
Landtype: Private - Land
Description: This restoration is part of a large, multi-year project to reestablish prairie and wetlands on the 1,330-acre Williams property. This parcel provides a key connection between the 4,300-acre Bluestem Prairie SNA and 460-acre Margherita/Audubon Prairie Preserves. To date, federal funding, previous LCCMR appropriations, and private funds have allowed the restoration of over 800 acres of wetland and prairie on this tract.

The goal for this project was to restore an additional 183 acres on this tract. We were able to successfully complete this work.

Restoration activities included: 1) Seed collection/preparation from adjoining native prairie, 2) Spraying with Glyphosate to prepare for seeding on 183 acres, 3) Seeding 183 acres, and 4) Spot mowing & spraying targeting trefoil, spurge, and reed canary grass in the restoration area.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$102,443.49	88.38	0.00
Other Funds	Restoration	$109,676.41	94.62	0.00
Northern Tallgrass Prairie Restoration Williams Total		**$212,119.90**	**183.00**	**0.00**

Project Name: Western MN Invasives Control & Prescribed Fire
Tract: Multiple
Township: 139, Range: 46, Section: 22

Activity: Grassland Restoration
Landtype: Private - Land
Description: The goal of this project is to accelerate fire management and invasives control on TNC-owned native prairies and wetlands in Western Minnesota. This work is essential to maintaining the long-term health and diversity of the natural communities on these lands.

The goal for this project was to manage an additional 1,000 acres. In the end, 1,067 acres were treated. Work was done at 6 sites. The largest share of this work was done in Bluestem Prairie SNA. Additional sites included Margherita/Audubon Prairie, Pankratz Memorial Prairie, Pembina Trail SNA, Strandness Prairie, Staffanson Prairie Preserves.

Restoration activities included: 1) Prescribed fire planning & implementation on 1,060 acres, 2) Removing an especially thick buckthorn infestation on 6 acres, and 3) Surveying for leafy spurge on ~4,000 acres, and then spot treating sites, totaling ~1 acre, that were the most severely affected.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$21,253.49	798.05	0.00
Other Funds	Restoration	$7,162.44	268.95	0.00
Western MN Invasives Control & Prescribed Fire Multi		**$28,415.93**	**1,067.00**	**0.00**

2N:Campaign for Conservation - Restoration - The Nature Conservancy

Project Name: Prairie Coteau Restoration
Township: 120, Range: 45, Section: 15

Activity: Grassland Restoration
Landtype: Private - Land
Description: This project allowed restoration of the most heavily-impacted portions of a recently protected 237-acre tract at Plover Prairie. This parcel connects existing native prairie ranked as outstanding by CBS. This restoration will help buffer and enhance the over 16,000 acres of prairie in the surrounding Lac qui Parle Prairie complex.

The original goal for this project was restoration on 90 acres. In the end, the project focused on 84 acres of the site. Fences were removed on the remainder of the property.

Restoration activities included: 1) Seeding 71 acres with locally-obtained native prairie seed, 2) Cultipacking to ensure better germination on 59 acres, 3) Clearing trees/site leveling on 8 acres, 4) Buckthorn removal on 5 acres, 5) Fence removal on entire property, totaling 2.2 miles.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$29,990.35	84.00	0.00

Project Area - 3 - Border Prairie

Project Name: Prairie Forest Border Restoration
Tract: Multiple
Township: 122, Range: 33, Section: 16

Activity: Grassland Restoration
Landtype: Private - Land
Description: This project is part of a multi-year TNC collaboration with our partners to accelerate management on grasslands, savannas, and forests in the prairie-forest transition zone. This effort includes fire management and invasive controls.

The original goal for this project was 1,500 acres. With favorable conditions and some great seasonal crews, this project completed management on 2,091 acres. Work was done at 7 sites, including Lake Alexander/Camp Ripley, Ordway Prairie, Ottawa Bluffs, Paul Bunyan Savanna, Regal Meadows, Sheepberry Fen, and Weaver Dunes SNA.

Restoration activities included: 1) Planning/implementing prescribed fire on 1,392 acres, 2) Invasive surveys/treatment on 560 acres, especially targeting cow vetch at Weaver Dunes, 3) Brush removal on 135 acres, 4) Buckthorn removal on 19 acres.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$86,609.53	1,932.26	0.00
Other Funds	Restoration	$7,115.19	158.74	0.00
Prairie Forest Border Restoration Multiple Total		**$93,724.72**	**2,091.00**	**0.00**

2N:Campaign for Conservation - Restoration - The Nature Conservancy

Project Area - 5 - Lower St. Louis River

Project Name: NE MN Conifer Restoration
Tract: Multiple
Township: 57, Range: 6, Section: 4

Activity: Woodland Restoration
Landtype: Public - State Forest
Description: TNC is working collaboratively with the MN DNR, Lake and St. Louis Counties, and the US Forest Service to ensure biodiversity conservation in Northeast Minnesota. This larger effort has promoted enhanced management and restoration on 3,000 acres. One key part of this effort is encouraging the regeneration of threatened conifers in this area. This project was focused on this need.

The goal for this phase of the project was conifer restoration on 140 acres. In the end, this team completed work on 114 acres with this round of funding. The discrepancy was due to a cooperative project with DNR forestry that was unable to proceed. Restoration work was done at 5 sites: Caribou Falls State Wayside, Caribou Falls WMA, DNR Forestry land near Little Marais WMA, Lake County Forestry land behind Split Rock State Park, and Manitou Collaborative lands in the Upper Manitou Forest Preserve.

Restoration activities included: 1) Brush saw release to control competing vegetation on 114 acres, 2) Budcapping for browse protection on 76 acres, 3) Installing grass mats and grubbing to control competing vegetation on 52 acres, 4) Installing single tree deer exclosures for browse protection on 7 new acres and additional exclosures on 16 acres that had received some previous treatment.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$27,174.16	114.00	0.00

Project Area - 11 - Mississippi Bluff Lands

Project Name: Sand Prairie Restoration
Tract: Burmeister
Township: 109, Range: 9, Section: 18

Activity: Grassland Restoration
Landtype: Private - Land
Description: This project allowed restoration of the most impacted portions of this recently protected 188-acre tract at Weaver Dunes SNA. The restored areas will help buffer and enhance the existing native prairie on other parts of this and adjoining protected properties. These prairies are part of the largest concentration of native prairie in Southeastern Minnesota, the 1,500 acre Weaver Dunes Prairie complex.

The goal for this restoration was 25 acres. In the end, this project team was able to complete work on 125 acres. A very successful cooperation with Conservation Corps Minnesota crews was instrumental in this.

Restoration activities included: 1) Burn 76 acres of adjoining native prairie to encourage seed production, 2) Seed harvesting/preparation on adjoining native prairie resulting in an exceptionally high-diversity seed mix with 115 species, 3) Two rounds of seeding with this high-diversity mix on 90 acres, 4) Site preparation for restoration on an additional 25 acres, 5) Brush clearing and herbicide application on an additional 60 acres, 6) Surveying/treating invasive, especially targeting cow vetch, on 100 acres.

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Prorated Shoreline*
ENTF	Restoration	$47,190.90	101.63	0.00
Other Funds	Restoration	$10,852.85	23.37	0.00
Sand Prairie Restoration Burmeister Total		**$58,043.75**	**125.00**	**0.00**

2N:Campaign for Conservation - Restoration - The Nature Conservancy

Restoration Project Totals (By Funding Type)

Funding Type	Funding Amount	Acres	Shoreline Feet
ENTF:	$314,661.92	3,118.32	0.00
Other Funds:	$134,806.89	545.68	0.00
Total:	**$449,468.81**	**3,664.00**	**0.00**

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

2N:Campaign for Conservation - Restoration - The Nature Conservancy

Work Program Expenditures - Not Attributable to Specific Projects

FundingType	*Category*	*Amount*	*Description*
Other Funds	Admin	$103,377.82	An indirect cost recovery rate of 23% has been applied to the $314,661.92 of reimbursable expenses and $134,806.89 of other funds incurred through the restoration portion of the grant. The Conservancy's federally approved indirect cost recovery rate is 23.05% for the fiscal year ending June 30, 2010 and 23.13% for the fiscal year beginning July 1, 2010. This rate is approved by the Conservancy's federal cognizant agency, the US Department of the Interior. A copy of the official negotiated indirect rate agreement can be provided upon request. To simplify reporting for the duration of this grant, that rate is being rounded down to 23%.
	Total:	**$103,377.82**	

Work Program Expenditures (Not Attributable to Specific Projects) By Funding Type

Funding Type	Amount
Other Funds	$103,377.82
Total	**$103,377.82**

Work Program Expenditures Breakdown

Funding Type:	Restoration Projects	Not Attributable to Specific Projects	Total
ENTF	$314,661.92	$0.00	$314,661.92
Other Funds	$134,806.89	$103,377.82	$238,184.71
Total	$449,468.81	$103,377.82	$552,846.63

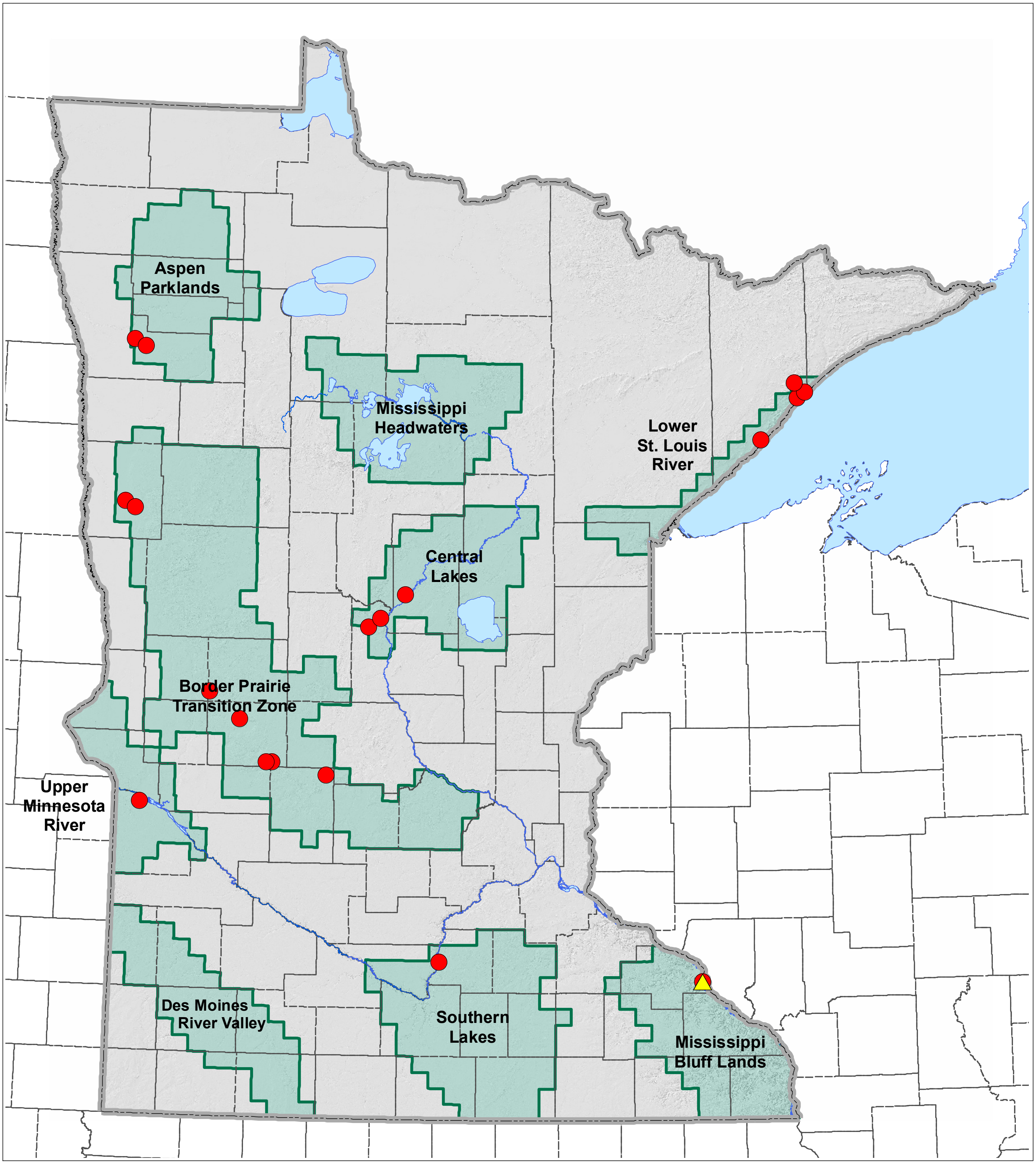
Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Campaign for Conservation

Habitat Conservation Partnership

2009 Appropriation (Phase 6) Accomplishments



Legend

- Restoration Project Locations
- Acquisition Project Locations
- Habitat Conservation Partnership Project Areas

N W E S

The Nature Conservancy

Protecting nature. Preserving life.

0 12.5 25 50 Miles

Map Created by: RCJ, TNC in MN-ND-SD, 2011/8/15

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2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Minnesota's Habitat Conservation Partnership (HCP) - Phase VI 2o: Prairie Landscape Restoration: Oak, Savanna, Grasslands, and Wetlands
PROJECT MANAGER: Greg Hoch
AFFILIATION: Friends of the Detroit Lakes Wetland Management District
MAILING ADDRESS: 26624 N Tower Rd
CITY/STATE/ZIP: Detroit Lakes, MN 56501
PHONE: 218-443-0476 (cell)
E-MAIL: gahoch@umn.edu
WEBSITE: http://www.mnhabitatcorridors.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chapter 143, Section 2, Subd. 4(e)2o
APPROPRIATION AMOUNT: $50,000

Overall Project Outcome and Results

This project restored approximately 40 acres of oak savanna on Kruger Waterfowl Production Area. Oak savanna is even rarer in Minnesota than tallgrass prairie and there are numerous plant and wildlife species that depend on this habitat. We removed invasive trees from these areas, restored an open, park-like structure to the vegetation, and created enough light gaps in the tree canopy to support a herbaceous understory. The biomass we removed was stacked and is drying. This fall the biomass will be chipped, hauled to the biomass burning plant in Benson, and converted to electrical power. This was a significant savings. Money that would have been spent burning or removing the biomass from the site was used for additional habitat work. After all the equipment is done at the site, FWS staff will overseed the areas where the trees were removed and any place equipment damaged the soil with a diverse mix of local ecotype grass and forb seed. The long-term maintenance of the site will be done through the FWS's fire management program.

Originally we planned to do both wetland and oak savanna restoration at the site. However, with the persistent rains over the period of this grant, we were not able to get heavy equipment into the wetlands to restore them. Therefore, we requested and were granted an amendment to spend the wetland funds on additional oak savanna work at the site.

Environmental and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report: 6/17/2011
Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: 11/2010

I. PROJECT TITLE: HCP Prairie Landscape Restoration: Oak, Savanna, Grasslands, and Wetlands

Project Manager: Greg Hoch
Affiliation: Friends of the Detroit Lakes Wetland Management District
Mailing Address: 26624 N Tower Rd
City / State / Zip: Detroit Lakes MN 56501
Telephone Number: 218-443-0476 (cell)
E-mail Address: gahoch@umn.edu
FAX Number: 218-847-4156
Web Site Address:

Location: *Becker County MN*

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**50,000**
	Minus Amount Spent:	**$**	**50,000**
	Equal Balance:	**$**	**0**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4e2o

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the sixth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $770,000 is for the Department of Natural Resources agency programs and $2,605,000 is for agreements as follows: $450,000 with Pheasants Forever; $50,000 with Minnesota Deer Hunters Association; $895,000 with Ducks Unlimited, Inc.; $85,000 with National Wild Turkey Federation; $365,000 with the Nature Conservancy; $210,000 with Minnesota Land Trust; $350,000 with the Trust for Public Land; $100,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; $50,000 with the United States Fish and Wildlife Service; and $50,000 with Friends of Detroit Lakes Watershed Management District to plan, restore, and acquire fragmented landscape corridors that connect areas of quality habitat to sustain fish, wildlife, and plants. The United States Department of Agriculture-Natural Resources Conservation Service is a cooperating partner in the appropriation. Expenditures are limited to the project corridor areas as defined in the work program. Land acquired with this appropriation must be sufficiently improved to meet at least minimum habitat and facility management standards as determined by the commissioner of natural resources. This appropriation may not be used for the

purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. Final Project Summary

This project restored approximately 40 acres of oak savanna on Kruger Waterfowl Production Area (WPA). Oak savanna is even rarer in Minnesota than tallgrass prairie and there are numerous plant and wildlife species that depend on this habitat. We removed invasive trees from these areas, restored an open, park-like structure to the vegetation, and created enough light gaps in the tree canopy to support a herbaceous understory. The biomass we removed was stacked and is drying. This fall the biomass will be chipped, hauled to the biomass burning plant in Benson, and converted to electrical power. This was a significant savings. Money that would have been spent burning or removing the biomass from the site was used for additional habitat work. After all the equipment is done at the site, Fish and Wildlife Service (FWS) staff will overseed the areas where the trees were removed and any place equipment damaged the soil with a diverse mix of local ecotype grass and forb seed. The long-term maintenance of the site will be done through the FWS's fire management program.

Originally we planned to do both wetland and oak savanna restoration at the site. However, with the persistent rains over the period of this grant, we were not able to get heavy equipment into the wetlands to restore them. Therefore, we requested and were granted an amendment to spend the wetland funds on additional oak savanna work at the site.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Oak savanna on Kruger WPA

Description:

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$ 50,000**
	Amount Spent:	**$ 50,000**
	Balance:	**$ 0**

Deliverable	Completion Date	Budget
1.cut and remove trees from savanna	12/2010	$ 20,000
2.burn trees	12/2010	
3.reseed savanna	3/2011	

Final Report Summary: Friends members and FWS staff worked with the contractors to experiment several new pieces of equipment and techniques for cutting and moving the trees. This was an iterative process and each group learned quite a bit from the experience. This included how staff and the contractors can most effectively interact as well as which types of equipment did each part of the project most efficiently. The contractors were definitely faster and more efficient towards the end of the project once we had worked out the best methods. As we will continue to use these contractors for future work on LCCMR and other grants, we anticipate even more area treated per dollar invested. Because we have made significant investments in this site, the biological staff have already established several monitoring projects at the site to examine resprouting of trees, seeds germinating from the seed bank, and the herbaceous plant community after the seeding. This was one of the first large-scale savanna restoration projects in this part of Minnesota. We feel we learned a significant amount from this project and know how to approach similar projects at other sites on FWS, DNR, and The Nature Conservancy (TNC) land. As the restoration matures and fire is reintroduced to the site, we will continue to learn about the effects of restoration and management that will inform all agencies in the area.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $
Contracts: $ 50,000 (Subsurface Contracting will do all savanna restoration work. USFWS staff will reseed the site after construction activities are done.)
Equipment/Tools/Supplies: $
Acquisition, including easements: $
Travel: $
Other: $

TOTAL TRUST FUND PROJECT BUDGET: $50,000

Explanation of Capital Expenditures Greater Than $3,500:

VI. PROJECT STRATEGY:

A. Project Partners: The project is coordinated by the Friends of the Detroit Lakes Wetland Management District.

B. Project Impact and Long-term Strategy: The goal of the project is to provide more habitat for savanna dependent plant and wildlife species, most of which are declining across Minnesota.

C. Other Funds Proposed to be Spent during the Project Period: We will be submitting NAWCA (North American Wetland Conservation Act) grants to match LCCMR dollars for similar restoration in the same general area of Becker County.

D. Spending History: We received $40,000 ENRTF dollars in the previous phase of ENRTF funding for wetland restoration at nearby Waterfowl Production Areas the Wetland Management District. This is part of our overall plan to restore habitats within the district to presettlement vegetation conducive to producing high densities of migratory waterfowl and songbirds.

VII. DISSEMINATION:

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted not later than 1 December 2009, 1 June 2010, and 1 Dec 2010. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS:

Figure 1. Location of Kruger WPA in northeast Becker County and an aerial photo of the site.

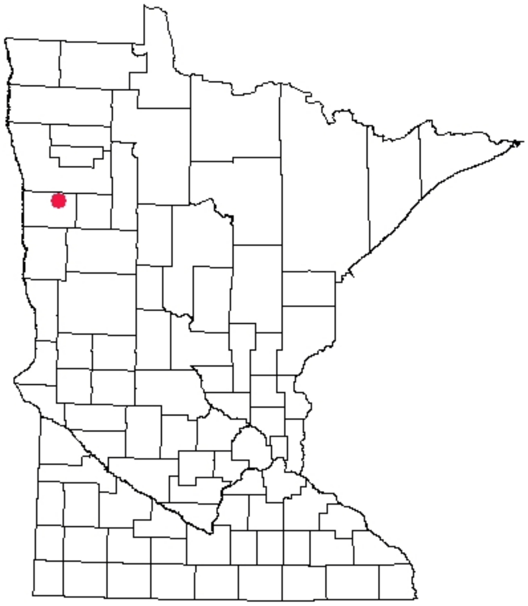


Figure 2. Photos from 2008 (top) and 2010 (below) showing trees removed during the first half of this project. Approximately twice as much area of savanna was restored by the completion of the project.

Attachment A: Final Budget Detail for 2009 Project

Project Title: *Prairie Landscape Restoration: Oak Savannas, Grasslands, and Wetlands*

Project Manager Name: *Greg Hoch*

Trust Fund Appropriation: $ *50,000*

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(9/10-9/30/2009)*	**Balance** *(5/2009)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Oak Savanna Restoration on Kruger WPA	*0*			
BUDGET ITEM					
PERSONNEL: wages and benefits *(List individual names, amount budgeted and %FTE; add rows as needed)*					
Contracts					
Professional/technical *(with whom?, for what?)*					
Other contracts *Strom Construction will do all wetland and savanna restoration work)*	50,000			$50,000	50,000
Strom (Subsurface Contracting)		5,120	44,880		
		5,024	39,856		
		4,764	35,092		
		5,093	30,000		
		9,138	20,862		
		20,862	0		
Other direct operating costs *(for what? – be specific)*					
COLUMN TOTAL		**$50,000**	**$0**	**$50,000**	**$0**

2009 Project Abstract
For the Period Ending June 30, 2011

TITLE:	Habitat Conservation Partnership (HCP) – Phase VI Shorelands Protection Program – 3A
PROJECT MANAGER:	Sarah Strommen
ORGANIZATION:	Minnesota Land Trust
ADDRESS:	2356 University Avenue West, Suite 240 St. Paul, MN 55114
WEB SITE ADDRESS:	www.mnland.org
FUND:	Environmental and Natural Resources Trust Fund
LEGAL CITATION:	Minnesota Laws 2009, Chapter 143, Section 2, Subdivision 4(e)

APPROPRIATION AMOUNT: $210,000

OVERALL PROJECT OUTCOME AND RESULTS

In the sixth phase of our Shorelands Protection project, the Minnesota Land Trust continued to work with landowners to secure permanent conservation easements on quality habitat along or containing critical riparian lands. We initiated or continued contact with more than 50 landowners and completed five conservation easements. Collectively, these easements preserve 566 acres of land (508 acres-ENRTF; 58 acres-other funds)—exceeding our original goal of 300 to 500 acres—and protect nearly 17,000 feet of fragile shoreline. Two of the five easements completed involved significant bargain purchases, while the other three projects were donated easements:

- Rabbit Lake in Aitkin County: 171 acres (all acres-ENRTF) containing forest, wetland, grassland, and hay field being restored to prairie.
- Blackhoof River in Carlton County: 248 acres (all acres-ENRTF) containing a mix of forest, wetlands, grasslands, and woodlands.
- Encampment River in Lake County: 88 acres (40 acres-ENRTF; 48 acres-other funds) containing a mature conifer forest with black ash lowlands and wetlands along the Encampment River.
- Blacklock Nature Sanctuary along Lake Superior in Lake County: 11 acres (1 acre-ENRTF; 10 acres-other funds) containing forest and cobblestone beach along Lake Superior.
- Lake Elysian in Waseca County: 48 acres (all acres-ENRTF) containing oak savanna and big woods.

All five projects met the following selection criteria:
1. Habitat: quality and quantity of existing habitat on site; protects riparian areas and buffers water resources
2. Context: proximity and relationship to other protected lands
3. Opportunity cost-benefit ratio: which landowners will participate now
4. Other Benefits: meeting multiple objectives, including visual and physical access, forestry goals, water quality, etc.

Additionally, the Land Trust prepared baseline property reports for each easement, detailing the condition of the property for future monitoring and enforcement. To fund this required perpetual obligation, the Land Trust dedicated funds to its segregated Stewardship and Enforcement Fund for several completed projects. For these projects, we estimated the anticipated annual expenses of each project and the investment needed to generate annual income sufficient to cover these expenses in perpetuity – all in accordance with our internal policies and procedures as approved by LCCMR. We will report to LCCMR annually on the status of the Stewardship and Enforcement Fund and the easements acquired with funds from this grant.

The value is known for only one of the easements. The donated value of this easement is $515,000. The cost to the State of Minnesota to complete the five projects completed under this phase of the grant was just over $370 per acre.

Cumulatively, across all phases of the HCP program, the Land Trust has protected 7,461 acres of critical habitat and more than 218,000 feet of shoreline, at a cost to the State of $283 per acre.

The Land Trust's work on this project continues to demonstrate the cost effectiveness of working with conservation easements to protect natural and scenic resources along Minnesota's lakes, rivers, and streams, as the cost to the State was well below the cost to purchase land along our increasingly threatened shorelines. This grant continued to generate interest among landowners, and therefore, ongoing funding will be important to sustained success. Additionally, our experiences during this phase of the grant indicate that funds to purchase easements will be necessary in the future as work becomes more targeted, selective, and focused on building complexes of protected land.

PROJECT RESULTS USE AND DISSEMINATION

The Land Trust disseminated information about the specific land protection projects completed under this grant though our newsletter, email updates, web site, and press releases. The Land Trust also shared information about conservation easements generally and our experience with our partner organizations, other easement holders, local communities, as well as policy makers including members of the LCCMR and L-SOHC.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6

Habitat Conservation Partnership

3A: Shoreland Protection Program - Minnesota Land Trust

Project Manager: Sarah Strommen

Affiliation: Minnesota Land Trust

Address: 2356 University Avenue West
St. Paul, MN 55114

Phone: 651-647-9590

Fax: 651-647-9769

E-mail: sstrommen@mnland.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation:

ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Balance	ENTF Funds Spent	ENTF Balance	Other Funds * Proposed	Other Funds * Spent
Easement	$210,000	$210,000	$0	$500,000	$18,000
Total	$210,000	$210,000	$0	$500,000	$18,000

*Other Funds are classified as non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds). Please note, however, that this work program has spent the following amounts not shown in the above table:

State Funds: $61,120.00
Other: $515,000.00
See the tables and funding type definitions at the end of this report for further explanation.

Work Program Summary

Overall Project Outcome and Results
In the sixth phase of our Shorelands Protection project, the Minnesota Land Trust continued to work with landowners to secure permanent conservation easements on quality habitat along or containing critical riparian lands. We initiated or continued contact with more than 50 landowners and completed five conservation easements. Collectively, these easements preserve 566 acres of land—exceeding our original goal of 300 to 500 acres—and protect nearly 17,000 feet of fragile shoreline. Two of the five easements completed involved significant bargain purchases, while the other three projects were donated easements.

All five projects met the following selection criteria:
1. Habitat: quality and quantity of existing habitat on site; protects riparian areas and buffers water resources
2. Context: proximity and relationship to other protected lands
3. Opportunity: cost-benefit ratio: which landowners will participate now
4. Other Benefits: meeting multiple objectives, including visual and physical access, forestry goals, water quality, etc.

Additionally, the Land Trust prepared baseline property reports for each easement, detailing the condition of the property for future monitoring and enforcement. To fund this required perpetual obligation, the Land Trust dedicated funds to its segregated Stewardship and Enforcement Fund for several completed projects. For these projects, we estimated the anticipated annual expenses of each project and the investment needed to generate annual income sufficient to cover these expenses in perpetuity – all in accordance with our internal policies and procedures as approved by LCCMR. We will report to LCCMR annually on the status of the Stewardship and Enforcement Fund and the easements acquired with funds from this grant.

The value is known for only one of the easements. The donated value of this easement is $515,000. The cost to the State of Minnesota to complete the five projects completed under this phase of the grant was just over $370 per acre.

Cumulatively, across all phases of the HCP program, the Land Trust has protected 7,461 acres of critical habitat and more than 218,000 feet of shoreline, at a cost to the State of $283 per acre.

3A: Shoreland Protection Program - Minnesota Land Trust

The Land Trust's work on this project continues to demonstrate the cost effectiveness of working with conservation easements to protect natural and scenic resources along Minnesota's lakes, rivers, and streams, as the cost to the State was well below the cost to purchase land along our increasingly threatened shorelines. This grant continued to generate interest among landowners, and therefore, ongoing funding will be important to sustained success. Additionally, our experiences during this phase of the grant indicate that funds to purchase easements will be necessary in the future as work becomes more targeted, selective, and focused on building complexes of protected land.

Project Results Use and Dissemination

The Land Trust disseminated information about the specific land protection projects completed under this grant though our newsletter, email updates, web site, and press releases. The Land Trust also shared information about conservation easements generally and our experience with our partner organizations, other easement holders, local communities, as well as policy makers including members of the LCCMR and L-SOHC.

3A: Shoreland Protection Program - Minnesota Land Trust

Easement Activities

Project Name: Rabbit Lake
Tract: San Felippo
Project Area: 4 - Central Lakes
Township: 46, Range: 25, Section: 18

Description: This 171-acre parcel on Rabbit Lake in Aitkin County is located within the northern edge of the Mille Lacs Uplands Ecological Subsection. It lies adjacent to an existing easement held by the Minnesota Land Trust. Additionally, it lies less than a mile from Rabbit Lake WMA.

The property contains forest, wetland, grassland, and a hay field that is gradually being restored to prairie, as well as 169 feet of shoreline along Rabbit Lake. The dominant forest cover is hardwood and pine-hardwood. The property provides natural and critical habitat that supports a diversity of wildlife including bald eagles, trumpeter swans, wood turtles, gray wolves, sharptail sparrows, and other Species in Greatest Conservation Need as listed by the Minnesota Department of Natural Resources.

The conservation easement protects these conservation values by prohibiting division of the property, limiting residential and agricultural use, and requiring that management be in accordance with a management plan approved by the Land Trust.

Easement Recorded in LCCMR office: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Stewardship	$15,000.00	171.00	8.00	78.00	57.00	169.00	0.00

Project Name: Blackhoof River
Tract: Schantz-Hansen
Project Area: 5 - Lower St. Louis River
Township: 48, Range: 17, Section: 28

Description: This 248-acre property in Carlton County protects approximately 5,688 feet of shoreline along both sides of the Blackhoof River. The property contains a mix of forest, wetlands, grasslands, and woodlands that provide significant habitat for a variety of plants and wildlife, including several species in greatest conservation need.

The conservation easement limits residential use and division of the property. It prohibits agricultural use and other uses that are inconsistent with preservation of the conservation values of the property. Management is required to be in accordance with a plan approved by the Land Trust.

Easement Recorded in LCCMR office: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Stewardship	$15,000.00	248.00	17.00	127.00	104.00	0.00	5,688.00

3A: Shoreland Protection Program - Minnesota Land Trust

Project Name: Encampment River
Tract: Jaeger
Project Area: 5 - Lower St. Louis River
Township: 53, Range: 10, Section: 3

Description: This 88-acre property (also known as the "Encampment Forest" project) in Lake County is located approximately one mile from Lake Superior within the Land Trust's North Shore Critical Landscape. The protected parcel is adjacent to a large property owned by the Encampment Forest Association.

The property consists of mature conifer forest, with black ash lowlands and wetlands along the Encampment River and one of its tributaries. The property contains 2,100 feet of shoreline along both sides of the Encampment River and 450 feet of shoreline along both sides of its tributary.

The conservation easement protects these conservation values by prohibiting agricultural use and division of the property. Residential use is limited. Management is required to be in accordance with a management plan approved by the Land Trust.

Easement Recorded in LCCMR office: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Stewardship	$15,000.00	40.00	0.00	34.09	5.45	0.00	1,176.82
Other Funds	Easement Acquisition Costs	$18,000.00	48.00	0.00	40.91	6.55	0.00	1,412.18
	Total:	**$33,000.00**	**88.00**	**0.00**	**150.00**	**12.00**	**0.00**	**2,589.00**

3A: Shoreland Protection Program - Minnesota Land Trust

Project Name: Lake Superior
Tract: Blacklock Nature Sanctuary
Project Area: 5 - Lower St. Louis River
Township: 55, Range: 8, Section: 28

Description: Located in Lake County, this property lies along the north shore of Lake Superior, immediately to the northeast of the entrance to Split Rock Lighthouse State Park.

It consists primarily of forest and cobblestone beach along Lake Superior. The property is within an area ranked as high biodiversity significance by the Minnesota County Biological Survey for its Aspen-Birch Hardwood Forest and Dry Bedrock Shore native plant communities. There also is a primitive campsite for the Lake Superior Water Trail on the beach area, and the Gitchi-Gami State Trail passes along the property.

The conservation easement was purchased for $125,000, an amount well below fair-market value. A portion of the purchase price came from the 2009 HCP grant. The remainder of the funds for the purchase price and easement stewardship came from the 2010 HCP grant (listed as "State Funds" in the funding summary below).

The easement protects the conservation values of the property by prohibiting division of the property, prohibiting agricultural use, and limiting residential use. The easement also requires that the primitive campsite be available to the public as long as the Lake Superior Water Trail continues to exist.

Easement Recorded in LCCMR office: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Easement Acquisition Costs	$78,780.00	1.32	0.04	1.20	0.00	193.55	0.00
Other	Donated Easement Value	$515,000.00	8.65	0.27	7.86	0.00	1,265.28	0.00
State Funds	Easement Acquisition Costs	$46,120.00	0.77	0.02	0.70	0.00	113.31	0.00
State Funds	Stewardship	$15,000.00	0.25	0.01	0.23	0.00	36.85	0.00
	Total:	**$654,900.00**	**11.00**	**0.34**	**40.00**	**0.00**	**1,609.00**	**0.00**

3A: Shoreland Protection Program - Minnesota Land Trust

Project Name: Lake Elysian
Tract: Jewison
Project Area: 10 - Southern Lakes
Township: 108, Range: 24, Section: 15

Description: The Lake Elysian project is located on the eastern side of Lake Elysian, approximately 15 miles east of Mankato in Waseca County. The property lies in an area where two ecological subsections, Oak Savanna and Big Woods, come together, and as such, the property embodies qualities of each ecological subsection.

The natural attributes of the property include the undeveloped shoreline and floodplain forest, which provide near-shore habitat for the great blue heron, double-crested cormorant, great egret, American white pelican and bald eagle.

The conservation easement protects these attributes by prohibiting residential buildings and structures, limiting agricultural uses, and prohibiting any other activities inconsistent with protecting the property's conservation features.

Easement Recorded in LCCMR office: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Stewardship	$15,000.00	48.00	4.00	14.00	5.00	3,162.00	0.00

Easement Totals (By Funding Type)

Funding Type:	Funding Amount	Prorated Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
ENTF	$138,780.00	508.32	29.04	304.00	171.45	3,524.55	6,864.82
Other Funds	$18,000.00	48.00	0.00	40.91	6.55	0.00	1,412.18
State Funds	$61,120.00	1.03	0.03	0.93	0.00	150.16	0.00
Other	$515,000.00	8.65	0.34	7.86	0.00	1,265.28	0.00
Total	**$732,900.00**	**566.00**	**29.34**	**304.00**	**178.00**	**4,940.00**	**8,277.00**

Work Program Expenditures (Not Attributable to Specific Projects)

FundingType	*Category*	*Amount*	*Description*
ENTF	Personnel Expenditures	$59,977.00	Salaries and related benefits for MLT and contract staff working on contacting landowners, negotiating conservation easements and completing all aspects of easement projects. Because of the large number of potential conservation projects involved in this grant and because many projects initiated or worked on under the grant are not actually completed in this phase of the project, the Land Trust does not allocate salaries to specific conservation easement projects.

3A: Shoreland Protection Program - Minnesota Land Trust

ENTF	Professional Services	$8,894.00	Title work, project specific mapping for prospective and completed projects, film, recording fees and other miscellaneous acquisition expenses related to projects pursued under this grant. Because of the large number of potential conservation projects involved, the Land Trust does not allocate these expenses to specific conservation easement projects.
ENTF	Travel	$2,349.00	Travel to evaluate sites, visit with landowners, and complete project requirements.
	Total:	**$71,220.00**	

Work Program Expenditures (Not Attributable to Specific Projects) By Funding Type

Funding Type	Amount
ENTF:	$71,220.00
Total:	**$71,220.00**

Work Program Expenditures Breakdown

Funding Type:	Easement Projects	Not Attributable to Specific Projects	Total
ENTF	$138,780.00	$71,220.00	$210,000.00
Other Funds	$18,000.00	$0.00	$18,000.00
Partner's State Leveraged Funds	$0.00	$0.00	$0.00
Other	$515,000.00	$0.00	$515,000.00
Total	**$732,900.00**	**$71,220.00**	**$804,120.00**

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail

Project Title:
Minnesota's Habitat Conservation Partnership--Phase 6
Minnesota Land Trust - Shoreland Protection Program -3(a)

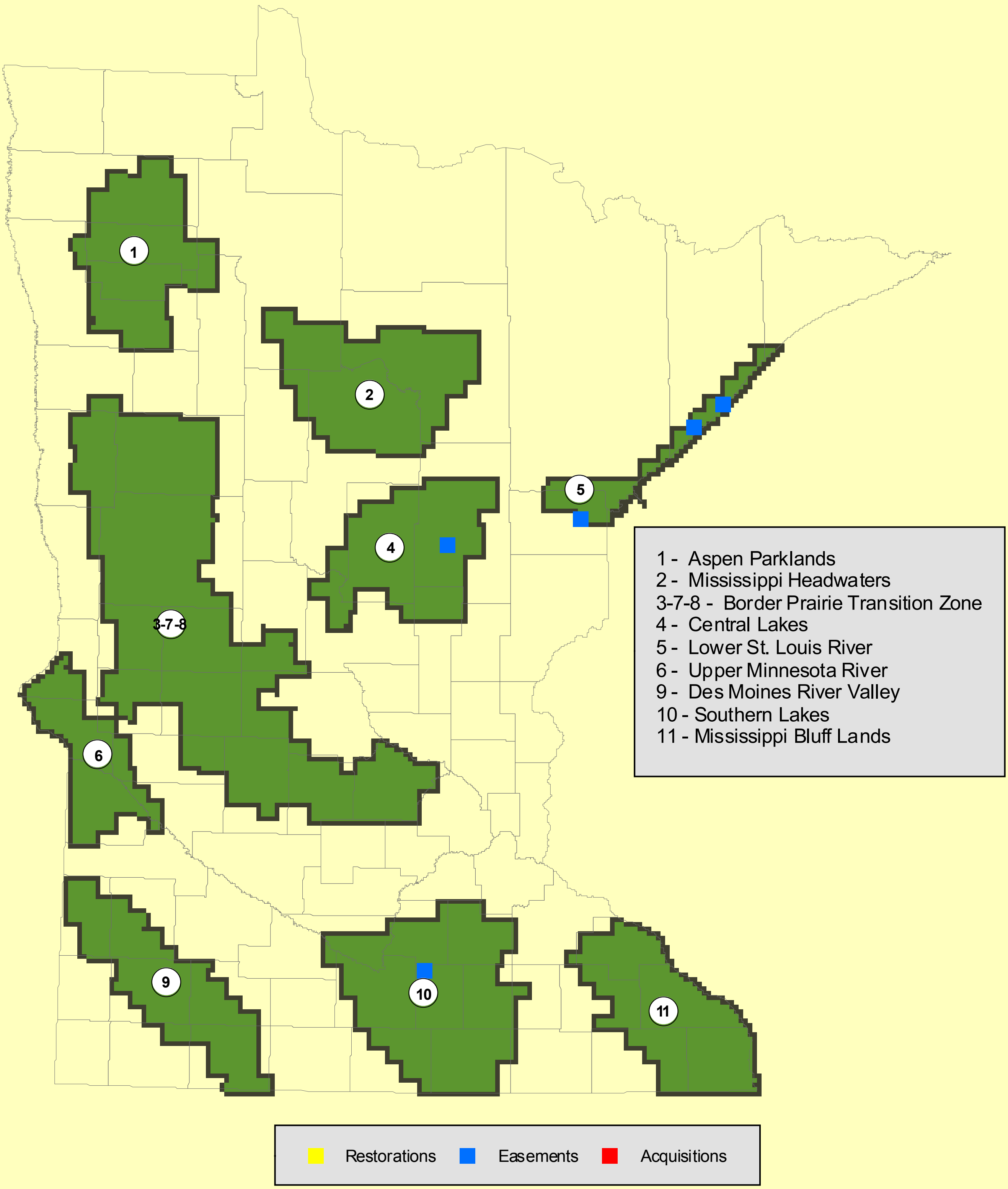
Project Manager: Sarah Strommen

ENTF Funds: $210.000

	Result 1 -- Acquiring CEs - Shoreland Protection Program : BUDGET (adjusted/approved June 2011)	FINAL BUDGET June 30, 2011	AMOUNT SPENT AS OF June 30, 2011	BALANCE AS OF June 30, 2011
BUDGET ITEM				
MLT and Contract Personnel:	$57,326.00	$59,977.00	$59,977.00	$0.00
Wages and benefits: Staff expenses including salaries, benefits (FICA,FUTA. SUI, worker's comp health insurance, 401 (k), etc.) and related costs for conservation directors or other land protection staff, staff attorney and other support staff.			$46,837.00	
Land protection project professional services, including negotiating and drafting conservation easements and/or completing easement baseline documentation and legal review services			$13,140.00	
Travel	$5,000.00	$2,349.00	$2,349.00	$0.00
Easement acquisition costs	$87,674.00	$87,674.00	$87,674.00	$0.00
Purchase price of conservtion easement(s)				
Title work, title insurance, and closing fees, etc				
Maps, GIS (including project mapping by Community GIS)				
Other (including appraisals and surveys)				
Easement stewardship	$60,000.00	$60,000.00	$60,000.00	$0.00
TOTAL	$210,000.00	$210,000.00	$210,000.00	$0.00

Habitat Conservation Partnership
Shoreland Protection Program

3A



Attachment A: Budget Detail

Project Title:
Minnesota's Habitat Conservation Partnership--Phase 6
Minnesota Land Trust - Shoreland Protection Program -3(a)

Project Manager: Sarah Strommen

ENTF Funds: $210,000

	Result 1 -- Acquiring CEs - Shoreland Protection Program : BUDGET	**Result 1 -- Acquiring CEs - Shoreland Protection Program : ADJUSTED BUDGET** as of June 1, 2011	**AMOUNT SPENT AS OF** April 30, 2011	**BALANCE AS OF** April 30, 2011
BUDGET ITEM				
MLT and Contract Personnel:	$70,000.00	$57,326.00	$42,326.00	$15,000.00
Wages and benefits: Staff expenses including salaries, benefits (FICA,FUTA. SUI, worker's comp health insurance, 401 (k), etc.) and related costs for conservation directors or other land protection staff, staff attorney and other support staff.			$34,656.00	
Land protection project professional services, including negotiating and drafting conservation easements and/or completing easement baseline documentation and legal review services			$7,670.00	
Travel	$5,000.00	$5,000.00	$2,348.00	$2,652.00
Easement acquisition costs	$75,000.00	$87,674.00	$7,656.00	$80,018.00
Purchase price of conservtion easement(s)				
Title work, title insurance, and closing fees, etc				
Maps, GIS (including project mapping by Community GIS)				
Other (including appraisals and surveys)				
Easement stewardship	$60,000.00	$60,000.00	$45,000.00	$15,000.00
TOTAL	$210,000.00	$210,000.00	$97,330.00	$112,670.00

LCCMR Work Program Final Report
Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

3C: Shallow Lake Easements - Ducks Unlimited

Project Manager: Jon Schneider
Affiliation: Ducks Unlimited
Address: 311 East Lake Geneva Road
Alexandria, MN 56308
Phone: (320)762-9916
Fax: (320)759-1567
E-mail: jschneider@ducks.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation:
ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Balance	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Easement	$250,000	$250,000	$0	$250,000	$103,532
Total	$250,000	$250,000	$0	$250,000	$103,532

Work Program Summary

Overall Project Outcome and Results
The objective of this project was to accelerate Ducks Unlimited (DU) efforts to help improve and protect shallow lakes managed for waterfowl. To protect shallow lakes, DU worked with private shallow lake shoreline landowners to secure permanent conservation easements on managed shallow lakes prioritized by DU for their importance to waterfowl and threat of development. The goal was to permanently protect at least 200 shallow lake shoreland acres.

DU land protection staff worked with several private landowners on multiple shallow lakes over the course of this two year grant, and eventually began negotiations with five landowners on four different shallow lakes who expressed a desire to proceed with appraisals and discuss easement terms. Through that process, two of the five easement negotiations were successful and became viable land protection deals. DU subsequently proceeded to close on a fully purchased conservation easement on 76 acres on Fish Lake in Stearns County in February 2011. DU then proceeded to seek approval to split the cost of a second larger easement of 150 acres on Garden and Johnson Lakes in Crow Wing County using the remaining funds from this 2009 Trust Fund appropriation (60%) and our 2010 Trust Fund appropriation (40%). Overall, DU successfully closed two conservation easements through this grant and permanently protected 226 acres in total, which was slightly more than our 200-acre goal.

The total project cost to protect shallow lakes through conservation easements was $353,532, which includes reimbursement of $250,000 from the Trust Fund through this grant plus the expenditure of $61,532 in Other Funds by DU and $42,000 donated to DU for easement stewardship.

Project Results Use and Dissemination
This grant helped DU accelerate the protection of shallow lakes by working with private landowners to secure conservation easements and promote conservation easement concepts. Conservation easements with private landowners are sensitive land deals that don’t lend themselves to widespread publicity, however, DU has recognized individual landowners and has publicized our work to protect shallow lake shorelines and shoreland locally through local conservation groups, soil and water districts, and tribal organizations supportive of our work to protect wild rice lakes. DU also informed the foundations supporting our Living Lakes Initiative of our conservation accomplishments. The accomplishment of securing two new permanent conservation easements through this grant has helped encourage other private landowners to consider working with DU to protect their shorelines, and news of our progress may be further disseminated through DU news releases and articles DU publications in the future.

3C: Shallow Lake Easements - Ducks Unlimited

Easement Activities

Project Name: Donovan-Posch on Garden & Johnson Lakes
Tract: 1
Project Area: 2 - Mississippi Headwaters
Township: 135, Range: 28, Section: 9

Description: DU purchased a permanent conservation easement on 150 acres from the Donovan-Posch landowner partnership on Garden and Johnson Lakes, two wild rice lakes west of Nisswa in Crow Wing County, to protect their shoreland through a permanent conservation easement. An appraisal determining the value of the easement at $132,000 was received and negotiations began in December, 2010. After to purchase the easement at a bargain sale rate failed, agreement to purchase the easement at full appraised price was reached in April 2011. Purchase of the easement using a combination of both 2009 and 2010 grant funds was approved by LCCMR staff in May. DU and the landowners agreed to endow future easement monitoring stewardship and enforcement costs with private funds, and DU commits to monitoring the easement annually and reporting to LCCMR as required. DU closed the easement in mid June, 2011. Purchase price was $132,000, with 66% of costs being funded from our 2009 grant and the other 34% of the costs being paid from our 2010 grant as per LCCMR staff approval ($52,977). The initial land acquisition report for this tract, # 11-035-002, and a copy of the recorded easement was submitted to LCCMR staff on July 29, 2011.

Easement Recorded in LCCMR office: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Easement Acquisition Costs	$81,586.00	78.67	0.00	25.17	53.49	0.00	0.00
ENTF	Personnel Expenditures	$3,240.00	0.00	0.00	0.00	0.00	0.00	0.00
ENTF	Professional Services	$7,931.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Personnel Expenditures	$5,257.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Stewardship	$21,000.00	20.25	0.00	6.48	13.77	0.00	0.00
	Total:	**$119,014.00**	**98.92**	**0.00**	**31.65**	**67.26**	**0.00**	**0.00**

3C: Shallow Lake Easements - Ducks Unlimited

Project Name: Kauller #2 on Fish Lake
Tract: 2
Project Area: 3-7-8 - Border Prairie Transition Zone
Township: 123, Range: 35, Section: 33

Description: DU negotiated the purchase of a permanent conservation easement with the Kauller LLC to protect 76 acres of land on Fish Lake in Stearns County. The easement value was appraised at $91,000 in fall 2010, and landowners declined a bargain sale offer for several months before DU agreed to purchase at the full appraised value. DU closed on the easement in February 2011. The easement protects 6 acres of wetlands and 70 acres of existing CRP land in southwest Stearns County. This new easement funded through the ENRTF on Kauller Tract 2 will be the second easement DU holds on Fish Lake and will further our efforts to protect all shoreland around Fish Lake from future subdivision and development. DU and the landowners agreed to endow future easement monitoring stewardship and enforcement costs with $21,000 of private funds. DU commits to annualy monitoring this easement and reporting to LCCMR staff as required. The initial land acquisition report #11-145-003 and a copy of the recorded easement was submitted to LCCMR staff on July 29, 2011.

Easement Recorded in LCCMR office: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Easement Acquisition Costs	$91,768.00	61.85	56.96	0.00	4.88	0.00	0.00
ENTF	Personnel Expenditures	$5,942.00	0.00	0.00	0.00	0.00	0.00	0.00
ENTF	Professional Services	$5,775.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Personnel Expenditures	$3,933.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Stewardship	$21,000.00	14.15	13.04	0.00	1.12	0.00	0.00
	Total:	**$128,418.00**	**76.00**	**70.00**	**0.00**	**6.00**	**0.00**	**0.00**

Project Name: Papenheim on Lake Christina
Tract: 1
Project Area: 3-7-8 - Border Prairie Transition Zone
Township: 130, Range: 40, Section: 4

Description: Ducks Unlimited continued attempts to secure an easement on the 170-acre Papenheim property that contains over one mile of Lake Christina shoreline. Following several years of negotiation and two appraisals, DU was hopeful that a workable option was in place that would protect the property and provide for the needs of the landowner. However, the landowner is hesitant, and DU continues to discuss options for configuration of easement restrictions that protects the lake but also allows the landowner to retain some farm land and allow for his children to build on the property too without subdivision. DU will continute working with the landowner through our 2010 Trust Fund grant and hopefully agree on mutually acceptable easement terms.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Personnel Expenditures	$420.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Personnel Expenditures	$784.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total:	**$1,204.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6

Habitat Conservation Partnership

3C: Shallow Lake Easements - Ducks Unlimited

Project Name: Radunz Easement on Cedar Lake

Project Area: 3-7-8 - Border Prairie Transition Zone
Township: 118, Range: 30, Section: 33

Description: Ducks Unlimited is working to purchase the 31-acre Brian Radunz easement located in Meeker County on 2,000-acre Cedar Lake prior to June 30, 2010 protecting over 1,400 feet of shoreline from subdivision and development. Cedar Lake is a large shallow lake that supports a diverse shoreline boundary containing numerous bays and points and is one of the few shallow lakes in Minnesota will multiple islands (11 total). DU currently holds one 52-acre easement on the lake and is also working to secure an additional 49-acre easement on the Mcleod County side through a NAWCA grant. The Radunz easement will protect over 6 acres of palustrine wetland, 15 acres of land enrolled in CRP, and seven acres of woodland comprised of mature species common to the Big Woods subsection of the eastern deciduous forest. An appraisal was received, and negotiations began in December 2010. However, the landowner has expressed great disappointment in the appraised value of the easement, and negotiations have stalled. DU may seek a second appraisal in our 2010 grant and continue negotiations.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Personnel Expenditures	$4,521.00	0.00	0.00	0.00	0.00	0.00	0.00
ENTF	Professional Services	$7,451.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Personnel Expenditures	$4,893.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total:	**$16,865.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

3C: Shallow Lake Easements - Ducks Unlimited

Project Name: Strohmeier Easement on Lake Christina

Project Area: 3-7-8 - Border Prairie Transition Zone
Township: 130, Range: 40, Section: 17

Description: DU is working to close a purchased permanent conservation easement on the 34-acre Strohmeier property on 4,000-acre Lake Christina in Douglas County that will protect 1,700 feet of shoreline from subdivision and development. Lake Christina is one of the largest shallow lakes in the prairie and transition region of Minnesota and is a key waterfowl staging area as well as an important habitat for many other migratory bird species. Ducks Unlimited currently holds six easements on the lake that protect over six miles of shoreline on Lake Christina and Lake Anka. The Strohmeier easement will protect 10 acres of wetlands, 16 acres of woods and low brush, and 8 acres of CRP that supports seeded native grasses. The Strohmeier easement directly adjoins the Carlson-Cunz DU conservation easement and will bring the total of contiguous land protection in that area to 237 acres of grass, woods and wetlands. Negotiations are underway with the landowner regarding reserved rights, and the landowner has requested more time to contemplate his land use plans and options for the property before an appraisal can be ordered. DU will remain engaged and attempt to continue negotiations with the landowner in summer or fall 2011 under our 2010 LCCMR grant.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Personnel Expenditures	$2,426.00	0.00	0.00	0.00	0.00	0.00	0.00
ENTF	Professional Services	$490.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Personnel Expenditures	$2,600.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total:	**$5,516.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Easement Totals (By Funding Type)

Funding Type:	**Funding Amount**	**Prorated Acres**	**Grassland Acres**	**Woodland Acres**	**Wetland Acres**	**Shoreline Feet**	**Riparian Feet**
ENTF	$211,550.00	140.52	56.96	25.17	58.38	0.00	0.00
Other Funds	$59,467.00	34.40	13.04	6.48	14.89	0.00	0.00
Total	**$271,017.00**	**174.92**	**70.00**	**31.65**	**73.26**	**0.00**	**0.00**

Work Program Expenditures (Not Attributable to Specific Projects)

FundingType	*Category*	*Amount*	*Description*
ENTF	Personnel Expenditures	$26,941.00	DU biological land protection staff conduct easement outreach and promotion to private landowners on key shallow lakes managed for wildlife by Minnesota DNR in an attempt to develop interest in conservation easements for subsequent negotiation.
ENTF	Personnel Expenditures	$11,509.00	DU manager time and in-state travel expense to coordinate, supervise, and administer this grant.

3C: Shallow Lake Easements - Ducks Unlimited

Other Funds	Personnel Expenditures	$25,980.00	DU biological land protection staff conduct easement outreach and promotion to private landowners on key shallow lakes managed for wildlife by Minnesota DNR in an attempt to develop interest in conservation easements for subsequent negotiation.
Other Funds	Personnel Expenditures	$18,085.00	DU manager time and in-state travel expense to coordinate, supervise, and administer this grant.
	Total:	**$82,515.00**	

Work Program Expenditures (Not Attributable to Specific Projects) By Funding Type

Funding Type	Amount
ENTF:	$38,450.00
Other Funds:	$44,065.00
Total:	**$82,515.00**

Work Program Expenditures Breakdown

Funding Type:	Easement Projects	Not Attributable to Specific Projects	Total
ENTF	$211,550.00	$38,450.00	$250,000.00
Other Funds	$59,467.00	$44,065.00	$103,532.00
Total	**$271,017.00**	**$82,515.00**	**$353,532.00**

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects - Summary and Budget Page

Project Title: **Shallow Lake Enhancement (2c) & Easements (3c)**
Minnesota's Habitat Conservation Partnership (Phase 6)

Project Manager Name: **Jon Schneider, Ducks Unlimited (DU)**

Trust Fund Appropriation: $ 475,000

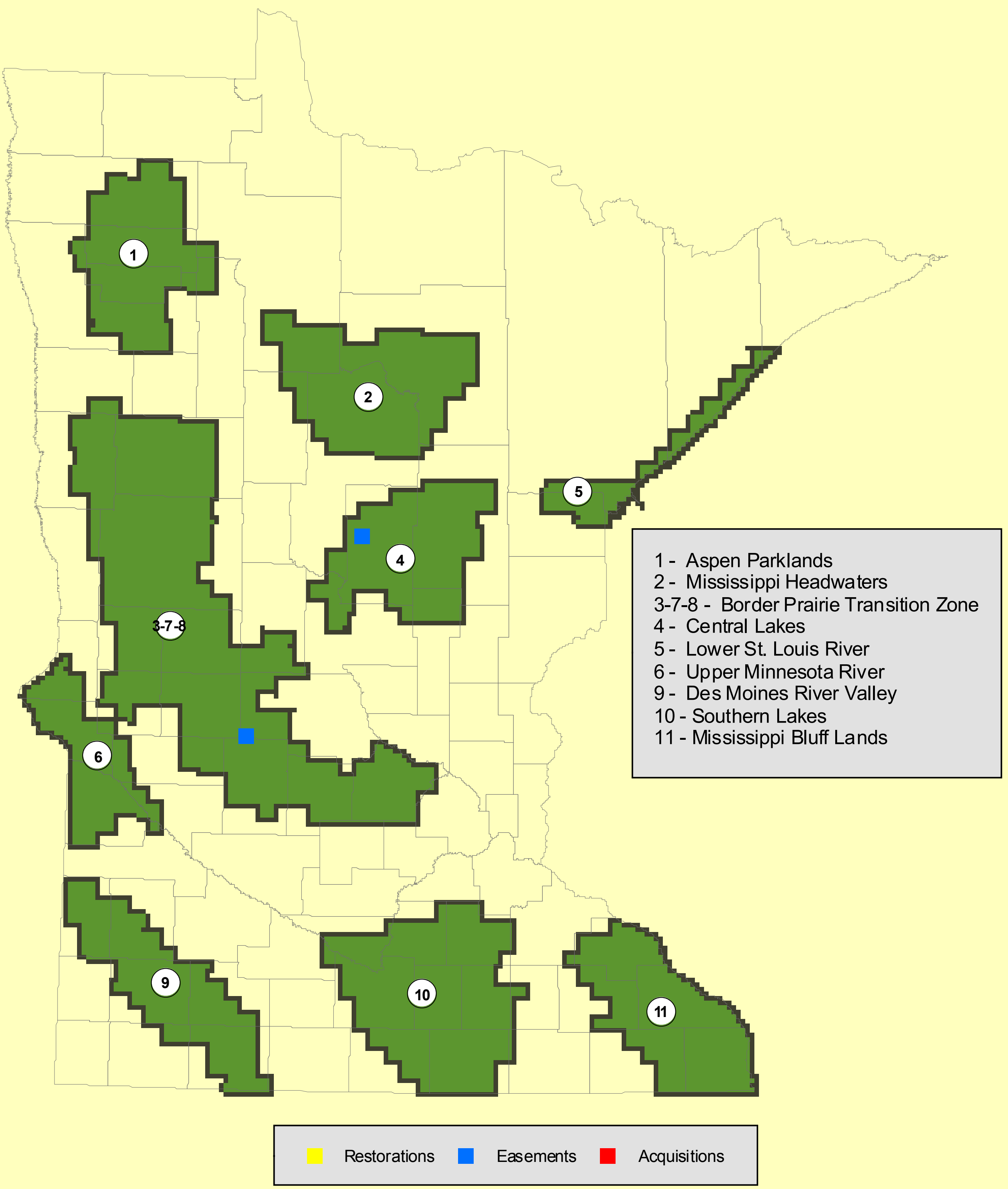
July 2011 FINAL REPORT

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent**	**Balance**	**Result 2 Budget:**	**Amount Spent**	**Balance**	**TOTAL BUDGET**	**TOTAL SPENT**	**TOTAL BALANCE**
	Shallow Lake Enhancement			Living Lakes Easements					
BUDGET ITEM									
PERSONNEL: wages and benefits for DU biologist (1 FTE), engineers (1 FTE), protection (1 FTE) field staff, and program manager (0.10 FTE) for grant administration/coordination (up to 4% of grant).	100,000	100,000	0	50,000	50,000	0	150,000	150,000	0
CONTRACTS: construction of water structures, purchase of easements, contracted professional services such as soils investigation, title clearance, appraisal, legal work, and baseline documentation	115,000	115,000	0	195,000		0	310,000	115,000	0
Professional/technical (consultant engineering and environmental services)					0		0	0	0
Land rights acquisition (easements)					173,353		0	173,353	0
Professional Services for Acquisition					21,647		0	21,647	0
Construction (water control structures)							0	0	0
TRAVEL: in-state for biologists and engineers	10,000	10,000	0	5,000	5,000	0	0	15,000	0
OTHER (easement monitoring stewardship)				0	0	0	0	0	0
COLUMN TOTAL	**$225,000**	**$225,000**	**$0**	**$250,000**	**$250,000**	**$0**	**$475,000**	**$ 475,000**	**$ -**

Habitat Conservation Partnership

Shallow Lake Easements

3C



2009 Project Abstract
For the Period Ending November 19, 2010

PROJECT TITLE:	Wetlands Reserve Program Minnesota's Habitat Conservation Partnership (Part 3d)
PROJECT MANAGER:	Jon Schneider, Manager – Minn. Conservation Programs
AFFILIATION:	Ducks Unlimited, Inc.
MAILING ADDRESS:	311 East Lake Geneva Road NE
CITY/STATE/ZIP:	Alexandria, Minnesota 56308
PHONE:	320-762-9916
E-MAIL:	jschneider@ducks.org
FAX:	320-759-1567
WEB SITE:	www.ducks.org

PROJECT CO-MANAGER:	Tim Koehler – Assistant State Conservationist
AFFILIATION:	USDA Natural Resources Conservation Service (NRCS)
MAILING ADDRESS:	USDA-NRCS Jackson Street, Suite 600, St. Paul, MN 55101
PHONE:	(651) 602-7857
E-MAIL:	Tim.Koehler@mn.usda.gov
FAX:	(651) 602-7914

FUNDING SOURCE:	Environment and Natural Resources Trust Fund
LEGAL CITATION:	Minnesota Law 2009, Chapter 143, Section 2, Subd. 4(e)3d

APPROPRIATION AMOUNT: $ 420,000

Overall Project Outcome and Results

In partnership with the USDA's Natural Resources Conservation Service (NRCS), Ducks Unlimited (DU) contracted with six Wetlands Reserve Program (WRP) technicians that began HCP Phase 6 work on September 10, 2009 with combined funding support from LCCMR Trust Fund and NRCS grants. The purpose of these contracted technicians was to provide technical assistance to private landowners and USDA - NRCS complete applications and enroll new lands into the WRP, and to help USDA-NRCS and private landowners plan, design, and implement restoration measures on lands previously enrolled in the WRP. The delivery goal for these technicians was to provide Technical Assistance (TA) to help NRCS protect 1,000 acres through new WRP easements and help restore wetlands and associated upland habitat on WRP easements in prairie Habitat Conservation Partnership (HCP) project areas at an estimated Other Funds cost of $1,500,000 to NRCS.

During the life of this grant, the contract specialists made 275 landowner contacts, helped process 80 applications, developed 96 easement conservation plans, completed 21 wetland restoration designs, and managed construction of 55 wetland restoration projects. Overall, NRCS closed (purchased) 25 new WRP easements protecting 2,721 acres with the assistance of these six contracted wetland specialists funded through this grant, which exceeds the easement acre goal of this project. This includes WRP easements protecting 1,031 acres of wetlands and 1,690 acres of adjacent uplands. Other Fund expense incurred by NRCS to purchase these easements and by DU to hire and manage the contractors totals $3,923,321 in non-state funding, more than double our Other Funds expense pledge of $1.5 million.

Project Results Use and Dissemination

Information on the WRP signups has been publicized through news releases from the USDA's NRCS and local Soil and Water Conservation Districts, and through hundreds of individual landowner contacts made by DU wetland restoration specialists. Additional announcements and landowner contacts continue to be made and publicized by DU and USDA's NRCS.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6

Habitat Conservation Partnership

3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Project Manager: Jon Schneider
Affiliation: Ducks Unlimited
Address: 311 East Lake Geneva Road
Alexandria, MN 56308
Phone: (320)762-9916
Fax: (320)759-1567
E-mail: jschneider@ducks.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation: ML 2009, Chapter 143, Section 2, Subd. 4(e)

Project Manager: Tim Koehler
Affiliation: USDA - Natural Resources Conservation Service
Address: 375 Jackson Street, Suite 600
St. Paul, MN 55101
Phone: (651) 602-7857
Fax: (651) 602-7926
E-mail: tim.koehler@mn.usda.gov

Total Biennial Project Budget

Result	ENTF Balance	ENTF Funds Spent	ENTF Balance	Other Funds * Proposed	Other Funds * Spent
Easement	$420,000	$420,000	$0	$1,500,000	$3,923,321
Total	$420,000	$420,000	$0	$1,500,000	$3,923,321

* Please note that most other funds reported here are federal in origin but do include some Ducks Unlimited costs.

Work Program Summary

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3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Easement Activities

Project Name: 66080023
Project Area: 3 - Border Prairie
Township: 123, Range: 38, Section: 24
Description: WRP-RIM easement in Pope County, MN.
Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$88,115.42	63.00	51.60	0.00	11.40	0.00	0.00

Project Name: 66080032
Project Area: 3 - Border Prairie
Township: 124, Range: 38, Section: 27
Description: WRP-RIM easement in Pope County, MN.
Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$158,491.51	117.60	97.90	0.00	19.70	0.00	0.00

Project Name: 66080073
Project Area: 3 - Border Prairie
Township: 130, Range: 41, Section: 27
Description: WRP-RIM easement in Grant county, MN.
Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$66,393.59	59.10	21.50	0.00	37.60	0.00	0.00

Project Name: 66080074
Project Area: 3 - Border Prairie
Township: 127, Range: 44, Section: 27
Description: NRCS secured a 151.5 acre WRP easement in grant County protecting 117.5 acres of upland and 34 acres of wetlands.
Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$201,375.00	151.50	117.50	0.00	34.00	0.00	0.00

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6

Habitat Conservation Partnership

3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Project Name: 66080075
Project Area: 3 - Border Prairie
Township: 127, Range: 43, Section: 17
Description: WRP-RIM easement in Grant County, MN.
Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$120,922.56	84.70	59.50	0.00	25.20	0.00	0.00

Project Name: 66080135
Project Area: 3 - Border Prairie
Township: 126, Range: 44, Section: 13
Description: WRP-RIM easement in Stevens County, MN.
Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$252,854.33	156.30	111.70	0.00	44.60	0.00	0.00

Project Name: 66080193
Project Area: 3 - Border Prairie
Township: 143, Range: 43, Section: 29
Description: NRCS secured a 117.3 acre WRP easement in Norman County protecting 98.3 acres of upland and 19 acres of wetlands.
Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$82,131.90	117.30	98.30	0.00	19.00	0.00	0.00

Project Name: 66080194
Project Area: 3 - Border Prairie
Township: 143, Range: 43, Section: 31
Description: NRCS secured a 214.1 acre WRP easement in Norman County protecting 115 acres of upland and 99.1 acres of wetlands.
Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$148,268.42	214.10	115.00	0.00	99.10	0.00	0.00

3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Project Name: 66080200
Project Area: 3 - Border Prairie
Township: 142, Range: 41, Section: 9

Description: NRCS secured a 128.6 acre WRP easement in Becker County protecting 75.1 acres of upland and 53.5 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$114,887.73	128.60	75.10	0.00	53.50	0.00	0.00

Project Name: 66080201
Project Area: 3 - Border Prairie
Township: 142, Range: 41, Section: 9

Description: NRCS secured a 89.6 acre WRP easement in Becker County protecting 64.1 acres of upland and 25.5 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$82,919.24	89.60	64.10	0.00	25.50	0.00	0.00

Project Name: 66080268
Project Area: 3 - Border Prairie
Township: 143, Range: 43, Section: 18

Description: NRCS secured a 113.1 acre WRP easement in Norman County protecting 103 acres of upland and 10.1 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$81,980.84	113.10	103.00	0.00	10.10	0.00	0.00

Project Name: 66080262
Project Area: 6 - Upper Minnesota River
Township: 121, Range: 43, Section: 28

Description: NRCS secured a 216.5 acre WRP easement in Swift County protecting 18.5 acres of upland and 198 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$382,009.08	216.50	18.50	0.00	198.00	0.00	0.00

3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Project Name: 66080009
Project Area: 7 - Alexandria Moraine
Township: 126, Range: 44, Section: 18

Description: NRCS secured a 122.8 acre WRP easement in Stevens County protecting 37.5 acres of upland and 85.3 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$194,549.00	122.80	37.50	0.00	85.30	0.00	0.00

Project Name: 66080036
Project Area: 7 - Alexandria Moraine
Township: 126, Range: 44, Section: 27

Description: NRCS secured a 158 acre WRP easement in Stevens County protecting 122 acres of upland and 36 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$241,263.15	158.00	122.00	0.00	36.00	0.00	0.00

Project Name: 66080072
Project Area: 7 - Alexandria Moraine
Township: 128, Range: 43, Section: 9

Description: NRCS secured a 75.9 acre WRP easement in Grant County protecting 54.9 acres of upland and 21 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$101,668.05	75.90	54.90	0.00	21.00	0.00	0.00

Project Name: 66080123
Project Area: 7 - Alexandria Moraine
Township: 128, Range: 26, Section: 34

Description: NRCS secured a 14.6 acre WRP easement in Douglas County protecting 6.5 acres of upland and 8.1 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$23,263.26	14.60	6.50	0.00	8.10	0.00	0.00

3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Project Name: 66080133
Project Area: 7 - Alexandria Moraine
Township: 123, Range: 44, Section: 5

Description: NRCS secured a 93.4 acre WRP easement in Stevens County protecting 74.4 acres of upland and 19 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$174,001.33	93.40	74.40	0.00	19.00	0.00	0.00

Project Name: 66080211
Project Area: 7 - Alexandria Moraine
Township: 131, Range: 43, Section: 25

Description: WRP-RIM easement in Otter Tail County, MN.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$11,739.20	12.40	0.00	0.00	12.40	0.00	0.00

Project Name: 66080213
Project Area: 7 - Alexandria Moraine
Township: 128, Range: 35, Section: 1

Description: WRP-Rim easement in Todd County, MN.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$180,101.38	170.20	136.00	0.00	34.20	0.00	0.00

Project Name: 660900MQK
Project Area: 7 - Alexandria Moraine
Township: 126, Range: 42, Section: 11

Description: WRP-RIM easement in Stevens County, MN.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$330,196.34	160.40	120.00	0.00	40.40	0.00	0.00

3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Project Name: 660900NSK
Project Area: 7 - Alexandria Moraine
Township: 128, Range: 40, Section: 6

Description: NRCS secured a 68.8 acre WRP easement in Douglas County protecting 62.6 acres of upland and 6.2 acres of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$100,003.83	68.80	62.60	0.00	6.20	0.00	0.00

Project Name: 66080025
Project Area: 10 - Southern Lakes
Township: 102, Range: 22, Section: 26

Description: NRCS secured a 113.1 easement in Freeborn County protecting 29.7 ac. of upland and 83.4 ac. of wetlands.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$243,940.58	113.10	29.70	0.00	83.40	0.00	0.00

Project Name: 66080026
Project Area: 10 - Southern Lakes
Township: 104, Range: 19, Section: 27

Description: WRP-RIM easement in Freeborn County, MN.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$233,269.46	119.80	48.30	0.00	71.50	0.00	0.00

Project Name: 66080027
Project Area: 10 - Southern Lakes
Township: 104, Range: 19, Section: 21

Description: WRP-RIM easement in Freeborn County, MN.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$14,382.64	6.00	0.00	0.00	6.00	0.00	0.00

3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Project Name: 66080149

Project Area: 10 - Southern Lakes
Township: 107, Range: 22, Section: 14

Description: WRP-RIM easement in Waseca County, MN.

Easement Recorded in LCCMR office: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
Other Funds	Easement Acquisition Costs	$240,198.44	94.40	64.50	0.00	29.90	0.00	0.00

Easement Totals (By Funding Type)

Funding Type:	Funding Amount	Prorated Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Other Funds	$3,868,926.28	2,721.20	1,690.10	0.00	1,031.10	0.00	0.00
Total	**$3,868,926.28**	**2,721.20**	**1,690.10**	**0.00**	**1,031.10**	**0.00**	**0.00**

Work Program Expenditures (Not Attributable to Specific Projects)

FundingType	*Category*	*Amount*	*Description*
ENTF	Professional Services	$407,035.00	Contract expense for six (6) wetland restoration specialists that DU contracted to help NRCS promote and deliver the USDA's Wetlands Reserve Program (WRP) and assist landowners and NRCS with restoring wetlands and native prairie grasslands enrolled into this conservation easement program within HCP Project Areas. During this grant, the contract specialists made 275 landowner contacts, helped process 80 applications, developed 96 easement conservation plans, completed 21 wetland restoration designs, and managed construction of 55 wetland restoration projects.
ENTF	Personnel Expenditures	$12,965.00	DU staff expense to hire and replace contract specialists, supervise their activities, and perform grant management tasks.
Other Funds	Personnel Expenditures	$54,395.00	DU staff expense to hire and replace contract specialists, supervise their activities, and perform grant management tasks.
	Total:	**$474,395.00**	

Work Program Expenditures (Not Attributable to Specific Projects) By Funding Type

Funding Type	Amount
ENTF:	$420,000.00
Other Funds:	$54,395.00
Total:	**$474,395.00**

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6

Habitat Conservation Partnership

3D: Wetlands Reserve Program - Ducks Unlimited (DU) & Natural Resources Conservation Services (NRCS)

Work Program Expenditures Breakdown

Funding Type:	Easement Projects	Not Attributable to Specific Projects	Total
ENTF	$0.00	$420,000.00	$420,000.00
Other Funds	$3,868,926.28	$54,395.00	$3,923,321.28
Total	**$3,868,926.28**	**$474,395.00**	**$4,343,321.28**

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects

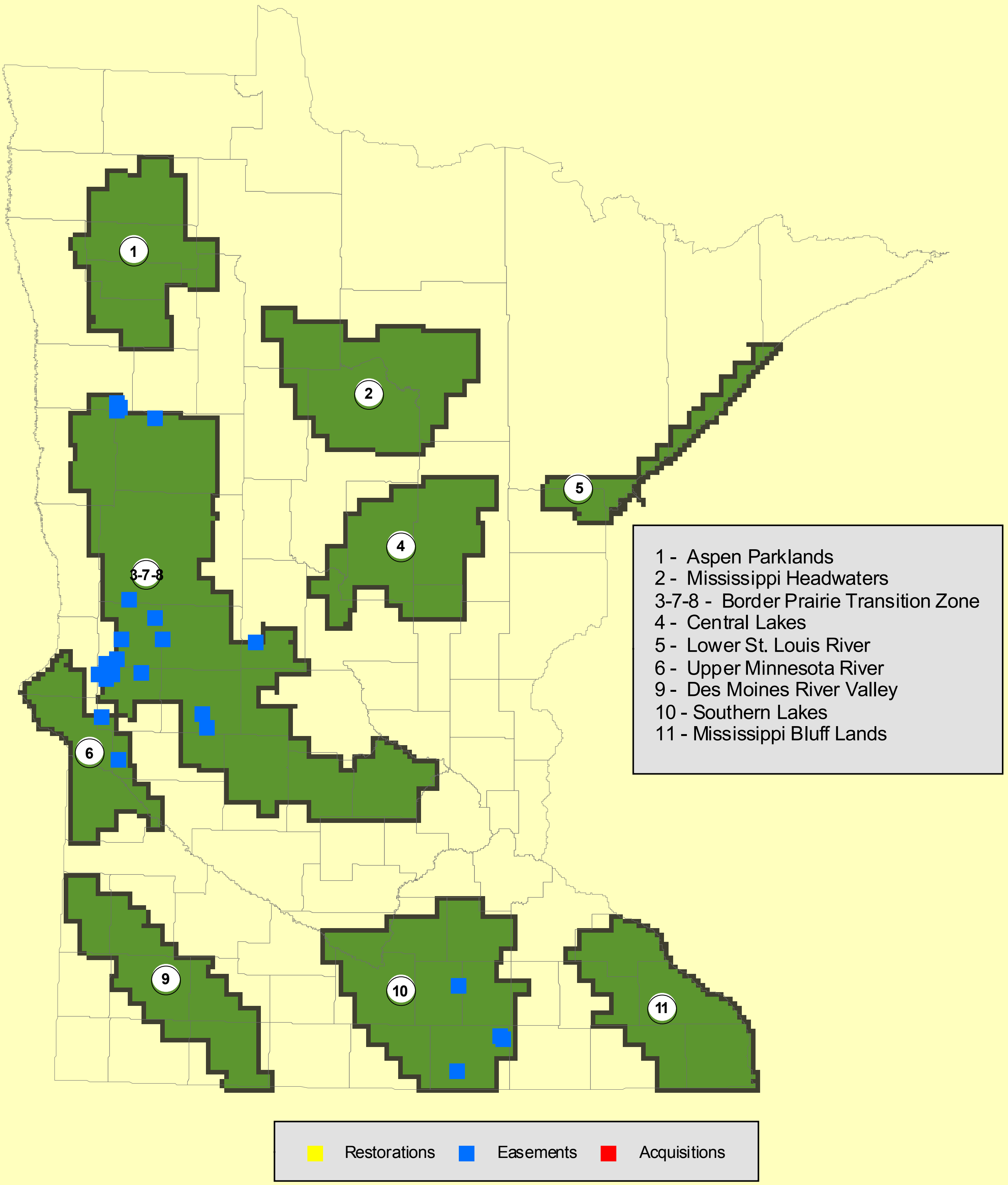
Project Title: Wetlands Reserve Program (HCP Part 3d)
Minnesota's Habitat Conservation Partnership Phase 6
Project Manager Name: Jon Schneider (DU) & Tim Koehler (USDA-NRCS)

Trust Fund Appropriation: $420,000

DATE: November 19, 2010 Final Report

2008 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent**	**Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
	WRP Easements				
BUDGET ITEM					
PERSONNEL: wages and benefits (for DU project administration, coordination, and contract tech hiring and supervision)	12,745	12,745	0	12,745	0
Contracts					
Professional/technical (contracted WRP wetland restoration field technicians to promote and help NRCS secure WRP easements)	407,035	407,035	0	407,035	0
Other contracts				0	0
Other				0	0
COLUMN TOTAL	**$420,000**	**$420,000**	**$0**	**$420,000**	**$0**

Habitat Conservation Partnership
Wetlands Reserve Program
3D



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Critical Lands Conservation Initiative - 4a – Pheasants Forever, Inc.
PROJECT MANAGER: Joe Pavelko
AFFILIATION: Pheasants Forever, Inc.
MAILING ADDRESS: 7975 Acorn Circle
CITY/STATE/ZIP: Victoria, MN 55386
PHONE: 612-532-3800
E-MAIL: jpavelko@pheasantsforever.org
WEBSITE: www.pheasantsforever.org www.minnesotapf.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4e4a

APPROPRIATION AMOUNT: $350,000

Overall Project Outcome and Results

To help slow the loss of habitat and declining wildlife populations, Pheasants Forever purchased in fee-title 2 parcels totaling 93 acres to permanently protect quality wildlife habitat lands within Chippewa and Lac Qui Parle Counties, MN. These lands have been or are in the process of being enrolled into the state Wildlife Management Area System and will be protected and managed in perpetuity by the Minnesota Department of Natural Resources. In addition, these newly acquired WMAs will provide access and recreational opportunities for ALL Minnesotans, so fundamentally important to our outdoor heritage.

More specifically, a total of 38 acres were acquired using $72,987.29 of Environment and Natural Resources Trust Funds that were matched with $56,000 of non-state funds to acquire an additional 55 acres totaling 93 acres. Of those total acres, 49 acres are grassland (including native prairie) and 43 acres of wetlands. Striving to build landscape level habitat complexes that will protect and sustain wildlife populations, both projects are additions to existing WMAs and build upon past investments in wildlife habitat conservation. Due to the volatile real estate market and county board approval requirements, a balance of funds were left. A project by project accounting and supporting context can be found in the final work program report and all accomplishment reports are available at www.mnhabitatcorridors.org.

Accomplishments were achieved by working with many local, state, and federal partners. Effective partnerships are the backbone of conservation in Minnesota. Through this project we have continued the effort to build and enhance effective conservation partnerships that provide wildlife and recreation benefits to all Minnesotans.

Project Results Use and Dissemination

All projects acquired through the Habitat Conservation Partnership acknowledge the funding from the Minnesota Environment & Natural Resources Trust Fund. These new public land additions will be incorporated into the DNR Wildlife Management Area System and will be added to appropriate maps, websites, and other WMA information dissemination outlets. Detailed accomplishment report information is available at www.mnhabitatcorridors.org.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

4A: Critical Lands Conservation Initiative - Pheasants Forever

Project Manager: Joe Pavelko
Affiliation: Pheasants Forever
Address: 7975 Acorn Circle
Victoria, MN 55386
Phone: 612-532-3800
Fax:
E-mail: jpavelko@pheasantsforever.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation:
ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Acquisition	$350,000	$72,987	$277,013	$350,000	$56,000
Total	$350,000	$72,987	$277,013	$350,000	$56,000

Work Program Summary

Overall Project Outcome and Results
To help slow the loss of habitat and declining wildlife populations, Pheasants Forever purchased in fee-title 2 parcels totaling 93 acres to permanently protect quality wildlife habitat lands within Chippewa and Lac Qui Parle Counties, MN. These lands have been or are in the process of being enrolled into the state Wildlife Management Area System and will be protected and managed in perpetuity by the Minnesota Department of Natural Resources. In addition, these newly acquired WMAs will provide access and recreational opportunities for ALL Minnesotans, so fundamentally important to our outdoor heritage.

More specifically, a total of 38 acres were acquired using $72,987.29 of Environment and Natural Resources Trust Funds that were matched with $56,000 of non-state funds to acquire an additional 55 acres totaling 93 acres. Of those total acres, 49 acres are grassland (including native prairie) and 43 acres of wetlands. Striving to build landscape level habitat complexes that will protect and sustain wildlife populations, both projects are additions to existing WMAs and build upon past investments in wildlife habitat conservation. Due to the volatile real estate market and county board approval requirements, a balance of funds were left. A project by project accounting and supporting context can be found in the final work program report and all accomplishment reports are available at www.mnhabitatcorridors.org.

Accomplishments were achieved by working with many local, state, and federal partners. Effective partnerships are the backbone of conservation in Minnesota. Through this project we have continued the effort to build and enhance effective conservation partnerships that provide wildlife and recreation benefits to all Minnesotans.

Project Results Use and Dissemination
All projects acquired through the Habitat Conservation Partnership acknowledge the funding from the Minnesota Environment & Natural Resources Trust Fund. These new public land additions will be incorporated into the DNR Wildlife Management Area System and will be added to appropriate maps, websites, and other WMA information dissemination outlets. Detailed accomplishment report information is available at www.mnhabitatcorridors.org.

4A: Critical Lands Conservation Initiative - Pheasants Forever

Acquisition Activities

Project Name: Benderberg WMA
Tract: 18
Project Area: 6 - Upper Minnesota River
Township: 119, Range: 42, Section: 13
Acquisition Holder: DNR-WMA
Description: This tract consists of 20 acres of wetland and 62 acres of upland and croplands. The croplands will be permanently retired and restored with a high diversity priaire mix. This tract is 2 miles from the 9,000 acre Lac Qui Parle WMA, 1.5 miles away from the Milan WMA, and adjoins another WMA. The acquisition of this tract builds upon previous wildlife habitat investments, will provide quality wildlife habitat, and will provide outdoor recreation opportunities to all Minnesotans. This project was completed using both 2008 and 2009 ENTF appropriations.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	88.00	64.00	0.00	20.00	0.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Fee-Title Acquisition Costs	$64,370.00	32.88	23.91	0.00	7.47	0.00	0.00
Benderberg WMA Total		**$64,370.00**	**32.88**	**23.91**	**0.00**	**7.47**	**0.00**	**0.00**

Project Name: Florida Creek WMA
Tract: 1
Project Area: 6 - Upper Minnesota River
Township: 116, Range: 45, Section: 17
Acquisition Holder: DNR-WMA
Description: This tract lies directly adjacent to the existing Florida Creek WMA. This parcel is dominated by wet meadow with relatively flat topography and Florida Creek meanders through the parcel. Acquisition of this parcel will allow for additional public recreation, straighten boundaries, reduce land owner conflicts with beaver, allow for potential water management options in the future, and provide quality wildlife habitat.
Acquisition reported via LCCMR website: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Fee-Title Acquisition Costs	$5,000.00	4.92	2.05	0.00	2.87	0.00	0.00
Other Funds	Fee-Title Acquisition Costs	$56,000.00	55.08	22.95	0.00	32.13	0.00	0.00
Florida Creek WMA Total		**$61,000.00**	**60.00**	**25.00**	**0.00**	**35.00**	**0.00**	**0.00**

Acquisition Totals (By Funding Type)

Funding Type:	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF:	$69,370.00	37.79	25.96	0.00	10.34	0.00	0.00
Other Funds:	$56,000.00	55.08	22.95	0.00	32.13	0.00	0.00

4A: Critical Lands Conservation Initiative - Pheasants Forever

Total:	**$125,370.00**	**92.88**	**48.91**	**0.00**	**42.47**	**0.00**	**0.00**

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

4A: Critical Lands Conservation Initiative - Pheasants Forever

Work Program Expenditures (Not Attributable to Specific Projects)

FundingType	Category	Amount	Description
ENTF	Personnel Expenditures	$3,617.29	Personnel direct bill hours
	Total:	**$3,617.29**	

Work Program Expenditures (Not Attributable to Specific Projects) By Funding Type

Funding Type	Amount
ENTF:	$3,617.29
Total:	**$3,617.29**

Work Program Expenditures Breakdown

Funding Type:	Acquistion Projects	Not Attributable to Specific Projects	Total
ENTF:	$69,370.00	$3,617.29	$72,987.29
Other Funds:	$56,000.00	$0.00	$56,000.00
Total:	**$125,370.00**	**$3,617.29**	**$128,987.29**

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects - Final Report

Project Title: Critical Lands Conservation Initiative – 4a   Pheasants Forever, Inc.

Project Manager Name: Joe Pavelko

Trust Fund Appropriation: $ 350,000

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** June 30, 2011	**Balance** June 30, 2011	**TOTAL BUDGET**	**TOTAL BALANCE**
	Fee Title Acquisition				
BUDGET ITEM					
PERSONNEL: wages and benefits (0.2 FTE For Regional Representative direct to project)	25,000	3,617	21,383	25,000	21,383
Land acquisition (including eligible expenses such as appraisal, survey, title, closing, etc)	325,000	69,370	255,630	325,000	255,630
COLUMN TOTAL	**$350,000**	**$72,987**	**$277,013**	**$350,000**	**$277,013**

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: 4B: Fisheries Acquisition – MN DNR – Division of Fish and Wildlife
PROJECT MANAGER: Mike Halverson
AFFILIATION: MN DNR – Division of Fish & Wildlife
MAILING ADDRESS: 500 Lafayette Rd.
CITY/STATE/ZIP: St. Paul, MN 55155
PHONE: (651) 259- 5209
FAX: (651) 297-4916
E-MAIL: mike.halverson@state.mn.us
WEBSITE: [

FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, CH 143, Sec. 2, Sub 4(e)

APPROPRIATION AMOUNT: $300,000

Overall Project Outcome and Results

This project focused on the acquisition of habitat linkages that provided environmental protection of the shoreline and riparian zone, exhibited a high risk of development, supplied angler access, and afforded management access necessary for implementing habitat improvement projects.

Project goals were to protect 120 acres (1.4 miles of lake and stream shoreline) with the help of partner and other state funding. Partner funding includes donations of land value and cash.

This project resulted in the acquisition of four parcels with a grand total of approximately 54.2 acres and 1.3 miles of lake and stream shoreline. Because of the extreme variation in shoreline values it is hard to accurately predict a reliable acre benchmark. Most years, including the 2008 ETF appropriation, we far exceeded our acres goal. For the 2009 ETF appropriation, we fell short of the acres goal, but nearly reached our “miles of shoreline” goal. Environmental and Natural Resources Trust dollars directly acquired approximately 35.12 acres of the total, including 0.4 miles of lake and stream shoreline. Donations of land value (“other funds” $396,600) and resulting Reinvest In Minnesota Critical Habitat match (“other state monies” $165,000), leveraged with trust dollars, totaled $561,600. These contributions helped acquire the remaining acres of the grand total, including 4.0 acres and 0.2 shoreline miles using other state dollars and 8.5 acres and 0.4 shoreline miles from donations of land value. Preece Point was acquired jointly using both 2009 and 2010 Supplemental grants to Minnesota’s Habitat Conservation Partnership – Fish and Wildlife Acquisition (4b). Results for Preece Point were proportionately distributed for each grant.

As a result of this project, 54.2 acres, including 1.3 miles of critical shoreline fish and wildlife habitat are now permanently protected and open to public angling and/or hunting - as well as other light use recreational activities. Acquired parcels are now designated and managed as Aquatic Management Areas (AMAs).

Project Results Use and Dissemination

Accomplishment Reports and press releases will be made available at http://www.mnhabitatcorridors.org, and all AMAs will be added to DNR's Public Recreational Information Maps (PRIM).

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Manager: Mike Halverson
Affiliation: MNDNR - Fisheries
Address: 500 Lafayette Road
St. Paul, MN 55155
Phone: (651)259-5209
Fax: (651)297-4916
E-mail: mike.halverson@dnr.state.mn.us

Fund: Environment and Natural Resources Trust Fund

Legal Citation: ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds * Proposed	Other Funds * Spent
Acquisition	$300,000	$300,000	$0	$0	$0
Total	$300,000	$300,000	$0	$0	$0

*Other Funds are classified as non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds). Please note, however, that this work program has spent the following amounts not shown in the above table:

State Funds:	$165,000.00
Other:	$396,600.00

See the tables and funding type definitions at the end of this report for further explanation.

Work Program Summary

Overall Project Outcome and Results
This project focused on the acquisition of habitat linkages that provided environmental protection of the shoreline and riparian zone, exhibited a high risk of development, supplied angler access, and afforded management access necessary for implementing habitat improvement projects.

Project goals were to protect 120 acres (1.4 miles of lake and stream shoreline) with the help of partner and other state funding. Partner funding includes donations of land value.

This project resulted in the acquisition of four parcels with a grand total of approximately 54.2 acres and 1.3 miles of lake and stream shoreline. Because of the extreme variation in shoreline values it is hard to accurately predict a reliable acre benchmark. Most years, including the 2008 ETF appropriation, we far exceeded our acres goal. For the 2009 ETF appropriation, we fell short of the acres goal, but nearly reached our “miles of shoreline” goal. Environmental and Natural Resources Trust dollars directly acquired approximately 35.12 acres of the total, including 0.4 miles of lake and stream shoreline. Donations of land value (“other funds” $396,600) and resulting Reinvest In Minnesota Critical Habitat match (“other state monies” $165,000), leveraged with trust dollars, totaled $561,600. These contributions helped acquire the remaining acres of the grand total, including 4.0 acres and 0.2 shoreline miles using other state dollars and 8.5 acres and 0.4 shoreline miles from donations of land value. Preece Point was acquired jointly using both 2009 and 2010 Supplemental grants to Minnesota’s Habitat Conservation Partnership – Fish and Wildlife Acquisition (4b). Results for Preece Point were proportionately distributed for each grant.

As a result of this project, 54.2 acres, including 1.3 miles of critical shoreline fish and wildlife habitat are now permanently protected and open to public angling and/or hunting - as well as other light use recreational activities. Acquired parcels are now designated and managed as Aquatic Management Areas (AMAs).

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Results Use and Dissemination
Accomplishment Reports and press releases will be made available at http://www.mnhabitatcorridors.org, and all AMAs will be added to DNR's Public Recreational Information Maps (PRIM).

Acquisition Activities

Project Name: Preece Point
Tract: 1
Project Area: 2 - Mississippi Headwaters
Township: 146, Range: 33, Section: 30
Acquisition Holder: DNR-AMA
Description: Preece Point is one of the most prominent geographic features on Lake Marquette - a Mississippi River headwaters lake. Here the lakeshore forms a long, narrow point, which is visible from virtually everywhere around the lake. The entire property along with it's associated aquatic habitat is unimpacted by human activities. This AMA will provide walk-in access to a lake that has no developed public access. The property was sold to DNR as a bargain sale, and the family is happy to know that it will be preserved forever in it's natural state. For these reasons Preece Point AMA scores very high on the AMA criteria list.
Acquisition reported via LCCMR website: Yes

			Acres	**Grassland Acres**	**Woodland Acres**	**Wetland Acres**	**Shoreline Feet**	**Riparian Feet**
	Non Prorated Totals:		15.00	0.00	8.00	7.00	0.00	0.00
Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Fee-Title Acquisition Costs	$72,126.00	6.29	0.00	3.35	2.94	0.00	0.00
ENTF	Professional Services	$7,074.80	0.00	0.00	0.00	0.00	0.00	0.00
	Preece Point Total	**$79,200.80**	**6.29**	**0.00**	**3.35**	**2.94**	**0.00**	**0.00**

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Name: Steamboat Lake AMA
Tract: 2
Project Area: 2 - Mississippi Headwaters
Township: 144, Range: 31, Section: 29
Acquisition Holder: DNR-AMA
Description: This property includes 36 acres of land, with 1,170 feet of shoreline on Steamboat Lake in Cass County. This parcel doubles the shoreline protected as AMA on Steamboat Lake. Acquisition of this site permanently protects habitat important to a variety of fish and wildlife species, as well as protecting vital surface and groundwater resources. For these reasons this acquisition ranked high on the AMA criteria list. This project was finalized with 2007 HCP funding, but professional services have carried over into 2008 and 2009.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	38.70	0.00	6.00	32.70	1,100.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$2,015.00	0.00	0.00	0.00	0.00	0.00	0.00
Steamboat Lake AMA Total		**$2,015.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Project Name: Bucks Mill AMA
Tract: 2
Project Area: 3 - Border Prairie
Township: 138, Range: 41, Section: 31
Acquisition Holder: DNR-AMA
Description: Buck Lake is one of two small lakes located on the Pelican River between Melissa and Little Pelican Lakes in Becker County. This property includes 29.6 acres of land, with 1,100 feet of shoreline. This parcel along with the existing AMA, protects 1/2 of the shoreline on Buck Lake which is rest and feeding link on this important sturgeon, walleye, northern pike, and white sucker migration route. This will also provide a much needed walk-in public access to this exellent fishing lake. For these reasons this parcel ranked high on the AMA criteria list.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	29.60	20.00	5.00	4.60	1,100.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Fee-Title Acquisition Costs	$142,000.00	29.60	20.00	5.00	4.60	1,100.00	0.00
ENTF	Professional Services	$17,558.30	0.00	0.00	0.00	0.00	0.00	0.00
Bucks Mill AMA Total		**$159,558.30**	**29.60**	**20.00**	**5.00**	**4.60**	**1,100.00**	**0.00**

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Name: Greenleaf AMA
Tract: 1
Project Area: 3 - Border Prairie
Township: 118, Range: 30, Section: 21
Acquisition Holder: DNR-AMA
Description: Property includes 28 acres of land, with 0.5 miles of shoreline on Souix Lake in Meeker County. This is part of a larger project called the Greenleaf Recreation Area. This AMA parcel will both protect the natural integrity of the shoreline habitat, and provide light use public access, including shorefishing. For these reasons this parcel ranked high on our AMA criteria list. This project ended up going into abeyance because the owners wanted more than the appraised value. Professional Services related to the attempted acquisition occured in both 2008 and 2009.
Acquisition reported via LCCMR website: No

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	28.00	8.00	10.00	10.00	1,700.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$3,720.00	0.00	0.00	0.00	0.00	0.00	0.00
Greenleaf AMA Total		**$3,720.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Project Name: Ida Lake AMA
Tract: 7
Project Area: 3 - Border Prairie
Township: 129, Range: 38, Section: 2
Acquisition Holder: DNR-AMA
Description: This parcel is a donation from the Vikings Sportsmens Club in Douglas County. They acquired this property in order to permanently protect important spawning habitat. The property includes 21.8 acres with 0.66 miles of shoreline on Ida Lake in Douglas County. The project provides permanent protection to an important gamefish spawning area, protects the natural integrity of the shoreline habitat and provides walk-in public access. For these reaons this parcel ranked high on the AMA criteria lsit. Acquisition of this parcel was finalized with the 2008 HCP appropriation. Professional services costs have continued on into 2009.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	21.80	0.00	5.00	16.80	1,350.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$695.60	0.00	0.00	0.00	0.00	0.00	0.00
Ida Lake AMA Total		**$695.60**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Name: Lizzie Lake AMA
Tract: 1
Project Area: 3 - Border Prairie
Township: 136, Range: 42, Section: 7
Acquisition Holder: DNR-AMA
Description: This is a joint project with the Division of Parks and Trails. The parcel includes 3-acres of land, with 900 feet of shoreline where the Pelican River enters Lizzie Lake in Becker County. The project will both protect the natural integrity of the shoreline habitat, and provide public access. For these reaons this parcel ranked high on the AMA criteria list. The acquisition was finalized with 2008 HCP funds. Current charges(2009) are mostly associated with a required survey. Parks and Trails will develop a walk-in access at this site.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	3.00	2.00	0.00	1.00	900.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$7,195.00	0.00	0.00	0.00	0.00	0.00	0.00
Lizzie Lake AMA Total		**$7,195.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Project Name: Mary Lake AMA
Tract: 1
Project Area: 3 - Border Prairie
Township: 127, Range: 38, Section: 4
Acquisition Holder: DNR-AMA
Description: This parcel is a donation from the Vikings Sportsmens Club in Douglas County. They acquired this property in 1964 to provide access to an inlet area that served as state carp trap. The property includes 1.4 acres with 715 feet of shoreline on Mary Lake in Douglas County. The project provides permanent protection to an important wetland connection to Mary Lake, protects the natural integrity of the shoreline habitat and provides walk-in public access. Fore these reasons this parcel ranked high on DNRs AMA criteria list. This project was finalized with 2008 HCP funding. Professional services have continued on into 2009.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	1.40	0.00	1.00	0.40	715.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$391.40	0.00	0.00	0.00	0.00	0.00	0.00
Mary Lake AMA Total		**$391.40**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Name: Mason Lake Pass
Tract: 1
Project Area: 3 - Border Prairie
Township: 133, Range: 39, Section: 22
Acquisition Holder: DNR-AMA
Description: This parcel is a donation by the last survivors of an old shooting club. They acquired this property in 1965 to use as a duck hunting property for pass shooting ducks between East And West Mason Lakes. The property includes 3.4 acres with 1,070 feet of shoreline. The project provides permanent protection to an important wetland, and public access to both lakes. For these reasons this parcel ranks high on DNRs AMA criteria list. Because all of the original owners are deceased, unresolved title issues continue to be worked on by heirs trying to fulfill their father's wishes.
Acquisition reported via LCCMR website: No

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	3.40	0.00	2.00	3.40	1,070.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$222.60	0.00	0.00	0.00	0.00	0.00	0.00
Mason Lake Pass Total		**$222.60**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Project Name: Middle Lake AMA
Tract: 1
Project Area: 3 - Border Prairie
Township: 121, Range: 35, Section: 9
Acquisition Holder: DNR-AMA
Description: This property includes 14 acres of land, with 3,010 feet of shoreline on Middle Lake in Kandiyohi County. This is a cooperative project with MN DNR Trails and Waterways, who will develop a public boat access on their portion. The Fisheries administered portion will both protect the natural integrity of the shoreline habitat, and provide light use public access, including shorefishing. For these reasons this parcel ranked high on the AMA criteria list. This was finalized with the 2007 HCP appropriation, but professional services costs have continued on into 2008 and 2009.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	8.80	0.00	8.00	0.80	1,715.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$251.60	0.00	0.00	0.00	0.00	0.00	0.00
Middle Lake AMA Total		**$251.60**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Name: Norway Lake AMA
Tract: 2
Project Area: 3 - Border Prairie
Township: 121, Range: 35, Section: 6
Acquisition Holder: DNR-AMA
Description: This is a 13.5 acre parcel that contains 3,290 feet of natural shoreline which serves as an important nursery/spawning area for a varity of both gamefish and non-gamefish species. The owner is donating nearly 2/3 of the land value in order to see it remain protected from development. For these reasons this acquisition ranked high on our AMA criteria list. Appraised value is $549,000. The owner has donating all but $200,000 of the value. RIM dollars resulting from donated value are contributing to the $200,000 purchase price.
Acquisition reported via LCCMR website: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Fee-Title Acquisition Costs	$35,000.00	0.86	0.00	0.83	0.03	209.74	0.00
ENTF	Professional Services	$2,762.75	0.00	0.00	0.00	0.00	0.00	0.00
Other	Donated Fee Value	$349,000.00	8.58	0.00	8.26	0.32	2,091.46	0.00
State Funds	Fee-Title Acquisition Costs	$165,000.00	4.06	0.00	3.91	0.15	988.80	0.00
Norway Lake AMA Total		**$551,762.75**	**13.50**	**0.00**	**13.00**	**0.50**	**3,290.00**	**0.00**

Project Name: Pelican Lake AMA
Tract: 1
Project Area: 4 - Central Lakes
Township: 136, Range: 28, Section: 25
Acquisition Holder: DNR-AMA
Description: This donated property includes 54 acres of land, with 2,200 feet of shoreline on Pelican Lake in Crow Wing County. The land is already encumbered with a Conservation Easement held by the Minnesota Land Trust, but was acquired because of the significant public access values. The fee title portion is being donated to the DNR and will provide light use public access, including shorefishing. For these reasons the parcel ranked high on the AMA criteria list. The project was finalized with 2008 HCP funding, but professional services have continued on into 2009.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	78.30	0.00	38.30	40.00	2,815.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$45.60	0.00	0.00	0.00	0.00	0.00	0.00
Pelican Lake AMA Total		**$45.60**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Name: Tallus Island
Tract: 1
Project Area: 5 - Lower St. Louis River
Township: 49, Range: 15, Section: 23
Acquisition Holder: DNR-AMA
Description: This property includes 51.3 acres of Shoreland, with over 1 mile of shoreline on the St. Louis River near Duluth. This donated property will permanently protect an extreemly important estuary where Knowlton Creek enters the St. Louis River. For these reasons this parcel ranked high on the AMA criteria list. This project is moving slowly and has not been finalized.
Acquisition reported via LCCMR website: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$1,627.00	0.00	0.00	0.00	0.00	0.00	0.00
Tallus Island Total		**$1,627.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Project Name: Big Stone Lake AMA
Tract: 1
Project Area: 6 - Upper Minnesota River
Township: 122, Range: 47, Section: 10
Acquisition Holder: DNR-AMA
Description: Big Stone AMA includes 2.5 acres of land, with 300 feet of shoreline on Big Stone Lake in Big Stone County. This property is located on a prominant point, about 500 feet from Big Stone State Park, and permanently protects habitat important to a variety of fish and wildlife species, as well as providing light use public access. The owner has donating this parcel. For these reasons Big Stone Lake AMA ranks high on the AMA priority list. The acquisition of this donated parcel finalized with the 2008 HCP appropriation. Some professional services have continued on into 2009.
Acquisition reported via LCCMR website: Yes

	Acres	**Grassland Acres**	**Woodland Acres**	**Wetland Acres**	**Shoreline Feet**	**Riparian Feet**
Non Prorated Totals:	2.50	0.00	2.00	0.50	300.00	0.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$3,915.00	0.00	0.00	0.00	0.00	0.00	0.00
Big Stone Lake AMA Total		**$3,915.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

4B: Fisheries Land Acquisition - MNDNR - Fisheries

Project Name: Whitewater Way AMA
Tract: 1
Project Area: 11 - Mississippi Bluff Lands
Township: 108, Range: 12, Section: 27
Acquisition Holder: DNR-AMA
Description: This is a fee title donation from the Multi-County Hosing and Redevelopment Authority and is located on the North Branch of the Whitewater River in Elgin. It will permanently protect 1,950 feet of natural shoreline and provide trout angling for the public, as well as management access for the DNR. There are also plans for this site to become an environmental education site for area schools. Fore these reasons this project ranked high on the AMA Criteria list.
Acquisition reported via LCCMR website: Yes

	Acres	Grassland Acres	Woodland Acres	Wetland Acres	Shoreline Feet	Riparian Feet
Non Prorated Totals:	6.87	2.00	5.00	1.00	0.00	1,950.00

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Professional Services	$3,399.35	0.00	0.00	0.00	0.00	0.00	0.00
Other	Donated Fee Value	$47,600.00	6.87	2.00	5.00	1.00	0.00	1,950.00
Whitewater Way AMA Total		**$50,999.35**	**6.87**	**2.00**	**5.00**	**1.00**	**0.00**	**1,950.00**

Acquisition Totals (By Funding Type)

Funding Type:	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF:	$300,000.00	36.75	20.00	9.18	7.57	1,309.74	0.00
State Funds:	$165,000.00	4.06	0.00	3.91	0.15	988.80	0.00
Other:	$396,600.00	15.45	2.00	13.26	1.32	2,091.46	1,950.00
Total:	**$861,600.00**	**56.26**	**22.00**	**26.35**	**9.04**	**4,390.00**	**1,950.00**

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects - Final Budget Page

Project Title: Fish and Wildlife Acquisition (4B)

Minnesota's Habitat Conservation Partnership (VI)

Project Manager Name: Mike Halverson

Trust Fund Appropriation: $ *300,000*

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

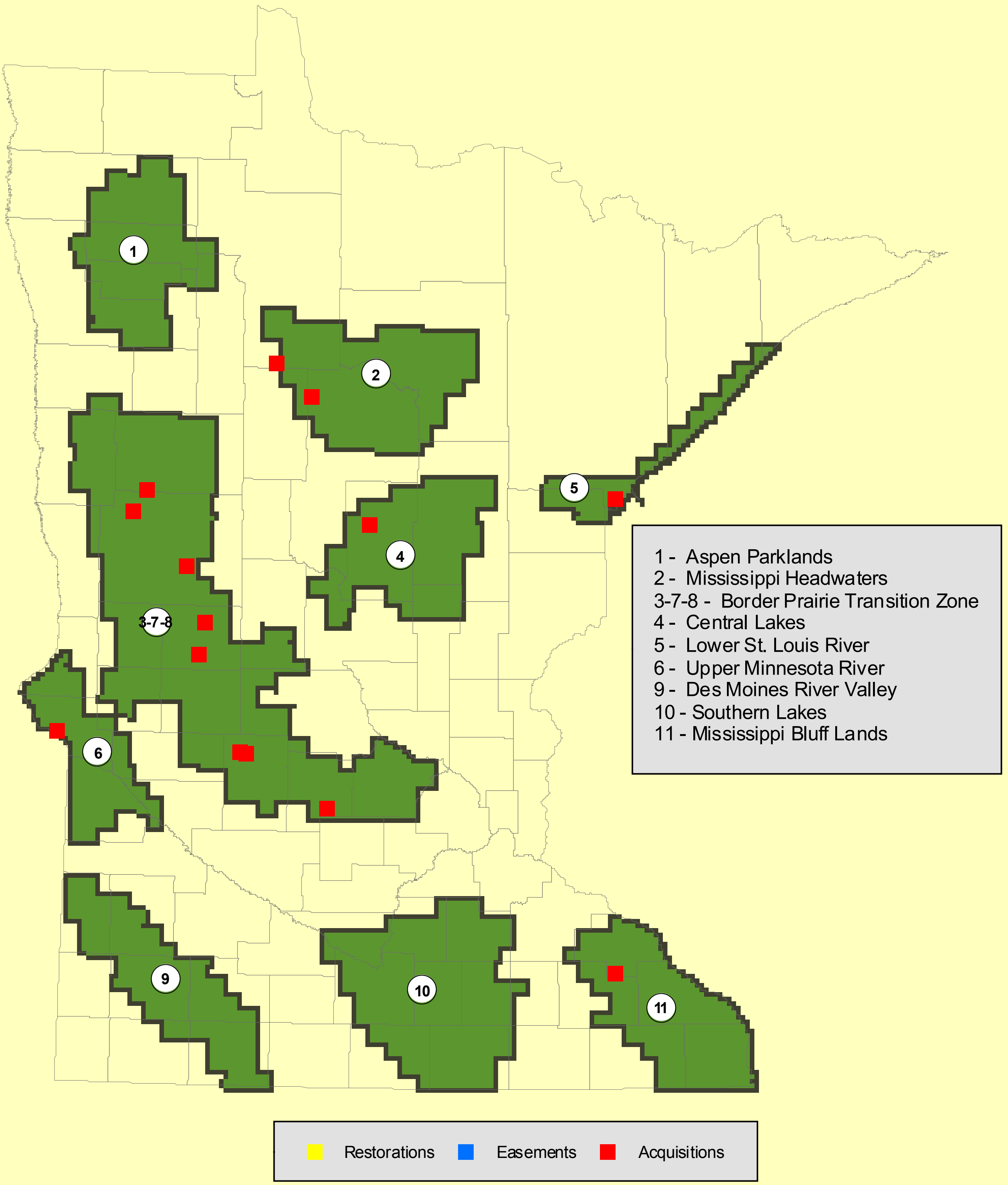
2) Remove any budget item lines not applicable

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Land Acquisition				
BUDGET ITEM			0	0	0
PERSONNEL: wages and benefits			0	0	0
Contracts			0	0	0
Professional/technical			0	0	0
Other contracts			0	0	0
Other direct operating costs			0	0	0
Equipment / Tools			0	0	0
Office equipment & computers			0	0	0
Other Capital equipment			0	0	0
Land acquisition	250,000	249,126	874	250,000	874
Land rights acquisition			0	0	0
Professional Services for Acq.	50,000	50,874	-874	50,000	-874
Printing			0	0	0
Other Supplies			0	0	0
Travel expenses in Minnesota			0	0	0
Travel outside Minnesota			0	0	0
Construction			0	0	0
Other land improvement			0	0	0
Other			0	0	0
COLUMN TOTAL	**$300,000**	**$300,000**	**$0**	300,000	0

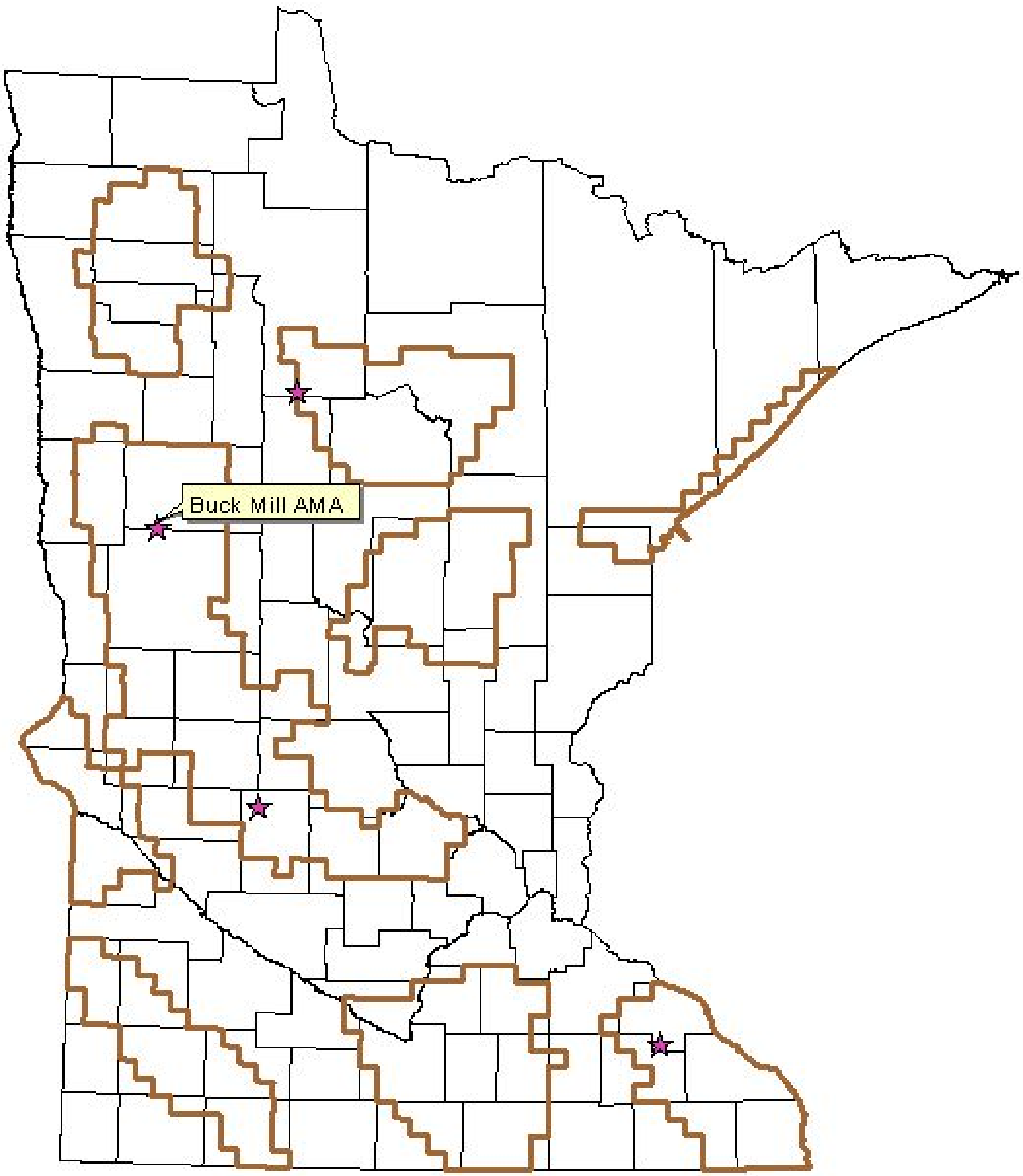
Habitat Conservation Partnership

Fisheries Land Acquisition

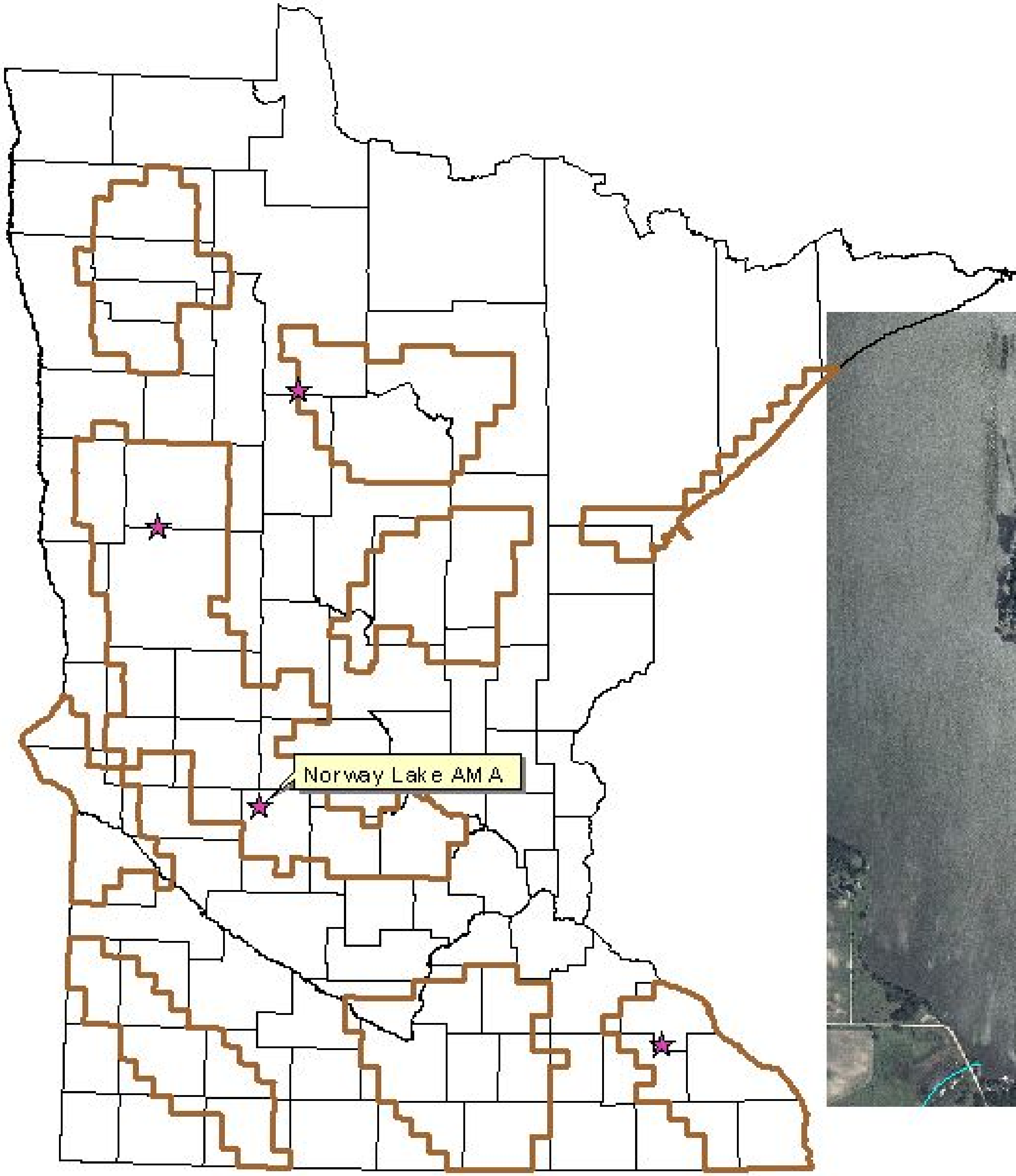
4B



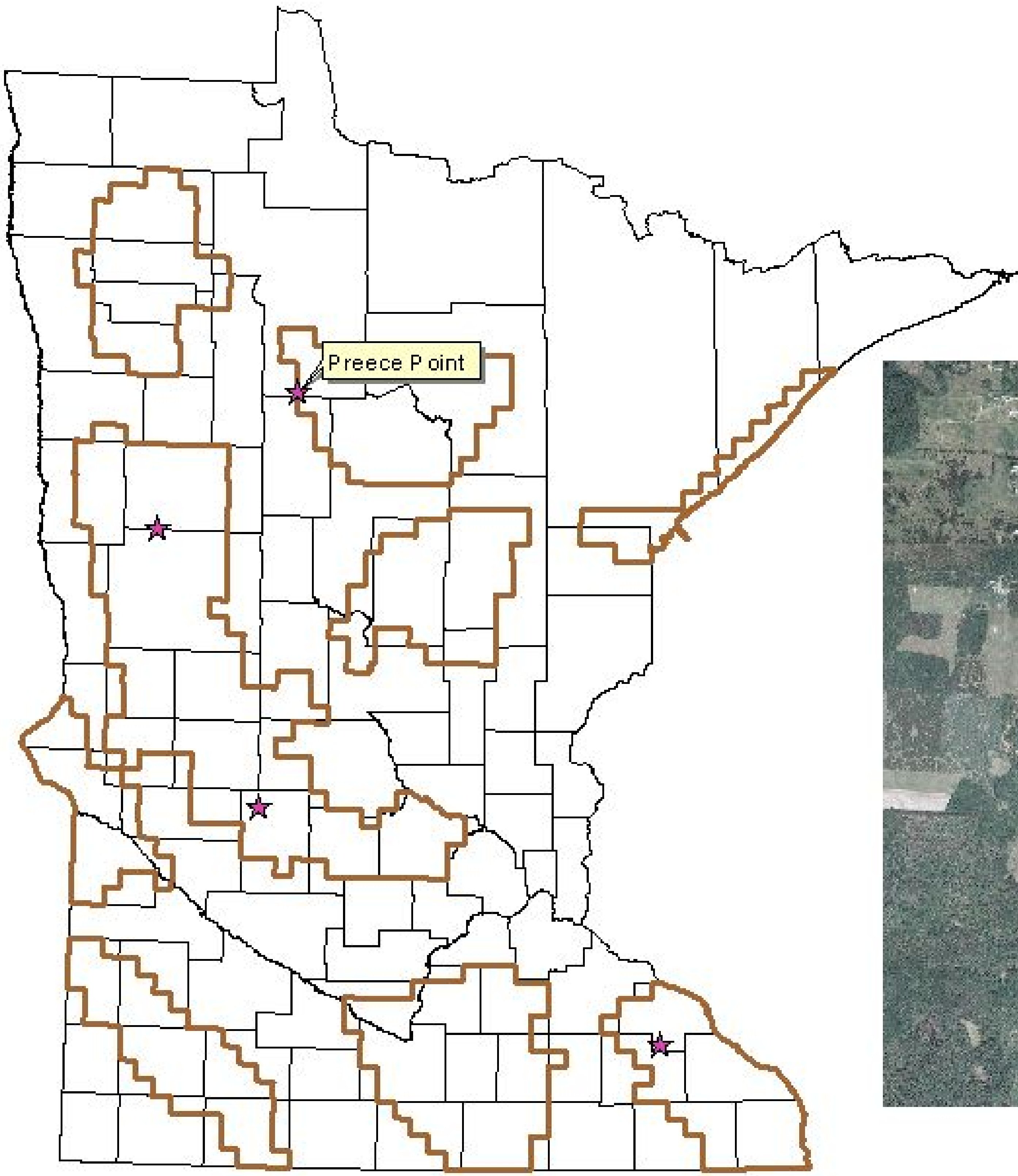
2009 LCCMR HCP Accomplishment
Bucks Mill AMA,
Becker County

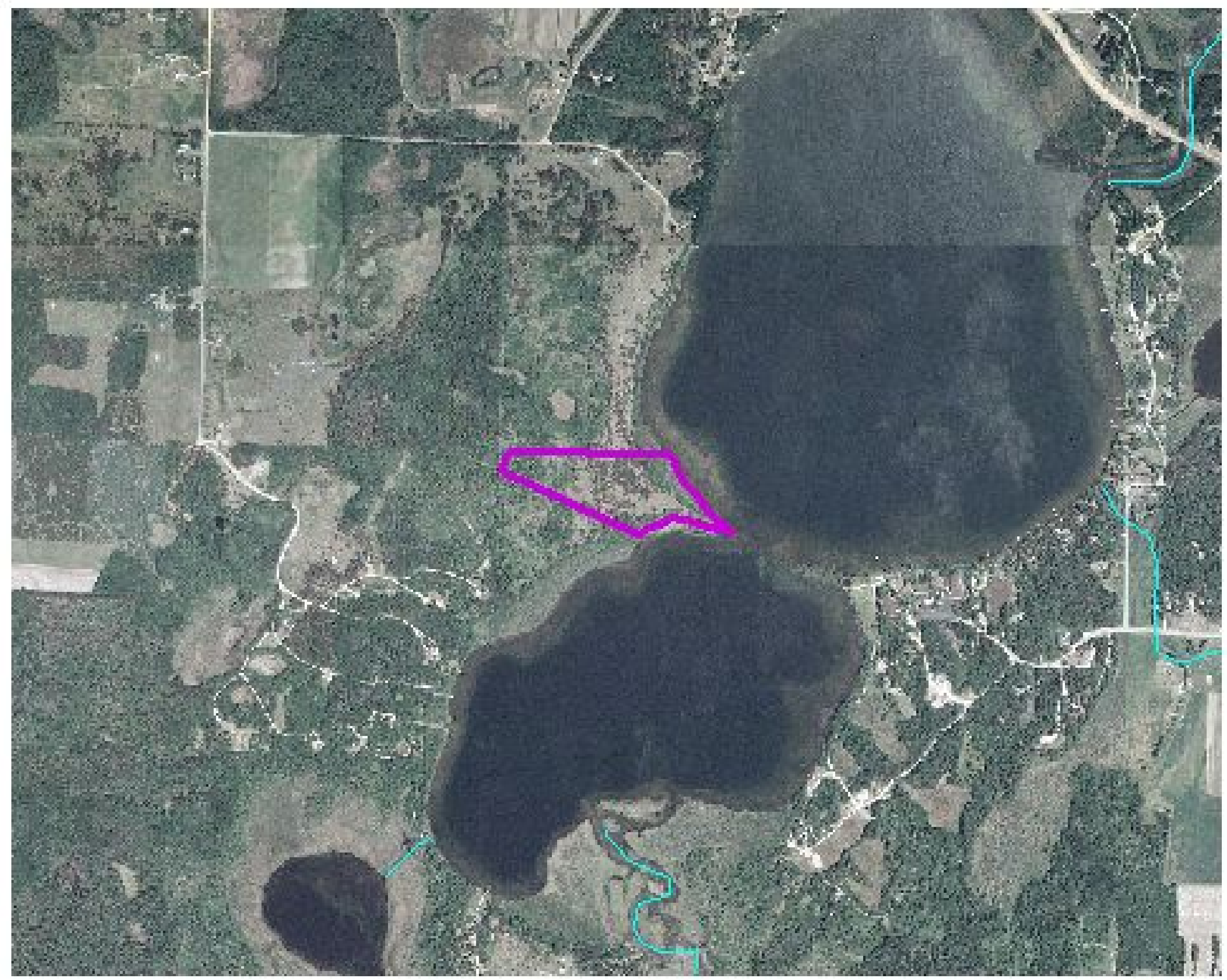


2009 LCCMR HCP Accomplishment
Norway Lake AMA,
Kandiyohi County

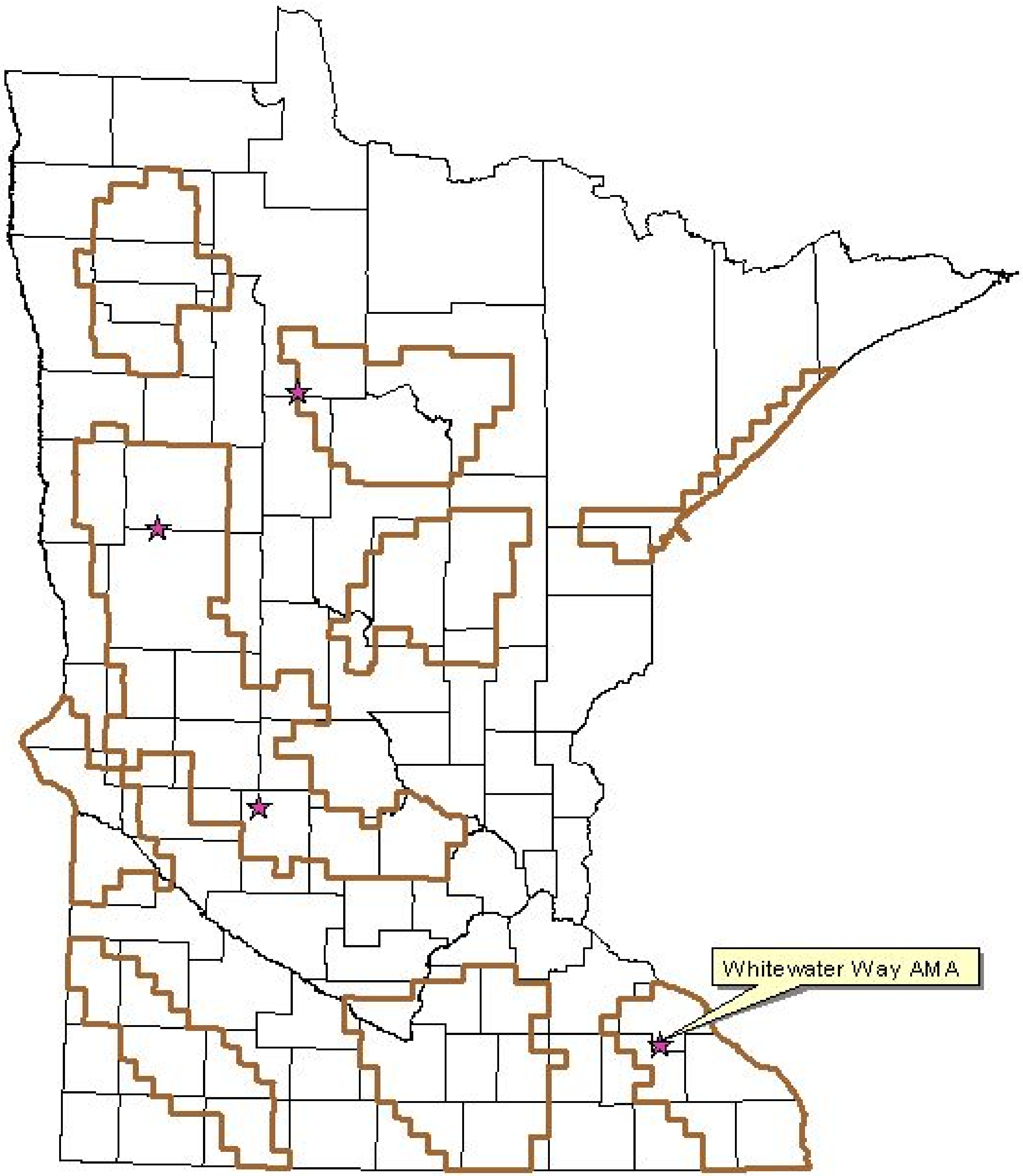


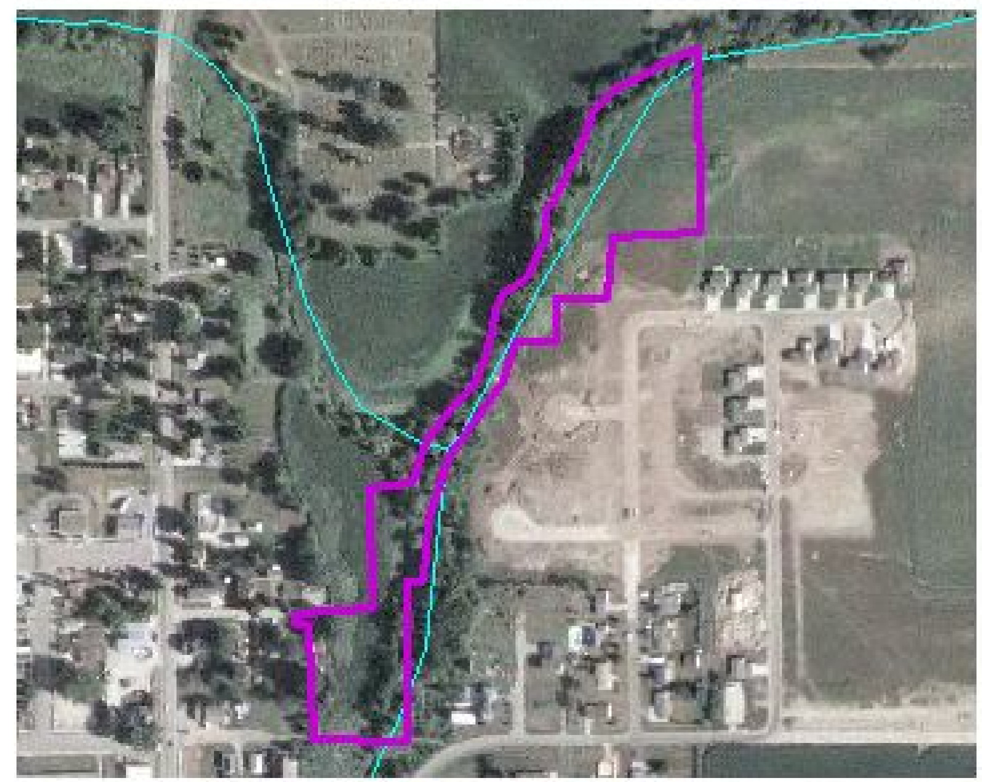
2009 LCCMR HCP Accomplishment
Preece Point AMA,
Beltrami County





2009 LCCMR HCP Accomplishment
Whitewater Way AMA,
Wabasha County





2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: *Critical Lands Protection Program, The Trust for Public Land*

Minnesota's Habitat Conservation Partnership Phase VI www.mnhabitatcorridors.org
PROJECT MANAGER: Robert McGillivray
AFFILIATION: The Trust for Public Land
MAILING ADDRESS: 2610 University Ave, #300
CITY/STATE/ZIP: St. Paul, MN 55114
PHONE: 651-999-5307
E-MAIL: rjm@tpl.org
WEBSITE: www.tpl.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chapter 143, Section 2, Subdivision 4(e)

APPROPRIATION AMOUNT: $350,000

Overall Project Outcome and Results

On September 30, 2011, the Trust for Public Land (TPL) acquired 510 acres in Le Sueur County containing high-quality wetlands and 1.64 miles of naturally flowing Cannon River just upstream from a concentration of rare freshwater mussels. Of the 510 acres, 104 acres were acquired with $350,000 from the Environment and Natural Resources Trust Fund (ENRTF) and the other 406 acres with $1,369,493 in other state funds. TPL immediately conveyed the property to the Department of Natural Resources (DNR) who will manage the land as a new Wildlife Management Area ("Dora Lake WMA"). In addition to conserving a large area of Minnesota County Biological Survey (MCBS) identified native habitat, acquisition of these tracts provides an opportunity to restore approximately 200 acres of tilled land in a sensitive water quality area. The DNR will restore them to wetlands, grassland and eventual guided succession to Big Woods. Protection of the property ensures habitat for fish, game and wildlife in the Cannon River watershed.

Project Results Use and Dissemination

Accomplishment Reports and press releases about the overall Habitat Conservation Partnership are available at http://www.mnhabitatcorridors.org. Information about this acquisition and the Cannon River Headwaters Habitat Complex effort will be posted on TPL's website: www.tpl.org. Information about the Cannon River Headwaters Habitat Complex effort has also been disseminated through its network of supporters which include: the Cannon River Watershed Partnership, the Tri-Lake Sports Club, the Dark House Anglers Southern Chapter, Minnesota Deer Hunters Association South Central Prairieland Bucks Chapter (Le Sueur, Rice, Waseca, and Steele Counties), Waterville Sportsman's Club, Montgomery Sportsmen's Club, Minnesota Waterfowl Association Scott- LeSueur Chapter, the Izaak Walton League Owatonna Chapter, and the Minnesota Department of Natural Resources.

Environment and Natural Resources Trust Fund
2009 Work Program Final Report

Date of Report:	January 23, 2012
Date of Next Progress Report:	Final Report
Date of Work Program Approval:	June 25, 2009
Project Completion Date:	June 30, 2011

I. PROJECT TITLE: *Critical Lands Protection Program, The Trust for Public Land*

Minnesota's Habitat Conservation Partnership Phase VI www.mnhabitatcorridors.org

Project Manager:	Robert McGillivray
Affiliation:	The Trust for Public Land
Mailing Address:	2610 University Ave, #300
City / State / Zip:	St. Paul, MN 55114
Telephone Number:	651-999-5307
E-mail Address:	rjm@tpl.org
FAX Number:	651-917-2248
Web Site Address:	www.tpl.org

Location: All Habitat Conservation Partnership work will be completed within the Project Area boundaries identified in the attached map.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$350,000**
	Minus Amount Spent:	**$350,000**
	Equal Balance:	**$ 0**

Legal Citation: M.L. 2009, Chapter 143, Section 2, Subdivision 4(e)

Appropriation Language:
(e) Minnesota's Habitat Conservation Partnership (HCP) – Phase VI
$3,375,000 is from the trust fund to the commissioner of natural resources for the sixth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $770,000 is for the Department of Natural Resources agency programs and $2,605,000 is for agreements as follows: $450,000 with Pheasants Forever; $50,000 with Minnesota Deer Hunters Association; $895,000 with Ducks Unlimited, Inc.; $85,000 with National Wild Turkey Federation; $365,000 with the Nature Conservancy; $210,000 with Minnesota Land Trust; $350,000 with the Trust for Public Land; $100,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; $50,000 with the United States Fish and Wildlife Service; and $50,000 with Friends of Detroit Lakes Watershed Management District to plan, restore, and acquire fragmented landscape corridors that connect areas of quality habitat to sustain fish, wildlife, and plants. The United States Department of Agriculture-Natural Resources Conservation Service is a cooperating partner in the appropriation. Expenditures are limited to the project corridor areas as defined in the work program. Land acquired with this appropriation must be sufficiently improved

to meet at least minimum habitat and facility management standards as determined by the commissioner of natural resources. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY:

On September 30, 2011, the Trust for Public Land (TPL) acquired 510 acres in Le Sueur County containing high-quality wetlands and 1.64 miles of naturally flowing Cannon River just upstream from a concentration of rare freshwater mussels. Of the 510 acres, 104 acres were acquired with $350,000 from the Environment and Natural Resources Trust Fund (ENRTF) and the other 406 acres with $1,369,493 in other state funds. TPL immediately conveyed the property to the Department of Natural Resources (DNR) who will manage the land as a new Wildlife Management Area (“Dora Lake WMA”). In addition to conserving a large area of Minnesota County Biological Survey (MCBS) identified native habitat, acquisition of these tracts provides an opportunity to restore approximately 200 acres of tilled land in a sensitive water quality area. The DNR will restore them to wetlands, grassland and eventual guided succession to Big Woods. Protection of the property ensures habitat for fish, game and wildlife in the Cannon River watershed.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Acquisition

Description: TPL may work in any one of the designated HCP project areas. Currently projects are underway in Cass, Crow Wing, Hubbard, Kandyiohi, Le Sueur, Olmsted, Otter Tail, Rice, and Wabasha Counties involving shoreline, wetlands, grasslands and woodlands. TPL will focus on habitat linkage projects that have the following characteristics: large, difficult and/or complex; multiple owners and multiple funding sources; proximity to regional growth centers; and/or, high risk of development. Priority will be given to lands with high quality natural resources, especially shoreland and other lands that provide natural buffers to water resources. The Statewide Conservation and Preservation Plan will be used to help identify such lands. Final acreage protection will ultimately be affected by landowner willingness to sell key parcels. Because TPL is focusing on lands buffering water resources, the per acre cost is higher than that of non-riparian land.

Summary Budget Information for Result 1: **Trust Fund Budget: $350,000**
Amount Spent: $350,000
Balance: 0

Deliverable	**Completion Date**	**Budget**
1. Acquire approximately 50 acres of habitat in designated project areas. See attached potential project list.	June 30, 2011	$350,000

Final Report Summary:
Overview: Of the various projects on TPL's potential project list, TPL used its 2009 ENRTF funding to acquire the Dora Lake WMA in the Cannon River Headwaters Complex. The Lester Lake SNA/AMA and Dead Lake WMA/AMA properties were successfully acquired and transferred to the State using other funding. Work on the other projects originally listed continues.

The Cannon River Headwaters Habitat Complex: The Dora Lake WMA ~510 acre acquisition is part of the Cannon River Headwaters Habitat Complex (CRHHC) program, focusing on protection of high-quality wetland, forest, lake, and Cannon River shoreline habitat for fish, game and wildlife in the Cannon River watershed located within Rice and LeSueur Counties. Protection of this large complex will provide opportunities for public hunting, fishing and wildlife conservation.

The Cannon River Headwaters Habitat Complex effort addresses the following problems: degradation and loss of quality and diversity of habitat in the prairie section of the State; degradation of water quality in the Cannon River Watershed; and lack of available public lands for hunting and angling opportunities, especially within an hour's drive for over half of the state's population.

This conservation effort is part of a multi-year effort that includes acquisition, protection, and restoration of core parcels of land that will contribute to a large complex of restored prairies, grasslands, wetlands, lakeshore, and river shoreline.

Protection and restoration of CRHHC parcels will provide critical habitat for game species, including migratory waterfowl (mallards, canvasback, wood ducks, hooded mergansers, pintails, lesser scaup), upland birds (dove, turkey, pheasant, and woodcock) white tail deer, and fish (northern pike, black crappies, bluegills, bullheads and walleye). Protection will also provide access for a diversity of recreational experiences including duck, pheasant, turkey and deer hunting as well as river, stream, and lake fishing. Non-game wildlife, including Species in Greatest Conservation Need, likely to benefit from this protection and restoration work includes Bald Eagle, Bell's Vireo, Cerulean Warbler, Loggerhead Shrike, Sandhill Crane, Red-headed Woodpecker, Greater Yellowlegs, Buff-breasted Sandpiper, Short-billed Dowitcher, Blanding's Turtle, Mudpuppies, and the Giant Floater, a species of freshwater mussel.

Protecting and restoring vegetative cover within basins and the riparian areas of the lakes, rivers, and streams in this focus area will also help protect water quality by reducing surface water runoff and by providing ecological services such as infiltration through natural buffers to our waterways. All wildlife—and humans—will benefit from improved water quality.

The Cannon River Headwaters Habitat Complex effort is highly supported by the Cannon River Watershed Partnership, the Tri-Lake Sports Club, the Dark House Anglers Southern Chapter, Minnesota Deer Hunters Association South Central Prairieland Bucks Chapter (Le Sueur, Rice, Waseca, and Steele Counties), Waterville Sportsman's Club, Montgomery Sportsmen's Club, Minnesota Waterfowl Association Scott- LeSueur Chapter, the Izaak Walton League Owatonna Chapter, and the Minnesota Department of Natural Resources.

<u>The Dora Lake WMA Acquisition</u>: This is a large (510-acre) upland-wetland complex with a mosaic of native plant types. It is near the Velishek, Diamond Lake, and the proposed LeTamaraque WMAs and the Delehanty Waterfowl Production Area (WPA). The parcel contains Minnesota County Biological Survey (MCBS)- identified native habitat including a portion of remnant Big Woods, some southern-most occurrence of tamarack swamp in the state, and 1.64 miles of naturally flowing Cannon River, directly upstream from a concentration of rare freshwater mussels. The Cannon is a large river basin that along with its associated uplands accomplishes Minnesota Statewide Conservation and Preservation Plan (MSCPP) habitat goals #1,2,5, and 7 by maintaining & enhancing water quality of a vital river. These tracts also provide an opportunity to retire approximately 200 acres of tilled land in a sensitive water quality area and restore them to wetlands, grassland and eventual guided succession to Big Woods.

This initial acquisition was prioritized because of its capacity to provide a large wetland/upland complex, the presence of MCBS identified features of the property, the presence of the Cannon River flowing through the property, and its location near existing protected areas. Landowner willingness to sell and the threat of development were also taken into consideration. Restoration work will focus on the degraded portions of the lands acquired and will include conversion of agricultural fields near the wetlands and river into native habitat.

TPL acquired the property on September 30, 2011 and immediately conveyed it to the DNR. Details of the funding for this acquisition are given below.

SOURCE OF FUNDS		**AMOUNT**	**PERCENT**	**ALLOCATED ACRES**
OHF 2011- Cannon River Headwaters (TPL)	$	1,369,493.00	71.33	363.77
ENRTF 2009- HCP (TPL)	$	350,000.00	18.23	92.97
Izaak Walton League (private)	$	507.00	0.03	0.13
ENRTF 2010- HCP (TPL)	$	200,000.00	10.42	53.13
Purchase Price & Appraised Value	$	1,920,000.00	100.00	510.00

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: NA
Contracts: NA
Equipment/Tools/Supplies: NA
Acquisition, including easements: $ 350,000
Travel: NA
Other: NA

TOTAL TRUST FUND PROJECT BUDGET: $350,000

Explanation of Capital Expenditures Greater Than $3,500: NA

VI. PROJECT STRATEGY:

A. Project Partners: We are part of the Habitat Conservation Partnership Phase VI proposal. Please see main proposal for complete partner list. The Trust for Public Land will transfer land to the DNR or another appropriate public or nonprofit entity for long-term stewardship.

B. Project Impact and Long-term Strategy: TPL believes that the success of conservation in Minnesota will depend on effective partnerships amongst nonprofit organizations and with public agencies. Through these public/private partnerships, greater conservation can be achieved with each partner bringing their own particular strengths to bear on the critical issues of protection, restoration, and long term stewardship and management. We believe that working within the Habitat Conservation Partnsership allows us to better conserve, restore, enhance and manage habitat for the purpose of sustaining fish, wildlife and native plant communities for all generations. We seek to do this with an emphasis on high quality natural resource lands buffering water resources that will provide outstanding access to nature for the public.

C. Other Funds Proposed to be Spent during the Project Period: The $350,000 in other funds may come from a variety of sources including federal (LWCF, forest legacy, ACUB, NAWCA, transportation), local (dedication, bonds or other), and private dollars (donations including land value donation).

D. Spending History: ENTF Spending: 2001: $900,000; 2003: $328,030; 2005: $425,000; 2007: $480,000. **Other Funds Spending:** 2001: $371,000; 2003: $202,000; 2005: $677,270; 2007: $0 "Other Funds," (but $355,000 in other state funds, $190,000 in partner ENTF funds and $175,000 in RIM leveraged land value donations).

VII. DISSEMINATION: Accomplishment Reports and press releases will be made available at http://www.mnhabitatcorridors.org

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than December 1, 2009. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR. All reports will be generated using the HCP online reporting system.

IX. RESEARCH PROJECTS: NA

Attachment A: Final Budget Detail for 2009 Project

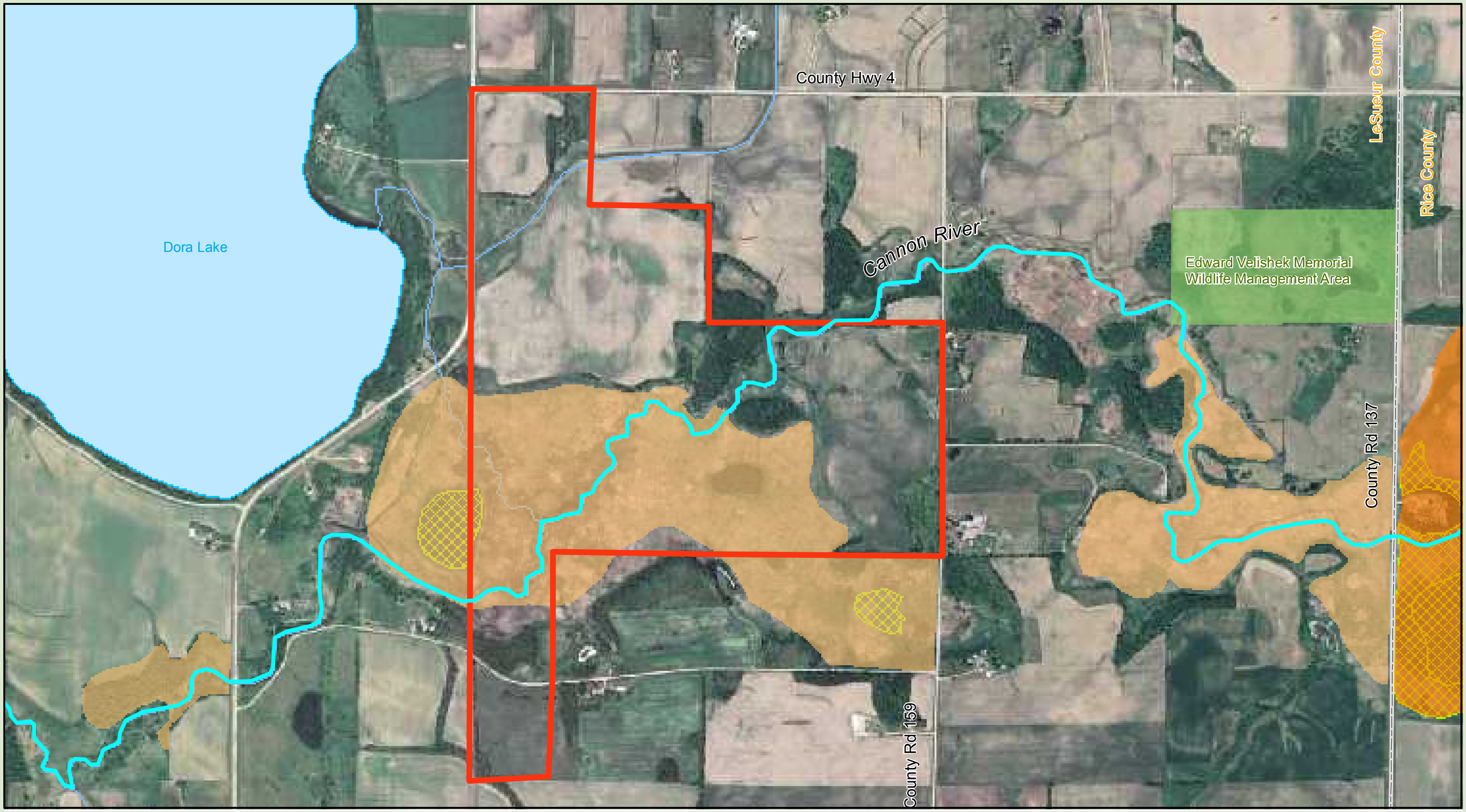
Project Title: TPL's Critical Lands Protection Program

Minnesota's Habitat Conservation Partnership (VI)

Project Manager Name: Robert McGillivray

Trust Fund Appropriation: $ *350,000*

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent 9-30-11**	**Balance 9-30-11**
	Acquisition		
BUDGET ITEM			0
Land acquisition	350,000	350,000	0
COLUMN TOTAL	**$350,000**	**$350,000**	**$0**



Proposed Dora Lake WMA (tracts 1 & 2)
LeSueur County, Minnesota

Legend

Cannon River

MN Sites of Biodiversity Significance
- Outstanding
- High
- Moderate
- Below

County Boundary
- County Boundary

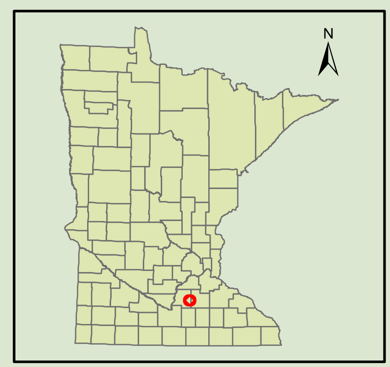
Natural Plant Communities
- Natural Plant Communities

THE TRUST for PUBLIC LAND
CONSERVING LAND FOR PEOPLE

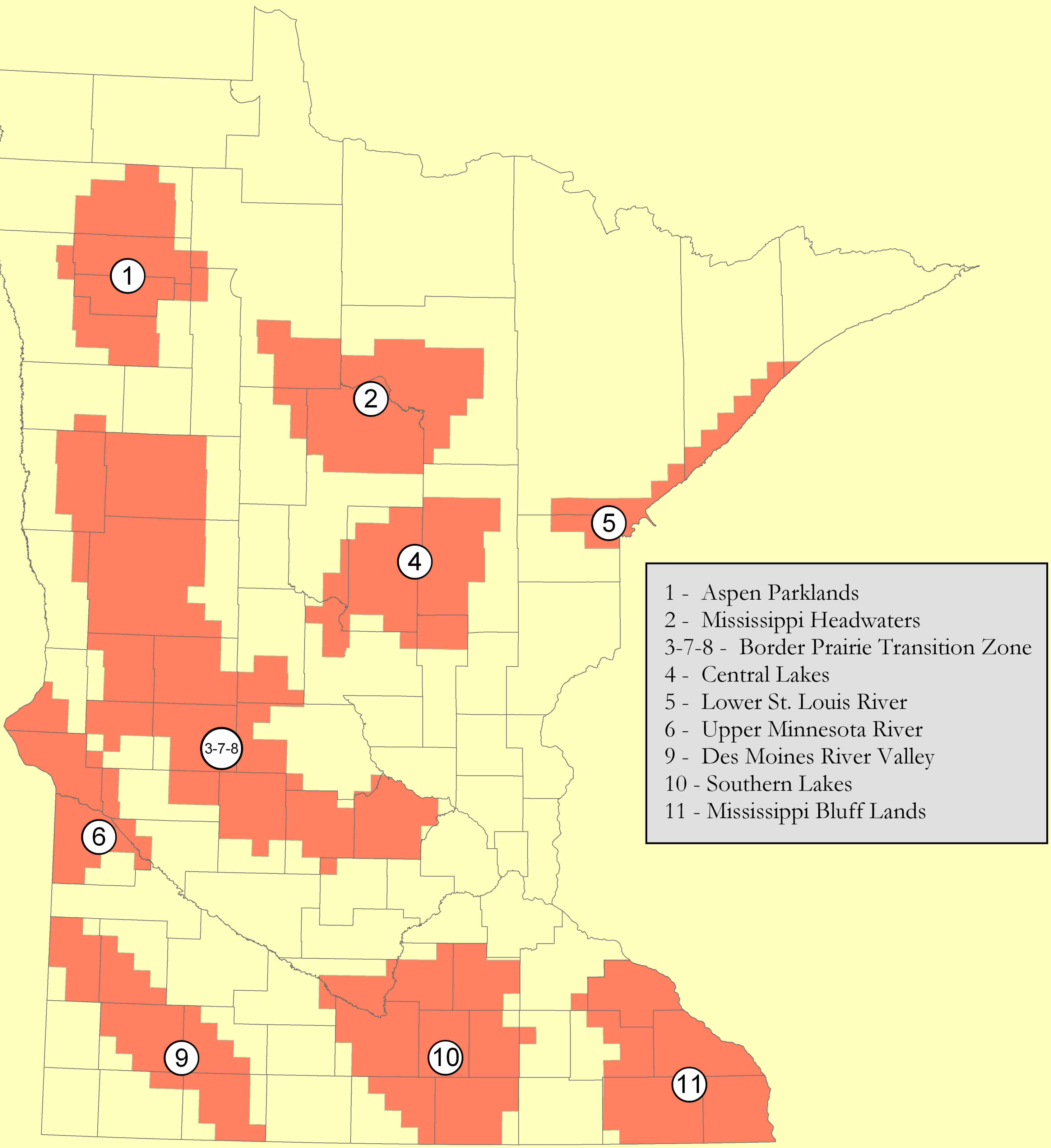
Map created by The Trust for Public Land
on 12/23/ 2010

Information on this map is provided for purposes of discussion and visualization only.

0 0.15 0.3 0.6 Miles



Habitat Conservation Partnership
Proposed Phase VI Project Areas
-Restoring Minnesota's Fish and Wildlife Habitat Corridors-




Remington

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Minnesota's Habitat Conservation Partnership (HCP) - Phase VI 4F: Campaign for Conservation - The Nature Conservancy
PROJECT MANAGER: Rich Johnson
AFFILIATION: The Nature Conservancy
MAILING ADDRESS: 1101 West River Parkway
CITY/STATE/ZIP: Minneapolis, MN 55415
PHONE: 612-331-0790
E-MAIL: rich_johnson@tnc.org
WEBSITE: http://www.mnhabitatcorridors.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chapter 143, Section 2, Subd. 4(e)
APPROPRIATION AMOUNT: $50,000

Overall Project Outcome and Results

In this phase, The Nature Conservancy's (TNC) proposed acquiring fee title to 115 acres of habitat with ENRTF and other funds. These projects would emphasize protecting and linking existing public and private conservation lands, helping to build larger, more sustainable areas of habitat.

Using ENRTF and private funds, TNC purchased two parcels adjoining Weaver Dunes SNA. The Conservancy purchased the Cox tract (30.6 acres) on November 16, 2010 and the Carroll-Fitzgerald tract (21.7 acres) on December 10, 2010. Together, these parcels total 52.3 acres.

Both parcels are located in an area identified as critical in both TNC's and the Habitat Conservation Partnership's planning processes. As part of the Conservation by Design process, The Conservancy develops a Conservation Area Plan (CAP) and Rapid Protection Plan (RPP) for each landscape where we are active. These plans define conservation objectives, management strategies, and areas targeted for action. Both parcels were identified as targets in TNC 's 2007 Conservation Area and Rapid Protection Plans for the Weaver Dunes-Zumbro Delta landscape.

Purchasing these parcels protects the native prairie found on portions of both properties. These prairies were ranked as having outstanding biodiversity significance by the Minnesota County Biological Survey. The protection and restoration of the remaining areas of converted or degraded prairie on these tracts will provide a valuable buffer to the large areas of outstanding native prairie on the 6,000 acres of adjoining TNC-, state-, and federally-protected lands.

The Conservancy will retain ownership and manage both properties as additions to the Weaver Dunes SNA. Funds for the continuing management of these acquisitions were ensured by placing 20% of the fair market value of the properties in a dedicated stewardship endowment. The income from this endowment provides the resources for approximately 50% of the ongoing costs of land management. The remaining 50% of future funding needs will be raised through private fundraising and private and public grants.

TNC was unable to reach our original goal for acres protected. The relatively -high cost of land in Southeastern Minnesota where these tracts are located and the continuing state-wide escalation in rural land prices made this difficult to achieve.

The Conservancy spent an additional $235,754.57 of its private funds in transaction-related expenses for these fee title acquisition projects.
For more details on the purchases, the associated costs, and their conservation significance, see the Transaction Cost Reporting Guidelines memo submitted to LCCMR on January 14, 2011.

Project Results Use and Dissemination

All acquired lands are open to the public. The Conservancy publicizes its work on these projects via press releases, membership publications, presentations and/or the Conservancy's website. TNC has also participated in publicizing the overall accomplishments of the Habitat Corridors Partnership project as it has reached significant milestones.

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

4F: Campaign for Conservation - The Nature Conservancy

Project Manager: Rich Johnson

Affiliation: The Nature Conservancy

Address: 1101 West River Parkway
Minneapolis, MN 55415

Phone: 612-331-0790

Fax: 612-331-0770

E-mail: rich_johnson@tnc.org

Fund: Environment and Natural Resources Trust Fund

Legal Citation:

ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Biennial Project Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Acquisition	$50,000	$50,000	$0	$292,563	$235,755
Total	$50,000	$50,000	$0	$292,563	$235,755

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Work Program Summary

Overall Project Outcome and Results
In this phase, The Nature Conservancy's (TNC) proposed acquiring fee title to 115 acres of habitat with ENRTF and other funds. These projects would emphasize protecting and linking existing public and private conservation lands, helping to build larger, more sustainable areas of habitat.

Using ENRTF and private funds, TNC purchased two parcels adjoining Weaver Dunes SNA. The Conservancy purchased the Cox tract (30.6 acres) on November 16, 2010 and the Carroll-Fitzgerald tract (21.7 acres) on December 10, 2010. Together, these parcels total 52.3 acres.

Both parcels are located in an area identified as critical in both TNC's and the Habitat Conservation Partnership's planning processes. As part of the Conservation by Design process, The Conservancy develops a Conservation Area Plan (CAP) and Rapid Protection Plan (RPP) for each landscape where we are active. These plans define conservation objectives, management strategies, and areas targeted for action. Both parcels were identified as targets in TNC's 2007 Conservation Area and Rapid Protection Plans for the Weaver Dunes-Zumbro Delta landscape.

Purchasing these parcels protects the native prairie found on portions of both properties. These prairies were ranked as having outstanding biodiversity significance by the Minnesota County Biological Survey. The protection and restoration of the remaining areas of converted or degraded prairie on these tracts will provide a valuable buffer to the large areas of outstanding native prairie on the 6,000 acres of adjoining TNC-, state-, and federally-protected lands.

The Conservancy will retain ownership and manage both properties as additions to the Weaver Dunes SNA. Funds for the continuing management of these acquisitions were ensured by placing 20% of the fair market value of the properties in a dedicated stewardship endowment. The income from this endowment provides the resources for approximately 50% of the ongoing costs of land management. The remaining 50% of future funding needs will be raised through private fundraising and private and public grants.

TNC was unable to reach our original goal for acres protected. The relatively-high cost of land in Southeastern Minnesota where these tracts are located and the continuing state-wide escalation in rural land prices made this difficult to achieve.

The Conservancy spent an additional $235,754.57 of its private funds in transaction-related expenses for these fee title

4F: Campaign for Conservation - The Nature Conservancy

acquisition projects.

For more details on the purchases, the associated costs, and their conservation significance, see the Transaction Cost Reporting Guidelines memo submitted to LCCMR on January 14, 2011.

Project Results Use and Dissemination
All acquired lands are open to the public. The Conservancy publicizes its work on these projects via press releases, membership publications, presentations and/or the Conservancy's website. TNC has also participated in publicizing the overall accomplishments of the Habitat Corridors Partnership project as it has reached significant milestones.

Acquisition Activities

Project Name: Weaver Dunes Preserve Addition - Carroll
Tract: Carroll-Fitzgerald
Project Area: 11 - Mississippi Bluff Lands
Township: 109, Range: 9, Section: 18
Acquisition Holder: TNC-Preserve
Description: The Nature Conservancy purchased 21.7 acres of outstanding native prairie and converted land in Wabasha County for $95,000, using its LCCMR Phase VI (2009) acquisition funding and privately-raised funds. The Conservancy will retain ownership and manage this property as an addition to its Weaver Dunes SNA preserve.

Other Funds contributed to this project total $125,174.10. This amount includes TNC's privately-raised acquisition funds; a stewardship endowment and start-up funds for site development; an appraisal; a survey; an environmental assessment document; and various other costs associated with closing. See the detailed breakdown provided below.

Acquisition reported via LCCMR website: No

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Fee-Title Acquisition Costs	$19,000.00	3.60	3.60	0.00	0.00	0.00	0.00
Other Funds	Fee-Title Acquisition Costs	$95,533.10	18.10	18.10	0.00	0.00	0.00	0.00
Other Funds	Professional Services	$2,590.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Professional Services	$1,576.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Professional Services	$1,000.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Professional Services	$500.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Professional Services	$225.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Site Development	$23,750.00	0.00	0.00	0.00	0.00	0.00	0.00
Weaver Dunes Preserve Addition -		**$144,174.10**	**21.70**	**21.70**	**0.00**	**0.00**	**0.00**	**0.00**

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

4F: Campaign for Conservation - The Nature Conservancy

Project Name: Weaver Dunes Preserve Addition - Cox
Tract: Cox
Project Area: 11 - Mississippi Bluff Lands
Township: 109, Range: 9, Section: 8
Acquisition Holder: TNC-Preserve
Description: The Nature Conservancy purchased 30.6 acres of outstanding native prairie and converted land in Wabasha County for $95,000, using its LCCMR Phase VI (2009) acquisition funding and privately-raised funds. The Conservancy will retain ownership and manage this property as an addition to its Weaver Dunes SNA preserve.

Other Funds contributed to this project total $110,580.47. This amount includes TNC's privately-raised acquisition funds; a stewardship endowment and start-up funds for site development; an appraisal; an environmental assessment document; and various other costs associated with closing. See the detailed breakdown provided below.

Acquisition reported via LCCMR website: Yes

Funding Type	*Funds Use*	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF	Fee-Title Acquisition Costs	$31,000.00	8.42	8.42	0.00	0.00	0.00	0.00
Other Funds	Fee-Title Acquisition Costs	$81,615.02	22.18	22.18	0.00	0.00	0.00	0.00
Other Funds	Professional Services	$3,980.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Professional Services	$1,010.45	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Professional Services	$225.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Funds	Site Development	$23,750.00	0.00	0.00	0.00	0.00	0.00	0.00
Weaver Dunes Preserve Addition -		**$141,580.47**	**30.60**	**30.60**	**0.00**	**0.00**	**0.00**	**0.00**

Acquisition Totals (By Funding Type)

Funding Type:	*Funding Amount*	*Prorated Acres*	*Grassland Acres*	*Woodland Acres*	*Wetland Acres*	*Shoreline Feet*	*Riparian Feet*
ENTF:	$50,000.00	12.02	12.02	0.00	0.00	0.00	0.00
Other Funds:	$235,754.57	40.28	40.28	0.00	0.00	0.00	0.00
Total:	**$285,754.57**	**52.30**	**52.30**	**0.00**	**0.00**	**0.00**	**0.00**

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects

Project Title: *Campaign for Conservation (4e 2n/4f) Minnesota's Habitat Conservation Partnership*

Project Manager Name: *Rich Johnson*

Trust Fund Appropriation: $365,000

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

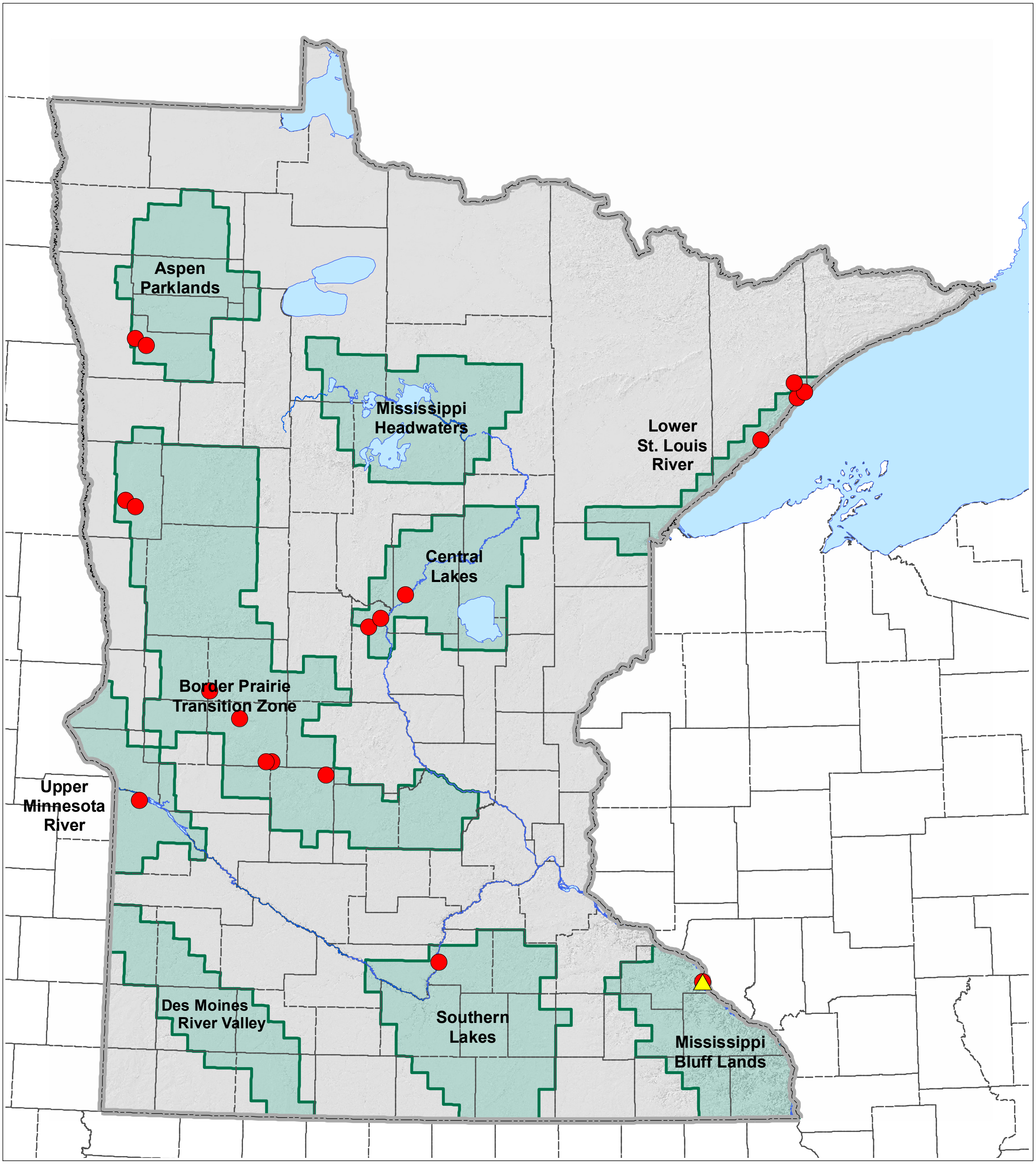
2) Remove any budget item lines not applicable

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(6/30/11)*	**Balance** *(6/30/11)*	**Result 2 Budget** (*Revision Approved 5/9/2011*)	**Amount Spent** *(6/30/11)*	**Balance** *(6/30/11)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Fee Title Acquisition			*Restoration*				
BUDGET ITEM								
PERSONNEL: wages and benefits - This figure includes a seasonal, short-term staff of 8 employees (3.20 FTE) at $12.00 per hour, for 5840 hours, plus 750 hours overtime at $18.00 per hour plus allowable fringe benefits. An existing, long-term Conservancy burn crew (0.15 FTE) will also work on these projects	0	0	0	96,858	102,082	-5,224	96,858	-5,224
Contracts								
Professional/technical - Vendor contractors TBD. Work will include seed harvesting/ cleaning/sowing, seedbed preparation, sowing, mowing, tree planting, prescribed burns, herbicide application, installation of conifer restoration exclosures, ditch removal, removing/leveling abandoned structures, fencing & trees, woody vegetation removal.	0	0	0	198,142	192,518	5,624	198,142	5,624
Supplies - Estimated costs include $7,500 for conifer restoration supplies, $6,000 for fuel for torches, chainsaws and vehicles dedicated 100% to the project, $2,000 for herbicide, $2,500 for monitoring supplies, $1,500 for brush cutting materials, $2,000 for tools and personal protection gear for spraying, $1,500 for general machinery parts & repairs.	0	0	0	20,000	20,062	-62	20,000	-62
Land acquisition	50,000	50,000	0		0	0	50,000	0
COLUMN TOTAL	**$50,000**	**$50,000**	**$0**	**$315,000**	**$314,662**	**$338**	**$365,000**	**$338**

*Budget clarification as of 6/1/2010 WP Update: The $3,000 for fuel includes fuel for vehicles that are dedicated 100% to the project.

Campaign for Conservation

Habitat Conservation Partnership
2009 Appropriation (Phase 6) Accomplishments



Legend

- Restoration Project Locations
- Acquisition Project Locations
- Habitat Conservation Partnership Project Areas

0 12.5 25 50 Miles

The Nature Conservancy
Protecting nature. Preserving life.

Map Created by: RCJ, TNC in MN-ND-SD, 2011/8/15
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2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Habitat Acquisition for Minnesota Valley Wetland Management District of USFWS – 4(h), Minnesota's Habitat Conservation Partnership Phase VI
PROJECT MANAGER: Deborah Loon
AFFILIATION: Minnesota Valley National Wildlife Refuge Trust, Inc.
MAILING ADDRESS: 2312 Seabury Avenue
CITY/STATE/ZIP: Minneapolis, MN 55406
PHONE: 612-801-1935
E-MAIL: DebLoon@comcast.net
WEBSITE: www.mnvalleytrust.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4e4h

APPROPRIATION AMOUNT: $100,000

Overall Project Outcome and Results

The Minnesota Valley Trust acquired 78.5 acres of priority lands in Lincoln Township of Blue Earth County to expand the Lincoln Waterfowl Production Area for the Minnesota Valley Refuge and Wetland Management District, US Fish and Wildlife Service. Of the 78.5 acres, 21 acres were acquired with Environment and Natural Resources Trust Fund; the other 56.5 acres were acquired with nonprofit / other, non-state funds.

This acquisition expands upon prior acquisitions for the Lincoln WPA that were funded in part by the Environment and Natural Resources Trust Fund in HCP Phases III and V, as recommended by the LCCMR. This and another acquisition completed concurrently by the Trust bring the total acreage of the Lincoln WPA to approximately 720 acres.

All parcels acquired to create the Lincoln Waterfowl Production Area, including this one, were identified by the US Fish and Wildlife Service as a high priority within an established USFWS Focus Area. Acquisition and restoration will complete USFWS objectives in the area for a host of waterfowl species.

After wetland and upland restoration on the lands is completed, the lands will be donated to the US Fish and Wildlife Service for perpetual management as part of the Minnesota Valley Wetland Management District. They will be managed for wildlife and wildlife-dependent recreation, including hunting, fishing, wildlife observation, photography, wildlife interpretation and environmental education.

Project Results Use and Dissemination

The Minnesota Valley Trust will publicize the completion of this project through its website and news releases. All funding partners will be acknowledged on Refuge kiosks, including the Environment and Natural Resources Trust Fund, as recommended by the Legislative Citizen Commission on Minnesota Resources.

Trust Fund 2009 Work Program

Date of Report: August 1, 2011
Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: July 26, 2011

I. PROJECT TITLE: Habitat Acquisition for Minnesota Valley Wetland Management District of USFWS – 4(h), Minnesota's Habitat Conservation Partnership Phase VI

Project Manager: Deborah Loon
Affiliation: Minnesota Valley National Wildlife Refuge Trust, Inc.
Mailing Address: 2312 Seabury Avenue
City / State / Zip: Minneapolis, MN 55406
Telephone Number: 612-801-1935
E-mail Address: DebLoon@comcast.net
FAX Number: 612-728-0700
Web Site Address: www.mnvalleytrust.org

Location: Southeast Region, Blue Earth County

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$ 100,000**
	Minus Amount Spent:	**$ 100,000**
	Equal Balance:	**$ 0**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4e4h

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the sixth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $770,000 is for the Department of Natural Resources agency programs and $2,605,000 is for agreements as follows: $450,000 with Pheasants Forever; $50,000 with Minnesota Deer Hunters Association; $895,000 with Ducks Unlimited, Inc.; $85,000 with National Wild Turkey Federation; $365,000 with the Nature Conservancy; $210,000 with Minnesota Land Trust; $350,000 with the Trust for Public Land; $100,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; $50,000 with the United States Fish and Wildlife Service; and $50,000 with Friends of Detroit Lakes Watershed Management District to plan, restore, and acquire fragmented landscape corridors that connect areas of quality habitat to sustain fish, wildlife, and plants. The United States Department of Agriculture-Natural Resources Conservation Service is a cooperating partner in the appropriation. Expenditures are limited to the project corridor areas as defined in the work program. Land acquired with this appropriation must be sufficiently improved to meet at least minimum habitat and facility management standards as determined by the commissioner of natural resources. This appropriation may not be used for the

purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY: The Minnesota Valley Trust acquired 78.5 acres of priority lands in Lincoln Township of Blue Earth County to expand the Lincoln Waterfowl Production Area for the Minnesota Valley Refuge and Wetland Management District, US Fish and Wildlife Service. Of the 78.5 acres, 21 acres were acquired with Environment and Natural Resources Trust Fund; the other 56.5 acres were acquired with nonprofit / other, non-state funds.

This acquisition expands upon prior acquisitions for the Lincoln WPA that were funded in part by the Environment and Natural Resources Trust Fund in HCP Phases III and V, as recommended by the LCCMR. This and another acquisition completed concurrently by the Trust bring the total acreage of the Lincoln WPA to approximately 720 acres.

This area boasted tremendous waterfowl production due to a high density of wetlands and prairie habitat prior to the advent of farming and aggressive tiling and drainage practices. The acquisition and restoration of these 720 acres of significant habitat will benefit a host of waterfowl species, including mallard, blue-winged teal, lesser scaup, northern pintail, redhead, wood duck, and canvasback, as well as more than 16 other species of waterfowl.

Major wetland and upland restoration is underway on the Lincoln WPA. Most of the funding is provided by the North American Wetland Conservation Act, with additional funding from MN Pheasants – Blue Earth County, USFWS and the Trust.

After restoration is complete, the lands will be donated to the US Fish and Wildlife Service for perpetual management as a Waterfowl Production Area by the Minnesota Valley Wetland Management District. The land will be managed for wildlife and wildlife-dependent recreation, including hunting, fishing, wildlife observation, photography, wildlife interpretation and environmental education.

Appraised value of $373,000 was paid for the 78.5 acres. Transaction costs paid by with other non-state funds were $400 legal, $1,400 appraisal, and $1,455 for closing costs, title insurance and recording fees.

Funds for the acquisition came from two sources:
1) Environment and Natural Resources Trust Fund -- $100,000
2) MN Valley National Wildlife Refuge Trust, Inc. -- $276,255

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Fee title acquisition

Description: The Minnesota Valley National Wildlife Refuge Trust, Inc. will acquire at least 20 acres of priority wetland and grassland habitat in HCP focus area 10 (Southern MN Lakes). The Trust will acquire at least an additional 20 acres, using Trust and other non-state funds, in the same area. Lands will be donated by the Trust, to be managed and owned by the US Fish & Wildlife Service as a Waterfowl Production Area.

The Trust is working with landowners in focus area 10 and may complete one of the following (or other) acquisitions with the Environment and Natural Resources Trust Fund grant:

- Acquisition of land to expand the Perch Lake Waterfowl Production Area in Beauford Township of Blue Earth County. Perch Lake is an important migratory waterfowl resting lake and a DNR designated shallow lake. This 480 acre lake hosts more than 10,000 migrating waterfowl each year and is designated as in important resting area for Lesser Scaup. The Trust earlier acquired other parcels to establish the Perch Lake WPA, in part with ETF funds through HCP Phases III and IV.
- Acquisition of land to expand the Lincoln WPA in Lincoln Township of Blue Earth County. Historically, the area boasted tremendous waterfowl production due to a high density of wetlands and prairie habitat. The Trust earlier acquired parcels to begin this WPA, in part with ETF funds through HCP Phases III and V.
- Acquisition of a parcel to expand the existing Evans Slough Complex in Ceresco Township of Blue Earth County. This will allow the Trust and USFWS to come one step closer to protecting and restoring a 200 + acre wetland basin that was drained forty years ago for agricultural purposes. The basin is significant for migration and breeding for a host of waterfowl and other prairie pothole species.

After acquisition and restoration of the habitat by the Minnesota Valley Trust, USFWS and other partners, the lands will be donated to the US Fish and Wildlife Service for management as part of the Minnesota Valley Wetland Management District.

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$ 100,000**
	Amount Spent:	**$ 100,000**
	Balance:	**$ 0**

Deliverable	Completion Date	Budget
1. Acquire 20 acres in fee title with ETF funds and 20 acres in fee title with other non-state funds	June 30, 2011	$ 100,000

Result Completion Date: July 26, 2011

Final Report Summary: The Minnesota Valley Trust acquired 78.5 acres of priority lands in Lincoln Township of Blue Earth County to expand the Lincoln Waterfowl Production Area for the Minnesota Valley Refuge and Wetland Management District, US Fish and Wildlife Service. Of the 78.5 acres, 21 acres were acquired with Environment and Natural Resources Trust Fund; the other 56.5 acres were acquired with nonprofit / other, non-state funds.

This acquisition expands upon prior acquisitions for the Lincoln WPA that were funded in part by the Environment and Natural Resources Trust Fund in HCP Phases III and V, as recommended by the LCCMR. This and another acquisition completed concurrently by the Trust bring the total acreage of the Lincoln WPA to approximately 720 acres.

All parcels acquired to create the Lincoln Waterfowl Production Area, including this one, were identified by the US Fish and Wildlife Service as a high priority within an established USFWS Focus Area. Acquisition and restoration will complete USFWS objectives in the area for a host of waterfowl species.

To complete this acquisition, the Minnesota Valley Trust did outreach to landowners within the prospective areas identified for expansion Waterfowl Production Areas. After landowners express interest in potentially selling their land, the Trust obtains an appraisal and makes an offer to acquire fee title at the appraised value. The appraisal is shared with the landowner and the landowner is notified that there is no obligation to sell to the Minnesota Valley Trust. After negotiations are complete, a purchase agreement is signed and the due diligence on the title commences.

After wetland and upland restoration on the lands is completed, the lands will be donated to the US Fish and Wildlife Service for perpetual management as part of the Minnesota Valley Wetland Management District. They will be managed for wildlife and wildlife-dependent recreation, including hunting, fishing, wildlife observation, photography, wildlife interpretation and environmental education.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $ 0
Contracts: $ 0
Equipment/Tools/Supplies: $ 0
Acquisition, including easements: $ 100,000
Travel: $ 0

Other: $ 0

TOTAL TRUST FUND PROJECT BUDGET: $ 100,000

Explanation of Capital Expenditures Greater Than $3,500:

VI. PROJECT STRATEGY:

A. Project Partners: US Fish & Wildlife Service, Friends of the Minnesota Valley, local soil and water conservation district, local watershed district, local conservation clubs.

B. Project Impact and Long-term Strategy: This project will benefit a host of waterfowl species, including mallard, blue-winged teal, lesser scaup, northern pintail, redhead, wood duck, and canvasback. All species are Priority Species listed by the Prairie Pothole Joint Venture, NAWCA, MN DNR Long Range Duck Recovery Plan, and the North American Waterfowl Management Plan. In addition, this area is host to more than 16 other species of waterfowl that will benefit from this project.

Acquisition and restoration of critical habitat are critical components and primary strategies of the Long Range Recovery Plan. This project will help to: 1) restore the breeding population objective of ducks; 2) restore the migration objectives for ducks in the Mississippi Flyway; and 3) fulfill the recreational objectives for waterfowl hunters and observers.

This particular project area is part of a larger strategy involving many other established projects and efforts -- NAWCA grants of more than $25 million and more than 50 partners, USFWS Challenge Grants, EPA grants, CREP, numerous local grant programs and more than 20 local sportsman clubs active in the area. USFWS and partners have acquired more than 2,000 acres of habitat in the area to date and are restoring another 50 wetlands and 500 upland acres through the Partners for Fish and Wildlife Program.

C. Other Funds Proposed to be Spent during the Project Period: $100,000

D. Spending History:
Phase II (2003) - $98,000 ETF and $741,700 other non-state funds
Phase III (2005) - $126,878 ETF and $1,688,649 other non-state funds
Phase IV (2007) - $100,000 ETF and $232,976 other non-state funds
Phase V (2008) - $50,000 ETF and $80,196 other non-state funds.

VII. DISSEMINATION: As projects are completed, the Minnesota Valley Trust will announce the accomplishments through press releases, the Trust website and the Habitat Conservation Partners website.

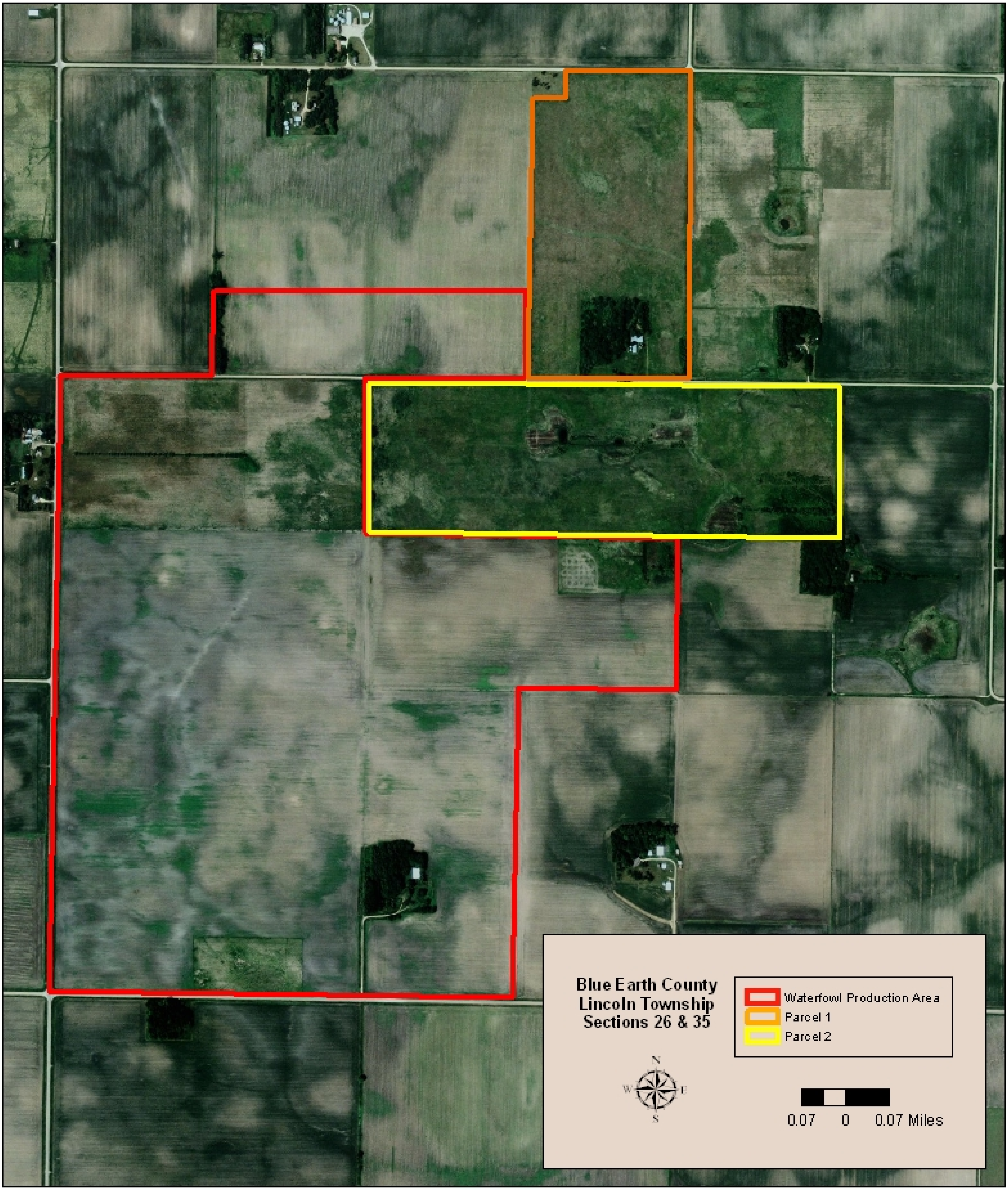
VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than May 30 and November 30. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS: NA

Attachment A: Budget Detail for 2009 Projects					
Project Title: Habitat Acquisition for Minnesota Valley Wetland Management District of USFWS – 4(h), Minnesota's Habitat Conservation Partnership Phase VI					
Project Manager Name: Deborah Loon					
Trust Fund Appropriation: $100,000					
2009 Trust Fund Budget	**<u>Result 1 Budget:</u>**	**Amount Spent** *(date)*	**Balance** *(date)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Fee title acquisition of 20 acres		**8.1.11**		
BUDGET ITEM					
Land acquisition	100,000	100,000	0	100,000	0
COLUMN TOTAL	**$100,000**	**$100,000**	**$0**	**$100,000**	**$0**

Minnesota Valley Trust
Minnesota Valley National Wildlife Refuge Trust, Inc.

Lincoln WPA - Meixell Project



LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

4I: Professional Services - MNDNR - Fisheries

Project Manager: Mike Halverson

Affiliation: MNDNR - Fisheries

Address: 500 Lafayette Road
St. Paul, MN 55,155

Phone: (651)259-5209

Fax: (651)297-4916

E-mail: mike.halverson@dnr.state.mn.us

Fund: Environment and Natural Resources Trust Fund

Legal Citation: ML 2009, Chapter 143, Section 2, Subd. 4(e)

Total Work Program Budget

Result	ENTF Allocation	ENTF Funds Spent	ENTF Balance	Other Funds Proposed	Other Funds Spent
Acquisition	$25,000	$ 24,381	$619	$0	$0
Total	$25,000	$ 24,381	$619	$0	$0

Work Program Summary

Overall Project Outcome and Results
This project focused on paying professional services related to the conveyance of habitat corridor lands to the DNR by HCP partners. Parcels acquired from HCP partners will be placed in public ownership and administered as State Wildlife Management Areas.

Project goals were to pay professional services as parcels are conveyed to DNR by nonprofit HCP partners. During this appropriation – only Pheasants Forever (PF) projects were conveyed to DNR.

This project resulted in professional services being paid on 15 different parcels as they were processed for conveyance to DNR by HCP Partners. Project funding by PF changed as time went by, with some projects not being acquired with ETF dollars at closing, and other unanticipated parcels changing to ETF dollars at closing. Some of these PF projects were closed last year, but continued to have residual professional services for closing the project out. Some projects have just started the acquisition process and will continue into the next phase of 4I: Habitat Acquisition – Professional Services. Consequently the range of dollars spent on projects varied greatly, but ranged from $20 to $3,700.

As a result of this project, DNR was able to pay for professional services and processing costs related to land acquisition transfers to the DNR from HCP partners. Costs include the following: staff time for Division of Lands and Minerals ($83/hour) and the Attorney General's Office ($110/hour), survey costs, recording and abstracting fees, and deed tax.

Project Results Use and Dissemination
Accomplishment Reports and press releases will be made available at http ://www.mnhabitatcorridors.org and all WMAs acquired with professional services funds will be added to DNR's Public Recreational Information Maps (PRIM).

LCCMR Work Program Final Report

Restoring Minnesota's Fish and Wildlife Habitat Corridors Phase 6
Habitat Conservation Partnership

4I: Professional Services - MNDNR - Fisheries

Work Program Expenditures

FundingType	*Funding Category*	*Amount*	*Description*
ENTF	Professional Services	$24,381.00	Real Estate/Attorney General's Fees, property taxes, appraisal review, deed taxes, recording fees, and abstracting related to tracts of land that will be accepted by DNR from HCP partners.
	Total:	**$24,381.00**	

Funding Type Definitions

ENTF:	Grant dollars provided through the Minnesota Environment and Natural Resources Trust Fund
Other Funds:	Non-state, non-state leveraged dollars (if partner funds are leveraging State Funds (e.g. RIM) they are not eligible to be considered Other Funds)
State Funds:	State Funds expended on HCP projects (not eligible for use as Other Funds commitment)
Partner's State Leveraged Funds:	Non State Funds that have leveraged State Funds as part of an HCP project (not eligible for use as Other Funds commitment)
Other:	Any other expenditures (e.g. grant income funds)

Attachment A: Budget Detail for 2009 Projects - Final

Project Title: Habitat Acquisition (4i)

Minnesota's Habitat Conservation Partnership (VI)

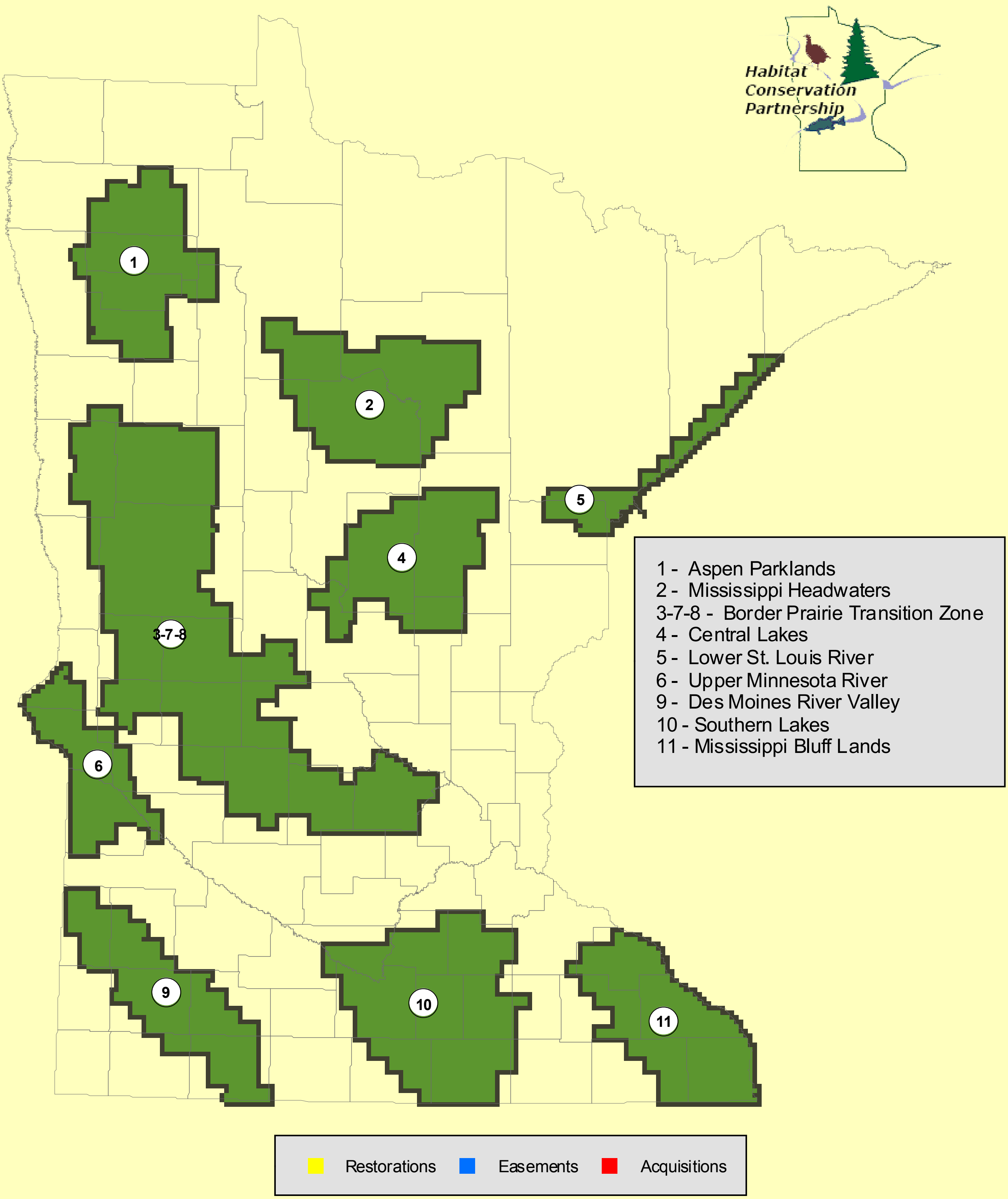
Project Manager Name: Mike Halverson

Trust Fund Appropriation: $ *25,000*

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(6/30/11)*	**Balance** *(6/30/11)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Land Acquisition				
BUDGET ITEM			0	0	0
Professional Services for Acq. - appraisals, abstracting, recording/deed tax, property tax, Attorney General and Division of Lands and Minerals costs).	25,000	24,381	619	25,000	619
Other			0	0	0
COLUMN TOTAL	**$25,000**	**$24,381**	**$619**	25,000	619

Habitat Conservation Partnership
Professional Services

4I



2009 Project Abstract
For the Period Ending June 30, 2011

TITLE:	Metro Conservation Corridors – Phase V Overall Summary
PROJECT MANAGER:	Sarah Strommen
ORGANIZATION:	Minnesota Land Trust
ADDRESS:	2356 University Avenue West, Suite 240 St. Paul, MN 55114
WEB SITE ADDRESS:	www.dnr.state.mn.us/metroconservationcorridors
FUND:	Environmental and Natural Resources Trust Fund
LEGAL CITATION:	Minnesota Laws 2009, Chapter 143, Section 2, Subdivision 4(f)

APPROPRIATION AMOUNT: $3,375,000

OVERALL PROJECT OUTCOME AND RESULTS

During the fifth phase of the Metro Corridors project, the Metro Conservation Corridors Partners continued their work to accelerate protection and restoration of remaining high-quality natural lands in the greater Twin Cities Metropolitan Area by strategically coordinating and focusing conservation efforts within a connected and scientifically-identified network of critical lands. This corridor network stretches from the area's urban core to its rural perimeter, including portions of 16 counties.

The Partners employed a multi-faceted approach, which included accomplishments in four specific result areas.

1. *Partnership and Program Coordination:* Partners met several times a year to review project accomplishments and coordinate activity. With DNR support, Version 2 of the online database was refined and implemented to facilitate tracking and reporting of MeCC projects over time. Additionally, DNR and Minnesota Land Trust have worked together to complete cumulative accomplishment mapping, gathering as much information as possible from previous grant phases, which allows the partnership to conduct historical analysis of our collective work.

2. *Restore and Enhance Significant Habitat:* Partners have restored and enhanced a total of 775 acres of significant habitat using Phase V funding plus an additional 450 acres with other funds.

3. *Acquire Significant Habitat:* Partners protected 977 acres of land, including nearly 7 miles of shoreline through acquisition of fee title and conservation easements and leveraged an additional 585 acres of land and 0.4 miles of shoreline using other funds.

4. *Other Conservation Tools and Incentives:* The Metro Greenways Program assisted eight cities, two counties, and one park district with the development and gathering of natural resources information to identify sites for protection or restoration and/or to implement conservation measures. Additionally, Metro Greenways organized and facilitated two annual events that brought all 25 DNR Community Assistance grantees together for a day of information-sharing and peer-to-peer learning, and also funded the development and offering of six new natural resource-based workshops for local government staff and appointed officials.

Since 2003, MeCC partners have protected more than 9,600 acres and restored more than 7,800 acres. These strategic and coordinated efforts address a number of recommendations of the Statewide Conservation and Preservation Plan, including, protecting priority land habitats, protecting critical shorelands of streams and lakes, restoring land, wetlands, and wetland-associated watersheds, and improving connectivity and access to outdoor recreation.

PROJECT RESULTS USE AND DISSEMINATION

As projects were completed, the individual partners were encouraged to publicize accomplishments through press releases, organization newsletters and websites. These efforts resulted in information being distributed to the public through websites, email lists, daily and weekly newspapers, newsletters, and other print materials. Additionally, an interactive public web map is now fully functional and shows the locations of MeCC projects over time. This web map can be accessed at: http://www.dnr.state.mn.us/maps/MeCC/mapper.html.

Environmental and Natural Resources Trust Fund
2009 Work Program Final Report

Date of Report: September 20, 2011
Final Report
Date of Work program Approval: June 16, 2009
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Metro Conservation Corridors Phase V: Overall Summary

Project Manager:	Sarah Strommen
Affiliation:	Minnesota Land Trust
Mailing Address:	2356 University Ave. W, Suite 240
City / State / Zip :	St. Paul, MN 55114
Telephone Number:	651-647-9590
E-mail Address:	sstrommen@mnland.org
FAX Number:	651-647-9769
Web Page address:	http://www.dnr.state.mn.us/metroconservationcorridors or www.mnland.org

Location: Within mapped focus areas in 16 counties (see 2009 Focus Area map)

Total Trust Fund Project Budget:	**Trust Fund Appropriation:**	**$**	3,375,000
	Minus Amount Spent:	**$**	3,149,904
	Equal Balance:	**$**	225,096

Legal Citation: M.L. 2009, Chapter 143, Section 2, Subdivision 4(f)

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural

resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY:
During the fifth phase of the Metro Corridors project, the Metro Conservation Corridors Partners continued their work to accelerate protection and restoration of remaining high-quality natural lands in the greater Twin Cities Metropolitan Area by strategically coordinating and focusing conservation efforts within a connected and scientifically-identified network of critical lands. This corridor network stretches from the area's urban core to its rural perimeter, including portions of 16 counties.

The Partners employed a multi-faceted approach, which included accomplishments in four specific result areas.

> *1. Partnership and Program Coordination:* Partners met several times a year to review project accomplishments and coordinate activity. With DNR support, Version 2 of the online database was refined and implemented to facilitate tracking and reporting of MeCC projects over time. Additionally, DNR and Minnesota Land Trust have worked together to complete cumulative accomplishment mapping, gathering as much information as possible from previous grant phases, which allows the partnership to conduct historical analysis of our collective work.

> *2. Restore and Enhance Significant Habitat:* Partners have restored and enhanced a total of 775 acres of significant habitat using Phase V funding plus an additional 450 acres with other funds.

> *3. Acquire Significant Habitat:* Partners protected 977 acres of land, including nearly 7 miles of shoreline through acquisition of fee title and conservation easements and leveraged an additional 585 acres of land and 0.4 miles of shoreline using other funds.

> *4. Other Conservation Tools and Incentives:* The Metro Greenways Program assisted eight cities, two counties, and one park district with the development and gathering of natural resources information to identify sites for protection or restoration and/or to implement conservation measures. Additionally, Metro Greenways organized and facilitated two annual events that brought all 25 DNR Community Assistance grantees together for a day of information-sharing and peer-to-peer learning, and also funded the development and offering of six new

natural resource-based workshops for local government staff and appointed officials.

Since 2003, MeCC partners have protected more than 9,600 acres and restored more than 7,800 acres. These strategic and coordinated efforts address a number of recommendations of the Statewide Conservation and Preservation Plan, including, protecting priority land habitats, protecting critical shorelands of streams and lakes, restoring land, wetlands, and wetland-associated watersheds, and improving connectivity and access to outdoor recreation.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Database Development, Project Tracking, Mapping and Coordination

Description: This result proposed to provide assistance in coordinating the conservation efforts of the partners through facilitating partnership meetings and providing overall work program management. It also included development of a GIS-based database to track MeCC projects and an improved web map where the public can see locations of completed projects.

Summary Budget Information for Result 1:		
	Trust Fund Budget:	**$** 100,000
	Amount Spent:	**$** 50,924
	Balance:	**$ 49,076**

Deliverable	**Status**
1. Complete overall work programs as required	Complete
2. Facilitate partner and executive meetings	Complete
3. MeCC Database Version 2	Complete
4. Generate overall tables from the database	Complete
5. MeCC Corridor Map	Complete
6. MeCC Database maintenance reimbursement	Complete

**This amount includes Deliverable #2.*

Final Completion Date: 6/30/2011

Final Report Summary: The Mapping and Coordination element of the MeCC Partnership provided coordination and leadership for the partnership by Minnesota Land Trust staff and improved prioritization through enhanced database development and mapping of the corridors by DNR staff.

During this phase of work, the coordination activity included regular meetings of the partners to share information and accomplishments, assisting partners with preparation of reports, compiling overall partnership results, and assisting DNR staff with the mapping, database development, and results tracking. The mapping activity included successful development and refinement of a GIS-based database to track historic and current MeCC projects. The database allows partners to generate tables and reports for status and accomplishment reporting for a variety of MeCC components – from project types, to funding sources, to activities, to partnerships, to location analysis. It also links to an interactive web map where the public can see the locations of completed projects.

Although the partnership had originally hoped to complete a mini-evaluation of the MeCC Partnership, due to the time involved in mapping and compiling historic project data, there was not time to complete the evaluation. Therefore, funds originally allocated for this activity were not spent.

Result 2: Restore and Enhance Significant Habitat

Description: The six restoration partner organizations proposed to restore and/or enhance 465 acres of significant upland and wetland habitat and 0.6 miles of shoreline. The partnership's restoration work strived to reconnect a highly fragmented urban and urbanizing landscape through re-establishing and planting native communities in critical locations, by upgrading existing native communities, and addressing the pervasive issue of invasive species. Site priorities were key upland or riparian habitats that serve to buffer existing habitat patches and to reconnect significant habitat patches in the regional landscape.

Summary Budget Information for Result 2:	**Trust Fund Budget:**	**$ 650,000**
	Amount Spent:	**$ 637,981**
	Balance:	**$ 12,019**

Deliverable	**Status**
1. Restore 465 acres and 0.6 miles of shoreline	Complete

Final Completion Date: 6/30/2011

Final Report Summary: Six partner organizations restored approximately 775 acres of significant upland and wetland habitat and 0.44 mile of shoreline with Phase V funding, as well as an additional 450 acres and 0.46 miles of shoreline through other funds. Restoration activities have taken place on SNAs, WMAs, USFWS property, and Regional Park lands, as well as other significant lands.

A summary of each sub-result is provided below. For additional information and details on projects and expenditures, please see Tables A and B and the individual final reports.

<u>2.1: Restore/Enhance significant watershed habitat – Friends of the Mississippi River</u>
Friends of the Mississippi River restored/enhanced a total of 242 acres with Phase V funding and an additional 126 acres with non-state funding. FMR exceeded all of

their goals committed to in the original proposal by restoring an additional 192 acres with Phase V funding and leveraging 96 additional acres and $5,323 more than originally proposed.

Restoration work was completed at the following sites:

- Pine Bend Bluffs SNA
- Riverside Park
- Hastings Sand Coulee Prairie SNA
- Crosby Park
- Rosemount Wildlife Preserve
- Wilmar Property
- Katharine Ordway Natural History Study Area
- Hastings River Flats Park
- Gores Pool WMA / Freitag
- Ravenna Block greenway
- Emrick property

2.2: Lower Minnesota Watershed Restoration and Enhancement Project – Friends of the Minnesota Valley

Friends of the Minnesota Valley and its partners were able to successfully restore and enhance 17 acres of native wet prairie, 48 acres of native dry sand-gravel oak savanna, and 28 acres of native dray sand-gravel prairie with Phase V funding for a total acreage of 93 acres. An additional 59 acres of native dry sand-gravel oak savanna was restored with non-LCCMR, non-state funds. Accomplishments include the following:

- St. Lawrence Unit: 17 acres of native wet prairie habitat were successfully restored and enhanced by removing invasive woody brush species such as buckthorn, honeysuckle, and prickly ash.
- Upgrala Unit: 7 acres of native dry sand-gravel prairie were successfully restored by cutting and herbicide treatment of non-native woody species.
- Rapids Lake Unit: 21 acres of native dry sand-gravel prairie and 34 acres of native dry sand-gravel oak savanna were successfully restored and enhanced by cutting and herbicide treatment of non-native woody species.
- Louisville Swamp Unit: 59 acres of native dry sand-gravel oak savanna was restored and enhanced by treating invasive woody brush species.

2.3: Restore/Enhance significant Habitat – Great River Greening

Great River Greening exceeded its goal by restoring and enhancing a total of 204 acres of habitat with Phase V funding and an additional 140 acres with more than $153,000 in leveraged non-state funds. Restoration and enhancement projects occurred on habitats of prairie, savanna, and forest, including nine native plant communities with biodiversity significance as identified by MCBS, providing habitat for 18 documented rare plant species. Volunteers contributed over 2,500 hours to these habitat projects.

Restoration/enhancement activities were completed at the following sites:

- Arcola Mills Historic Foundation (Stillwater)
- St Croix Valley (Taylors Falls and Marine locations)
- Spring Lake Regional Park (Scott County)
- Spring Lake Park Reserve (Dakota County)
- Hidden Valley Park (Savage)
- Snail Lake Regional Park (Shoreview)
- St. Croix Savanna SNA (Bayport)
- Lost Valley Prairie SNA (Denmark Township)
- Pond Dakota Mission (Bloomington)
- Pilot Knob Hill (Mendota Heights)
- Lake Edith site (Afton)
- Central Corridor (Woodbury and Cottage Grove)
- Eagle Creek AMA (Savage)
- Heritage Village Park (Inver Grove Heights)
- OH Anderson Elementary (Mahtomedi)

<u>2.4: Habitat/Enhancement Grants – DNR Metro Greenways</u>

Five restoration grants totaling $90,000 were awarded to three counties and one city. A total of approximately 255 acres of city, county, and regional park lands were restored to native vegetation, primarily prairie and savanna. Two projects came in under budget, resulting in a balance of $10,907. Grantees contributed $91,667 in local in-kind to project completions (1:1 match). The average cost of restoration for all five projects, including both grant funding and local in-kind match, was $678/acre.

Projects include the following accomplishments:

- Becklin Homestead County Park, Isanti County: 50 acres of the county park/WMA were restored to oak savanna ecotype
- Lebanon Hills Regional Park, Dakota County: 25 acres were restored to savanna
- Miesville Ravine Regional Park, Dakota County: The Six Prairies Project restored a total of 151 acres to prairie
- Sunfish Lake Park, City of Lake Elmo: 20 acres was restored to prairie
- Crow Hassan Park Reserve, Three Rivers Park District: 9 acres site restored to native prairie

<u>2.5: Scientific & Natural Area Restoration and Enhancement – DNR Ecological Services</u>

DNR Ecological Services successfully completed restoration and enhancement activities on 187 acres, resulting in native habitat enhancement at 13 Scientific and Natural Areas (SNA) in 7 counties:

- Cannon River Turtle Prairie SNA – Goodhue County
- Clear Lake SNA – Sherburne County
- Falls Creek SNA – Washington County
- Grey Cloud Dunes SNA – Washington County
- Hastings Sand Coulee SNA- Dakota County

- Lost Valley Prairie SNA – Washington County
- Savage Fen SNA – Scott County
- Seminary Fen SNA – Carver County
- Spring Creek Prairie SNA – Goodhue County
- St. Croix Savanna SNA – Washington County
- Uncas Dunes SNA – Sherburne County
- Wolsfeld Woods SNA – Hennepin County
- Wood-Rill SNA – Hennepin County

2.6: Stream Habitat Restoration – DNR Fisheries & Wildlife
DNR Fish & Wildlife completed stream habitat restoration work on 0.9 miles of Vermillion River channel. As part of this project, Environmental and Natural resources Trust dollars ($150,000) restored 0.44 miles of the total. Other State dollars (OHF = $140,000) restored 0.41 miles, and other funding (Vermillion River Watershed = $20,000) restored 0.05 miles of the total.

Result 3: Acquire Significant Habitat

Description: The nine partner organizations proposed to protect at least 652 acres of regionally significant habitat. This was accomplished through acquisition of conservation easements or fee title acquisition by the funded Metro Corridors partners, as well as through matching grants to local units of government and/or non-profits qualified to own and manage land. Partners applied a suite of criteria to select and prioritize for sites for funding within the Focus Areas, including: (1) site is located within, buffers, or connects to a regionally significant ecological area; (2) site contains rare species or plant communities, (3) site protects surface and ground water quality and/or supply, (4) site is threatened by development pressure and fragmentation, degradation, or loss, (5) site offers opportunities for compatible public uses, (6) site has a committed landowner who is willing and ready to sell or donate fee title or easement; (7) site has a committed land steward who will purchase fee title or easement and support stewardship and monitoring of the land; (8) site has a feasible funding strategy that leverages non-state funds to protect water quality and natural lands; and (9) site conservation is only possible through a partnership arrangement.

Summary Budget Information for Result 3:	**Trust Fund Budget:**	**$ 2,330,000**
	Amount Spent:	**$ 2,190,820**
	Balance:	**$ 139,180**

Deliverable	**Status**
1. Acquire 652 acres	Complete

Final Completion Date: 6/30/2011

Final Report Summary: Six partners acquired fee title or conservation easements on 21 sites, protecting a total of 977 acres and nearly 7 miles of shoreline.

Acquisition of an additional 585 acres and 0.4 mile of shoreline was completed using other funds.

A summary of each sub-result is provided below. For additional information and details on projects and expenditures, please see Tables A and B and the individual final reports.

3.1: Critical Land Protection Program fee title & conservation easement acquisition- The Trust for Public Land

The Trust for Public Land (TPL) successfully secured fee title on 21.63 ENRTF acres of 402 total acquired acres. TPL then conveyed these lands to public agencies for permanent protection. Individual project successes include:

- Allemansratt Wilderness Park: $318,000 2009 ENRTF funds were used to protect 14.43 ENRTF acres of land as part of a larger 64-acre purchase of shoreline designated by the MN DNR as a “regionally significant ecological area.” TPL conveyed the land to the City of Lindstrom to create the Allemansratt Wilderness Park.
- Cedar Creek Conservation Area: $62,000 2009 ENRTF funds were used to protect 7.2 ENRTF acres of land as part of a 338-acre acquisition of one of the largest undeveloped and contiguous tracts of open space in the Twin Cities Metro Area. TPL then conveyed the land to Anoka County.

TPL leveraged $380,000 in 2009 ENRTF funding with $992,000 in non-state funds to protect 87.79 additional pro-rated acres of land. Additionally, $500,000 in state remediation grant funds, $1,900,000 in Outdoor Heritage Funds, $338,000 in TPL’s 2010 ENRTF funds, and $200,000 in DNR’s 2008 ENRTF funds were used to purchase the remainder of the property, totaling 402 acres. Since a portion of TPL’s 2010 ENRTF funding was used for the Cedar Creek Conservation Area project, a portion of these results will also be reflected in TPL’s 2010 MeCC Work Program update and Final Report.

3.2: Protecting significant habitat by acquiring conservation easements – Minnesota Land Trust

The Minnesota Land Trust successfully completed eight perpetual conservation easements that collectively protect 765 acres of land and more than 33,000 feet of shoreline. Three easements were purchased, and the remaining five easements were donated. While two of the purchased easements used both 2009 and 2010 ENRTF funding, accomplishments are reported only as part of the 2009 report, and will not be reported in future 2010 reports to avoid double-counting. Values are known for only five of the eight easements acquired, and this value totals $854,500, with a known donated value of $413,500. The cost to the State of Minnesota to complete these projects was just over $326 per acre.

All eight projects represent unique opportunities to protect high quality natural habitat, riparian areas, and to build upon prior land protection work by the Land Trust at several priority sites:

- Deer Lake: 45 acre property, Anoka County

- Elk River: 148-acre property, Sherburne County
- Camp Kingswood: 44-acre property, Hennepin County
- Hardwood Creek: 157-acre property , Washington County
- Scandia: 5-acre property, Washington County
- Valley Creek: 126-acre property, Washington County
- Wild River State Park: 39-acre property, Chisago County
- Bay Point Park: 201-acre property, Goodhue County

3.3: Fee Acquisition for the MN Valley National Wildlife Refuge – Minnesota Valley National Wildlife Refuge Trust, Inc.

The Minnesota Valley Trust acquired 96 acres of priority lands in the Minnesota River Valley floodplain in Sibley County to expand the Jessenland Unit of the Minnesota Valley National Wildlife Refuge. Of the 96 acres acquired, the Environment and Natural Resources Trust Fund paid for 90 acres and the Minnesota Valley Trust paid for 6 acres with nonprofit / other non-state funds.

Using other non-state funds, the Minnesota Valley Trust also acquired 44.67 acres of priority lands in the Minnesota River Valley in Scott County to expand the Blakely Unit of the Minnesota Valley National Wildlife Refuge. The Blakely and Jessenland Units are on opposite (facing) sides of the Minnesota River and, together, form a large contiguous block of priority wildlife habitat.

3.4: Grants & Acquisition of fee title & conservation easements – Minnesota Department of Natural Resources – Metro Greenways

Six protection projects were awarded a total of $650,000. However, only three projects were initiated and completed (Lindstrom, Grannis, and Niebur), resulting in the protection of just 120 acres of the 325 acre projected target for Metro Greenways.

- Allemansratt Wilderness Park: Lindstrom's new 64-acre park honors its name, which means "every man's right" to walk anywhere. Situated amid several lakes, the new park will provide the residents of northern metro with the opportunity to explore a deciduous hardwood forest. Note that Trust for Public Land was the lead for this acquisition project and acres and match are included in their numbers only in the attached Table A in order to avoid double counting.
- Grannis and Nieber properties: Two grants to Dakota County added a total of 56 acres under conservation easements to its green infrastructure network being created by the Farmland and Natural Areas Program.

Unfortunately, a $200,000 grant to Anoka Conservation District did not materialize and the funds were transferred to the DNR's Scientific and Natural Areas Program via an amendment; a $10,000 grant awarded to Chanhassen was denied by the city and these funds were put toward the Grannis project in Dakota County; and an $80,000 balance remained when Washington County notified the DNR in 2011 that its project would not move ahead. As a result, the target for this result was not met, with only 120 acres protected for $370,000.

3.5: DNR Fish & Wildlife Acquisition – Minnesota Department of Natural Resources – Fisheries & Wildlife

DNR Fish & Wildlife completed two fee title acquisition parcels on the Vermillion River in Dakota County and two fee title acquisition parcels on Eagle Creek in Scott County. The combined total for all four acquisitions is 50.5 acres with 1.08 miles of shoreline. One of the parcels on the Vermillion River was also paid for with other ENRTF funds, resulting in both acres and miles being divided proportionately between the two phases. 2009 ENRFTF dollars ($350,000) directly acquired approximately 38.8 acres of the total, including 0.69 miles of stream. Donation of value ($106,800) accounted for approximately 11.7 acres, including 0.4 miles of stream.

3.6: Scientific & Natural Areas (SNA) Acquisition – Minnesota Department of Natural Resources – Ecological Services

DNR Ecological Services successfully acquired 148.5 acres of high quality native habitat threatened by urban development that expanded two metro Scientific and Natural Areas (SNAs). In the first acquisition, 80 acres were acquired (36.7 acres pro-rated to this appropriation) and added to the Hastings Sand Coulee SNA. The addition contains native oak savanna and prairie and increases this SNA to 267 acres, protecting more than half of the largest remaining prairie complex in Dakota County, home to 13 resident rare species (including 3 snake and 2 butterfly species).

The second acquisition protects 68.5 acres of habitat (6.2 acres pro-rated to this appropriation) added to Savage Fen SNA in Scott County. This site offers urban residents close-to-home nature-based recreation, including a new archery hunting opportunity on 300 acres at Savage Fen SNA and public fishing frontage on the Credit River.

Result 4: Outreach

Description: The Metro Greenways Program, with partnership input, proposed to provide matching grants to about 10-15 communities to assist them in developing and gathering needed natural resources information to identify sites for protection or restoration and/or to implement conservation measures for already identified natural areas. Community selection was based on established selection criteria, including: communities that have remaining high quality land cover types or sensitive wetlands, shore land, or aquatic habitats that are relatively unimpaired; rapid growth and projected increases in impervious surface area; ability to provide cash or in-kind project support; willingness to incorporate project deliverables into local planning and implementation decisions; willingness to work across jurisdictional boundaries to accomplish conservation outcomes. Fast growth communities with high value natural resources that contact the program, seeking assistance with well-conceived projects, were especially desirable recipients for these grants. Anticipated deliverables included: land cover data (MLCCS) for critical natural areas; natural resources data compilation and assessment for direct application; integration of conservation strategies into comprehensive and other local plans; ordinance revision to afford greater protection of natural resources; and identification of various conservation approaches to be applied locally.

Summary Budget Information for Result 4:	**Trust Fund Budget:**	**$ 295,000**
	Amount Spent:	**$ 270,179**
	Balance:	**$ 24,821**

Deliverable	**Status**
1. 10-15 local government consultations/projects	Complete

Final Completion Date: 6/30/2011

Final Report Summary: Incentive grants were solicited and awarded through DNR's Community Conservation Assistance (CCA) Program to 13 cities and counties. All projects were completed, although two projects relinquished good portions of their grant awards due to insufficient time.   Projects included:

- Corcoran – new and updated zoning ordinances
- Hugo – natural resource inventory
- Lake Elmo – forest assessment & management plan for Sunfish Lake Park
- Lakeland – updating ordinances and community outreach
- Minneapolis – urban tree canopy mapping and management plan
- North Branch – land cover inventory using MLCCS
- Princeton – Rum River recreational area planning
- St. Paul – urban tree canopy mapping
- Scott County – natural resources planning for Blakely Bluff ecological corridor
- Scott County – development of a program to protect natural areas
- Sherburne County – land cover inventory using MLCCS for four townships
- Three Rivers Park District – forest assessment and management strategies for Murphy-Hanrehan Park

In addition to the grant-making, DNR's Community Conservation Assistance manager organized and facilitated two annual events that brought all 25 DNR Community Assistance grantees together for a day of information-sharing and peer-to-peer learning. These gatherings were extremely well attended and received by the grantees. The DNR also convened its three city grantees that completed urban tree canopy (UTC) inventories, along with the University of Minnesota forestry and extension service, U.S. Forestry Service, and Minneapolis Park and Recreation Board to hear about each city's findings and proposed applications of UTC data.

This third result area also funded the development and offering of six new natural resource-based workshops for local government staff and appointed officials. These workshops were offered in the metro area and were promoted by Government Training Services to its clientele (local government commissioners). Almost 235 local government staff and officials (62% from cities; 14% counties; 14% special districts and others; and 10% townships) attended these workshops on shoreland conservation, stormwater management, and the incorporation of natural resources into land use planning and engineering design. The workshops all received excellent evaluations from attendees.

V. TOTAL TRUST FUND PROJECT BUDGET:

Please also see the attached Table B and individual final reports for additional detail.

Staff or Contract Services:	$ 628,521
Equipment/Tools:	$ 3,397
Restoration:	$ 281,025
Acquisition, including easements:	$1,920,597
Travel:	$ 5,496
Other:	$ 310,580

TOTAL TRUST FUND PROJECT BUDGET: $3,149,904 ($3,375,000 appropriated)

Explanation of Capital Expenditures Greater Than $3,500: N/A

VI. OTHER FUNDS & PARTNERS:

A. Project Partners: Trust for Public Land, MN Land Trust, Friends of the Mississippi River, Friends of the Minnesota River, MN Valley National Wildlife Refuge Trust, Great River Greening, DNR Metro Greenways, DNR Fish and Wildlife, DNR SNA Program

B. Project Impact and Long-term Strategy: The Metro Conservation Corridors partnership works to accelerate protection and restoration of key natural lands in the metro area. Coordinating conservation efforts within this regional framework helps to increase the cost-effectiveness of our work by efficiently leveraging private and public partners and resources and building upon prior investments. The mapping function helps the partnership focus on areas with the greatest regional importance for habitat using state-of-the-art natural resource assessments and regional prioritization methods. Finally, development of a Metro Corridors database will allow the partnership to track its results history, assess progress, and identify opportunities to build upon prior protection and restoration work.

C. Other Funds Spent during the Project Period: Approximately $2,530,000 in other non-state funds and $182,000 in other state funds were proposed to be spent during the project period. Actual funds spent or leveraged were: $4,071,900 of other state funds and $4,540,303 of other non-state funds (see Table A).

D. Spending History: LCCMR appropriations only:

MeCC Phase I (2003) - $4,500,000 ($4,850,000 appropriated)

MeCC Phase II (2005) - $3,529,655 ($3,530,000 appropriated)

MeCC Phase III (2007) - $2,465,225 ($2,500,000 appropriated)

MeCC Phase IV (2008) – $3,149,248 ($3,150,000 appropriated)

VII. DISSEMINATION: As projects were completed, the individual partners were encouraged to publicize accomplishments through press releases, organization newsletters and websites. These efforts resulted in information being distributed to the public through websites, email lists, daily and weekly newspapers, newsletters, and other print materials. Additionally, an interactive public web map is now fully functional and shows the locations of MeCC projects over time. This web map can be accessed at: http://www.dnr.state.mn.us/maps/MeCC/mapper.html.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports were submitted not later than February 1st and August 1st of each year. This is the final work program report.

Metro Conservation Corridors 2009 - Phase V

Table A: Summary of Funding & Accomplishments

LCCMR Appropriated Dollars: **$3,375,000**

Result / Activity	Partner	Project Funding						Accomplishments				
		ENRTF 2009 Funds			Other Funds		Total Project Funds Spent *(ENRTF, Other State Funds & Non-State Funds combined)*	ENRTF		Other Funds		Total Project Acres Completed *(ENRTF & Other Funds combined)*
		ENRTF 2009 Funds Allocated	ENRTF 2009 Funds Spent	ENRTF 2009 Funds Balance	Other State Funding Spent	Other Non-State Funding Spent		ENRTF 2009 Acres/Miles Completed		Other Funds Acres/Miles Completed		
								ACRES	MILES	ACRES	MILES	
1. Coordinate MeCC Program												
1.1. Coordination of MeCC program, local outreach and conservation implementation assistance for two year project term	DNR and Minnesota Land Trust	$100,000	$50,924	$49,076	$0	$0	$50,924					-
2. Restore & Enhancement Significant Habitat												
2.1. Restore/enhance significant watershed habitat.	Friends of the Mississippi River	$90,000	$89,329	$671		$56,459	$145,788	179		108		287
2.2. Lower Minnesota River Watershed Restoration & Enhancement Project.	Friends of MN Valley	$90,000	$89,979	$21		$83,190	$173,169	93		59		152
2.3. Restore/enhance significant habitat.	Great River Greening	$155,000	$155,000	$0		$153,000	$308,000	204		140		344
2.4. Habitat restoration/enhance. grants.	DNR - Metro Greenways	$100,000	$89,093	$10,907		$10,680	$99,773	112		143		255
2.5 Scientific & Natural Area (SNA) restoration & enhancement.	DNR - Ecological Services	$65,000	$64,580	$420			$64,580	187				187
2.6 Stream Habitat Restoration	DNR - Fisheries & Wildlife	$150,000	$150,000	$0	$140,000	$20,000	$310,000		0.44		0.46	-
SUBTOTAL		$650,000	$637,981	$12,019	$0	$303,329	$941,310	775	0.44	450	0.46	1,225
3. Acquire Significant Habitat												
3.1 Critical Land Protection Program fee title & conservation easement acquisition.	The Trust for Public Land	$380,000	$380,000	$0	$2,938,000	$992,000	$4,310,000	22		380		402
3.2. Protecting significant habitat by acquiring conservation easements.	Minnesota Land Trust	$250,000	$250,000	$0	$293,900	$115,000	$658,900	765	6.30			765
3.3. Fee acquisition for Mn Valley National Wildlife Refuge.	MN Valley NWR Trust, Inc.	$225,000	$225,000	$0		$150,701	$375,701	90		51		141
3.4. Grants & acquisition of fee title & conservation easements.	DNR - Metro Greenways	$543,045	$462,978	$80,067		$277,473	$740,451	19		37		56
3.5. DNR Fish & Wildlife Acquisition.	DNR - Fisheries & Wildlife	$350,000	$292,025	$57,975		$106,800	$398,825	39	0.69	12	0.40	51
3.6. Scientific & Natural Area (SNA) Acquisition.	DNR - Ecological Services	$581,955	$580,817	$1,138	$840,000	$2,595,000	$4,015,817	43		106		149
SUBTOTAL		$2,330,000	$2,190,820	$139,180	$4,071,900	$4,236,974	$10,499,694	977	6.99	585	0.40	1,562
4. Community Conservation Assistance												
4.1 Assist local governments to promote the conservation of natural habitats.	DNR - Metro Greenways	$295,000	$270,179	$24,821			$270,179					
TOTAL		**$3,375,000**	**$3,149,904**	**$225,096**	**$4,071,900**	**$4,540,303**	**$11,762,107**	**1,752**	**7.43**	**1,035**	**0.86**	**2,787**

Metro Conservation Corridors 2009- Phase V

Table B: LCCMR Funding - Budget Detail **LCCMR Appropriated Dollars: $3,375,000**

Final Report

Activity	Partners	LCCMR Funding Spent								Budget Explanation (staff/contractservices, development, equipment, other)
		Staff/contract services	Equipm't	Developm't	Restoration	Acquisition	Travel	Other	Total	
1. Coordinate MeCC Program										
1.1. Coordination of MeCC program & local outreach and implementation assistance for two year project term	DNR OMBS w/ subcontract to Minnesota Land Trust & DNR Management Information Services	$ 50,924							$ 50,924	Staff from DNR Central Region for mapping support for two years; Contract to Minnesota Land Trust to cover a portion of the salaries and related benefits of staff working on coordination (approximately .25 FTE conservation program staff and other support staff), project specific conference calls and travel
2. Restore & Enhance Significant Habitat										
2.1. Restore/enhance significant watershed habitat	Friends of the Mississippi River	$ 11,871	$ -	$ -	$ 76,896	$ -	$ 562		$ 89,329	Restoration: Includes hiring contractors to conduct restoration and enhancement activities and purchasing supplies and materials.
2.2. Lower Minnesota River Watershed restoration & enhancement project	Friends of Minnesota Valley	$ 64,989	$ -	$ -	$ 24,990	$ -	$ -	$ -	$ 89,979	Staff/Contracts: Director of Conservation Programs for project coordination and implementation; Contracts for earth work, installing water control structures, breaking drain tile, etc.; Restoration:native plants and seed, trees, water control structures
2.3. Restore/enhance significant habitat	Great River Greening	$ 49,149	$ 1,473		$ 93,614		$ 3,095	$ 7,669	$ 155,000	Staff: Ecologists and Conservation Director; Field Manager; Volunteer Manager; Restorations Technicians; Project Administration. Restoration: Contracts for site prep, prairie seeding; plant, mulch, and seed purchase; travel within Minnesota. Equipment: Seed drill, mower, harrow, roller, sprayers, Rx burn eq't, saws, loppers, etc. Other: Volunteer event supplies (approved food and bevg, port. toilets, tent rentals etc.)
2.4 Habitat restoration/enhance. Grants	DNR - Metro Greenways	$ 10,470	$ -	$ -	$ 78,622	$ -	$ -	$ -	$ 89,093	Grants to LGU's and NGO's for restoration and enhancement and staff administration of grants
2.5 Scientific & Natural Area (SNA) restoration & enhancement	DNR - Ecological Services	$ 55,498	$ 1,924	$ -	$ 6,903	$ -	$ 255	$ -	$ 64,580	Staff/contract services: DNR SNA crew, MCC, and contractors selected through bid process as needed to complete restoration and development projects; Equipment: truck & equipment fleet charges & incidental parts; Restoration: restoration & development materials and supplies, such as fencing, signs, gloves, PPE
2.6. Fish and wildlife stream habitat restoration	DNR - Fisheries & Wildlife	$ 150,000							$ 150,000	Staff/contract services: Professional/technical services and other restoration contracts
SUBTOTAL		$ 341,977	$ 3,397	$ -	$ 281,025	$ -	$ 3,912	$ 7,669	$ 637,981	
3. Acquire Significant Habitat										
3.1 Critical Land Protection Program fee title & conservation easement acquisition	The Trust for Public Land					$ 380,000			$ 380,000	To protect 17 acres of habitat at Lindstrom - Phase I, Savage Fen, or Cedar Creek - Phase II.
3.2. Protecting significant habitat by acquiring conservation easements	Minnesota Land Trust	$ 88,413	$ -	$ -	$ -	$ 80,062	$ 1,525	$ 80,000	$ 250,000	Staff: Includes conservation director or land protection staff; staff attorney; and support staff. Acquisition: costs associated with acquiring donated or purchased CE's. Travel: Mileage and related travel expenses. Other: easement stewardship
3.3. Fee acquisition for Mn Valley National Wildlife Refuge	MN Valley NWR Trust, Inc.	$ -	$ -	$ -	$ -	$ 225,000	$ -	$ -	$ 225,000	Fee title acquisition of significant habitat in Minnesota River Valley
3.4. Grants & acquisition of fee title & conservation easements	DNR - Metro Greenways	$ 92,978	$ -	$ -	$ -	$ 370,000	$ -	$ -	$ 462,978	Grants to LGUs and NGOs for direct acquisition of fee title & conservation easements.
3.5. DNR Fish & Wildlife Acquisition	DNR - Fisheries & Wildlife	$ -	$ -	$ -	$ -	$ 292,025	$ -	$ -	$ 292,025	DNR fee acquistion of lands for AMA and/or WMA, including related real estate transaction costs
3.6. Scientific & Natural Area (SNA) Acquisition	DNR - Ecological Services	$ 7,248	$ -	$ -	$ -	$ 573,510	$ 59	$ -	$ 580,817	Acquisition: fee title acquisition, including related real estate transaction costs.
SUBTOTAL		$ 188,639	$ -	$ -	$ -	$ 1,920,597	$ 1,584	$ 80,000	$ 2,190,820	
4. Community Conservation Assistance										
4.1 Assist local governments to promote the conservation of natural habitats	DNR - Metro Greenways	$ 46,981	$ -	$ -	$ -	$ -	$ -	$ 223,198	$ 270,179	Grants to assist local governments with gathering and integrating natural resources information into local development and conservation planning and policy decisions
TOTAL		**$ 628,521**	**$ 3,397**	**$ -**	**$ 281,025**	**$ 1,920,597**	**$ 5,496**	**$ 310,867**	**$ 3,149,904**	

METRO CONSERVATION CORRIDORS PARTNERSHIP

Phase V (2009) Completed Projects

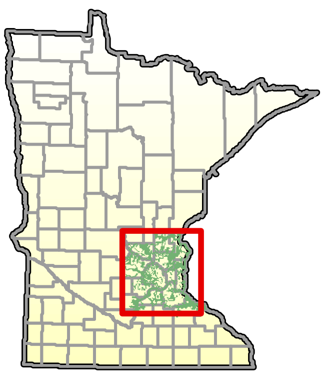
Metro Conservation Corridors

Fee Title Acquisition

Conservation Easement

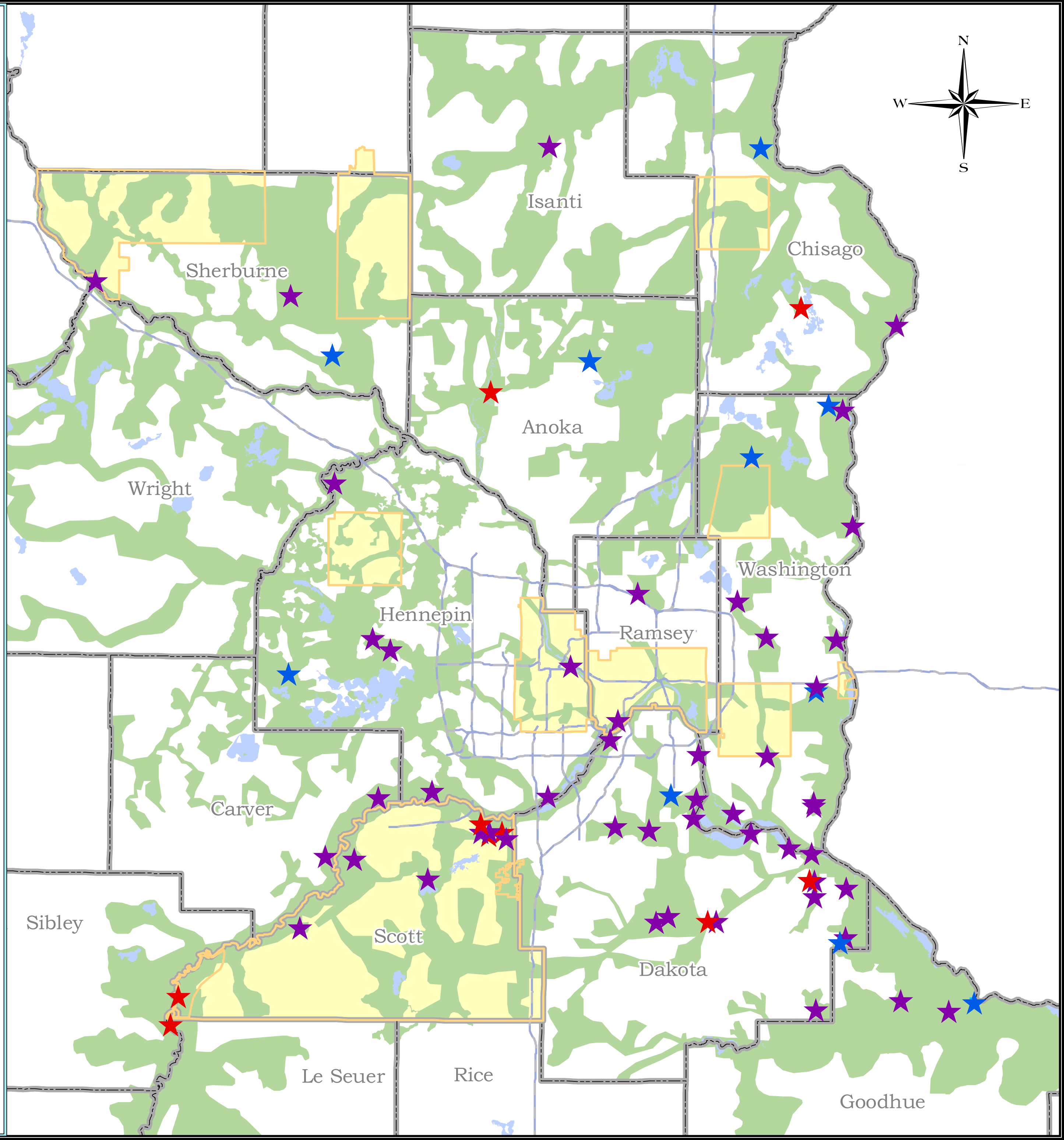
Restoration/Enhancement

Community Conservation Assistance



Accomplishments during Phase V include:

- 1,225 acres of restored/enhanced habitat
- 1,562 acres of protected land through fee title acquisition and conservation easements.
- Community conservation assistance was provided to eight cities, two counties, and one park district.



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Metro Conservation Corridors Phase V – Mapping and Coordination

PROJECT MANAGER:	Bart Richardson (mapping)	Sarah Strommen (coordination)
AFFILIATION:	Minnesota DNR	Minnesota Land Trust
MAILING ADDRESS:	1200 Warner Rd.	2356 University Ave. W. STE 240
CITY/STATE/ZIP:	St. Paul, MN 55106	St. Paul, MN 55114
PHONE:	651-259-5796	651-647-9590
E-MAIL:	bart.richardson@state.mn.us	sstrommen@mnland.org

WEBSITE: [If applicable]

FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chap. 143, Sec. 2, Subd. 4(f) 1.1

APPROPRIATION AMOUNT: $100,000

Overall Project Outcome and Results

The Metro Conservation Corridors (MeCC) Partnership completed its fifth phase of work to accelerate protection and restoration of remaining high-quality natural lands in the greater Twin Cities metropolitan area. Work was accomplished by strategically coordinating and focusing conservation efforts within a connected network of critical lands that stretches from the area's urban core to its rural perimeter, including portions of 16 counties.

Projects and activities took place within science-based corridors and were guided by the Minnesota Statewide Conservation and Preservation Plan, Minnesota's Comprehensive Wildlife Conservation Strategy, as well as numerous local and resource-specific plans. This project addressed several recommendations of the Statewide Conservation and Preservation Plan:

- Protect priority land habitats
- Protect critical shorelands of streams and lakes
- Restore land, wetlands, and wetland-associated watersheds
- Improve connectivity and access to outdoor recreation

The Mapping and Coordination element of the MeCC Partnership provided coordination and leadership for the partnership by Minnesota Land Trust staff and improved prioritization through enhanced database development and mapping of the corridors by DNR staff.

During this phase of work, the coordination activity included regular meetings of the partners to share information and accomplishments, assisting partners with preparation of reports, compiling overall partnership results, and assisting DNR staff with the mapping, database development, and results tracking. The mapping activity included successful development and refinement of a GIS-based database to track historic and current MeCC projects. The database allows partners to generate tables and reports for status and accomplishment reporting for a variety of MeCC components – from project types, to funding sources, to activities, to partnerships, to location analysis. It also links to an interactive web map where the public can see the locations of completed projects.

Although we had originally hoped to complete a mini-evaluation of the MeCC Partnership, due to the time involved in mapping and compiling historic project data, there was not time to complete the evaluation.

Project Results Use and Dissemination

The Metro Conservation Corridors Partnership primarily distributed information through individual partners as projects were completed. Partners publicized accomplishments through press releases and organization newsletters and websites. Additionally, the Partnership now has a public web map where the public can view MeCC projects. This web map can be accessed at: http://www.dnr.state.mn.us/maps/MeCC/mapper.html.

Environment and Natural Resources Trust Fund
2009 Work Program Final Report

Date of Report: August 9, 2011
Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Metro Conservation Corridors Phase V – Mapping and Coordination

Mapping Project Manager: Bart Richardson
Affiliation: Minnesota Department of Natural Resources
Mailing Address: 1200 Warner Road
City / State / Zip: St. Paul, MN 55106
Telephone Number: 651-259-5796
E-mail Address: bart.richardson@state.mn.us
FAX Number:
Web Site Address: www.dnr.state.mn.us

Coordination Project Manager: Sarah Strommen
Affiliation: Minnesota Land Trust (MLT)
Mailing Address: 2356 University Ave. W., Suite 240
City / State / Zip: St. Paul, MN 55114
Telephone Number: 651-647-9590
E-mail Address: sstrommen@mnland.org
FAX Number: 651-647-9769
Web Site Address: www.mnland.org

Location: 16 county metro area consisting of Wright, Hennepin, Dakota, Carver, Scott, Washington, Ramsey, Anoka, Chisago, Isanti, Goodhue and Sherburne.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$100,000**
	MLT Total	*$50,000*
	DNR Total	*$50,000*
	Minus Amount Spent:	**$50,924**
	MLT Amount Spent:	*$12,304*
	DNR Amount Spent:	*$38,620*
	Equal Balance:	**$49,076**

Legal Citation: ML 2009, Chap. 143, Sec. 2, Subd. 4(f)1.1

Appropriation Language: $3,375,000 is from then trust fund to the commissioner of natural resources for the fifth appropriation for the acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for the Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with

Friends of the Mississippi; $155,000 with Great River greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easements acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee title obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY

The Metro Conservation Corridors (MeCC) Partnership completed its fifth phase of work to accelerate protection and restoration of remaining high-quality natural lands in the greater Twin Cities metropolitan area. Work was accomplished by strategically coordinating and focusing conservation efforts within a connected network of critical lands that stretches from the area's urban core to its rural perimeter, including portions of 16 counties.

Projects and activities took place within science-based corridors and were guided by the Minnesota Statewide Conservation and Preservation Plan, Minnesota's Comprehensive Wildlife Conservation Strategy, as well as numerous local and resource-specific plans. This project addressed several recommendations of the Statewide Conservation and Preservation Plan:

- Protect priority land habitats
- Protect critical shorelands of streams and lakes
- Restore land, wetlands, and wetland-associated watersheds
- Improve connectivity and access to outdoor recreation

The Mapping and Coordination element of the MeCC Partnership provided coordination and leadership for the partnership by Minnesota Land Trust staff and improved prioritization through enhanced database development and mapping of the corridors by DNR staff.

During this phase of work, the coordination activity included regular meetings of the partners to share information and accomplishments, assisting partners with preparation of reports, compiling overall partnership results, and assisting DNR staff with the mapping, database development, and results tracking. The mapping activity included successful development and refinement of a GIS-based database to track historic and current MeCC projects. The database allows partners to generate tables and reports for status and accomplishment reporting for a variety of MeCC components – from project types, to funding sources, to activities, to partnerships, to location analysis. It also links to an interactive web map where the public can see the locations of completed projects.

Although we had originally hoped to complete a mini-evaluation of the MeCC Partnership, due to the time involved in mapping and compiling historic project data, there was not time to complete the evaluation.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Partnership and Program Coordination

Description: For this phase of the MeCC grant, the partnership agreed that DNR would subcontract with the Minnesota Land Trust to provide partnership and program leadership and coordination.

Coordination of the partnership specifically included:

1) Convene and facilitate meetings of the partnership (estimated at 4 per year) and the executive committee (estimated at 4 per year)
2) Provide support to partners in preparing work programs and reports
3) Compile overall work programs, status reports and final reports
4) Coordinate the identification of focus areas where the partners will direct their restoration and protection efforts
5) Work with DNR staff on Result 2: Corridor Data Base Development, Project Tracking, and Mapping to ensure coordination with other partnership activities
6) Coordinate outreach efforts to local communities and other potential partners
7) Assist with public relations promoting the accomplishments of the partnership, Environment and Natural Resources Trust Fund and LCCMR, as appropriate
8) Provide information to LCCMR as needed or requested

The Land Trust focused efforts on the 2009 MeCC grant but also assisted with closing out the 2007 and 2008 phases in order to create consistency and a smooth transition between phases of this program.

Summary Budget Information for Result 1: Trust Fund Budget: $ 50,000
Amount Spent: $ 12,304
Balance: $ 37,696

Deliverable	Completion Date	Estimated Budget

1. Convene and facilitate partnership meetings	6-30-2011	
2. Provide support to partners	6-30-2011	
3. Compile overall work programs	6-30-2011	
4. Coordinate the identification of focus areas	6-30-2011	
5. Work with DNR staff on Result 2	6-30-2011	
6. Coordinate outreach efforts	6-30-2011	
7. Assist with public relations	6-30-2011	
8. Provide information to LCCMR	6-30-2011	

Final Report Summary:
The Land Trust staff successfully coordinated the MeCC Partnership by convening and facilitating regular meetings of the partnership, compiling and providing overall work program updates to LCCMR staff, and providing other information as needed to both partners and LCCMR staff. The MeCC Partnership also held its first joint meeting with the Habitat Conservation Partnership.

Land Trust staff also assisted the DNR staff and partners to map past projects and enter historic project data into the new MeCC database, going back to the first appropriation in 2003. Because mapping of specific projects was not done or required to the same level it is today, it was a larger undertaking than originally anticipated.

As is evident in the budget information section, the coordination function only required a little more than half of the funds originally appropriated for this activity. There are two reasons for this outcome. First, when the project proposals and work programs were originally put together, it was anticipated the DNR would provide the coordination function for the partnership as it had in all the previous phases. Therefore, the budget was developed with DNR's structure in mind – not the Minnesota Land Trust's. Second, we had originally intended to conduct a mini-evaluation of the partnership and its past accomplishments, which would have involved paying an outside contractor. Unfortunately, we were unable to complete this evaluation due to timing constraints. As noted above, the process of gathering and compiling data from past phases and entering this information into the MeCC database took longer than anticipated. At the point this task was complete and we were ready to move forward with the evaluation, LCCMR staff asked us to not proceed given the shortness of time. It is the hope of the MeCC partners that the evaluation can be completed at some point in the future.

Result 2: Corridor Data Base Development, Project Tracking, and Mapping

Description: This result was carried out by classified staff within the Department Management Information System (MIS) section supported by special projects funds that are cost-coded.

In 2008 the DNR Central Region contracted with the DNR MIS to develop a GIS-based database to track MeCC projects. In 2009 project partners began entering information into the database and DNR MIS scoped out additional database functions. Version 2 of the database, created under this result, will allow partners to generate tables and reports for status and accomplishment reporting for a variety of MeCC components – from project types, to funding sources, to activities, to partnerships, to location analysis. It also created an improved web map where the public can see the locations of completed projects. Finally, MIS was reimbursed for database server space and application maintenance.

Summary Budget Information for Result 2: **Trust Fund Budget: $50,000**
Amount Spent: $38,620
Balance: $11,380

Deliverable	**Completion Date**	**Budget**
1. MeCC Database Version 2 a. Display MeCC projects on a public web map b. Partner tables and project maps c. Historical data entry assistance to partners d. Project administration	 August 2009 January 2011 January 2011 March 2011 June 2011	
2. Generate overall tables from the database a. Status report 1 b. Status report 2 c. Status report 3 d. Status report 4 e. Final report	 August 2009 Feb. 2010 August 2010 Feb. 2011 July 2011	
3. MeCC Corridor Map a. Draft a protocol for partner adoption b. Manage any edit requests	 June 30, 2010	
4. MeCC Database maintenance reimbursement	June 30,2011	

Final Report Summary:
DNR staff completed updates to Version 2 of the MeCC Database. The database is now able to quickly generate tables for reports and to both upload and export shapefile information for individual projects. A database mapping application allows partners to easily map project areas.

Additionally, an interactive public web map is now fully functional and shows the locations of MeCC projects over time. This web map can be accessed at: http://www.dnr.state.mn.us/maps/MeCC/mapper.html.

Although we had originally hoped to create a direct interface with LCCMR systems in order to generate the Land Acquisition Reports, it was determined that this was not possible due to differences in the MeCC and LCCMR systems. However, the MeCC database is now able to generate all the information necessary for partners to quickly complete LCCMR land acquisition work program reports.

V. TOTAL TRUST FUND PROJECT BUDGET: $100,000

Personnel: DNR: $38,620 (includes 0.5 FTE Classified ITS-3 within the Department Management Information System (MIS) section supported by special projects funds that are cost-coded for Result 2.)
Contracts: $12,304 to Minnesota Land Trust to cover a portion of the salaries and related benefits of staff working on coordination, project-specific conference calls and travel.

TOTAL TRUST FUND PROJECT BUDGET: $100,000

Explanation of Capital Expenditures Greater Than $3,500: N/A

VI. PROJECT STRATEGY:

A. Project Partners: Project partners include:

Trust for Public Land	Critical Land Protection Program
MN Land Trust	Protect Significant Habitat by Acquiring Conservation Easements
Friends of the Mississippi River	Mississippi River Valley Habitat Restoration
Friends of the Minnesota River	Lower Minn. River Watershed Restoration & Enhancement Project
MN Valley Nat. Wild. Refuge Trust	Expansion of MN Valley Nat. Wildlife Refuge
Great River Greening	Restore/Enhance Significant Habitat
DNR Metro Greenways	Metro Greenways
DNR Fish and Wildlife	Acquisition and Restoration
DNR SNA Program	Scientific and Nat. Area Acquisition/Restoration

B. Project Impact and Long-term Strategy: The Metro Conservation Corridors partnership works to accelerate protection and restoration of key natural lands in the metro area. Coordinating conservation efforts within this regional framework helps to increase the cost-effectiveness of our work by efficiently leveraging private and public partners and resources and building upon prior investments. The mapping function helps the partnership focus on areas with the greatest regional importance for habitat using state-of-the-art natural resource assessments and regional prioritization methods. Finally, development of a Metro Corridors database will allow the partnership to track its results history, assess progress, and identify opportunities to build upon prior protection and restoration work.

C. Other Funds Proposed to be Spent during the Project Period: No other funds were spent on coordination and mapping functions.

D. Spending History: $24,800 of the 2007 LCCMR Overall Coordination Result 1. $50,000 was appropriated in 2008 for coordination and mapping efforts through June 30, 2010.

VII. DISSEMINATION: The Metro Conservation Corridors partnership primarily distributed information through individual partners as projects were completed. Partners publicized accomplishments through press releases and organization newsletters and websites. Additionally, as noted above the partnership now has a public web map where the public can view MeCC projects.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports were submitted not later than February 1st and August 1st of each year. This is the final work program report.

IX. RESEARCH PROJECTS: N/A

Attachment A: Budget Detail for 2009 Projects

Project Title: Metro Conservation Corridors Phase V - Mapping and Coordination 1.1

Project Manager Name: Bart Richardson (Mapping) and Sarah Strommen (Coordination)

Trust Fund Appropriation: $100,000

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent as of June 30, 2011**	**Balance**	**Result 2 Budget:**	**Amount Spent as of June 30, 2011**	**Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
BUDGET ITEM	Partnership & Program Coord.			Corridor Data Base, Project Tracking				
PERSONNEL: wages and benefits: staff from DNR Central Region for Result 2				50,000	38,620	11,380	50,000	11,380
CONTRACTS: to Minnesota Land Trust to cover a portion of the salaries and related benefits of staff working on coordination (approximately .25 FTE conservation program staff and other support staff), project-specific conference calls and travel.	50,000	12,304	37,696				50,000	37,696
COLUMN TOTAL	**$50,000**	**$12,304**	**$37,696**	**$50,000**	**$38,620**	**$11,380**	**$100,000**	**$49,076**

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Metro Conservation Corridors (MeCC) Phase V – Restore and Enhance Significant Watershed Habitat (2.3)

Project Manager: Tom Lewanski
Affiliation: Friends of the Mississippi River
Mailing Address: 360 North Robert Street, Suite 400
City / State / Zip: St. Paul, MN 55101
Telephone Number: 651 222-2193 Ext. 12
E-mail Address: tlewanski@fmr.org
Fax Number: 651 222-6005
Web Page address: www.fmr.org

FUNDING SOURCE**:** Environment and Natural Resources Trust Fund
LEGAL CITATION: Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subdivision 4(f)2.3

APPROPRIATION AMOUNT: $ 90,000

Overall Project Outcome and Results

The Twin Cities contains significant habitat areas. There is a concerted effort to protect, improve and link these areas. FMR's goal with this project was to partner with landowners to restore and enhance habitat at a number of these areas. During this phase of the MeCC project, FMR conducted activities at 9 distinct sites resulting in the restoration of a total of 287 acres, including 179 acres using Environment and Natural Resources Trust Fund funds and 108 acres using leveraged funds. A management plan exists for each site, which served as guide for the restoration and enhancement activities. These sites included:

1. **Pine Bend Bluffs Natural Area**: Spot treated weeds on a 17-acre restored prairie and conducted exotic brush control on 28 acres of woodland. Conducted follow up buckthorn control on 3-acres of woodland.
2. **Sand Coulee Prairie**. Conducted prescribed burns, mowing, and spot-spraying on 83-acres. Volunteers assisted in collecting seeds and removing weeds.
3. **Rosemount Wildlife Preserve**. Conducted a prescribed burn on 16 acres of woodland.
4. **Wilmar**. Mowed a 25-acre prairie restoration & treated exotic invasive plans in a 15-acre woodland.
5. **Mississippi River Gorge.** Volunteers installed native tree and shrubs on 2-acre and installed prairie plants to enhance a 4-acre prairie restoration within Crosby Park. Volunteers also hand weeded the site. At the Riverside Park in Minneapolis, volunteers installed native plants within 4-acre of woodland.
6. **Hastings Riverflats Park.** Applied basal bark treatment to buckthorn on 27 acres of floodplain forest.
7. **Gores Pool Wildlife Management Area and Aquatic Management Area.** Exotic brush was removed and sprouts treated on 67 acres of woodland. Native grass seed was broadcasted over this woodland. Prairie restoration activities took place on a 4-acre old field. A 4-acre reed canary grassland was treated as part of a re-forestation effort.

8. **Ravenna Block Greenway-Dakota County.** Buckthorn was removed from 12 acres of woodland, while a prescribed burn was conducted and native prairie seed was broadcasted on a 24-acre grassland.
9. **Emrick.** 22 acres of a former farm field were seeded to prairie, followed by a mowing. Nine acres of exotic dominated woodland were removed and chipped for biofuels.

Project Results Use and Dissemination

FMR organizes many tours and stewardship events at the sites where we conduct restoration activities. We share information about this project with the participants of these events. FMR also occasionally publishes articles in its paper and electronic newsletters regarding restoration projects that it is involved in. The following are four examples that highlight some of these projects & ENRTF:

- http://www.fmr.org/news/current/fmr_to_restore_bluffland-2009-08
- http://www.fmr.org/news/current/fmr_wins_sustainability_award-2011-04
- http://www.fmr.org/sites/fmr.org/files/fmr_newsletter_2010-03. Landowner Steps Up To Help The River. Page 3. Restoring a Woodland: One Stem at a Time. Page 5.
- Fall 2010 newsletter (paper copy). Program Updates. Restoration Begins at Minneapolis' Riverside Park. Page 4.

Environment and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report: 8/1/11

	M.L. 2009
Date of Work program Approval:	June 16, 2009
Project Completion Date:	June 30, 2011

I. PROJECT TITLE: Metro Conservation Corridors (MeCC) Phase V – Restore and Enhance Significant Watershed Habitat (2.3)

Project Manager: Tom Lewanski
Affiliation: Friends of the Mississippi River
Mailing Address: 360 North Robert Street, Suite 400
City / State / Zip: St. Paul, MN 55101
Telephone Number: 651 222-2193 Ext. 12
E-mail Address: tlewanski@fmr.org
Fax Number: 651 222-6005
Web Page address: www.fmr.org

Location: Within mapped focus area in the counties of Dakota, Goodhue, Hennepin, Ramsey, Anoka, and Washington.

Total Trust Fund Project Budget:	**M.L. 2009**
Trust Fund Appropriation:	**$90,000**
Minus Amount Spent:	**$89,329.21**
Equal Balance:	**$670.79**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subdivision 4(f)2.3

2009 Appropriation Language:

$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY:

The Twin Cities contains significant habitat areas. There is a concerted effort to protect, improve and link these areas. FMR's goal with this project was to partner with landowners to restore and enhance habitat at a number of these areas. During this phase of the MeCC project, FMR conducted activities at 9 distinct sites resulting in the restoration of a total of 287 acres, including 179 acres using Environment and Natural Resources Trust Fund funds and 108 acres using leveraged funds. A management plan exists for each site, which served as guide for the restoration and enhancement activities. These sites included:

1. **Pine Bend Bluffs Natural Area**: Spot treated weeds on a 17-acre restored prairie and conducted exotic brush control on 28 acres of woodland. Conducted follow up buckthorn control on 3-acres of woodland.
2. **Sand Coulee Prairie**. Conducted prescribed burns, mowing, and spot-spraying on 83-acres. Volunteers assisted in collecting seeds and removing weeds.
3. **Rosemount Wildlife Preserve**. Conducted a prescribed burn on 16 acres of woodland.
4. **Wilmar**. Mowed a 25-acre prairie restoration & treated exotic invasive plans in a 15-acre woodland.
5. **Mississippi River Gorge.** Volunteers installed native tree and shrubs on 2-acre and installed prairie plants to enhance a 4-acre prairie restoration within Crosby Park. Volunteers also hand weeded the site. At the Riverside Park in Minneapolis, volunteers installed native plants within 4-acre of woodland.
6. **Hastings Riverflats Park.** Applied basal bark treatment to buckthorn on 27 acres of floodplain forest.
7. **Gores Pool Wildlife Management Area and Aquatic Management Area.** Exotic brush was removed and sprouts treated on 67 acres of woodland. Native grass seed was broadcasted over this woodland. Prairie restoration activities took place on a 4-acre old field. A 4-acre reed canary grassland was treated as part of a re-forestation effort.
8. **Ravenna Block Greenway-Dakota County.** Buckthorn was removed from 12 acres of woodland, while a prescribed burn was conducted and native prairie seed was broadcasted on a 24-acre grassland.
9. **Emrick.** 22 acres of a former farm field were seeded to prairie, followed by a mowing. Nine acres of exotic dominated woodland were removed and chipped for biofuels.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: N/A

Result 2: Restore & Enhance Significant Habitat:
Description:

FMR will work with both public and private landowners to restore and/or enhance 50 acres of significant habitat using MeCC phase V funding. This funding will enable

FMR to leverage non-state funding to restore an additional 30 acres of significant habitat.

Specific habitat types that may be restored and/or enhanced include prairie, oak savanna, deciduous forest and/or wetland communities. Techniques that will be employed to restore and enhance these areas will be based on the specific requirements of each project site to be chosen, but may include: soil preparation (spraying, burning, disking, dragging), seed drilling or broadcasting, mowing, prescribed burning, spot spraying, installation of native plants, and removal of invasive plant species. Vendors will complete some of the restoration techniques. Vendor contracts will be awarded on a competitive and performance basis. We will consider contracting with the Minnesota Conservation Corps when appropriate.

Guidelines for project selection will include but will not be limited to: ecological importance of site (based on size, habitat quality, buffering of existing high quality habitat, water quality benefits, & connectivity to other natural areas), matching funds, and partner interest and commitment. Priority will be given to projects on public land and on private land that has been permanently protected through a conservation easement. Prior to the initiation of restoration activities on private land, a landowner agreement will be secured.

Selection of native plants and seeds will follow the LCCMR's guidelines as outlined in the brochure: Native Plant Material-Local vegetation ecotype sequencing. Seed mix selection will be based on the DNR's native plant community field guides.

Ecological management plans will be developed prior to initiation of restoration activities. These management plans contain information regarding existing conditions & issues, goals, activities designed to pursue these goals, preliminary costs associated with the activities, and a timeline.

These restoration and/or enhancement activities will be targeted to: See Exhibit 1 for a list of targeted projects and associated activities.

Summary Budget Information for Result 2:

	M.L. 2009
Trust Fund Budget:	**$90,000**
Amount Spent:	**$89,329.21**
Balance:	**$670.79**

Deliverable	**Completion Date**	**Budget**	**Status**
1. **M.L. 2009**- 50 acres restored	6/30/2011	$90,000	Completed

and/or enhanced (*partner acres and other funding not counted here)*			

Final Completion Date: M.L. 2009 = 6/30/2011

Result Status as of 8/1/2011

Funding Source	$ From Work Program	$ Actual	Acres – From Work Program	Acres - Actual
ENRTF	**$90,000**	**$89,329.21**	**50**	**242**
Non-State Match	**$70,000**	**$75,323**	**30**	**126**
Other funding	**-**	**$4,078**	**-**	**-**
Total	**$160,000**	**$168,730.21**	**80**	**368**

During this time period FMR conducted restoration and enhancement activities at numerous sites.

The largest project area was 83-acres at the Sand Coulee prairie. 72 of these acres were enhanced with ENRTF funding and 11 acres enhanced using non-state matching funds. Specific activities included a prescribed burn in both 2010 and 2011 on 20-acre and 27-acre units, respectively. We spot-treated invasive herbaceous weeds on 18 acres. In fall 2010 the DNR seeded an 18-acre cropland to native prairie, which we mowed in June 2011 along with a 4-acre unit that had been seeded the previous year. A grant from the Vermillion JPO funded several volunteer events that accomplished prairie management and enhancement. 36 volunteers collected over 33 lbs of prairie seed, including many species not typically obtained by mechanical seed harvest methods, that was used in the 18-acre restoration. We also had volunteers hand-pulled small patches of invasive weeds that were growing among native plants where herbicide would not be used. A high school class collected seed and installed plants grown from coulee seed as part of a prairie enhancement. Propagation of the plants was donated by a local nursery, The Vagary, located in Hampton MN. MeCC funds covered 39% of the project costs.

ENRTF funds covered 10% of the costs for ecological work at 67 acres of Gores WMA (the former Freitag property). Funds from the National Fish and Wildlife foundation covered the majority of the costs. Tasks accomplished were removal of very dense exotic brush from most of the 67 acres, plus follow-up treatment of resprouts and new growth; prairie restoration activities on a 4-acre old field (herbicide, burn, herbicide, seed, mow, spot-spray weeds); herbicide treatment of a 4-acre reed canary grassland as part of a re-forestation effort; and native seed applied to an oak savanna restoration. The latter was done in order to get adequate fuels to burn the site, which was significantly opened up after buckthorn removal. Fire will help to control buckthorn and stimulate growth of any native prairie seedbank. Total number of acres is 75. 8 acres are assigned to ENRTF funding, while 67 acres are assigned to non-state funding.

Ravenna Block: MeCC funds covered most of the costs for restoration of an oak woodland at the Almquist property in Ravenna Township – buckthorn was removed from 12 acres. The landowner contributed by cutting and burning numerous boxelder from a grassland that will later be restored to prairie. MeCC also covered most of the costs for a small project to manage a 24-acre grassland at the adjacent Curtis property. The grassland was burned and native seed was broadcast as a method for reducing brome grass and increasing native species. The landowner contributed by broadcasting the native seed. 35 acres were assigned to ENRTF and 1 acre to non-state matching funds.

At Pine Bend Bluffs SNA the following management was conducted on 45 acres using ENRTF funding: spot treatment of weeds on a 17-acre prairie restoration, and exotic brush removal (cut, basal treat and burn slash) on 28 acres. MeCC funded most of that work. FMR funded two volunteer events focused on hand-pulling invasive weeds from a high-quality prairie remnant and oak forest. At the Katharine Ordway Natural History Study Area, within the Pine Bend Bluffs area, we conducted follow up buckthorn control using foliar herbicide spray on 3-acres of woodland.

On-going management of the Wilmar property along the Vermillion River continued with mowing a 25-acre prairie restoration, spot-treating invasive weeds, re-treating exotic brush resprouts as well as girdling/treating exotic invasive trees from the 15-acre adjacent woods. MeCC funded 67% of this work with 33% funded by the Dakota County Farmland and Natural Areas Program (non-state) for prairie mowing. 27 acres were assigned to ENRTF and 13 acres were assigned to non-state matching funds.

At the Emrick property, prairie seed was installed in two former cropland areas, totaling 22 acres. They were frost-seeded in early March 2011, followed by one mowing in June. A few native species were already visible in the first year. A 3-acre woodland dominated by non-native invasive trees was removed in fall 2010 and chipped for biofuels, along with 6 additional acres of brush. The woodchip was brought to District Energy. Non-state funding from the Dakota County Farmland and Natural Areas Program covered 24% of the total project costs and the landowners contributed 10%. 22 acres were assigned to ENRTF funding and 11 acres were assigned to non-state matching funds.

Several projects were completed at the Mississippi River Gorge. At Riverside Park in Mpls. a planting was completed at a 1-acre woodland. At Hidden Falls Park trees and shrubs were installed to prevent erosion in a 1-acre woodland and prairie plants were installed to enhance a 4-acre prairie restoration. Volunteers also hand-pulled invasive weeds at three events at 4-acres Crosby and two events at Riverside. 5-acres were assigned to ENRTF and 5-acres were assigned to non-state matching funds.

At the Hastings River Flats Park, we employed basal bark herbicide treatment to buckthorn on 27-acres of floodplain forest. The City of Hastings, using their own financial resources, assisted at this site by cutting and chipping Siberian Elm. 25 acres were assigned to ENRTF funding and 2 acres to non-state funding.

At the Rosemount Wildlife Preserve, a prescribed burn was completed within a 16-acre woodland to address buckthorn resprouts. Prairie Restorations Inc, who has done much of the site work, donated the burn. All 16 acres were assigned to non-state funding.

Note: FMR is seeking a budget revision. We are asking permission to move $2,843.36 from the Professional/Technical line to the Other Direct Operating Costs line. We have also moved $98.83 from the Ecologist line to the Business Manager line.

Final Report Summary (June 30, 2011):

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $12,420.00
Contracts: ~~$77,000.00~~ ~~$73,740~~ $70,897
Equipment/Tools/Supplies:
Acquisition, including easements:
Travel: $580.00
Other: ~~$0~~ ~~$3,260~~ $6,103

TOTAL 2009 TRUST FUND PROJECT BUDGET: $90,000

VI. OTHER FUNDS & PARTNERS/ PROJECT STRATEGY:
A. Project Partners:

Metro Conservation Corridor partners, Vermillion River Joint Powers Organization (funding partner), The Vagary, Hastings High School, Dakota County, Minneapolis Parks Board, City of St. Paul, City of Hastings, City of Rosemount, community volunteers and private landowners.

B. Other Funds Proposed To Be Spent During The Project Period:

Non-state: $75,323.

- Private landowners: $3,536 (partial in-kind).
- FMR Stewards Program (Vermillion River Joint Powers Organization): $11,000.
- The Vagary: $1,000 (in-kind).
- Dakota County Farmland and Natural Area Program: $10,753.
- National Fish and Wildlife Foundation: $34,634.
- Pheasants Forever (through DNR): $5,355.
- City of Hastings: $500 (in-kind).
- Prairie Restorations Inc.: $3,545 (in-kind).

- Corporate Grants: $5,000

Other state:
- DNR: $4,078 (in-kind).

Total Other Funds: $79,401.

C. Spending History:

M.L. 2009: Metro Wildlife Corridors I, II, III, IV - $327,000

D. Time:
M.L. 2009: 2 years. June 16, 2009 – June 30, 2011

E. Project Impact and Long-term Strategy:

FMR will conduct restoration activities on 50 acres (utilizing M.L. 2009 Metro Wildlife Corridors funding) of significant habitat. FMR is a placed based conservation organization that focuses its conservation work in the south metro area. Our goal is assist both MeCC and other partners in protecting, restoring, and enhancing important wildlife areas in the Twin Cities Metro Area. We practice retail conservation. That is, we reach out to individual private and public landowners in the designated corridors and engage them in the broader goal of developing a system of interconnected habitat corridors in the Metro area and throughout the state. Because FMR is focused in theTwin Cities we can build strong, long-standing relationships with conservation partners and landowners. Our goal is to stay engaged in all of our projects over the long-term to ensure continuity and that the habitat values are maintained and improved over time.

VII. DISSEMINATION:
FMR organizes many tours and stewardship events at the sites where we conduct restoration activities. We share information about this project with the participants of these events. FMR also occasionally publishes articles in its paper and electronic newsletters regarding restoration projects that it is involved in. The following are four examples that highlight some of these projects & ENRTF:
- http://www.fmr.org/news/current/fmr_to_restore_bluffland-2009-08
- http://www.fmr.org/news/current/fmr_wins_sustainability_award-2011-04
- http://www.fmr.org/sites/fmr.org/files/fmr_newsletter_2010-03. Landowner Steps Up To Help The River. Page 3. Restoring a Woodland: One Stem at a Time. Page 5.
- Fall 2010 newsletter (paper copy). Program Updates. Restoration Begins at Minneapolis' Riverside Park. Page 4.

VIII. REPORTING REQUIREMENTS: Work program progress reports were submitted on February 1, 2010, August 1, 2010, February 1, 2011 with a final report submitted on August 1st, 2011.

Attachment A: Final Budget Detail for 2009 Project

Project Title: *Metro Conservation Corridors (MeCC) Phase V – Restore and Enhance Significant Watershed Habitat (2.3)*

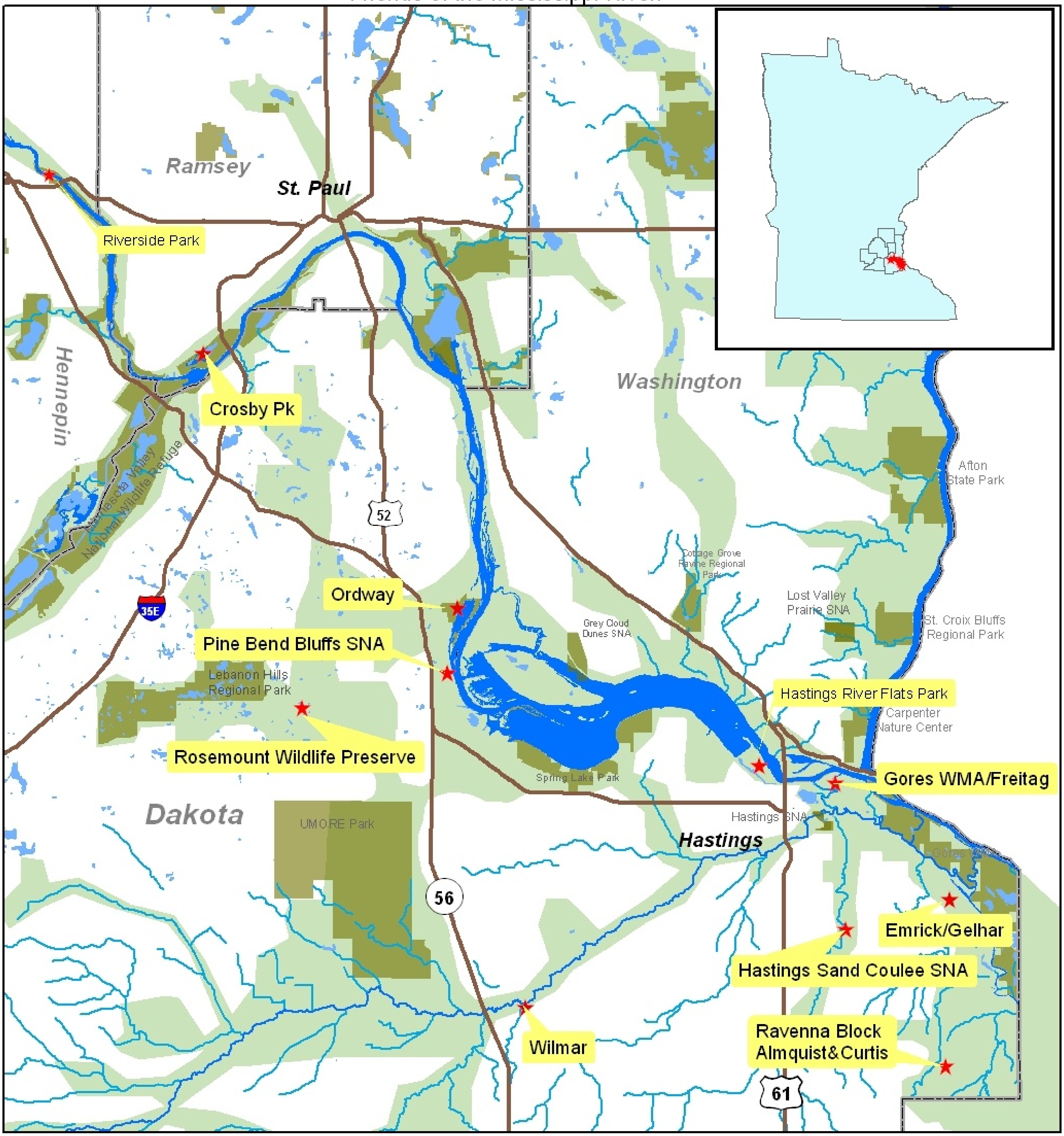
Project Manager Name: *Tom Lewanski*

Trust Fund Appropriation: $ *90,000*

2009 Trust Fund Budget	**Result 2 Budget:**	**Revised Result 2 Budget 2/1/11:**	**Revised Result 2 Budget 8/1/11:**	**Amount Spent** *(8/1/10)*	**Amount Spent** *(12/31/10)*	**Amount Spent** *(1/1/11 - 6/30/11)*	**Balance** *(7/1/11)*
BUDGET ITEM	Restore & Enhance Significant Habitat:		budget revision was requested in final work program report				
PERSONNEL: wages and benefits *(List individual names, amount budgeted and %FTE; add rows*							
Conservation Director (2% FTE)	$2,850.00	$2,850.00	$2,850.00	$0.00	$1,295.81	$1,387.88	$166.31
Ecologist (2) (6% FTE)	$8,481.00	~~$8,481.00~~	$8,382.17	$0.00	$2,834.83	$5,164.28	$383.06
Business Manager (.5%	$1,089.00	~~$1,089.00~~	$1,187.83	$0.00	$680.97	$506.86	$0.00
Total Personnel	$12,420.00	$12,420.00	$12,420.00	$0.00	$4,811.61	$7,059.02	$549.37
Contracts							
Professional/technical. *Vendors to provide restoration activities such as burns, soil prep., seeding, woody and exotic plant removal, etc. (Vendor contracts will be awarded on a competitive and performance basis.)*	~~$77,000~~	~~$73,740~~	70,897	$3,662	$33,342	$33,807	$86.03
Travel expenses in Minnesota	$580	$580	$580	$0	$253	$310	$17.77
Other direct operating costs *(plant material and supplies)*	~~$0~~	~~$3,260~~	$6,103		$1,018	$5,067	$17.62
COLUMN TOTAL	**$90,000**	**$90,000**	**$90,000**	**$3,662**	**$39,424**	**$46,243**	**$671**

2009-2011 LCCMR Projects
PROJECT TITLE: MeCC5
Restore and Enhance Significant Watershed Habitat

Friends of the Mississippi River.



Parkland, WMA's

Metro Conservation Corridors

1:215,000

0 1 2 4 6 Miles

N

Almquist: Very dense buckthorn understory before removal 11/17/10

Almquist: Very dense buckthorn understory before removal 3/21/11.

Almquist: Cut, treat, burn buckthorn 3/21/11.

Almquist: Understory much more open after exotic brush removal. 6-13-11.

Gores WMA-Freitag: Prairie resto site preparation – after herbicide. 9/29/10

Gores WMA-Freitag: Prairie resto after burn, ready to seed. 10-11-10


Emrick: East side of wooded 3-ac slope during tree removal. 10-18-10.


Emrick: West side of wooded 3 ac during tree and exotics removal. 10-8-10


Emrick: West slope after exotic tree removal. 4-30-11.


EEmrick: After tree removal. 4-30-11. Trees were used for biofuels.


Emrick: Frost seeding 22 ac to prairie 3/25/11.


Curtis: Rx burn of grassland 4-18-11

 Pine Bend SNA: Cut, treat, burn exotic brush from 4 ac, expanding on previous removal area. 3-21-11.	 Pine Bend SNA: Volunteers pull garlic mustard in good quality oak forest. 5/12/11.
 Wilmar: Additional exotic brush removal work in the woodland. 11-15-10.	 Wilmar: First growing season of 25 ac reconstructed prairie. Natives are doing well after 2 mowings. 8/4/10.
 Crosby Park: Volunteers remove weeds from pairie installation and plant prairies species. 6/11/11.	 Hidden Falls: Volunteers plant shrubs to stabilize ravine slopes and enhance native shrub diversity. 6/18/11.

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Metro Conservation Corridors-Phase V-Friends of the Minnesota Valley (2.4)
PROJECT MANAGER: Lori Nelson
AFFILIATION: Friends of the Minnesota Valley
MAILING ADDRESS: 10800 Lyndale Avenue South, Suite #120
CITY/STATE/ZIP: Bloomington, MN 55420
PHONE: 952-881-9065
E-MAIL: lnelson@friendsofmnvalley.org
WEBSITE: www.friendsofmnvalley.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4(f)

APPROPRIATION AMOUNT: $90,000

Overall Project Outcome and Results

Friends of the Minnesota Valley (FMV) undertook restoration of habitat for the Lower Minnesota River Watershed portion of the Metropolitan Conservation Corridors Project (MeCC) as a continuation of our wildlife habitat restoration within the Minnesota Valley National Wildlife Refuge and Wetland Management District (Refuge) and within the Lower Minnesota River Watershed. FMV sought to restore native habitats within the Refuge and to work in concert with the U.S. Fish & Wildlife Service and other partners on critical, publicly-owned habitat on Refuge lands. During this phase of the MeCC project, FMV and our partners were able to successfully restore and enhance 17 acres of native wet prairie, 48 acres of native dry sand-gravel oak savanna, and 28 acres of native dray sand-gravel prairie with Environment and Natural Resources Trust Fund funds for a total acreage of 93 acres. We were also able to restore additional match acreage of 59 acres of native dry sand-gravel oak savanna with non-LCCMR, non-state funds, bringing total acres impacted by this project to 152 acres.

The FMV objectives were to complement and connect habitat restoration and management of Refuge lands with that being done by other entities. Restoration sites were selected to address primary management issues and challenges, including the need to restore hydrology within floodplain communities and to restore upland communities such as native oak savanna and wet and dry prairies. Public access to restored lands for recreation and education and the assurance of permanent protection were also primary factors. Due to persistent flooding, our access to wetland sites was severely limited and, as a result, we shifted our focus to upland restoration, as reflected in our amended work program.

All work was completed on four Refuge Units. Work included cutting and herbicide treatment of non-native woody brush species such as buckthorn, honeysuckle, prickly ash, eastern red cedar, and Siberian elm. Minnesotans will be able to access and appreciate the restored sites through the access and education provided to Minnesota Valley National Wildlife Refuge visitors. Our project data is publicly accessible by contacting FMV, through information disseminated through our newsletter and on our website, and through information provided by the MeCC Partnership.

Project Results Use and Dissemination

As projects were completed, Friends of the Minnesota Valley publicized project accomplishments through the Friends' quarterly newsletter, our annual report, publication of a habitat restoration prospectus, and the posting of projects on our website. Other dissemination of information occurred through the Metro Conservation Corridors partnership and on the Metro Corridors website.

Environment and Natural Resources Trust Fund 2009 Work Program Final Report and Trust Fund 2010 Work Program

Date of Report: August 22, 2011

	M.L. 2009	**M.L. 2010**
Date of Next Status Report:	FINAL	February 1, 2012
Date of Work Program Approval:	June 16, 2009	June 9, 2010
Project Completion Date:	June 30, 2011	June 30, 2012

I. PROJECT TITLE: Metro Conservation Corridors – Phase V – Friends of the MN Valley – 2.4, Lower Minnesota River Watershed Restoration & Enhancement Project [M.L. 2009]

Project Manager: Lori Nelson
Affiliation: Friends of the Minnesota Valley
Mailing Address: 10800 Lyndale Avenue South, Suite 120
City / State / Zip: Bloomington, MN 55420
Telephone Number: 952-881-9065
E-mail Address: lnelson@friendsofmnvalley.org
FAX Number: 952-881-3174
Web Site Address: www.friendsofmnvalley.org

Location: Lower Minnesota River Watershed of Carver, Hennepin, Le Sueur, Sibley, and Scott Counties

Total Trust Fund Project Budget:	**M.L. 2009**	**M.L. 2010**	**Total**
Trust Fund Appropriation:	**$90,000**	**$50,000**	**$140,000**
Minus Amount Spent:	**$89,988.88**	**$ 0**	**$ 89,988.88**
Equal Balance:	**$11.12**	**$50,000**	**$50,001.12**

Legal Citation:
M.L. 2009, Chp. 143, Sec. 2, Subd. 4(f)
Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be

perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

M.L. 2010, Chp. 362 , Sec. 2, Subd. 4(g)
Appropriation Language:
$1,750,000 is added to Laws 2009, chapter 143, section 2, subdivision 4, paragraph (f), from the trust fund to the commissioner of natural resources for acceleration of agency programs and cooperative agreements. Of this appropriation, $1,750,000 is for agreements as follows: $890,000 with the Trust for Public Land; $485,000 with Minnesota Land Trust; $325,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $50,000 with Friends of the Minnesota Valley for planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement.

II. PROJECT SUMMARY AND RESULTS

<u>M.L. 2009 FINAL PROJECT SUMMARY</u>
Friends of the Minnesota Valley (FMV) undertook restoration of habitat for the Lower Minnesota River Watershed portion of the Metropolitan Conservation Corridors Project (MeCC) as a continuation of our wildlife habitat restoration within the Minnesota Valley National Wildlife Refuge and Wetland Management District (Refuge) and within the Lower Minnesota River Watershed. FMV sought to restore native habitats within the Refuge and to work in concert with the U.S. Fish & Wildlife Service and other partners on critical, publicly-owned habitat on Refuge lands. During this phase of the MeCC project, FMV and our partners were able to successfully restore and enhance 17 acres of native wet prairie, 48 acres of native dry sand-gravel oak savanna, and 28 acres of native dray sand-gravel prairie with Environment and Natural Resources Trust Fund funds for a total acreage of 93 acres. We were also able to restore additional match acreage of 59 acres of native dry sand-gravel oak savanna with non-LCCMR, non-state funds, bringing total acres impacted by this project to 152 acres.

The FMV objectives were to complement and connect habitat restoration and management of Refuge lands with that being done by other entities. Restoration sites were selected to address primary management issues and challenges, including the need to restore hydrology within floodplain communities and to restore upland communities such as native oak savanna and wet and dry prairies. Public access to restored lands for recreation and education and the assurance of permanent protection were also primary factors. Due to persistent flooding, our access to wetland sites was severely limited and, as a result, we shifted our focus to upland restoration, as reflected in our amended work program.

All work was completed on four Refuge Units. Work included cutting and herbicide treatment of non-native woody brush species such as buckthorn, honeysuckle, prickly ash, eastern red cedar, and Siberian elm. Minnesotans will be able to access and appreciate the restored sites through the access and education provided to Minnesota Valley National Wildlife Refuge visitors. Our project data is publicly accessible by contacting FMV, through information disseminated through our newsletter and on our website, and through information provided by the MeCC Partnership.

<u>M.L. 2010</u>:
Restore and/or enhance 50 acres of significant biological communities throughout the MeCC mapped corridors, including wetlands, prairie, and oak savanna, focusing on the Minnesota River Corridor within the Lower Minnesota River Watershed. An additional 25 acres will be restored and/or enhanced using other, non-state funds.

III. PROGRESS SUMMARY AS OF:

August 22, 2011:

<u>M.L. 2009</u>
Completed (See “M.L. 2009 Final Project Summary” in Section II above)

<u>M.L. 2010</u>:
N/A - work has not yet begun on M.L. 2010.

IV. OUTLINE OF PROJECT RESULTS*:*

Result/Activity 1: Restore and/or enhance significant habitat

Description:
<u>M.L. 2009</u>:
Restore and enhance 90 acres of significant biological communities and wildlife habitat throughout the MeCC mapped corridors of the Lower Minnesota River Watershed within Carver, Hennepin, LeSueur, Sibley, and/or Scott Counties. An additional 45 acres will be restored/enhanced using other, non-state funds.

Restoration efforts will focus on public lands including the Minnesota Valley National Wildlife Refuge, land purchased by the Minnesota Valley Trust, Inc., and on private lands. Priority will be given to permanently protected lands. Restorations on private lands will be protected through a minimum 10 year landowner agreement through the U.S. Fish and Wildlife’s Partners For Fish and Wildlife Program. Projects will be selected based on but not limited to: ecological importance of area, based on size, habitat quality, buffering of existing high quality habitat, water quality benefits, connectivity to other natural areas, matching funds, and partner interest and commitment.

Friends of the MN Valley and its partners will restore and enhance the hydrology of wetlands such as shallow lakes, for the benefit of wildlife and water quality, plant retired agriculutral fields to prairie using native ecotype seed, remove and manage exotic species, and restore important floodplain forest communities along the Minnesota River. Following LCCMR local ecotype guidelines, only native plant species will be used with specific native seed mixes being adjusted for local site conditions and availability. All contracts will be awarded based upon a competitive, experience, and performance basis.

Ecological restoration and management plans will be developed prior to restoration work. With the underlying goal to restore a self sustaining ecosystem, the restoration plans meet or exceed the project requirements as laid out by the LCCMR (M.L. 2009, Chap. 143, Sec. 2, Subd. 11. Project Requirements) and utilize natural processes to the extent possible to help establish and maintain the best restoration. Elements of the restoration and management plans will include a description of current conditions including biotic and abiotic elements; descriptions of target communities; descriptions of proposed restoration methodology; evaluation processes utilized for determining the effectiveness of restoration; and proposed ongoing management activities and responsibilities. Restoration and management plans will be developed by the U.S. Fish & Wildlife Service in consultation with Friends of the Minnesota Valley.

<u>M.L. 2010</u>:
Restore and enhance 50 acres of significant biological communities and wildlife habitat throughout the MeCC mapped corridors of the Lower Minnesota River Watershed within Carver, LeSueur, Sibley, and/or Scott Counties. An additional 25 acres will be restored/enhanced using other, non-state funds.

Restoration efforts will focus on public lands including the Minnesota Valley National Wildlife Refuge and on lands that will become new refuge units purchased by the Minnesota Valley Trust, Inc. Projects will be selected based on but not limited to: ecological importance of area, based on size, habitat quality, buffering of existing high quality habitat, water quality benefits, connectivity to other natural areas, matching funds, and partner interest and commitment.

Friends of the MN Valley and its partners will restore and enhance the hydrology of wetlands such as shallow lakes, for the benefit of wildlife and water quality, plant retired agriculutral fields to prairie using native ecotype seed, remove and manage exotic species, and restore important floodplain forest communities along the Minnesota River. Following local ecotype guidelines, only native plant species will be used with specific native seed mixes being adjusted for local site conditions and availability. Restoration and management plans will be developed prior to restoration work. Contracts will be awarded based upon a competitive, experience, and performance basis.

All restoration and enhancement work will be permanently protected and managed by the U.S. Fish and Wildlife Service as part of the Minnesota Valley National Wildlife Refuge.

Ecological restoration and management plans will be developed prior to restoration work. With the underlying goal to restore a self sustaining ecosystem, the restoration plans meet or exceed the project requirements as laid out by the LCCMR (M.L. 2009, Chap. 143, Sec. 2, Subd. 11. Project Requirements) and utilize natural processes to the extent possible to help establish and maintain the best restoration. Elements of the restoration and management plans will include a description of current conditions including biotic and abiotic elements; descriptions of target communities; descriptions of proposed restoration methodology; evaluation processes utilized for determining the effectiveness of restoration; and proposed ongoing management activities and responsibilities. Restoration and management plans will be developed by the U.S. Fish & Wildlife Service in consultation with Friends of the Minnesota Valley.

See attached project list.

Summary Budget Information for Result/Activity 1:

	Total	M.L. 2009	M.L. 2010
Trust Fund Budget:	**$ 140,000**	**$90,000**	**$50,000**
Amount Spent:	**$ 13,032**	**$89,989**	**$0**
Balance:	**$126,968**	**$11**	**$50,000**

Deliverable/Outcome	Completion Date	Budget
1. **M.L. 2009** Restore and/or enhance 90 acres	June 15, 2011	$ 90,000
2. **M.L. 2010** Restore and/or enhance 50 acres	June 30, 2012	$50,000

Result Completion Date: M.L. 2009: June 15th, 2011; M.L. 2010: June 30, 2012

M.L. 2009 Final Report Summary (August 2011):
Within the focus area, Friends of the Minnesota Valley has restored and enhanced 93 acres of significant biological communities and wildlife habitat throughout the MeCC mapped corridors of the Lower Minnesota River Watershed within Carver, Hennepin, Le Sueur, Sibley, and/or Scott Counties. An additional 59 acres was restored/enhanced using other, non-state funds.

Restoration efforts focused on public lands including the Minnesota Valley National Wildlife Refuge. Priority was given to permanently protected lands. Projects were selected based on but not limited to: ecological importance of area, based on size, habitat quality, buffering of existing high quality habitat, water quality benefits, connectivity to other natural areas, matching funds, and partner interest and commitment.

Friends of the Minnesota Valley and its partners removed and managed exotic species, and restored important upland communities along the Minnesota River. Following LCCMR local ecotype guidelines, only native plant species were used with specific native seed mixes being adjusted for local site conditions and availability. All contracts were awarded based upon a competitive, experience, and performance basis.

Ecological restoration and management plans were developed prior to restoration work. With the underlying goal to restore a self sustaining ecosystem, the restoration plans met or exceed the project requirements as laid out by the LCCMR (M.L. 2009, Chap. 143, Sec. 2, Subd. 11. Project Requirements) and utilized natural processes to the extent possible to help establish and maintain the best restoration. Elements of the restoration and management plans include a description of current conditions including biotic and abiotic elements; descriptions of target communities; descriptions of proposed restoration methodology; evaluation processes utilized for determining the effectiveness of restoration; and proposed ongoing management activities and responsibilities. Restoration and management plans were developed by the U.S. Fish & Wildlife Service in consultation with Friends of the Minnesota Valley.

St. Lawrence Unit
Friends of the Minnesota Valley, along with the U.S. Fish & Wildlife Service, successfully treated 17 acres of invasive woody brush species such as buckthorn, honeysuckle, and prickly ash at the St. Lawrence Unit of the Minnesota Valley National Wildlife Refuge in order to restore native wet prairie habitat. Treatment consisted of cutting and herbicide treatment of non-native species, based on community descriptions by the Minnesota Department of Natural Resources' County Biological Survey. All project costs were paid by Friends of the Minnesota Valley with Phase V funding for a total project area of 17 acres. Match dollars from partners includes USFWS ($2,245) and FMV ($1,250).

Some work initially planned for the fall of 2010 was delayed at the St. Lawrence and Upgrala project sites due to heavy snow that occurred before the ground was frozen. Deep snow insulated the ground and prevented freezing, High valued plant communities targeted for additional woody invasive species removal were susceptible to damage with unfrozen ground.

Upgrala Unit
Friends of the Minnesota Valley, along with the U.S. Fish & Wildlife Service, successfully restored 7 acres of native dry sand-gravel prairie at the Minnesota Valley National Wildlife Refuge's Upgrala Unit. Treatment consisted of cutting and herbicide treatment of non-native species such as buckthorn, honeysuckle, prickly ash, eastern red cedar, and Siberian elm. All project costs were paid by Friends of the Minnesota Valley with Phase V funding for a total project area of 7 acres. Partner match dollars include USFWS ($2,245) and FMV ($1,250).

Bald eagle nesting season limited access to some areas of the unit, resulting in fewer acres being treated than originally anticipated in the work program.

Rapids Lake Unit
Friends of the Minnesota Valley, along with the U.S. Fish & Wildlife Service, successfully restored 21 acres of native dry sand-gravel prairie and 34 acres of native dry sand-gravel oak savanna at the Minnesota Valley National Wildlife Refuge's Rapids Lake Unit. Treatment consisted of cutting and herbicide treatment of non-native species such as buckthorn, honeysuckle, prickly ash, eastern red cedar, and Siberian elm. All project costs were paid by Friends of the Minnesota Valley with Phase V funding for a total project area of 55 acres. Partner match dollars include USFWS ($2,245) and FMV ($1,250).

Louisville Swamp Unit
Friends of the Minnesota Valley and the U.S. Fish & Wildlife Service restored and enhanced 59 acres of native dry sand-gravel oak savanna at the Minnesota Valley National Wildlife Refuge's Louisville Swamp Unit. The restoration was accomplished by treating invasive woody brush species, based on community descriptions by the Minnesota Department of Natural Resources' County Biological Survey data. Restoration activities include cutting and herbicide treatment of buckthorn, honeysuckle, prickly ash, eastern red cedar, and Siberian elm. No Phase V project funds were used but Friends of the Minnesota Valley in-kind services were provided. Federal funds from the American Recovery and Reinvestment Act were used for restoration project costs, resulting in a total match acreage project area of 59 acres. Partner match dollars include USFWS ($2,245 in-kind; $69,210 in ARRA dollars) and FMV ($1,250).

M.L. 2010:

Result Status as of: August 22, 2011
N/A - work has not yet begun on M.L. 2010.

Result Status as of: February 1, 2012:

M.L. 2010 Final Report Summary:

V. TOTAL TRUST FUND PROJECT BUDGET: 90,000
M.L. 2009:
Personnel: $15,000 - FMV Watershed Initiative Coordinator (.48 FTE). Total expended during grant period: $14,998.88.
Contracts: $ 50,000 (for earthwork contractors to install water control structures, build earthen dams, break drainage tile lines, field prep, seed installation, invasive species removal, etc.) Total expended during grant period: $50,000
Equipment/Tools/Supplies: $ 25,000 (for native seed and trees, water control structures, herbicide, chainsaws, gloves, etc.) Total expended during grant period: $24,990.
Acquisition, including easements: $ NA
Travel: $ 0
Other: $ 0

TOTAL 2009 TRUST FUND PROJECT BUDGET: $ 90,000
Total expended during grant period: $89.988.88.

Explanation of Capital Expenditures Greater Than $3,500: NA

M.L. 2010:
Personnel: $ 5,000 - Watershed Initiative Coordinator (.16 FTE)
Contracts: $ 35,000 (for earthwork contractors to install water control structures, build earthen dams, break drainage tile lines, field prep, seed installation, invasive species removal, etc.)
Equipment/Tools/Supplies: $ 10,000 for supplies only (includes native seed and trees, water control structures, herbicide). Herbicide cost is estimated at approximately $500, water control structures at around $2,500 and native seed and trees at around $7,000.
Acquisition (Fee Title or Permanent Easements): $ 0
Travel: $ 0
Additional Budget Items: $ 0

TOTAL 2010 ENRTF PROJECT BUDGET: $50,000

Explanation of Capital Expenditures Greater Than $3,500: NA

VI. PROJECT STRATEGY:

A. Project Partners: U.S. Fish & Wildlife Service, MN Valley National Wildlife Refuge Trust, Inc., local units of government, private landowners, and other partners.

B. Project Impact and Long-term Strategy: Restoration efforts will increase breeding/migratory habitat for resident/migrant waterfowl including wood ducks and lesser scaup, resident/migrant shorebirds, as well as a myriad of other species including resident game species such as pheasant and deer. Restoration efforts will improve and protect the water quality of the Minnesota River and its tributaries through wetland restoration and restoring retired cropland and publicly-owned permanently-protected lands to native habitat such as prairie, oak savanna, and floodplain forest. Friends of the Minnesota Valley will continue to restore and enhance significant biological communities throughout the MeCC mapped corridors within the Lower Minnesota River Watershed.

C. Other Funds Proposed to be spent during the Project Period:

Original anticipated match was $45,000. Match actually acquired and spent during the grant period totaled $83,190.

D. Spending History: ETF - 2001: $ 0; 2003: $ 18,000 (BRP); 2005: $ 40,000 (MeCC)
2007: $34,000; 2008: $107,000;
Other Funds - : $ 0; 2003: $ 0; 2005: $ 5,000 (MeCC); 2007: $5,000
2009: $54,000

VII. DISSEMINATION:

M.L. 2009

As projects were completed, Friends of the Minnesota Valley publicized project accomplishments through the Friends' quarterly newsletter, our annual report, publication of a habitat restoration prospectus, and the posting of projects on our website. Other dissemination of information occurred through the Metro Conservation Corridors partnership and on the Metro Corridors website.

M.L. 2010

Status as of August 22, 2011: N/A - work has not yet begun on M.L. 2010.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than February 2010, August 2010, February 2011, August 2011, February 2012. A final work program report and associated products will be submitted between June 30 and August 1, 2011 for M.L. 2009 and between June 30 and August 1, 2012 for M.L. 2010 as requested by the LCCMR.

IX. RESEARCH PROJECTS: NA.

Attachment A: Final Budget Detail for 2009 Projects

Project Title: Metro Conservation Corridors – Phase V – Friends of the MN Valley – 2.4, Lower Minnesota River Watershed Restoration & Enhancement Project

Project Manager Name: *Scott Sparlin, Watershed Initiative Coordinator*

Trust Fund Appropriation: $ 90,000

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(date)*	**Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
	Restore and/or Enhance 90 acres				
BUDGET ITEM					
PERSONNEL: wages and benefits *(Scott Sparlin, .48 FTE)*	15,000	14,998.88	1.12	15,000	1.12
Contracts					
Professional/technical *(engineering firms to design wetland restorations, earthwork contractors to install water control structures, break drainage tile lines, and build earthen damns, contractors to install native seed, prep fields, remove and treat invasive species etc.)*	50,000	50,000	0	50,000	0
Non-capital Equipment / Tools *(local ecotype native seed, chainsaws, gloves, water control structures, culverts, erosion matting, survey lath, etc.)*	25,000	24,990	10	25,000	10
COLUMN TOTAL	**$90,000**	**$89,988.88**	**$11.12**	**$90,000**	**$11.12**

LCCMR - MeCC Ph. 5: FMV
Mn Valley NWR - Louisville Swamp Unit Oak Savanna Resto.
Woody/Invasive Species: Mechanical, Chemical, Rx Fire
44d 44m 14s N, 93d 36m 03s W

GS 8/17/11

LCCMR - MeCC Ph. 5: FMV

Mn Valley NWR - Rapids Lk. Unit Native Prairie & Savanna Resto.

Woody/Invasive Species: Mechanical

44d 44m 18s N, 93d 38m 39s W

LCCMR - MeCC Ph. 5: FMV

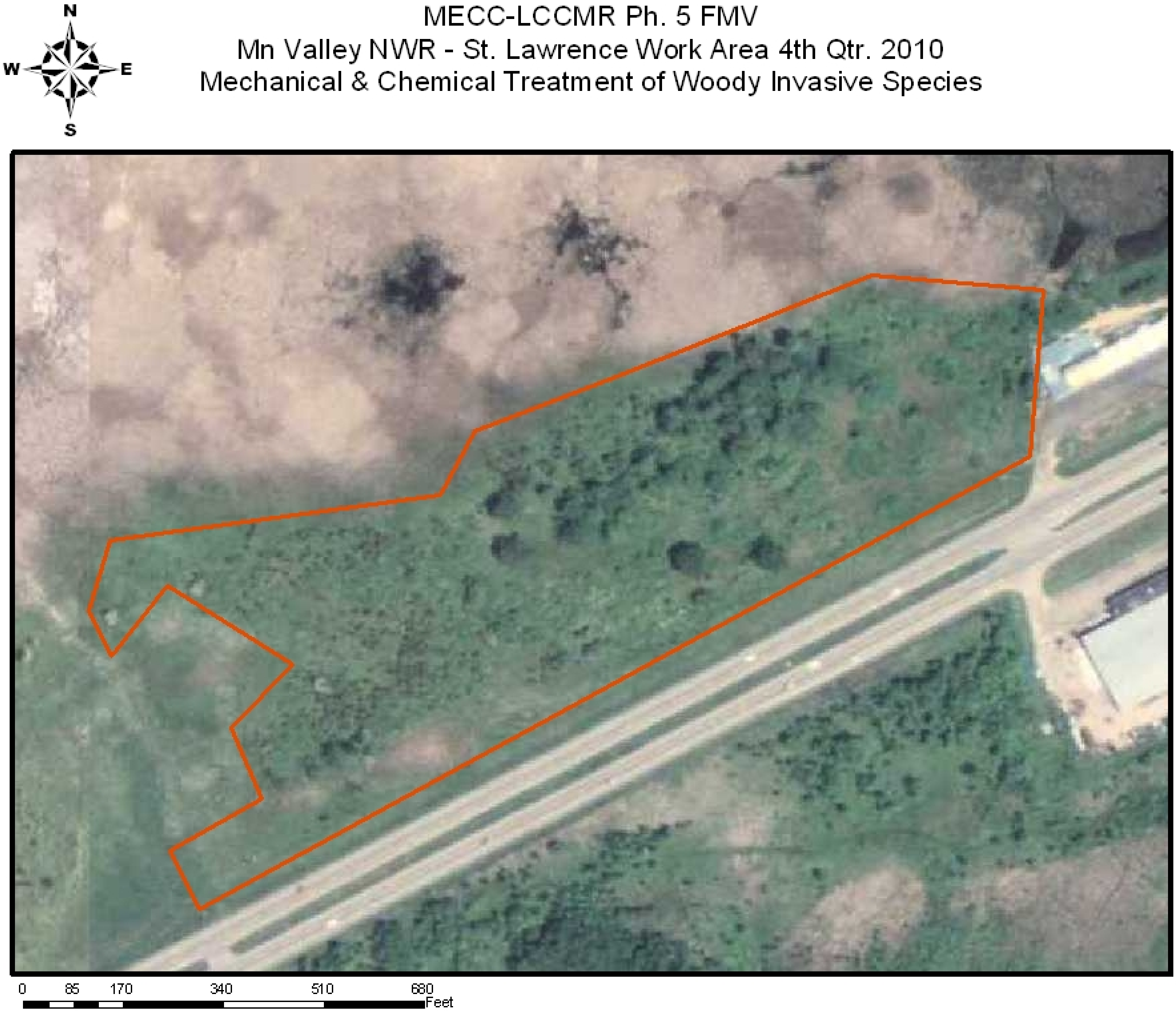
Mn Valley NWR - Upgrala Unit Native Prairie Resto.

Woody/Invasive Species: Mechanical

44d 49m 06s N, 93d 28m 03s W

GS 8/17/11

MECC-LCCMR Ph. 5 FMV
Mn Valley NWR - St. Lawrence Work Area 4th Qtr. 2010
Mechanical & Chemical Treatment of Woody Invasive Species



CREATING A CONSERVATION LEGACY:

WILDLIFE HABITAT RESTORATION IN THE MINNESOTA RIVER VALLEY

2011-2012
HABITAT RESTORATION PROJECTS:
A PROSPECTUS

Friends of the Minnesota Valley

FRIENDS of the MINNESOTA VALLEY
The River. The Land. The Future.

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

INTRODUCTION

Friends of the Minnesota Valley works to conserve the natural resources within the eleven-county Lower Minnesota River Watershed. The Friends is also one of three nongovernmental organizations working to improve the water quality of the Minnesota River. Founded in 1982, the Friends' first objective was to help establish the Minnesota Valley National Wildlife Refuge. The organization has a Valley-wide conservation vision and strives to protect resources beyond refuge boundaries by taking a watershed-based approach.

As part of our programmatic agenda, Friends of the Minnesota Valley restores native wildlife habitat in the Minnesota River Valley. Through our partnership and involvement in the Metropolitan Conservation Corridors Project, funded with proceeds from the Minnesota State Lottery and administered by the Legislative-Citizens Commission on Minnesota Resources, and with additional financial assistance provided by the McKnight Foundation and other private funders, we are actively restoring hundreds of acres of native habitat including native prairie, oak savanna , wetlands, shallow lakes, and other riparian habitat each year.

Our partners include the U.S. Fish & Wildlife Service, the Minnesota Valley National Wildlife Refuge Trust, other private conservation organizations, local soil and water conservation districts, and private landowners. For more information on Friends and the Minnesota Valley and our programs, please visit www.friendsofmnvalley.org.

The refuge's wetlands provide habitat for waterfowl, such as this male wood duck.

HISTORICAL HABITAT

Early explorers' accounts and paintings provide glimpses of what the landscape resembled before widespread European settlement. Many explorers wrote descriptions about the rich flora and fauna and Native Americans inhabiting the Minnesota River Valley in the 1700s and 1800s. They described a landscape covered in tall grass, wetlands, shallow lakes and forested areas with numerous American Indian tribes living along the Minnesota River.

The area in which Friends of the Minnesota Valley is conducting wildlife habitat restoration in 2011-2012 is in commonly known as The Big Woods. At one time, a 2,000 to 3,000-square mile forest extended from the Mankato area north to Monticello. Filled with elm, sugar maple, basswood and oak, this deciduous forest stood in contrast to the surrounding immense prairie-wetland landscape. French explorers in the 17th Century called it bois fort or bois grand, later translated as the "Big Woods" by English-speaking settlers. Today, less than 2 percent of the original "Big Woods" remains after Euro-American settlers began to clear the forest to establish farms, plant crops and build cities (Minnesota State University Water Resources Center, *Minnesota River Trends,* 2009, page 4). In 1850, approximately 62% of The Big Woods was forest. By 1988, 62% of The Big Woods had been converted to farmland (Id.).

The Minnesota River runs through the middle of the once predominantly-forested Big Woods. The Mississippi River forms the northeastern boundary. Lakes and wetlands are common; more than 100 lakes are greater than 160 acres in size, and many are groundwater-controlled with no inlets or outlets. Twin Cities metropolitan area continues to expand into The Big Woods, and both farming and urbanization have led to dramatic changes in habitats. Water quality is also a conservation concern in this agricultural landscape (Minnesota Department of Natural Resources, *Tomorrow's Habitat for the Wild and Rare, Big Woods Subsection Profile,* 2006, page 76). 121 Species in Greatest Conservation Need (SGCN) are known or predicted to occur within the Big Woods, the fourth most of all subsections in Minnesota. These SGCN include 55 species that are federal or state endangered, threatened, or of special concern. Big Woods habitats feature woodland birds such as red-shouldered hawks and warblers, savanna species such as Blanding's turtles and red-headed woodpeckers, and wetland species such as turtles, ospreys, Forster's terns, and black terns. The Minnesota River also provides habitat to many species. Smooth softshell turtles utilize exposed sand bars and south-facing cut-banks as basking and nest sites.
Forested river terraces are occupied by milk snakes and western foxsnakes, while bull snakes and racers live among open sandy terraces (Id.).

The Minnesota River Basin is located in the so-called "duck factory," considered North America's best waterfowl breeding habitat and one of the most important duck breeding areas in the world. This area covers the southern part of Minnesota along with the Dakotas, Iowa and central Canada. Much of the prairie and wetlands originally found in the "duck factory" area have disappeared and what remains faces continued pressure to be broken up and drained for agricultural production. Ducks rely on upland areas around wetlands and shallow lakes for both nesting and as a food source. With the elimination of nearly 95 percent of wetlands in the basin over the last 80 years, there is less habitat and food sources for ducks. Many of the remaining wetlands have degraded water quality and quantity. The immense drainage system put in place across the basin has significantly decreased the duck population capability (*Minnesota River Trends,* page 52).

CURRENT RESTORATION GOALS

Friends of the Minnesota Valley is a restoration partner in the Metro Conservation

Corridors. Started in 2003, the Metro Conservation Corridors (MeCC) is a partnership of conservation organizations whose goal is to protect a series of connected corridors throughout the greater Twin Cities area. These corridors provide area citizens with open space, wildlife habitat, and water quality benefits.

With funding from the Environmental Trust Fund as recommended by the Legislative-Citizens Commission on Minnesota Resources, the project partners permanently protect and restore ecologically important land in predetermined corridors.

During the 2011 and 2012 field seasons, Friends of the Minnesota Valley plans to restore a minimum of 210 acres of significant biological communities and wildlife habitat throughout the MeCC-mapped corridors of the Lower Minnesota River Watershed within Carver, Hennepin, Le Sueur, Sibley, and/or Scott Counties. Our restoration projects focus on lands within the Minnesota Valley National Wildlife Refuge. We will focus our restoration efforts on publicly-accessible lands within the Minnesota Valley National Wildlife Refuge, within the Refuge's boundary expansion area, and on private lands. We will give priority to permanently-protected lands. Restorations on private lands will be protected through a minimum 10-year landowner agreement through the U.S. Fish and Wildlife's Partners For Fish and Wildlife Program. Projects will be selected based on but not limited to criteria such as the ecological importance of the restoration area, based on size, habitat quality, buffering of existing high quality habitat, water quality benefits, connectivity to other natural areas, matching funds, and partner interest and commitment.

Friends of the Minnesota Valley and its partners will restore and enhance the hydrology of wetlands such as shallow lakes, for the benefit of wildlife and water quality, plant retired agricultural fields to prairie using native ecotype seed, remove and manage exotic species, and restore important floodplain forest communities along the Minnesota River. Only native plant species will be used with specific native seed mixes being adjusted for local site conditions and availability. We will develop ecological restoration and management plans prior to beginning our restoration work.

Elements of the restoration and management plans will include a description of current conditions including biotic and abiotic elements; descriptions of target communities; descriptions of proposed restoration methodology; evaluation processes utilized for determining the effectiveness of restoration; and proposed ongoing management activities and responsibilities. Restoration and management plans will be developed by the U.S. Fish & Wildlife Service in consultation with Friends of the Minnesota Valley.

PLANNED RESTORATION PROJECTS

Project #1: Jessenland Unit, Sibley County
Ecotypes: Wetland, Oak Savanna, Floodplain Forest

Description:

Restoration Phase I (Construction) – 400 Total Unit Acres/ 126 Minimum Restored Acres
Friends of the Minnesota Valley will restore approximately 25 acres of Type I, II, and VI wetlands by breaking drain tile, shallow scraping, and constructing earthen dams within drainage ditches. We will seed wetlands with native wetland species. Local ecotype oak savanna grasses and forbs have been planted to restore approximately 101 acres. After the grasses are established, we will plant oak trees to complete the oak savanna restoration. We will remove exotic species such as buckthorn through mechanical and chemical treatment to allow native species to re-establish or expand. In addition, woody species will be removed to create firebreaks for future fire management of the oak savanna.

Restoration Phase II (Management and Maintenance)
After the completion of Phase I, the land will be protected and managed in perpetuity by the U.S. Fish and Wildlife Service (USFWS). The USFWS will manage and monitor the restoration and will ensure the long-term success of the project through multiple mechanisms including prescribed fire, exotic species control, and ecological assessment.

Results and Benefits
This restoration is an important piece in linking floodplain forest habitats in the Jessenland Conservation Area Boundary. When combined with adjacent downstream parcels, the restoration will complete the Jessenland Unit of Valley National Wildlife Refuge and complement the permanently-protected Reinvest in Minnesota (RIM) and Conservation Reserve Enhancement Program (CREP) habitat easements on the Scott County side of the Minnesota River.

Picture depicting oak savanna habitat

Project #2: Henderson Unit, Scott & Sibley Counties
Ecotypes: Wetland, Floodplain Forest

Description:

Restoration Phase I (Construction) – 1250 Total Unit Acres/ 130 Minimum Restored Acres
We will convert 80 acres currently in agricultural production to floodplain forest and shallow riverine wetland habitats. Approximately 50 acres of Type I, II, and III wetlands will be restored by breaking drain tile, shallow scraping, and constructing earthen dams within drainage ditches. We will also seed wetlands with native local ecotype wetland species. Exotic species such as buckthorn will be mechanically and chemically treated to allow native species to re-establish or expand.

Restoration Phase II (Management and Maintenance)
After completion of Phase I, the land will be protected and managed in perpetuity by the U.S. Fish and Wildlife Service (USFWS). The USFWS will manage and monitor the restoration and will ensure the long term success of the project through multiple mechanisms including pre-scribed fire, exotic species control, and ecological assessment.

Results and Benefits
Wetland and riparian habitat in the vicinity of the Henderson Unit that supports 22 species of ducks, geese and other waterbirds will be enhanced by this restoration project. Many other birds are known to frequent the area, including gulls, terns, hawks, ospreys, eagles, herons, egrets, rails, kingfishers, and swallows.

Picture depicting wetland habitat

Project #3: St. Lawrence Unit, Scott County
Ecotypes: Wetland, Prairie

Description

<u>Restoration Phase I (Construction) – 160 Total Unit Acres/ 20 Minimum Restored Acres</u>
The absence of fire has resulted in the encroachment of woody species within the wetland and prairie, specifically cedar trees. Approximately 35 acres of cedars and other woody species such as buckthorn and honeysuckle will be mechanically removed and chemically treated to allow native species to re-establish and expand. In addition, approximately 20 acres of Type I, II, and III wetlands will be restored by breaking drain tile, shallow scraping, and constructing earthen dams within drainage ditches. Wetlands will also be seeded with native local ecotype wetland species.

<u>Restoration Phase II (Management and Maintenance)</u>
The property is located within the Minnesota Valley National Wildlife Refuge and is permanently protected by the U.S. Fish and Wildlife Service (USFWS). After completion of Phase I, the USFWS will manage and monitor the restoration and will ensure the long term success of the project through multiple mechanisms including prescribed fire, exotic species control, and ecological assessment.

<u>Benefits and Results</u>
This restoration will provide high quality habitat for nesting, breeding, and brood-rearing of migratory waterfowl and birds. In addition, the close proximity to other permanently-protected state and federal public lands magnifies the potential benefit to wildlife, water quality, and recreational opportunities.

Picture depicting prairie habitat

Project #4: Upgrala Unit, Hennepin County
Ecotype: Prairie

Description

<u>Restoration Phase I (Construction) – 32 Total Unit Acres/ 15 Minimum Restored Acres</u>
The absence of fire has resulted in the encroachment of woody species within the prairie. The Friends and our partners will remove 4 acres of cedars, elms, and other woody species through mechanical means. Eleven (11) acres of non-native brush, such as buckthorn and honeysuckle, will be mechanically removed and chemically treated to allow native species to re-establish and expand.

<u>Restoration Phase II (Management and Maintenance)</u>
The property is located within the Minnesota Valley National Wildlife Refuge and is permanently protected by the U.S. Fish and Wildlife Service (USFWS). After completion of Phase I, the USFWS will manage and monitor the restoration and will ensure the long term success of the project through multiple mechanisms including prescribed fire, exotic species control, and ecological assessment.

<u>Benefits and Results</u>
The prairie is part of the Minnesota Valley National Wildlife Refuge and is identified by the Minnesota County Biological Survey as a high-quality southern dry prairie remnant with four documented species listed on this site. The site is listed as a critical habitat type in the Minnesota Valley National Wildlife Refuge/ Wetland Management District Comprehensive Conservation Plan and is also recognized as a rare ecosystem in the Minnesota Department of Natural Resources' Tomorrow's Habitat for the Wild and Rare Plan.

Photo provided courtesy of Scott Sharkey

Project #5: Jailhouse Marsh Unit, Scott County
Ecotype: Wetland

Description

Restoration Phase I (Construction) – 84 Total Unit Acres/ 50 Minimum Restored Acres
River flooding has caused an earthen dike and fixed crest water control structures to fail, reducing the extent and quality of this wetland. With completion of this proposed work to replace the dike and water control structure, a minimum of 50 acres of this marsh will be restored or enhanced to support Type I, II, & III wetlands.

Restoration Phase II (Management and Maintenance)
The property is located within the Minnesota Valley National Wildlife Refuge and is permanently protected by the U.S. Fish and Wildlife Service (USFWS). After completion of Phase I, the USFWS will manage and monitor the restoration and will ensure the long term success of the project through multiple mechanisms including prescribed fire, exotic species control, and ecological assessment.

Benefits and Results
The site is listed as critical habitat type in the Minnesota Valley National Wildlife Refuge/ Wetland Management District Comprehensive Conservation Plan. This restoration will provide high-quality habitat for nesting, breeding, and brood-rearing of migratory waterfowl and birds. In addition, the close proximity to permanently-protected state and federal lands magnifies the potential benefit to wildlife, water quality, and recreational opportunities.

Photo provided courtesy of Chad Gustafson

Project #6: Louisville Swamp Unit, Scott County
Ecotype: Oak Savanna

Description

Restoration Phase I (Construction) – 1,000 Total Unit Acres/ 5 Minimum Restored Acres
The Louisville Swamp Unit of the Minnesota Valley National Wildlife Refuge includes many parcels of degraded oak savanna. With this project, restoration will be initiated on 5 acres of degraded oak savanna. This work will include mechanical removal of woody vegetation not associated with oak savanna ecosystems. Also included in this restoration phase is herbicide treatment of stumps (twice), seeding with oats to build a fine fuel base, and the application of prescribed fire.

Restoration Phase II (Management and Maintenance)
The property is located within the Minnesota Valley National Wildlife Refuge and is permanently protected by the U.S. Fish and Wildlife Service (USFWS). After completion of Phase I, the USFWS will manage and monitor the restoration and will ensure the long term success of the project through multiple mechanisms including prescribed fire, exotic species control, and ecological assessment.

Benefits and Results
The site is listed as critical habitat type in the Minnesota Valley National Wildlife Refuge/ Wetland Management District Comprehensive Conservation Plan. Also, the project is identified by the Minnesota Department of Natural Resources' Minnesota County Biological Survey as supporting Dry Sand-Gravel Oak Savanna communities of significant (high) quality. With this project, we will maintain that quality and expand the extent of savanna communities. Restoration and management activities for this project specifically implement those actions recommended for this habitat as identified in Minnesota's Comprehensive Wildlife Conservation Strategy *Tomorrow's Habitat for the Wildlife and Rare.*

Project #7: Rapids Lake Unit, Carver County
Ecotype: Oak Savanna, Prairie

Description

Restoration Phase I (Construction) – 1,000 Total Unit Acres/ 35 Minimum Restored Acres
The Rapids Lake Unit of the Minnesota Valley National Wildlife Refuge includes many areas of degraded prairie remnant intermixed with degraded oak savanna. With this project, restoration will be initiated on 35 acres of degraded remnant prairie and oak savanna. This work will include mechanical removal of woody vegetation not associated with prairie and oak savanna ecosystems. Also included in this restoration phase is herbicide treatment of stumps and seeding with oats to stabilize erosive soils and build a fine fuel base for future prescribed fires.

Restoration Phase II (Management and Maintenance)
The property is located within the Minnesota Valley National Wildlife Refuge and is permanently protected by the U.S. Fish and Wildlife Service (USFWS). After completion of Phase I, the USFWS will manage and monitor the restoration and will ensure the long term success of the project through multiple mechanisms including prescribed fire, exotic species control, and ecological assessment.

Benefits and Results
The site is listed as critical habitat type in the Minnesota Valley National Wildlife Refuge/ Wetland Management District Comprehensive Conservation Plan. Also, the project is identified by the Minnesota Department of Natural Resources' Minnesota County Biological Survey as supporting Southern Dry Prairie and Dry Sand-Gravel Oak Savanna communities of significant (high) quality. With this project, we will maintain that quality and expand the extent of prairie and savanna communities. Restoration and management activities for this project specifically implement those actions recommended for this habitat as identified in Minnesota's Comprehensive Wildlife Conservation Strategy *Tomorrow's Habitat for the Wildlife and Rare.*

Photo provided courtesy of the U.S. Fish & Wildlife Service

Guarantee Our Outdoor Legacy: Support Habitat Restoration In the Minnesota River Valley

You can help make it possible for us to complete our profiled wildlife habitat restoration projects by making a contribution to Friends of the Minnesota Valley. Our funders, including the Minnesota Environment and Natural Resources Trust Fund and the McKnight Foundation, encourage and anticipate that the Friends and our partners will identify and raise matching funds to help support our work. Matching funds from non-state sources, such as Friends' members and supporters, help make annual grant applications for the Metro Conservation Corridors project more competitive. In addition, the McKnight Foundation will match donations for restoration projects at 100% up to $10,000.

Each of our restoration projects can cost tens of thousands or even hundreds of thousands of dollars. Restoration is a sound investment but not an exact science. Projects are influenced by variables such as weather and field conditions and unforeseen circumstances sometimes require modification or substitution. A typical restoration project budget includes costs for professional and technical services such as engineering services for wetland restoration design; earthwork to install water control structures, break drainage tile lines, and build earthen dams; installation of native seed, field preparation, and removing and treating invasive species. Other costs include the acquisition of equipment and tools needed to complete restoration such as local ecotype native seed, chainsaws, gloves, water control structures, culverts, erosion matting and survey lath. We make sure our project planning and restoration dollars are used efficiently by working with the U.S. Fish & Wildlife Service to develop comprehensive ecological restoration and management plans prior to beginning our restoration work.

HOW YOU CAN HELP

Your support is key to the success of Friends of the Minnesota Valley's wildlife habitat restoration projects in the Minnesota River Valley. By making a contribution today, you can help ensure that wildlife in the Minnesota Valley National Wildlife Refuge and in the Minnesota River Watershed will have a sustainable future. You will also be investing in our outdoor legacy to ensure that future generations will be able to continue to enjoy our natural environment for many years to come.

MORE ABOUT YOUR GIFT

In return for your financial contribution, you will receive a donation letter to confirm your 100%-tax deductible donation to Friends of the Minnesota Valley. Of course, you will receive the reward of knowing that your gift goes directly to support the real, tangible restoration of critical habitat in the Valley.

Gifts can be given to support our restoration program as a whole or to support a specific restoration project. To learn more about our program or specific projects, or to arrange a meeting to discuss potential support of our program or a project, please contact Lori Nelson at 952-881-9065 or lnelson@friendsofmnvalley.org.

> With your gift of **$25** or more, you will receive a signed acknowledgment letter recognizing your support of our restoration program or designated project.
>
> With your gift of **$100** or more, you will receive an authentic, signed certificate of appreciation with a special thank-you letter from the Friends' President.
>
> With your gift of **$500** or more, you will receive a signed, framed certificate of appreciation and special thank-you letter, plus special recognition on our website, in our annual report, and at our annual dinner.
>
> With your gift of **$1,000** or more, you will receive all of the above, plus a beautiful bound project scrapbook including a project description, "before and after" pictures, and other details. This scrapbook is our special gift to you and can be displayed in your home or at your office.

Send your gift to: *Friends of the Minnesota Valley, Attn: Restorations, P.O. Box 20697, Bloomington, MN 55420 OR give online at GiveMN.org.*

Our promise: If project changes are required, we will contact you and make every effort to find an acceptable substitute restoration project.

Published by and for the Benefit of
Friends of the Minnesota Valley
P.O. Box 20697
Bloomington, MN 55420

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Restore/Enhance Significant Habitat: MeCC Phase IV
PROJECT MANAGER: Wiley Buck
AFFILIATION: Great River Greening
MAILING ADDRESS: 35 W. Water St.
CITY/STATE/ZIP: St. Paul, MN 55107
PHONE: 651-665-9500
E-MAIL: wbuck@greatrivergreening.org
WEBSITE: www.greatrivergreening.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4(f)2.5

APPROPRIATION AMOUNT: $155,000

Overall Project Outcome and Results

Great River Greening, along with our volunteers and partners, restored and enhanced a total of 204 acres of habitat with Trust Fund dollars, exceeding our goal of 155 acres, and an additional 140 acres with over $153,000 in leveraged non-state funds. Habitats included prairie, savanna, and forest, including nine native plant communities with biodiversity of statewide significance (as rated by Minnesota County Biological Survey), and habitat for 18 documented rare plant species (1 invertebrate, 2 bird, and 15 plant species). Restorations/enhancements also occurred at sites in priority watersheds rich with rare terrestrial and aquatic rare species, including the St. Croix, Mississippi, and Minnesota; as well as Valley Creek and Eagle Creek trout stream watersheds. A total of 15 different sites were restored/enhanced.

Enhancement of native plant communities with existing significant biodiversity occurred at: Arcola Mills Historic Foundation (Stillwater); St Croix Valley Early Detection/Rapid Response Garlic Mustard (Taylors Falls and Marine locations); Spring Lake Regional Park (Scott Co); Spring Lake Park Reserve (Dakota Co); Hidden Valley Park (Savage); Snail Lake Regional Park (Shoreview); St. Croix Savanna SNA (Bayport); Lost Valley Prairie SNA (Denmark Township); and Pond Dakota Mission (Bloomington).

Restoration/enhancement of habitats in important and strategic locations were: prairie/savanna establishment at Pilot Knob Hill (Mendota Heights), located in an area identified by DNR as a top-tier township for habitat for Species of Greatest Conservation Need; a large prairie/savanna restoration/enhancement at Belwin Conservancy's Lake Edith site (Afton), in the Valley Creek watershed; early detection and control of garlic mustard at a Valley Creek watershed location; prairie restoration/enhancement at Central Corridor (Woodbury and Cottage Grove), historically connected to Lost Valley Prairie SNA; savanna maintenance at Eagle Creek AMA (Savage), a metro trout stream; floodplain forest enhancement at Heritage Village Park (Inver Grove Heights) to expand on existing significant floodplain forest on the banks of the Mississippi River; and a prairie reconstruction burn at OH Anderson Elementary (Mahtomedi), habitat that is also used extensively in classroom studies.

Volunteers contributed over 2500 hours to these habitat projects.

Project Results Use and Dissemination

In January, 2010, Great River Greening included a feature article on the ENRTF, LCCMR, and the Metro Conservation Corridors program and projects in our e-postcard, circulation 3200. A write up on the Metro Conservation Corridors program with features of select projects was included in our Spring 2011 Newsletter, and an article featuring the Pond Dakota Mission restoration was featured in our Fall 2010 newsletter. These are available for continued viewing at http://www.greatrivergreening.org/news.asp. In addition, project descriptions are included in our volunteer recruitment efforts to all the volunteers in our database. In addition, Greening is in active partnership with landowners and other land managers, resulting in a dynamic and timely exchange of information and results.

Environment and Natural Resources Trust Fund
2009 Work Program Final Report

Date of Report: 15 August 2011
Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: 30 June 2011

I. PROJECT TITLE: Great River Greening, Restore/Enhance Significant Habitat

Project Manager: Wiley Buck
Affiliation: Great River Greening
Mailing Address: 35 W. Water St., Ste. 201
City / State / Zip: St. Paul MN 55107
Telephone Number: 651-665-9500 x15
E-mail Address: wbuck@greatrivergreening.org
Fax Number: 651-665-9409
Web Site Address: www.greatrivergreening.org

Location: Several sites within MeCC mapped corridors in the counties of Anoka, Carver, Chisago, Dakota, Goodhue, Hennepin, Isanti, LeSueur, Nicollet, Ramsey, Rice, Scott, Sherburne, Sibley, Washington and Wright.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**155,000**
	Minus Amount Spent:	**$**	**155,000**
	Equal Balance:	**$**	**-0-**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4(f)2.5

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All

conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY (equals abstract, 300 words

Great River Greening, along with our volunteers and partners, restored and enhanced a total of 204 acres of habitat with Trust Fund dollars, exceeding our goal of 155 acres, and an additional 140 acres with over $153,000 in leveraged non-state funds. Habitats included prairie, savanna, and forest, including nine native plant communities with biodiversity of statewide significance (as rated by Minnesota County Biological Survey), and habitat for 18 documented rare plant species (1 invertebrate, 2 bird, and 15 plant species). Restorations/enhancements also occurred at sites in priority watersheds rich with rare terrestrial and aquatic rare species, including the St. Croix, Mississippi, and Minnesota; as well as Valley Creek and Eagle Creek trout stream watersheds. A total of 15 different sites were restored/enhanced.

Enhancement of native plant communities with existing significant biodiversity occurred at: Arcola Mills Historic Foundation (Stillwater); St Croix Valley Early Detection/Rapid Response Garlic Mustard (Taylors Falls and Marine locations); Spring Lake Regional Park (Scott Co); Spring Lake Park Reserve (Dakota Co); Hidden Valley Park (Savage); Snail Lake Regional Park (Shoreview); St. Croix Savanna SNA (Bayport); Lost Valley Prairie SNA (Denmark Township); and Pond Dakota Mission (Bloomington).

Restoration/enhancement of habitats in important and strategic locations were: prairie/savanna establishment at Pilot Knob Hill (Mendota Heights), located in an area identified by DNR as a top-tier township for habitat for Species of Greatest Conservation Need; a large prairie/savanna restoration/enhancement at Belwin Conservancy's Lake Edith site (Afton), in the Valley Creek watershed; early detection and control of garlic mustard at a Valley Creek watershed location; prairie restoration/enhancement at Central Corridor (Woodbury and Cottage Grove), historically connected to Lost Valley Prairie SNA; savanna maintenance at Eagle Creek AMA (Savage), a metro trout stream; floodplain forest enhancement at Heritage Village Park (Inver Grove Heights) to expand on existing significant floodplain forest on the banks of the Mississippi River; and a prairie reconstruction burn at OH Anderson Elementary (Mahtomedi), habitat that is also used extensively in classroom studies.

Volunteers contributed over 2500 hours to these habitat projects.

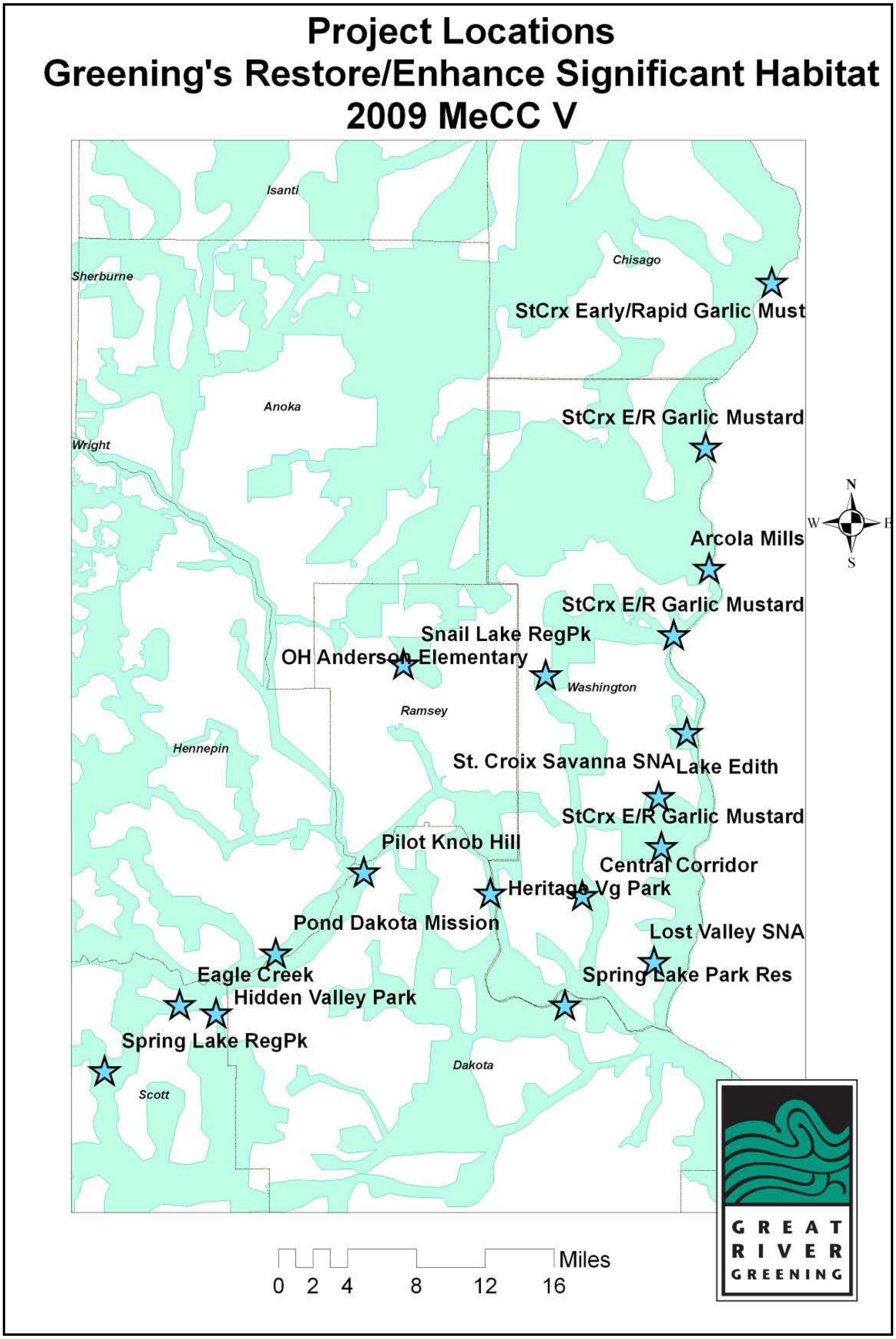


Figure 1: Overall Project Locations

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Restore/Enhance 155ac of Significant Habitat

Description:

Much of the quality habitat in the project area is rapidly threatened by loss, fragmentation, invasive species, development, altered hydrology, and climate change. Restoration of these habitats is needed to save Minnesota's natural heritage for future generations, protect rare and declining species, for clean water, and as an avenue to connect residents with their local natural areas. Projects will be chosen based on ecological significance, partner commitment, opportunity, and community importance, with our Million Acorn Campaign focus on oak communities in the Anoka Sandplain; our St. Croix Healthy Waters Initiative focus in the Franconia Corridor; restoration in the collar county Park systems; and continuing restoration work in the core urban areas, which hosts significant habitat including that for Species of Greatest Conservation Need, and a vibrant volunteer community.

Restoration plans will consider soil, geology, topography, and other relevant factors that will provide the best chance for long-term success of the restoration projects. Plans will include a proposed time table for implementing the restoration, including site preparation, establishment of diverse plant species, maintenance, and additional enhancement to establish the restoration; identify long-term maintenance and management needs of the restoration and how the maintenance, management, and enhancement will be financed; and take advantage of the best available science and include innovative techniques to achieve the best restoration; and private lands will have a 10 year landowner agreement. Species lists will be based on DNR, DNR/Great River Greening, and USDA Plants Database lists, following local ecotype guidelines. Contracts will be awarded on a competitive, experience, and performance basis; licensed if required. Great River Greening's professional field crew is led by experienced, trained, and licensed personnel.

Summary Budget Information for Result 1: Trust Fund Budget: $155,000
Amount Spent: $155,000
Balance: $ -0-

Deliverable	Completion Date	Budget
1. 21ac Complete + 100ac <25% done	1 Feb 2010	$30,000
2. 100 ac >50%done and 34ac<25%	1 Aug 2010	$50,000
3. 134ac >50%done	1 Feb 2011	$25,000
4. 134ac Complete	30 June 2011	$50,000

Result Completion Date: June 30, 2011

Final Report Summary:

Greening was active with restoration/enhancement activities at most of our sites in spring 2011, while a few projects were completed earlier.

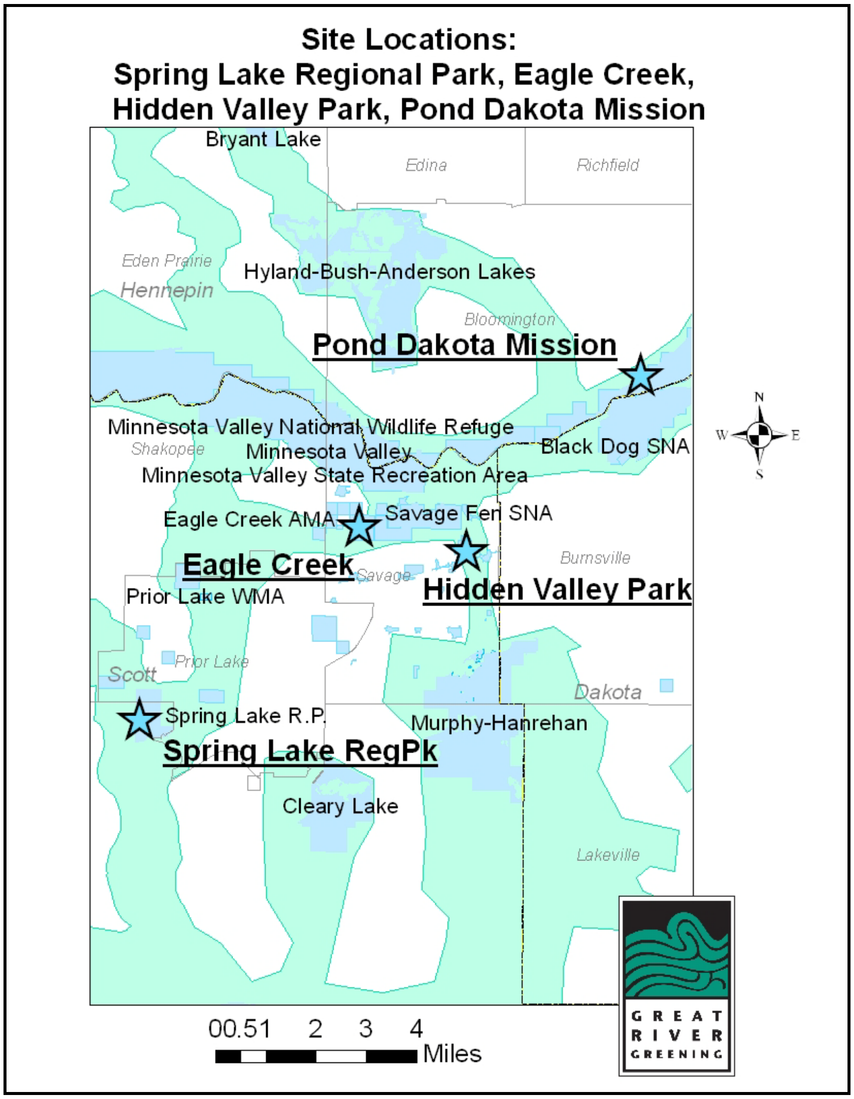


Figure 2: Regional Site locations, Southwest

- At Spring Lake Regional Park (Scott Co.) Phase II, woody invasive treatment was completed with a final sweep in this oak forest with significant biodiversity (per Minnesota County Biological Survey). Timing of invasive control was nearly ideal, treating the site while much of it was still in early stages of infestation (36 ac Trust Fund).

- In response to drought and severe deer herbivory pressure, additional oak protection at Eagle Creek AMA (Savage), home to one of the few remaining metro trout streams, was installed in 2010 at key portions of earlier oak plantings. This oak planting is currently exceeding expectations (0.1 ac Trust Fund).

- At Hidden Valley Park (Savage), invasive species control including leafy spurge biocontrol continued in spring 2011, in addition to the woody invasive control from the fall. This dry hill prairie with significant biodiversity (MCBS) hosts populations of the rare species' Hill's thistle and kittentails (1.5 ac Trust Fund).

- At Pond Dakota Mission (Bloomington), savanna establishment mowing, and spot treatment of invasive species in the woodland were undertaken in spring 2011 as follow through to the earlier site prep and seeding of savanna, and woody invasive removal in the woodland. This site is part of a large area identified as having significant biodiversity (MCBS) (1 ac Trust Fund).

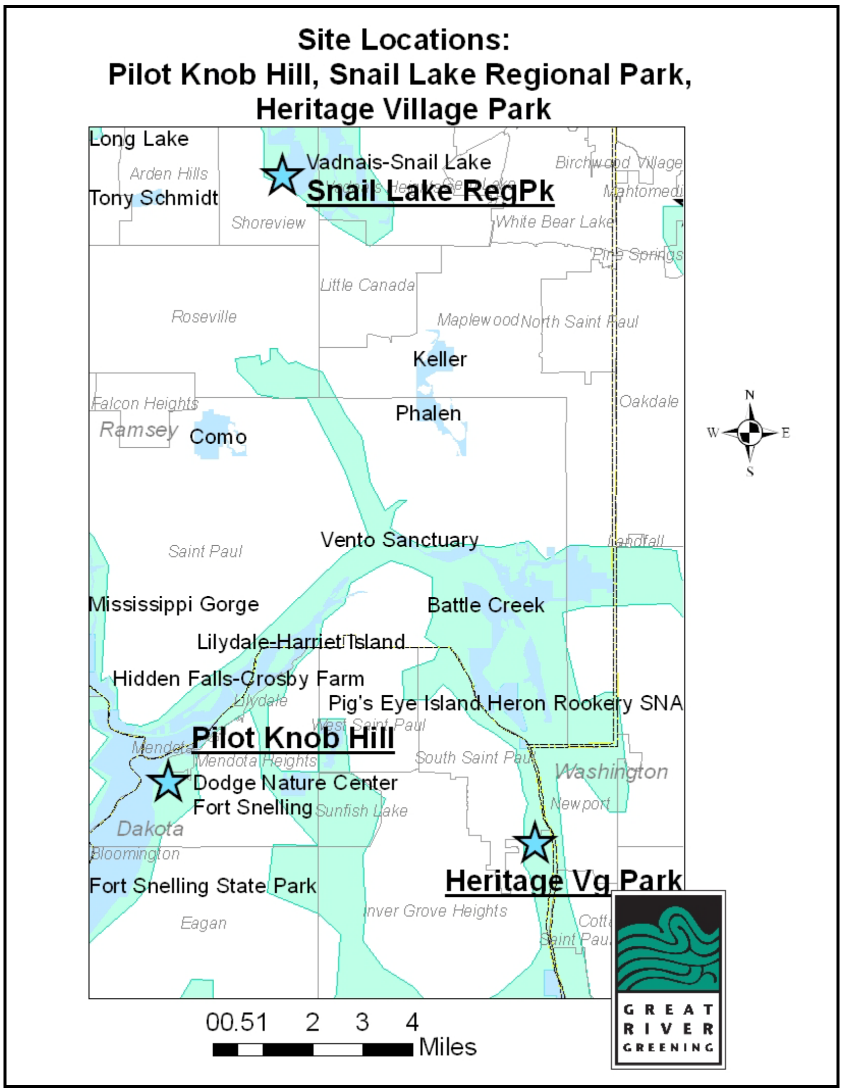


Figure 3: Regional Site Locations, Central

- At Pilot Knob Hill (Mendota Heights), prairie and oak savanna maintenance and establishment consisted of invasive species control, supplemental seeding and plugging, and wind break removal. Spring 2011 activities included prairie establishment mowing and spot spraying of invasive species (7 ac Trust Fund)

- Buckthorn and woody encroachment control at the Grass Lake oak savanna unit of Snail Lake Regional Park (Shoreview) was completed after numerous adjustments due to weather, and was followed with spring 2011 seeding of the herbaceous layer over most of the acres. The anticipated prescribed burn in spring 2011 did not occur, due to the combination of delays in winter cutting due to deep snow, and poor burning weather in spring 2011. A large 223 person volunteer event was held in March. This wooded and wetland site with significant biodiversity (MCBS) provides habitat for the rare Red-shouldered hawk (15 ac Trust Fund).

- At Heritage Village Park (Inver Grove Heights), a second round of buckthorn and garlic mustard control was implemented, as well as the planting of 35 six-foot Sugar Maples in the floodplain, in spring 2011 as part of the floodplain forest enhancement. (Trust Fund: 2.5 ac).

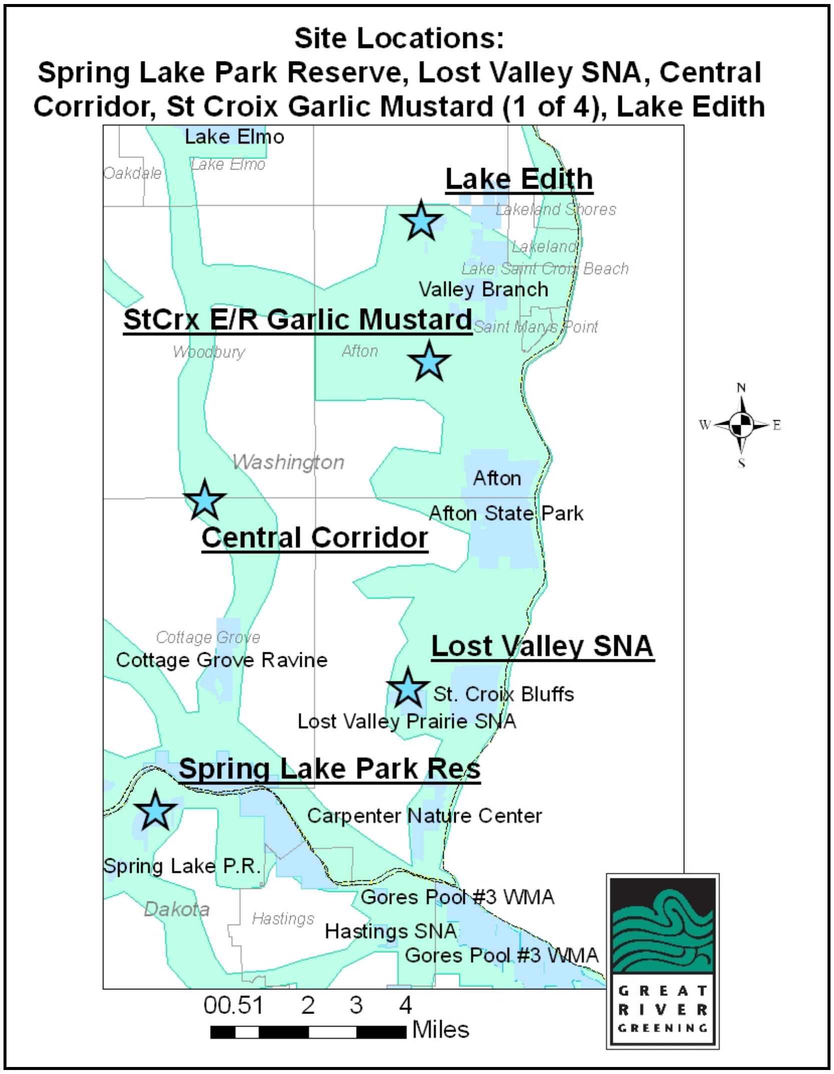


Figure 4: Regional Site Locations, SE

- Forest invasive work at Spring Lake Park Reserve (Dakota Co.), concluded with a second sweep of garlic mustard and woody invasive species control in the spring of 2011, as well as planting of 60 replacement shrubs, in this forest/savanna system with significant biodiversity (MCBS) and habitat for two rare plant species (76 ac Trust Fund).

- First-wave woody encroachment removal at one of the prairie remnants at Lost Valley Prairie SNA (Denmark Township) was followed with a second sweep in spring 2011, at this site of outstanding biodiversity significance (MCBS) which provides habitat for six rare plant and one rare invertebrate species (1.5 ac Trust Fund).

- The Central Corridor (Woodbury and Cottage Grove) project consisted of 1 acre of prairie enhancement through burning and invasive species control, and 22 acres of prairie reconstruction (site prep, interseeding and seeding) including a spring 2011 seeding (12 ac Trust Fund).

- At Belwin Conservancy's Lake Edith site (Afton), a third round of invasive species as well as the final third of prairie seeding brought this restoration/enhancement to the establishment phase. This large habitat project is an important part of the Valley Creek watershed, which includes trout habitat and is adjacent to dry hill prairie habitat of biodiversity significance (MCBS) (43 ac Trust Fund). Radical restorations from wooded to grassland such as this one require an extended timeline, manifested in additional site prep undertaken before seeding on this project.

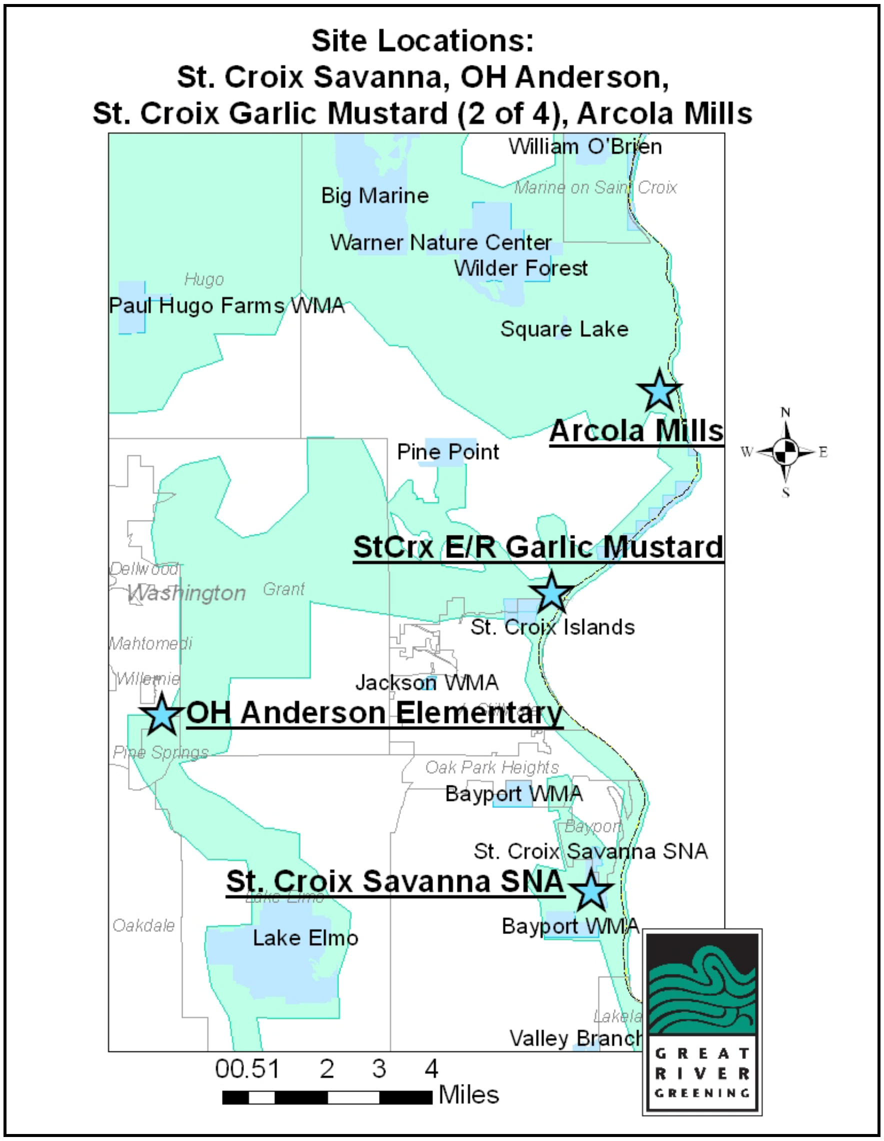


Figure 5: Regional Site Locations, East

- Sumac removal at St. Croix Savanna SNA (Bayport) with at-risk youth was completed in summer 2010 , at this site of outstanding biodiversity significance (MCBS) which provides habitat for four rare plant and one rare bird species (2 ac Trust Fund).

- The first prairie burn was completed in 2010 at the prairie restoration at OH Anderson Elementary (Mahtomedi). In addition to providing prairie habitat, this reconstruction is used for K-6 outdoor study (1 ac Trust Fund).

- In spring 2011, garlic mustard control was sustained and native plants installed for erosion control at Arcola Mills Historic Foundation (Stillwater) to add to the 2010 buckthorn control activities at this forested site with significant biodiversity significance (MCBS) and three rare species; furthermore, offshore of Arcola's 0.5 mile of shoreline, the St Croix River has a high density of rare species, including a recent record of gilt darter (2.5 ac Trust Fund).

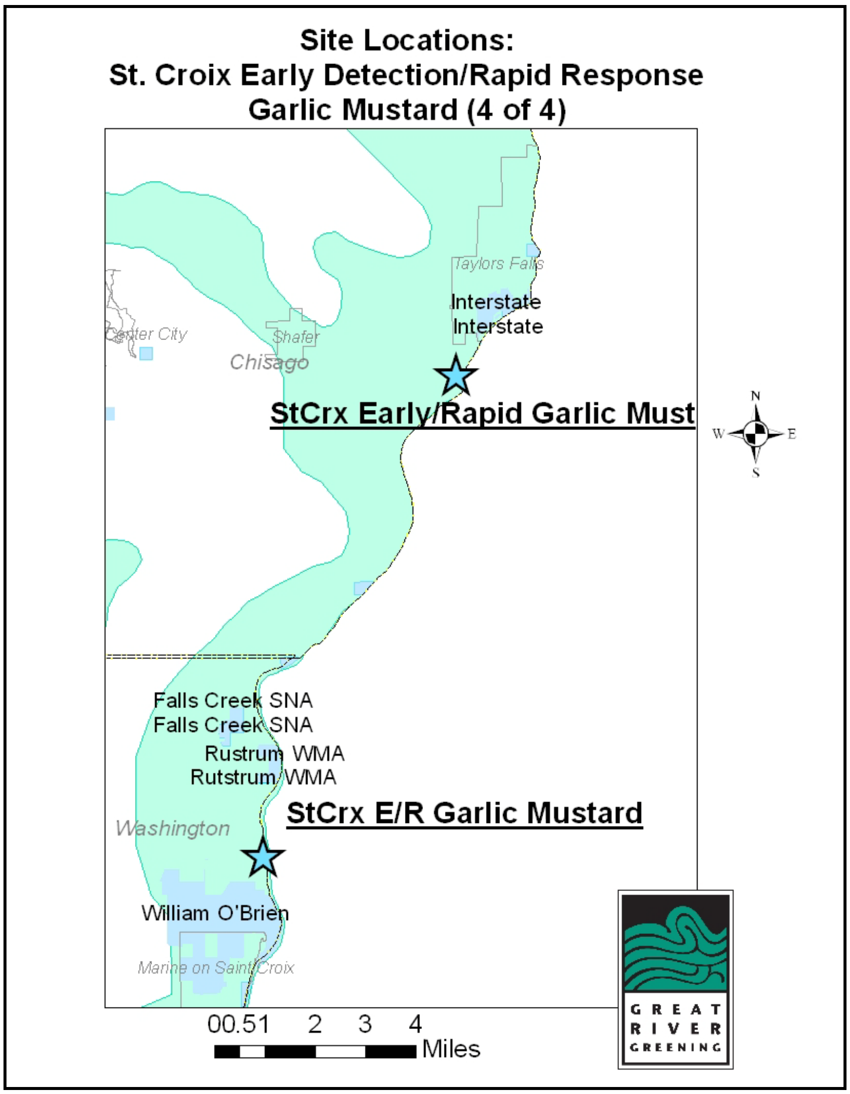


Figure 6: Regional Site Locations, NE

- Rapid response to early garlic mustard invasion in the rare-species rich St. Croix Valley continued at four locations (NPS protected land in Taylor's Falls and Marine, assisting volunteers in Valley Creek watershed, and assisting with monitoring at Boom Site Landing) (3.5 ac Trust Fund). Absence of matching funds to date has not allowed the full vision of this undertaking to be realized, but Greening remains committed and is encouraged by recent activity of local partners.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: ~~$49,500~~ $49,149
Contracts: ~~$17,000~~ $16,417
Equipment/Tools/Supplies: ~~$85,300~~ $86,339
Acquisition, including easements: $ 0
Travel: ~~$3,200~~ $3,095
Other: $ 0

Budget changes are end of project completion adjustments. Prior approval received from LCCMR to make final adjustments as needed for close out.

TOTAL TRUST FUND PROJECT BUDGET: $ 155,000

Explanation of Capital Expenditures Greater Than $3,500:

VI. PROJECT STRATEGY:

A. Project Partners: Project partners included all Metro Conservation Corridor partner organizations; DNR; National Fish and Wildlife Foundation; St. Croix National Park Service; private donors; foundations, organizations, corporations, and individuals; and local units of government.

B. Project Impact and Long-term Strategy:
Restoration is a long term process; Greening evaluates long-term partner commitment and is in turn committed to raising matching funds for the duration. The support of ENTF funds for enhancement (maintenance) is very valuable.
The overall need and opportunities for restoration will continue into the foreseeable future, especially in light of 50-100 years of climate change (SCPP pg. 26) and increasing development pressures. Intermediately, Greening's Million Acorn Campaign is scheduled for completion in 2012, and our St. Croix Healthy Water's Initiative will be reevaluated if/when the St. Croix River is delisted from the impaired waters list.

C. Other Funds Proposed to be Spent during the Project Period: These projects leveraged over $153,00 was from non-state sources including Ramsey Co. Parks; Dakota Co. Parks; South Washington Watershed District; City of Mendota Heights; City of Inver Grove Heights; City of Savage; City of Bloomington; Mahtomedi ISD; National Fish and Wildlife Foundation; Arcola Mills Historic Foundation; Toro Foundation; Nash Family Foundation; McKnight Foundation (General Operating Support); Allianz Foundation; and a private donor. These projects also leveraged over $500 from MN-DNR, and significant in-kind from landowners, volunteers, and vendor services/discounts.

D. Spending History:
2008 GRG Phase IV - $111,000 ENRTF; $140,000 non-state
2007 Phase III - $60,000 ENRTF; $90,000 non-state + $31,000 state
2005 Phase II - $100,000 ENRTF; $202,000 non-state
2003 Phase I - $124,000 ENRTF; $100,000 non-state

VII. DISSEMINATION:

In January, 2010, Great River Greening included a feature article on the ENRTF, LCCMR, and the Metro Conservation Corridors program and projects in our e-postcard, circulation 3200. A write up on the Metro Conservation Corridors program with features of select projects was included in our Spring 2011 Newsletter, and an article featuring the Pond Dakota Mission restoration was featured in our Fall 2010 newsletter. These are available for continued viewing at http://www.greatrivergreening.org/news.asp. In addition, project descriptions are included in our volunteer recruitment efforts to all the volunteers in our database. In addition, Greening is in active partnership with landowners and other land managers, resulting in a dynamic and timely exchange of information and results.

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted not later than 1 Feb 2010, 1 August 2010,1 Feb 2011. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS:

Attachment A: Final Budget Detail for 2009 Project

Project Title: *Restore/Enhance Significant Habitat - Great River Greening*

Project Manager Name: Wiley Buck

Trust Fund Appropriation: $ *155,000*

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

2009 Trust Fund Budget	**Result 1 Budget**	**Revised Result 1 Budget** *Budget changes are end of project completion adjustments. Prior approval received from LCCMR to make final adjustments as needed for close out.*	**Amount Spent**	**Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
	Restore/Enhance 155 ac of Significant Habitat	*Restore/Enhance 155 ac of Significant Habitat*				
BUDGET ITEM						
PERSONNEL: wages and benefits *Ecologists (Buck, Walton, Rexine,new hire), Field Crew (Varien,Newhouse,Dougherty, Blanchett,Ramsden,Ulrich.), Volunteer Coordinator (Turbak), Admin: (Wenz,Gagner,Buck) (~ 2.10 FTE for 1 year = 1.05 FTE for 2 years) (Difficult to anticipate amounts per person at this early stage) Benefits ~21% of Salary (8% FICA, 8% Health, 5% Retirement Cont.)*	~~49,500~~	49,149	49,149	0	49,149	0
Contracts						
Professional/technical *(with whom?, for what?)*		0	0	0	0	0
Other contracts *Restoration Contracts: site prep, prairie install, direct hardwood seeding, tree services, earthwork etc. by, e.g. Minn. Native Landscapes, Ostvig Tree, North Am. Prairies, PRI, Zumbro Valley Forestry, Outback Nursery, MCC, farmers and other local partners. All are Vendors.*	~~17,000~~	16,417	16,417	0	16,417	0
Non-capital Equipment / Tools *(what equipment? Give a general description and cost) GPS unit; ATV attachment(s); Toro Dingo attachment(s); landscape staple gun; chainsaws, brush cutters, sprayers, shovels, loppers, weed wrenches, bow saws, water packs, drip torch, safety equipment.*	~~1,500~~	1,473	1,473	0	1,473	0
Supplies *(list specific categories) Vol. Event Supplies (approved food and bev., portable toilets, tents, signage, PA system)*	~~7,700~~	7,669	7,669	0	7,669	0
Supplies *Restoration supplies, materials, and fees: mulch, plants, seeds, erosion control blanket, soil analysis fees, etc.*	~~76,100~~	77,197	77,197	0	77,197	0
Travel expenses in Minnesota	~~3,200~~	3,095	3,095	0	3,095	0
COLUMN TOTAL	**$155,000**	**$155,000**	**$155,000**	**$0**	**$155,000**	**$0**

Appendix B

2009 Subd. 4(f)2.5 Greening Phase V Metro Conservation Corridors
Final Report

SITE: Name, Owner, Location	Ecological Significance	Native Communities and Restoration Goals	Project Description	Ph	Proposed Restoration Activities	Acreage, est. (*after pro-rated with 'other state').	Status
St. Croix Valley Early Detection Garlic Mustard. NPS fee title, NPS scenic easement, DNR	Very early stages of invasion	Forest	Early detection/rapid response to garlic mustard	IV	Garlic mustard location, mapping, smothering, cutting, spraying	1	Underway; progress observed; coordinate with NPS
				V	Continuation of existing sites and limited addition of new sites. Continue coordination with NPS and St Croix Watershed Research Station.	4	Completed
St Croix Savanna SNA, Bayport.	Extremely high quality savanna	Oak Savanna, prairie	High School youth conducting invasive species control thru our Natural Areas Teen Network program.	V	Sumac cutting; knapweed pulling	4	Completed
OH Anderson Elementary, Mahtomedi	Nature classroom site in Corridor connecting Lake Elmo RP to Square/Carnelian Lakes complex	Prairie	Prairie reconstruction	I - III	Site prep; prairie seeding; 1st year est. mow and knapweed control; plug planting	3	Complete
				IV	Invasive species control, woody encroachment control, plug planting	3	Complete
				V	First Rx burn, spot invasive species control (Maintenance/ Enhancement)	2	Completed
Arcola Mills Historic Foundation, Stillwater	CBS quality forest with 0.5 mile shoreline and rare species. (Protected private)	Forest	Invasive species control, pine planting, erosion control; garlic mustard control.	I - III	1st wave woody invasives; pine planting; raingarden; ravine erosion control; garlic mustard control	50,6	Complete
				IV	Garlic mustard control; follow up buckthorn control;	30	Complete
				V	Garlic mustard control; follow up buckthorn control; Arcola volunteers (Maintenance/ Enhancement)	3.5	Completed
Pilot Knob Hill, Mendota Heights	Located in top tier township for SGCN opportunities/needs. Adjacent to Ft Snelling SP in MN River Valley	Prairie/Savanna	Reconstruction; non-game habitat.	II	Phase I site prep, seeding. Volunteer event.	8	Complete
				IV	Phase I establishment mow, spray. Phase II site prep, seeding, snake hibernaculum, snag creation. Volunteer event.	8 + 14	Completed
				V	Phase II Establishment; Invasive Species Control; Volunteers; Phase I Maintenance/ Enhancement	22	Completed
Eagle Creek AMA, Savage	Metro Trout stream	Prairie, Savanna, Woodland	Tree layer reconstruction; invasive spp control	III	Oak planting with herbivory protection, using volunteers	4*	Complete
				IV	Maintanence. Prairie invasive species control	3*	Completed
				V	Double-walled deer exclosures for growing oaks, with special needs volunteers and DNR Fisheries.	.05	Completed

Spring Lake Regional Park, Prior Lake	Large park with large CBS quality M-B forest	M-B forest	Low density buckthorn control; volunteer events; isolated patches of high density b.t.; siberial elm and other woody invasives	IV	Buckthorn control; volunteer stacking.	80	Completed
				V	Low density and high density b.t. control; volunteer event(s); siberian elm etc. control.	56	Complete
Hidden Valley City Park, Savage	CBS quality prairie with kittentails, on Credit River	Prairie	Prairie restoration; raingarden b/w parking lot and River	I-III	Woody and herbaceous inv species control; Rx burn; raingarden; volunteers	5	Completed
				IV	Invasive species control; supplemental plugs; volunteers.	3	Completed
				V	Primarily leafy spurge, cow vetch, and honeysuckle control.	3	Completed
Pond Dakota Mission City Park, Bloomington	Part of large native plant communities on MN River	Oak savanna, woodland	Reconstruction from forest and turf.	IV-V	Site prep, seeding	6	Compleeted
Lost Valley SNA, Denmark Township	CBS quality remnant prairie with rare species	Prairie	Prairie restoration	V	Woody removal	2	Completed
Snail Lake Regional Park, Shoreview	'Grass Lake' portion with Blanding's turtle and red-shouldered hawk	Oak savanna	Restoration	V	First wave patchy buckthorn and woody encroachment removal.	29	Completed
Belwin Conservancy, Afton. Lake Edith LE1 LE3 and LE2 units	100+ acre natural area undergoing intensive restoration, in Valley Ck watershed priority area	Oak Savanna, prairie	Reconstruction of herbaceous layer.	n/a	Woody encroachment removal using 'biofuels for restoration' grant.		Completed
				V	Site prep including spraying and soil prep (woody removal already completed), seeding, weed control.	62	Completed
Heritage Village City Park, Inver Grove Heights.	Mississippi River park undergoing extensive restoration and reconstruction.	Floodplain and Terrace forest	Invasive species control and silver maple planting.	n/a	Site Cleanup and grading in portions using DNR Remediation Fund grant		Completed
				V	Invasive species control, silver maple planting	5	Completed
Central Corridor I and II Open Space, Cottage Grove and Woodbury	40+ acre natural area undergoing intensive restoration and reconstruction and protected by Metro Greenways and local easements.	Dry prairie, mesic prairie	Restoration of dry prairie remnants; reconstruction of mesic prairie	V	Rx burn, woody removal, seed collection/seeding, mesic prairie planting.	23	Completed
Spring Lake Park Reserve - *Dakota* Co., west of Hastings. Church's Woods area	Several hundred acre park with numerous MCBS native plant communities, including forest, prairie, and savanna	Oak Forest	Primarily low density invasives control, limited forest gap planting, limited medium density invasives control.	V	Siberian elm, box elder, and woody shrub control. Survey and control of low density woodland herbaceous invasives, if any. Forest gap planting, likely acorns.	122	Completed

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE:	Metro Conservation Corridors Phase V – Metro Greenways (2.4, 3.4, 4.1)
PROJECT MANAGER:	Sharon Pfeifer
AFFILIATION:	DNR Eco Waters
MAILING ADDRESS:	1200 Warner Road
CITY/STATE/ZIP:	St. Paul, MN 55106
PHONE:	651.259.5790
E-MAIL:	Sharon.pfefier@state.mn.us
WEBSITE:	http://www.dnr.state.mn.us/nrplanning/cca/index.html
FUNDING SOURCE:	Environment and Natural Resources Trust Fund
LEGAL CITATION:	M.L. 2009, Chap. 143, Sec. 2, Subd. 4f2.6/3.4/4.1

APPROPRIATION AMOUNT: $1,175,000

Overall Project Outcome and Results

The DNR Metro Greenways Program has worked since its inception in 1998 toward the goals of protecting, restoring, and reconnecting remaining natural areas in the Twin Cities greater (12-county) metropolitan region. The principal strategies employed by the Program to achieve these goals included: 1) competitive grants to local and regional governments to restore degraded habitats; 2) competitive grants that support the acquisition of or conservation easements on strategically important parcels of terrestrial, wetland, or riparian habitat; 3) incentive grants to local governments to address other conservation needs such as land cover inventories, natural resource based land use decision tools, and ordinance revisions to support conservation efforts; and 4) natural resource based workshops on topics of interest to local government staff and officials.

The 2009 appropriation concludes DNR Central region's Metro Greenways Program, which is sun setting after 13 years. This final allotment of $1,175,000 was used to fund a total of 21 projects and to develop and offer six new natural resource-based workshops. Combined, the restoration and protection projects conserved an additional 375 total acres in the 12-county greater metropolitan region, almost meeting Metro Greenways' combined target of 385 acres of lands restored and protected:

- Five restoration grants totaling $90,000 were awarded to three counties and one city. In combination with other funds, a total of approximately 255 acres of city, county, and regional park lands were restored to native vegetation, primarily prairie and savanna. The newly restored acreage was over two times more than targeted for this result (120 acres).
- Six protection projects were awarded a total of $650,000. Only three projects totaling $370,000 were initiated and completed (Lindstrom, Grannis, and Niebur), resulting in the protection of just 120 acres of the 325 acre projected target for Metro Greenways. The city of Lindstrom acquired a new 64 acre Allemansratt "wilderness" park that will give residents the chance to explore its several clear lakes and deciduous hardwood forest. Two grants to Dakota County added a total of 56 acres under conservation easements to its green infrastructure network being created by the Farmland and Natural Areas Program. Unfortunately, a $200,000 grant to Anoka Conservation District did not materialize and a $10,000 grant awarded to Chanhassen was turned down. These funds were put toward other projects. A Washington County project fell through very late in the biennium, leaving an $80,000 balance for this result category.
- Metro Greenways' Community Conservation Assistance Program awarded 13 grants to cities, counties and special districts that supported a variety of locally-specific conservation needs: a) to obtain land cover and urban tree canopy (UTC) inventories; b) to develop natural resource-based land use decision models; c) to create interjurisdictional partnerships to protect high quality natural

areas; and d) to write new or revise existing ordinances to protect natural resources. In addition to these grants, the Program organized and facilitated two annual events (Rendez-Vous) that brought all DNR Community Assistance grantees (2008 and 2009 appropriations) together for full days of information-sharing and peer-to-peer learning. The DNR also convened the three cities undertaking urban tree canopy (UTC) inventories, along with the University of Minnesota forestry and extension service, U.S. Forestry Service, and Minneapolis Park and Recreation Board, to hear about each city's findings and proposed applications of UTC data.

This third result area also funded the development and offering of six new natural resource-based workshops in 2010/2011 for local government staff and appointed officials. These workshops were offered in the metro area and were promoted by Government Training Services to its clientele (local government commissioners). Almost 325 local government staff and officials (62% from cities; 14% counties; 10% townships; and14% special districts and others) attended these workshops on shoreland conservation, stormwater management, and the incorporation of natural resources into land use planning and engineering design. The workshops all received excellent evaluations from attendees.

Project Results Use and Dissemination
Press releases were sent to local newspapers where projects were funded. The DNR convened all of the Community Conservation Assistance (CCA) project managers in November of 2009 and in February 2011 to share the findings of their conservation work. CCA Project Profiles were drafted and posted on the DNR website. Protection and restoration project information is available through the Metro Conservation Corridor partnership map created for public use. The CCA deliverables will be tried and tested as part of the Results Outcomes effort by the State of Minnesota.

Environment and Natural Resources Trust Fund
2009 Work Program Final Report

Date of Report: 8/15/2011
Date of Next Progress Report: none
Date of Work Program Approval: 06/24/2009
Project Completion Date: 6/30/2011

I. PROJECT TITLE: MeCC – Metro Greenways

Project Manager: Sharon Pfeifer
Affiliation: DNR Ecological and Water Resources
Mailing Address: 1200 Warner Road
City / State / Zip: St. Paul, Mn 55106
Telephone Number: 651-259-5970
E-mail Address: Sharon.pfeifer@dnr.state.mn.us
Fax Number: 651-772-7799
Web Site Address: http://www.dnr.state.mn.us/greenways/index.html

Location: Within the mapped Metropolitan Conservation Corridors in 12 of the MeCC Partnership's 16 counties (7 core counties plus Isanti, Goodhue, Chisago, Wright, and Sherburne) that are included in DNR's 23-county Central Region.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**1, 175,000**
	Minus Amount Transferred	**$**	**236,955**
	Minus Amount Spent:	**$**	**822,249**
	Equal Balance:	**$**	**115,786**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4f2.6/3.4/4.1

Appropriation Language
$3,375,000 is from the trust fund to the commissioner of natural resources for the, fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner

of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY:

The DNR Metro Greenways Program has worked since its inception in 1998 toward the goals of protecting, restoring, and reconnecting remaining natural areas in the Twin Cities greater (12-county) metropolitan region. The principal strategies employed by the Program to achieve these goals included: 1) competitive grants to local and regional governments to restore degraded habitats; 2) competitive grants that support the acquisition of or conservation easements on strategically important parcels of terrestrial, wetland, or riparian habitat; 3) incentive grants to local governments to address other conservation needs such as land cover inventories, natural resource based land use decision tools, and ordinance revisions to support conservation efforts; and 4) natural resource based workshops on topics of interest to local government staff and officials.

The 2009 appropriation concludes DNR Central region's Metro Greenways Program, which is sun setting after 13 years. This final allotment of $1,175,000 was used to fund a total of 21 projects and to develop and offer six new natural resource-based workshops. Combined, the restoration and protection projects conserved an additional 375 total acres in the 12-county greater metropolitan region, almost meeting Metro Greenways' combined target of 385 acres of lands restored and protected:

- Five restoration grants totaling $90,000 were awarded to three counties and one city. In combination with other funds, a total of approximately 255 acres of city, county, and regional park lands were restored to native vegetation, primarily prairie and savanna. The newly restored acreage was over two times more than targeted for this result (120 acres).
- Six protection projects were awarded a total of $650,000. Only three projects totaling $370,000 were initiated and completed (Lindstrom, Grannis, and Niebur), resulting in the protection of just 120 acres of the 325 acre projected target for Metro Greenways. The city of Lindstrom acquired a new 64 acre Allemansratt "wilderness" park that will give residents the chance to explore its several clear lakes and deciduous hardwood forest. Two grants to Dakota County added a total of 56 acres under conservation easements to its green infrastructure network being created by the Farmland and Natural Areas Program. Unfortunately, a

$200,000 grant to Anoka Conservation District did not materialize and a $10,000 grant awarded to Chanhassen was turned down. These funds were put toward other projects. A Washington County project fell through very late in the biennium, leaving an $80,000 balance for this result category.

- Metro Greenways' Community Conservation Assistance Program awarded 13 grants to cities, counties and special districts that supported a variety of locally-specific conservation needs: a) to obtain land cover and urban tree canopy (UTC) inventories; b) to develop natural resource-based land use decision models; c) to create interjurisdictional partnerships to protect high quality natural areas; and d) to write new or revise existing ordinances to protect natural resources. In addition to these grants, the Program organized and facilitated two annual events (Rendez-Vous) that brought all DNR Community Assistance grantees (2008 and 2009 appropriations) together for full days of information-sharing and peer-to-peer learning. The DNR also convened the three cities undertaking urban tree canopy (UTC) inventories, along with the University of Minnesota forestry and extension service, U.S. Forestry Service, and Minneapolis Park and Recreation Board, to hear about each city's findings and proposed applications of UTC data.

This third result area also funded the development and offering of six new natural resource-based workshops in 2010/2011 for local government staff and appointed officials. These workshops were offered in the metro area and were promoted by Government Training Services to its clientele (local government commissioners). Almost 325 local government staff and officials (62% from cities; 14% counties; 10% townships; and14% special districts and others) attended these workshops on shoreland conservation, stormwater management, and the incorporation of natural resources into land use planning and engineering design. The workshops all received excellent evaluations from attendees.

IV. OUTLINE OF PROJECT RESULTS

Result 1: Restore and Enhance Significant Habitat

Final Report Description: The total budget for this result was $100,000 with $90,000 designated for matching grants to 4-8 local units of government and $10,000 reserved for grant administration. The projected target for this Result was to restore or enhance a total of about 120 acres (60 acres funded by Metro Greenways) of significant upland, shore land, or wetland habitat, following LCCMR's guidelines for local ecotype sequencing.

An open Request for Proposals was announced in the spring of 2009, and 18 proposals were received. Proposals were evaluated by an expert review panel using an established set of criteria (Attachment B1) and five projects were recommended for program funding (see following table).

A total of $87,425 was awarded. All of the projects were either prairie or savanna restorations in existing public places (parks and wildlife management area). Collectively a total of 255 acres were restored, exceeding the target of 60 acres. It should be mentioned that the oak savanna restoration in Isanti County on a wildlife management area provided additional public benefit in that the restored site is for use by disabled hunters.

Grantees contributed $91,667 in local in-kind to project completions (1:1 match). The average cost of restoration for all five projects, including both grant funding and local in-kind match, was $ 678/acre.

The Lake Elmo and Isanti County projects came in under budget, resulting in a balance (9%).

Grantee	Completed Restoration Project	Location	Project Description	Total Project Cost $	Spent Metro Greenways $	Other Funds $
Isanti County	Oak savanna	Becklin Homestead County Park	50 acres of the county park/WMA were restored to oak savanna ecotype	25,403	12,702	12,701
Dakota County	Prairie and oak savanna	Lebanon Hills Regional Park	25 acres near the park's east entrance were restored to savanna with natives from Prairie Moon Nursery; the first prescribed burn will occur in 2013 or 2014	30,500	12,500	18,000
Dakota County	Dry and mesic prairie	Miesville Ravine Regional Park	The Six Prairies Project restored a total of 151 acres of prairie with natives from Prairie Moon Nursery	60,000	25,000	35,000
City of Lake Elmo	Tallgrass. mesic prairie	Sunfish Lake Park, Lake Elmo	20 acres of ag land was restored to prairie within the Sunfish Lake Park borders	41,743	20,871	20,872
Three Rivers Park District	Native prairie	Crow Hassan Park Reserve	9 acres site restored to native prairie; prescribed burn to occur in 2012	17,594	7,500	10,094

Final Budget Information for Result 1: **Trust Fund Budget: $ 100,000**
Amount Spent: $ 89,092
Balance: $ 10,907

$10,000 (10%) was used to administer grants for Result 1.

Result 2: Protect Significant Habitat

Final Report Description: The total protection budget initially was $780,000, with $650,000 designated for matching grants to 2-5 local units of government to protect about 650 acres (325 acres funded by Metro Greenways) of regionally important natural habitat through acquisition (fee title or conservation easement). The remaining $130,000 was used to administer the protection grants as well as for: 1) participation in the MeCC partnership and DNR's Conservation Easement Working Group; 2) monitoring of Metro Greenways projects; 3) support to local government staff to identify priority lands for conservation; and 4*)* other administration functions.

The original projected target for this Result was to protect just over 650 acres of high quality terrestrial or wetland habitat within the 12-county metropolitan region. This target was not met, with only 120 acres of a projected 325 acres being acquired or protected through conservation easement. Other funding sources contributed a total of $1,129,537 to these three projects (3:1 match). The average cost of protection by conservation easement was $7990/acre; the acquisition cost per acre was $16,440/acre.

An open Request for Proposals was announced in the spring of 2009, and 26 proposals were received, totaling $6,701,400 in requests. Proposals were evaluated by an expert review panel using established criteria (Attachment B2) and six projects were recommended for program funding and approved by DNR's Commissioner.
A total of $650,000 was awarded to six projects (2 acquisition and 4 conservation easements). Of these 6 projects, only three protection projects were completed to add another 126 acres of protected land to the region's green infrastructure (see matrix below). Two conservation easements in Dakota County added 56 acres to Dakota County's Farmland and Natural Areas network. Monitoring of the easements will be done annually by Dakota County staff or its representative with funds from the county's general levy funds. DNR's Metro Greenways Program contributed $200,000 toward purchase of 64 acres for the new Allemansratt Wilderness Park in the edge city of Lindstrom, Chisago County. A natural resources management plan for this park was approved by the city on 16 June 2011.

Two of the six projects were cancelled at the grantees' requests: 1) Anoka Conservation District passed a resolution on May 17, 2010, to cancel its agreement to receive a $200,000 grant to assist with the purchase of a conservation easement due to a much lower property appraisal; and 2) the City of Chanhassen declined to enter into a grant agreement to received $10,000 to purchase property in the Bluff Creek Corridor, citing potential conflicts due to deed restrictions on future highway construction. The relinguished $200,000 was transferred via amendment* to DNR's SNA Program for the purposes described in the amendment. The $10,000 was put toward the purchase of the Grannis property in Dakota County.

With the departure of the Metro Greenways coordinator in May 2011, $36,955 budgeted for administration of this result was also transferred to the SNA program via amendment** .

*<u>*Amendment Request (10/19/2010); Amendment Approval (29 October 2010):</u> Transfer $200,000 of unencumbered grant dollars in Result 2: Protect Significant Habitat to MeCC partner DNR Scientific and Natural Area (SNA) Program for **one** of these two pending acquisitions: Option 1: Acquire 21 acres to add to the Seminary Fen SNA that includes the highest quality, unprotected calcareous fen currently in private ownership. Option 2: Acquire about 25 acres of predominantly mapped native plant community to add to the Hastings Sand Coulee SNA; this could be all of a 25-acre acquisition from the City of Hastings and/or a portion of 80 acres in private ownership – both sites immediately adjoining a new northern unit at the Sand Coulee that SNA is receiving from DNR Wildlife. SNA staff is actively pursuing both options and proceed with the acquisition that is most likely to be completed by the June 20, 2011 deadline.*

*<u>**Amendment Request (2/18/2011); Amendment Approval (18 February 2011)</u>*
*Transfer the balance of the salary budget to **(**$36,955 as of 2/18/2011) to MeCC partner DNR Scientific and Natural Area (SNA) Program. These dollars will be applied to the Holst property acquisition to protect and add 80 acres of land to the Hastings Sand Coulee SNA.*

The Washington County project ($80,000) did not materialize in time and was cancelled by the county in May 2011.

Grantee	Completed Protection Project	Location	Project Description	Total Cost $	Spent Metro Greenways $	Other Funds $
Dakota County	Grannis	Inver Grove Heights, Dakota County	17 acre parcel (one of several) contains moderate quality oak forest and a deep, clear lake; it is within the Northern Dakota County Greenway	320,000	130,000	190,000
Dakota County	Niebur	Dakota County	39 acre parcel is in the Lower Mississippi River conservation corridor and abuts 2 other FNAP parcels; land cover is oak forest with remnant native prairie; bisected by DNR public waterway	127,473	40,000	87,473
City of Lindstrom	Allemansratt Wilderness Park	Chisago County	64 acre parcel abuts 2 popular fishing lakes and is dominated by maple-basswood-oak forest on glacial eskers; 18 wetlands	1,052,164	200,000	852,064

Final Budget Information for Result 2: **Trust Fund Budget: $ 780,000**
Amount Spent: $ 462,978
Amount Transferred: $ 236,955
Balance: $ 80,067

$93,045 (17%) was used to administer grants for Result 2.

Result 3: Community Conservation Assistance (Other Tools)

Final Report Description: The total budget for this result was $295,000 to accomplish two key objectives: 1) to provide $250,000 for conservation incentive grants to 10-20 local governments; and 2) to work with subject matter consultants to develop and offer new natural resource based workshops targeted to local government officials and staff about why natural resources are important and how to plan and design to conserve land and water resources.

During the biennium, three separate Requests for Proposals were issued for the Community Conservation Assistance Program. A total of 13 grants ($248,000) were competitively awarded using an established set of criteria (Attachment B3). Grants were provided to assist local governments with: 1) land cover and tree canopy inventories; 2) natural resource informed land use decision-making models; 3) ordinance revisions or new ordinances to conserve natural habitats and guide development; and 4) cooperative, inter-jurisdictional efforts to plan for or manage a natural habitat.

As can be seen from the following list of projects, 9 of the 13 Community Conservation Assistance grants aided communities that were more rural, where communities have less capacity and fewer resources to address conservation issues. It is important to recognize that these small incentive grants, averaging $19,000, can have a bigger conservation footprint than acquisition because the inventories, decision-making tools, and partnerships affect larger geographic areas (see attached map). For example, Goodhue County's natural resource informed land use decision-making model has county-wide application, informing the cities within the county as well as the county itself.

In addition to the 13 incentive grants**,** this result also produced six new natural resource based workshops that were offered in 2010 and 2011 as part of Government Training Services' 2010 and 2011 *Working Nature into Land Use Decisions* series, started by the DNR in partnership with GTS in 2008. Workshop development and delivery necessitated that the DNR issue a Request for Proposals in February 2011 to find and select a consultant to assist the DNR with workshop development and execution. The consulting firm CR Planning was selected and worked with DNR's Community Conservation Assistance manager to design and deliver new workshops. An annual plan was also executed with Government Training Services (GTS) to utilize its experience with workshop logistics, registration, and program promotion and evaluation*. On selected workshops, NEMO (Nonpoint Education for Municipal Officials) and other consulting firms were engaged to design the workshop format and content

Collectively, all of these workshops increased the environmental awareness of 235 local government staff and officials from around the region about why consideration of natural resources is essential in local planning and ways to conserve nature locally.

The following workshops for local government were developed and offered:

- May 2010, **Shoreland Conservation in Urban Settings** was offered in Bloomington to 29 LGU participants (also given in Brainerd)

- June 2010 **Working Nature into Land Use Decisions** was given in Bloomington to 26 LGU participants
- March 2011,**Stormwater Management 101 for Local Leaders** was presented in Shoreview to 21 LGU participants
- April 2011, **Managing New and Existing Shoreland Development** was given in Shoreview to 24 LGU participants (also given in Brainerd)
- May 2011, **Planning and Designing with Nature for Planners and Engineers** was given in Roseville to 35 attendees
- June 2011, **Healthy Watersheds, Healthy Communities** was offered in Northfield to 29 LGU participants

A breakdown of workshop participants shows that 62% were from cities; 24% from counties and townships; and 14% from special districts, academia, consulting firms, and foundations. Workshop evaluations compiled by GTS were excellent for all workshops and a tally indicated that 47% of workshop attendees included the "hard to get" local Commissioners.

**An approved amendment dated January 29, 2010, authorized using $10,000 of the $30,000 originally allotted to contracts to provide technical assistance to communities via natural resource workshops offered through Government Training Services' (GTS) Working Nature into Land Use Series (2010, 2011).*

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Local Government	Project	Amount Awarded	Year
Corcoran	New and updated environmental zoning ordinances (conservation focused)	$24,000	2009
Hugo	Natural resource inventory to identify and prioritize future conservation areas east of highway 61 and to inform future sewer extension by the Met Council	$25,125	2010
Lake Elmo	Forest assessment and management strategies for Sunfish Lake Park	$8,306	2009
Lakeland	Update existing Vegetative Cutting Ordinance and draft a model ordinance that protects the scenic and natural values of the St. Croix River; combined with outreach to neighboring St. Croix communities	$18,000	2010
Minneapolis	Urban Tree Canopy mapping using LIDAR and satellite imagery to develop city-wide conservation and tree management strategies	$29,000	2009
North Branch	City-wide land cover inventory using MLCCS to identify higher quality remaining natural areas	$17,500	2010
Princeton	Rum River Recreation Area planning process among 6 townships to identify and create a trail system that interconnects green space along the river	$10,000	2010

St. Paul	Urban Tree Canopy mapping to document trees on private land and in uninventoried public spaces	$21,000	2009
Scott County	Inter-jurisdictional collaborative planning effort to protect the Blakely Bluff ecological corridor in the Minnesota River Valley	$11,000	2009
Scott County	Develop a Transfer of Development Rights Program through an open process that engages stakeholders as a future tool to protect important natural areas in the county	$25,000	2010
Sherburne County	Land cover inventory using MLCCS of four townships most likely to experience growth in the near future	$27,000	2010
Three Rivers Park District	Forest assessment and management strategies for regionally significant Murphy-Hanrehan Park	$12,000	2009
Woodbury	Urban Tree Canopy mapping to idenitfy locations to increase its tree canopy	$19,000	2009

ordinances
decision tools
inventories
mgmt plans

Final Budget Information for Result 3: **Trust Fund Budget: $ 295,000**
Amount Spent: $ 270,179
Balance: $ 24,821

$20,181 (7%) was used to administer grants for Result 3.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $ 123,629 was used for 1.0 unclassified FTE to administer and represent the Metro Greenways Program.
Contracts: $ 16,800 was used to hire subject matter experts for workshop design and facilitation; $10,000 was used to secure assistance in 2010 and 2011 with workshop promotion, set up, and evaluation by Government Training Services.
Equipment/Tools/Supplies: $ 0
Acquisition, including easements:
Travel: $ 0
Other: $78,622 was expended to restore 255 acres of upland habitat to prairie or savanna; $370,000 purchased land for a new park in Lindstrom MN and conservation easements on two parcels in Dakota County; and $ 223,198 helped support conservation by local governments through means other than acquisition (i.e., planning, policies, and practices).

TOTAL TRUST FUND PROJECT BUDGET: $1,175,000

Explanation of Capital Expenditures Greater Than $3,500: n/a

VI. PROJECT STRATEGY:

A. Project Partners: Local governments, special districts, consultants, University of Minnesota, and Metro Conservation Corridor Partnership (Friends of the Minnesota River Valley, Friends of the Mississippi, Great River Greening, Minnesota Land Trust, Minnesota Valley Natural Wildlife Refuge Trust, Trust for Public Land, and the MN DNR Fish and Wildlife and Scientific and Natural Areas Programs.)

B. Project Impact and Long-term Strategy: The Metro Greenways Program is based on the green infrastructure concept, which is a proactive and strategic approach to conservation that aims to recreate a web of natural lands in developed/developing landscapes. Initiated in 1998 with support of the Legislative Commission on Minnesota Resources (LCMR), the Metro Greenways Program has built support over the years for conservation among local governments over the years, to the extent that several counties and cities now have their own green infrastructure programs and/or have passed referenda to support local land conservation.

A key success of the Program, that has longer term applications, is the land cover inventories and mapping that were funded throughout the metro region by the Metro Greenways Planning Grant Program between 1998-2004. These land cover data continue to be used by local government in a variety of ways to plan for conservation and development.

With the passage of time, the Metro Greenways has worked with its partners to restore and protect habitat, but it has also recognized the importance of increasing awareness about conservation and providing conservation options for local government staff and officials, who control the myriad of land use decisions that occur daily. As Metro Greenways sunsets in 2011, the DNR's Community Conservation Assistance Program has also had an impact on how the agency thinks about conservation. Recognizing that the State owns and manages only 5% of the landscapes, the DNR has a heightened awareness that it needs to work side-by-side with local governments, using a wider variety of conservation approaches (policies, plans, practices), if the collective whole is to make a difference in conserving our resources for the future.

C. Other Funds Spent during the Project Period: $1,282,000 in local government cash or in-kind match.

D. Spending History:

M.L. 2009, Chp. 143, Sec. 2, Subd.4f2.6/3.4/4.1	$1,175,000
M.L. 2008, Chap. 367, Sec. 2, Subd. 3(a)	$950,000
M.L. 2007, Chap. 30, Sec.2, Subd. 4 (c)	$944,000
M.L. 2005, 1st Spec. Sess., Chap. 1, Art. 2, Sec. 11, Subd. 5(b)	$1,200,000
2005 Bonding	$500,000
M.L. 2001, 1st Spec. Sess., Chap 2, Sec. 2, Subd. 4(g)	$2,730,000

2000 Bonding	$1,500,000
1998 Bonding	$4,000,000

VII. DISSEMINATION:
Press releases were sent to local newspapers where projects were funded. The DNR convened all of the Community Conservation Assistance (CCA) project managers in November of 2009 and in February 2011 to share the findings of their conservation work. CCA Project Profiles were drafted and posted on the DNR website. Protection and restoration project information is available through the Metro Conservation Corridor partnership map created for public use. The CCA deliverables will be tried and tested as part of the Results Outcomes effort by the State of Minnesota.

VIII. REPORTING REQUIREMENTS: Final report 8/15/2011.

IX. RESEARCH PROJECTS: N/A

Attachment B1

EVALUATION CRITERIA CHECK LIST - 2009 Metro Greenways **Restoration** Grants

Project Number: ____________

Reviewer: ____________

Required Elements:

Local (non-state) cash or in kind match not less than 1:1

Metro Conservation Corridors are mapped within project area

	Points Awarded	10	7	4	0	Key Evaluation Criteria
1		highly appropriate	appropriate	somewhat appropriate	not appropriate	The **ecological community** is appropriate (i.e., the goal plant community once the project activities have been completed)
2		yes - most to all of the parcel	yes - but less than half of the parcel	no but within 1/2 mile	none	**Regionally Significant Environmental Areas** are mapped within the project area
3		yes - complete connection	yes -single break in the connection	multiple breaks in the connection	no	Project site **connects to** natural habitats
4		yes - high quality area	yes - moderate quality area	yes - low quality area	no	Project site **buffers** a natural area
5		highly compatible	compatible	somewhat compatible	not compatible	**Adjacent land use** is compatible* with protecting the project area * does not negatively affect the ecological structure or function
6		strong	moderate	slight	no	**Project budget, tasks and timeline** seem appropriate in the context of the project scope
7		strong	moderate	slight	no	**Restoration plan** matches target ecological community
8		strong	moderate	slight	no	Commitment and ability to carry out long term management
		Total Points (max 80)				

Attachment B2

EVALUATION CRITERIA CHECK LIST - 2009 Metro Greenways **Protection** Grants

Project Number: ______________

Required Elements: Local (non-state) cash or in kind match not less than 1:1
Metro Conservation Corridors are mapped within project area

Reviewer: ______________________

	Points Awarded	**10**	**7**	**4**	**0**	**Key Evaluation Criteria**
1		80 - 100%	50-79%	25-49%	0-24%	Percent of coverage of native communities on the project site (as mapped by MCBS, MLCCS or comparable Natural Resource Inventory)
2		overall outstanding	overall high	overall moderate	overall poor	Existing **cover condition** (as mapped by MCBS, MLCCS or comparable Natural Resource Inventory)
3		mapped within project area	mapped nearby	contains habitat	none	The site contains habitat for documented rare, endangered or threatened **wildlife species**
4		within project area	adjacent to the project (approx. <5mi)	within the region (>5 but<10)	> 10 miles	Site proximity to a **Regionally Significant Ecological Area**
5		connects high quality areas	connects moderate quality	connects lower quality areas	doesn't connect	The site **connects** natural habitat(s)
6		buffers high quality area	buffers moderate quality	buffers low quality area	doesn't buffer	The site **buffers** natural habitat(s)
7		> 500 acres	101 to 500 ac	26 to 100 ac	<25 acres	Proposed **size** of the final project area
8		highly compatible	compatible	somewhat compatible	not compatible	**Adjacent land use** is compatible* with protecting the project area * does not negatively affect the ecological structure or function
9		very likely	likely	not sure	unlikely	Project will be completed within the timeframe
		Total Points (max 90)				

Attachment B3

EVALUATION CRITERIA CHECK LIST - 2009 Metro Greenways
Community Conservation Assistance

Project Number:
Reviewer:

Required Elements:

Local (non-state) cash or in kind match not less than 25%

Project at least partially in Metro Conservation Corridors defined area

	Points Awarded	10	7	4	0	Key Evaluation Criteria
1		very clear	fairly clear	many unanswered questions	not clear	It is clear how the project deliverables will be used to conserve land and/or water resources in the near term
2		supports 4 or more local plans	supports 2-3 local plans	supports one other local plan	no	The project deliverables support conservation priorities identified in other local plans
3		MCBS or RSEA* and unimpaired waters	moderate quality habitats	low quality habitats	city scapes	Natural resources targeted for conservation
4		strong	adequate	minimal	none	Evidence of increasing pressures on the community's land and water resources
5		well covered	fairly well covered	brief, unclear mention	None/No mention	Need for collaboration with other jurisdictions (watersheds, joint powers, SWCD's, townships, etc)
6		yes	most likely	not likely	no	Project will be completed within the timeframe

Total Points (max 60 points)

* MCBS= Mn County Biological Survey; RSEA = Regionally Significant Ecological Area

Attachment A: Final Budget Detail for 2009 Project
Project Title: MeCC - Metro Greenways

Project Manager Name: Sharon Pfeifer

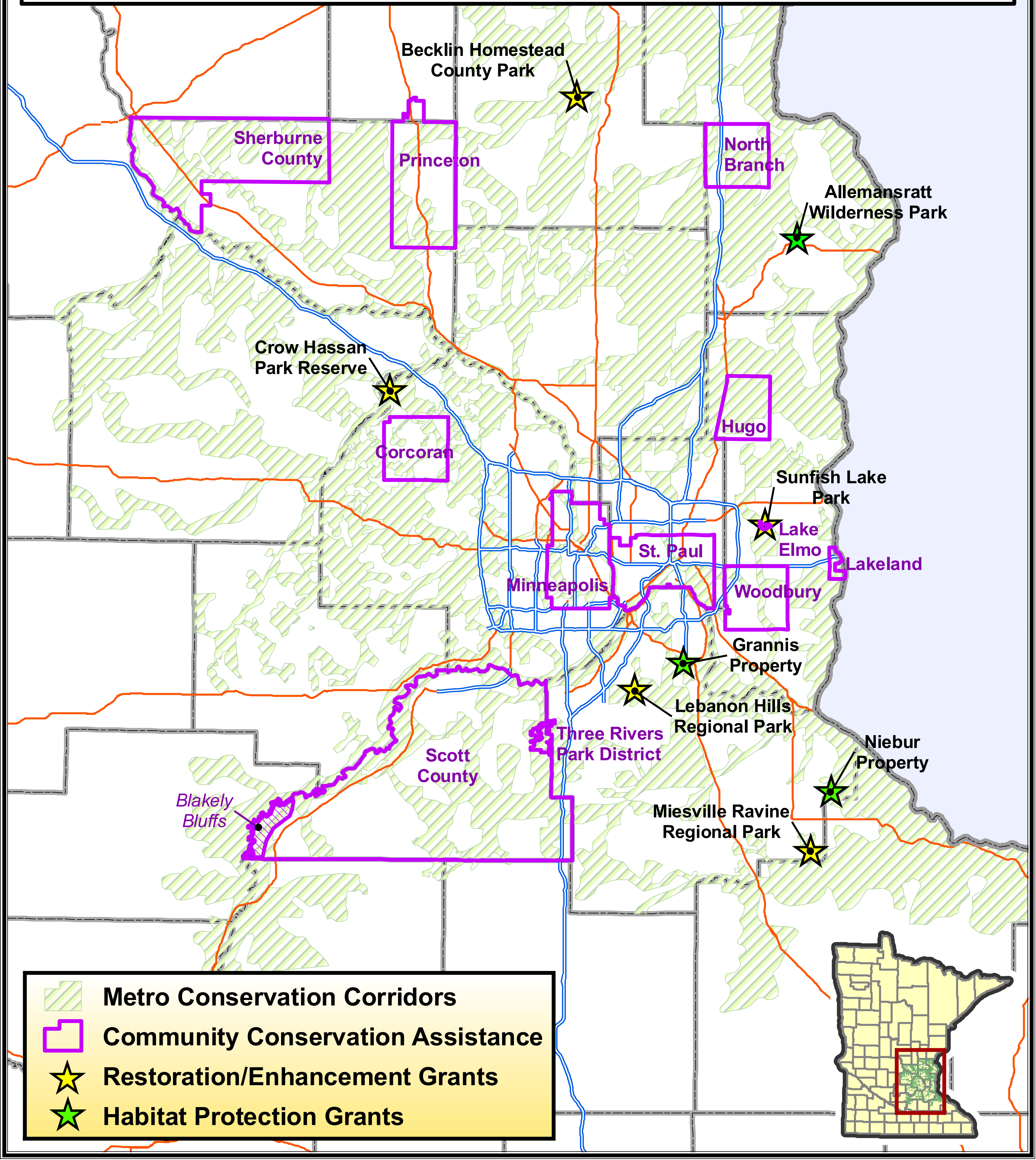
Trust Fund Appropriation: $1,175,000 (original); $938,045 following amendments to transfer funds to DNR's SNA Program

Amendment approved 10/29/2010
Amendment approved 2/18/2011

2009 Trust Fund Budget	**Budgeted**	**Spent**	**Balance**	**Budgeted for Revised Result**	**Spent**	**Balance**	**Budgeted**	**Spent**	**Balance**	**Total Budgeted for all results**	**Totals Spent**	**Total Balances**
Budget Item	**Result 1: Restore and Enhance Significant Habitat**			**Result 2: Protect Significant Habitat**			**Result 3: Other Conservation Tools**					
Personnel: wages and benefits 1 FTE + benefits for 2 years	10,000	10,470	-470	93,045	92,978	67	17,000	20,181	-3,181	120,045	123,629	-3,584
Professional/technical Contracts												
$ 20,000 for 2 to 6 contracts with technical experts such as CR Planning, Brauer and Associates, and others to be identified as needed to help local units of government apply conservation tools other than acquisition.							20,000	16,800	3,200	20,000	16,800	3,200
$10,000 to provide technical assistance to communities via natural resource workshops offered through Government Training Services' (GTS) Working Nature into Land Use Series (2010, 2011).							10,000	10,000	0	10,000	10,000	0
Other Grants to local units of government	90,000	78,622	11 ,378	450,000	370,000	80,000	248,000	223,198	24,802	788,000	$671,820	116,180
Grand Totals and Remaining Balances	$100,000	$89,092	**$10,907**	$543,045	$462,978	**$80,067**	$295,000	$270,179	**$24,821**	$938,045	822,249	**$115,796**

METRO CONSERVATION CORRIDORS PHASE V

Metro Greenways Completed Projects



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: **Metro Conservation Corridors – Phase V: Scientific and Natural Area Restoration and Acquisition (4f) – (2.7 & 3.6)**

PROJECT MANAGER: Margaret (Peggy) Booth
AFFILIATION: DNR Division of Ecological & Water Resources
MAILING ADDRESS: 500 Lafayette Rd, Box 25
CITY/STATE/ZIP: St Paul, MN 55155-4025
PHONE: 651-259-5088
E-MAIL: peggy.booth@state.mn.us
WEBSITE: www.mndnr.gov/snas

FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4(f) 2.7 & 3.6

APPROPRIATION AMOUNT: $646,955

Overall Project Outcome and Results

Nearly 150 acres of high quality native habitat threatened by urban development was acquired and added to two metro Scientific and Natural Areas (SNAs). First, 80 acres were acquired (36.7 acres pro-rated to this appropriation) and added to the Hastings Sand Coulee SNA. The addition contains native oak savanna and prairie and increases this SNA to 267 acres. Thus, more than half of this largest remaining prairie complex in Dakota County is protected for its 13 resident rare species (including 3 snake and 2 butterfly species) and for public use, including hiking and nature observation. Second, about 70 acres – including public fishing frontage on the Credit River – was acquired (6.2 acres pro-rated to this appropriation) and added to the Savage Fen SNA in Scott County. These sites offer urban residents close-to-home nature-based recreation, including a new archery hunting opportunity on 300 acres at Savage Fen SNA.

SNA restoration and enhancement activities were completed on 187 acres at 13 SNAs in 7 counties in the greater metropolitan area. For example, a 55-acre prairie was reconstructed (restored) at Lost Valley Prairie SNA with the help of volunteers and a Sentence-to-Serve crew using seed collected on site by hand and mechanically harvested by the SNA crew. Almost 100 acres was prescribed burned at 5 SNAs. About 34 acres received invasive species control actions, including work by Conservation Corps Minnesota. These activities result in better habitat for the SNAs' rare features and improved quality for users of SNAs.

Project Results Use and Dissemination

Information about Scientific and Natural Area (SNA) sites, including those SNAs with new acquisition, restoration, enhancement and development activities through this appropriation, is available on the DNR website (www.mndnr.gov/snas). DNR-sponsored volunteer events, such as those involved in the Lost Valley Prairie, are regularly posted at: www.dnr.state.mn.us/volunteering/sna/index. Both of the acquisition projects received publicity in local newspapers and in partner organization newsletters. Specifically, Savage Fen SNA acquisition was publicized in the *Shakopee Valley News* and in the Trust for Public Land's electronic newsletter and electronic invite. The Hastings Sand Coulee SNA acquisition was referenced in articles in the *Hastings Gazette* and the Friends of the Mississippi River website.

Environment and Natural Resource Trust Fund
2008 Final Work Program and 2009 Final Work Program

Date of Report: August 25, 2011
Final Report

	M.L. 2008	M.L. 2009
Date of Work program Approval:	June 10, 2008	June 16, 2009
Project Completion Date:	June, 30 2010	June 30, 2011

I. PROJECT TITLE: **Metro Conservation Corridors – Phase IV – Scientific & Natural Areas (3a) - (2.5 & 3.6) [M.L. 2008]**
Metro Conservation Corridors – Phase V: Scientific and Natural Area Restoration and Acquisition (4f) – (2.7 & 3.6) [M.L. 2009]

Project Manager: Margaret (Peggy) Booth
Affiliation: DNR Division of Ecological Resources
Mailing Address: 500 Lafayette Rd, Box 25
City / State / Zip : St Paul, MN 55155-4025
Telephone Number: 651-259-5088
E-mail Address: peggy.booth@state.mn.us
FAX Number: 651-296-1811
Web Page address: www.dnr.state.mn.us/snas

Location: Current and proposed Scientific and Natural Areas within mapped Focus Area in the counties of Anoka, Carver, Chisago, Dakota, Goodhue, Hennepin, Isanti, LeSueur, Nicollet, Ramsey, Rice, Scott, Sherburne, Sibley, Washington and Wright. See Figure 1

Total Trust Fund Project Budget:	M.L. 2008	M.L. 2009	Total
Trust Fund Appropriation:	$358,000	$646,955	$1,004,955
Minus Amount Spent:	$358,000	$645,397	$1,003,397
Equal Balance:	$0	$1,558	$1,558

Legal Citation:
M.L. 2008, Chap. 367, Sec. 2, Subd. 3(a) 2.5 & 3.6
Appropriation Language:
$3,150,000 is from the trust fund to the commissioner of natural resources for the fourth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $1,915,000 is for Department of Natural Resources agency programs and $1,235,000 is for agreements as follows: $475,000 with the Trust for Public Land; $92,000 with Friends of the Mississippi River; $111,000 with Great River Greening; $225,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $107,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management

standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement.

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4(f) 2.7 & 3.6

Appropriation Language:

$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY:

M.L. 2009 – FINAL ABSTRACT

Nearly 150 acres of high quality native habitat threatened by urban development was acquired and added to two metro Scientific and Natural Areas (SNAs). First, 80 acres were acquired (36.7 acres pro-rated to this appropriation) and added to the Hastings Sand Coulee SNA. The addition contains native oak savanna and prairie and increases this SNA to 267 acres. Thus, more than half of this largest remaining prairie complex in Dakota County is protected for its 13 resident rare species (including 3 snake and 2 butterfly species) and for public use, including hiking and nature observation. Second, about 70 acres – including public fishing frontage on the Credit River – was acquired (6.2 acres pro-rated to this appropriation) and added to the Savage Fen SNA in Scott County. These sites offer urban residents close-to-home nature-based recreation, including a new archery hunting opportunity on 300 acres at Savage Fen SNA.

SNA restoration and enhancement activities were completed on 187 acres at 13 SNAs in 7 counties in the greater metropolitan area. For example, a 55-acre prairie was reconstructed (restored) with the help of volunteers and a Sentence-to-Serve crew using seed collected on site by hand and mechanically harvested by the SNA crew. Almost 100 acres was prescribed burned at 5 SNAs. About 34 acres received invasive species control actions, including work by Conservation Corps Minnesota. These activities result in better habitat for the SNAs' rare features and improved quality for users of SNAs.

<u>M.L. 2008 – FINAL ABSTRACT</u>

A new state Scientific and Natural Area (SNA) unit was acquired and designated as part of the State Outdoor Recreation System and almost 270 acres of restoration and enhancement activities were completed on existing SNAs. Specifically, a 47.9 acre parcel (including funding through the federal State Wildlife Grant, 34.58 acres pro-rated to this appropriation) in southeast Isanti County was acquired and designated as the new Twin Lakes SNA. It features white pine-hardwood forest of high biodiversity significance and 1450' of Horseshoe Lake shoreline and provided habitat for state threatened Blandings turtles and for state special concern red-shouldered hawks. Restoration and enhancement activities (prescribed burning and invasives treatment) were completed on 266.7 acres, plus .4 miles of deer exclosure fencing was reconstructed – resulting in native habitat enhancement at 11 SNAs in 6 counties within the Metro Conservation Corridors.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: SNA Restoration & Enhancement

Description: The SNA Program and partners will restore and enhance native habitat on approximately 50 acres (20 acres with M.L. 2008 funding and 30 acres with M.L. 2009 funding; partner acres and other funding not counted here). Any planting will use seeds or plant stock of local ecotype collected within about 20 miles of the restoration. This work will directly contribute towards achievement of restoration of degraded and rare land features (particularly native prairie, savanna, and forest) needed to support Species of Greatest Conservation Need (SGCN) and thereby helps achieve Habitat Recommendation 5 of the SCPP.

Under the 2008 appropriation, work will be targeted to projects on SNAs with critical habitat restoration needs, such as:

- fen restoration (e.g. woody encroachment removal/treatment and prescribed burning) at proposed Seminary Fen SNA (Carver Co), Black Dog Preserve SNA (Dakota Co) and/or Savage Fen SNA (Scott Co);
- prairie and savanna restoration (e.g. woody encroachment removal/treatment and prescribed burning, seed collection, and/or planting) at Grey Cloud Dunes SNA and Lost Valley Prairie (Washington Co), Rice Lake Savanna SNA (Sherburne Co), River Prairie Terrace SNA, Spring Creek Prairie SNA, and Cannon River Turtle Preserve SNA (Goodhue Co); and/or Pine Bend Bluffs SNA and Hastings Sand Coulee SNA (Dakota County); and

- white pine-hard forest restoration (e.g. deer exclosure construction, seed collection, and/or propagation) at Boot Lake SNA (Anoka Co) and/or Falls Creek SNA (Washington Co).

Additional site development and habitat restoration work may be done at SNAs, e.g. Wolsfeld Woods, Wood-Rill, Mary Schmidt Crawford Woods, Clear Lake, Chamberlain Woods, Uncas Dunes, Harry W Cater Homestead Prairie, and those listed above.

Under the 2009 appropriation, all SNAs within the mapped Metro Corridors are candidates for restoration, enhancement, and development work, with the highest priority sites (to date) listed in Table and highlighted in Figure 1.

Activities for restoration, development, and native habitat enhancement purposes and to bring sites acquired up to minimum standards will be carried out by SNA program or other Department crews, Minnesota Conservation Corps (MCC), Sentence to Service personnel, volunteers, and/or contractors. This includes activities, such as seed collection, site preparation, planting, establishment period maintenance, removal and treatment of exotics, control of woody encroachment, site clean-up, signing, deer exclosures and other fencing, prescribed burns, and updating of management plans or completion of new adaptive management plans for targeted sites. Opportunities will be cultivated to complete cooperative projects with other MeCC partners with results reported for all non-duplicated acres with activities accomplished through these funds (e.g. acres of exotics removed or treated, miles of burn breaks installed or acres of prescribed burns, acres of seed harvest, acres planted, etc. All restoration will use seeds or plants of a local ecotype, collected whenever possible from onsite or within 25 miles.

Summary Budget Information for Result 1:

	M.L. 2008	**M.L. 2009**	**Total**
Trust Fund Budget:	**$61,335**	**$65,000**	**$126,335**
Amount Spent:	**$61,335**	**$64,580**	**$125,915**
Balance:	**$0**	**$420**	**$420**

Deliverable	**Completion Date**	**Budget**
1. M.L. 2008: 20 acres restoration activities (includes restoration/reconstruction, invasives species control & woody encroachment removal, prescribed burning, and site development)	June 30, 2009	$61,335 *(revised to reflect final $s spent)*
2. M.L. 2009: ~10 acres restoration/reconstruction	June 30, 2011	$11,000
3. M.L. 2009: ~20 acres invasive species control & woody encroachment removal	June 30, 2011	$12,000
4. M.L. 2009: ~120 acres prescribed burning	June 30, 2011	$24,000 *(allocation increased)*
5. M.L. 2009: site development at ~ 4 SNAs	June 30, 2011	$7,000

6. M.L. 2009: ~ 2 management plan (updates or new)	March 1, 2011	$11,000

Note: 2009 $s increased primarily to reflect additional $5,000 from DNR Metro Greenways as per work program amendment.

Completion Date: M.L. 2008: June 30, 2009; M.L. 2009: June 30, 2011

M.L. 2008 Final Report Summary: Restoration and enhancement activities (prescribed burning and invasives treatment) were completed on 266.7 acres, plus .4 miles of deer exclosure fencing was reconstructed – resulting in native habitat enhancement at 11 SNAs in 6 counties – see Table 1a.

M.L. 2009 Final Report Summary: SNA restoration and enhancement activities completed include: prairie reconstruction, prescribed burning, and invasives treatment on 187 acres; development projects on 4 sites (signs, fencing, site cleanup, etc), and one new Adaptive Management Plan and Inventory – resulting in native habitat enhancement and site improvements at 13 SNAs in 7 counties – see Table 1b and the map in Figure 1.

Specifically, a 55-acre prairie reconstruction project was completed at Lost Valley Prairie SNA involving volunteers, Sentence-to-Serve, and SNA staff harvesting on-site seed by hand and with ATV and flail vac equipment; seeding this seed both with equipment broadcasting it across the snow and also by hand; and initial mowing. Invasive species control activities included 18 acres of tree-shrub removal/treatment (primarily buckthorn) on 18 acres at 8 sites; and pulling or spraying herbaceous/seedling invasives on 16 acres at 4 sites. Prescribed burns were completed on 98 acres at 5 sites. Also, additional burn plans were completed, burn breaks installed, and partner burns assisted – but not counted here. Site development work at 4 sites included: almost 1 mile of fence repair to prevent ATV use and habitat damage; and installation of boundary signs at the new addition at Lost Valley Prairie SNA. Finally, this funding contributed towards completion and approval of 16 burn-unit plans; and completion of one comprehensive management plan. The later comprehensive, 80+ page Adaptive Management Plan and Inventory for Hastings Sand Coulee was completed by Friends of the Mississippi River (contracted through a competitive bid process). It was targeted due to the Hastings Sand Coulee SNA's substantial expansion (see below) and because the SNA did not previously have a full management plan.

Result 2: SNA Acquisition

Description: Through the M.L. 2008 appropriation, the SNA program will acquire and designate as SNA approximately 47 acres (and leverage about 13 acres of acquisition through partner funds – totaling about 60 acres protected) of high priority habitat, i.e. shoreland, riparian land, and other lands critical to implement the State Wildlife Action Plan and protect water quality and rare features.

Through the M.L. 2009 appropriation, about 30 acres of high quality native habitat within the Metro Corridors mapped corridors will be acquired and designated as

Scientific and Natural Area (SNA). This will protect rare and endangered plant and animal species, undisturbed plant communities, and geological features, and provide for their public use for scientific study, education, and nature observation.

Very high priority parcels within sites of biodiversity significance will be targeted for protection that have been identified by the Minnesota County Biological Survey, approved as qualifying as SNA by the Commissioners Advisory Committee, are critical to meeting the SNA Long Range Plan, and which help fulfill Habitat Recommendations 1 and 3 of the Statewide Conservation and Preservation Plan (SCPP). Project sites are selected using two sets of criteria a) importance of site for protecting the rare features (e.g. its rareness on national or state scale; its quality and genetic diversity; degree of threat; and protection status in subsection) and b) practical considerations (e.g. feasibility of managing site; landowner willingness; funding for protection and management; and use for research and education).

Through the M.L. 2008 and 09 funding, all or part of about 2-5 sites would be protected at estimated costs of $5,000 to $15,000/acre depending on appraised land values in the location(s) being acquired. These funds would be targeted at sites that will not be protected through currently available ENRTF and bonding funds within the Metro Conservation Corridors mapped corridors – particularly sites with opportunities for collaboration with other MeCC partners. Specifically, to date the sites have been identified as conservation priorities for potential acquisition under this grant are listed in Table 2 and shown in Figure 1. [*Note: Table 2 is not included with FINAL REPORT.*]

Summary Budget Information for Result 2:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$296,665**	**$581,955**	**$878,620**
Amount Spent:	**$296,665**	**$580,817**	**$877,482**
Balance:	**$0**	**$1,138**	**$1,138**

Deliverable	Completion Date	Budget
1. M.L. 2008: 34.6 acres acquired & designated SNA *Note: $ reduced to 65% original & acres reduced to 72% original as per work program amendment moving $s to DNR Fisheries*	June 30, 2009	$296,665 *(revised)*
2. M.L. 2009: 40 acres acquired & designated SNA *Note: acres & $s increased to reflect additional $231,955 from DNR Metro Greenways as per work program amendment*	June 30, 2011	$581,955 *(revised)*

Completion Date: M.L. 2008: June 30, 2009; M.L. 2009: June 30, 2011

M.L. 2008 Final Report Summary The final outcome of Result 2 (2008 appropriation) is acquisition of a 47.9 acre parcel (34.58 acres pro-rated to this 2008 appropriation – including all transaction and staff costs spent paid for with this 2008 appropriation for all acquisition projects pursued under this appropriation). Specifically, acquisition of the 47.9 acre parcel featuring white pine-hardwood forest of high biodiversity significance and 1450' of Horseshoe Lake shoreline in southeast Isanti County closed and was designated as the Twin Lakes SNA on June 28-29, 2010. In addition to monies through this 2008 appropriation, $114,250 of federal State Wildlife Grant funds contributed to the landowner payment for the Twin Lakes site.

The remainder of this 2008 appropriation (plus some funds from this 2009 appropriation) were allocated to a second 63-acre Twin Lakes acquisition. The offer made in February and a subsequent counter-offer were rejected by the landowner in May 2010.

M.L. 2009 Final Report Summary: Additions to two SNAs totaling 148.5 acres (42.9 acres pro-rated to this 2009 appropriation based upon landowner payments only – amounts and funding source of all transaction costs will be reported separately). First, in November 2010, at Savage Fen SNA in Scott County, DNR cooperated with the Trust for Public Land to acquire a 68.5-acre addition (6.2 acres pro-rated to this 2009 appropriation to the SNA – see table below) which features MCBS-mapped wetland communities which are integrally part of the calcareous fen complex, MCBS-mapped hardwood forest bluffs above the fen complex, and frontage on the Credit River. This addition to the SNA and a transfer of land from USFWS to DNR SNA is enlarging Savage Fen SNA to about 300 acres – which through a public hearing process – is open in 2011 to archery hunting for its habitat improvement (herbivory control) and recreation opportunity.

Second, using in part about $232,000 reallocated from Metro Greenways 2009 appropriation, an acquisition of another SNA addition was completed in June 2011. Specifically, the DNR acquired in an 80-acre addition (36.7 acres pro-rated to this 2009 appropriation to the SNA – see table below) to the Hastings Sand Coulee SNA in Dakota County. The parcel acquired features MCBS-mapped dry sand-gravel prairie and a large (but degraded) area of native oak savanna.

This funding was also used to initiate another 25.6-acre addition to the Hastings Sand Coulee SNA done in cooperation with the Friends of the Mississippi River that ended up being acquired with the 2009 ENRTF SNA statewide appropriation. These two new additions to the Hastings Sand Coulee SNA along with the transfer of about 78 acres from WMA to SNA, brings the SNA to a total of 267 acres – over half of the largest remaining prairie complex in Dakota County which is home to 13 rare species including 3 snakes and 2 butterflies.

Through this funding, an offer was made in 2010 on an addition to Seminary Fen SNA, but turned down by the landowner. The balance remaining in this appropriation for Result 2 ($1,138) is because of lower costs than anticipated for the Hastings Sand Coulee addition's attorney general and closing costs.

Savage Fen SNA addition			
Total acres acquired as SNA:	68.49		
Funding Source	**Landowner Payment**	**%**	**Pro-Rated Acres**
OHF- Big Rivers Partnership (TPL)	$ 1,500,000.00	43.0%	29.4
ENRTF- TPL MeCC 2009 ENRTF- TPL MeCC 2010	$ 552,000.00	15.8%	10.8
Landowner donation	$ 490,000.00	14.0%	9.6
TPL-Landowner Subtotal	**$ 2,542,000.00**		
RIM	$ 300,000.00	8.6%	5.9
Bonding - SNA 2006	$ 289,506.55	8.3%	5.7
ENRTF- SNA MeCC 2009	**$ 315,000.00**	**9.0%**	**6.2**
ENRTF- SNA 2010	$ 43,493.45	1.2%	0.9
DNR Subtotal	**$ 948,000.00**		
TOTAL	**$ 3,490,000.00**	**100.0%**	**68.5**

Hastings Sand Coulee SNA - Holst addition			
Total acres acquired as SNA:	80		
Funding Source	**Landowner Payment**	**%**	**Pro-Rated Acres**
Dakota County - FNAP	$ 50,000.00	10.4%	8.3
Non-State Subtotal	**$ 50,000.00**		
Bonding - SNA 2008 Prairie	$ 61,800.00	12.9%	10.3
ENRTF- SNA MeCC 2009	**$ 220,000.00**	**45.8%**	**36.7**
ENRTF- SNA 2009	$ 148,200.00	30.9%	24.7
DNR Subtotal	**$ 430,000.00**		
TOTAL	**$ 480,000.00**	**100.0%**	**80.0**

V. TOTAL TRUST FUND PROJECT BUDGET:

M.L. 2008

Staff or Contract Services: $58,903 – unclassified acquisition staff – ≤ 0.1 FTE paid exclusively from project funds; and classified DNR crew – equivalent to 0.8 FTE for 1 year – and seasonal burn crew – approx. 7 laborers for 3 weeks).

Equipment: $2,545 (fleet charges and incidental parts for trucks and field equipment).

Development and Restoration: $2,945 (materials and supplies, such as fencing, signs, etc and instate travel needed for restoration and development work by crews)

Acquisition, including easements: $268,650 (towards fee acquisition of about 34 acres) PLUS $24,824 of related real estate transaction costs for this and other projects under this appropriation and $133 of acquisition related instate travel expenses – not including personnel listed above)

Other: NA

TOTAL TRUST FUND PROJECT BUDGET: $358,000 *[reduced from $515,000 with $157,000 transferred to DNR Fisheries].*

M.L. 2009

Personnel: $62,746 (for classified and unclassified SNA program & other DNR staff paid almost exclusively with special project funds: ~ 0.06 FTE acquisition specialist; up to ~0.04 FTE management plan writer- coordinator – new position; up to ~ 0.2 FTE specialists and technicians; and ~ 0.3 FTE laborers and seasonal crews) – *including about $5,000 transferred from DNR Metro Greenways*.

Contracts: $6,903 (MCC and contractors selected through bid process to complete restoration and development projects and SNA adaptive management plan).

Equipment/Tools/Supplies: $2,299 (truck & equipment fleet charges & incidental parts; materials and supplies, such as fencing, signs, gloves, PPE, chemical, etc.)

Acquisition, including easements: $574,648 (towards fee acquisition of about 40 acres to be owned by DNR & designated SNA; including related real estate transaction costs for all projects initiated through this appropriation – *including addition majority of funds transferred from DNR Metro Greenways*).

Travel: $359 (instate travel as needed by land acquisition specialists evaluating site & negotiating with landowners & as needed by project staff for restoration & development work.)

Other:

TOTAL 2009 TRUST FUND PROJECT BUDGET: $646,955 s*[increased from $410,000 with $236,945 transferred from DNR Metro Greenways].*

Explanation of Capital Expenditures Greater Than $3,500: NA

VI. OTHER FUNDS & PARTNERS:

A. Project Partners:

M.L. 2008 & M.L. 2009

SNA will develop and implement its projects in cooperation with Metro Greenways, Friends of the Mississippi River, Friends of the Minnesota Valley, Great River Greening, The Trust for Public Land, and local partners. SNA may also involve the Minnesota Conservation Corps, Sentence to Serve, local groups, and volunteers in project implementation.

B. Other Funds Proposed to be Spent during the Project Period:

M.L. 2008 & M.L. 2009

Restoration/enhancement project work will be supplemented by bonding (estimated at $100,000 not listed as match) and NGO partners using other state or non-state funds (not listed as match). Acquisitions under the M.L. 2008 appropriation are expected to leverage non-state funding and/or landowner donations (estimated at $125,000, listed in Table A of overall Metro Corridors proposal) and be supplemented as needed by state bonding (not listed as match). Funding sources used for acquisition projects done through these appropriations and pro-rated acreages will be reported in work program updates.

C. Spending History:

SNA acquisition, restoration and development project funding targeted at the Metro Corridors received in CY 2005-2008: LCCMR – 2007 SNA Metro Corridors $243K and 2008 SNA Metro Corridors $515K; other State appropriations – RIM Match $78K; federal funds – LAWCON $384K; non-state funds Dakota County $566K and other partner contributions & landowner donations._The SNA program general fund includes approximately $400,000 annually for statewide operations and crew.

D. Time: M.L. 2008: July 1, 2008 – June 30, 2010; M.L. 2009: July 1, 2009 – June 30, 2011.

E. Project Impact and Long-term Strategy:
This project will help protect and perpetuate rare species, SGCNs, and natural features of state significance at 12-17 SNA sites within the Metro mapped corridors the state selected because of their importance and strategic value in protecting these rare resources. As a part of the State Outdoor Recreation system, all of these sites are managed as state SNAs that provide public access and opportunities to the public for nature observation and study.

The SNA Long Range Plan has a goal of protection through SNA designation within each ecological subsection of five occurrences of each native plant community (NPC) and three occurrences of each natural heritage element found in that subsection. The Division of Ecological Resources is in the process of using the recently revised Native Plant Community Classification system to assess the extent of protection for each NPC per subsection – looking at both numbers of occurrences (NPC polygons) and acreage protected. This demonstrates a substantial need for more SNA land acquisition and native habitat restoration/development for at least the next 2 decades. Towards this end, the Division could readily utilize support from the Environment and Natural Resources Trust fund and/or the Lessard Outdoor Heritage Council of $2M to $8M per biennium over this timeframe.

VII. DISSEMINATION: SNA in cooperation with its partners will issue a press release and/or publicize a dedication event for each acquisition completed through this project. Other dissemination of information will be through Metro Corridors partnership, Embrace Open Space, and on the Metro Corridors website.

VIII. REPORTING REQUIREMENTS:
Periodic work program progress reports will be submitted not later than February 1st and August 1st of each year. A final work program report and associated products for M.L. 2008_will be submitted no later than August 1, 2010 as requested by the LCCMR and a final work program report and associated products for M.L. 2009 will be submitted no later than August 1, 2011.

IX. RESEARCH PROJECTS: NA

Attachment A: FINAL Budget Detail for 2009 Project — FINAL 8/19/11

Project Title: Metro Conservation Corridors - Phase V: Scientific & Natural Area Restoration and Acquisition

Project Manager Name: Margaret (Peggy) Booth

Trust Fund Appropriation: $ 410,000 + 236.954.60 (fr Metro Greenways - MGW) = 646,954.60

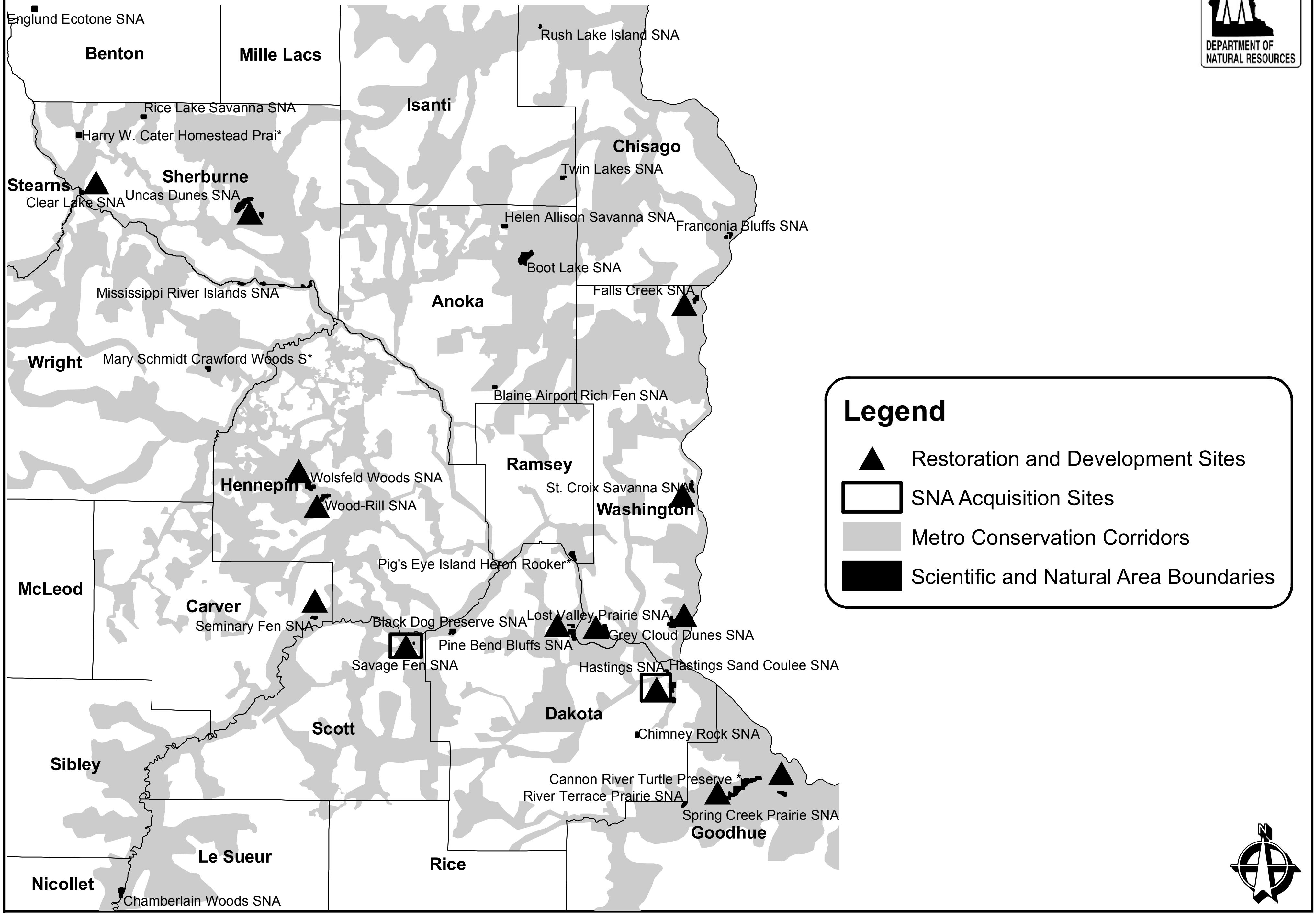
2009 Trust Fund Budget	Result 1 Budget:	Amount Spent *(6-30-11)*	Balance *(6-30-11)*	Result 2 Budget:	Amount Spent *(6-30-11)*	Balance *(6-30-11)*	TOTAL BUDGET	TOTAL BALANCE
	Restoration & Development			**Acquisition & Designation**				
BUDGET ITEM								
PERSONNEL: wages and benefits for classified and unclassified SNA program staff paid almost exclusively with special project funds: ~ 0.06 FTE acquisition specialist; up to ~0.04 FTE management plan writer-coordinator – new position; up to ~ 0.2 FTE specialists and technicians; and ~ 0.3 FTE laborers and seasonal crews	55,498	55,498	0	7,248	7,248	0	62,746	1
Contracts								
Other contracts: MCC and contractors selected through bid process as needed to complete restoration and development projects and preparation of adaptive management plans	6,903	6,903	0			0	6,903	0
Non-capital Equipment / Tools: truck & equipment fleet charges & incidental parts	2,000	1,924	76	0	0	0	2,000	76
Land acquisition			0	535,000	535,000	0	535,000	0
Real Estate Transaction Costs (e.g. professional services, survey, AG, title, recording, etc)			0	39,648	38,510	1,138	39,648	1,138
Supplies: restoration & development materials and supplies, such as fencing, signs, gloves, PPE, chemical, etc.	299		299			0	299	299
Travel expenses in Minnesota	300	255	45	59	59	0	359	45
COLUMN TOTAL	**$65,000**	**$64,580**	**$420**	**$581,955**	**$580,817**	**$1,138**	**646,955**	**1,558**

Note: the budget above has been adjusted with **reductions** in equipment (fleet) reduced from $3500 to $2000; acquisition from $540K (post-MGW additional $s) to $535K; real estate costs from $39,946 to $39,648; supplies from $2500 to $299; & travel from $1500 to $359, and **increases** for staff from $48,500 to $62,746, and contracts from $4000 to $6903

Table 1b. 2009 SNA - METRO CORRIDORS - Restoration & Development Activities - ACCOMPLISHMENTS
FINAL REPORT

SNA Name	County	SITE COUNTED AS ENHANCED THROUGH THIS PROJECT (other sites - rows grayed out)	General Target Native Plant Community Type (Reconstruction)	Acres Completed - July 1, 2009 -June 30, 2011: Native Plant Community Reconstruction (acres)	Woody Encroachment-Invasives Removal (acres)	Prescribed Burning (acres)	Burn Break (miles) - not included in overal total	Non-Woody or Seedling Invasives Control (acres)	Boundary signs and fencing (miles)not included in overal total	Development	TOTAL (non-duplicated estimate)	COMMENTS (including regarding other work done, not measured in miles or acre)
Black Dog Preserve	Dakota		fen & prairie				1.0				0	Burn plan written and approved; NOT BURNED: conditions too wet & green to burn.
Boot Lake	Anoka		oak/white pine forest				1.0				0	Burn plan written and approved; NOT BURNED: not prescribed wind
Cannon R Turtle Prairie	Goodhue	1	floodplain forest		1	2	1.0				3	Two unit burn plans written and approved; 1 unit BURNED
Clear Lake	Sherburne	2								1	0	parking area moving & mgmt
Falls Creek	Washington	3	oak/pine forest							1	1	site cleanup & parking area mowing & mgmt
Grey Cloud Dunes	Washington	4			5	61	1.0		0.9	1	66	Two unit burn plans written and approved; BURNED IN 2010 (1 unit) & in 2011 (2 units); .9 miles fence repaired to prevent ATV use & habitat damage
Harry Cater Homestead	Sherburne					***					0	Burn plan written; other funding used for burn
Hastings Sand Coulee	Dakota	5	prairie		1	***					0	Two unit burn plans written and approved; burn done by contractor through FMR who counted acres; full management plan completed
Lost Valley Prairie	Washington	6	prairie	55	1	21	1.0		1.0		77	Two burn plans written and approved; BURNED IN 2010; new unit signed; seed harvest, planting & mowing.
Rice Lake Savanna	Sherburne		savanna			***	1.0				0	Burn plan written; other funding used for burn
Savage Fen	Scott	7						3			3	
Seminary Fen	Carver	8	savanna			***	0.5	3		1	3	Burn plan written and approved; other funding used for burn; site cleanup
Spring Creek Prairie	Goodhue	9			7	4	1.5				11	Two unit burn plans written and approved.
St. Croix Savanna	Washington	10	prairie		1	10	1.0	8			19	Three unit burn plans written and approved.
Uncas Dunes	Sherburne	11	savanna		***	***					0	SNA staff technical support for woody biomass project. Burn plan written & contractor assisted with burn (burn acres counted by GRG)
Wolsfeld Woods	Hennepin	12	maple-basswood forest		1			2			3	Includes MCC contract
Wood-Rill	Hennepin	13	maple-basswood forest		1						1	
TOTAL acres				55	18	98	9.0	16	1.9	4	187	

Figure 1. Metro Conservation Corridors - Phase V (2009)
Scientific & Natural Areas - Restoration, Development & Acquisition



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Fish and Wildlife Habitat Restoration (2.9)/ Fish and Wildlife Land Acquisition (3.5)
Metropolitan Conservation Corridors
PROJECT MANAGER: Mike Halverson
AFFILIATION: MN DNR – Division of Fish & Wildlife
MAILING ADDRESS: 500 Lafayette Rd.
CITY/STATE/ZIP: St. Paul, MN 55155
PHONE: (651) 259- 5209
FAX: (651) 297-4916
E-MAIL: mike.halverson@state.mn.us
WEBSITE:
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chap. 143, Sec. 2, Subd. 4f 2.9/3.5

APPROPRIATION AMOUNT: $500,000

Overall Project Outcome and Results

This project had a two pronged focus. **Result 1** (4f2.9) focused on a trout stream habitat restoration project located within Vermillion River Aquatic Management Areas (AMA), in Dakota County. This stretch of the Vermillion River channel had been altered by ditching. **Result 2** (4f3.5) focused on securing fee title parcels on the Vermillion River in Dakota County and Eagle Creek in Scott County. Parcels include habitat linkages that provided environmental protection of the shoreline and riparian zone, exhibit a high risk of development, supply angler access, and afford management access necessary for implementing habitat improvement projects. Project goals were to restore 0.6 miles of stream habitat and acquire 60 acres with 1.0 mile of shoreline. Partner funding includes donations of land value and cash.

Result 1 (4f2.9): Restoration of 0.9 miles of Vermillion River channel. Environmental and Natural Resources Trust Fund (ENRTF) dollars directly restored approximately 0.44 miles of the total restored channel. Other State dollars (TU OHC = $140,000) restored 0.41 miles, and other funding (Vermillion River Watershed = $20,000) restored 0.05 miles of the total.

Result 2 (4f3.5): Acquisition of four parcels with a grand total of approximately 50.5 acres and 1.1 miles of stream shoreline. Because of the extreme variation in shoreline values it is hard to accurately predict a reliable acre benchmark. Most years, including the 2008 ENRTF appropriation, we far exceeded our acres goal. For the 2009 ENRTF appropriation, we fell short of the acres goal, but reached our "miles of shoreline" goal. ENRTF directly acquired approximately 38.8 acres of the total, including 0.7 miles stream shoreline. Donations of land value ("other funds" $106,800) accounted for 11.7 acres and 0.4 shoreline miles. One of the Vermillion River parcels (parcel 7) was acquired jointly using both 2008 and 2009 grants to Metro Corridors Conservation Partnership. Results for Vermillion River, P7 were proportionately distributed for each grant.

Overall, as a result of this project, 0.9 miles of Vermillion River channel was restored to its original course, after being ditched for 50 or more years. Also, as a result of this project, 50.5 acres, including

1.1 miles of critical shoreline fish and wildlife habitat are now permanently protected and open to public angling and/or hunting - as well as other light use recreational activities. Due to failed negotiations, two acquisitions went into abeyance towards the end of the grant, resulting in $57,975 being turned back to the ENRTF. Acquired parcels are now designated and managed as AMAs.

Project Results Use and Dissemination

All new AMA lands will be added to DNR's Public Recreational Information Maps (PRIM).

2009 Environment and Natural Resources Trust Fund (ENRTF)
Final Work Program Report

Date of Report: Aug 1, 2011
Date of Next Status Report: NA
Date or Work Program Approval: July 1, 2009
Project Completion Date: June 30, 2011

I. **PROJECT TITLE:** Fish and Wildlife Habitat Restoration (2.9)/ Fish and Wildlife Land Acquisition (3.5)
Metropolitan Conservation Corridors- Phase V

Project Manager: Mike Halverson
Affiliation: DNR Division of Fish & Wildlife
Mailing Address: 500 Lafayette Rd, Box 20
City / State / ZIP: St Paul, 55155-4020
Telephone Number: 651-259-5209
E-mail Address: Mike.Halverson@dnr.state.mn.us
Fax Number: 651-259-5209
Web Page Address: www.dnr.state.mn.us

Location: Projects may occur anywhere within mapped corridor area including, but not limited to, Dakota County (Vermillion River), Scott County (Eagle Creek), and Washington County (Browns Creek) depending on priorities, risk of development, and potential partners.

Total Trust Fund Project Budget:	**Trust Fund Appropriation:**	$	500,000
	Minus Amount Spent:	$	442,025
	Equal Balance:	$	57,975

Legal Citation: M.L. 2009, Chap. 143, Sec. 2, Subd. 4f 2.9/3.5

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by

the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. & III. FINAL PROJECT SUMMARY:
This project had a two pronged focus. **Result 1** (4f2.9) focused on a trout stream habitat restoration project located within Vermillion River Aquatic Management Areas (AMA), in Dakota County. This stretch of the Vermillion River channel had been altered by ditching. **Result 2** (4f3.5) focused on securing fee title parcels on the Vermillion River in Dakota County and Eagle Creek in Scott County. Parcels include habitat linkages that provided environmental protection of the shoreline and riparian zone, exhibit a high risk of development, supply angler access, and afford management access necessary for implementing habitat improvement projects. Project goals were to restore 0.6 miles of stream habitat and acquire 60 acres with 1.0 mile of shoreline. Partner funding includes donations of land value and cash.

Result 1 (4f2.9): Restoration of 0.9 miles of Vermillion River channel. Environmental and Natural Resources Trust Fund (ENRTF) dollars directly restored approximately 0.44 miles of the total restored channel. Other State dollars (TU OHC = $140,000) restored 0.41 miles, and other funding (Vermillion River Watershed = $20,000) restored 0.05 miles of the total.

Result 2 (4f3.5): Acquisition of four parcels with a grand total of approximately 50.5 acres and 1.1 miles of stream shoreline. Because of the extreme variation in shoreline values it is hard to accurately predict a reliable acre benchmark. Most years, including the 2008 ENRTF appropriation, we far exceeded our acres goal. For the 2009 ENRTF appropriation, we fell short of the acres goal, but reached our “miles of shoreline” goal. ENRTF directly acquired approximately 38.8 acres of the total, including 0.7 miles stream shoreline. Donations of land value (“other funds” $106,800) accounted for 11.7 acres and 0.4 shoreline miles. One of the Vermillion River parcels (parcel 7) was acquired jointly using both 2008 and 2009 grants to Metro Corridors Conservation Partnership. Results for Vermillion River, P7 were proportionately distributed for each grant.

Overall, as a result of this project, 0.9 miles of Vermillion River channel was restored to its original course, after being ditched for 50 or more years. Also, as a result of this project, 50.5 acres, including 1.1 miles of critical shoreline fish and wildlife habitat are now permanently protected and open to public angling and/or hunting - as well as other light use recreational activities. Due to failed negotiations, two acquisitions went into abeyance towards the end of the grant, resulting in $57,975 being turned back to the ENRTF. Acquired parcels are now designated and managed as AMAs.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Fish and Wildlife Stream Habitat Restoration
Allocation $150,000 Balance $0

Program Area/Result	Trust Dollars Spent	Trust Accomplishments
	$ 150,000	0.9 miles of river restored

Completion Date: June 30, 2011

Description: Fish & Wildlife will focus on trout stream habitat restoration projects that have the following characteristics: stream channel has been altered due to ditching or some other manmade influence, affected area allows angler access through either fee title or a permanent easement, and affected area allows access for DNR personnel and constituent cooperators to do habitat improvement projects. Ultimately projects will be dependent on first obtaining fee title or permanent easement for angler access and habitat management.

Project money will provide funding to restore stream habitat on approximately 0.3 miles of designated trout stream, and leverage restoration of another 0.4 miles of designated trout stream through partner funds. The project will take place on the Vermillion River, Dakota County. Project will generate additional funded restoration through partnerships with Minnesota Trout Unlimited (MNTU) and the Vermillion River Watershed Joint Powers Organization (VRWJPO), for a grand total of 0.6 miles of restored stream habitat. MNTU will contribute $140,000 from a Lessard Sams Outdoor Heritage Fund (LSOHF) grant, and VRWJPO will contribute up to $100,000 for re-vegetation work in 2011. Accomplishment reporting will divide the length of stream restored pro-rata based on the relative contribution of each funding source.

Vermillion River AMA, Channel Restoration, Dakota County

Trust Dollars	TU OHC Dollars	Watershed Dollars	Trust Miles	TU OHC Miles	Watershed Miles	Total Miles
$150,000	$140,000	$20,000	0.44	0.41	0.05	0.9

Professional Services Total: $19,740 Grand Total (Trust only): $ 150,000

Summary Budget Information for Result 1: Trust Fund Budget: $ 150,000
Balance: $ 0

Result 2: Fish and Wildlife Land Acquisition
Allocation $350,000 Balance $57,975 (back to ETF)

Program Area/Result	Trust Dollars Spent	Trust Accomplishments
	$ 290,025	50.5 acres with 1.1 miles of shoreline

Professional services in the amount of $34,525 related to land acquisition is included

Completion Date: June 30, 2011

Description: This project will secure fee title or easements on approximately 40 acres (0.7 miles of shoreline). Priority will be given to acquiring regionally significant fish and wildlife habitat that will both build on the existing shoreline habitat and provide angler access. Project money is expected to generate additional non-state funded acres and shoreline miles, for a grand total of 60 acres and 1.0 miles of critical shoreline habitat. Collaborative partnerships will be promoted in order to acquire key lands. Projects will take place on one or more of the following sites: Vermillion River, Dakota County, Eagle Creek, Scott County, and Browns Creek, Washington County, depending on priorities, risk of development, and potential partners. Collaborative partnerships will be promoted in order to acquire key lands. Easements are currently monitored by Area Fisheries Staff during yearly management activities such as stocking, creel survey, electrofishing, and habitat improvement. Anglers also keep close watch and report unusual activities. Our current monitoring activities will include a monitoring form, which will be kept at area offices.

Enforcement and stewardship requirements become part of the regular workload and are funded with Fisheries project dollars.

Vermillion River, Parcel 7, Dakota County

Trust Acres	Trust Miles	Trust $	Other St. $	Other $	Other St. Acres	Other St. Miles	Other Acres	Other Miles	Total Acres	Total Miles
6.6	0.05	$35,500	$0	$0	0	0	0	0	6.6	0.05

Vermillion River, Parcel 8, Dakota County

Trust Acres	Trust Miles	Trust $	Other St. $	Other $	Other St. Acres	Other St. Miles	Other Acres	Other Miles	Total Acres	Total Miles
32.2	0.64	$222,000	$0	$0	0	0	0	0	32.2	0.64

Eagle Creek, Parcel 3, Scott County

Trust Acres	Trust Miles	Trust $	Other St. $	Other $	Other St. Acres	Other St. Miles	Other Acres	Other Miles	Total Acres	Total Miles
0	0.0	$0	$0	$91,000	0	0	10.2	0.36	10.2	0.36

Eagle Creek, Parcel 4, Scott County

Trust Acres	Trust Miles	Trust $	Other St. $	Other $	Other St. Acres	Other St. Miles	Other Acres	Other Miles	Total Acres	Total Miles
0	0.0	$0	$0	$15,800	0	0	1.5	0.03	1.5	0.03

Total

38.8	0.69	$257,500	$0	$106,800	0	0	11.7	10.39	323.3	2.75

Professional Services Total: $34,525 **Grand Total (Trust only): $ 290,025**

Summary Budget Information for Result 1: Trust Fund Budget: $ 350,000
Balance: $ 57,975

V. OTHER FUNDS & PARTNERS:

A. Project Partners: Minnesota Trout Unlimited, Vermillion River Watershed Joint Powers Organization

B. B. Other Funds Being spent during the Project Period:

Year	Funding Source	Fisheries
2009	OHC	$5,748,000
Total		$5,748,000

D. Spending History

Restoration:

Year	Funding Source	Fisheries
2007	ENRTF – Metro	$ 65,000
Total		$ 65,000

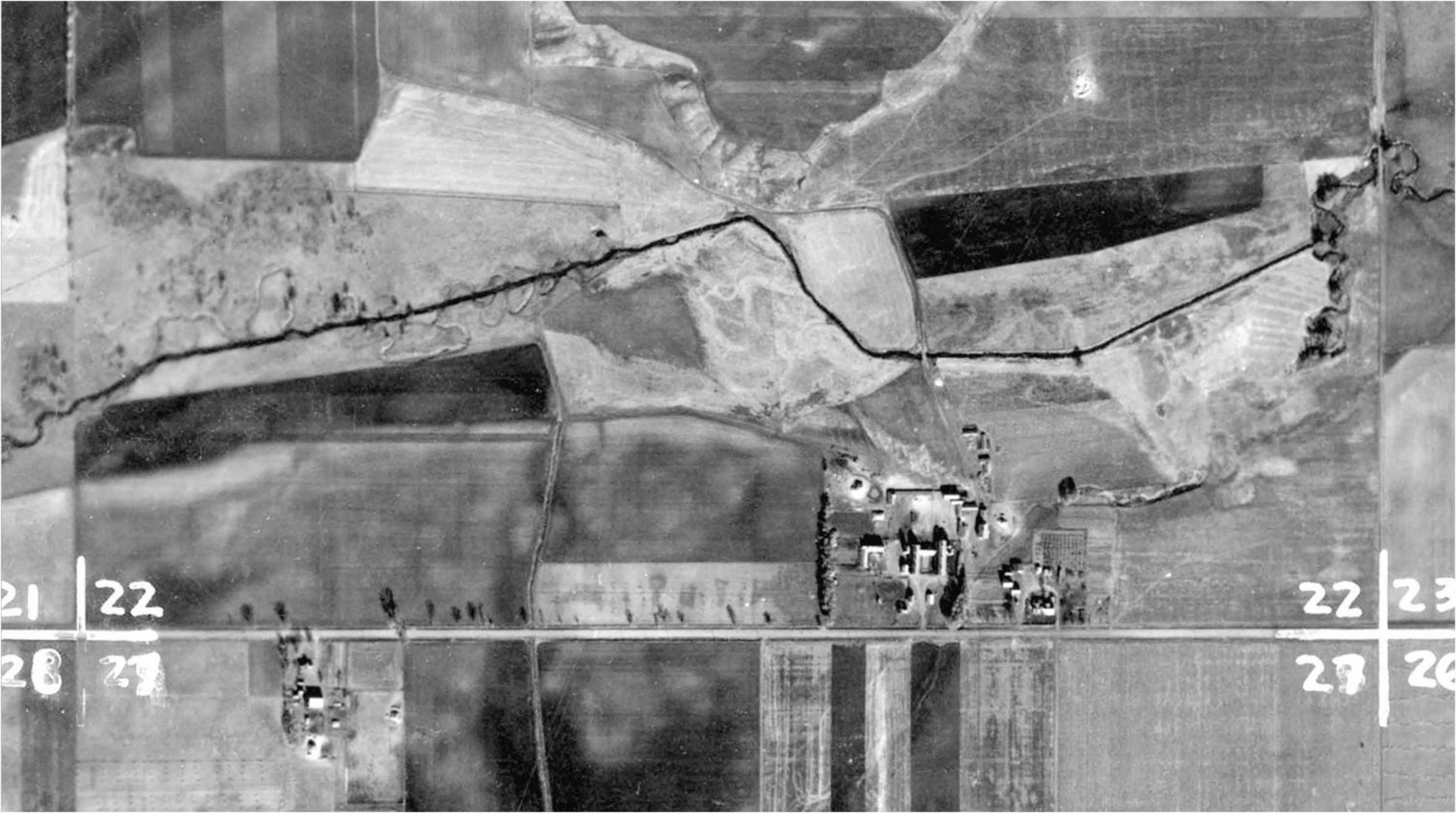
Acquisition:

Year	Funding Source	Fisheries
2006	ENRTF - Bonding	$2,000,000
2007	ENRTF – Outstate	$ 500,000
2007	ENRTF – Metro	$ 172,000
2008	ENRTF – Outstate	$ 250,000
2008	ENRTF – Metro	$ 400,000
2008	ENRTF – Bonding	$ 1,000,000
2009	ENRTF – Outstate	$ 300,000
2009	ENRTF – Metro	$ 500,000
Total		$5,122,000

VII. DISSEMINATION: All new AMA lands will be added to DNR's Public Recreational Information Maps (PRIM).

VIII. REPORTING REQUIREMENTS:
Periodic work program progress reports will be submitted not later than February 1, 2010, August 1, 2010, and February 1, 2011. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS: NA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2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Metro Conservation Corridors (MeCC) Phase V- The Trust for Public Land's Critical Lands Protection Program [M.L. 2009]
PROJECT MANAGER: Becca Nash
AFFILIATION: The Trust for Public Land
MAILING ADDRESS: 2610 University Ave West, Suite 300
CITY/STATE/ZIP: St. Paul, MN 55114
PHONE: 651-999-5325
E-MAIL: Becca.Nash@tpl.org
WEBSITE: www.tpl.org
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chap. 143, Sec. 2, Subd. 4(f)

APPROPRIATION AMOUNT: $380,000

Overall Project Outcome and Results

In its Critical Lands Protection Program, The Trust for Public Land (TPL) used **$380,000 ENRTF funds** to secure fee title on **21.63 ENRTF acres** of 402 total acquired acres. TPL conveyed these lands to public agencies for permanent protection. Individual project successes include the following:

- TPL spent $318,000 2009 ENRTF funds to protect 14.43 ENRTF acres of land as part of a larger 64-acre purchase of shoreline designated by the Minnesota Department of Natural Resources as a "regionally significant ecological area." TPL conveyed the land to the City of Lindstrom to create the **Allemansratt Wilderness Park**.

- TPL spent $62,000 2009 ENRTF to protect 7.2 ENRTF acres of land as part of a 338-acre acquisition of one of the largest undeveloped and contiguous tracts of open space in the Twin Cities Metro Area. TPL then conveyed the land to Anoka County. Located at the confluence of Cedar Creek and the Rum River, this land will be managed by the County as the **Cedar Creek Conservation Area**.

TPL **leveraged $380,000** in TPL Metro Conservation Corridors (MeCC) 2009 funding on these projects with **$992,000** in non-state funds to protect 87.79 additional pro-rated acres of land. $652,000 of this was non-state public funds and $339,500 of this was from private land value donations. Additionally, $500,000 in state remediation grant funds were used to protect 22.7 pro-rated acres and $1,900,000 in Outdoor Heritage Funds were used to protect 221.4 pro-rated acres. TPL's 2010 ENRTF funds in the amount of $338,000 and DNR's 2008 ENRTF funds in the amount of $200,000 were used to protect 39.4 pro-rated acres and 9.08 pre-rated acres respectively. All acres acquired total 402.

*Please note, since a portion of TPL's 2010 ENRTF funding was used for the Cedar Creek Conservation Area project, a portion of these results will also be reflected in TPL's 2010 MeCC Work Program update and Final Report.

Project Results Use and Dissemination

As conservation transactions were completed, The Trust for Public Land disseminated information on the TPL website, www.tpl.org, broadcast emails to Embrace Open Space (EOS) and TPL list serve members, distributed press releases, and included information in TPL's newsletters as appropriate. TPL also worked with the long-term stewards to ensure information was distributed to their listserves and posted on their websites as well.

Trust Fund 2009 Final Report and
Trust Fund 2010 Work Program

Date of Report: October 29, 2010
Date of Next 2010 Progress Report: February 1, 2011

	M.L. 2009	M.L. 2010
Date of Work Program Approval:	June 16, 2009	June 2, 2010
Project Completion Date:	June 30, 2011	June 30, 2012

I. PROJECT TITLE: Metro Conservation Corridors (MeCC) Phase V—The Trust for Public Land's Critical Lands Protection Program [M.L. 2009]

Metro Conservation Corridors (MeCC) Phase V Supplemental – The The Trust for Public Land's Critical Lands Protection Program (3.1) [M.L. 2010]

Project Manager: Becca Nash
Affiliation: The Trust for Public Land
Mailing Address: 2610 University Avenue, Suite 300
City / State / Zip: St. Paul, MN 55114
Telephone Number: 651-999-5325
E-mail Address: Becca.nash@tpl.org
FAX Number: 651-917-2248
Web Site Address: www.tpl.org/minnesota

Location: Within mapped Metro Conservation Corridors in the counties of Anoka, Carver, Chisago, Dakota, Goodhue, Hennepin, Isanti, LeSueur, Nicollet, Ramsey, Rice, Scott, Sherburne, Sibley, Washington and Wright (please see Metro Conservation Corridors map)

Total Trust Fund Project Budget:	M.L. 2009	M.L. 2010	Total
Trust Fund Appropriation	$380,000	$890,000	$1,270,000
Minus Amount Spent:	$380,000	$338,000	$ 718,000
Equal Balance:	$0	$552,000	$552,000

Legal Citation:
M.L. 2009, Chap. 143, Sec. 2, Subd. 4(f)
Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at

least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

M.L. 2010, Chap. 362, Sec. 2, Subd. 4(g)
Appropriation Language:
$1,750,000 is added to Laws 2009, chapter 143, section 2, subdivision 4, paragraph (f), from the trust fund to the commissioner of natural resources for acceleration of agency programs and cooperative agreements. Of this appropriation, $1,750,000 is for agreements as follows: $890,000 with the Trust for Public Land; $485,000 with Minnesota Land Trust; $325,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $50,000 with Friends of the Minnesota Valley for planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement.

II. PROJECT SUMMARY AND RESULTS:

M.L.2009 Final Project Summary:

In its Critical Lands Protectino Program, The Trust for Public Land (TPL) secured fee title on a total of **402 acres** of land worth $4,310,000 and conveyed them to public agencies for permanent protection. Individual project successes include the following:

- TPL purchased 64 acres of shoreline designated by the Minnesota Department of Natural Resources as a “regionally significant ecological area” and conveyed it to the City of Lindstrom to create the **Allemansratt Wilderness Park**. TPL spent $318,000 2009 ENRTF funds to protect 14.43 (pro-rated) acres of land.

- TPL purchased 338 acres of one of the largest undeveloped and contiguous tracts of open space in the Twin Cities Metro Area and conveyed the land to Anoka County. Located at the confluence of Cedar Creek and the Rum River, this land will be managed by the County as the **Cedar Creek Conservation Area**. TPL spent $62,000 2009 ENRTF to protect 7.2 (pro-rated) acres of land.

TPL leveraged $380,000 in TPL Metro Conservation Corridors (MeCC) 2009 funding on these projects with $992,000 in non-state funds to protect 87.79 (pro-rated) acres of land. $652,000 of this was non-state public funds and $339,500 of this was from private land value donations. Additionally, $500,000 in state remediation grant funds and $1,900,000 in Outdoor Heritage Funds were used to protect 22.7 (pro-rated) acres and 221.4 (pro-rated) acres respectively. TPL's 2010 ENRTF funds in the amount of $338,000 and DNR's 2008 ENRTF funds in the amount of $200,000 were used to protect 48.48 (pro-rated) acres out of 402 total acres.

*Please note, since a portion of TPL's 2010 ENRTF funding was used for the Cedar Creek Conservation Area project, a portion of these results will also be reflected in TPL's 2010 MeCC Work Program update and Final Report.

M.L. 2010:
The Trust for Public Land (TPL) will secure fee title on up to 33 acres of high quality habitat in the Metro Conservation Corridor areas. TPL will use $890,000 of the Environment and Natural Resources Trust Fund (ENRTF) funds for capital costs of acquisition and will leverage $445,000 in non-state funds for this acquisition work. Acquired land will be conveyed or donated to the Minnesota Department of Natural Resources (DNR) or other qualified public or private land steward for long-term stewardship. TPL will prioritize potential land protection projects within the Metro Conservation Corridors based on the priorities established by the public agencies with which we work, on landowner willingness to sell, and will focus on shoreland, shallow lakes and other lands of highest ecological value. We will also consider resource mapping, stakeholder suggestions, and joint recommendations made by the coalition of groups involved in this overall effort. Unless necessary to protect priority lands and subject to work plan amendment at that time, TPL will not acquire residential structures.

III. PROGRESS SUMMARY AS OF FEBRUARY 1, 2010:

M.L. 2010: N/A

PROGRESS SUMMARY AND REQUEST FOR AMENDMENT AS OF AUGUST 1, 2010:

M.L. 2010: TPL has the Savage Fen--Credit River (SNA) property under option and is currently working through due diligence issues with a revised aim of closing within the coming months. TPL also has the 338-acre Cedar Creek Conservation Area (Phase II) property in West-Central Anoka County under option with the aim of closing within the coming months. Whichever transaction closes first will use the remaining $62,000 of TPL's 2009 ENRTF dollars in addition to a portion of TPL's 2010 ENRTF dollars.

TPL therefore requests LCCMR approval to spend 2009 ENRTF funding concurrently with 2010 ENRTF funding on either the Savage Fen—Credit River (SNA) or the Cedar Creek Conservation Area (Phase II) conservation transaction, whichever happens first.

LCCMR approved this amendment on September 10, 2010.

PROGRESS SUMMARY AS OF October 29, 2010:

M.L. 2010: TPL closed on the acquisition of the 338-acre property at the confluence of Cedar Creek and the Rum River in west-central Anoka County. TPL immediately conveyed the property to Anoka County to be managed as part of the newly established Cedar Creek Conservation Area. TPL also still has the Savage Fen SNA addition property under option with the intent to close on the acquisition within the next month, thus closing out TPL's 2010 ENRTF balance.

IV. OUTLINE OF PROJECT RESULTS*:*

Result/Activity 1: Acquire Significant Habitat

Description: TPL is working in many communities within defined regionally significant Metro Conservation Corridors, with a priority on high quality natural resources or conservation lands that provide natural buffers to water resources, including shorelands and wetlands. Many of these areas include lakes that appear on the DNR's 2007 map of "Shallow Lakes in Minnesota" (50 acres or greater, maximum depth of 15 feet). Following is a list of projects and project areas, in priority order, on which TPL is focusing its efforts. <u>The first two projects are the highest priority for the 2010 Phase V Supplemental funding</u> due to landowner urgency/impending threat of loss of the resource. If matters do not progress as we hope for these two projects, project 3 below is highest priority for 2010 funding. As is the nature of land acquisitions for public ownership, conditions may change and therefore the following information may also change:

1) In southern Chisago County, TPL is working with the City of Lindstrom and multiple landowners to protect lakeshore and high quality forested lands designated by the DNR as "regionally significant ecological areas." The land would be owned by the City of Lindstrom and would be managed as a natural resource based park. The total estimate of acres protected would be approximately 64. ENRTF acres protected would be approximately 9-14. Approximately $320,000 in non-state funds would be leveraged. COMPLETED with M.L. 2009 ENRTF funds.

2) In northern Scott County, TPL is working with a landowner, local partners including the City of Savage & Scott County, and the DNR's SNA Program to protect a number of parcels of land containing fen, wetlands, associated upland forest & bluffland, and stream frontage on a Minnesota River tributary. The total estimate of acres protected as an SNA through Phase I and Phase II of this effort would be 75. 2010 ENRTF dollars would protect approximately 7-10 acres. Approximately $180,000 in non-state funding would be leveraged.

3) In west-central Anoka County, TPL is working with landowners and a local public agency partner to protect a large patch of regionally significant ecological lands including rivers shoreline, wetlands and forests and prairie habitat. Approximately 570 total acres would be protected; Anoka County would own and manage the property as a natural area. ENRTF dollars would protect approximately 35- 47 acres. Approximately $400,000 in non-state funds would be leveraged. COMPLETED with M.L. 2009 and M.L. 2010 ENRTF funds.

4) In the St. Croix Valley (Washington and Chisago counties), TPL is working with several landowners, MeCC partners, and local public agency partners to protect sensitive ravines and high quality ecological areas – both important to St. Croix Valley water quality and habitat. Land would be owned and managed by the DNR, the local unit of government, or the National Park Service. Specific acres to be protected and funding needs not certain at this time.

5) In northern Washington County, the Trust for Public Land is working with local and state public agency partners to protect a lakeshore and high quality forest lands identified by the DNR as "regionally significant ecological areas. Land would be owned and managed by the DNR or the local unit of government. Specific acres to be protected and funding needs not certain at this time.

   In completing its work under this appropriation, TPL will work with the long-term steward of land acquired with this appropriation to ensure a restoration and management plan is developed and that funding is identified for long-term stewardship. TPL will also provide documentation of transaction-related costs and will seek Commissioner approval before acquiring an interest of land to be conveyed to the DNR, as required.

Summary Budget Information for Result/Activity 1:

	M.L. 2009	**M.L. 2010**	**Total**
Trust Fund Budget:	**$380.000**	**$890,000**	**$1,270,000**
Amount Spent:	**$ 380,000**	**$338,000**	**$718,000**
Balance:	**$ 0**	**$552,000**	**$552,000**

Deliverable/Outcome	**Completion Date**	**Budget**
1. M.L. 2009: Approx. seventeen (17) acres of high quality habitat protected	June 30, 2011	$380,000
2. M.L. 2010: Approx. thirty three (33) acres of high quality habitat protected	June 30, 2012	$890,000

Result Completion Date: M.L. 2009: June 30, 2011; M.L. 2010: June 30, 2012

Result Status as of February 1, 2010:

M.L. 2010: N/A

Result Status as of August 1, 2010:

M.L. 2010: TPL has the +/- 75 acre Savage Fen--Credit River (SNA) property under option and is currently working through due diligence issues with a revised aim of closing within the coming months. This property's forest, wetlands, and stream frontage—adjacent to the Savage Fen SNA in Scott County—have been ranked by the State as an outstanding representation of biodiversity significance. The property contains a small portion of a calcareous fen (one of Minnesota's most endangered plant communities) and seepage meadows, but also significant forested uplands that could be developed to the detriment of the sensitive fen area and to the Credit River, which flows through the property to the Minnesota River. This area supports 18 known Species in Greatest Conservation Need (SGCN).

TPL also has the 338-acre Cedar Creek Conservation Area (Phase II) property in West-Central Anoka County under option with the aim of closing within the coming months. Once acquired, TPL would transfer ownership to Anoka County, which would manage the property as a natural area. This is the second phase in an effort to protect 550 acres of regionally significant ecological land including river shoreline, wetlands, forests and prairie habitat. 212 acres (Phase I) were protected earlier this year with non- ENRTF funds.

Whichever transaction closes first will use the remaining $62,000 of TPL's 2009 ENRTF dollars in addition to a portion of TPL's 2010 ENRTF dollars. TPL is therefore seeking LCCMR approval to spend 2009 ENRTF funding concurrently with 2010 ENRTF funding on either the Savage Fen—Credit River (SNA) or the Cedar Creek Conservation Area (Phase II) conservation transaction, whichever happens first.

LCCMR approved this amendment on September 10, 2010.

Result Status as of October 29, 2010:

M.L. 2009 Final Report Summary:

Allemansratt Nature Reserve
The Trust for Public Land closed on the acquisition of the 64-acre Lindstrom Phase I property on March 31, 2010. TPL immediately conveyed the property to the City of Lindstrom, which will manage the property as the Allemansratt Nature Reserve.

Purchase of this land allows it to be protected in nearly the same condition as that which originally attracted Swedish emigrants to Chisago County in the 1850's. The site, which includes high quality forest designated by the DNR as a "regionally significant ecological area," provides wildlife habitat, water quality benefits, and public access in a high –growth area. The land abuts two popular fishing lakes with approximately a mile of shoreline. Ecological features include glacial eskers, high quality oak forest, eighteen wetlands (two ephemeral), and diverse wildlife, including many species- such as the Forster's tern- that are listed as being in greatest conservation need. The property has a greater impact on wildlife and connectivity because it is adjacent to19 acres of land already protected by the City. The comprehensive plans of both the City and Chisago County identify this land as a unique resource to be protected.

TPL purchased the property for $1,370,500 and sold the property to Lindstrom for $1,053,500 (TPL's purchase price minus TPL's $318,000 ENRTF contribution). In purchasing the property from TPL, the City of Lindstrom used $500,000 from the State's Remediation Fund Grant Program; $200,000 from Metro Greenways Grant Program (ENRTF 2008); and $352,500 in City funds. The appraised fair market value of the property was $1,410,000. The $39,500 discount to fair market value that TPL was able to secure was passed along as a land value donation by TPL to the City of Lindstrom.

The total ENRTF funding used on this protection project was $518,000 (please see chart below for a complete breakdown of project funding).

Allemansratt Nature Preserve Acquisition, Lindstrom, MN				
Funding Source*	Partner on Allemansratt project	Amount of funding for land acquisition costs	Allocated Acreage	Recipient of Grant Funds (if applicable)
State Funds				
State Remediation Grant Funds	DNR	$500,000	22.70	City of Lindstrom
ENTF - Metro Greenways 2008 (DNR)	DNR	$200,000	9.08	City of Lindstrom
ENTF - Metro Wildlife Corridors Phase IV 2009 (TPL)	TPL	$318,000	14.43	TPL
	Sub Total	**$1,018,000**		
Local Government Funds				
City of Lindstrom	City of Lindstrom	$352,500	16.00	City of Lindstrom
	Sub Total	**$352,500**		
Private Funds				
TPL Land Value Donation	TPL	$39,500	1.79	N/A
	Sub Total	**$39,500**		
	TOTAL	**$1,410,000**	64.00	
*Please note that total ENRTF funding is		$518,000		
total other state funding is		$500,000		
total non-state public funding is		$352,500		
total private funding is		$39,500		
TOTAL funding & appraised fair market value of property is		$1,410,000		

Cedar Creek Conservation Area
On September 22, 2010, TPL closed on the acquisition of a 338-acre property at the confluence of the Rum River and Cedar Creek. TPL immediately conveyed the property to Anoka County, which will manage the land as Cedar Creek Conservation Area. This was the second phase of a two-phase acquisition project. The first phase of 212 acres closed on March 17. 2010 and did not involve any ENRTF funds.

This land has long been a conservation priority for Anoka County and many other organizations and individuals. On June 13, 2000, the Anoka County Board adopted the Cedar Creek Greenway Corridor Plan after a lengthy planning process involving the County, the Cities of Oak Grove and Andover, the Anoka Conservation District, the Rum River Watershed Management Organization, the DNR, the University of Minnesota, and a Citizens Advisory Committee. The study was funded in part by the DNR Metro Greenways program and recognized the creek as an outstanding natural resource and habitat corridor that should be protected.

The 550- acre property (Phase I and Phase II) at the confluence of the Rum River and Cedar Creek offers exceptional quality wildlife habitat and public recreational opportunities with a diversity of topography, aquatic systems, plant communities and wildlife. The rolling land has a rich mix of woodlands, wetlands, prairie remnants and fields. It contains 1.5 miles of shoreline on the Rum River, an outstanding fishery and a component of the state wild and scenic river system. It also contains ¾ of a mile of land along Cedar Creek in a recognized wildlife corridor. The acquisition not only conserves one of the largest undeveloped and contiguous tracts of open space in the Twin Cities metropolitan area, but also more than doubles the amount of public open space in the area as the property is directly across the river from the existing 434-acre Rum River Central Regional Park.

As a new County Conservation Area, this land will provide excellent hunting, fishing and wildlife observation opportunities close to home for many citizens in a quickly developing area. The County has developed a detailed management plan that includes restoring over 150 acres to native prairie.

The second phase of 338 acres closed on September 22, 2010 and was purchased for $2,600,000. The appraised fair market value of the property was $2,900,000. TPL immediately conveyed the property to Anoka County. The acquisition was funded with $400,000 TPL had received in 2009 ENRTF funding, an additional $1,900,000 in OHF funding Anoka County had received, and $300,000 of the County's own funds. Please see the following chart for a complete breakdown.

Cedar Creek Conservation Area, Anoka, MN				
Funding Source*	Partner on project	Amount of funding for land acquisition costs	Allocated Acreage	Recipient of Grant Funds (if applicable)
PHASE II				
State Funds				
2010 OHF	Anoka County	$1,900,000	221.4	Anoka County
ENRTF - Metro Wildlife Corridors Phase V 2009 (TPL)	TPL	$62,000	7.2	TPL
ENRTF - Metro Wildlife Corridors Phase V Supp. 2010 (TPL)	TPL	$338,000	39.4	TPL
	Sub Total	**$2,300,000**		
Local Government Funds				
Anoka County	Anoka County	$300,000	35	N/A
	Sub Total	**$300,000**		
Private Funds				
TPL Land Value Donation	TPL	$300,000	35	N/A
	Sub Total	**$300,000**		
	TOTAL PHASE II	**$2,900,000**	338	
	TOTAL PHASES I & II	**$4,800,000**	550	

*Please note that total ENRTF funding is	$400,000		
total other state funding is	$2,238,000		
total non-state public funding is	$300,000		
total private funding is	$300,000		
TOTAL funding & appraised fair market value of property is	$2,900,000		

M.L. 2010: TPL closed on the acquisition of Cedar Creek Conservation Area using $338,000 of TPL's 2010 ENRTF funds as described above in the M.L. 2009 Final Report Summary. TPL also continues to have the Savage Fen--Credit River (SNA) property under option with the aim of closing within the next month.

Result Status as of February 1, 2011:
Result Status as of August 1, 2011:
Result Status as of February 1, 2012:

M.L. 2010 Final Report Summary:

V. TOTAL TRUST FUND PROJECT BUDGET:
M.L. 2009:
Personnel: $0
Contracts: $0
Equipment/Tools/Supplies: $0
Acquisition, including easements: $380,000 (Capital costs for 21.63 pro-rated ENRTF acres of fee title acquisition; TPL transfered interests in land to two local units of government for long term protection).
Travel: $0
Other: $0

TOTAL M.L. 2009 TRUST FUND PROJECT BUDGET: $380,000

M.L. 2010:
Personnel: $0
Contracts: $0
Equipment/Tools/Supplies: $0
Acquisition (Fee Title or Permanent Easements): $890,000
Travel: $0
Additional Budget Items: $0

TOTAL ENRTF PROJECT BUDGET: $890,000

Explanation of Capital Expenditures Greater Than $3,500: N/A

VI. PROJECT STRATEGY:

A. Project Partners: TPL works closely with private landowners and with the public agency or non-profit partner to which TPL will transfer the land and which will serve as the long-term steward of the land interest that TPL purchases using ENRTF funds. Long-term stewards and other project partners may include local governments, regional agencies, state agencies, water-related agencies, federal agencies, and private nonprofit organizations. We also work closely with citizen groups and coordinate our work with other Metro Conservation Corridor partners (See Table A). When TPL transfers interests in land to a long-term steward, TPL will donate to the land steward the land value of the ENRTF funds.

B. Project Impact and Long-term Strategy: The Trust for Public Land is working toward a vision that in the next 25 years, every one of us—in particular every child—will have a nearby natural area, park, garden, or playground to visit. Our region's parks system will be expanded into an interconnected web of public parks, gardens, trails, lakes, rivers and natural areas in the Twin Cities area stretching from the vibrant central business districts of Minneapolis and St. Paul through our inner city neighborhoods to our growing suburban and exurban fringe. The Metro Conservation Corridors Program provides the opportunity to positively impact the quality of life of the estimated sixty percent of the state's population that lives in the counties served by this overall project. By focusing on protecting and restoring high quality natural areas that are close to home for millions of Minnesotans, this program will provide: recreation opportunities and physical health; economic well-being; and a healthy and working natural resource system that in turn will provide safe drinking water for people and healthy habitat for fish, birds and other wildlife—especially for Species of Greatest Conservation Need, as described in the report Tomorrow's Habitat for the Wild and Rare.

C. Other Funds Proposed to be Spent during the Project Period: M.L. 2009: TPL leveraged 380,000 2009 ENRTF funds with $3,930,000 in other state and non-state funds for this acquisition work. Additional acquisition funding was contributed by: the City of Lindstrom, Anoka County, state agencies, and landowners as outlined in detail above. M.L. 2010: TPL aims to leverage ENRTF funds with $445,000 in non-state funds for this acquisition work from sources including: cities, counties, regional park districts, federal agencies, and landowners and/or other private donors.

D. Spending History:*.* Past allocations of ENRTF funding through the Metro Conservation Corridors Program have been spent to create and/or protect the following:

Land Protected	ENRTF Appropriation Year	ENRTF Amount Spent by TPL	ENRTF Amount Spent by Partners	Non-ENRTF Amount Leveraged
East Rush Lake AMA/WMA	2005	$100,000	$200,000	$303,000
Horseshoe Lake Regional Park	2005	$100,000	$100,000	$956,000
Franconia Bluffs SNA	2005	$420,000	$0	$105,000
Franconia Bluffs SNA	2007	$ 10,000	$0	
Camp Ojiketa on Green Lake	2007	$410,000	$100,000	$3,215,000

Camp Ojiketa on Green Lake	2008	$475,000		
Total		**$1,515,000**	**$400,000**	**$4,579,000**

VII. DISSEMINATION: As conservation transactions are completed, The Trust for Public Land will disseminate information on the TPL website, www.tpl.org, broadcast emails to Embrace Open Space (EOS) and TPL list serve members, distribute press releases, and include information in TPL's newsletters as appropriate. TPL will also work with the long-term steward to ensure information is distributed to its listserves and on its website as well.

VIII. REPORTING REQUIREMENTS: For the 2009 and 2010 appropriations, periodic work program progress reports will be submitted February 1st and August 1st of each year. A final work program report and associated products for the 2009 appropriation will be submitted not later than August 1, 2011. A final work program report and associated products for the 2010 appropriation will be submitted not later than August 1, 2012.

IX. RESEARCH PROJECTS: N/A

Attachment A: Budget Detail for 2009 Metro Conservation Corridors Project 10/29/2010

Project Title: *Metropolitan Area Conservation Corridors Phase 5-- The Trust for Public Land's Critical Lands Protection Program*

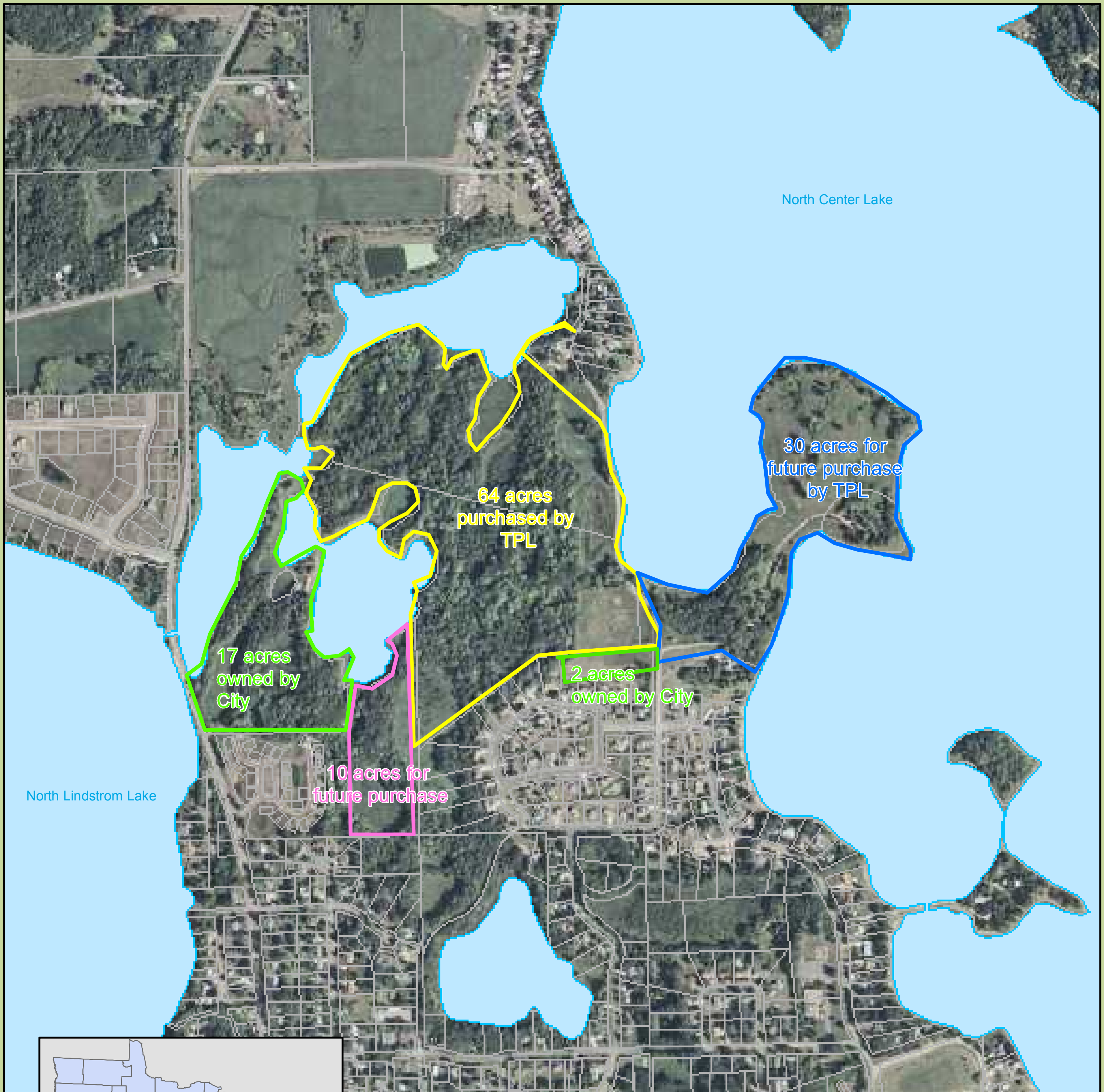
Project Manager Name: *Becca Nash*

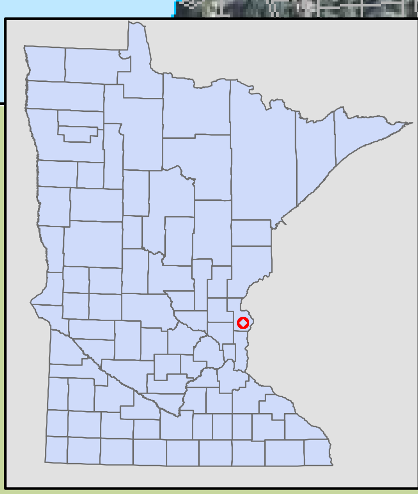
Trust Fund Appropriation: $*380,000*

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

2009 Trust Fund Budget	Result 1 Budget:	Amount Spent 10/29/10	Balance 10/29/10	TOTAL BUDGET	TOTAL BALANCE
	Acquire significant habitat				
BUDGET ITEM					
Land acquisition	380,000	380,000	0	380,000	0
Easement acquisition					
COLUMN TOTAL	**$380,000**	**$380,000**	**$0**	**$380,000**	**$0**





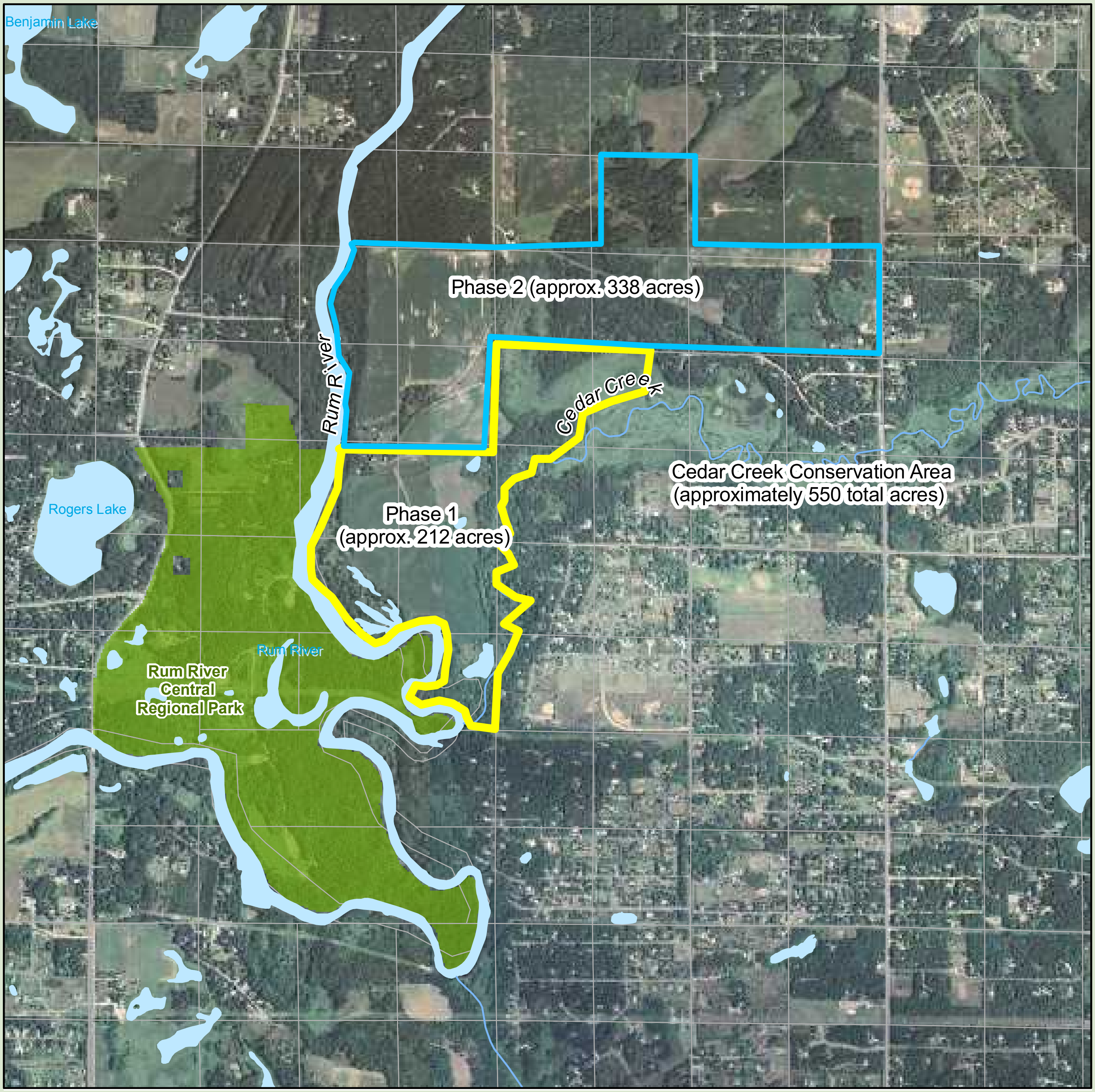
Allemansratt Wilderness Park

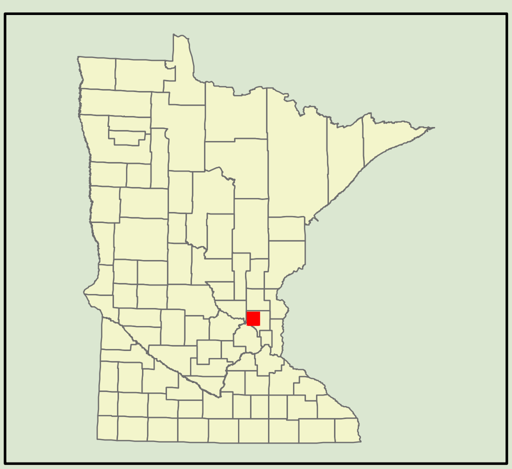
Map created by The Trust for Public Land
on 11/5/10

Information on this map is provided for purposes of discussion and visualization only.

N

0 0.1 0.2 0.4 Miles





Cedar Creek Conservation Area
Phase 1 and Phase 2 Acquistions

Map created by The Trust for Public Land
on 11/ 5/ 2010

Information on this map is provided for purposes of discussion and visualization only.

N

0 0.25 0.5 1 Miles

THE TRUST for PUBLIC LAND

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE:	Metro Conservation Corridors – Phase V Protecting Significant Habitat by Acquiring Conservation Easements - 3.2

PROJECT MANAGER: Sarah Strommen
AFFILIATION: Minnesota Land Trust
MAILING ADDRESS: 2356 University Avenue West, Suite 240
CITY/STATE/ZIP: St. Paul, MN 55114
PHONE: 651-647-9590
E-MAIL: sstrommen@mnland.org
WEBSITE: [If applicable] www.mnland.org

FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chapter 143, Section 2, Subdivision 4(f)

APPROPRIATION AMOUNT: $250,000

Overall Project Outcome and Results

During the fifth phase of the Metro Corridors project, the Minnesota Land Trust continued to work with landowners throughout the greater metropolitan area to permanently protect lands that are key components of Minnesota's remaining natural areas in the region. Eight perpetual conservation easements were completed that collectively protect 765 acres of land and more than 13,000 feet of shoreline. Three easements were purchased, and the remaining five easements were donated. While two of the purchased easements used both 2009 and 2010 ENRTF funding, we are reporting the accomplishments as part of our 2009 report. We will not report these acres in future 2010 reports to avoid double-counting. All eight projects represent unique opportunities to protect high quality natural habitat, riparian areas, and to build upon prior land protection work by the Land Trust at several priority sites. The specific project sites of the conservation easements include:

- 45 acres, including 1,095 feet of shoreline, along Deer Lake in Anoka County (purchased using both ML 2009 and ML 2010 ENRTF appropriations);
- 148 acres, including 2,527 feet of shoreline, along Elk River in Sherburne County (donated);
- 44 acres, including 3,065 feet of shoreline, on Kingswood Pond in Hennepin County (purchased using both ML 2009 and ML 2010 ENRTF appropriations);
- 157 acres near Hardwood Creek in Washington County (donated);
- 5 acres in Scandia in Washington County (donated);
- 126 acres near the headwaters of Valley Creek in Washington County (donated);
- 39 acres adjacent to Wild River State Park in Chisago County (purchased using ML 2009 ENRTF appropriation only);
- 201 acres near Baypoint Park in Goodhue County (donated).

Additionally, the Land Trust prepared baseline property reports for each easement, detailing the condition of the property for future monitoring and enforcement. To fund this required perpetual obligation, the Land Trust dedicated ENRTF and other funds to its segregated Stewardship and Enforcement Fund for all completed projects. We estimated the anticipated annual expenses of each project and the investment needed to generate annual income sufficient to cover these expenses in perpetuity – all in accordance with our internal policies and procedures as approved by LCCMR. We will report to LCCMR annually on the status of the Stewardship and Enforcement Fund and the easements acquired with funds from this grant.

Values are known for only five of the eight easements acquired, and this value totals $854,500, with a known donated value of $413,500. The cost to the State of Minnesota to complete these projects was just over $326 per acre.

Cumulatively, across phases I-V of the Metro Corridors program, the Land Trust has protected 3,298 acres of critical habitat and more than 75,000 feet of shoreline, at a cost to the State of $520 per acre.

The Minnesota Land Trust's work on this project continues to demonstrate the cost effectiveness of working with conservation easements to protect natural and scenic resources within developed and developing areas, as the cost to the State was well below the cost to purchase land in the Twin Cities region. This grant continued to generate interest among landowners, and therefore, ongoing funding will be important to sustained success. Additionally, our experiences during this phase of the grant continue to indicate that funds to purchase easements, as opposed to obtaining donated easements, will be necessary in the future as work becomes more targeted, selective, and focused on building complexes of protected land.

Project Results Use and Dissemination

The Minnesota Land Trust disseminated information about the specific land protection projects completed under this grant though our newsletter, email updates, web site, and press releases. The Land Trust also shared information about conservation easements generally and our experience with our partner organizations, other easement holders, local communities, as well as policy makers including members of the LCCMR and L-SOHC.

Environment and Natural Resources Trust Fund
2009 Final Report and
Environment and Natural Resources Trust Fund
2010 Work Program Status Report

Date of Report: August 1, 2011
ENRTF 2009 Final Report
ENRTF 2010 Status Report

Date of Next 2010 Status Report: February 1, 2012

	M.L. 2009	**M.L. 2010**
Date of Work program Approval:	June 16, 2009	June 9, 2010
Project Completion Date:	June, 30 2011	June 30, 2012

I. PROJECT TITLE: Metro Conservation Corridors – Phase V
Protect Significant Habitat by Acquiring Conservation Easements [M.L. 2009]
Metro Conservation Corridors – Phase V Supplemental
Protect Significant Habitat by Acquiring Conservation Easements [M.L. 2010]

Project Manager: Sarah Strommen, Conservation Director, Central Region
Affiliation: Minnesota Land Trust
Mailing Address: 2356 University Avenue West, Suite 240
City / State / Zip : St. Paul, MN 55114
Telephone Number: 651-647-9590
E-mail Address: sstrommen@mnland.org
FAX Number: 651-647-9769
Web Page address: www.mnland.org

Location: Within mapped corridors (see map included with overall work program) in the counties of Anoka, Carver, Chisago, Dakota, Goodhue, Hennepin, Isanti, LeSueur, Nicollet, Ramsey, Rice, Scott, Sherburne, Sibley, Washington and Wright.

Total Trust Fund Project Budget:	**M.L. 2009**	**M.L. 2010**	**Total**
Trust Fund Appropriation:	**$250,000**	**$485,000**	**$735,000**
Minus Amount Spent:	**$250,000**	**$293,900**	**$543,900**
Equal Balance:	**$0**	**$191,100**	**$191,100**

Legal Citation: M.L. 2009, Chapter 143, Section 2, Subdivision 4(f)

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

Legal Citation: M.L. 2010, Chapter 362, Section 2, Subdivision 4(g)
Appropriation Language:
$1,750,000 is added to Laws 2009, chapter 143, section 2, subdivision 4, paragraph (f), from the trust fund to the commissioner of natural resources for acceleration of agency programs and cooperative agreements. Of this appropriation, $1,750,000 is for agreements as follows: $890,000 with the Trust for Public Land; $485,000 with Minnesota Land Trust; $325,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $50,000 with Friends of the Minnesota Valley for planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless

expressly approved in the work program. All conservation easements must be perpetual and have a natural resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement.

II. PROJECT SUMMARY AND RESULTS:

M.L. 2009 Final Project Summary:
During the fifth phase of the Metro Corridors project, the Minnesota Land Trust continued to work with landowners throughout the greater metropolitan area to permanently protect lands that are key components of Minnesota's remaining natural areas in the region. Eight perpetual conservation easements were completed that collectively protect 765 acres of land and more than 13,000 feet of shoreline. Three easements were purchased, and the remaining five easements were donated. While two of the purchased easements used both 2009 and 2010 ENRTF funding, we are reporting the accomplishments as part of our 2009 report. We will not report these acres in future 2010 reports to avoid double-counting. All eight projects represent unique opportunities to protect high quality natural habitat, riparian areas, and to build upon prior land protection work by the Land Trust at several priority sites. The specific project sites of the conservation easements include:

- 45 acres, including 1,095 feet of shoreline, along Deer Lake in Anoka County (purchased using both ML 2009 and ML 2010 ENRTF appropriations);
- 148 acres, including 2,527 feet of shoreline, along Elk River in Sherburne County (donated);
- 44 acres, including 3,065 feet of shoreline, on Kingswood Pond in Hennepin County (purchased using both ML 2009 and ML 2010 ENRTF appropriations);
- 157 acres near Hardwood Creek in Washington County (donated);
- 5 acres in Scandia in Washington County (donated);
- 126 acres near the headwaters of Valley Creek in Washington County (donated);
- 39 acres adjacent to Wild River State Park in Chisago County (purchased using ML 2009 ENRTF appropriation only);
- 201 acres near Baypoint Park in Goodhue County (donated).

Additionally, the Land Trust prepared baseline property reports for each easement, detailing the condition of the property for future monitoring and enforcement. To fund this required perpetual obligation, the Land Trust dedicated ENRTF and other funds to its segregated Stewardship and Enforcement Fund for all completed projects. We estimated the anticipated annual expenses of each project and the investment needed to generate annual income sufficient to cover these expenses in perpetuity – all in accordance with our internal policies and procedures as approved by LCCMR. We will report to LCCMR annually on the status of the Stewardship and Enforcement Fund and the easements acquired with funds from this grant.

Values are known for only five of the eight easements acquired, and this value totals $854,500, with a known donated value of $413,500. The cost to the State of Minnesota to complete these projects was just over $326 per acre.

Cumulatively, across phases I-V of the Metro Corridors program, the Land Trust has protected 3,298 acres of critical habitat and more than 75,000 feet of shoreline, at a cost to the State of $520 per acre.

The Minnesota Land Trust's work on this project continues to demonstrate the cost effectiveness of working with conservation easements to protect natural and scenic resources within developed and developing areas, as the cost to the State was well below the cost to purchase land in the Twin Cities region. This grant continued to generate interest among landowners, and therefore, ongoing funding will be important to sustained success. Additionally, our experiences during this phase of the grant continue to indicate that funds to purchase easements, as opposed to obtaining donated easements, will be necessary in the future as work becomes more targeted, selective, and focused on building complexes of protected land.

M.L. 2010:

The Minnesota Land Trust proposes to use its 2010 allocation of $485,000 as a supplement to the 2009 phase of this grant to complete 1-2 urgent projects that require capital funding. The Minnesota Land Trust will protect up to 40-80 acres of high-quality forest and wetland habitats by securing permanent conservation easements and dedicating funds for the perpetual monitoring, management, and enforcement of those easements. One of the easements is anticipated to be co-held with the Anoka Conservation District.

III. PROGRESS SUMMARY AS OF AUGUST 1, 2011:

M.L. 2010

2010 Goal:	**40-80 acres**
Number of Easements Completed:	**(2 projects included in 2009 results)**
Total Acres of Easements Completed:	**(89 acres included in 2009 results)**
Total Acres of Potential Easements:	**To be determined**

To date we have completed two projects (Deer Lake and Camp Kingswood) that used both 2009 and 2010 funds. To avoid double counting, acreage will only be counted as part of ENRTF 2009 accomplishments. Full details of these two projects can be found in our 2009 final report.

At this point in time, we anticipate that we will complete one additional project to close out our 2010 grant. An updated project list that includes only 2010 projects (2009 projects deleted) is attached. As the list indicates, we had originally intended to complete the Valley Creek project, but we are no longer considering this project.

Therefore, once we determine which new project will be completed as part of the 2010 grant, we will seek approval for a revised list and provide additional information for that project through a work program status report.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Protect Significant Habitat by Acquiring Conservation Easements

Description: For the 2009 phase of the Metro Conservation Corridors, the Minnesota Land Trust will protect critical habitat the mapped corridors by identifying and contacting interested landowners, negotiating and completing 4-6 permanent conservation easements on up to 150 acres of land, and dedicating funds for the perpetual monitoring, management and enforcement of the easements.

The Land Trust will work in any of the mapped corridors and currently has numerous projects pending. Current potential projects are identified on the attached list and map. We will continually evaluate these projects and pursue those that protect the highest quality habitat, maximize public benefit, and would be most appropriate to complete each of the two phases of the grant. While some of these projects may not be completed at all, new projects will be added as landowners are identified.

The 2010 grant is supplemental to the 2009 grant. With this supplemental funding, the Land Trust will complete 1-2 urgent projects that require capital funding. The Minnesota Land Trust will protect up to 40-80 acres of high-quality forest and wetland habitats by securing permanent conservation easements and dedicating funds for the perpetual monitoring, management, and enforcement of those easements.

Summary Budget Information for Result 1:

	M.L. 2009	M.L. 2010	Total
Trust Fund Budget:	**$250,000**	**$485,000**	**$735,000**
Amount Spent:	**$250,000**	**$293,900**	**$543,900**
Balance:	**$0**	**$191,100**	**$191,100**

Deliverable	Completion Date	Budget
1. M.L. 2009: Protect up to 150 acres by: a. identifying and contacting landowners b. completing 4-6 conservation easements c. dedicating funds to ensure long-term easement sustainability	Complete	$250,000 a. included in personnel b. included in CE acquisition costs, travel, and personnel c. $80,000 All as outlined in Attachment A.
2. M.L. 2010: Protect up to 40-80 acres by: a. completing 1-2 conservation	June 30, 2012	$485,000 a. included in CE acquisition costs,

easements b. dedicating funds to ensure long-term easement sustainability		and personnel b. estimated at $10,000 All as outlined in Attachment A.

Completion Date: M.L. 2009: June 30, 2011; M.L. 2010: June 30, 2012

M.L. 2009 Final Report Summary:
Under this phase of the Metro Corridors program, the Land Trust met project goals and exceeded acreage goals by completing 8 conservation easements, which collectively protect 765 acres of land and more than 33,000 feet of shoreline. While two of the projects used both 2009 and 2010 ENRTF funding, we are reporting the accomplishments as part of our 2009 report. In our reports on the 2010 appropriation, we will discuss the projects but will not include these acres in order to avoid double counting.

Of the eight projects, two are located in the Northwest Area, one in the Central Area, four in the East Area, and one in the Southeast Area. All eight projects are located within Land Trust priority sites and build upon prior protection work completed under previous phases of this grant or other Land Trust initiatives. Specifically, these parcels met the following project selection criteria:

1. Habitat: quality and quantity of existing habitat on site; protects riparian areas and buffers water resources
2. Context: proximity and relationship to other protected lands
3. Opportunity: cost-benefit ratio: which landowners will participate now
4. Other Benefits: meeting multiple objectives, including visual and physical access, forestry goals, water quality, etc.

Our average parcel size for projects completed under this phase of the grant was approximately 96 acres. This is significantly higher than our typical average parcel size of 50 acres for Metro area projects and a further demonstration of the unique conservation opportunity represented by the properties protected by the Land Trust under this phase of the grant.

Because of the large number of potential conservation projects involved in this grant and because many projects initiated or worked on under this grant are not actually completed in this phase of the project, the Land Trust does not allocate professional services expenses to specific conservation easement projects. Funding that is attributable to a specific project is described below and on the attached summary of purchased easements.

Descriptions and Results by Area:

<u>Northwest Area: Wright, Sherburne, Isanti and Anoka Counties</u>
Acres protected: 193
Easements completed: 2

Project: Deer Lake, Anoka County
Description: This 45-acre property is located in East Bethel, adjacent to and containing portions of the Sandhill Crane Natural Area. The property includes oak forest, mixed hardwood swamp, and emergent marsh plant communities that have been mapped by the Minnesota County Biological Survey. Additionally, the property features 1,095 feet of undeveloped shoreline along Deer Lake.

The easement prohibits division of the property. Residential use is limited, and agricultural use is prohibited.

The Land Trust purchased this easement for the fair market value of $163,000. To simplify grant accounting, we used funds from the 2010 supplemental grant to cover the entire purchase price (minus the option consideration of $100). $15,000 of 2009 ENRTF funds were used to cover stewardship on this project. 2009 ENRTF funds also were used to cover personnel and project costs such as appraisal, title work and mapping. As stated above, the acreage for this project was counted under the 2009 ENRTF grant, and will not be counted under the accomplishments for the 2010 supplemental grant. Additional detail is provided in the attached Summary of Purchased Easements.

Project: Elk River, Sherburne County
Description: This 148-acre property is a mix of high quality oak forest, restored prairie and a large wetland complex. The protected land also includes 2,527 feet of undeveloped shoreline along two ponds and provides habitat for a variety of wildlife including Blanding's turtle, sandhill crane, bald eagle, and a variety of neotropical migratory birds.

The easement prohibits division of the property. Residential use is limited, and agricultural use is prohibited.

$15,000 of ENRTF funds were used to cover easement monitoring, management, and enforcement. The value of this donated easement is $319,500.

Central Area: Hennepin and Ramsey Counties

Acres protected: 44
Easements completed: 1

Project: Camp Kingswood, Hennepin County
Description: The property consists of 44 acres in western Hennepin County in the City of Minnetrista and lies within one of the County's highest priority natural resource corridors. The remnant maple-basswood forest and the eastern red cedar woodland on the property have both been identified as native plant communities by the Minnesota Land Cover Classification System. The property also features approximately 3,065 feet of shoreline along Kingswood Pond, which also is the site of a floating tamarack bog. The

property also lies adjacent to other Camp Kingswood property that is protected with a conservation easement held by the MN DNR (through the former Metro Greenways program). Protection of this property also complements Gale Woods Park and other private easements on Whale Tail Lake, which lie within the same priority corridor.

The easement prohibits division of the property and agricultural use. Limited camp facilities, including an alternative residential use, are allowed. This easement is co-held with Hennepin County.

The Land Trust purchased this easement for $200,000, a price below the fair-market value of $225,000. Funds for the purchase price came from the Land Trust's 2009 and 2010 grants, as well as Hennepin County. Hennepin County also provided $15,000 to cover easement stewardship on this project. As noted above, the acreage for this project was counted under the 2009 ENRTF grant, and will not be counted under the accomplishments for the 2010 supplemental grant. Additional detail is provided in the attached Summary of Purchased Easements.

East Area: Chisago and Washington Counties

Acres protected: 327
Easements completed: 4

Project: Hardwood Creek, Washington County
Description: This 157-acre property is located in northern Washington County, adjacent to the Hardwood Creek Wildlife Management Area. This area contains one of the largest remaining complexes of high quality native plant communities in Washington County. The forest and wetland mosaic on the property includes four native plant communities identified by the Minnesota County Biological Survey: shrub swamp, hardwood swamp forest, maple-basswood forest, and minerotrophic tamarack swamp.

The easement prohibits division of the property and residential use. Agricultural use is limited to a small portion of the property.

This was a donated easement, and the Land Trust dedicated $15,000 of ENRTF funds to cover easement stewardship. The value of this easement is unknown.

Project: Scandia, Washington County
Description: This project involved adding 5 acres of land to an existing easement of 15 acres. The property has a rolling topography and lies at the start of the fall line to the St. Croix Valley. It contains restored prairie and wetlands, both of which are key habitats for a variety of species in conservation need.

The easement prohibits division of the entire 20-acre property and agricultural use. Residential use is limited.

$10,000 of ENRTF funds were used to cover easement monitoring, management, and enforcement. The value of this donated easement is $69,000.

Project: Valley Creek, Washington County
Description: This 126-acre property lies at the headwaters of Valley Creek, an area where the Land Trust has focused conservation work in recent years. The property contains natural communities of shrub swamp and mesic oak forest that have been mapped by the Minnesota County Biological Survey and the property can provide habitat for such species in greatest conservation need as northern harriers, bobolinks, and peregrine falcons.

The easement prohibits division of the property and agricultural use. Residential use is limited. Recreational, education, and/or research structures are allowed but limited.

$10,000 of ENRTF funds were used to cover easement monitoring, management, and enforcement. The value of this donated easement is unknown.

Project: Wild River State Park, Chisago County
Description: This 39-acre property lies adjacent to Wild River State Park and three other Land Trust conservation easements. It features oak forest and white pine-hardwood forest that have been mapped by the MCBS.

The easement prohibits division of the property, residential use, and agricultural use.

The Land Trust purchased this easement for the fair-market value of $78,000 using funds from the Doris Duke Charitable Foundation/Conservation Fund. $15,000 of 2009 ENRTF funds were used to cover easement monitoring and enforcement. Additional detail is provided in the attached Summary of Purchased Easements.

Southeast Area: Dakota and Goodhue Counties
Acres protected: 201
Easements completed: 1

Project: Baypoint Park, Goodhue County
Description: The 201-acre property features land along the Mississippi River within the City of Red Wing. The scenic property protects 8,893 feet of Mississippi River shoreline and 5,597 feet along both sides of Hay Creek, a state designated trout stream. Two city parks are located in the property and provide extensive recreational and educational opportunities and public access to the Mississippi River. Natural communities in the property include lowland floodplain forests, a mixed emergent marsh, wet meadow, ponds and several grassland areas. Important habitat types in the property are used by both

migratory and resident wildlife including several species in greatest conservation need. The land is part of a greater Audubon Important Bird Area and is located near several regionally significant protected lands along the Upper Mississippi River corridor.

The easement prohibits agricultural and residential use on the property. Commercial use is limited.

2009 ENRTF funds were used to cover personnel and project costs such as appraisal, title work and mapping. $22,000 was provided by The Saint Paul Foundation to cover easement monitoring, management, and enforcement. The value of this donated easement is unknown.

Result Status as of August 1, 2011:

M.L. 2010: As stated above we completed two projects that partially used 2010 funds, but we have reported these accomplishments as part of our 2009 final report. Because we are no longer considering the Valley Creek project, we need to determine which new project will complete our deliverables under this phase of the grant. We will provide additional details once that project has been selected.

Result Status as of June 13, 2011:

M.L. 2010: As noted in the 2009 update, the Land Trust intends to use 2010 funds for a portion of the Camp Kingswood acquisition. Details related to this project and transaction are described in the 2009 update.

Result Status as of February 1, 2011:

M.L. 2010: The Deer Lake project, protecting 45 acres in Anoka County and described in detail in the 2009 update, was completed using 2010 funds for the purchase price of this conservation easement. Additionally, we anticipate completing two additional projects that will require 2010 funds.

Amendment Request
The Land Trust also intends to complete 4-5 additional projects to complete both the 2009 and 2010 grants. Three of these projects will involve donated easements, which will be completed using 2009 funds. One of these three projects will require ENRTF stewardship funding. Two projects will involve purchases, which will require the use of 2009 and 2010 funds. Again, one of these purchased easements will require ENRTF stewardship funding. Therefore, we are requesting the following budget amendment:

In order to complete the remaining 5 potential projects, the Land Trust is requesting the following budget amendment:

1. 2009 Budget: Move $20,000 from “Easement Acquisition” to “Easement Stewardship” - As noted above, this adjustment is needed because we are completing more projects than originally anticipated and will allow us to fulfill

stewardship funding needs for projects completed at the end of 2010 and for one additional easement yet to be completed.

2. 2010 Budget: Move $20,000 from “Easement Stewardship” to “Easement Acquisition.” This adjustment will keep the combined total 2009 and 2010 stewardship budget as originally proposed and approved. The additional stewardship funds are not needed in 2010 because we used 2009 funds for the Deer Lake project. This was done pursuant to the approval we received on July 8, 2010 to run the two grants concurrently, which required that we spend 2009 dollars first in categories other than acquisition.
3. 2010 Budget: Move $5,000 from “Personnel” to “Easement Acquisition.” Because we continue to use the 2009 personnel budget, it is anticipated that we will not require all of the 2010 dollars originally planned for personnel expenses.

Amendment approved on February 14, 2011.

Result Status as of August 1, 2010:

M. L. 2010: The Land Trust just recently received approval to work on this grant concurrently with the 2009 grant and signed contracts with the Minnesota DNR. We anticipate closing our first project, Deer Lake (described above), during the month of August.

Request to Work on Grants Concurrently:
One of the projects (Deer Lake) on which the Land Trust is currently working is scheduled to close as early as July or August 2010 and requires capital funds as the Land Trust will be purchasing the easement from the landowner. This is a high-priority project on a natural environment lake in Anoka County. In order to complete this project, the Land Trust would need to use the Phase 5 Supplemental (2010) funds for the acquisition capital. Therefore, we are requesting approval to be able to work on both grants concurrently. Request approved on: July 8, 2010.

Result Status as of February 1, 2010:

M.L. 2010: This phase is pending action from the Minnesota Legislature.

Result Status as of February 1, 2012:

M.L. 2010 Final Report Summary:

V. TOTAL TRUST FUND PROJECT BUDGET:

M.L. 2009

MLT and Contract Personnel: $88,413: $58,043 to cover a portion of the salaries and related benefits of staff working on projects funded under this grant—approximately .75 FTE conservation program staff and .25 legal and other support staff. $30,370 for land protection project professional services, including negotiating

and drafting conservation easements and/or completing easement baseline documentation and legal review services. We anticipate contracting with Lee Markell, Melinda Beck, or other individuals familiar with conservation easements. All contractors will comply with the Land Trust's Conflicts of Interest policy.
Acquisition, including easements: $80,062 to acquire 8 conservation easements protecting 765 acres of land to be held by the Minnesota Land Trust. A limited amount was used for the direct cost of acquiring easements where landowners were not be able to donate the full value of an easement. The remaining funds were used for related transaction costs such as for appraisals, surveys, title work, mapping, etc. NOTE: Exact amounts are not known at this time. Transaction costs are higher for purchases than donations and amounts were allocated as specific projects were identified for completion under this grant.
Travel: $1,525 to cover mileage and related travel expenses in Minnesota.
Stewardship: $80,000 to be dedicated to the Stewardship and Enforcement Fund. Actual amounts committed for stewardship were determined based upon the number and nature of specific projects completed and the availability of other funds. Typical stewardship fund requests are approximately $12,000-15,000 per project.
TOTAL 2009 TRUST FUND PROJECT BUDGET: $ 250,000

<u>M.L. 2010</u>
Personnel: $15,000 to cover a portion of the salaries and related benefits of staff working on projects funded under this grant
Acquisition, including easements: $460,000
Stewardship: $10,000 to be dedicated to the Stewardship and Enforcement Fund. Actual amounts committed for stewardship will depend upon the number and nature of specific projects completed and the availability of other funds. Currently, typical stewardship fund requests are approximately $12,000-15,000 per project.
TOTAL 2010 TRUST FUND PROJECT BUDGET: $485,000

Explanation of Capital Expenditures Greater Than $3,500: N/A

VI. OTHER FUNDS & PARTNERS:

A. Project Partners: Project partners for 2009 and 2010 include Metro Conservation Corridors partners (please see overall MeCC work program for list of project partners) and private landowners, local governments, regional, state and federal agencies, nonprofit organizations and citizen groups.

B. Other Funds Spent/Proposed to be Spent during the Project Period: By working to acquire primarily donated conservation easements, or easements through bargain purchases, the Minnesota Land Trust was able to protect lands at a fraction of what it would cost to purchase comparable lands in fee. The known donated value of easements completed in the 2009 grant phase is $413,500, but values are known for only five of the eight easements completed. Additional funds were spent by the Minnesota Land Trust to cover costs associated with the project not covered by the grant.

The value of easements is difficult to predict, but we expect a similar level of leverage for 2010.

C. Past Spending: The Minnesota Land Trust has received the following from past Metro Corridors grants: $ 230,000 in 2003; $ 230,000 in 2005; $134,000 in 2007; $225,000 in 2008; $250,000 in 2009; and $485,000 in 2010. Of the total funds appropriated through these grants, $1,064,300 has been spent to date.

D. Time: For the 2009 phase, work was initiated in December 2009 and was completed in June 2011. For the 2010 phase, work was initiated in July 2010 and will be completed not later than June 30, 2012. The 2009 and 2010 phases are a continuation of the Minnesota Land Trust's exisiting Metro Conservation Corridors Partnership project. Components were designed to be overlapping so that activities could continue seamlessly. For example, we may initiate work with a landowner in one phase of the grant, but the project may not be completed until the next phase.

E. Project Impact and Long-Term Strategy: This project is part of the Land Trust's long-term, strategic conservation agenda. The conservation agenda sets out the specific conservation focus of the Minnesota Land Trust. This focus includes natural habitats for wildlife, fish and plants, lakeshores, rivers and streams, and scenic landscapes accessible or visible to the public. The conservation agenda also identifies a suite of critical landscapes throughout Minnesota that embody the natural and cultural features that make Minnesota unique. The Metropolitan Conservation Corridors is one of the Land Trust's identified critical landscapes – one that addresses the unique conservation challenges that exist in a largely developed area.

VII. DISSEMINATION: For 2009 projects, the Land Trust completed press releases for Camp Kingwood, Deer Lake, Hardwood Creek, and Wild River State Park. The Deer Lake project was publicized in the Star Tribune and two other projects, Bay Point Park and Camp Kingswood, were publicized in local papers. The Land Trust will continue to disseminate results for 2009 and 2010 projects in our publications and on our web page. We will work to publicize completed projects in the media, targeting communities in which projects are located. Additionally, we will participate when possible in broader efforts of the Metro Conservation Corridors Partnership. These efforts may include emails to people on the Embrace Open Space (EOS) database, through the EOS quarterly meetings and jointly held county meetings, and on the partnership website.

VIII. REPORTING REQUIREMENTS:

For the 2009 appropriation, periodic work program progress reports were submitted February 1st and August 1st of each year, starting February 2010. This is the final work program report.

For the 2010 appropriation, periodic work program progress reports will continue to be submitted February 1st and August 1st of each year. A final work program report and associated products will be submitted not later than August 1, 2012.

IX. RESEARCH PROJECTS: N/A

Attachment A: Budget Detail for 2010 Projects

Project Title: *Metro Conservation Corridors - Phase V: Minnesota Land Trust*

Project Manager Name: *Sarah Strommen*

Trust Fund Appropriation: $ *485,000*

2010 Trust Fund Budget	**Result 1 Budget:** Amended/Approved February 2011	**Amount Spent** *as of 6/30/2011*	**Balance** *as of 6/30/2011*
	Aquiring Conservation Easements		
BUDGET ITEM			
MLT and Contract Personnel:	15,000	0	15,000
Wages and benefits: Staff expenses including salaries, benefits (FICA,FUTA. SUI, worker's comp health insurance, 401 (k), etc.) and related costs for conservation directors or other land protection staff, staff attorney and other support staff.			
Land protection project professional services, including negotiating and drafting conservation easements and/or completing easement baseline documentation and legal review services			
Conservation Easement Acquisition Costs *(less than fee)*	460,000	293,900	166,100
Purchase price of conservation easement(s)			
Title work, insurance, etc.			
Maps, GIS (including project mapping by Community GIS)			
Film			
Other (including appraisals, survey, recording fees, etc.)			
Easement Stewardship: funds dedicated to perpetually monitoring, managing, and enforcing acquired easements	10,000	0	10,000
COLUMN TOTAL	**$485,000**	**$293,900**	**$191,100**

Minnesota Land Trust
2010 LCCMR Metro Corridors Phase 5 Supplemental Project List
August 1, 2011

The following is a list of projects the Minnesota Land Trust currently is considering. Other projects may be added to the list as new landowners are contacted. Some projects on the list will not be completed. Projects not completed under the 2010 phase may be moved to future phases.

PROJECTS:

Northwest Area: Wright, Sherburne, Isanti and Anoka Counties

Site/County	Approximate Acres	Water Body	STATUS
Deer Lake Anoka County	45	Deer Lake	Completed
TOTAL	**45 (reported under 2009 grant)**		

Central Area: Hennepin and Ramsey Counties

Site/County	Approximate Acres	Water Body	STATUS
Camp Kingswood Hennepin County	41	Pond	Completed
TOTAL	**41 (reported under 2009 grant)**		

East Area: Chisago and Washington Counties

Site/County	Approximate Acres	Water Body	STATUS
Valley Creek Washington County	8		No longer considering
TOTAL			

Southwest Area: Carver, Scott, Sibley, LeSueur, Nicollet Counties

Site/County	Approximate Acres	Water Body	STATUS
TOTAL			

Southeast Area: Dakota and Goodhue Counties

Site/County	Approximate Acres	Water Body	STATUS
TOTAL			

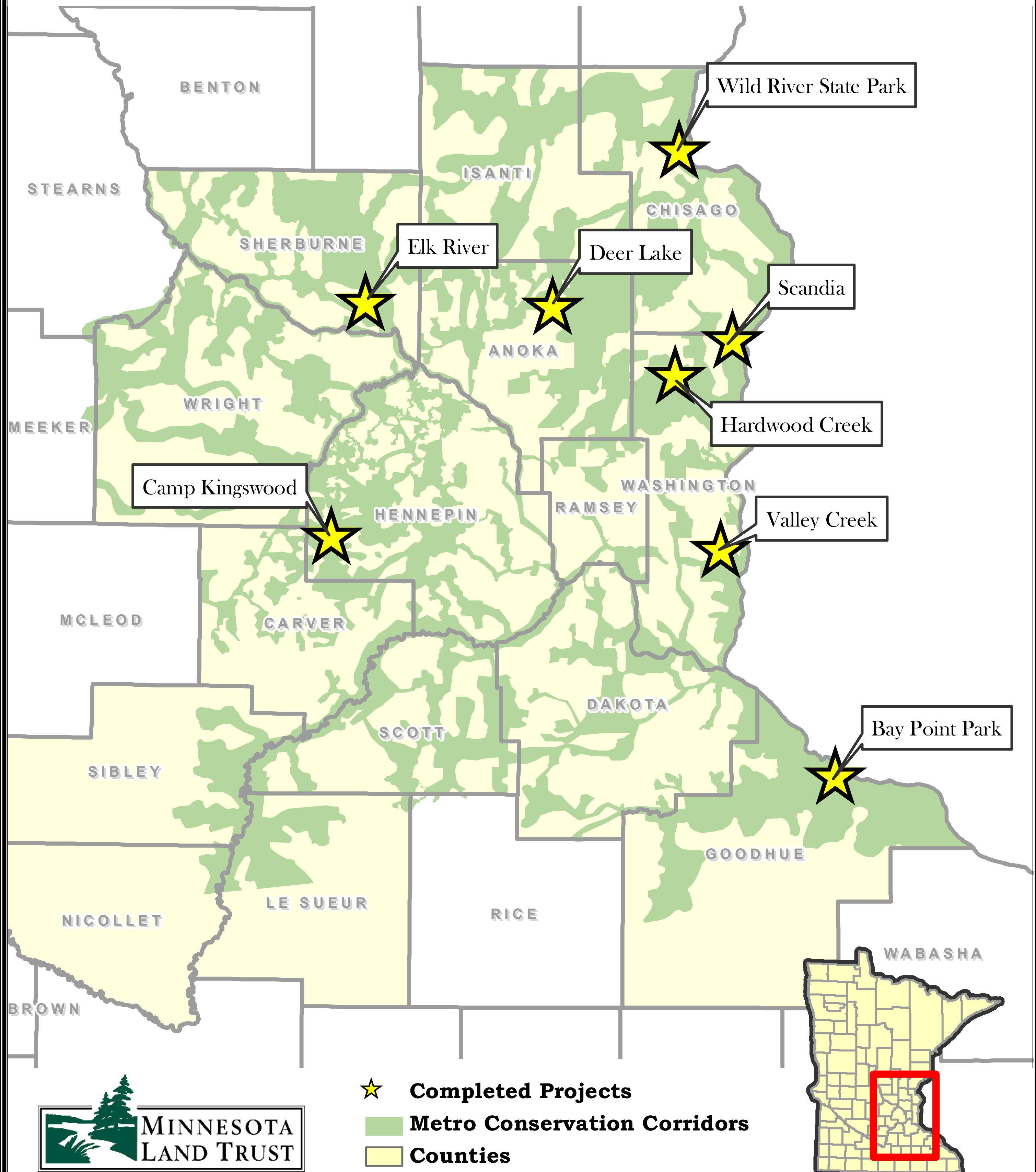
Minnesota Land Trust: Metro Conservation Corridors – 2009 and 2010 (Phase 5 and Phase 5 Supplemental)
Summary of Purchased Easements

Project	Acres	Funding Type	Funds Use	Funding Amount
Deer Lake Anoka County	45	ENRTF – 2010 Land Trust allocation	Purchase price of conservation easement	$163,000
		ENRTF – 2009 Land Trust allocation	Stewardship	$15,000
Wild River State Park Chisago County	39	The Conservation Fund/Doris Duke Foundation	Purchase price of conservation easement	$78,000
		ENRTF-2009 Land Trust allocation	Stewardship	$15,000
Camp Kingswood Hennepin County	44	ENRTF-2009 Land Trust allocation	Purchase price of conservation easement	$41,500
		ENRTF-2010 Land Trust allocation	Purchase price of conservation easement	$131,000
		Hennepin County	Purchase price of conservation easement	$27,500
		Hennepin County	Stewardship	$15,000
		Landowner donation	Donated value of conservation easement	$25,000

In addition to the expenses listed above, staff time and professional services expenses covering closing costs, title review, etc. were incurred and covered by the Land Trust's 2009 Metro Conservation Corridors allocation. The Land Trust does not allocate staff time or professional services expenses to specific conservation projects.

Minnesota Land Trust Completed Projects

METRO CONSERVATION CORRIDORS PARTNERSHIP
PHASE V



MINNESOTA LAND TRUST

2009 Project Abstract
For the Period Ending June 30, 2011

TITLE: Metropolitan Conservation Corridors – Phase V – Minnesota Valley Trust, Inc. – 3.3, Expansion of Minnesota Valley National Wildlife Refuge
PROJECT MANAGER: Deborah Loon
ORGANIZATION: Minnesota Valley National Wildlife Refuge Trust, Inc.
ADDRESS: 2312 Seabury Avenue, Minneapolis, MN 55406
WEB SITE ADDRESS: www.mnvalleytrust.org
FUND: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 4f3.3

APPROPRIATION AMOUNT: $225,000

<u>Overall Project Outcome and Results</u>

The Minnesota Valley National Wildlife Refuge Trust, Inc. acquired 96 acres of priority lands in the Minnesota River Valley floodplain in Sibley County to expand the Jessenland Unit of the Minnesota Valley National Wildlife Refuge. Of the 96 acres acquired, the Environment and Natural Resources Trust Fund paid for 90 acres and the Minnesota Valley Trust paid for 6 acres with nonprofit / other non-state funds.

Using other non-state funds, the Minnesota Valley Trust also acquired 44.67 acres of priority lands in the Minnesota River Valley in Scott County to expand the Blakely Unit of the Minnesota Valley National Wildlife Refuge. The Blakely and Jessenland Units are on opposite (facing) sides of the Minnesota River and, together, form a large contiguous block of priority wildlife habitat.

Both of these acquisitions expand upon prior acquisitions funded in part by the Environment and Natural Resources Trust Fund, as recommended by the LCCMR. The parcels acquired are adjacent to other lands protected by the Minnesota Valley Trust for the Minnesota Valley National Wildlife Refuge.

The Blakely and Jessenland Units of the Refuge were identified through a planning process by the US Fish and Wildlife Service as priority expansion units of the Minnesota Valley National Wildlife Refuge. The parcels acquired are within the expansion boundaries of those Refuge units.

After any needed restoration, the lands will be donated to the USFWS for perpetual management as part of the Minnesota Valley National Wildlife Refuge. They will be managed for wildlife and wildlife-dependent recreation, including hunting, fishing, wildlife observation, photography, wildlife interpretation and environmental education.

<u>Project Results Use and Dissemination</u>

The Minnesota Valley Trust will publicize the completion of this project through its website and news releases. All funding partners will be acknowledged on Refuge kiosks, including the Environment and Natural Resources Trust Fund, as recommended by the Legislative Citizen Commission on Minnesota Resources.

Trust Fund 2009 Work Program Final Report

Date of Report: November 1, 2010
Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Metropolitan Conservation Corridors – Phase V – Minnesota Valley Trust, Inc. – 3.3, Expansion of Minnesota Valley National Wildlife Refuge

Project Manager:	Deborah Loon
Affiliation:	Minnesota Valley National Wildlife Refuge Trust, Inc.
Mailing Address:	2312 Seabury Avenue
City / State / Zip:	Minneapolis, MN 55406
Telephone Number:	612-801-1935
E-mail Address:	DebLoon@comcast.net
FAX Number:	612-728-0700
Web Site Address:	www.mnvalleytrust.org

Location: Metro, Central or Southeast (Minnesota River Valley). **County:** Carver, Scott, LeSueur and/or Sibley Counties.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**225,000**
	Minus Amount Spent:	**$**	**225,000**
	Equal Balance:	**$**	**0**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4f3.3

Appropriation Language:
$3,375,000 is from the trust fund to the commissioner of natural resources for the fifth appropriation for acceleration of agency programs and cooperative agreements. Of this appropriation, $2,185,000 is for Department of Natural Resources agency programs and $1,190,000 is for agreements as follows: $380,000 with the Trust for Public Land; $90,000 with Friends of the Mississippi River; $155,000 with Great River Greening; $250,000 with Minnesota Land Trust; $225,000 with Minnesota Valley National Wildlife Refuge Trust, Inc.; and $90,000 with Friends of the Minnesota Valley for the purposes of planning, restoring, and protecting important natural areas in the metropolitan area, as defined under Minnesota Statutes, section 473.121, subdivision 2, and portions of the surrounding counties, through grants, contracted services, technical assistance, conservation easements, and fee title acquisition. Land acquired with this appropriation must be sufficiently improved to meet at least minimum management standards as determined by the commissioner of natural resources. Expenditures are limited to the identified project corridor areas as defined in the work program. This appropriation may not be used for the purchase of residential structures, unless expressly approved in the work program. All conservation easements must be perpetual and have a natural

resource management plan. Any land acquired in fee title by the commissioner of natural resources with money from this appropriation must be designated as an outdoor recreation unit under Minnesota Statutes, section 86A.07. The commissioner may similarly designate any lands acquired in less than fee title. A list of proposed restorations and fee title and easement acquisitions must be provided as part of the required work program. All funding for conservation easements must include a long-term stewardship plan and funding for monitoring and enforcing the agreement. To the maximum extent practical, consistent with contractual easement or fee acquisition obligations, the recipients shall utilize staff resources to identify future projects and shall maximize the implementation of biodiverse, quality restoration projects in the project proposal into the first half of the 2010 fiscal year.

II. and III. FINAL PROJECT SUMMARY: The Minnesota Valley Trust acquired 96 acres of priority lands in the Minnesota River Valley floodplain in Sibley County to expand the Jessenland Unit of the Minnesota Valley National Wildlife Refuge. Of the 96 acquired, the Environment and Natural Resources Trust Fund paid for 90 acres and the Minnesota Valley Trust paid for 6 acres with nonprofit / other non-state funds.

Using other non-state funds, the Minnesota Valley Trust also acquired 44.67 acres of priority lands in the Minnesota River Valley in Scott County to expand the Blakely Unit of the Minnesota Valley National Wildlife Refuge. The Blakely and Jessenland Units are on opposite (facing) sides of the Minnesota River and, together, form a large contiguous block of priority wildlife habitat.

Both of these acquisitions expand upon prior acquisitions funded in part by the Environment and Natural Resources Trust Fund, as recommended by the LCCMR. The parcels acquired are adjacent to other lands protected by the Minnesota Valley Trust for the Minnesota Valley National Wildlife Refuge.

The Blakely and Jessenland Units of the Refuge were identified through a planning process by the US Fish and Wildlife Service as priority expansion units of the Minnesota Valley National Wildlife Refuge. The parcels acquired are within the expansion boundaries of those Refuge units.

After any needed restoration, the lands will be donated to the US Fish and Wildlife Service for perpetual management as part of the Minnesota Valley National Wildlife Refuge. They will be managed for wildlife and wildlife-dependent recreation, including hunting, fishing, wildlife observation, photography, wildlife interpretation and environmental education.

Appraised value was paid on both parcels:
1) $240,000 on the 96 acres in Sibley County for the Jessenland Unit
2) $129,543 on the 44.67 acres in Scott County for the Blakely Unit

Transaction costs for the acquisitions were paid by with other non-state funds and were as follows:

1) $4,143 on the 96 acres in Sibley County for Jessenland Unit -- $1,901 legal, $950 appraisal, $1,292 closing costs, title insurance, recording fees
2) $1,875.05 on the 44.67 acres in Scott County for Blakely Unit -- $1,050 appraisal, $825.05 closing, title insurance, recording fees; legal fees are not recorded at this time

Total cost of the two acquisitions -- $375,561.05. Funds for the acquisitions came from two sources:
1) Environment and Natural Resources Trust Fund -- $225,000
2) MN Valley Trust funds -- $150,561.05

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Fee title acquisition

Description: Fee title acquisition of 45 acres of significant habitat in the Minnesota River Valley within Carver, Scott, LeSueur and/or Sibley Counties. The Minnesota Valley Trust will leverage these grant funds and acquire an additional 45 acres or more with other, non-state funds.

The Trust is working with multiple landowners within expansion units of the Minnesota Valley National Wildlife Refuge, as prioritized and delineated by the USFWService in its Comprehensive Conservation Plan.

The prospective lands offer significant habitat for wildlife and opportunities for wildlife-dependent recreation. The lands run along the Minnesota River and include river frontage, floodplain, cropland and bluffs. Some are adjacent to lands already in public ownership (FWS, DNR) or previously acquired by the MN Valley Trust for the Refuge expansion.

These acquisitions will connect the river, floodplain forest and prairie habitat in the Minnesota River bottoms, benefiting many species of wildlife including wood ducks, mallards, bald eagles, grassland nesting birds as well as numerous resident game species such as turkeys and deer.

This project will improve water quality by retiring cropland in the Minnesota River Valley and restoring lands to the natural habitats of floodplain forest, wetlands and prairie. When donated to the USFWS, the public will be given access to the lands for wildlife-dependent recreational activities, such as birding, photography, hiking, interpretation, hunting and fishing.

After acquisition and restoration of the habitat by the Minnesota Valley Trust and other partners, the lands will be donated to the USFWS for management by the Minnesota Valley National Wildlife Refuge.

Summary Budget Information for Result 1: **Trust Fund Budget: $ 225,000**
Amount Spent: $ 225,000
Balance: $ 0

Deliverable	**Completion Date**	**Budget**
1. Acquire 45 acres in fee title with ETF funds and 45 acres in fee title with other non-state funds	June 30, 2011	$ 225,000

Result Completion Date: November 1, 2010

Final Report Summary: The Minnesota Valley Trust acquired 96 acres of priority lands in the Minnesota River Valley floodplain in Sibley County to expand the Jessenland Unit of the Minnesota Valley National Wildlife Refuge. Of the 96 acquired, the Environment and Natural Resources Trust Fund paid for 90 acres and the Minnesota Valley Trust paid for 6 acres with nonprofit / other non-state funds.

Using other non-state funds, the Minnesota Valley Trust also acquired 44.67 acres of priority lands in the Minnesota River Valley in Scott County to expand the Blakely Unit of the Minnesota Valley National Wildlife Refuge. The Blakely and Jessenland Units are on opposite (facing) sides of the Minnesota River and, together, form a large contiguous block of priority wildlife habitat.

Both of these acquisitions expand upon prior acquisitions funded in part by the Environment and Natural Resources Trust Fund, as recommended by the LCCMR. The parcels acquired are adjacent to other lands protected by the Minnesota Valley Trust for the Minnesota Valley National Wildlife Refuge.

The Blakely and Jessenland Units of the Refuge were identified through a planning process by the US Fish and Wildlife Service as priority expansion units of the Minnesota Valley National Wildlife Refuge. The parcels acquired are within the expansion boundaries of those Refuge units.

To achieve these results, the Minnesota Valley Trust did outreach to landowners within the expansion units. After landowners express interest in potentially selling their land, the Trust obtains an appraisal and makes an offer to acquire fee title at the appraised value. The appraisal is shared with the landowner and the landowner is notified that there is no obligation to sell to the Minnesota Valley Trust. After negotiations are complete, a purchase agreement is signed and the due diligence on the title commences.

After any needed restoration on the lands is completed, the lands will be donated to the US Fish and Wildlife Service for perpetual management as part of the Minnesota Valley National Wildlife Refuge. They will be managed for wildlife and wildlife-dependent recreation, including hunting, fishing, wildlife observation, photography, wildlife interpretation and environmental education.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $ 0
Contracts: $ 0
Equipment/Tools/Supplies: $ 0
Acquisition, including easements: $ 225,000
Travel: $ 0
Other: $ 0

TOTAL TRUST FUND PROJECT BUDGET: $ 225,000

Explanation of Capital Expenditures Greater Than $3,500:

VI. PROJECT STRATEGY:

A. Project Partners: US Fish & Wildlife Service, Friends of the Minnesota Valley, local units of government and others.

B. Project Impact and Long-term Strategy: This project is part of a long-term strategy to expand the Minnesota Valley National Wildlife Refuge by up to 10,000 acres. The expansion strategy was developed by the US Fish and Wildlife Service in its Comprehensive Conservation Plan for the Refuge, completed September 2004 after a thorough public input process.

This project will further acquisition work completed previously by the Minnesota Valley Trust with support from the ENRTF. The benefits of the project include the following:

- Connect the river, floodplain forest and prairie habitat in the Minnesota River bottoms, benefiting many species of wildlife including wood ducks, mallards, bald eagles, grassland nesting birds as well as numerous resident game species such as turkeys and deer.
- Improve water quality of the Minnesota River by retiring cropland and restoring lands to the natural habitats of floodplain forest, wetlands and prairie.
- Establish new lands for the public's enjoyment through the wildlife-dependent recreational activities of birding, photography, hiking, interpretation, hunting and fishing.

C. Other Funds Proposed to be Spent during the Project Period: $225,000

D. Spending History:
MeCC Phase I (2003) - $290,000 ETF and $1,137,030 other non-state funds
MeCC Phase II (2005) - $230,000 ETF and $428,000 other non-state funds
MeCC Phase III (2007) - $210,000 ETF and $376,473 other non-state funds

MeCC Phase IV (2008) - $225,000 ETF and $197,985.20 other non-state funds

VII. DISSEMINATION: As projects are completed, the Minnesota Valley Trust will announce the accomplishments through press releases, the Trust website and the Metro Conservation Corridors website.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than February 1 and August 1. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS: NA

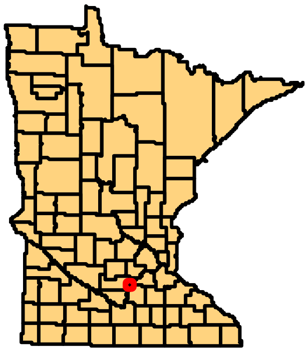
Attachment A: Budget Detail for 2009 Projects

Project Title: Metropolitan Conservation Corridors – Phase V – Minnesota Valley Trust, Inc. – 3.3, Expansion of Minnesota Valley National Wildlife Refuge

Project Manager Name: Deborah Loon

Trust Fund Appropriation: $225,000

2009 Trust Fund Budget	Result 1 Budget:	Amount Spent *(date)*	Balance 11/1/2010	TOTAL BUDGET	TOTAL BALANCE
	Fee title acquisition of 45 acres				
BUDGET ITEM					
Land acquisition	225,000	225,000	0	225,000	0
COLUMN TOTAL	$225,000	$225,000	$0	$225,000	$0



Minnesota Valley Trust, Inc. - MeCC 3.3 2009

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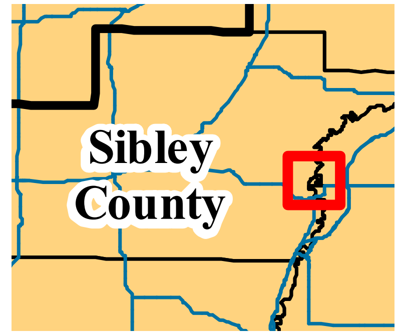

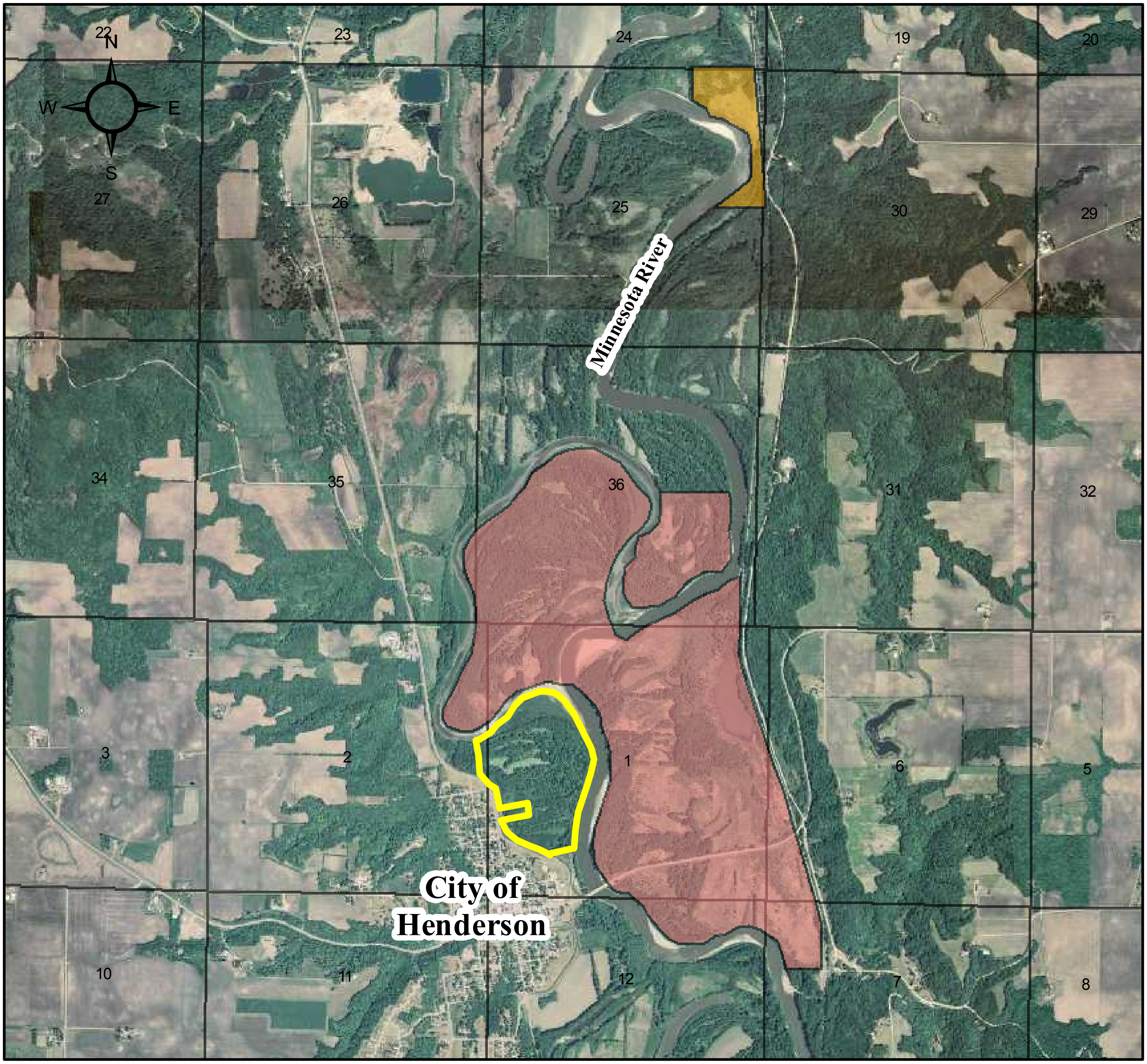

2009 ENRTF - Grant Funds Acquisition - 96 Acres

Section Boundary

MN Valley Trust - Acquired

2009 ENRTF - Match Funds Acquisition - 45 Acres

2008 Project Abstract
For the Period Ending June 30, 2011

Project Title: Statewide Ecological Ranking of CRP and Other Critical Lands

Project Manager: Greg Larson
Affiliation: MN Board of Water and Soil Resources
Mailing Address: 520 Lafayette Road North
City / State / Zip: St. Paul, MN 55155
Telephone Number: 651-297-7029 (cell 612 751-3060)
E-mail Address: Greg.a.Larson@state.mn.us
FAX Number: 651-297-5615
Web Page address: www.bwsr.state.mn.us

Funding Source: Environment and Natural Resources Trust Fund

Legal Citation:
(1) M.L. 2007, Chap. 30, Sec. 2, Subd. 7
Appropriation Language:
$160,000 is from the trust fund to an emerging issues account as authorized in Minnesota Statutes, section 116P.08, subdivision 4, paragraph (d).[$13,000 of the total $160,000 was allocated toward this project]
(2) M.L. 2008, Chap. 367, Sec. 2, Subd. 7
Appropriation Language:
$155,000 is from the trust fund for an emerging issues account as authorized under Minnesota Statutes, section 116P.08, subdivision 4, paragraph (d).
(3) M.L. 2009, Chp. 143, Sec. 2, Subd. 4g
Appropriation Language:
$107,000 is from the trust fund to the Board of Water and Soil Resources to continue the efforts funded by the emerging issues account allocation to identify and rank the ecological value of conservation reserve program (CRP) and other critical lands throughout Minnesota using a multiple parameter approach including soil productivity, landscape, water, and wildlife factors.

Appropriation Amount: $275,000

Overall Project Outcomes and Results

To allocate scarce fiscal resources to natural resource programs, identifying the location and ranking the ecological value of critical lands is important. Using parameters of soil productivity, soil erosion risk, water quality risk, and habitat quality, an ecological ranking tool was developed. An economic model was also incorporated to analyze CRP (Conservation Reserve Program) parcels and determine the likelihood of contract renewal given anticipated crop prices and land quality. A parameter for soil erosion risk was developed using several factors from the Universal Soil Loss Equation. To identify lands posing a risk to water quality, or lands that are most likely to contribute overland runoff to surface waters, terrain analysis was used. Runoff rankings from terrain analysis were then integrated with a proximity analysis of surface water features based on DNR 24k surface water data. A parameter for habitat quality was derived from an update to the work done as part of the Minnesota Conservation and Preservation Plan (LCCMR, 2008). Combining the data sets therein, and assessing them with a “weight of evidence” approach, produced a ranking of wildlife quality. These several parameters were combined into an environmental benefits index (EBI). High EBI translates into high risk. Therefore, a high EBI score implies a site has a high value for conservation. CRP or other parcels deemed critical for conservation can be assessed simultaneously on the basis of multiple ecological benefits. The EBI tool has demonstrated utility as users can establish thresholds for EBI values based on program goals and amount of funding available.

Project Results Use and Dissemination

The EBI was first presented to a general audience through a WEBINAR. A follow-up technical training session, geared to GIS professionals, was developed. The technical sessions were attended by 42 conservation professionals representing local units of government, state and federal agencies, non-governmental organizations and private companies.

A majority (70%) of participants at the three technical training sessions said they planned to use the ecological ranking tool in their professional work. Given the diverse professional affiliations of the participants, their active involvement in conservation planning and delivery, and their connection to the network of natural resource professionals, it is likely that the Ecological Ranking Tool will be integrated into many conservation activities throughout Minnesota.

Presentations of the project and project results were provided to the LCCMR, Lessard-Sams Outdoor Heritage Council and the Board of Water and Soil Resources.

A final report was prepared. The report describes all results in more detail and includes maps and graphics and suggestions for use. A website was established by the Board of Water and Soil Resources

www.bwsr.state.mn.us/ecological_ranking/

that provides an overview of the ranking methodology. The BWSR website also includes links to an interactive ranking tool (located at the University of Minnesota, Natural Resources Research Institute (NRRI) and the final report, which is available in downloadable format.

Environment and Natural Resources Trust Fund 2008 Work Program Final Report

Date of Report: August 30, 2011
Final Report

	M.L. 2007	M.L. 2008	M.L. 2009
Date of Work program Approval:			June 16, 2009
Project Completion Date:	June 30, 2009	June, 30 2010	June 30, 2011

I. PROJECT TITLE: Statewide Ecological Ranking CRP and Other Critical Lands

Project Manager: Greg Larson
Affiliation: MN Board of Water and Soil Resources
Mailing Address: 520 Lafayette Road North
City / State / Zip: St. Paul, MN 55155
Telephone Number: 651-297-7029 (cell 612 751-3060)
E-mail Address: Greg.a.Larson@state.mn.us
FAX Number: 651-297-5615
Web Page address: www.bwsr.state.mn.us

Location: Statewide

Total Trust Fund Project Budget:

	M.L. 2007	M.L. 2008	M.L. 2009	Total
Trust Fund Appropriation:	**$13,000**	**$155,000**	**107,000**	**$275,000**
Minus Amount Spent:	**$13,000**	**$155,000**	**$106,997**	**$274,997**
Equal Balance:	**$0**	**$0**	**$3**	**$3**

Legal Citation: M.L. 2007, Chap. 30, Sec. 2, Subd. 7
Appropriation Language:
$160,000 is from the trust fund to an emerging issues account as authorized in Minnesota Statutes, section 116P.08, subdivision 4, paragraph (d).[$13,000 of the total $160,000 was allocated toward this project]

Legal Citation: M.L. 2008, Chap. 367, Sec. 2, Subd. 7
Appropriation Language:
$155,000 is from the trust fund for an emerging issues account as authorized under Minnesota Statutes, section 116P.08, subdivision 4, paragraph (d).

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4g
Appropriation Language:
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II. and III. FINAL PROJECT SUMMARY

Overall Project Outcomes and Results

To allocate scarce fiscal resources to natural resource programs, identifying the location and ranking the ecological value of critical lands is important. Using parameters of soil productivity, soil erosion risk, water quality risk, and habitat quality, an ecological ranking tool was developed. An economic model was also incorporated to analyze CRP (Conservation Reserve Program) parcels and determine the likelihood of contract renewal given anticipated crop prices and land quality. A parameter for soil erosion risk was developed using several factors from the Universal Soil Loss Equation. To identify lands posing a risk to water quality, or lands that are most likely to contribute overland runoff to surface waters, terrain analysis was used. Runoff rankings from terrain analysis were then integrated with a proximity analysis of surface water features based on DNR 24k surface water data. A parameter for habitat quality was derived from an update to the work done as part of the Minnesota Conservation and Preservation Plan (LCCMR, 2008). Combining the data sets therein, and assessing them with a "weight of evidence" approach, produced a ranking of wildlife quality. These several parameters were combined into an environmental benefits index (EBI). High EBI translates into high risk. Therefore, a high EBI score implies a site has a high value for conservation. CRP or other parcels deemed critical for conservation can be assessed simultaneously on the basis of multiple ecological benefits. The EBI tool has demonstrated utility as users can establish thresholds for EBI values based on program goals and amount of funding available.

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Presentations of the project and project results were provided to the LCCMR, Lessard-Sams Outdoor Heritage Council and the Board of Water and Soil Resources.

A final report was prepared. The report describes all results in more detail and includes maps and graphics and suggestions for use. A website was established by the Board of Water and Soil Resources

www.bwsr.state.mn.us/ecological_ranking/

that provides an overview of the ranking methodology. The BWSR website also includes links to an interactive ranking tool (located at the University of Minnesota, Natural Resources Research Institute (NRRI) and the final report, which is available in downloadable format.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Prioritize statewide CRP lands that will expire by 2014 according to soil productivity.

Description: The potential for growing annual crops on CRP lands was assessed. Because of their ability to produce agricultural crops, expiring CRP lands with the highest soil productivity would be difficult to acquire or convert to long term conservation cover. This GIS analysis identified the location of expiring CRP lands and their soil productivity rating. The location of each CRP project was mapped. The premise is that expiring CRP lands with low soil productivity may be candidates for continued protection through conservation programs. For this result, the University of Minnesota utilized the previously developed Crop Productivity Index which was provided to BWSR, and BWSR conducted the analysis to determine which expiring CRP lands fell within the target range of soil productivity.

Summary Budget Information for Result 1:

	M.L. 2007	M.L. 2008	M.L. 2009	Total
Trust Fund Appropriation:	**$13,000**	**$3,000**	**$0**	**$16,000**
Minus Amount Spent:	**$13,000**	**$3,000**	**$0**	**$16,000**
Equal Balance:	**$0**	**$0**	**$0**	**$0**

Deliverable	Completion Date	Budget
1. Economic analysis and identifying yields based on soil productivity	March 30, 2009	$8,000
2. Estimated potential loss and location of CRP acreage	March 30, 2009	$8,000

Completion Date: April 1, 2009

Final Report Summary:

An economic model was developed to analyze all CRP parcels and determine whether contract renewal was financially prudent. The logic is simple: if the price offered for a given crop is high enough, the owner will switch from whatever was being grown before (if different) to the demanded crop. The prediction model considers factors such as crop prices and production costs. CRP parcels were those as of 2007 (the most recent available data). Results of the analysis predicted 774,540 acres to exit based on 2010 crop prices. An assessment of the crop productivity (CP) of exiting parcels suggests that it may be more economically optimum to let highly productive parcels (CP>60) exit the program. Of the exiting acres, there are 56,000 acres of CRP with CP values <60. If expiring CRP acres are to be targeted for re-enrollment, on the basis of fiscal prudence and quality of the land, these 56,000 acres are suggested candidates.

Result 2: Determining which of the CRP parcels identified in Result 1 that have low productivity and high potential erosion rates.

Description: This analysis included taking the CRP parcels that meet the CPI criteria from Result 1 and intersecting them with soils that have high potential erosion rates to determine CRP parcels that have both low productivity and high potential erosion rates. In order to determine the value for "high erosion" a panel of experts from BWSR, USDA, FSA, MN Dept of Ag, and the University of Minnesota was formed to establish the breakpoint erosion rates. Once these critical erosion rates were determined, low productivity expiring CRP parcels were identified. CRP parcels were then sub-divided into groups based on contract expiration dates and type of conservation practice (permanent wildlife habitat, wetland restoration, perennial grass, buffer strips, etc). Expiring CRP parcels were ranked according to environmental vulnerability, crop productivity, erosion potential and critical habitat identified in the Statewide Conservation Plan. The highest ranked CRP parcels were identified and mapped. BWSR developed recommendations concerning which expiring CRP lands are most deserving of protection. This information was shared with the LCCMR, Lessard Outdoor Heritage Council, the BWSR Board and others through presentation formats and the data and information was made available through appropriate GIS data portals.

Summary Budget Information for Result 2:

	M.L. 2007	M.L. 2008	M.L. 2009	Total
Trust Fund Appropriation:	**$0**	**$55,000**	**$0**	**$55,000**
Minus Amount Spent:	**$0**	**$55,000**	**$0**	**$55,000**
Equal Balance:	**$0**	**$0**	**$0**	**$0**

Deliverable	Completion Date	Budget
1. Recommendations on the expiring CPR lands ranked as the highest priority for continued protection through conservation programs.	September 30, 2009	$55,000

Completion Date: September 30, 2009

Final Report Summary:
(For details concerning the ranking of CRP parcels on the basis of soil productivity, see the final report summary for Result1.)
To develop a data layer for lands, including CRP parcels, with high potential soil erosion, rainfall runoff, soil erodibility, and slope actors from the Universal Soil Loss Equation were integrated with NRCS soil survey data and statewide county climate maps. These data were subsequently divided into terrain zones and ranked on the basis of risk from water erosion. Soil management factors such as vegetation and conservation practices were not included. This is because there are no reliable statewide data representing these factors. Moreover, management factors are temporal and will change over time. Since only non-management factors were used, the resulting data layer should be viewed as a "worst-case" scenario. Although the soil loss numbers may be exaggerated, the data layer offers a qualitative

comparison of landscape risk to water-borne soil loss. As used in this model, the higher the erosion potential, the greater the conservation need. The resulting data layer was part of the final ranking methodology that included elements described in results 3 and 4.

Result 3: Identify and prioritize other critical lands on a statewide basis by land and surface water features and overlay the CRP critical lands identified in Results 1 and 2.

Description: The University of Minnesota and NRRI (Natural Resources Research Institute) used terrain analysis of statewide digital elevation models and surface hydrologic features, such as impaired waters, to identify lands that are not currently enrolled in the CRP program but are critical for maintaining and improving wildlife habitat and water quality. The results of conservation efforts were improved by targeting these critical lands with conservation projects such as riparian buffer strips, perennial or cover crop plantings, and wetland restoration.

Summary Budget Information for Result 3:

	M.L. 2007	M.L. 2008	M.L. 2009	Total
Trust Fund Appropriation:	**$0**	**$53,000**	**$8,000**	**$61,000**
Minus Amount Spent:	**$0**	**$53,000**	**$8,000**	**$61,000**
Equal Balance:	**$0**	**$0**	**$0**	**$0**

Deliverable	Completion Date	Budget
1. Ranking of CRP and other critical lands according to erosion, proximity to water, and potential for delivery of sediment and nutrients to surface waters.	December 1, 2010	$61,000

Completion Date: December 1, 2010

Final Report Summary:
A data layer was developed to illustrate areas that are most likely to contribute overland runoff to surface waters. Two data sources were used in the assessment: stream power index (SPI) and proximity to water. Terrain analysis is used to estimate SPI, a runoff potential based on 30 meter digital elevation models. SPI is estimated from flow accumulation and slope steepness. As flow accumulation and slope steepness increase, runoff potential also increases. The Minnesota landscape was ranked according to SPI. The SPI rankings were then integrated with a proximity analysis of surface water features. The DNR 24k surface water features (Lake or intermittent/perennial stream) data layer was used to assess proximity to surface water. Land in close proximity to surface water generally has a higher sediment delivery ratio than land farther away. The resulting data layer identifies land areas (and CRP parcels) posing the highest risk to contribute overland runoff to surface waters.

Result 4: Further identify and prioritize the expiring CRP and other critical lands mapped in Results 1, 2 and 3 with biological and other habitat criteria.

Description: The University of Minnesota, NRRI, overlaid the lands identified in Results 2 and 3 with GIS data for wildlife management areas, scientific and natural areas, biological indices, other sites of significant biodiversity, forest resources, and integrated terrestrial and aquatic habitat scores. This final iteration provided a comprehensive map and corresponding GIS layers that greatly improved the targeting of conservation program funds and therefore will result in better environmental outcomes including improved water quality and wildlife habitat.

Summary Budget Information for Result 4:

	M.L. 2007	M.L. 2008	M.L. 2009	Total
Trust Fund Appropriation:	**$0**	**$44,000**	**$17,000**	**$61,000**
Minus Amount Spent:	**$0**	**$44,000**	**$17,000**	**$61,000**
Equal Balance:	**$0**	**$0**	**$0**	**$0**

Deliverable	**Completion Date**	**Budget**
1. Maps and GIS data of expiring CRP and other critical lands according to soil productivity, erosion, proximity to water, potential for delivery of sediment to surface waters, and relevant natural resource features potential will be produced.	February 1, 2011	$61,000

Completion Date: February 1, 2011

Final Report Summary:

Habitat quality was the final data layer. The mapping used for this layer was updated from the work done as part of the Minnesota Conservation and Preservation Plan (LCCMR, 2008). The primary goal of habitat mapping was to collate available information to prioritize important areas for conservation by integrating both positive (resources) and negative (threats to resources) factors. Combining data sets and assessing them with a “weight of evidence” approach produced a ranking of wildlife habitat.

The final part of Result 4 was development of an environmental benefits index (EBI). EBI is a composite score of multiple ecological benefits. The score is based on a 0-300 scale, where a score of 300 is most valuable from a conservation perspective. The EBI is the sum of three independent layers: soil erosion risk (Result 2), water quality risk (Result 3), and wildlife habitat quality values (Result 4). Each of those component layers contributes 0-100 points to the EBI. High EBI translates into high risk. Therefore, a high EBI score implies the site has a high value for conservation. CRP or other parcels deemed critical for conservation can be assessed simultaneously on the basis of multiple ecological benefits. Land areas or parcels with high EBI scores can be further screened by Crop Productivity Index (CPI) values. The rationale behind combining these two values is that incentives to place marginal land in conservation programs will generally be less costly than incentives to place productive crop land in conservation programs. As an example, roughly 36,000 acres of cropland statewide are extremely marginal for crop production (CPI values <25) and have very high EBI scores. The EBI tool has great utility as users can establish thresholds, and produce output, for EBI values based on program goals and amount of funding available. The tool is available at www.nrri.umn.edu/EcolRank.

Result 5: Promotion and providing training to conservation program delivery system partners and staff.

Description: University of Minnesota Extension staff and BWSR project development staff developed appropriate materials and provided training, mostly on-line, to BWSR field staff and conservation field staff in other agencies, such as the DNR and Dept of Ag, and conservation project organizations, such as Ducks Unlimited and Pheasants Forever and those engaged in the Working Lands Initiative. The training provided background information on the development of this information and how it can best be applied and used for targeting conservation program decisions at the local level. These professionals will then work one-on-one with their LGUs and organizations to custom fit the data and information available from this project to the local needs, priorities and funding available.

Summary Budget Information for Result 5:

	M.L. 2007	M.L. 2008	M.L. 2009	Total
Trust Fund Appropriation:	**$0**	**$0**	**$62,000**	**$62,000**
Minus Amount Spent:	**$0**	**$0**	**$62,000**	**$62,000**
Equal Balance:	**$0**	**$0**	**$0**	**$0**

Deliverable	Completion Date	Budget
1. Training and education of Soil and Water Conservation District and other appropriate program implementers of conservation programs on the conservation targeting tools developed above.	June 30, 2011	$62,000

Completion Date: June 30, 2011

Final Report Summary:
The EBI was first presented to a general audience through a WEBINAR. Three hands-on technical training sessions, geared to GIS professionals, were held during June 2011 in St.Cloud, Moorhead and Marshall, Minnesota to provide data and methodology on the Ecological Ranking Tool to local units of government and other conservation partners. The purposes of these training sessions were to:

- Introduce the Environmental Benefits Index (EBI) and components to local users
- Train local GIS users on performing EBI calculations

- Provide examples of how to supplement EBI with a variety of different data sources
- Interpret results on the landscape for specific examples provided

The sessions were attended by 42 conservation professionals representing local units of government, state and federal agencies, non-governmental organizations and private companies.

A majority (70%) of participants at the three technical training sessions said they planned to use the ecological ranking tool in their professional work and they provided many different examples -- and some heretofore unknown and useful data layers -- of how the tool would improve their ability to identify and rank priority conservation areas. Given the diverse professional affiliations of the participants, their active involvement in conservation planning and delivery, and their connection to the network of natural resource professionals, it is likely that the Ecological Ranking Tool will be integrated into many conservation activities throughout Minnesota.

Result 6: Develop and deliver recommendations for acquisition and protection of CRP and other critical lands.

Description: A final report was prepared that reviews this project and project results, including case study information, along with policy and funding recommendations for future conservation program efforts. Presentations of the project and project results were provided to the LCCMR, Lessard-Sams Outdoor Heritage Council, and the BWSR. GIS data is available and provided through appropriate GIS portals. Reports and other pertinent summary materials are available on the BWSR website.

Summary Budget Information for Result 6:

	M.L. 2007	M.L. 2008	M.L. 2009	Total
Trust Fund Appropriation:	**$0**	**$0**	**$20,000**	**$20,000**
Minus Amount Spent:	**$0**	**$0**	**$20,000**	**$20,000**
Equal Balance:	**$0**	**$0**	**$0**	**$0**

Deliverable	**Completion Date**	**Budget**
1. Completion of Final Report, which will include an example application of the targeting strategy.	June 30, 2011	$20,000

Completion Date: June 20, 2011

Final Report Summary:

A final report was completed. The report describes results 1 through 5 in more detail and includes maps and graphics and suggestions for use. A website was established by the Board of Water and Soil Resources www.bwsr.state.mn.us/ecological_ranking/

that provides an overview of the ranking methodology described herein. The BWSR website also includes links to an interactive ranking tool (located at the University of Minnesota, Natural Resources Research Institute (NRRI) and the final report, which is available in downloadable format.

V. TOTAL TRUST FUND PROJECT BUDGET:

Staff: Board of Water and Soil Resources (BWSR): $**55,000**

- GIS Specialist: conducted GIS analysis, managed data, interpreted data, assisted in overall project coordination, field training, report development, and participated in project meetings. 10% FTE
- Soil Scientist: managed data, interpreted data, assisted in overall project coordination, field training, report development, and participated in project meetings 5% FTE
- Training Coordinator: worked with the project team to develop training materials and training program, conducted training and provided follow-up assistance 7% FTE

Contract Services: University of Minnesota: $ **220,000**

- Soil, Water & Climate in St. Paul, GIS Specialist: conducted GIS analysis, managed data, interpreted data, assisted in overall project coordination, report development, and participated in project meetings 20%FTE
- Soil, Water & Climate in St. Paul, Grad Research Asst: conducted GIS analysis, managed data, interpreted data, assisted in report development, and participated in project meetings 50%FTE
- Involvement of UM Extension experts: developed on-line training materials
- Department of Applied Economics in St. Paul: Developed an economic model
- NRRI in Duluth, Scientist: analyzed and interpreted data, assisted in overall project coordination, report development, and participated in project meetings 8.3%FTE
- NRRI in Duluth, Scientist: interpreted data, assisted in overall project coordination, report development, and participated in project meetings 25%FTE
- NRRI in Duluth, Info Tech Prof: conducted GIS analysis, managed data, interpreted data and participated in project meetings 15%FTE
- NRRI: Supplies, In-state Travel, and GIS Lab fees

TOTAL TRUST FUND PROJECT BUDGET: $ 275,000
(M.L. 2007 Emerging Issues= $13,000; M.L. 2008 Emerging Issues = $155,000; M.L. 2009 = $107,000)

Explanation of Capital Expenditures Greater Than $3,500: NA

VI. PROJECT STRATEGY:

A.Project Partners

The project team included Greg Larson, State Soil Specialist and Project Manager, BWSR; Julie Blackburn, Assistant Director, BWSR; Aaron Spence, GIS Specialist, BWSR; Professors David Mulla, George Host and Steve Taff, UM, and Joel Nelson, GIS Specialist, UM, and UM Extension staff specialist, Ann Lewandowski.

B. Other Funds Spent during 2008 and 2009:

BWSR provided in-kind contributions of about $5,000 annually.

C. Spending History:

N/A

D. Time:

2007 funds were spent by June 30, 2009
2008 funds were spent by June 30, 2010
2009 funds were spent by June 30, 2011

VII. DISSEMINATION: As described in Results 5 and 6, BWSR established a website that includes a description of the project, the ranking methodology and a link to the interactive ranking tool and the final report.

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports were submitted July 20, 2009; January19, 2010; July 21, 2010 and February 01, 2011. A final work program report and associated products was submitted August 30, 2011.

IX. RESEARCH PROJECTS: N/A

Attachment A: Final Budget Detail for 2008 Project [08/26/11]

Project Title: Statewide Ecological Ranking CRP and Other Critical Lands

Project Manager Name: Greg Larson

Emerging Issues Acct 2007: $ 13,000 **BWSR: 13,000**
Emerging Issues Acct 2008: $ 155,000 **BWSR: 35,000 UM: 120,000**
2009 Trust Fund Appropriation: $ 107,000 **BWSR: 7,000 UM: 100,000**
Totals **$275,000** **BWSR: 55,000 UM 220,000**

2008 Trust Fund Budget	Result 1 Budget:	Amount Spent (082611)	Balance (082611)	Result 2 Budget:	Amount Spent (082611)	Balance (082611)	Result 3 Budget:	Amount Spent (082611)	Balance (082611)	Result 4 Budget:	Amount Spent (082611)	Balance (082611)	Result 5 Budget	Amount Spent (082611)	Balance (082611)	Result 6 Budget	Amount Spent (082611)	Balance (082611)	TOTAL BUDGET	TOTAL BALANCE
	Prioritize CRP lands statewide according to soil productivity.			Determining CRP parcels that have low productivity and high potential erosion rates.			Identify and prioritize CRP and other critical lands by land and surface water features			Further identify and prioritize CRP and other critical with wildlife and other habitat criteria. lands			Promotion and provide training to conservation program delivery system partners and staff			Develop and deliver recommendations for acquisition and protection of CRP and other critical lands				
BUDGET ITEM																				
PERSONNEL: wages and benefits [BWSR]	8,000	8,000	0	19,000	19,000	0	15,000	15,000	0	6,000	6,000	0	7,000	7,000	0				55,000	0
Contracts																				
University of Minnesota/NRRI: Personnel, supplies, in-state travel and GIS lab fees.	8,000	8,000	0	36,000	36,000	0	46,000	46,000	0	55,000	55,000	0	55,000	55,000	0	20,000	19,997	3	220,000	3
COLUMN TOTAL	**$16,000**	**$16,000**	**$0**	**$55,000**	**$55,000**	**$0**	**$61,000**	**$61,000**	**$0**	**$61,000**	**$61,000**	**$0**	**$62,000**	**$62,000**	**$0**	**$20,000**	**$19,997**	**$3**	**$275,000**	**$3**
Emerging Issues Account 07	**13,000**	**13,000**	**0**																**13,000**	0
Emerging Issues Account 08	3,000	3,000	0	55,000	55,000	0	53,000	53,000	0	44,000	44,000	0	0	0	0	0	0	0	155,000	0
2009 Trust Fund Account	0			0			8,000	8,000	0	17,000	17,000	0	62,000	62,000	0	20,000	19,997	3	107,000	3
																			275,000	

Statewide Ranking of Ecological Value of CRP and other Critical Lands

Funded by ENRTF as recommended by LCCMR 2008 -2009

ENVIRONMENT
AND NATURAL RESOURCES
TRUST FUND

D. J. Mulla, S. J. Taff, G. Host, J. Galzki, T. Brown, A. Lewandowski, and J. Nelson

UNIVERSITY OF MINNESOTA
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Minnesota Board of Water & Soil Resources

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Introduction

Minnesota’s natural lands face many kinds of pressures, from human development to increased demands on agricultural productivity. This project is designed to identify ecologically important land parcels, with the objective of more effectively targeting conservation programs to Conservation Reserve Program (CRP) and other critical lands. Other critical lands could include marginally productive crop-lands, surface water protection areas, or important habitat areas.

As defined for this project, the conservation value of a parcel of land is based on several factors:

- the soil erosion risk of the land based on soil and slope characteristics
- the water quality risk of the land based on the shape of the terrain and its proximity to surface water
- the habitat quality based on the Statewide Conservation and Preservation Plan

These factors are integrated into an Environmental Benefits Index (EBI) - a score which represents a summary of the above factors. This methodology has unique characteristics; it includes soils and landscape (terrain) analysis which are relatively new to conservation targeting efforts. It addresses erosion potential and runoff potential. It also includes surface water quality, and wildlife habitat factors. Finally, the EBI integrates these layers to address multiple conservation benefits simultaneously.

A web site was produced (*www.nrri.umn.edu/EcolRank*) to provide a mapping tool by which natural resource managers can visualize and interact with spatial data layers developed for the project. Managers have the ability to specify the relative importance of habitat, soil erosion potential, or other components of the EBI, and view how the ecological ranking of parcels changes under different scenarios. All data developed by the project can be downloaded.

The ecological ranking tool has several applications. It can be used to identify parcels of high conservation value within a county, township, watershed, or other area of interest. The ecological ranking can be coupled with an economic analysis to identify parcels that, because of their economic value, are likely to exit the CRP. This information can inform the targeting of conservation activities to best balance land conservation, surface water quality, and economic objectives. The ecological ranking tool provides a methodology that may help guide the allocation of conservation funds to the most critical lands.

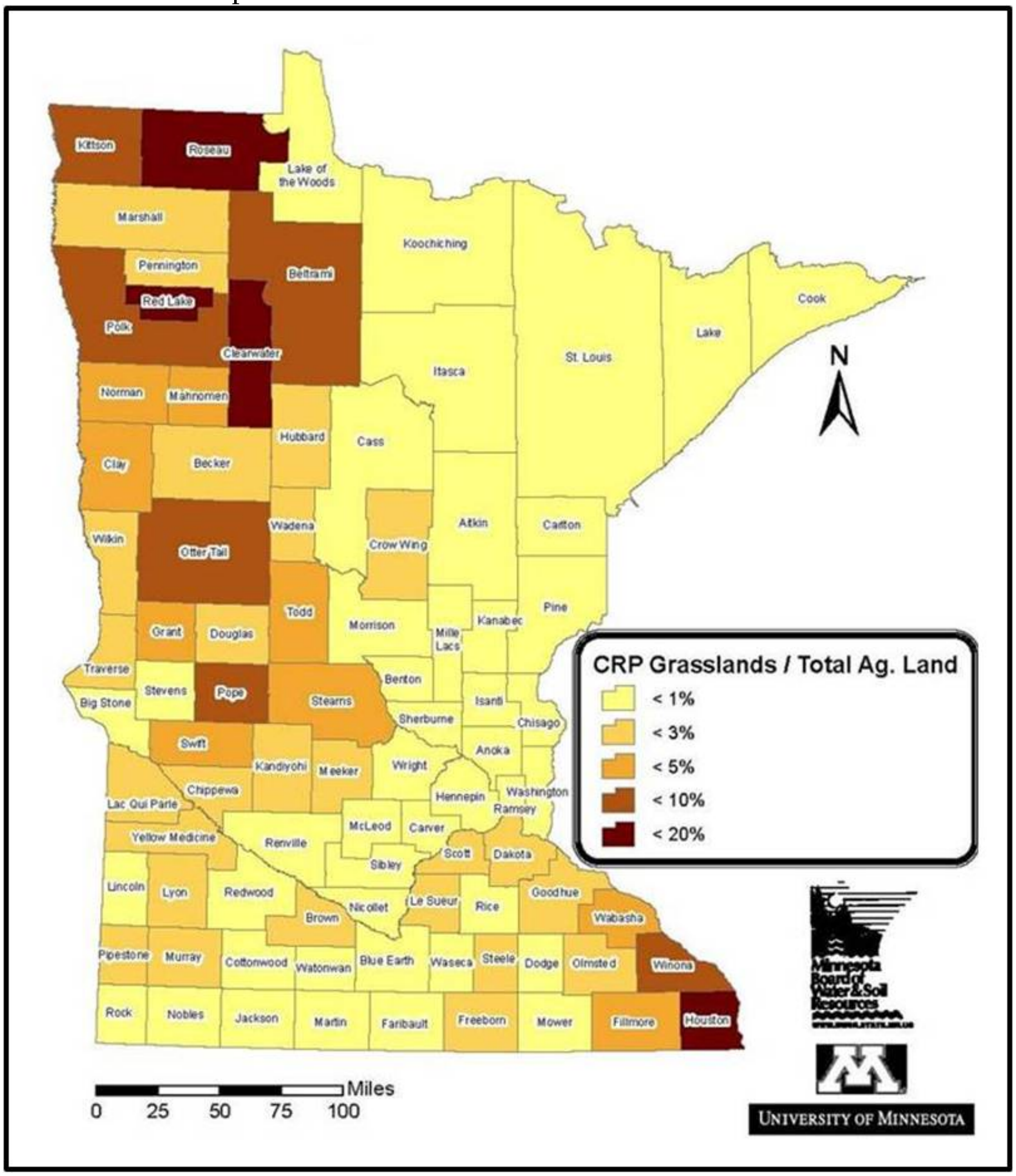
This work is a collaborative effort between the Board of Soil and Water Resources and the University of Minnesota.

Economic Model

An economic model was developed to analyze all CRP parcels and determine whether contract renewal was financially prudent. The economic model is similar in concept—but not in detail—to those used in Valentas et al. (2009) and in Turner et al. (2010). The logic is simple: if the price offered for a given crop is high enough, the owner will switch from whatever was being grown before (if different) to the demanded crop. In the present version, each Conservation Reserve

Program (CRP) parcel owner faces the decision: given 2010 prices and costs, is it financially prudent to renew the existing CRP contract? For present purposes, it is assumed that all examined contracts expire in 2010 and can be renewed or not renewed without penalty.

Fig. 1: Percent CRP grassland acres potentially expiring relative to total agricultural land area. Many of these acres are expected to be re-enrolled.

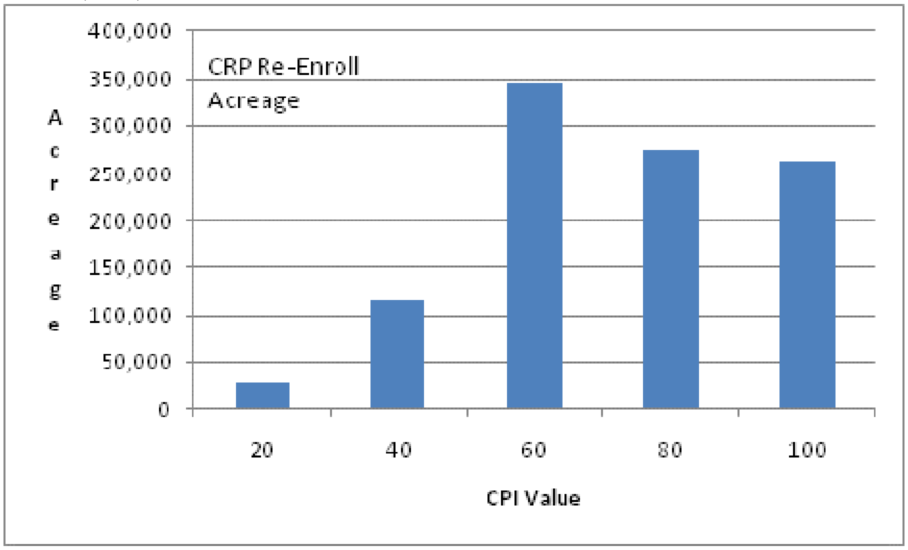


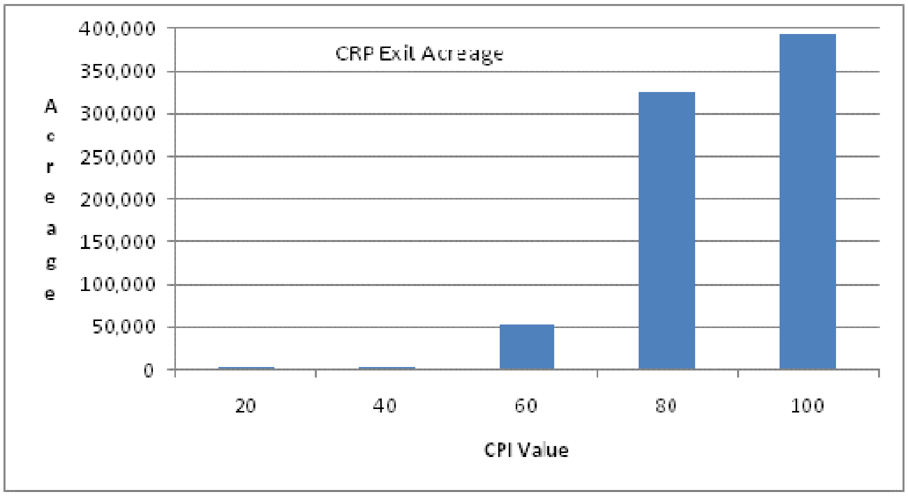
The prediction model is a set of Microsoft Access queries that mimic farmer crop selections for each parcel at each crop price level. The variable factors are crop choices, crop yields, crop production costs (including shipping and handling), and crop prices. Land owners are assumed to select the crop that promises the highest annual net return. Decisions on crop selection are made at CRP parcel level. In the model, "parcels" are defined as all geographically discrete parcels currently (2007) in CRP.

Results of the CRP economic analysis predicted that 47,195 CRP parcels covering an area of 774,540 ac are predicted to exit the CRP program based on current economic data. Keeping all of these parcels in CRP would require incentive payments totaling $95,327,478/yr.

There are significant differences in the productivity of soil for CRP parcels predicted to exit the program as compared to the productivity for CRP parcels predicted to re-enroll in the program. The average area weighted crop productivity index (CPI)[1] value for CRP parcels predicted to exit the program is 78.1, whereas it is only 62 for parcels predicted to re-enroll in the program. Even more telling is the variation in CRP acreage by CPI value for parcels predicted to exit the program as compared with parcels predicted to re-enroll in the program (Fig. 2).

Fig. 2: a) Acreage of CRP parcels predicted to re-enroll in the program by Crop Productivity Index (CPI) value, and b) acreage of CRP parcels predicted to exit the program by Crop Productivity Index (CPI) value





[1] CPI, or Crop Productivity Index, is based on soil physical and chemical properties important to crop growth. The index ranks all soils from 0 to 100, with 100 being the most productive.

It may be more economically optimum to let highly productive CRP parcels exit the program. Retaining the less productive CRP parcels in the program could be achieved with lower incentive payments. It would cost roughly $3,875,000/yr in incentive payments to keep 56,000 ac of CRP with CPI values less than 60 enrolled in the program. These parcels represent marginally productive land.

Soil Erosion Risk

The potential for soil erosion is based on a number of factors, including climate, soil type, and slope characteristics. We summarized these using factors from the Universal Soil Loss Equation. The Soil Erosion data layer represents a general risk score for potential soil erosion on a 0-100 point scale, 100 being the highest risk. Larger values indicate soils that have a higher potential to erode if no conservation practices were in place and overland sheet or rill runoff was present.

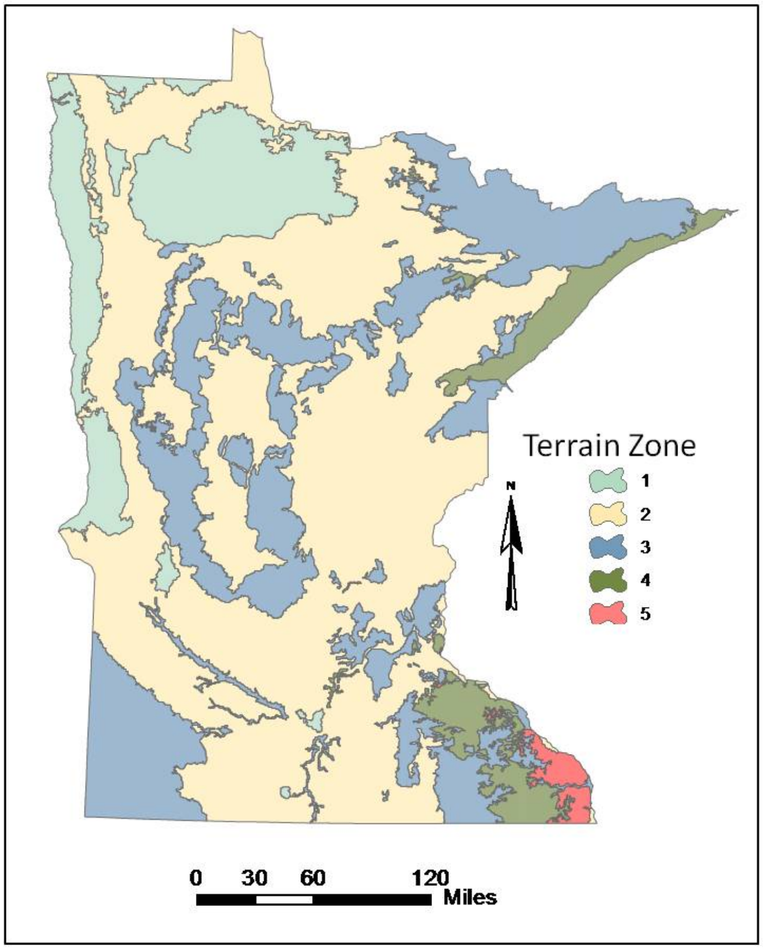
A subset of the Universal Soil Loss Equation (USLE) was used to determine soil erosion risk values. The USLE is a multiplicative equation using the formula A =R x K x LS x C x P where:

- A = potential long term average annual soil loss in tons/acre/year
- R = rainfall and runoff erosivity factor
- K = soil erodibility factor
- LS = slope length-gradient factor
- C = crop/vegetation and cover management factor
- P = support practice factor

The R (Rainfall Runoff Erosivity), K (Soil Erodibility), and LS (Length/Slope) factors were used and calculated based on NRCS spatial and tabular Soil Survey Geographic (SSURGO) Database soils data, statewide county climate maps, as well as mathematical formulas based on standard USLE calculations.

These data were divided into five state-wide terrain zones, and percentile ranks were assigned to erosion risk values for each individual zone, and then spatially merged into one data layer. These terrain zones used to stratify slope-related data represent physiographic regions of Minnesota with similar slope characteristics, and remove bias from landscapes with extremely high relief (Fig. 3).

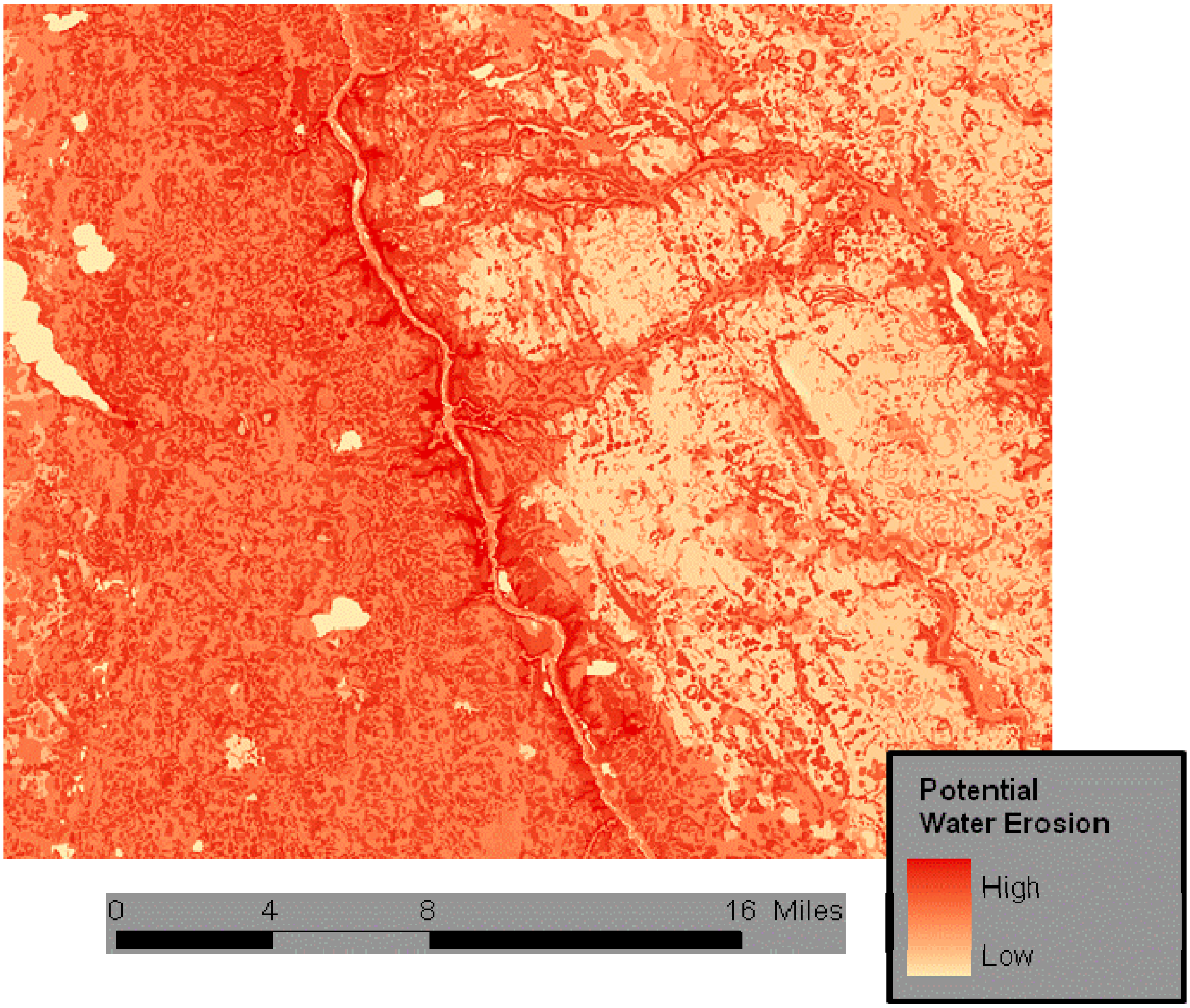
Fig. 3: Terrain zones used to stratify slope-related data statewide.



The crop/vegetation and cover management factor (C) and support practice factor (P) were not used. This is because there are no reliable statewide spatial data that represent these factors. Although statewide data depicting current cropping practices exist, there are no statewide data representing current tillage methods (e.g. fall plow, ridge tillage, no-till) or support practice (e.g. cross slope, contour farming, strip cropping) that are required for these calculations. Furthermore these factors are temporal and will therefore shift over time.

Since only non-management factors were used, the resulting data layer should be viewed as a "worst-case" scenario, i.e. highest potential soil erosion of bare soil with no mitigating land use practices in place (Fig. 4). Although quantitative soils loss numbers (tons/acre/year) may be exaggerated under this model, the resulting data layer is used here in a qualitative, comparative capacity in order to evaluate the relative differences in soil loss risk between various parts of the landscape. The higher the erosion potential, the greater the conservation need.

Fig.4: Potential risk from water erosion for a selected region of Minnesota.



Water Quality Risk

The risk score for Water Quality ranges from 0-100, with larger values indicating areas that are more likely to contribute overland runoff than smaller values. This risk was defined using two data sources: Stream Power Index and proximity to water.

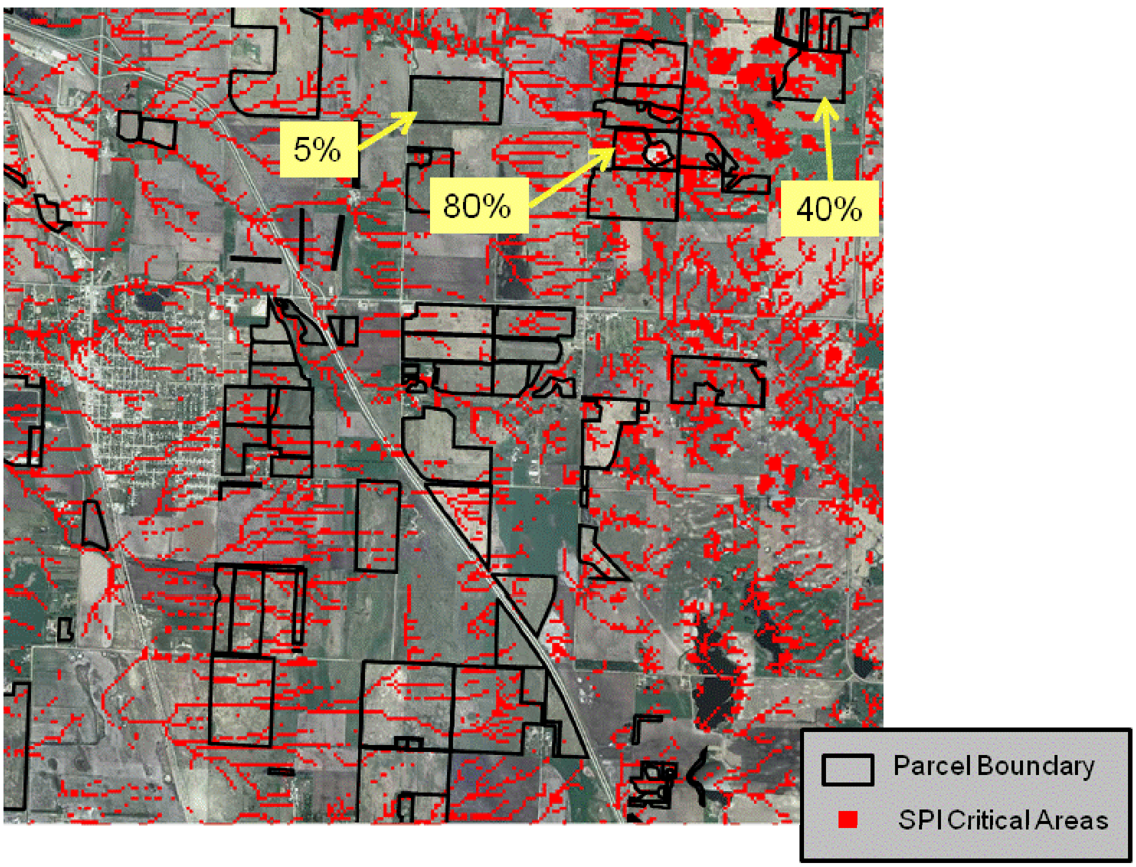
Stream Power Index

Terrain analysis is used to estimate Stream Power Index (SPI), a runoff potential based on 30 m Digital Elevation Models (DEMs). SPI is estimated from flow accumulation and slope steepness. As flow accumulation and slope steepness increase, runoff potential also increases.

Stream Power Index (SPI) measures the erosive power of overland flow. SPI was calculated statewide, but summarized by terrain zones, which represent physiographic regions of Minnesota with similar slope characteristics. The use of terrain zones again removes bias from landscapes with extremely high relief. Large SPI values (i.e. those in the 85th percentile or higher) from each of the five terrain zones were used to create a critical area layer where overland erosion is likely to occur. These critical SPI areas were summarized by SSURGO soil polygons: the proportion of SPI critical areas within each SSURGO polygon was used to assign a percentile rank to these polygons, the larger the proportion of critical SPI data, the larger risk score for that polygon. This percentile rank represents 50 of the total 100 points for this risk layer.

The proportion of any parcel above the SPI critical threshold can be calculated (Fig. 5). These are then ranked and assigned values. Highest conservation value is given to parcels with the highest proportions of area above the SPI critical threshold.

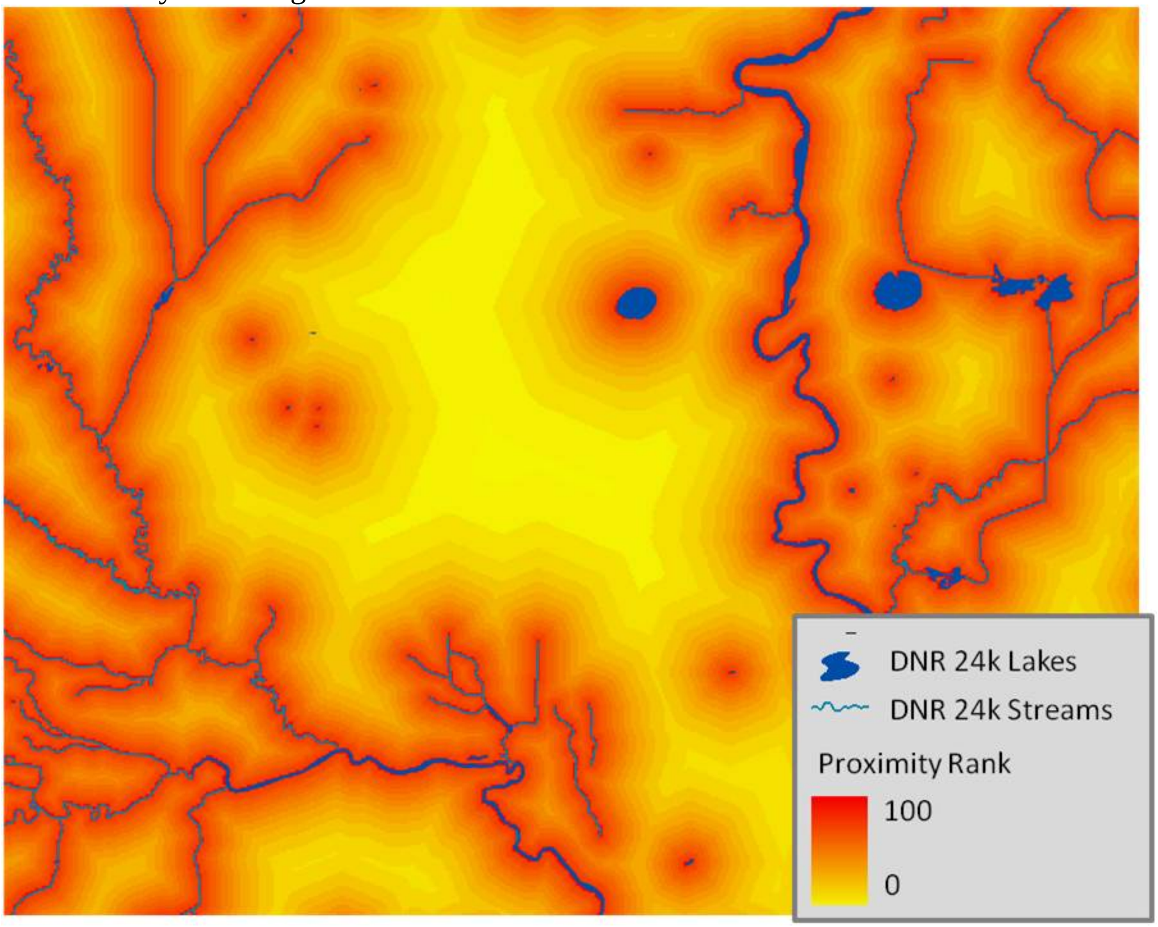
Fig. 5: Percentage of selected land parcels having Stream Power Index (SPI) values above the critical threshold value.



Proximity to Water

The remaining points in the Water Quality Risk layer were determined by calculating proximity from each 30 m pixel to the nearest DNR 24k surface water feature (Lake or Intermittent/perennial stream). Proximity to surface water affects delivery of sediment and other pollutants in runoff (Fig. 6). Land in close proximity to surface water generally has a higher sediment delivery ratio than land farther away. A percentile rank of these proximity values assigned to each 30 m pixel represents the remaining 50 points, where the highest risk scores are given to the pixels closest to water features.

Fig. 6: Proximity of 30 m grid cells to surface water.



<u>Habitat Quality Mapping</u>

The habitat mapping used in this plan was updated from the work done as part of Minnesota's Statewide Conservation and Preservation Plan (SCPP) (LCCMR, 2008). The primary goal of habitat mapping was to collate available information for Minnesota to prioritize important areas for conservation (protection, acquisition, restoration) by integrating both positive (resources) and negative (threats to resources) information on biodiversity, habitat quality, outdoor recreation (e.g., hunting and fishing), and water quality. Positive components included features such as known occurrences of rare species, sites of biodiversity significance, or high levels of game species abundance, while negative components included the dominant drivers of environmental change such as human development, land use, and road density. By acquiring and objectively processing information related to these components, it was possible to rank areas in Minnesota according to their conservation priority.

The habitat analyses for the statewide plan are unique for several reasons. First, the analysis team comprised the major natural resource management agencies in the state, including several divisions of the DNR, the MPCA, BWSR, MN Dept of Agriculture, and others with a wealth of expert knowledge. Second, the analyses were highly integrated: composite maps of critical terrestrial and aquatic habitat were integrated across taxa and habitats, providing a ‘weight-of-evidence' approach to the habitat rankings. Finally, the intersection of high-quality terrestrial and aquatic habitat with the composite environmental risk map identifies those regions of the state where critical habitats are most 'at-risk'.

Twelve terrestrial data sets from a variety of sources were compiled for the habitat analysis (Table 1). Each of these data sets were available on a statewide basis. High resolution data were derived or gridded to 30 m cells, the resolution of Landsat satellite imagery used for many of the statewide land cover classification and subsequent habitat analyses.

Table 1: Data sources for terrestrial habitat model.

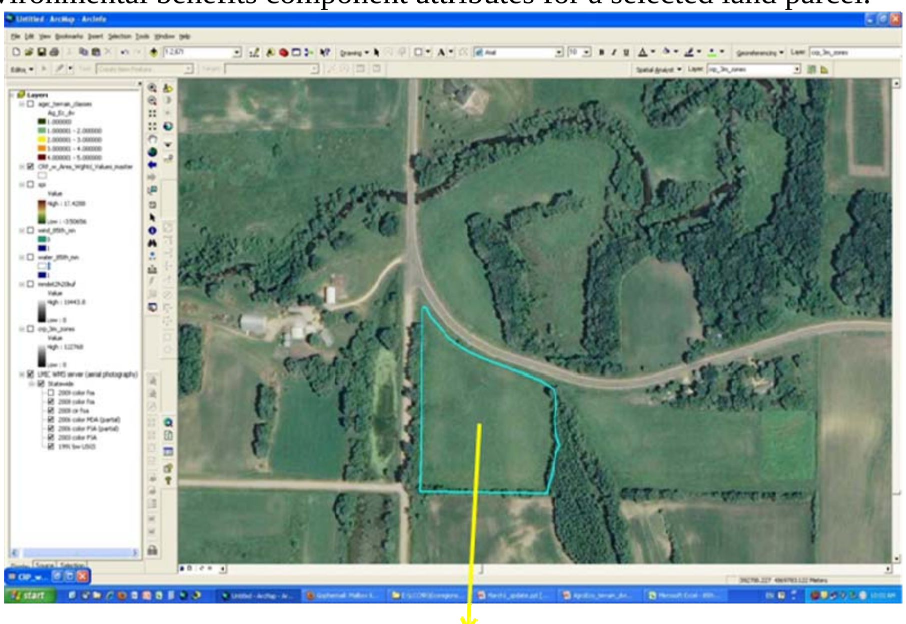
Habitat Model Input	Description
Sites of Biodiversity Significance	A multi-faceted assessment of this land for its importance from a regional perspective in terms of biodiversity and ecosystem function. Higher values indicate higher biodiversity significance.
MN DNR GAP terrestrial vertebrate models - Game species	The number of game species for which this land may be habitat. Higher values indicate higher numbers of game species potentially using this land.
MN DNR GAP terrestrial vertebrate SGCN models	The number of Species of Greatest Conservation Need (SGCN) for which this land may be habitat. Higher values indicate higher numbers of SGCN species potentially using this land.
Bird potential habitat models -- USFWS	Probable number of bird species (from a set of 17) using this land. Higher values indicate more of these 17 species using this land.
MN DNR GAP Habitat by protection level	Number of terrestrial vertebrate species potentially using this land weighted by the current level of habitat protection statewide for each species. Higher values indicate more species potentially using this land, weighted as described.
Wildland Urban Interface	Wildland Urban Interface maps initial encroachment of development into areas of largely intact natural cover. Decisions made here determine whether natural areas are preserved or pressured.
Wildland Urban Intermix	Wildland Urban Intermix map intermixing of development and significant natural cover. Connectivity can be maintained or lost by decisions made in these areas.
CRP lands	Lands enrolled in the Conservation Reserve Program, USDA.
Road density	A measure of the density of roads within the township. Major roads receive a higher weighting. Higher values indicate higher density of roads in the township.
Housing density 2000	Housing density from census data (census blocks) for 2000 for this land. Higher values indicate higher housing density.

Environmental Benefits Index

This Environmental Benefits Index (EBI) is a composite score of multiple ecological benefits. The score is based on a 0-300 scale, where a score of 300 is most valuable from a conservation perspective. The EBI is the sum of the three independent layers described above: soil erosion risk, water quality risk, and wildlife habitat quality values (Fig. 7). Each of those component layers contributes 0-100 points to the EBI. High EBI translates into high risk (e.g. water erosion), or high quality (e.g. habitat). Therefore, a high EBI score implies the site has a high value for conservation.

The EBI layer was created with the intention to rank CRP and other critical lands on multiple ecological benefits simultaneously. This approach is similar to the EBI used by the USDA-NRCS Farm Service Agency to rank farmers requests to enroll land in the Conservation Reserve Program. Our approach differs in that it offers flexibility in the weighting scheme, and allows users to explore both the spatial distribution of the data and the consequences of using alternative weighting systems. For example, if identifying land having high soil erosion risk is important, the habitat quality and water quality risk maps can be down weighted (e.g. scaled from 0-50). This would produce a map that differs from one where all attributes are weighted equally.

Fig. 7: Environmental benefits component attributes for a selected land parcel.



Soil Degradation risk	Water Quality risk	Habitat Quality Score	EBI score
86	33	67	186

The Ecological Ranking Tool can be used to quickly identify land with a high conservation need anywhere in Minnesota. Some examples of ecological rankings are shown below (Figs. 8-9). Land with high EBI scores adjacent to lakes or rivers is particularly important from a conservation perspective.

Fig. 8: Environmental Benefits Index (EBI) scores for agricultural land in a selected region of central Minnesota.

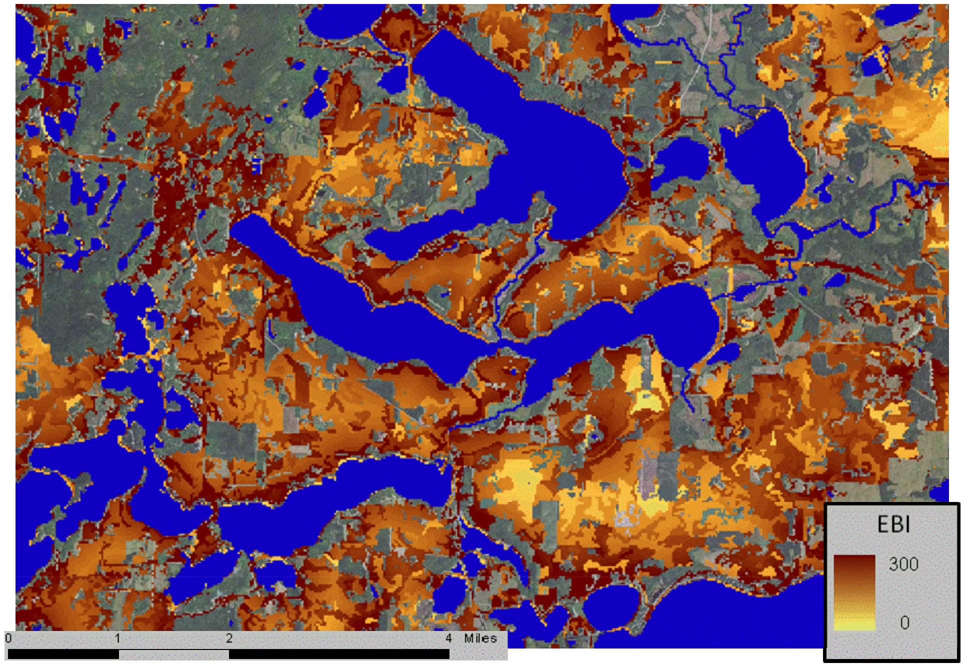
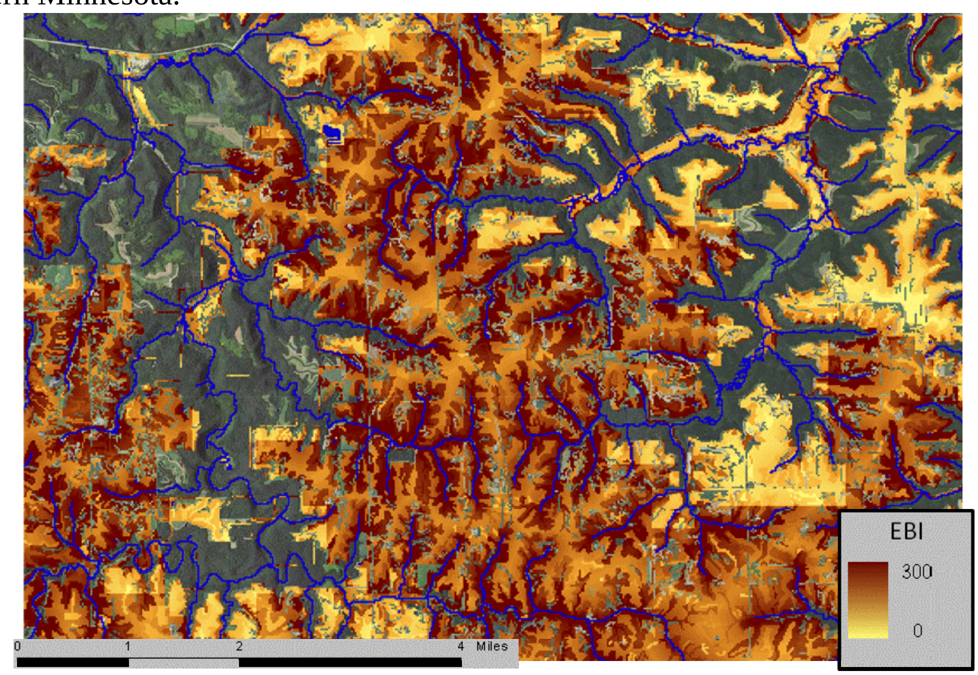


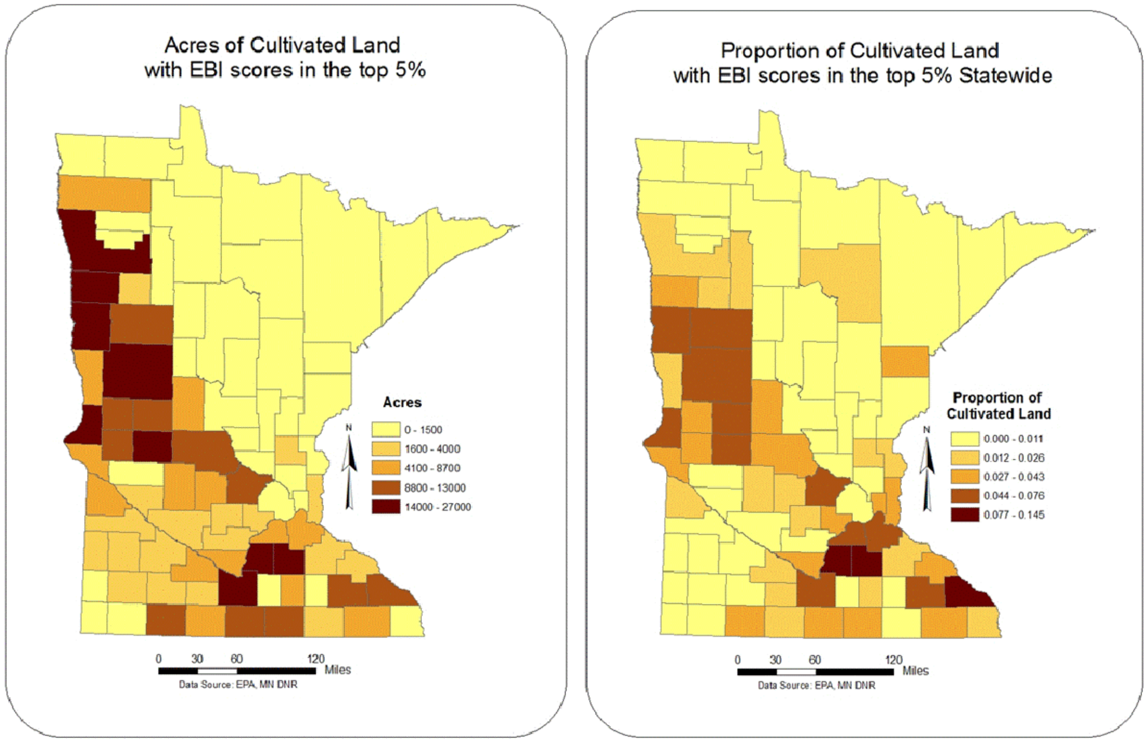
Fig. 9: Environmental Benefits Index (EBI) scores for agricultural land in a selected region of southeastern Minnesota.



The Ecological Ranking Tool can be used to identify Minnesota counties that have a high need for conservation. Counties with a high acreage of cultivated land with EBI scores in the top 5% are shown in Fig. 10. These counties are clustered in the Red River Basin of the North, the southern and eastern portions of the Minnesota River Basin, in portions of the Upper Mississippi

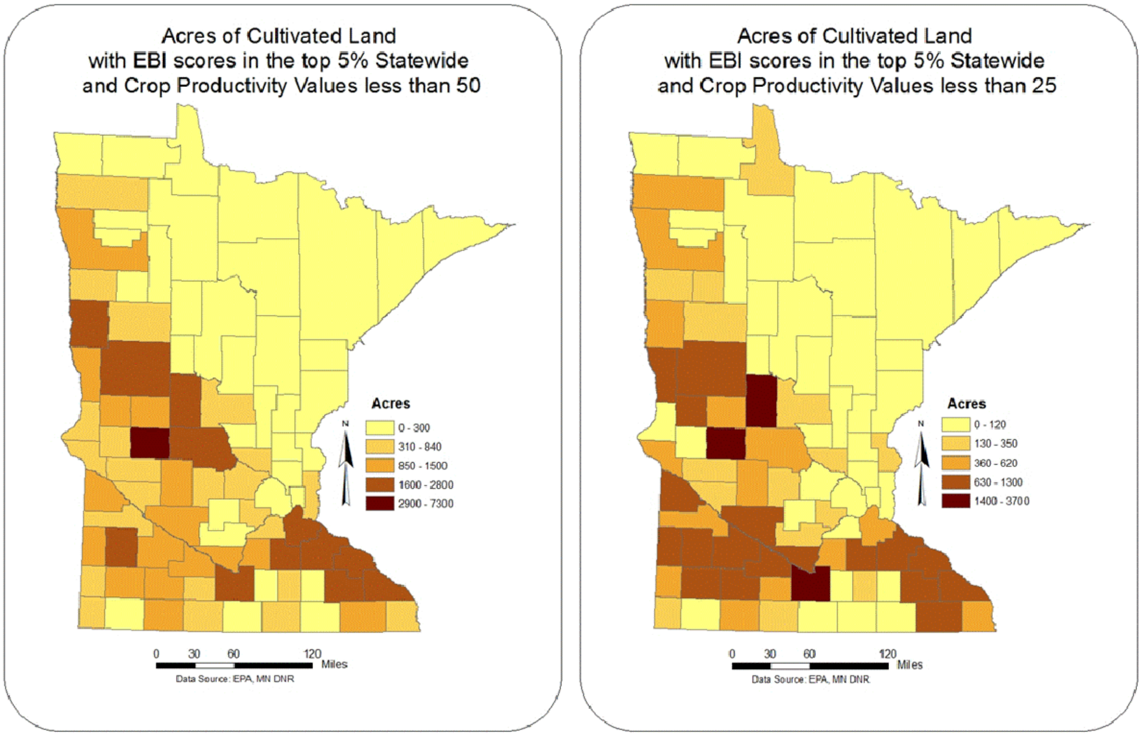
River Basin near St. Cloud, and in southeastern Minnesota. A total of 487,000 ac statewide is in the top 5% of EBI scores.

Fig. 10: a) Acres of cultivated land with the highest 5% of EBI scores and b) proportion of cultivated land with EBI scores in the top 5%.



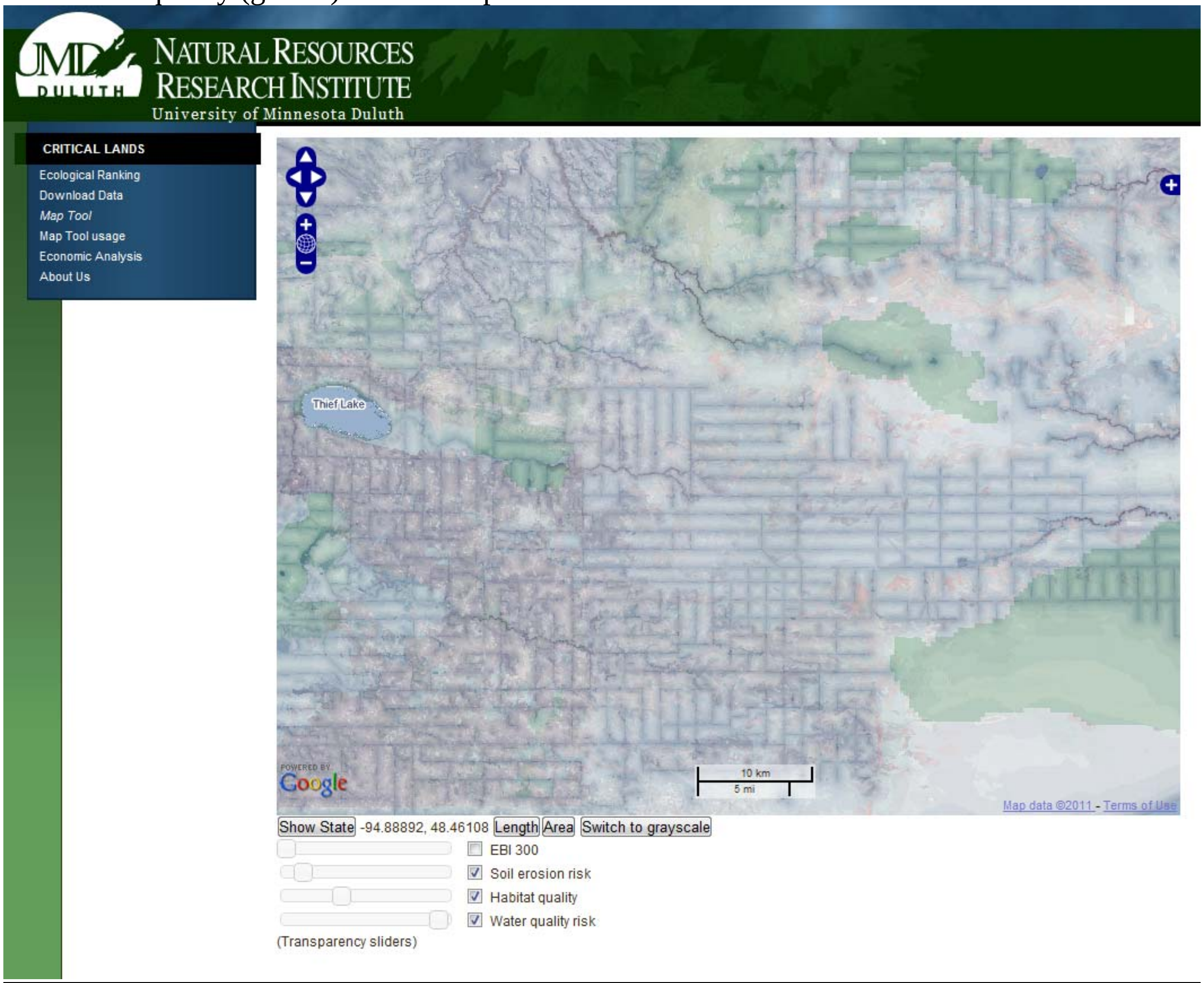
Areas with high acreage of land with high conservation need (high EBI scores) can be further screened by Crop Productivity Index (CPI) values (Fig. 11). The rationale behind combining these two values is that incentives to place marginal land in conservation programs will generally be less costly than incentives to place productive crop land in conservation programs. Roughly 67,000 ac of cropland statewide are marginal for crop production (CPI values <50) and have very high EBI scores (Fig. 11a). This is a much lower acreage than high EBI scoring land statewide, and it is perhaps feasible to construct an incentive program to put this land into conservation programs. Only 36,000 ac of cropland statewide are extremely marginal for crop production (CPI values <25) and have very high EBI scores (Fig. 11b).

Fig. 11: a) Acres of cultivated land with EBI scores in the top 5% and Crop Productivity Index values less than 50, and b) acres of cultivated land with EBI scores in the top 5% and Crop Productivity Index values less than 25.



In addition to the county summaries presented above, this project developed an interactive map-based tool to explore the EBI and its three component layers at a fine spatial resolution. The tool allows a user to view how each of the layers independently contributes to the overall EBI. The tool is based on slider bars which adjust the transparency of the three different layers, either in color or in grayscale (Fig. 12). It uses a Google-like open map platform that allows the user to pan and zoom around the map, turn on other layers of interest, and explore the EBI data. This tool is available at *www.nrri.umn.edu/EcolRank*.

Fig. 12 Interactive map tool, showing detail of soil erosion risk (reds), water quality risk (blues), and habitat quality (greens) in an example area of northwestern Minnesota.



Technical Training Sessions

Three hands-on technical training sessions were held during June 2011 in St. Cloud, Moorhead and Marshall, Minnesota to provide data and methodology on the Ecological Ranking Tool to local units of government and other local conservation partners. The purposes of these training sessions were to:

- Introduce Environmental Benefits Index (EBI) and components to local GIS users
- Train local GIS users on performing EBI calculations
- Provide examples of how to supplement EBI with a variety of different data sources
- Interpret results on the landscape for specific examples provided

A workbook with GIS training material was developed for these sessions. There were several learning objectives for the workshops, including:

- Learn about the four data layers in the Ecological Ranking Tool, and how they were created
- Learn to access the data layers
- Learn to adjust weightings for the Environmental Benefits Index (EBI)
- Learn to incorporate ancillary data (i.e., understand how to resample layers and incorporate weightings into a customized EBI)
- Learn the process for incorporating LiDAR-derived hydrologic data
- Learn the process for identifying priority lands
- Learn how to explain the Ecological Ranking Tool to others

Technical training sessions were attended by 42 conservation professionals. Thirty-eight percent represented local government (SWCDs, Watershed Districts, counties, or cities); 33% represented state or federal agencies; 15% were from non-profit, non-governmental organizations; and the final 15% were from educational institutions or private companies.

Despite the challenge of training people with diverse GIS technical experience, the evaluations of the training sessions were overwhelmingly positive. People appreciated the organization and presentation of the material. Attendees said they understood how the ecological ranking approach was developed, and what each layer represented. Of the four layers, the habitat layer was the least well understood. They were confident of their ability to use, modify and teach the ecological ranking tools to others. Participants were interested in learning more about auxiliary information that could be incorporated into the tool, advanced data processing such as the use of LiDAR data, and examples of how the tool could be applied to support local decision making.

A majority (70%) said they planned to use the ecological ranking tool in their professional work, and they provided many different examples of how it would improve their ability to identify and rank high priority conservation areas. Thus, it appears that the development of the ecological ranking tool achieved all of its initial objectives.

Summary

The ecological ranking project provides information to support decisions on land conservation at a time of shifting economic conditions and new demands on lands, especially lands used for crop production. It does not provide a final decision, but does allow resource managers to assess how different weightings of soil erosion, water quality, and wildlife habitat factors influence the relative conservation value of agricultural lands, particularly those enrolled in the conservation reserve program. To this end, it is an innovative approach that incorporates the best current information available statewide to make informed conservation decisions.

Acknowledgements

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR). This "Statewide Ecological Ranking of CRP and Other Critical Lands" project was managed by the Board of Water and Soil Resources (BWSR). We appreciate the support and collaboration of BWSR staff, in particular Greg Larson, Aaron Spence and Julie Blackburn, who assisted in both conceptualization and implementation of this project. We would also like to thank Victor Gauto from the University of Minnesota's Department of Applied Economics for his assistance with the economic model.

2009 Project Abstract

PROJECT TITLE: Protection of Granite Rock Outcrop Ecosystem
PROJECT MANAGER: Thomas J. Kalahar
AFFILIATION: Renville County Soil & Water Conservation District
MAILING ADDRESS: 1008 West Lincoln
CITY/STATE/ZIP: Olivia MN 56277
PHONE: 320-523-1559
E-MAIL: kalahar@yahoo.com
WEBSITE: www.renvilleswcd.com
FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: ML 2009, Chap. 143, Sec. 2, Subd. 4(h)

APPROPRIATION AMOUNT: $1,500,000

Overall Project Outcome and Results

A total of 560.4 acres of rare and unique Minnesota River Valley landscape were permanently protected and sixteen landowners were paid $1,379,814 for voluntarily placing perpetual conservation easements on those acres. Five counties participated in the project including Lac qui Parle, Chippewa, Yellow Medicine, Redwood and Renville. Easement applications were scored by resource professional teams and funding was based on those scores.

Soil & Water Conservation District (SWCD) employees saw a need to protect the natural environment and to provide economically viable choices for the landowners. The Minnesota River Valley contains exposed ancient granite rock outcrops that provide unique landscape features and habitat for specialized plant and animal communities rarely found elsewhere in Minnesota. No programs existed that would give landowners a payment if they chose to protect the area from development by mining, overgrazing and other development interests. Rock outcrops are a component of the Minnesota River's riparian zone, and destruction of this unique habitat degrades water quality and wildlife habitat in the Minnesota River and its tributaries. Removal of the rock results in severe degradation and permanent loss of these unique landscape features. The Minnesota River Corridor is easily susceptible to fragmentation because it comprises such a small percentage of the Minnesota River Watershed. Past development activities and mining operations have already fragmented large areas of the fragile Minnesota River Corridor.

Demand for aggregate is growing as our population and infrastructure grow. Interest in mining exposed granite rock outcrops in the Minnesota River Valley is high because the rock is readily available and there is no overburden to remove. This encourages the practice of horizontal mining, removing the easiest and most profitable rock, and moving on. Unlike gravel mining operations, there is no reclamation plan possible for replacing this unique landscape feature once it is removed.

Environment and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report: August 15, 2012
Final Report
Date of Work Program Approval: Initial approval June 16, 2009
January 3, 2012
Project Completion Date: June 30, 2012

I. PROJECT TITLE: Protection of Granite Rock Outcrop Ecosystem

Project Manager: Thomas J. Kalahar
Affiliation: Renville SWCD
Mailing Address: 1008 West Lincoln
City / State / Zip: Olivia MN 56277
Telephone Number: 320-523-1559
E-mail Address: Kalahar@yahoo.com
FAX Number: 320-523-2389
Web Site Address: www.renvilleswcd.com

Location: Portions of the Minnesota River Valley located in Lac qui Parle, Yellow Medicine, Chippewa, Redwood & Renville Counties.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$ 1,500,000**
	Minus Amount Spent:	**$ 1,442,119**
	Equal Balance:	**$ 57,881**

Legal Citation: ML 2009, Chap. 143, Sec. 2, Subd. 4(h).

Appropriation Language: (h) Protection of Granite Rock Outcrop Ecosystem. $1,500,000 is from the trust fund to the Board of Water and Soil Resources, in cooperation with the Renville Soil and Water Conservation District, to acquire perpetual easements of unique granite rock outcrops located in the Upper Minnesota River Valley and to restore their ecological integrity

FINAL PROJECT SUMMARY

A total of 560.4 acres of rare and unique Minnesota River Valley landscape were permanently protected and sixteen landowners were paid $1,379,814 for voluntarily placing perpetual conservation easements on those acres. Five counties participated in the project including Lac qui Parle, Chippewa, Yellow Medicine, Redwood and Renville. Easement applications were scored by resource professional teams and funding was based on those scores.
Soil & Water Conservation District (SWCD) employees saw a need to protect the natural environment and to provide economically viable choices for the landowners. The Minnesota River Valley contains exposed ancient granite rock outcrops that provide unique landscape features and habitat for specialized plant and animal

communities rarely found elsewhere in Minnesota. No programs existed that would give landowners a payment if they chose to protect the area from development by mining, overgrazing and other development interests. Rock outcrops are a component of the Minnesota River's riparian zone, and destruction of this unique habitat degrades water quality and wildlife habitat in the Minnesota River and its tributaries. Removal of the rock results in severe degradation and permanent loss of these unique landscape features. The Minnesota River Corridor is easily susceptible to fragmentation because it comprises such a small percentage of the Minnesota River Watershed. Past development activities and mining operations have already fragmented large areas of the fragile Minnesota River Corridor. Demand for aggregate is growing as our population and infrastructure grow. Interest in mining exposed granite rock outcrops in the Minnesota River Valley is high because the rock is readily available and there is no overburden to remove. This encourages the practice of horizontal mining, removing the easiest and most profitable rock, and moving on. Unlike gravel mining operations, there is no reclamation plan possible for replacing this unique landscape feature once it is removed.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: <u>Habitat Protection through Perpetual Easements</u>

Description: This project protected 560.4 acres of rock outcrop complexes within the Minnesota River Corridor and its tributaries. Using several layers of data, including the MN County Biological Survey, this project utilized a scoring system to identify and protect the highest quality sites along the Minnesota River Corridor within the five counties. Easement applications were prioritized by a local work group comprised of technical experts from local, state, and federal agencies. Easements were secured through the Reinvest in Minnesota (RIM) conservation easement process. The easements are held by the State of Minnesota working through the Board of Water and Soil Resources and the local Soil & Water Conservation Districts (SWCD). Compensation for easements with willing landowners was determined using the local cropland rates of the RIM easement program. Administration and processing of the easements was done through the Minnesota Board of Water and Soil Resources (BWSR) and Renville, Redwood, Chippewa, Yellow Medicine, and Lac qui Parle SWCD staff. The $30,000 in Deliverable 3, was paid to local SWCD staff to process easements. When multiple easements were funded in a county, the administration funds to that SWCD were capped at $7,500.

Final Budget Information for Result 1:

Trust Fund Budget	**$1,500,000**
Amount Spent:	**$ 1,442,119**
Balance:	**$ 57,881**

Deliverable	Completion Date	Budget	Amount Spent
1. Easement Acquisition	6-30-2012	$1,435,400	$1,379,814
2. Promotion of program, landowner contacts & initial completion of applications ($2,500 to each of the 5 SWCD offices—numerous contacts resulting in 5-7 apps per county)	12/31/2009	$12,500	$12,500
3. Easement processing/admin/conservation planning/practice implementation for funded easements (maximum $7,500 per SWCD office)	6/30/2012	$30,000	$30,000
4. Legal fees & title insurance & recording fees	6/30/2012	$13,000	$10,705
5. BWSR -- Easement processing ($350/easement X 16 easements)	6/30/2012	$5,600	$5,600
6. Grant Administration (Renville SWCD)	6/30/2012	$3,500	$3,500

Final Report Summary:
Deliverable 1:
Fifteen easements totaling 560.4 acres have been recorded and the landowners paid a total of $1,355,814. A sixteenth easement was partially funded ($24,000) from this grant bringing the total easement payments to $1,379,814. A total of $55,586 remains in this deliverable. An application that was accepted for funding had to be cancelled when the necessary landowner signatures could not be obtained in time to encumber the funds.

Deliverable 2: Program promotion was completed early in the grant period and all funds disbursed.

Deliverable 3: Funds were disbursed to the SWCD offices that processed easements and worked on conservation plans.

Deliverable 4: The final total for legal fees and title insurance was $10,705 leaving $2,295 unspent in this category. It is impossible to estimate the exact amount needed in this deliverable as the amount of legal work needed varies greatly from easement to easement and the bills for both attorney fees and title insurance are received after the easements are recorded and the landowners paid.

Deliverable 5: The Board of Water and Soil Resources staff are a partner in this process and are willing to process easements for $350/easement. The funds have been disbursed to BWSR.

Deliverable 6: Renville County SWCD acts as grant manager and partial fiscal manager. The administrative funds were paid to the Renville County SWCD.

Result 2: Habitat Protection Invasive Species Removal

Description: A Conservation Plan is required for each RIM easement. The plan outlines conservation practices such as removal of invasive species and livestock exclusion, and provides for improvement measures. Habitat maintenance may include rotational grazing systems, fencing, native and non-native invasive species removal (i.e. Red Cedar, Buckthorn, Siberian Elm, & Sumac), prescribed burning and in some cases seeding of native species. Restoration activities began as easement were recorded and landowners issued easement payment. Individual easement conservation plan practices were targeted for completion within one year of easement recording. No ENRTF monies were used for practice implementation. SWCD Staff actively pursued funds from Minnesota DNR, the US Fish & Wildlife Service, BWSR Programs, USDA programs and funds from private conservation groups for practice implementation and were able to fund all the work outlined in the conservation plans with funds from these sources.

Summary Budget Information for Result 2: Trust Fund Budget: $ -0-
Amount Spent: $ -0-
Balance: $ -0-

Deliverable	Completion Date	Budget		
1. Conservation Plan Practice implementation for 16 easements totaling 583 acres.	6/30/2012	$0		

Result Completion Date: June 30, 2012
Final Result Summary:
Each easement is required to have a conservation plan that outlines any practice implementation or restoration for that easement. Local SWCD offices continue to assist landowners with enhancement as requested. Local SWCD staff have been successful in finding other sources to fund the practices. Included in these funding sources are two easements where the Conservation Corps of Minnesota worked a

total of 140 hours removing trees. On another easement cedar were removed and a prescribed burn conducted. That was totally funded through the USDA NRCS Environmental Quality Incentive Program (EQIP). Funding was also secured from the USDA NRCS Wildlife Habitat Incentive Program (WHIP) and from the State of Minnesota Native Buffer Cost-Share Program. Several of the easements did not require any restoration work. All the work that was done was scheduled based on the grassland management/restoration plans and/or tree removal plans written by DNR staff for each of the easements. It is the role of the SWCD to work with easement holders on maintenance and enhancement of easements not only during the easement process but permanently. Easements are spot checked regularly with SWCD staff maintaining regular contact with the landowners about the condition of their easement and assisting with not only information on maintenance, but also assistance with funding for maintenance projects.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $45,000
Each of the five SWCD offices received $2,500 to promote the program within their county at an estimated 3% FTE. The work involved media promotion, direct contact with landowners who had eligible lands, and working with interested landowners on the initial applications that were submitted for scoring. Forty-four applications were scored and eventually 16 of those projects were funded. Eventually one of those easements was cancelled well into the easement processing. Renville SWCD received $3,500 to administer the grant at an estimated 4% FTE. $30,000 was budgeted for Easement Specialists to process easements, write conservation plans, work with landowners, contractors and other agency staff on restoration activities. This was budgeted at $7,500/SWCD and comes to 9% FTE. After the scoring process, administration payments were adjusted based on number of easements funded per county. One county did not have any funded applications in this grant and did not receive a payment.

Contracts: $18,600
Contracts included $350/easement to the BWSR to process RIM easements for a total of $5,600 ($350 X 16). Also included in the budget item is $13,000 for attorney fees to do title searches, generate title opinions and for payment of title insurance policies and recording fees. Of the budgeted amount, $10,705 was spent and $2,295 remained in the unspent category at the end of the grant period. It is difficult to accurately budget for these costs as they vary by hundreds of dollars depending on the amount of legal research required and also on the amount of the title insurance policy payment.

Equipment/Tools/Supplies: $0

Acquisition, including easements: $1,435,400

As stated earlier, the final amount of easement payments was $1,379,814 leaving $55,586 unspent due to the difficulty of obtaining the necessary landowner signatures in time to encumber the funds.

Other (Restoration): $0
Funds will be secured from other sources.

TOTAL TRUST FUND PROJECT BUDGET: $1,500,000

Explanation of Capital Expenditures Greater Than $3,500: N/A

VI. PROJECT STRATEGY:

A. Project Partners:

Renville SWCD is the lead for grant administration. Throughout the grant period, SWCD staff in Renville, Redwood, Lac qui Parle, Chippewa and Yellow Medicine Counties worked with landowners in their respective county to promote and process easements, as well as develop conservation and restoration plans. The US Fish & Wildlife Service and Minnesota Department of Natural Resources provided staff for the technical evaluation of easement applications and restoration practices. County Boards of Commissioners, along with the Upper and Lower Sioux Indian Communities, provided letters of support for this project. Soil & Water Conservation District Boards of Supervisors in the five Counties submitted letters of support and pledged staff time aimed toward the successful completion of this project.

B. Project Impact and Long-term Strategy:

Protecting the rock outcrops is important to the Dakota people. To degrade/destroy rock outcrops or sacred landscapes is to destroy the Dakota Culture. The Dakota consider the Minnesota River Valley their spiritual home. Their relationship with nature calls for reverence, respect, and humility.

Protection and restoration of rock outcrops preserves unique landscapes and habitats and benefits the numerous endangered, threatened, and special concern species found in this ecosystem. The rock outcrops, and their associated wetland complexes, are home to the following state and federal rare, threatened, and endangered species (both flora and fauna): **Federal Threatened**: Prairie bush clover. **State Endangered:** Wolf's spikerush, lichen (*Buellia nigra*), Ball cactus, Henslow's sparrow. **State Threatened:** Kittentails, Short-pointed umbrella sedge, Dakota skipper, Ottoe skipper, Loggerhead shrike. **State Special Concern:** Water-hyssop, Larger water-starwort, mudwort, Great Plains prickly pear, Clustered broomrape, Five-lined skink, Bald eagle, Pawnee skipper, Powesheik skipper, Regal fritillary. **Species of Greatest Conservation Need:** Upland sandpiper. **Non-listed/tracked species:** Carolina foxtail, Eastern fox snake, Three-stamened waterwort, Little barley, Virginia forget-me-not, Mousetail.

Some of the conservation plans required the removal of native and non-native invasive species, such as Red Cedar, Buckthorn, Siberian Elm and Sumac, and encouraged establishment and the proliferation of specialized plant and animal communities rarely found elsewhere in Minnesota. Mining and intensive grazing disturbance leave the land susceptible to increased soil and mineral erosion and increased nutrient loading. This project is helping to protect the water quality of the Minnesota River, its tributaries, and rock outcrop wetlands, by preventing mining and unmanaged grazing on rock outcrops. The protection of the rock outcrop associated wetlands from mining, development, and agricultural production insures that the inherent benefits of these existing wetlands, such as groundwater recharge and reduced flooding impacts, are perpetuated.

In 2007 the LCCMR funded the initial $563,000 to protect Granite Rock Outcrops and Associated Wetlands in Redwood and Renville Counties. A total of 212.4 acres is enrolled into Perpetual RIM Easements as a result of that grant. The current project protects an additional 560.4 acres and expands the eligible area to five counties along the Minnesota River. Prescribed grazing, haying, and prescribed burning will all be essential tools in the future management of this unique landscape.

C. Other Funds Proposed to be Spent during the Project Period:

Minnesota DNR & US Fish & Wildlife Service will provide $9,600 in in-kind for staff to do site visits of all applications and score and prioritize sites for acceptance & funding. In addition there was BWSR native Buffer Cost-Share Program, Minnesota DNR and the US Fish & Wildlife Service, and Minnesota Conservation Corps funds and staff time to assist with the cost of invasive species removal and other conservation practice implementation.

D. Spending HIstory: $563,000.00 has been spent on this project since July 1, 2007 under ML 2007, Chap. 30, Sec 2, Subd. 5(b). $517,410.72 was spent to fund four easements protecting 212.4 acres. $6,540.00 was spent for professional services including $350/easement to BWSR for RIM easement development & processing, attorney fees for title searches & title opinions as well as payment for title insurance policies. $6,049.28 of grant funds were spent for Habitat Restoration. In addition there was $31,440.72 obtained from other sources for Habitat Restoration. Those sources included US Fish & Wildlife Service, the Minnesota DNR from both Wildlife & Ecological Services Divisions, the State of Minnesota Native Buffer Cost-Share program and the USDA Natural Resource Conservation Service EQIP program. There was a total of $33,000 in Personnel costs for this project which was disseminated to the Renville & Redwood SWCD offices.

VII. DISSEMINATION: The Renville SWCD website (www.renvilleswcd.com) continues to update the public on the Rock Outcrop projects by posting information & photos in the "News" section of the website. Each SWCD in Minnesota is required to maintain a website. Those websites contain information on available programs and update the public on current topics of interest in the county.

Each SWCD has a unique position within their community to deliver conservation programs. SWCDs are the local “go to” agency for conservation program delivery and the staff are both trusted and respected by local landowners. Each SWCD office will personally contact landowners who have high quality rock outcrop landscapes on their property. This one-on-one contact will be a major source of providing information to the public.

The 2007 LCCMR Grant received significant media coverage in the area and the 2009 Grant funding has been publicized. Recently there was an article in the weekend “Outdoors” section of the West Central Tribune publicizing the project and encouraging interested landowners to contact their local SWCD staff if they would like to make application for this grant or for potential future grant applications. Tom Kalahar, Project Manager, was interviewed for the article and quoted several times. He was also interviewed by Fred Harris for an article on the Hard Rock Outcrop Easement Program that was published in the March-April 2009 issue of the Minnesota Conservation Volunteer magazine. Individual SWCD offices are also contacting their local newspapers to include articles on the Hard Rock Easement Program. In addition to that information, a landowner workshop was held in Granite Falls on March 28, 2009 which provided information to interested landowners on the Hard Rock Outcrop Easement Program.

Individual SWCD offices will continue to keep their local press informed on the progress of the program. Tom Kalahar will be in contact with the regional West Central Tribune of Willmar, MN as potential stories unfold.

In early November 2009, the West Central Tribune published an article about the program on the front page of their weekend Outdoor section. The article included several color photos.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than December 31, 2009, June 30, 2010, December 31, 2010, June 30, 2011 and December 31, 2011. A final work program report and associated products will be submitted between June 30, 2012 and August 15, 2012 as requested by the LCCMR.

IX. RESEARCH PROJECTS: N/A

Attachment A: Final Budget Detail for 2009 Projects

Project Title: Protection of Granite Rock Outcrop Ecosystem

Project Manager Name: Thomas J. Kalahar

Trust Fund Appropriation: $1,500,000

2009 Trust Fund Budget	**Result 1 Budget**	**Amount Spent**	**Final Balance**	**Result 2**	**Amount Spent**	**Final Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
	Habitat Protection through Perpetual Easements			**Habitat Protection Invasive Species Removal**				
BUDGET ITEM								
PERSONNEL: wages and benefits Technical staff from 5 cooperating SWCD offices. $2,500/SWCD for promotion (3% FTE) and landowner contacts to generate applications from interrested landdowners (25-30 apps).	$12,500	$12,500	$0				$12,500	$0
$7,500/easement for easement processing, conservation plans, working with landowners, contractors and other agencies on practice implementation (9% FTE)--maximum per SWCD of $7,500	$30,000	$30,000	$0				$30,000	$0
$3,500 to Renville SWCD for grant management (4% FTE).	$3,500	$3,500	$0				$3,500	$0
Contracts								
Professional/technical BWSR for Easement development & processing ($350/easement X 5)	$5,600	$5,600	$0				$5,600	$0
Easement acquisition ($2,400/acre X 530 acres)	$1,435,400	$1,379,814	$55,586				$1,435,400	$55,586
Professional Services for Acq. (Attorney fees for title searches, develop title opinions and pay for title insurance policies: $2,000/easement X 5 easements)	$13,000	$10,705	$2,295				$13,000	$2,295
Other May include rotational grazing systems, fencing, native & non-native invasive species removal, prescribed burning & in some cases seeding of native grasses. $307/acres X 530 acres	$0			$0	$0	$0	$0	$0
COLUMN TOTAL	**$1,500,000**	**$1,442,119**	**$57,881**		**$0**	**$0**	**$1,500,000**	**$57,881**

Granite Rock Outcrop Applications
2009 & 2010 ENRTF Grants

Landowner	County	Twp/Sec	Acres	Score	Land Pymt	Year	Status
Available funds							
Borgerson	LQP	Agassiz 10	45.10	175	$ 97,781.31	2009-1	complete
Dahmes	Redwood	Delhi 11	21.60	165	$ 49,533.12	2009-2	complete
Kern	Redwood	Sherman 23/24	132.50	165	$ 381,600.00	2009-3	complete
Thomson	LQP	LSN 20	30.00	160	$ 62,667.00	2009-4	complete
Peterson	Yellow Medicine	ESR 29 & 30	18.50	160	$ 42,624.00	2009-5	complete
Tjaden	Yellow Medicine	MF 10	26.30	150	$ 59,411.70	2009-6	complete
Josh Haen East	Renville	BF 18	0.00	140	$ -	cancel ap	cancel
Gaasch West	Renville	BC 31	3.70	140	$ 9,886.77	2009-7	complete
Essame	Yellow Medicine	SA 12	43.10	140	$ 97,330.50	2009-8	complete
Haas Trust West	Redwood	HO 28	50.00	140	$ 92,520.00	2009-10	complete
Stegner	Redwood	SF 24	46.40	135	$ 109,954.08	2009-11	complete
Enesvedt	Renville	SSH 16	27.60	135	$ 73,998.36	2009-12	complete
Skalbeck	Renville	SSH 16	16.60	135	$ 44,506.26	2009-13	complete
Skjefte	Yellow Medicine	MF 4 & 5	40.40	135	$ 91,263.60	2009-14	complete
Smith	Redwood	SF 7	177.90	135	$ 421,569.63	2010-1	complete
Sebring Trust	Yellow Medicine	MF 10	44.50	135	$ 100,525.50	2010-2	complete
Red Cedar of YM Cty	Redwood	SF 18	79.90	130	$ 189,339.03	2010-3	complete
Haas Trust East	Redwood	PX	53.90	130	$ 143,126.20	2010-4	complete
Mauer/Kodet	Redwood	PX	13.00	130	$ 24,055.20	2010-5	complete
Lawrence Muetzel	Renville	LF 2	15.80	125	$ 45,248.04	2010-6	complete
Almich	Yellow Medicine	MF 3 & 4	43.60	125	$ 98,492.40	2010-7	complete
Jensen	Renville	BF 18	6.30	125	$ 16,834.23	2010-8	complete
Tufto	Redwood	SF 24	20.00	120	$ 47,394.00	2010-9	complete
Tjosvold	Chippewa	GF 28	35.10	120	$ 86,714.55	2010-10	pending
Peterson Family Trust	Chippewa	GF 28	39.70	120	$ 98,078.85	2010-11	complete
Ross	Yellow Medicine	MF 2	40.90	120	$ 92,393.10	2010-12	complete
Opdahl / Burgeson	Yellow Medicine	MF 2 & 11	67.90	120	$ 153,386.10	2010-13	complete
Josh Haen West	Renville	BF 18	0.00	115	$ -	cancel ap	cancel
Dirlam	Redwood	Delhi 4	6.20	110	$ 14,217.84		
Kollen	Yellow Medicine	ESR 32	36.50	105	$ 21,327.30		
Huseby	Redwood	SF 18	9.00	105	$ 84,096.00		
Bakken	Yellow Medicine	MF 1, 2, 12	99.00	100	$ 223,641.00		
Gaasch East	Renville	BC 36	13.10	95	$ 44,891.28		
Hayes	Renville	LF 3	20.00	95	$ 57,275.00		
Dahmes South	Redwood	Delhi 11	17.40	85	$ 39,901.68		
Clark	Chippewa	Sparta 28	21.50	50	$ 52,380.45		
Scored after 2010 grant							
Roden	Yellow Medicine	MF 11 & 2	61.00	175	$ 137,799.00	2010-14	complete
Malecha	Renville	BF 20	30.70	165	$ 82,033.47	2009-15	complete
Baker	Yellow Medicine	MF 4 & 5	13.50	145	$ 30,496.50	2010-15	complete
Borgerson	Lac qui Parle		0.00	185	$ -	2009 cancel	cancel
Larson	Lac qui Parle		28.00	145	$ 60,704.00	2009-16	complete
Ross	Yellow Medicine		35.40	145	$ 80,127.90	**both****	complete
Forkrud	Renville	LSH 22	38.80	110	$ 144,491.20		
Monson, Andrew	Yellow Medicine		28.80	90	$ 66,355.20		
Total Applications			**1,599.20**		**$ 3,869,971.35**		

LCCMR Granite Rock Outcrop Grant Program

2009 Grant Funds			**2010 Grant**		
Funded Acres	**560.50**		**Funded Acres**	**748.40**	
Total Easement funding	**$ 1,355,814.17**		**Easement Funds**	**1,765,580.23**	$ 1,741,580.23

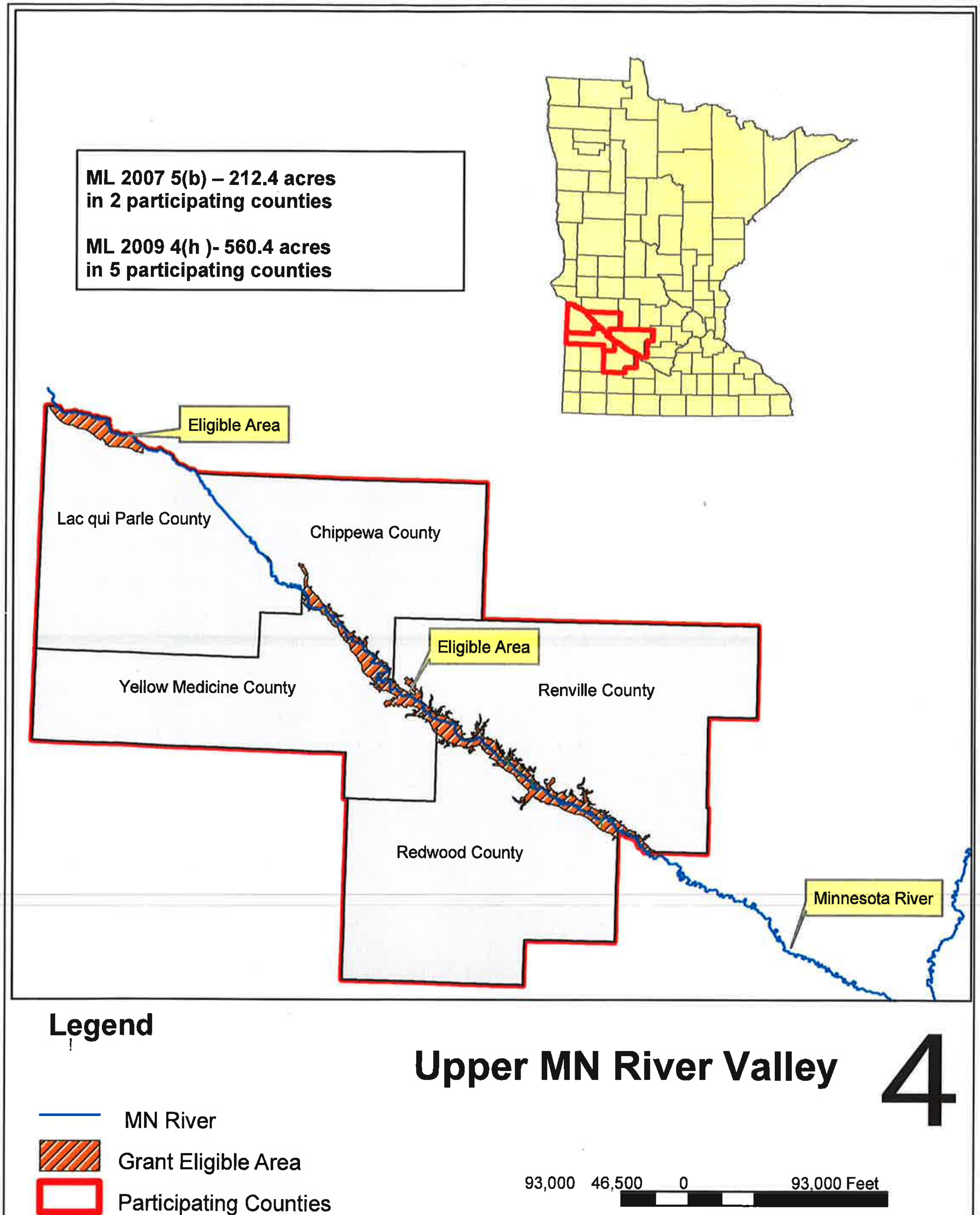
Total funded acres 2009 & 2010 Grants **1,308.90** **Total funded 2009 & 2010** **$ 3,121,394.40**

$3,181,815 total budgeted for easements in 2009 & 2010 grants
(after 12/31/2011 revision request for 2009 grant)

**NOTE: The Ross easement acres and cost are included in the 2010 totals. The easement will in fact use $24,000 of 2009 funds and $56,127.90 from 2010 funds therrefore exhibit A for .
2009 final report will show $1,379,814 spent & 2010 will show $1,741,580

Updated 8/13/2012

LCCMR Granite Rock Outcrop Grant Eligible Area



37-01-09-07

Donald Thomson
3534 221th Ave
Madison MN 56256

Granite Outcrop
Easement 30 Acres

Lac qui Parle SWCD
8-6-12

Legend

Easement Area
Sections

Lac qui Parle County
NE1/4 120N R44W
Lake Shore North 20

0 320 640 1,280 1,920 2,560 Feet

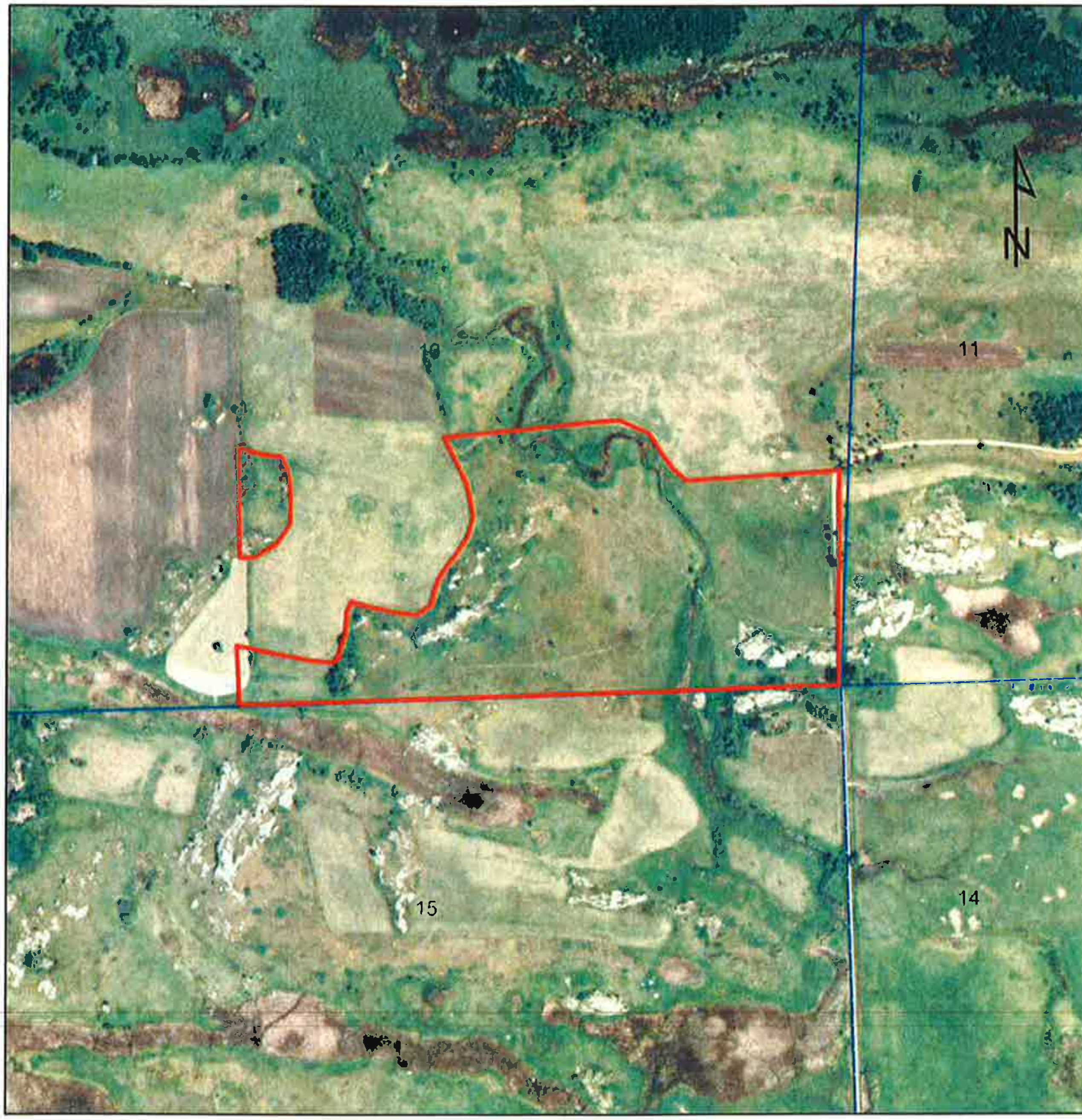
N
W E
S

37-02-09-07

Alfred and Barbara Borgerson
3820 191st Ave.
Odessa MN, 56276

Granite Outcrop
Easement 45.1 Acres

Lac qui Parle SWCD
8-6-12



Legend

Easement Area
Sections

Lac qui Parle County
SE1/4 120N R45W
Agassiz 10

0 230 460 920 1,380 1,840
Feet

N
W E
S

37-04-09-07

Dan Larson
3741 161st Ave.
Odessa MN 56276

Granite Outcrop Easement 28 Acres

Lac qui Parle SWCD
8-6-12

Legend

Easement Area
Sections

Lac qui Parle County
SW1/4 120N R45W
Agassiz 10

0 235 470 940 1,410 1,880 Feet

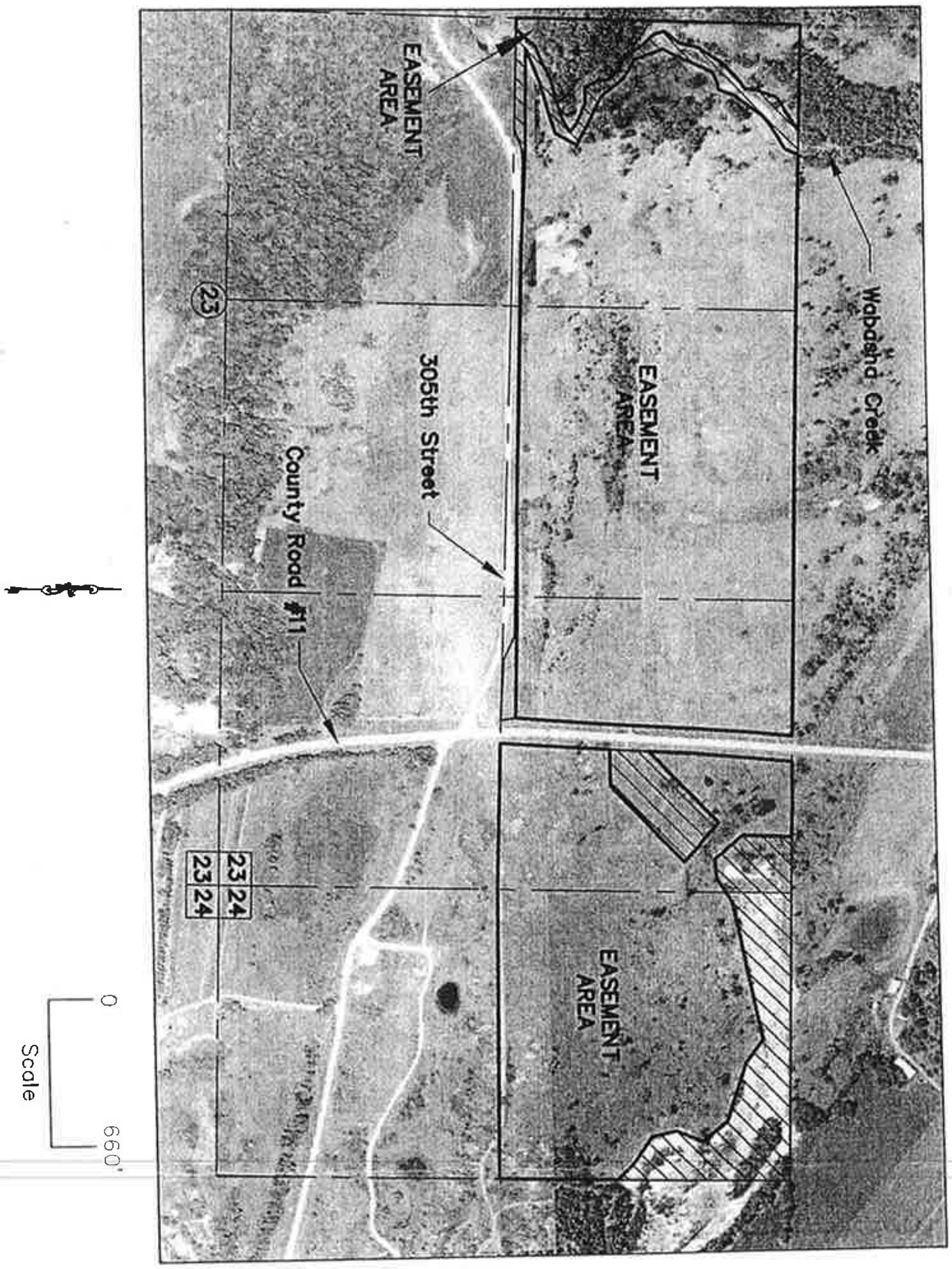
N
W E
S

Easement I.D. No: 64-01-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
AMENDED EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 23/24 T. 112 N., R. 34 W., Redwood County



Prepared By:

Board of Water and Soil Resources

Dated:

July 26th, 2010

LEGEND

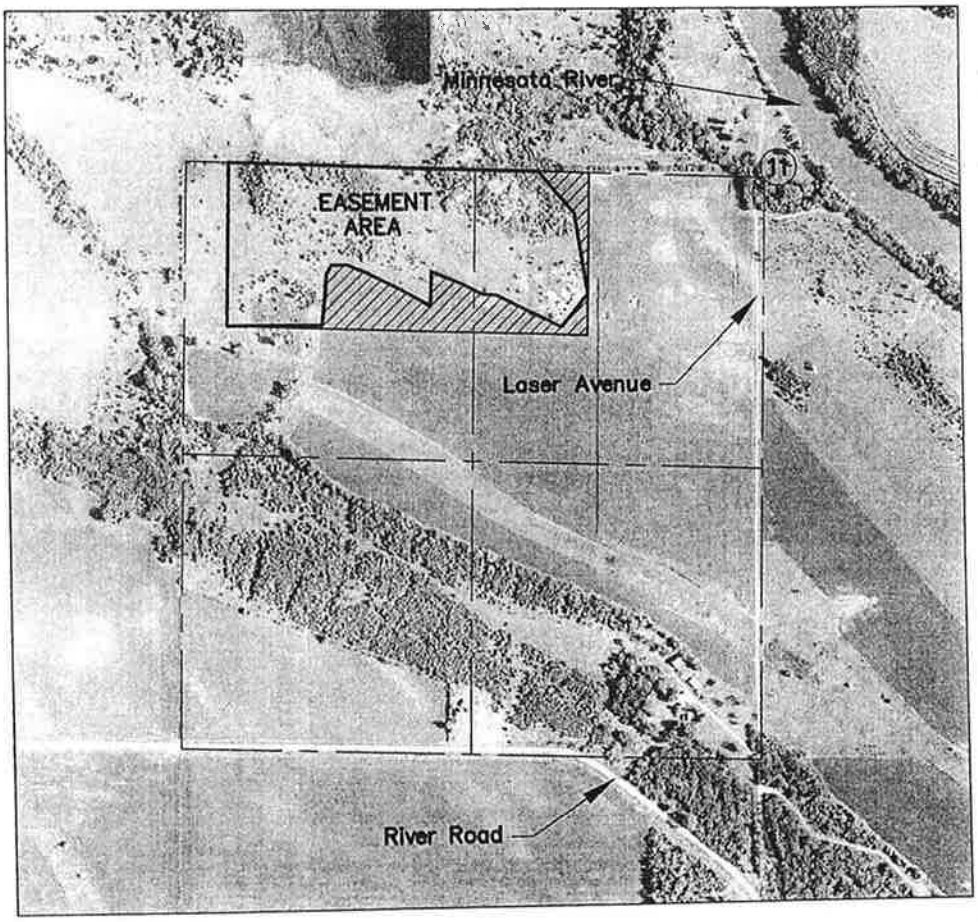
- Center of Section
- Boundary of Described Lands
- Lands Included in Easement
- Lands Not Included in Easement
- Section/Quarter/Sixteenth Line

Easement I.D. No: 64-02-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 11 T. 113 N., R. 36 W., Redwood County



0 660'
Scale

Prepared By:

Board of Water and Soil Resources

Dated:

November 10, 2009

LEGEND

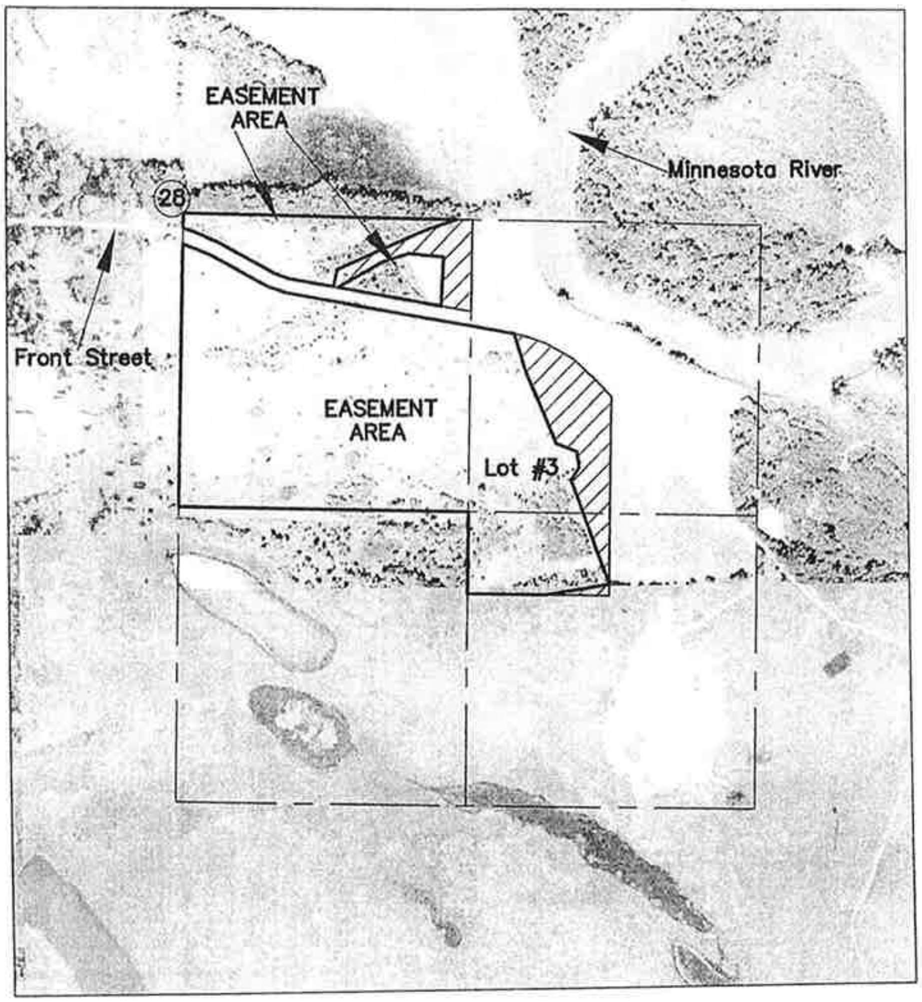
Center of Section
Boundary of Described Lands
Easement Area — Lands Included in Easement
Lands Not Included in Easement
Section/Quarter/Sixteenth Line

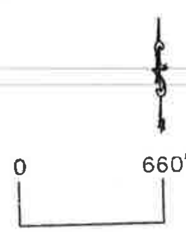
Easement I.D. No: 64-03-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 28 T. 113 N., R. 35 W., Redwood County





Prepared By:

Board of Water and Soil Resources

Dated:

November 12th, 2009

LEGEND

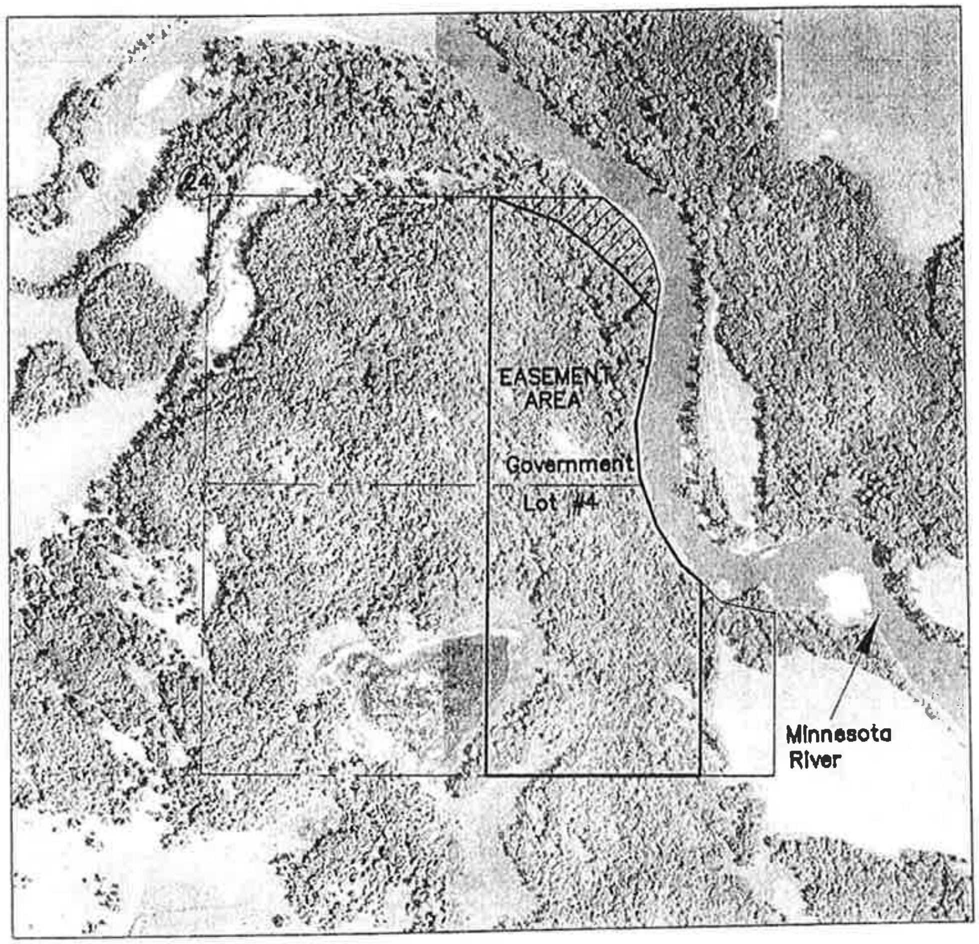
- Center of Section
- Boundary of Described Lands
- Easement Area — Lands Included in Easement
- Lands Not Included in Easement
- Section/Quarter/Sixteenth Line

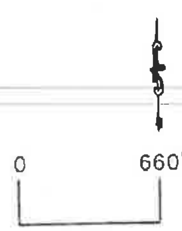
Easement I.D. No: 64-04-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 24 T. 114 N., R. 37 W., Redwood County





Prepared By:

Board of Water and Soil Resources

Dated:

January 25th, 2010

LEGEND

○	Center of Section
———	Boundary of Described Lands
Easement Area	Lands Included in Easement
//////	Lands Not Included in Easement
—— — ——	Section/Quarter/Sixteenth Line

DOC# A356900

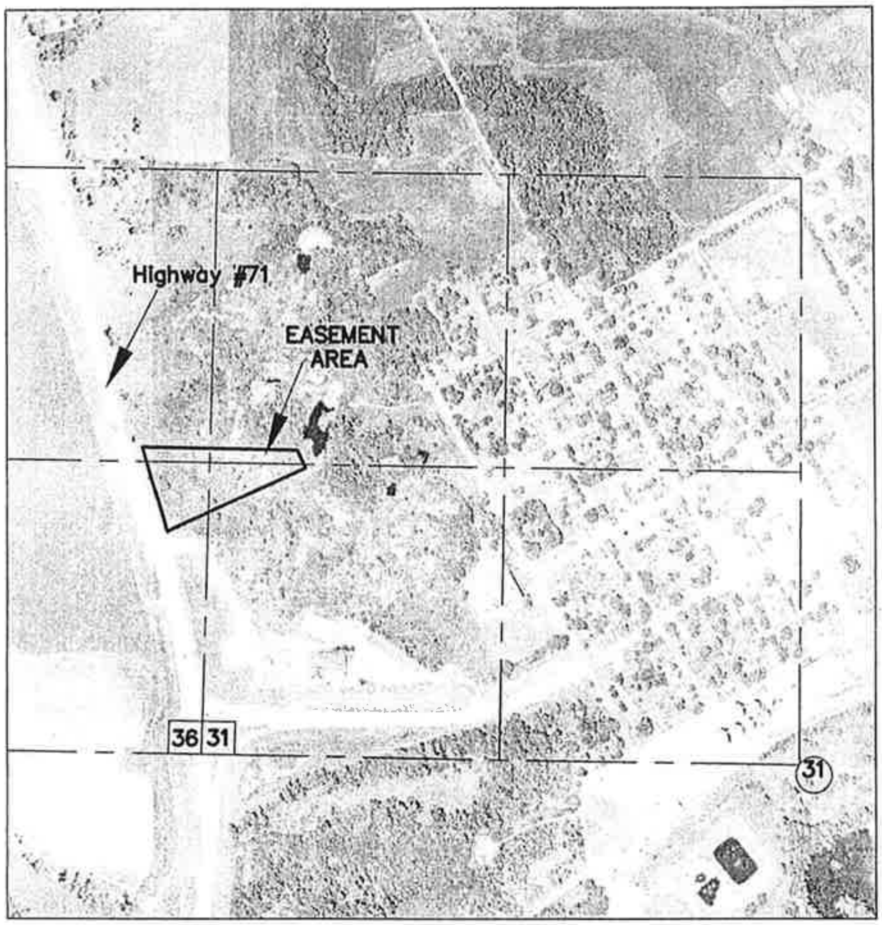
DC # A 356298

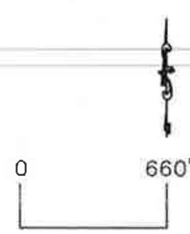
Easement I.D. No: 65-04-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 31 T. 113 N., R. 34 W., Renville County
Section 36 T. 113 N., R. 35 W.,





Prepared By:

Board of Water and Soil Resources

Dated:

November 16th, 2009

LEGEND

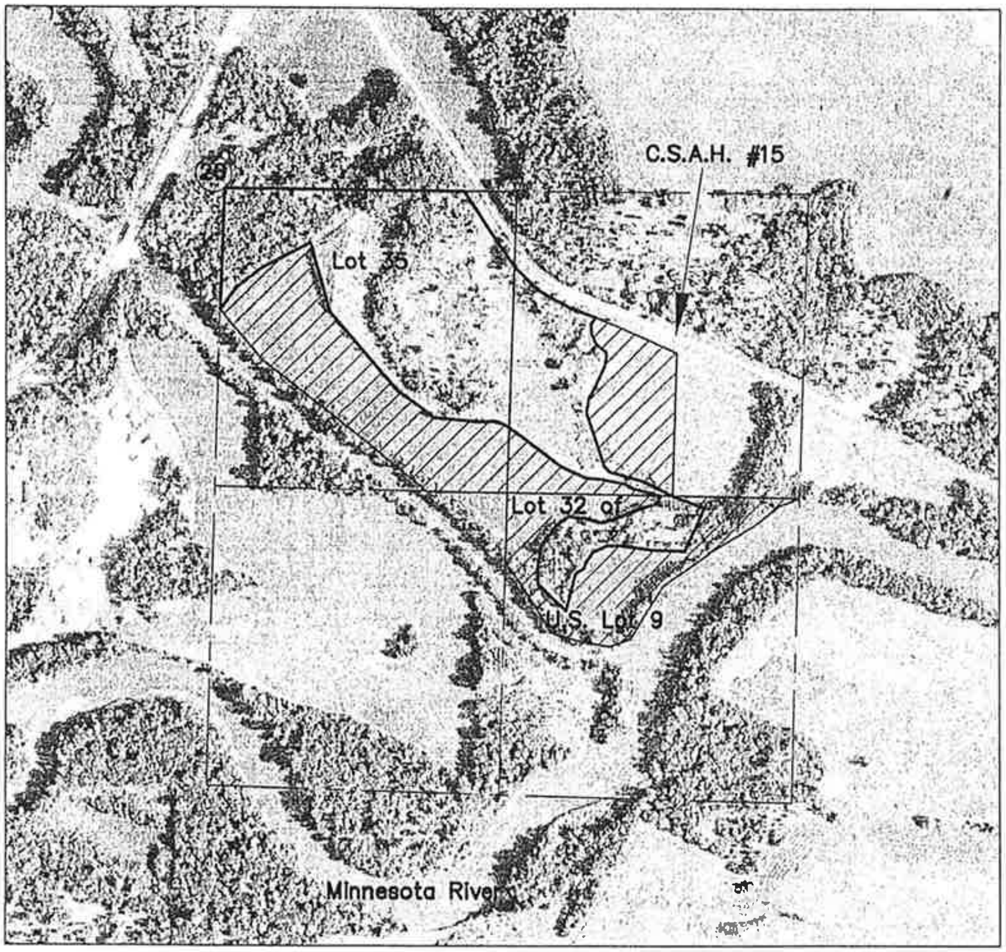
◯	Center of Section
———	Boundary of Described Lands
Easement Area	Lands Included in Easement
//////	Lands Not Included in Easement
— — —	Section/Quarter/Sixteenth Line

Easement I.D. No: 65-05-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 20 T. 113 N., R. 35 W., Renville County



0 660'
Scale

Prepared By:

Board of Water and Soil Resources

Dated:

March 15th, 2011

LEGEND

Center of Section
Boundary of Described Lands
Easement Area — Lands Included in Easement
Lands Not Included in Easement
Section/Quarter/Sixteenth Line

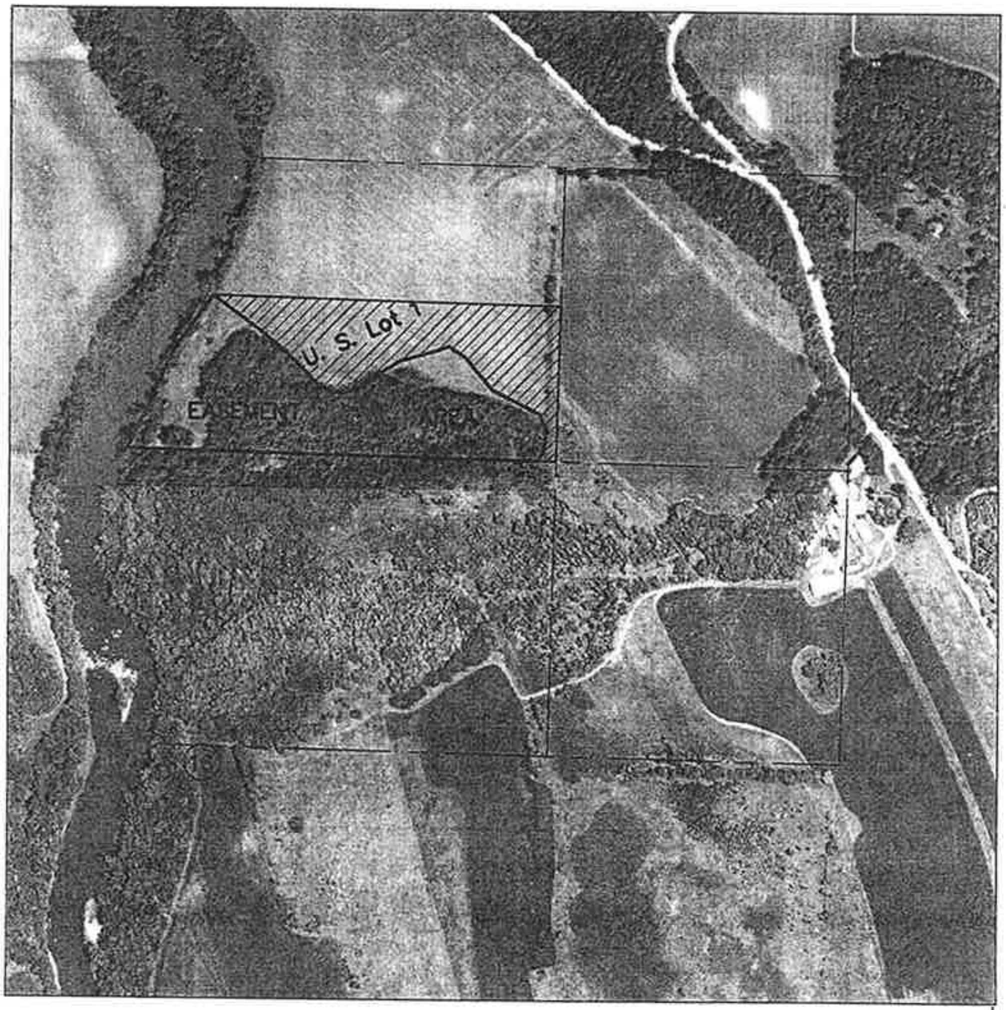
DOC A 355842

Easement I.D. No: 65-03-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 16 T. 114 N., R. 37 W., Renville County



0 660'
Scale

Prepared By:

Board of Water and Soil Resources

Dated:

November 19, 2009

LEGEND

Center of Section
Boundary of Described Lands
Easement Area — Lands Included in Easement
Lands Not Included in Easement
Section/Quarter/Sixteenth Line

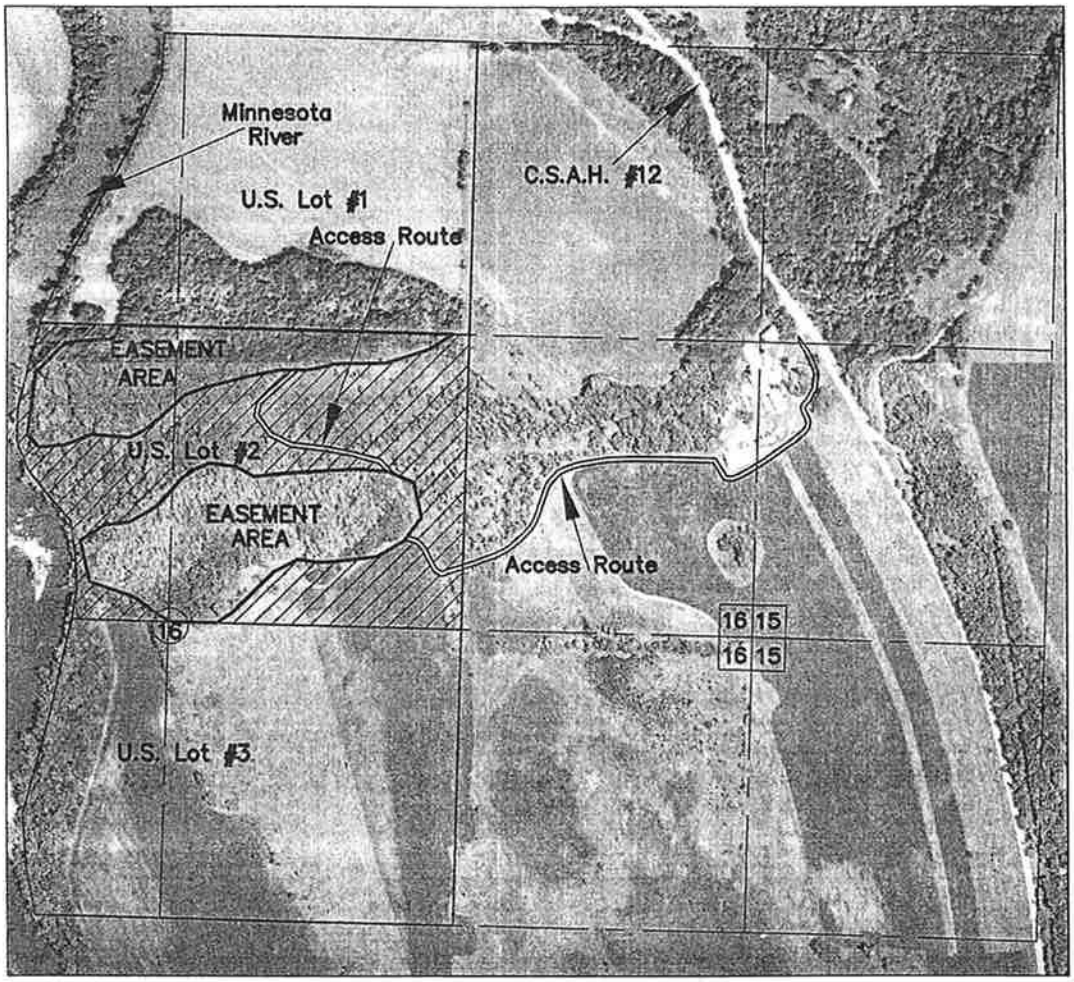
DOC# A359431

Easement I.D. No: 65-01-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 16 T. 114 N., R. 37 W., Renville County



0 660'
Scale

Prepared By:

Board of Water and Soil Resources

Dated:

August 20th, 2010

LEGEND

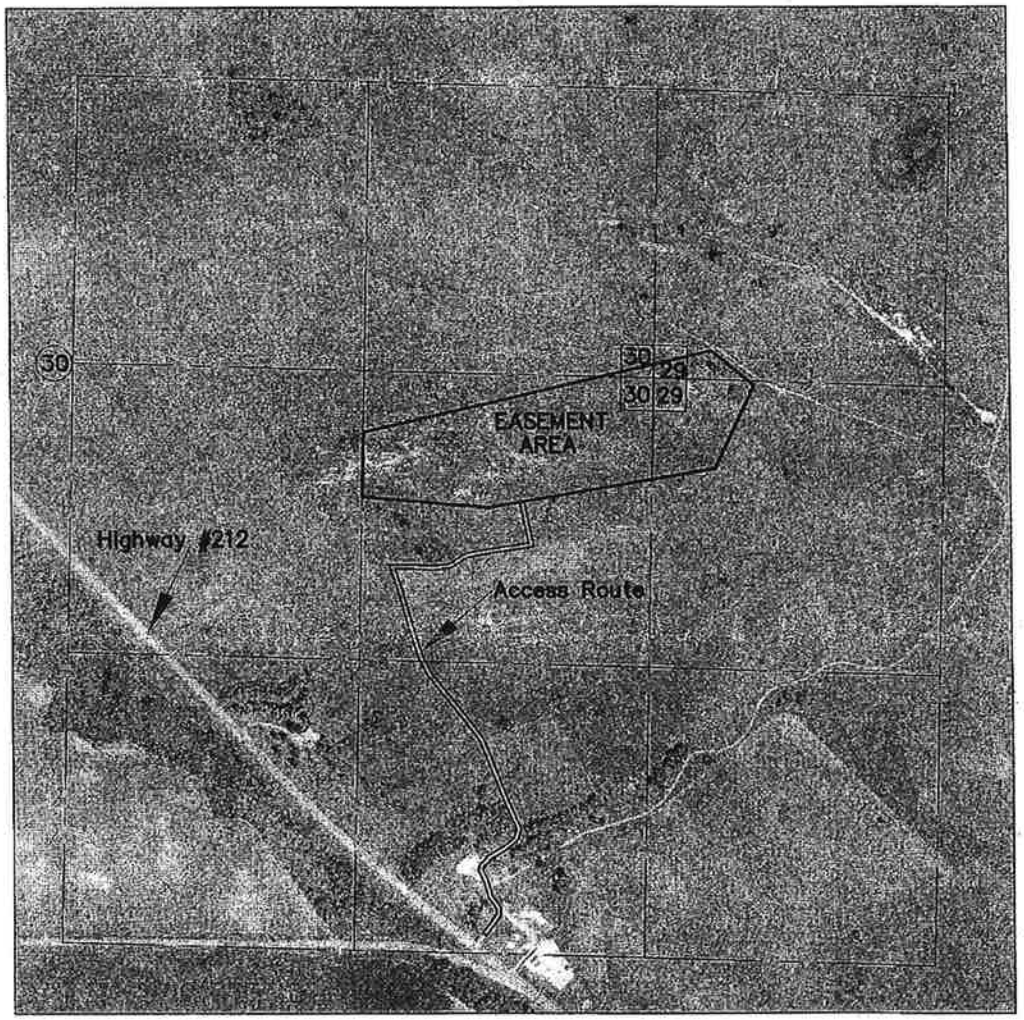
Center of Section
Boundary of Described Lands
Easement Area — Lands Included in Easement
Lands Not Included in Easement
Section/Quarter/Sixteenth Line

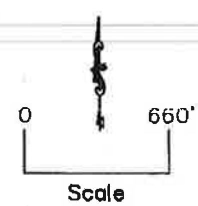
Easement I.D. No: 87-01-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 29/30 T. 116 N., R. 39 W., Yellow Medicine County





Prepared By:

Board of Water and Soil Resources

Dated:

November 9th, 2009

LEGEND

Center of Section
Boundary of Described Lands
Lands Included in Easement
Lands Not Included in Easement
Section/Quarter/Sixteenth Line

Easement I.D. No: 87-02-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 10 T. 115 N., R. 39 W., Yellow Medicine County

Prepared By:

Board of Water and Soil Resources

Dated:

November 16th, 2009

LEGEND

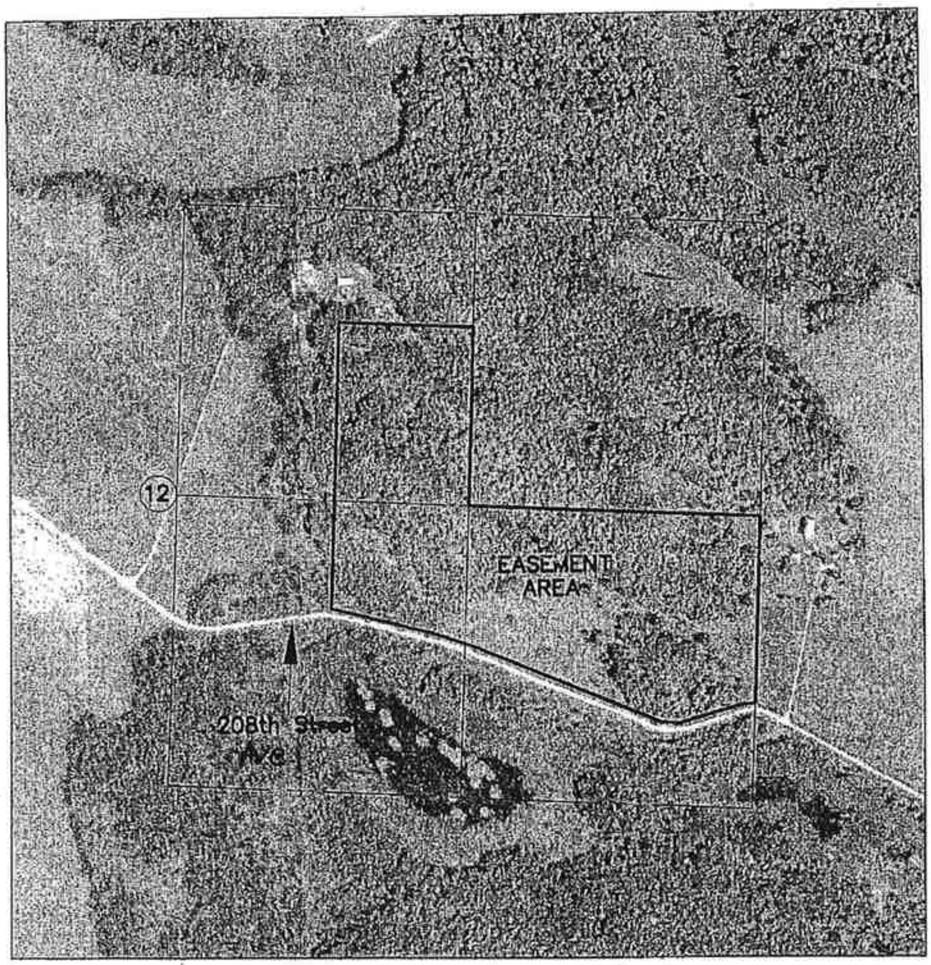
Center of Section
Boundary of Described Lands
Easement Area — Lands Included in Easement
Lands Not Included in Easement
Section/Quarter/Sixteenth Line

Easement I.D. No: 87-03-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 12 T. 114 N., R. 38 W., Yellow Medicine County



0 660'
Scale

Prepared By:

Board of Water and Soil Resources

Dated:

December 8th, 2009

LEGEND

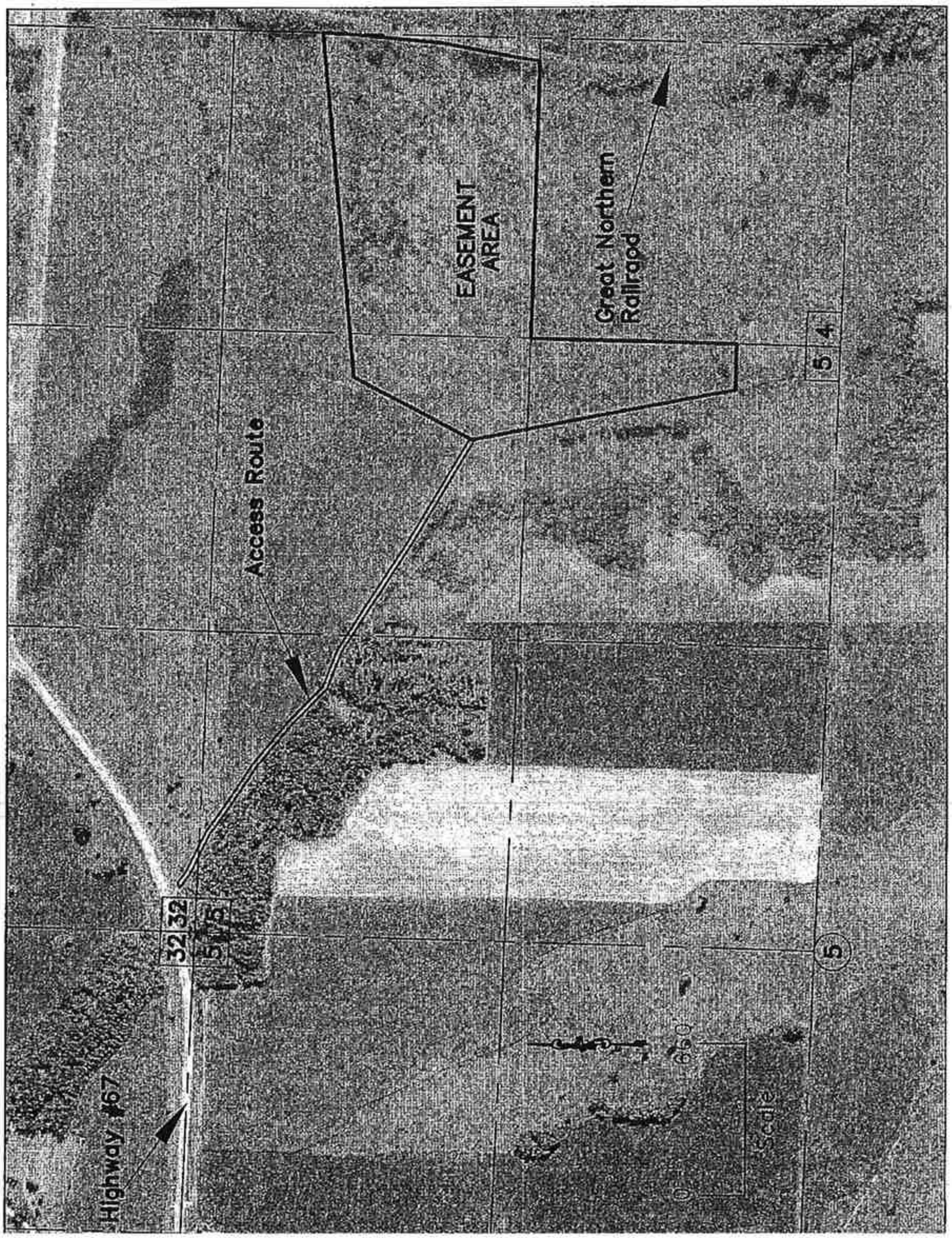
Center of Section
Boundary of Described Lands
Easement Area — Lands Included in Easement
Lands Not Included in Easement
Section/Quarter/Sixteenth Line

Easement I.D. No: 87-04-09-07
Map 1 of 1

STATE OF MINNESOTA
BOARD OF WATER AND SOIL RESOURCES
CONSERVATION EASEMENT
EXHIBIT 'A'

This map delineates the easement area(s) referred to in the attached easement conveyance. ***This is not a legal survey, and not intended for use as a survey plat.***

Section 4/5 T. 115 N., R. 39 W., Yellow Medicine County



2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Minnesota Farm Bill Assistance Project
PROJECT MANAGER: Tabor Hoek
AFFILIATION: MN Board of Water and Soil Resources
MAILING ADDRESS: 1400 E. Lyon Street
CITY/STATE/ZIP: Marshall, MN 56258
PHONE: (507) 537-7260
E-MAIL: tabor.hoek@state.mn.us
WEBSITE: www.bwsr.state.mn.us
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec.2, Subd.4i

APPROPRIATION AMOUNT: $1,000,000

Overall Project Outcome and Results

A joint effort of MN Board of Water and Soil Resources, MN Dept. of Natural Resources, MN Pheasants Forever, and local Soil and Water Conservation Districts, the focus was acceleration of technical assistance to private landowners for enrollment in federal USDA conservation programs as they relate to grassland and wetland resources. This effort provided 16 full time equivalents at the field level with a goal to establish or restore 50,000 ac. of grassland and wetlands during the 2 year period ending June 1, 2011. This goal was exceeded with a total enrollment of 69,081 acres resulting in $79,000,000 of USDA program payments coming to MN landowners for implementing conservation practices on their land. Efforts of this project will continue for at least another 2 years under new funding from the Environment and Natural Resources Trust Fund and partner agency contributions.

Project Results Use and Dissemination

Overall project results and its impact can be found in the Minnesota Conservation Lands Summary table found at http://www.bwsr.state.mn.us/easements/COENROL_083111.pdf.

Trust Fund 2009 Work Program

Date of Report: August 3, 2011
Date of Next Progress Report: July 31, 2011
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Minnesota Farm Bill Assistance Project

Project Manager:	Tabor Hoek
Affiliation:	MN Board of Water and Soil Resources
Mailing Address:	1400 E. Lyon Street
City / State / Zip:	Marshall, MN 56258
Telephone Number:	507-537-7260
E-mail Address:	tabor.hoek@state.mn.us
Fax Number:	507-537-6368
Web Site Address:	www.bwsr.state.mn.us

Location: *Statewide*

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	$	1,000,000
	Minus Amount Spent:	$	919,446
	Equal Balance:	$	80,554

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 4i

Appropriation Language:
$1,000,000 is from the trust fund to the Board of Water and Soil Resources to provide funding for technical staff to assist in the implementation provisions of conservation programs including the federal farm bill conservation programs. Documentation must be provided on the number of landowner contacts, program participation, federal dollars leveraged, quantifiable criteria, and measurement of the improvements to water quality and habitat.

II. PROJECT SUMMARY AND RESULTS:

Overall Project Outcome and Results
A joint effort of MN Board of Water and Soil Resources, MN Dept. of Natural Resources, MN Pheasants Forever, and local Soil and Water Conservation Districts, the focus was acceleration of technical assistance to private landowners for enrollment in federal USDA conservation programs as they relate to grassland and wetland resources. This effort provided 16 full time equivalents at the field level with a goal to establish or restore 50,000 ac. of grassland and wetlands during the 2 year period ending June 1, 2011. This goal was exceeded with a total enrollment of 69,081 acres resulting in $79,000,000 of USDA program payments coming to MN landowners for implementing conservation practices on their land. Efforts of this

project will continue for at least another 2 years under new funding from the Environment and Natural Resources Trust Fund and partner agency contributions.

Project Results Use and Dissemination

Overall project results and its impact can be found in the Minnesota Conservation Lands Summary table found at http://www.bwsr.state.mn.us/easements/COENROL_083111.pdf.

III. PROGRESS SUMMARY AS OF: June 30, 2011

Completion of employment of the 22.19 fte's within 36 counties. Staff worked total of 88,106 hours and have accomplished 69,081 ac. of wetland, grassland and management activities. This total exceeds the original two year goal of 50,000 ac. We have now leveraged approximately $79,000,000 in federal USDA Farm Program funds as a result of this project. In addition to the direct accomplishments of this project, numerous other projects were accomplished as a result of the FBA marketing effort, but were handed off to a partner organization to achieve the landowners final objectives. An example of this might be a landowner choosing to sell fee title to a public agency vs. enrollment in a CRP contract.

At the close of the project, we have a remaining balance of $80,554 that was not able to be used. Reasons for this include staff vacancies and partner organizations providing funding that dovetails with LCCMR funding. BWSR will be issuing payment back to LCCMR and the ENRTF at the next available opportunity.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1:

Assistance on enrolling, retaining, and managing 50,000 acres of critical private grasslands, and wetlands.

Description:

This project will focus on enrollment, retention and management of 50,000 acres of native grasslands and wetlands over the two year project. This activity will occur on private land within the 23 million acre agricultural zone. Management will occur on lands already established and in the greatest need based upon threat to quality of vegetation and location. New land enrollment as well as management activities will be targeted within key geographic areas, based on local priorities such as: DNR Working Lands Target Areas, CRP critical lands study, Riparian Buffer Initiative, RIM-WRP priority mapping, TMDL areas and local water management plans to name a few. Strategic staffing of 16 FTE's will be done within individual SWCD's through a competitive application process.

Process:
The Farm Bill Assistance Committee governs over this project and is made up of one member from DNR, BWSR and Pheasants Forever. This committee will make initial project selections by July 1, 2009. There is potential to build upon this initial listing with available funding as the project evolves and need arises. Staff positions will be selected for funding based upon historical performance, location within DNR Working Lands areas, resource opportunity/need, ability to provide match to grant, and goals identified by each applicant on their application. Upon recommendation of the committee the BWSR will enter into a contractual relationship with successful applicants starting July 1, 2009. These contracts with SWCD's will reimburse 70% of the cost for two years of 16 FTE's. The remaining 30% will be provided as cash match from local sources. For purposes of this project, a maximum FTE cost of $45,000/year has been put in place.

Outcomes:
Participants will complete monthly progress reports that will track: hours spent, landowners contacted, acres enrolled or managed by resource type. An estimate of federal leveraged funds will also be included with each status report. At the end of each six month period, a summary will be prepared and submitted by the SWCD for reimbursement from BWSR. BWSR has been collecting this data since 2002 and will modify that process to accommodate the requirements of this work program.

Summary Budget Information for Result 1: **Trust Fund Budget:** $1,000,000
Amount Spent: $ 919,446
Balance: $ 80,554

Deliverable	**Completion Date**	**Budget**
1. Request for Proposals from SWCD's	June 30, 2009	$0
2. Contracts Implemented to Employ 16 FTE's for 2 years	July 30, 2009	$1,000,000
3. Enrollment or management of 50,000 acres	June 30, 2011	$0

Result Completion Date: June 30, 2011

Result Status as of: January 31, 2010
On April 14, 2009 the committee sent out the RFP for staffing assistance to SWCD's. The deadline for requests was May 29^{th}. The committee met on June 9^{th} to rank applications based on their stated goals and historic performance. At the June 24^{th} BWSR meeting the board approved the project and authorized entering into contracts for implementation. Contracts were

sent out in July for local authorization. The application serves as the workplan for the position. Reimbursement for work accomplished is being done on a quarterly basis to help with cash flow for the positions. We currently have worked through the first two quarters of fiscal year 2010 as you will note in attachment B.

This project currently has 22.07 fte's employed providing service to 37 counties. Staff have worked a total of 20,347 hrs., made 5,628 landowner contacts, and have accomplished 15,765 ac. of critical buffer strips, wetland restoration, grassland habitat, and vegetation management. After the first six months, we are on track of obtaining our goal of 25,000 ac. per year and 50,000 over the two yr. project. It is estimated that this project has leveraged in excess of $16,500,000 dollars of federal and other state funds to achieve these acreage amounts. Our initial goal was to employ 16 fte's with the LCCMR grant, but have been able to secure outside funding from DNR and BWSR to increase this to the current level of 22.07 fte's. Attachment B is the current status of where the positions are located. It summarizes how many hours have been approved for each position and the year-to-date reimbursement request. It further shows the reimbursement sent out by BWSR, with a breakdown of how much has been paid out from LCCMR and DNR funding sources. The balance column shows what remains available for each position through June 30, 2010.

Result Status as of: July 31, 2010

We have now concluded the first year of the two year project to employ technical staff. We had a slight staffing increase in the last six months due to workload in one county needing to be met. We currently have 22.19 fte's covering 36 counties. Landowner contacts continue to be made for a cumulative project total of 11,048 achieving 30,751 ac. Of this amount 20,009 ac. of grassland and wetlands have been added with the balance of 10,742 in management activities on existing grassland. We have exceeded the initial goal of 25,000 ac. each of the two years. This project has now leveraged an estimated $31,000,000 in federal and other state project funding. With the outlook of a summer 2010 CRP signup as well as some very successful easement options funded by the State of MN, we should easily accomplish or exceed our goal for the second and final year. Attachment B has been updated to show the conclusion of the first year.

In preparation for the second year the FBA committee has sent out an RFP for positions in May to existing participants. In June the committee reviewed the applications for past success and future goals. The recommendation for funding was brought to the BWSR board on June 23rd for approval. We are currently working to secure second year contracts with participants. The committee has also secured an additional $150,000 in funding from DNR.

Based upon our current budget for this project, we will easily expend the remainder of the LCCMR funding by June 30, 2011.

Result Status as of: January 31, 2011

We are maintaining the 22.19 fte's covering 36 counties. Landowner contacts continue to be made for a cumulative project total of 17,240 achieving 56,289 ac. Of this amount 42,403 ac. of grassland and wetlands have been added with the balance of 13,886ac. in management activities on existing grassland. We have exceeded the two year goal of 50,000 ac. This project has now leveraged an estimated $65,000,000 in federal and other state project funding. We had a very successful CRP signup in 2010 and there is another signup scheduled for 2011 along with MN Bonding and LSOHC funding for RIM easements. Attachment B has been updated to show progress to Dec. 31, 2010.

Result Status as of: June 30, 2011

In the final six months of this project we finished with the 22.19 fte's covering 36 counties. Landowner contacts totaled 25,817 achieving 69,081 ac. Of this amount 51,262 ac. of grassland and wetlands have been added with the balance of 17,819 ac. of management activities on existing grassland. We have exceeded the two year goal of 50, 000 ac. This project has now leveraged an estimated $79,000,000 in federal and other state project funding. We had a successful CRP signup in spring of 2011, but continue to see CRP expire in MN at a faster rate. Other sources of funding continue to be Bonding, Clean Water Fund and LSOHC funding for RIM easements. Attachment B has been updated to show progress to June 30, 2011.

Final Report Summary: July 31, 2011

Final numbers for this project were 25,817 landowner contacts achieving 69,081 ac. Of this amount 51,262 ac. of grassland and wetlands have been added with the balance of 17,819 ac. of management activities on existing grassland. We have exceeded the two year goal of 50, 000 ac. This project has now leveraged an estimated $79,000,000 in federal and other state project funding. We were able to spend most of the allocated funds, but will be returning a balance of $80,554 due to staff vacancies. Attachment B has been updated to show progress to June 30, 2011. With the approval of M.L. 2011 Acceleration of Minnesota Conservation Assistance funding $625,000 we will be able to maintain some of the core functions of this project into the future.

V. TOTAL TRUST FUND PROJECT BUDGET:

Contracts: $ 1,000,000 for Contracts with SWCD's for employment of 16 FTE's.

TOTAL TRUST FUND PROJECT BUDGET: $1,000,000

VI. PROJECT STRATEGY:

A. Project Partners:

MN BWSR, MN DNR, MN Pheasants Forever, and MN SWCD's

B. Project Impact and Long-term Strategy:

This project creates an employment opportunity for 16 FTE's over the next two years and is an investment in our natural resources. The investment in 16 FTE's leverages an estimated $75,000,000 in federal and state conservation program payments to MN landowners. This project is necessary to continue progress towards meeting Minnesota's prairie and wetland restoration needs as identified in the Minnesota Statewide Conservation and Preservation Plan, July 2008 (SCPP).

C. Other Funds Proposed to be spent during the Project Period:

See Attachment B

D. Spending HIstory:

During the period July 1, 2007 through June 30, 2009 there was a cash total of $2,216,728 plus an estimated $400,000 of inkind.

VII. DISSEMINATION:

Data is collected on time spent, acres impacted and landowners contacted on a monthly basis and is available to the project partners and participants. The overall status of conservation programs in MN is available at www.bwsr.state.mn.us/easements/COENROL.XLS

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted not later than January 2010, July 2010, and January 2011. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

Attachment A: Budget Detail for 2009 Projects - Summary and a Budget page for each partner (if applicable)

Project Title: Minnesota Farm Bill Assistance Project

Project Manager Name: Tabor Hoek

Trust Fund Appropriation: $ *1,000,000*

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent**	**Balance July 31, 2010**
	Assistance on 50,000ac. of critical private land projects.		
BUDGET ITEM			
Contracts with SWCDs for Staff	1,000,000	919,446	80,554
COLUMN TOTAL	**$1,000,000**	**$919,446**	**$80,554**

2009 Project Abstract
For the Period Ending June 30, 2012

Project Title: Intensified Tile Drainage Evaluation
Project Manager: Shawn Schottler
Affiliation: Science Museum of Minnesota-
St. Croix Watershed Research Station
Mailing Address: 16910 152nd St. North
City / State / Zip: Marine, MN 55047
Telephone Number: 651-433-5953 x 18
E-mail Address: schottler@smm.org
Web Site Address: smm.org

Funding Source: Environment and Natural Resources Trust Fund
Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 5d

Overall Project Outcome and Results

Agricultural rivers throughout Minnesota are impaired by excess sediment, a significant portion of which comes from non-field, near-channel sources, suggesting that rivers have become more erosive over time. In the upper Mississippi basin, crop conversions have lead to an intensification of artificial drainage, which is now a critical component of modern agriculture. Coincident with the expansion of drainage networks were increases in annual rainfall. To disentangle the effects of climate and land-use we compared changes in flow, runoff ratio, precipitation, crop conversions, and extent of drained depressional areas in 21 watersheds over the past 70 years. Major finding from this study are:

- flow and runoff ratio have increased by than more 50% in about half of the watersheds.
- increases in rainfall generally account for less than half of the increases in flow.
- the largest increases in flow are correlated to the largest conversions to soybeans and extent of artificial drainage.
- using a water budget, calibrated to the first 35 years of record, we calculate that artificial drainage accounts for the majority of the statistically significant increases in flow.
- artificial drainage of depressional areas reduces water residence time on the landscape, consequently; a significant portion of annual rainfall that was once returned to the atmosphere via evapo-transpiration, is now routed to the rivers.
- loss of depressional areas and wetlands are strongly correlated to increases in excess flow in the 21 watersheds, thus supporting the proposed linkage between facilitated drainage of depressional areas and increases in river flow.
- rivers with increased river flow have experienced channel widening of 10-40%.
- climate, crop conversion and artificial drainage have combined to create more erosive rivers, with drainage as the largest driver of this change.

Project Results Use and Dissemination

Results of this study have been submitted for publication to the journal Hydrological Processes and have been accepted pending final review. Summaries and findings and implications of this study have been presented at more than 30 technical meetings in

Minnesota and nationally. Many of these presentations have been in conjunction with local watershed groups, and have an audience of County Commissioners, farmers, SWCD staff, and agricultural consultants. These meetings have been highly successful at delivering the findings of this study to people who are directly involved in watershed management but are less likely to attend scientific meetings or read scientific journals.

Trust Fund 2009 Work Program

Date of Report: September 15, 2012
Final Report
Program Approval: 6/16/2009
Project Completion Date: July 1, 2012

I. PROJECT TITLE: Intensified Tile Drainage Evaluation

Project Manager:	Shawn Schottler
Affiliation:	Science Museum of Minnesota- St. Croix Watershed Research Station
Mailing Address:	16910 152nd St. North
City / State / Zip:	Marine, MN 55047
Telephone Number:	651-433-5953 x 18
E-mail Address:	schottler@smm.org
FAX Number:	651-433-5925
Web Site Address:	smm.org

Location: Study will evaluate 24 watersheds throughout Minnesota contributing to Lake Pepin. See map in appended research addendum.

Total Trust Fund Project Budget:		
	Trust Fund Appropriation	**$ 300,000**
	Minus Amount Spent:	**$ 300,000**
	Equal Balance:	**$ 0**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 5d

Appropriation Language:
$300,000 is from the trust fund to the Science Museum of Minnesota for the St. Croix watershed research station to conduct a comparative assessment of hydrologic changes in watersheds with and without intensive tile drainage to determine the effects of climate and tile drainage on river erosion. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. and III. FINAL PROJECT SUMMARY:

Agricultural rivers throughout Minnesota are impaired by excess sediment, a significant portion of which comes from non-field, near-channel sources, suggesting that rivers have become more erosive over time. In the upper Mississippi basin, crop conversions have lead to an intensification of artificial drainage, which is now a critical component of modern agriculture. Coincident with the expansion of drainage networks were increases in annual rainfall. To disentangle the effects of climate and land-use we compared changes in flow, runoff ratio, precipitation, crop conversions, and extent of drained depressional areas in 21 watersheds over the past 70 years. Major finding from this study are:

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- artificial drainage of depressional areas reduces water residence time on the landscape, consequently; a significant portion of annual rainfall that was once returned to the atmosphere via evapo-transpiration, is now routed to the rivers.
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- rivers with increased river flow have experienced channel widening of 10-40%.
- climate, crop conversion and artificial drainage have combined to create more erosive rivers, with drainage as the largest driver of this change.

IV. OUTLINE OF PROJECT RESULTS*:*

Introduction

Rivers in intensively row-cropped watersheds are often impaired by high sediment turbidity (Belmont *et al*., 2011; Engstrom *et al*., 2009; Schottler *et al*., 2010; Thoma *et al*., 2005), which degrades their habitat and recreational value and negatively impacts downstream surface waters. In the latter half of the 20th century, cropping patterns in the USA and especially the midwestern corn belt underwent major changes (USDA, 2011). One of the most dramatic shifts was the conversion of small grains and forage crops to soybeans (see Result 1 below). Over this same period both river flows and sediment loading from agricultural watersheds increased markedly (Engstrom *et al*., 2009; Lenhart *et al*., 2011; Novotny and Stefan, 2007; Raymond *et al*., 2008; Schilling *et al*., 2008; Zhang and Schilling, 2006). Although it is tempting to assume that conversion to row crops resulted in increased erosion from fields, several studies have shown large contributions from non-field, near-channel sources such as streambanks, bluffs, and ravines (Belmont *et al*., 2011; Schottler *et al*., 2010; Sekely *et al*., 2002; Thoma *et al*., 2005). This observation and the need to target effective management strategies raises the question, have rivers in agricultural watersheds become more erosive, and if so, why?

Understanding increases in river flows and non-field suspended sediment loads over the latter half of the 20th century is confounded by multiple possible causes. Higher flows have been related to increased precipitation (Johnson *et al*., 2009; Nangia *et al*., 2010; Novotny and Stefan, 2007) however, other critical factors are coincident and cannot be neglected. In particular, the 20th century crop conversions are relevant to watershed hydrology, not only because they can induce significant changes in seasonal evapotranspiration (ET) potential from the landscape (Schilling *et al*., 2008; Zhang and Schilling, 2006), but also because the conversion is often accompanied by an increase in artificial drainage(Blan *et al*., 2009; Schilling and Helmers, 2008; Sugg, 2007). However, the specific effects of artificial drainage as contributors to increased streamflow are not well known. Given the extent of past wetland drainage and current intensification of subsurface drainage (Blann *et al*., 2009; Sugg, 2007), artificial drainage networks in total have the potential to alter water budgets and river flows on a watershed scale and must be quantified before management strategies can be fully developed.

The central hypothesis examined in this study was: ***Has artificial drainage created more erosive rivers****?* In Result 1 of this study we estimate the current and historical extent of artificial drainage and changes in cropping patterns for 21 watersheds with long-term data sets of climate and flow. In Result 2 we quantify the changes in flow for these watersheds, and construct a water balance to apportion the change in flow due to changes in rainfall, crop conversion and increases in artificial drainage. Rivers in about half of the watersheds were found to have significant increases in flow. Artificial drainage was a major driver of this increase, exceeding the effects of precipitation and crop conversion. Rivers with altered hydrology were also shown to exhibit channel widening since the mid-20th century, supporting the hypothesis that agricultural land-use changes have created more erosive rivers.

RESULT 1: QUANTIFICATION OF TEMPORAL AND SPATIAL EXTENT OF ARTIFICIAL DRAINAGE

Result 1 was conducted by the Water Resources Center at Minnesota State University, Mankato. The principal investigator for this work was Richard Moore.

Deliverable	Completion Date
1. Estimation of present day artificial drainage.	July 2011
2. Historical trends of installation of artificial drainage	July 2012

Summary Budget Information for Result 1: **Trust Fund Budget:** **$ 150,000**
Amount Spent: **$ 150,000**
Balance: *$ 0*

Deliverable	Completion Date	Budget	Status
1. Estimation of present day artificial drainage.	July 2011	$ 75,000	100%
2. Historical trends of installation of drainage	July 2012	$ 75,000	100%

Final Report Summary

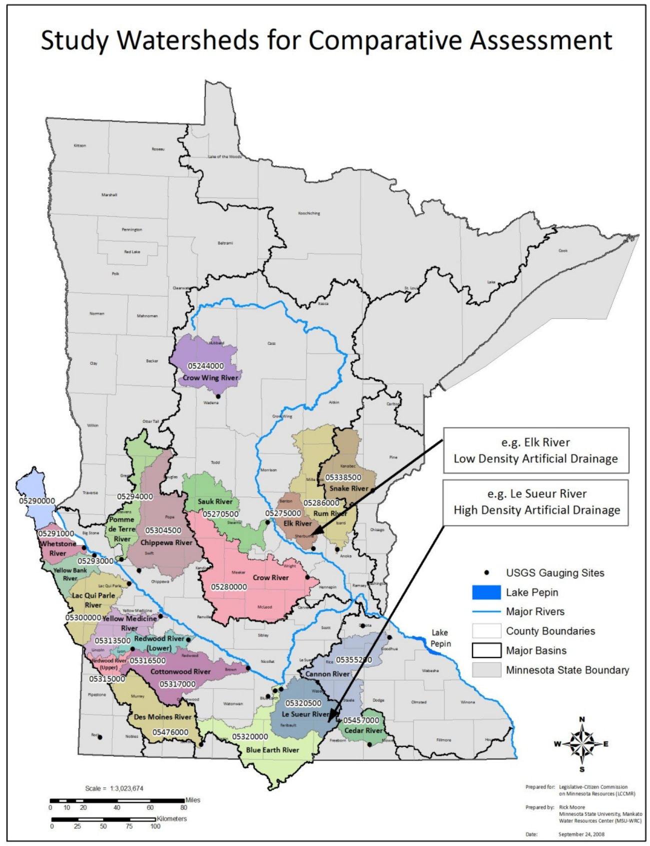
Artificial Drainage

Artificial drainage is any physical alteration to the landscape that changes the natural flow pattern and rate of removal of water. These hydrologic alternations are often done for the explicit purpose of improving agricultural productivity, but can have unintended consequences on river hydrology. Currently, most common purpose of artificial drainage is to remove excess water from the soil profile in order to enhance crop production. Subsurface drainage removes excess water from the soil profile, usually through a network of subsurface tile or pipes which eventually drain into surface drainage systems. The most common form of tile is corrugated plastic tubing. The plastic tubing is placed about 3 – 4 feet under the surface and have a general spacing of 40 – 80 feet between the tile lines. The water infiltrates through the soil until it reaches the tile and then is transported through the tile. This in essence lowers the water table to a level that is beneficial to plant growth. Surface drainage is the removal of water that collects on the land surface. Many fields have low spots or depression where water ponds, either seasonally or perennially. Surface drainage techniques such as constructing surface inlets to subsurface drains and the construction of shallow ditches or waterways can allow the water to leave the field rather than causing prolonged wet areas.

As shown in Figure 1, an artificial drainage system consists of many different components. The main component of this system is the drainage ditch, also called surface drainage. The drainage ditches were initially created to drain overland flow and connect low areas together so as to remove the water from the lowest areas of the land. Further up the system are tile mains. Tile mains are subsurface drainage that connect smaller areas of low depressions as well as act as conduits for pattern tiling. Pattern tiling is the tiling of fields in equally spaced rows of tile that are connected together by the main lines which eventually lead to the drainage ditch. Surface inlets are tile that is brought to the surface to improve the drainage of low areas that hold water for an extended period of time. The direct connection to the surface by these tiles removes the water quickly but also can act as an efficient conduit for sediment and nutrients through the system. In combination, the various forms of artificial drainage not only remove surplus water from the soil profile, but also allow for drain surface water from wetland and shallow depressional areas. Before artificial drainage, these depressional areas could have held water in them for a short period of time (ephemeral ponds) or perennially (wetlands) depending on the soil type and geomorphology of the depression. Under natural conditions water would leave these depressions through a combination of infiltration and evapotranspiration (ET). A significant portion of infiltrated water would have been routed to the river as shallow groundwater, while ET would have returned the water to the atmosphere and remove it from the watershed. After drainage has been introduced, a greater proportion of the water is removed quickly and routed to the rivers. The cumulative result of drainage is the increased connectivity between storage areas (wetlands/depressions) and natural flow paths (streams/rivers). This reduces water residence time on the landscape (i.e. quickly dries a field for planting) and increases the watershed area that directly contributes to river flow.

Figure 1. Aerial photography from the Beauford sub-watershed (Blue Earth River watershed) showing different components of an artificial drainage system and the density of installation.

In the comparative assessment of our study watersheds, we analyzed data that could help us identify the amount of each of these artificial drainage features in the 21 watersheds. Some of the data can be readily mapped or may have existing datasets that could be analyzed, however some of these features are sub-surface and cannot be easily seen through aerial photographs. Through multiple methods, we have attempted to estimate the extent of the different forms of artificial drainage and their importance relative to changes in long-term water budgets.



Study Watersheds

The 21 watersheds in our study occur throughout Minnesota as well as a small part of Iowa and South Dakota as shown in Figure 2. For the most part, watersheds are located in the southern half of Minnesota with Crow Wing Watershed being the furthest north. All the watersheds ultimately flow into the Mississippi. Landuse in the most of the watersheds is dominated by row crops, mainly corn and soybeans. The amount of land in row crops varies across the 21 watersheds with the Snake River watershed having only 4.2% and the Blue Earth River Watershed having the most at 82.5% based on the Crop Data Layer from the National Agricultural Statistics Service (NASS). The dominant soil materials of the different watersheds range from mainly silty glacial sediments in the southern two-thirds of our study area along with some sand and gravel textures along the riverine systems. Near the Blue Earth and Le Sueur River watersheds, they have a dominant soil material of clay and silt. In the northern watersheds such as Crow Wing, Elk, Snake and Rum, their dominant soil material is a combination of sandy glacial sediments varying from sandy loam to gravel. There has been a large change in cropping patterns across the basin mainly from corn and small grain crops in the 1940 to mainly corn and soybeans in 2010.

Figure 2. Map depicting the 21 study watersheds.

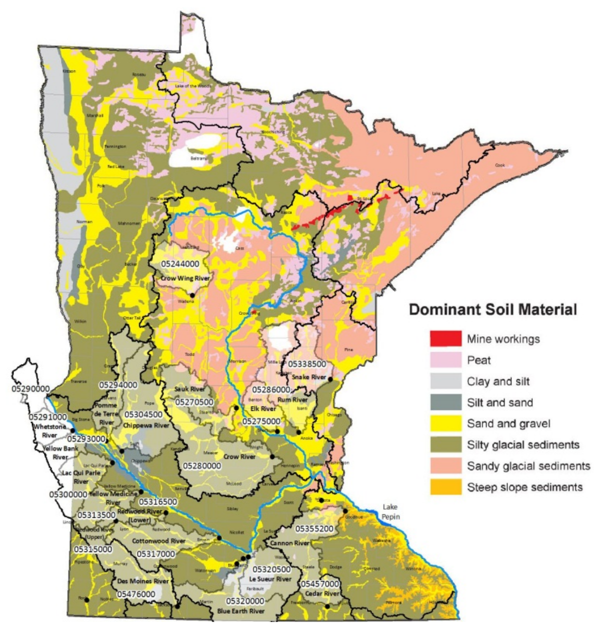


Figure 3. Dominant soil material in Minnesota and the study watersheds.

Result 1: Deliverable 1.

ESTIMATION OF PRESENT DAY ARTIFICAL DRAINAGE

Note: The original workplan included 23 watersheds for assessment. After reviewing available data for all watersheds, it was determined that the flow records in two watersheds had more than 15 years of missing data, and could not be reliably used.

1.1.1 POORLY DRAINED SOILS AND POTENTIAL FOR DRAINAGE.

The potential for drainage is a difficult feature to map. Surface drainage is easily seen through aerial photography, however, subsurface drainage is below ground and not easily mapped through aerial photography. A surrogate for mapping drainage or the potential for drainage is through the analysis of soil types. Soil types classified by the Soil Survey Geographic database (SSURGO) as poorly drained are soils that would benefit from tile drainage. Using the SSURGO soils database for each county in our study area, we can query certain attributes that reflect this description of poorly drained soils. Numerous soil properties and interpretations within this database can be used to indicate the need for drainage. Examples include the land capability class modifier “water”, soil drainage class information such as poorly drained, and the hydrologic class modifier “D”. Across the 21 watersheds, soil types vary considerably yielding different amounts of areas that would benefit from artificial drainage—thus providing a surrogate to compare differences in expected drainage density between the 21 watersheds.

Methods

The extent and distribution of poorly drained soils were determined using the SSURGO database. Seven classes of natural soil drainage are recognized in SSURGO: excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. We extracted the poorly drained and very poorly drained classes to reflect the soils that would benefit from artificial drainage. The polygon input layers were clipped to the 21 watersheds using GIS software and converted to raster format at a 56-m^2 pixel size. A 56-m^2 resolution was selected for identification because of the size of the study area in this project as well as for consistency with the resolution of the NASS crop data layer. Current cultivated land and crop type were determined from data compiled by the National Agricultural Statistics Service (NASS), which used a 2008 Landsat satellite image with 56-m^2 resolution. The NASS produces a GIS raster layer called the Cropland Data Layer (CDL) going back multiple years for the states in our study area. The CDL can be considered a “Census by Satellite”, as it is a comprehensive land-use classification covering an entire state and uses ortho-rectified imagery to accurately locate and identify field crops. We then computed the area of poorly drained soils by multiplying the cell count by 56 m^2. The representative slope from the SSURGO data was also used to stratify the data; taking into account that subsurface drainage occurs on lands with minimal slopes. The areas of cultivated crops were intersected with the poorly drained soils (see section 1.1.6) and then combined with the slopes layer to yield a final product predicting those areas that should have sub-surface artificial drainage.

Findings

The percentage of area for each watershed meeting the soil and land cover criteria are summarized in Figure 4. While there are no absolute criteria to compare these estimates against, work done by Jayne and James (2008) in “The Extent of Farm Drainage in the United States” show a correlation by area that matches our analysis. The majority of the soils that would benefit from drainage occur in the watersheds in the Minnesota River Basin. The Blue Earth, Le Sueur, and Cottonwood watersheds show the greatest need for drainage based on soil types, while the watersheds in the northern part of the study, Crow Wing, Snake, Elk and Rum, have better drained soils. Physiographically, the area in southern Minnesota lies within the northern portion of the western young drifts section of the central lowland province. The final phase of the "Wisconsin glaciation" covered much of southern Minnesota and northern Iowa. The ice lobe which extended as far south as Des Moines, Iowa is known as the Mankato Lobe. Characteristic features of the landscape within the Mankato Lobe are large areas of level plain of outwash, lacustrine and drift origin, interspersed with low, indistinct recessional moraines, which often impart a gently rolling appearance to the landscape.

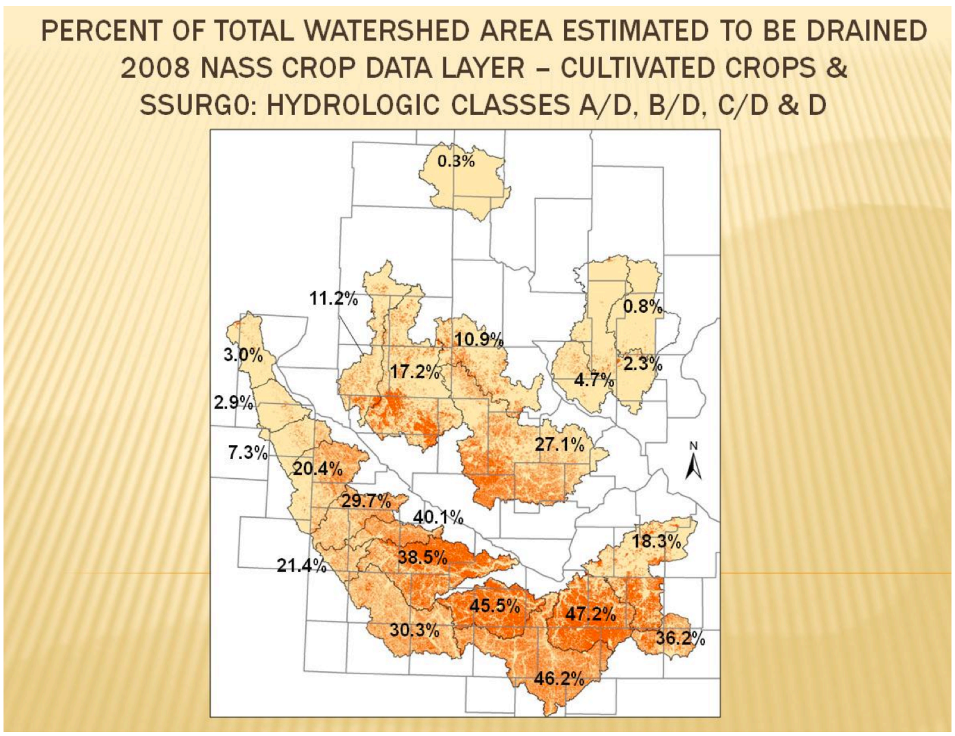


Figure 4. Estimation of drainage in each watershed based on soil types and land use. Both the National Land Cover Dataset (NLCD) and the Crop Data Layer from NASS were used for land use. The SSURGO soils database was used for the soil analysis.

In these watersheds, the level nature of the topography and heavy textured soils have caused a lack of natural drainage which is reflected by numerous shallow lakes, marshes, meadowland and wet prairie areas. Under such conditions, native vegetation ranged from mesic and wet prairie interspersed with cattail/sedge wetlands. This vegetation and soil types contributed to the development of the poorly drained Webster series of prairie soils which cover much of the central and southern portions of the Mankato Lobe. The higher upland areas of the Minnesota River Basin tend to have a more rolling landscape and a greater relief change. In the southwestern portion of the Minnesota River Basin, the prairie coteau has a relief change from the uplands to the Minnesota River of 1000 feet in some areas.

The areas adjacent to the Minnesota River and the low flat landscape of the southern part of the Minnesota River basin, combined with the soil types in this area, make this a prime area in need of drainage to accommodate farming of the land. Our estimates predict that one-third to one-half of all cultivated land in these watershed has been modified with tile drainage. In contrast, the western watersheds which are drier, and the northern study watersheds which have better natural drainage are estimated to have generally less than 10% of the cultivated lands modified by tile drainage.

1.1.2 SURVEY OF SURFACE INLETS

Surface water inlets, or vertical drains, are used to allow ponded water to flow directly into the sub-surface tile networks without seeping through the soil. For this reason, they are of great value in poorly drained depressions where water collects and would drown the plants if not removed. Surface inlets work much like a bath-tub drain to quickly remove surface ponded water. Examples of surface inlets are shown in Figure 5. They are seldom necessary in well drained soils or sloping lands with natural outlets. An inventory of surface risers was completed for all 21 watersheds in June of 2011. The survey quantified the density of surface risers in 40 locations throughout each of the watersheds and used this to predict the total number and density of surface inlets for the watersheds. This inventory provides an indication of the amount of tiling in an area and ability of that watershed to quickly route water to the rivers.

Methods

The inventory consisted of 40 random point locations within the cultivated areas of the watersheds. The strategy for efficiently completing the inventory utilized the public road network. Road segments consisting of a one mile straight stretch of road were selected from the larger datasets. Each road segment was then converted to its center point by doing a polyline to point transformation. One mile straight road segments were chosen to allow the selection of risers within a one mile stretch and be able to compare similar stretches throughout each watershed. The second dataset used in the inventory was the 2008 NASS Crop Data Layer. The raster image for the 21 watersheds was converted to a vector shapefile and all areas/fields that contained cultivated crops were selected. The areas of these polygons were then calculated. A selection of cultivated polygons that were within 100 feet of the road segment point and

Figure 5. Examples of surface risers observed in the survey

had an area of 160 acres were selected. Of the remaining road segments, each segment was given a random number through a random number generator. The first forty points from the lowest random number to the highest were selected. A layer of 40 points was created for each watershed and network analysis created a route for the points to be surveyed.

The field inventory occurred over two seasons from early May until middle June in 2010 and 2011. When conducting the survey, the surveyors drove from one end of the line segment to the other and recorded the location of the surface risers. Both sides of the roads and at a distance of ¼ mile from the road segment were surveyed. The point locations of the risers were mapped using ESRI ArcPad and given a location on the map. The type of riser was also included in the attributes such as Higgenbottom, flag, rock inlet, etc.

Findings

The number of risers is highest in the Chippewa, Crow, Cottonwood, and Redwood watersheds. Not surprisingly, fewer risers are seen in the naturally well-drained watersheds of Snake, Crow Wing, Elk, Rum and the upper watersheds of the Minnesota River Basin (Figure 6). However, the poorly drained, but flat watersheds in the middle Minnesota basin (Blue Earth, LeSueur, Cottonwood, Cedar) also had fewer surface inlets. The amount of small, shallow closed basins in a rolling landscape (e.g. Crow) versus a flat landscape (Cedar) is a likely reason for the differences in surface inlet density. We compared the distribution of elevation differences measured for our point locations to the total number of surface risers occurring in a one mile by one mile square area. The analysis (Figure 7) shows a correlation between the range in elevations and the number of surface risers occurring. There are very few risers in areas with relatively uniform elevation (net difference in elevation = 0 to 20 meters, i.e. flat areas), and many more risers where elevations vary by 20 to 45 meters (rolling terrain). In agricultural watersheds that have a flat landscape, the use of pattern tiling may help drain a field better than having a surface inlet within the field. In a rolling landscape, deep, concentrated low areas may need to be connected by tile and the surface risers can drain the water from these depressions in a quicker manner than pattern tiling.

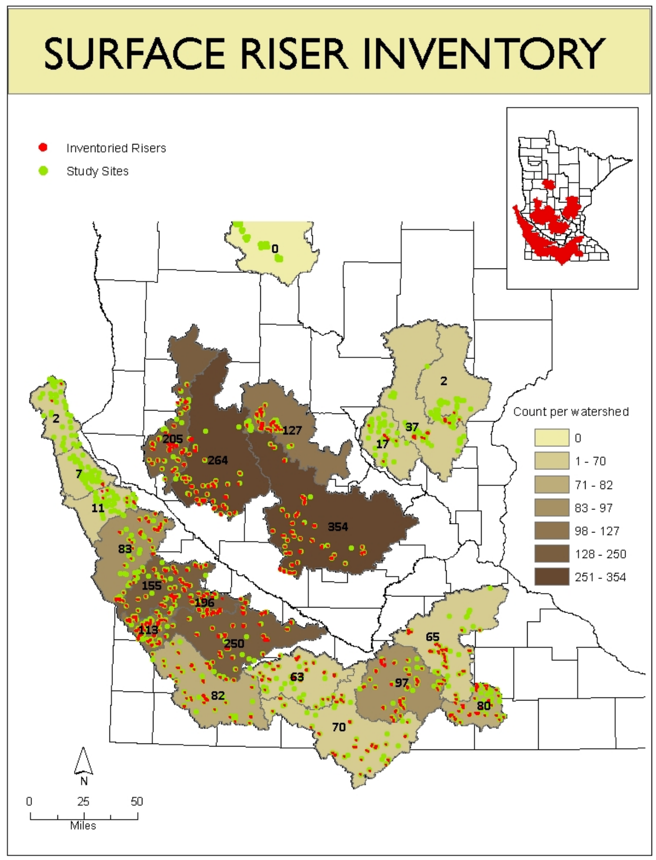


Figure 6. Map of the surface riser locations and density in each of the watersheds.

Also pattern tiling may not work in these rolling landscapes depending on the amount of relief and the slope characteristics.

1.1.3 Drainage Ditch Density and Length

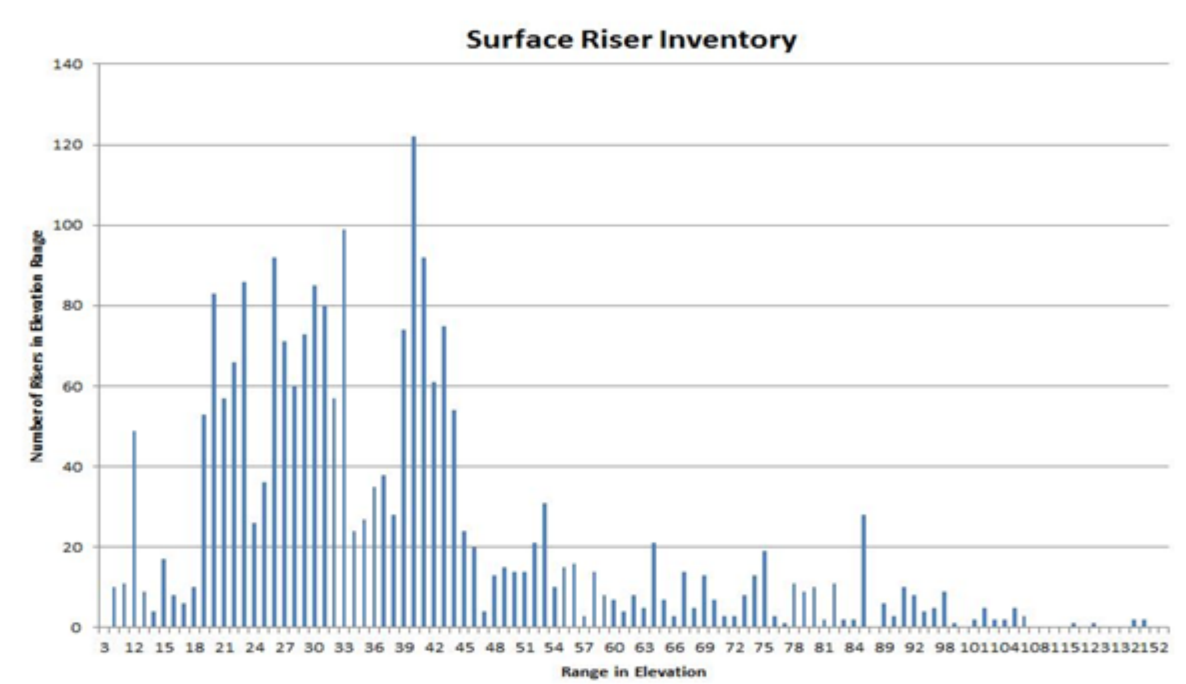


Figure 7. This chart shows ranges in elevation for points surveyed and the number of points that fall within those elevation ranges.

Drainage ditches are open trenches and serve as the main arteries to convey water in a drainage network. Typically, shallow ditches draining individual fields flow into deeper collection ditches that ultimately discharge into streams and other surface waters. Water enters both shallow and deeper ditches via surface and subsurface pathways. In areas with high water tables, drainage ditches effectively lower the water table to allow farm machinery to operate at critical times, such as planting. Drainage ditches act as direct conduits between agricultural fields and surface waters. In determining drainage ditch density, no pre-existing dataset that encompasses the broad region of our study area was available. The most detailed information for each watershed comes from the counties that fall within those watersheds as

Figure 8. Example drainage ditch in the Minnesota River Basin during harvest time.

well as any watershed districts that work within those watersheds. Availability of data varies between counties, with some counties in the forefront having their ditch systems digitized and attributed in detail. Other counties still may be using paper maps but that is slowly changing. Other ditch inventories have been conducted at larger scales such as the 13 county ditch dataset created by the Water Resources Center at Minnesota State University. The information comes from data retrieved from the counties in the early 1990's. This dataset only contains the ditch systems and not the natural systems. Also, the extent of the 13 county layer would cover only about 5 or 6 of the watersheds in our study.

The National Hydrography Dataset (NHD) is a vector dataset used by GIS systems. The NHD contains features such as lakes, ponds, streams, rivers, canals, dams and stream gages. These data are designed to be used in general mapping and in the analysis of surface water systems. NHD flowlines are important features in the NHD because they contain flow direction and form a network. We used the NHD for our analysis of drainage ditch density and length.

Methods

The NHD flowline dataset attributes a line feature as either a river/stream or main channel. This is the most basic attribute and is the basis for the natural hydrology flow path. Also contained in the attributes of the database is a connector definition. A connector is a flow path through a lake or large waterbody that connects back to rivers, streams or ditches. In order to do flow analysis with this dataset, the flow of water through a lake needs to have that connection. The final attribute that shows up in our study area is the canal/ditch. A canal/ditch is a flow path that has been altered to convey water across the landscape. The canal/ditch flowline is our delineation for altered hydrology.

The NHD is a living database, meaning new data is always being added to it or information is being updated. This is noted because five of our watersheds did not contain any attributes defining flow paths as ditches or canals, even though past research shows that these watersheds do contain ditch systems. Information from the Chippewa, Pomme de Terre, Little Minnesota, Whetstone, and Yellow Bank watersheds has not been integrated into the database and were removed from the analysis.

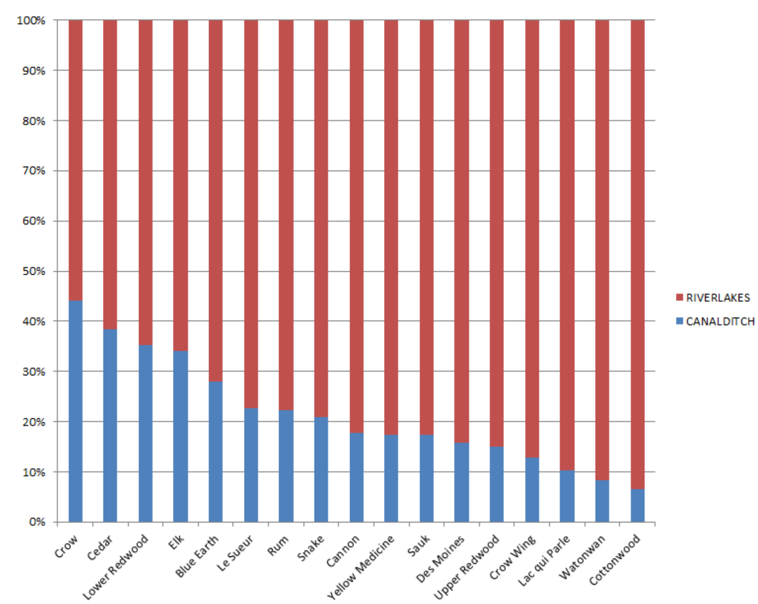


Figure 9. Percentage of the total surface flow paths that are altered (ditch/canal) and unaltered (river/lake) in each watershed. Blue bars are altered flow paths (ditches) and red bars are natural flow paths.

To determine the

amount of natural versus altered hydrology contained in each watershed, we combined all NHD layers for different basins into one larger database that was then clipped to our 16 watersheds. The lengths of the streams/rivers, the connectors, and the main channel/artificial path were calculated and the resulting values were combined for their watershed and displayed in Figure 9.

In order to compare the amount of natural hydrology systems to altered hydrology systems, we needed to analyze them at a smaller scale within each watershed. Using the Watershed Hydrography Dataset from the Minnesota Department of Natural Resources, we intersected the National Hydrography Dataset layer with it. This assigned a watershed code to each stretch in the NHD dataset. We then recalculated the length of each stretch so that the line segments had the correct length assigned to it. The next step was to analyze the amount of the natural systems and altered systems in each smaller watershed, and then join those values back to the MNDNR Watershed Hydrography Dataset. This information could then be mapped to show the percentage of altered versus natural networks in each of the watersheds. The information was then mapped as shown in Figure 10.

Findings

Figures 9 and 10 show total percentages and distribution of natural hydrology compared to altered hydrology for each watershed. The findings from this analysis show that the Crow River watershed has the highest percentage of flow systems devoted to ditches or altered hydology. Watersheds such as the Blue Earth and Le Sueur are near the top of the grouping of watersheds but their percentages fall between 20% and 30%. If we take topography into account as we look at Figure 9, watersheds with a high elevation change in their upper reaches, such as the Lac qui Parle and Yellow Medicine, have fewer ditches (alter flow paths) because the high relief creates natural channels for water to flow off the landscape.

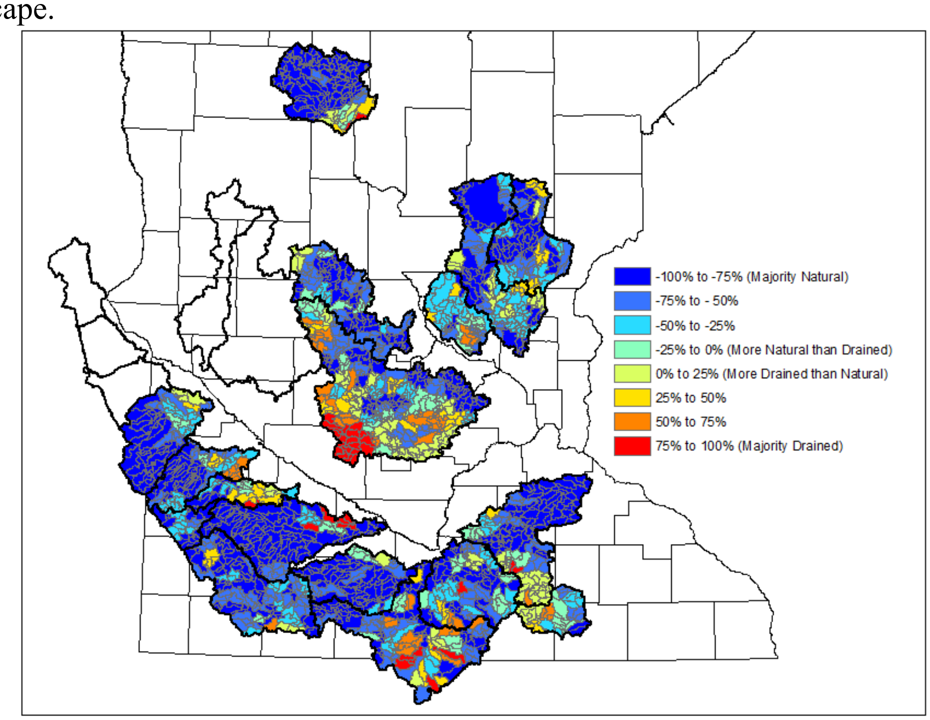


Figure 10 – Distribution of natural versus altered surface hydrology in watersheds with available data from the MN DNR Hydrology Dataset**.**

Flat watersheds need ditch systems to move water across their landscape. This effect can be seen in Figure 10 where the greatest density of artificial drainage occurs in the flatter regions of the watersheds, such as the lower reaches of the western Minnesota River basin watersheds or the upper reaches of the Blue Earth and Le Sueur watersheds. Natural or unaltered systems tend to dominate in areas that have a higher elevation difference, such as the prairie coteau of the the western Minnesota River Basin or the lower reaches of the Cannon River near the Mississippi River. Many altered systems connect directly to natural systems over short distances and this may not be reflected in Figure 10. Overall this analysis provides a comparative assessment of the watersheds and an estimate of how much altered hydrology exists in each of the watersheds.

1.1.4 Drained Depressional Areas

Wetlands are typically defined by the presence of saturated soils and vegetation which is specifically suited to wet conditions. Wetlands typically occur in topographical low areas where rainwater collects or where groundwater reaches the surface. Depressional areas and prairie potholes are the result of glacier activity. The decaying ice sheet left behind depressions formed by the uneven deposition of till in ground moraines. These depressions can fill with water, creating seasonal wetlands. Depressional areas and wetlands, historically, drained either by infiltration or by evapotranspiration. Wetlands, prairie potholes and seasonally inundated depressions were common features on the natural landscape in our 21 study watersheds (Figure 11). These were often described as wet-prairie in the original land surveyor notes from the mid 1800's, and comprised a significant portion of the pre-European land classification.

Figure 11. Aerial photograph of the prairie pothole region of the Minnesota River Basin.

In order to quantify how many wetlands or depressional areas with ponded water were originally on the landscape we used the Restorable Wetlands Inventory (RWI). This inventory covered most of our study area and was beneficial to the discussion of water residence time and water storage capability discussed in Result 2. The RWI along with the National Wetlands Inventory (NWI) allow us to show the landscape as it may have originally looked prior to settlement. Using this dataset, we can make comparisons between the different watersheds and how much loss of depressional areas has occurred.

Methods

Depressional areas were calculated based on the data from the Minnesota Restorable Wetlands Inventory (RWI) created by the Restorable Wetlands Working Group (USFWS 2011), as well as data from the National Wetlands Inventory (USFWSb, 2011) (Figure 12). These inventories used National Aerial Photography Program (1:40,000 scale) color infrared photographs viewed in stereo pairs at 5X magnification to delineate and digitize existing and drained depressional areas. Drained depressional wetlands were delineated on mylar and then digitized to a polygon shapefile dataset. The RWI consulted collateral data during the delineation process to validate the results. These data consisted of published county soil-

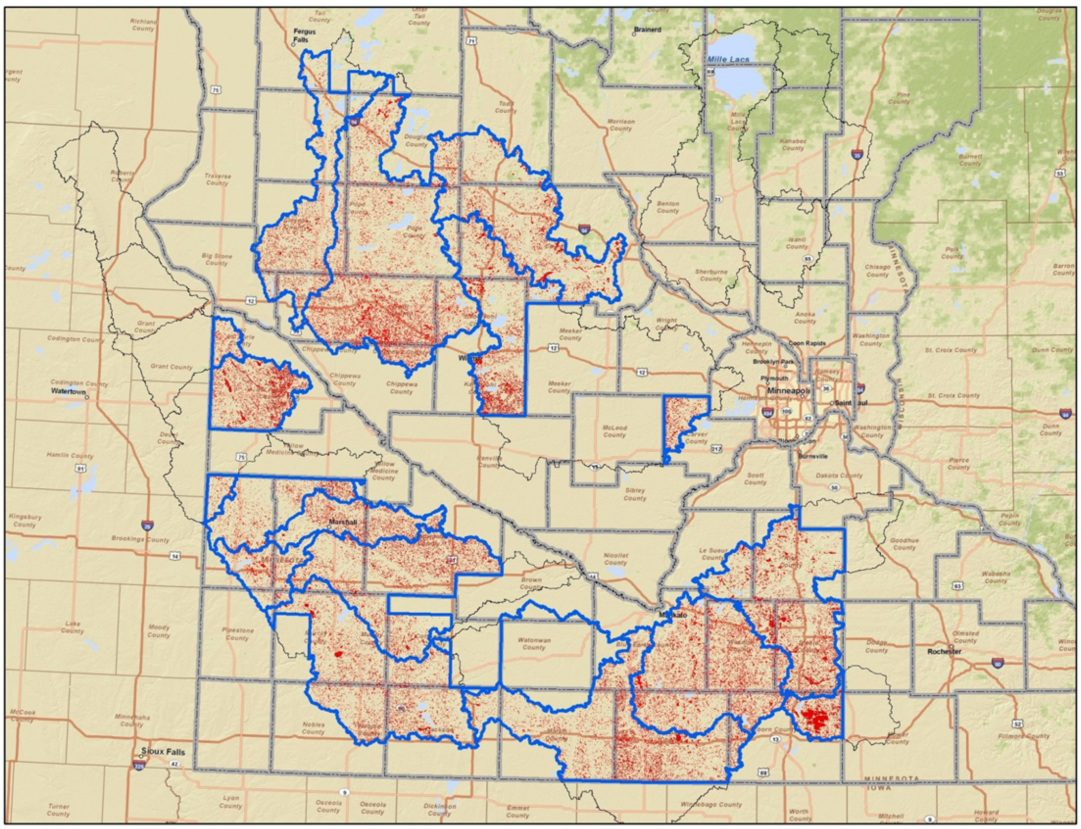


Figure 12. Restorable Wetlands Inventory – The red polygons show the areas of restorable wetlands in our study watersheds per the restorable wetlands inventory where data is available.

surveys and descriptions of hydric soils, USDA Farm Service Agency compliance slides (aerial 35 mm slides) acquired in 1993 (immediately after a period of intense precipitation), USGS 7.5 min topographic maps, and National Wetlands Inventory (NWI) maps.

The data were downloaded from the Ducks Unlimited website (USFWSa 2011), reviewed and found to contain duplicate data within certain files for some counties. Staff at the Water Resources Center at MSU-Mankato manually removed the duplicate polygons to create a clean dataset. The county data were then clipped to each watershed in the study area and then each partial county was aggregated into the corresponding watershed (Figure 13).

The RWI data and analysis of drained depressional areas only encompassed about 60% of the total area in our 21 watersheds. To estimate the total loss of depressional area for an entire watershed, we calibrated the relationship between drained depressional areas and poorly drained cultivated soils in the watersheds with RWI data to predict the amount of drained depressional areas in watersheds without RWI data (Figure 14).

The extent and distribution of poorly drained soils were determined using the Soil Survey Geographic (SSURGO) database (see Result 1.1.1) We extracted the poorly drained and very poorly drained classes, which reflect the soils that would benefit from artificial drainage, and intersected these with cultivated lands to determine the amount of poorly-drained, cultivated soils in each watershed. The county data were then clipped to each

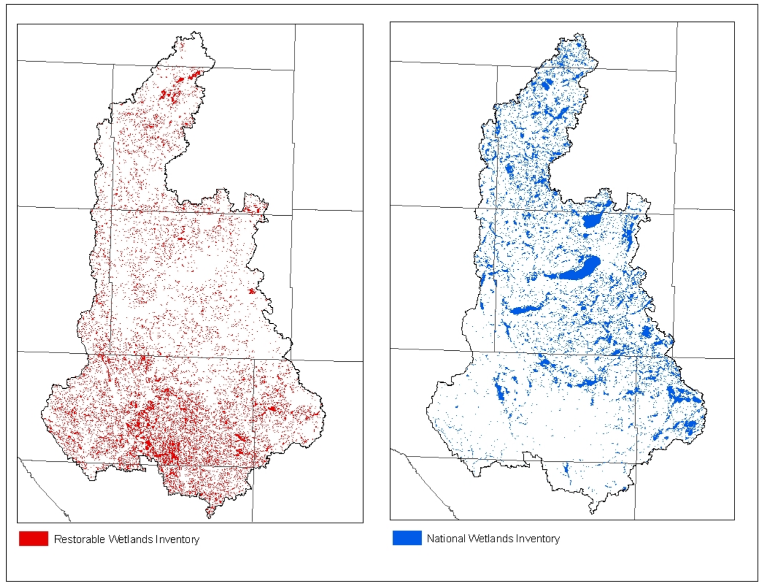


Figure 13. Restorable Wetlands Inventory and National Wetlands Inventory for Chippewa River Watershed

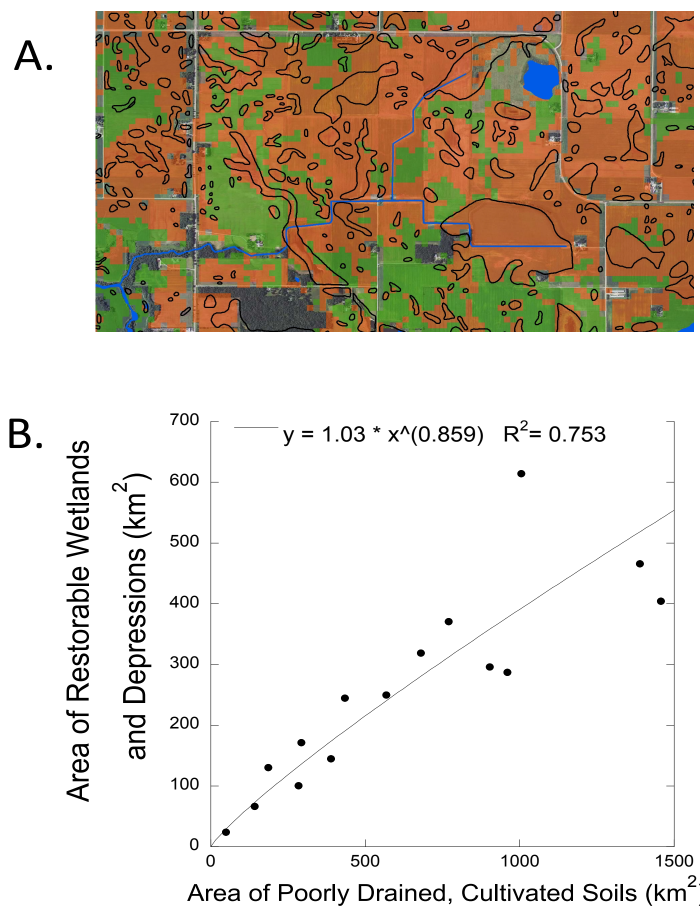


Figure 14. (A)Example of RWI data showing drained depressional areas, soil type and cultivated lands. (B) Predictive relationship between drained depressions and poorly drained cultivated soils

watershed in the study area and then each partial county was aggregated into the corresponding watershed and the area of poorly drained, cultivated soil was regressed against the amount of drained depressions as determined from the RWI. This regression (r^2= 0.75) and the total amount of poorly drained cultivated soils in each watershed was used to estimate the total depressional area lost in each of the 21 watersheds (Figure 14).

Findings

Our estimates for the loss of depressional areas using the Restorable Wetlands Inventory dataset show that watersheds with poorly drained soils and a high percentage of cultivated land have high losses of depressional areas. In these watersheds nearly all of the natural wetlands and depressional areas have been altered by drainage, representing a

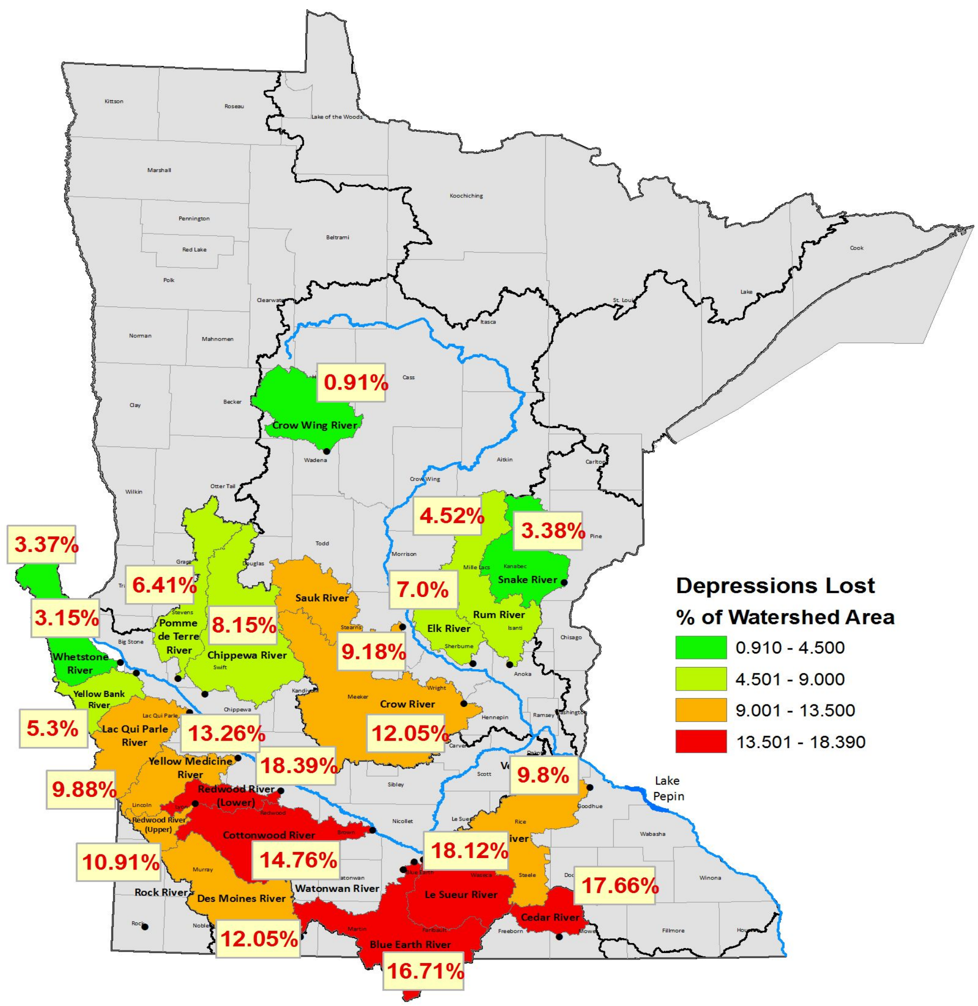


Figure 15. Drained depressional area as a percentage of total watershed area.

profound hydrological modification of up to 20% of the total watershed area (Figure 15).

The loss of these depressional areas translates into a reduced water residence time of ponded water and thus a reduction in ET with less water routed back to the atmosphere—and presumably more water routed to rivers. These depressions range from former wetlands with significant residence times to extensive ephemeral ponded water in fields. In all cases artificial drainage reduces the amount of time that water is on the landscape that can be lost to ET. In watersheds where drained depressional areas represent 10 to18% of the total watershed area this represents a major alteration to the hydrologic cycle.

The RWI inventories offer a good starting point for assessing changes to ET and the routing of water through a watershed. In result 2 below, the loss of depressional areas provides a quantitative way to compare hydrologic changes among watersheds and offers an important mechanistic correlation to changes in water budgets. However, these inventories do not give detailed temporal trends that can be compared to long term flow records and are an incomplete surrogate for estimating changes in ET. The RWI and NWI inventories likely do not capture very shallow depressions with short residences times. This type of ponded water continues to be drained with intensive, close-spaced pattern tiling. It is possible that the pattern tiling under small but extensive depressions is continuing to reduce water residence time on the landscape, and that this form of artificial drainage remains an important alteration to the water budget and stream flow.

1.1.5 Changes in Cropping Patterns

Quantifying changes in cropping patterns was not an initial objective of this study, but given the potential effect of crop conversions on water budgets and ultimately river flow, it was added to the study. The role of crop conversions as a driver of changes to river flow is discussed in Result 2 below. An analysis of annual crop acreage from 1940 to 2009 was completed using the NASS historical data of crop production for all counties in the study watersheds. The National Agricultural Statistics Service (USDA, 2010) has a database of crops grown by county from roughly 1920 until the present. This type of data is valuable because it not only gives us a historical account of how land cover has changed and the temporal relationship to trends in river flow, but can also be used to estimate changes in crop evapotranspiration (see result 2)

Methods

An analysis of crops harvested annually since the 1920's was completed using the National Agricultural Statistics Service (USDA 2010) with data of crop production for Minnesota, South Dakota and Iowa downloaded from their Quick Stats site. County data was intersected with the 21 watershed and aggregated to calculate the acres harvested of each crop type for the give watershed. Acreages of corn, soybeans, small grains, hay, alfalfa, pasture, and non-crop land were determined for each year. Median acreages for the two 35-year time periods (1940-1974 and 1975-2009) were used to assess and compare crop conversion in the different watersheds watersheds.

Findings

The cropping patterns analysis yields an interesting and important picture of the evolution of cropping patterns within our study area and is representative of the Midwest as a whole. In the heavily agriculture area of the Minnesota River Basin, soybeans only started to be grown in the 1940's and their importance as crop increased steadily for the next 70 years. In many of the watersheds, soybeans now constitute nearly half of the row-cropped acreage, with corn comprising the remainder. This increase in soybeans is mirrored by a decrease in acreage of small grains and hay. Interestingly over the 90-year time span of NASS crop records, the total acreage in row-crop does not change much, and there were nearly as many acres of corn planted in 1940 as there was in 2009. A few watersheds, such as the Blue Earth and Le Sueur showed minor increases (less than 10%) in the total amount of land used for row-crops, principally from an increase in corn acreage. The conversion from a diverse set of row-

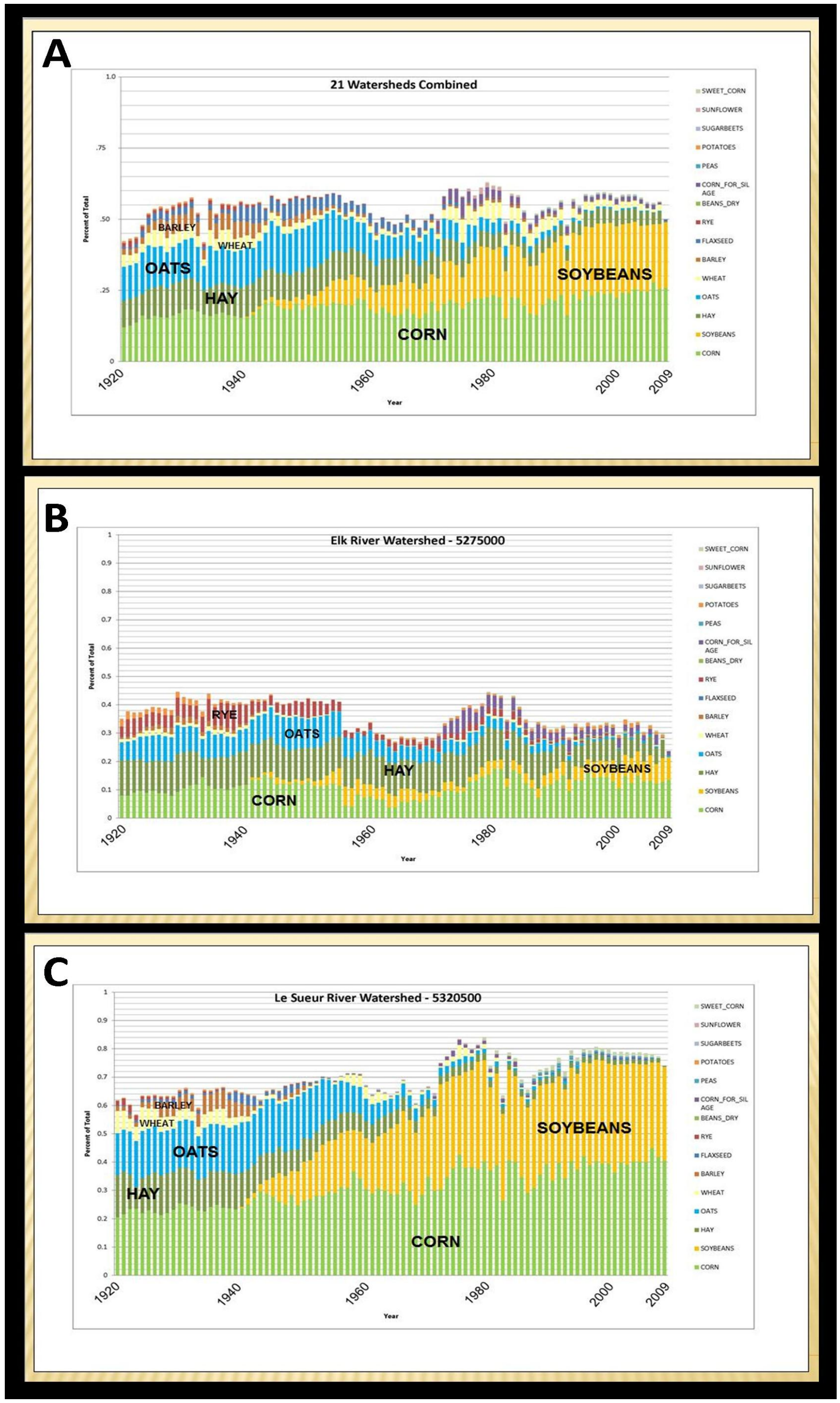


Figure 16. Changes in cropping patterns from 1920 to 2009. Percent of harvested acres of each crop for (A) all watersheds, (B) Elk River watershed and (C) Le Sueur River.

crops to a soybean and corn monoculture is most pronounced in the Minnesota River Basin in the watersheds of Le Sueur, Blue Earth, Cedar, Cottonwood, and Redwood. The smallest changes in increase or the amount of land in corn/soybean production occur in the watersheds in the northern part of our study.

Table 1. Change in cropping patterns for the 21 study watersheds. "Ag" is the percentage of the total watershed that is cultivated for any crop. Percentages are the fraction of the total watershed used for a particular crop. Values represent the mean for a 35 year time period. The increase in soybeans is simply the difference between the two periods. The increase in soybeans is mirrored by a decrease in hay and small grains. In most watersheds, the total amount of land in cultivation and the percentage used for corn changes by less than 10% over the 70 year record.

	% of Watershed Area 1940 - 1974				% of Watershed Area 1975 - 2009					
Watershed	**Ag**	**Soy**	**Corn**	**Hay, , Small Grains**	**Ag**	**Soy**	**Corn**	**Hay, Small Grains**	**Increase in Soy: percent of total watershed**	**Decrease in Hay, Small Grains**
Blue Earth	68%	18%	34%	16%	82%	37%	42%	3%	19%	-12%
Cannon	57%	8%	22%	27%	62%	21%	31%	10%	13%	-17%
Cedar	66%	14%	27%	25%	77%	31%	38%	8%	17%	-17%
Chippewa	57%	7%	17%	34%	57%	18%	23%	17%	12%	-17%
Cottonwood	72%	14%	31%	27%	79%	35%	36%	7%	21%	-19%
Crow	56%	7%	20%	29%	59%	19%	26%	14%	12%	-15%
Crow Wing	16%	0%	2%	13%	15%	2%	3%	11%	2%	-2%
Des Moines	72%	12%	33%	27%	78%	35%	37%	5%	23%	-21%
Elk	36%	3%	10%	23%	35%	5%	16%	13%	2%	-9%
Lac qui Parle	65%	7%	22%	36%	63%	24%	24%	15%	16%	-21%
Le Sueur	68%	17%	29%	21%	77%	33%	39%	5%	16%	-16%
Little Minnesota	55%	2%	10%	44%	46%	13%	11%	22%	11%	-22%
Lower Redwood	72%	11%	32%	29%	78%	34%	36%	8%	23%	-21%
Pomme de Terre	60%	5%	16%	39%	64%	20%	21%	22%	15%	-16%
Rum	20%	1%	5%	14%	20%	3%	8%	9%	2%	-5%
Sauk	46%	1%	12%	33%	47%	6%	20%	21%	5%	-12%
Snake	14%	0%	3%	12%	15%	1%	4%	10%	1%	-2%
Upper Redwood	68%	5%	28%	36%	68%	25%	30%	12%	20%	-23%
Whetstone	57%	2%	11%	44%	49%	15%	13%	21%	13%	-23%
Yellow Bank	59%	3%	14%	42%	53%	17%	17%	19%	14%	-24%
Yellow Medicine	69%	7%	28%	34%	71%	28%	31%	12%	20%	-22%

1.1.6 Estimation of Tile Density from Aerial Photography and Landowner Survey

Quantifying the amount and distribution of subsurface tile networks is difficult. Records for tile currently being installed are limited and even less is documented for tile networks installed in earlier decades. Until recently, maps of tile lines may have not been created or saved after the installation of the tile lines. Many of the maps currently being produced are submitted to the permitting agency and privacy issues do not allow the data to be viewed by the public. Methods used to map tile lines are through aerial photography or landowner surveys of their property. Both of these techniques have limitations.

Landowner surveys can be beneficial if the land owner has kept good records of their installation of tile and have mapped the tile at time of installation. However, many landowners have not kept good records of the installation, usually relying on their memory of the installation. Another problem with landowner surveys is the participation rate of the landowners within a watershed to share their information on the location of their tile lines. Participation rates can affect any type of analysis if data is missing for parts of the watershed.

An alternative method for mapping tile lines is through aerial photography (see figure 17 for example). The resolution of aerial photography allows us to pick out the details of a feature that could only encompass a couple of meters wide. As the tiling removes the moisture from the ground, the soil above the tile dries at a quicker rate than the soil between the tile lines, making the tile patterns visible. This type of regular aerial photography has its limitation in that the identification of tile lines is by visual examination of the photo and requires the correct season and soil conditions to make the networks visible. Different sensors can be integrated into the aerial imagery such as color infrared or thermal imaging, but these additional sensors increase the cost of the imagery and are not always done. Freely available imagery from the USDA Farm Service Agency (FSA) does contain color infrared layers but the imagery is usually acquired in the summer months. The resulting imagery does not produce the necessary signature due to the vegetation cover. Spring leaf off imagery can produce the signature but the timing needs to done at the right time when the soils are drying at different rates due to the presence of tiling underneath the ground.

Methods

At the beginning of this project, the Blue Earth County LiDAR aerial photography was known to show tile lines for a majority of the county. The LiDAR was flown in early April of 2005 at the time that the soils were warming up and the moisture in the soil was starting to flow through the tile lines. Research from previous studies on locating tile lines has shown that flying aerial photography 2–3 days after a one inch rainfall can produce effects similar to Blue Earthy County aerial photography (Naz and Bowling, 2008). The digitizing of the Blue Earth County tile lines was completed in December 2010 by visually identifying the tile lines from the aerial photo and creating line features in a GIS shapefile. At that point, we were trying to determine the amount of tile and the length of the tile that we could identify using this aerial photography (Figure 17).

A subset of the data from Blue Earth County was used to analyze the relationship between the soil type (i.e. poorly drain and well drained, See Section 1.1.1) to the total length of sub-surface tile. Using 19 sub-basins within the Le Sueur watershed (Figure 18), we delineated the areas of poorly drained and well drained cultivated land and then, using the aerial photography, estimated the length of sub-surface tile in each of the watersheds (see

Figure 17 for example). This provides a current estimate of sub-surface tile density (total length per acre) for poorly drained and well drained cultivated lands in the watershed.

In a separate project, the Minnesota River Assessment Project (MRAP) surveyed 32 small watersheds (< 25 mi^2) back in 1991 for the extent of tile in those watersheds. This data was recorded through aerial photographs and surveys. In 2010, five of the watersheds were resurveyed and updated based on available information. The Beauford Ditch was inventoried for tile back in 1991 under MRAP and a reinventory was completed in 2010 using landowner interviews and the additional aerial photography from 1991 and 2005 (Blue Earth LiDAR photography). Additional data from the MRAP Tile Re-inventory project was used to improve the data for the Beauford Ditch watershed. The other four minor watersheds in Kandiyohi, Cottonwood, Redwood counties were reinventoried as well, and one additional in Blue Earth County was added. Tile density (length of tile per cultivated area) for each of these watersheds was estimated and the data is available but due to privacy issues with landowner surveys, we have not included this data in this report. However, relationships from these four watersheds are similar to the Blue Earth and Beauford watershed.

Figure 17. Blue Earth county LiDAR aerial photograph overlaid with linework showing the locations of tile lines as digitized from the aerial photograph.

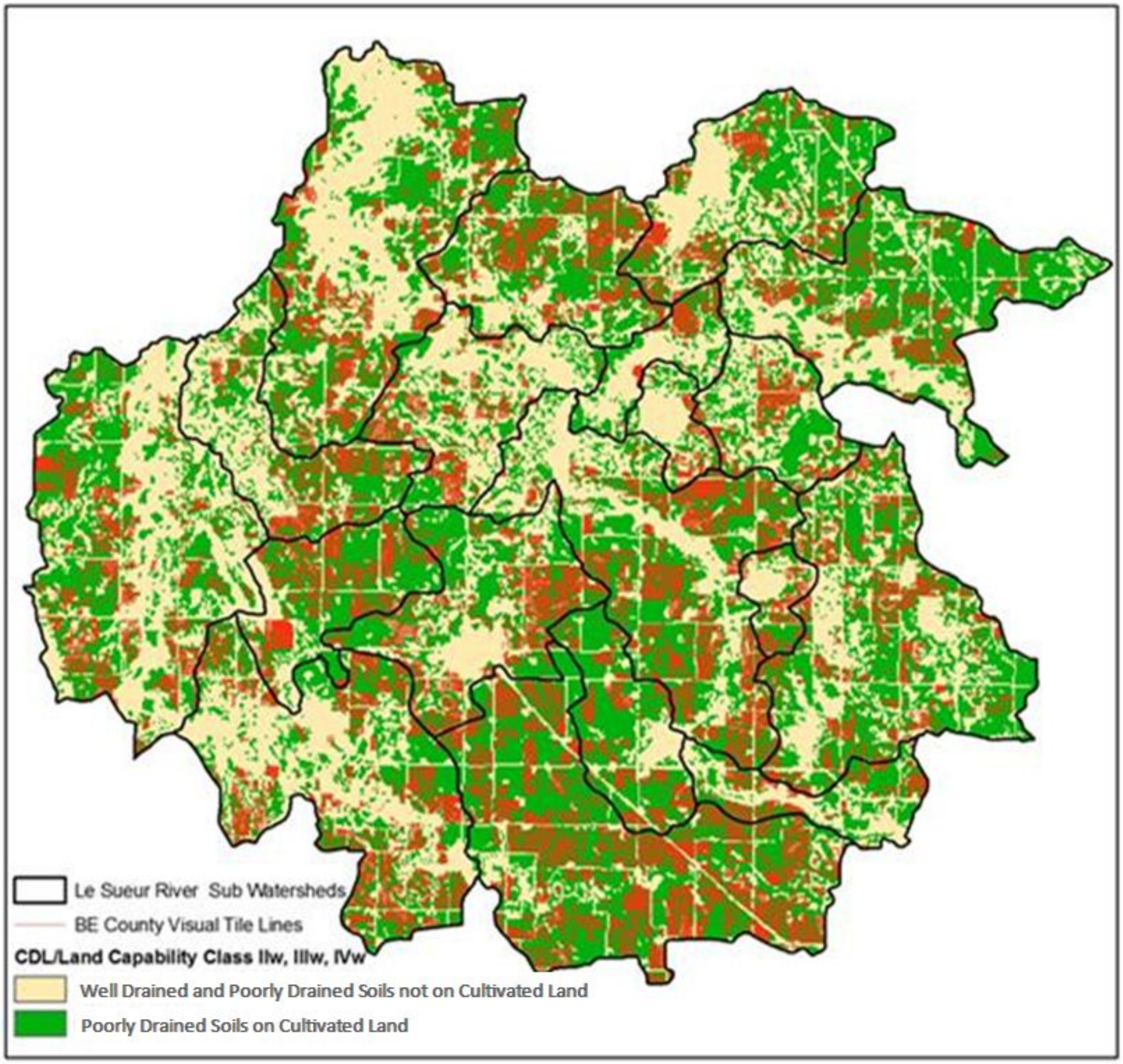


Figure 18. Blue Earth county LiDAR derived tile lines and SSURGO derived poor and very poorly drained soils on cultivated land for 19 sub-basins within the Blue Earth and Le Sueur watersheds

Findings

In general, the density of pattern tiling is associated with cultivated soils that are specified as poorly drained and very poorly drained (Figure 18). Correlation of soil type to the length of tile for 19 sub-basins in the Le Sueur watershed demonstrates this relationship and provides an estimation of the overall density of tile on poorly drained and well drained soils (Figure 19). For the 19 sub-basins combined, 71% of the cultivated land is classified as poorly drained and has an average of 141 meters of sub-surface tile per hectare of row-cropped land. As expected the poorly drained soils have a higher density of tile but it is only about double that of the well drained soils (164 v. 94 m/ha respectively, Figure 19). The strong correlation shown in Figure 19 indicates that the density of tile on cultivated land is similar throughout the watershed and can be reasonably predicted from soil type and landuse.

The two regressions shown in figure 19 provide a method to estimate tile density that is applicable to watersheds with similar soils, farming practices, climate and topography, but further analysis on other watersheds is necessary to define the regional applicability of the regression.

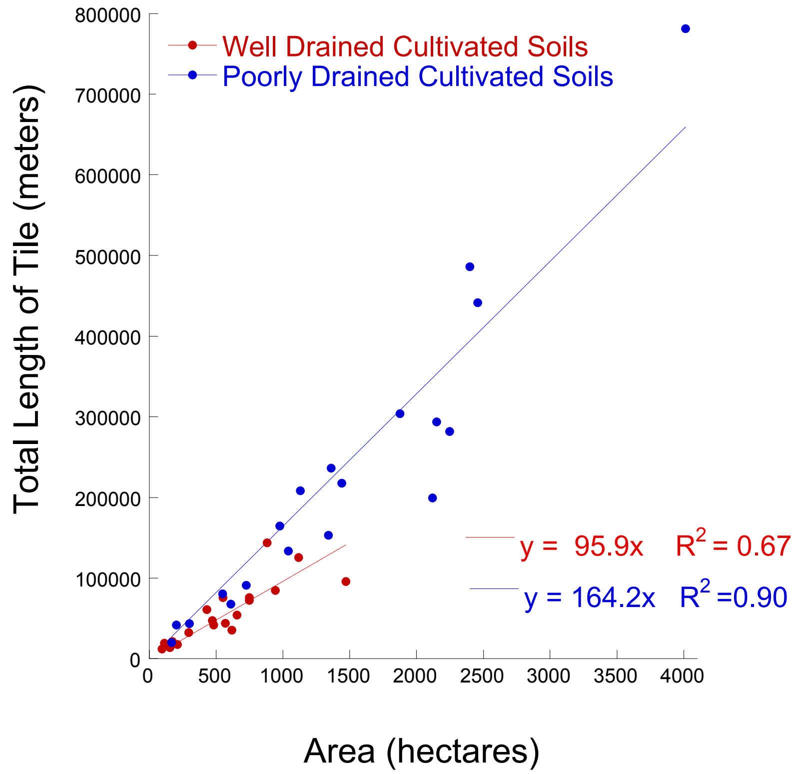


Figure 19. Relationship of length of tile per area of cultivated land for 19 sub-basins in the Le Sueur watershed (eastern Blue Earth county). The slope of the regression predicts the overall density (meters/ha) of tile on poorly drained and well drained cultivated soils.

1.1.7 Changes in Urbanization

Increases in impervious surface could contribute to increases in river flow. We used changes in population or urbanization as a surrogate for changes in the amount impervious surface area. Presumably as population increases, and agricultural lands are urbanized, there is proportional increase in impervious surface. The first step to toward examining this change is to quantify the change in population upstream of the flow monitoring site in each watershed.

Methods

An analysis of the population trends within the 21 watersheds was completed in October of 2010. Using historical census data for township, villages, and cities within the 21 watersheds, we created a detailed analysis of the actual population that resided in the portions of the watersheds upstream of where rive flow was measured. Aggregating data to a watershed level from county level data can be misleading due to the fact that population is not consistent across the county, and that many of the larger urban areas are below our monitored flow site. For example, the city of Mankato is downstream of the gauging stations on the Le Sueur and Blue Earth rivers, thus changes in Mankato impervious surface area have no effect on the flow trends in these two rivers. By using the township and city data, we can more accurately reflect the population trends in the watersheds as relate these to any observed trends in river flow.

Using the 1990 census population layer as our base layer of townships and cities/towns, we used the census population publications from 1930 – 1980 and inputted the population for these areas into a spreadsheet accordingly. The 1990 and 2000 census populations were already in shapefile format from the census bureau and other sources. Upon creating layers for each census year from 1930 to 2000, we clipped the layers by the 21 watersheds. Townships and cities along the boundary of the watersheds were clipped along the boundary. The areas of the two clipped polygons were calculated and the percentage of the two clipped polygons was calculated based on the original area of the full polygon. This percent and the population of the full polygon were multiplied to determine a population of the clipped polygons. Finally, all polygons within each watershed were aggregated into their corresponding watershed to determine the population of the watershed

Findings

Several ways to view changes in population are shown in Figures 20-22: Census population by watershed (Figure 20), Acres per person (Figure 21) and Persons per Acre (Figure 22). Both the Population Census (Figure 20) and the Persons per Acre (Figure 22), show that many watersheds in the Minnesota River Basin actually have decline in population from 1930 until the present. The Redwood River watershed which encompasses Marshall and Redwood Falls is an exception. The Le Sueur River watershed shows a consistent persons per acre over the 70 year time span. The Le Sueur River watershed is located just south of Mankato and certain growth areas of Mankato fall into this watershed. The Sauk, Elm, Crow and Rum River Watersheds showed an increase in population over the time period. These watersheds are located north and west of the Minneapolis-St. Paul Twin Cities Metropolitan Statistical Area. Their proximity to the ever expanding Twin Cities have seen population growth consistent with the urban expansion. Other watersheds seeing increased growth in persons per acre are the Cannon, Cedar and Snake River. These watersheds have a major city or cities that have seen a growth in both size and population.

In result 2 below, we show that many of the agricultural watersheds in the Minnesota River basin have had large and significant increases in river flow. These same watersheds have had minmal population changes, and several have actually decreased. Based on this data, it is reasonable to conclude that for these study watersheds, urbanization is not be an important driver of changes to hydrology.

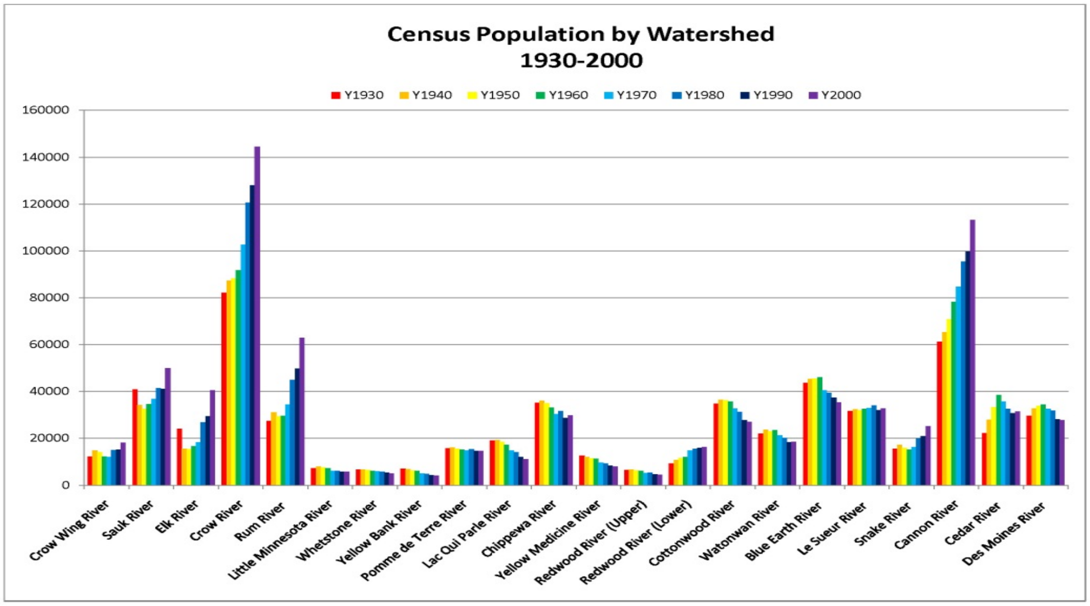


Figure 20. Census population by watershed for the years 1930 -2000. The population estimates were aggregated by the smallest township and city units available for those years.

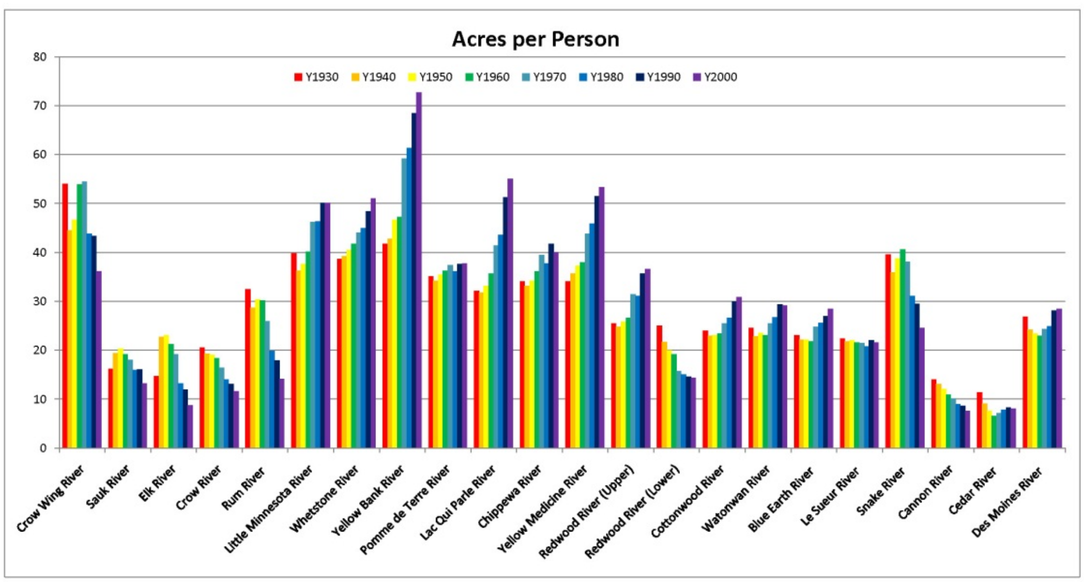


Figure 21. Acres per Person by watershed for the years 1930 -2000. The population estimates were aggregated by the smallest township and city units available for those years.

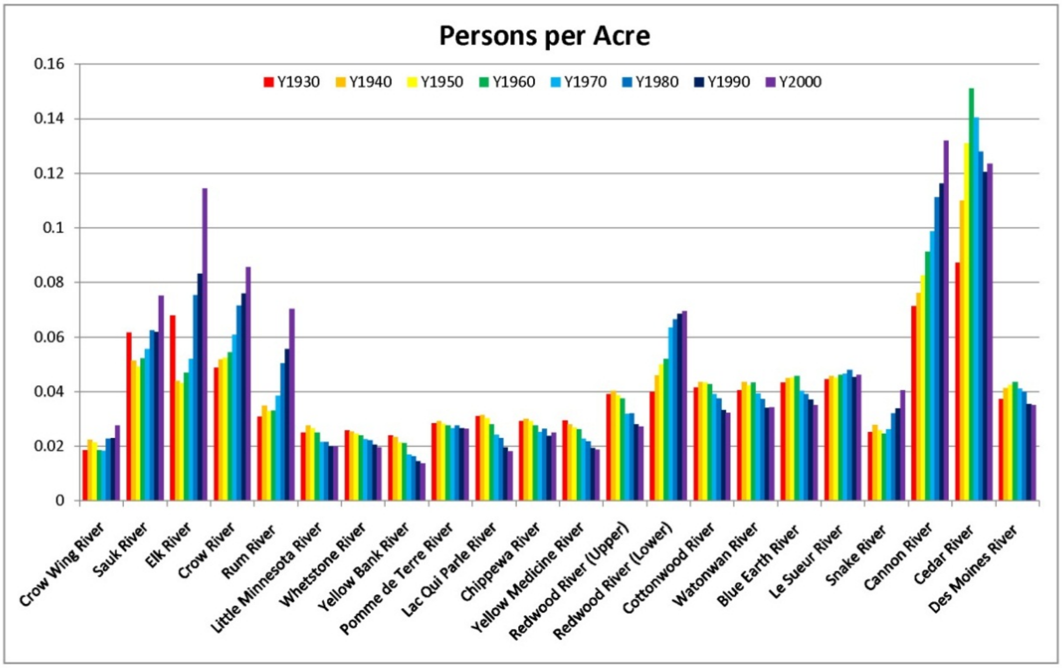


Figure 22. Persons per Acre by watershed for the years 1930 -2000. The population estimates were aggregated by the smallest township and city units available for those years.

Result 1: Deliverable 2.

HISTORICAL TRENDS IN INSTALLATION OF DRAINAGE

1.2.1 SUMMARY OF EXISTING DATA: SEVEN MILE CREEK

The Seven Mile Creek Watershed completed a study called, "An Historical Perspective on Hydrologic Changes in Seven Mile Creek Watershed" which documented hydrologic changes, but more specifically wetland losses, in the Seven Mile Creek Watershed. (http://mrbdc.mnsu.edu/sites/mrbdc.mnsu.edu/files/public/org/bnc/pdf/smc_airphoto.pdf)
The analysis completed by Kevin Kuehner on the Seven Mile Creek Watershed mirrored many of the methods we used in our study and was thus a good comparison study area to compare to our analysis. Seven Mile creek does not have a long-term flow record, thus temporal trends in river flow could not be compared to the trends in drainage installation. Nonetheless, the drainage history in the Seven Mile creek watersheds offers a useful surrogate for the drainage trends in the agricultural watersheds of Minnesota.

Methods

The 95.3 km^2 (36.8 mi^2) study area is a small, agricultural watershed located in south-central Minnesota. Historical aerial photos along with a Geographic Information System (GIS) were used to assess changes in water resource features of the watershed. More than 130 aerial photographs from seven different periods dating back to 1938 were scanned and rectified for use in a GIS database. Wetland areas converted to cropland were delineated and digitized. In addition, other land use changes, such as surface and sub-surface drainage modifications and cropping system shifts, were mapped and documented.

Findings

Results from the study indicate significant hydrologic changes have occurred in the watershed. Analysis of pre-settlement maps and survey notes indicate that about 50% of the watershed was once covered by wetlands. Of those wetlands, it is estimated that 88% of the natural wetlands have been converted to cropland. About 47% of those losses occurred from early settlement (late 1800's) to 1938. From 1938 to 1985, an additional 41% of the wetlands were drained and converted to cropland. This translates to an average annual net wetland loss of 40 hectares (100 ac.) per year.

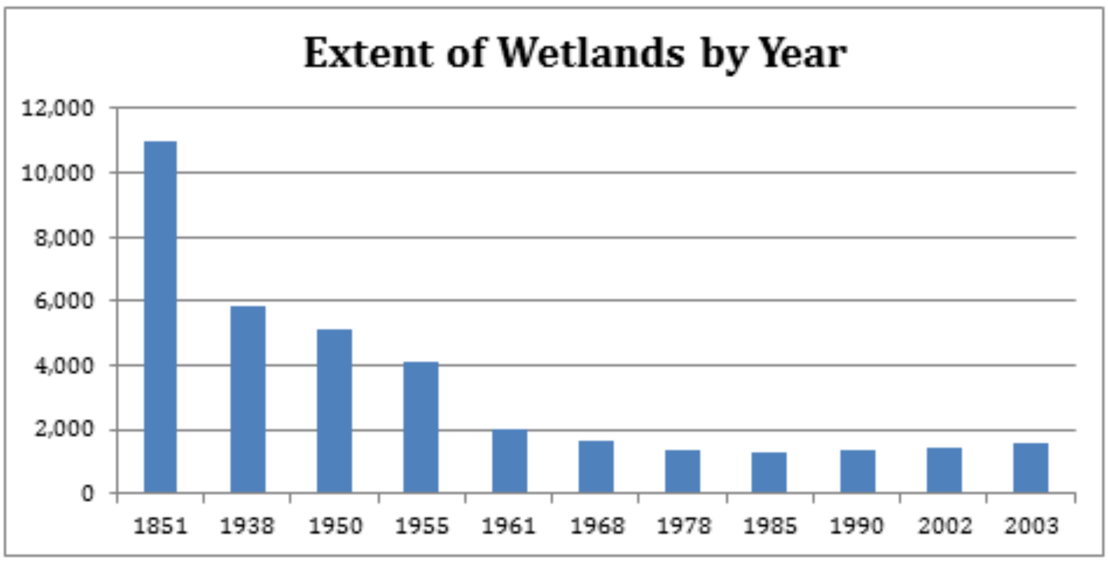


Figure 23. Extent of wetlands by year in the Seven Mile Creek Watershed.

During this same period (1938- 1985), 40 km (25 mi.) of drainage ditches were constructed, more than 966 km (600 mi.) of public and private sub-surface drainage systems were installed, and it is estimated that total corn and soybean acreage increased from 30% to 96% within the watershed. The most rapid percent change, a 50% wetland decrease, occurred between 1955 and 1961. The construction of two county drainage ditch systems in 1955 accounts for this change. After 1985 the rate of wetland lost decreased. Wetland increases are a direct result of conservation programs combined with grants from private and state water resource protection programs. Figure 23 shows the change in acres of wetland area in Seven Mile Creek Watershed.

Using the original land survey records and pre-settlement maps for the almost 11,000 acres were originally considered wet areas1800's (Figure 24). By 1938, surface drainage systems had already connected many of these wet areas to the natural hydrology and thus the outlet to the watershed. Areas that originally held water on the landscape for a long period of time (wetlands) were now altered to route this water directly to the creeks, ditches or river, thus allowing these areas to be used for pasture or cultivation. This landscape alteration is documented in detail for the period 1938 to 1985. Starting in 1985, wetland complexes were being constructed to benefit water quality, and the loss of wetlands has stabilized. Nonetheless, nearly all wetlands in the Seven Mile creek watershed have been drained. While the time trend of wetland loss cannot be documented as well in our study watersheds, the extent and magnitude of wetland loss observed in Seven Mile creek is representative of watersheds in the Minnesota River basin.

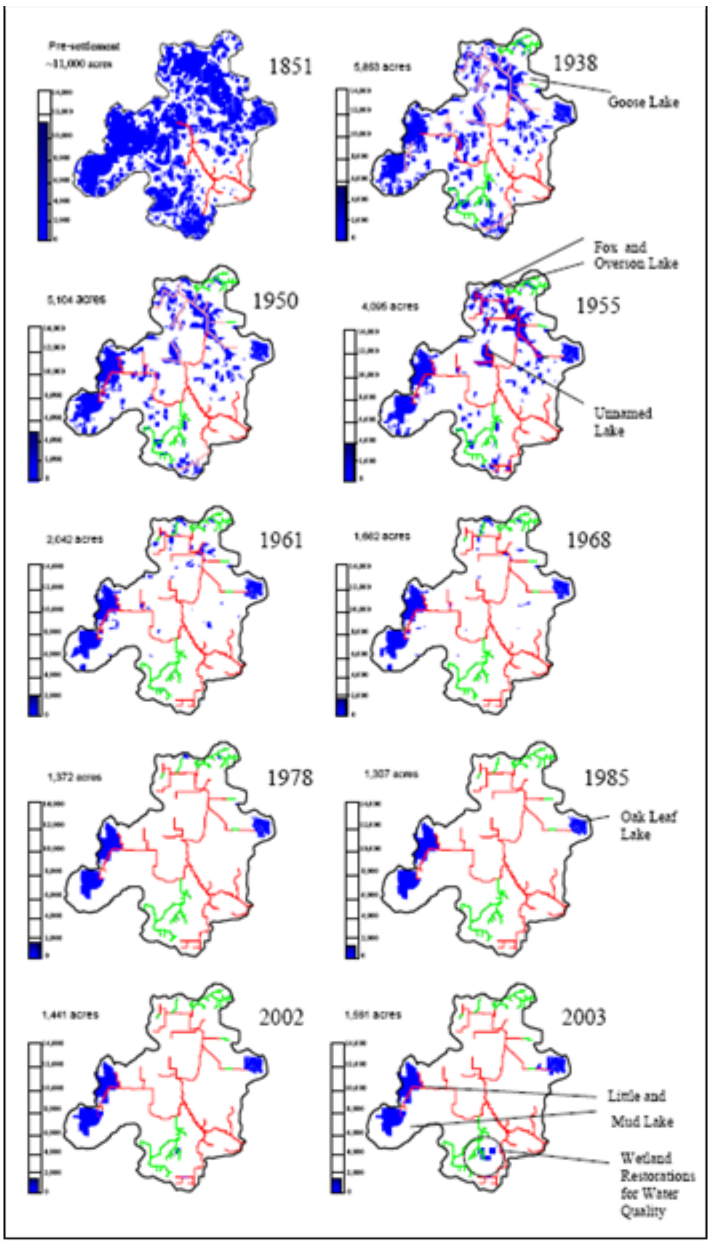


Figure 24. Historical distribution of wetlands in Seven Mile Creek Watershed, show the time trends of wetland drainage.

2.1.2 SUMMARY OF HISTORICAL DATA FROM BERT BURNS

In 1954, Bert Burns, a Ph.D. candidate at the University of Nebraska Lincoln, conducted a detailed study on the agronomic and economic advantage of installing artificial drainage. His Thesis, "Artificial Drainage in Blue Earth County, Minnesota", was a detailed look at land use, geography and drainage patterns in Blue Earth County (Burns, 1954). He wanted to determine the nature and extent of the wetlands of Blue Earth County, find the manner in which their drainage had been accomplished, and measure the physical and cultural results of their drainage. He proposed that the trends and observations in Blue Earth County were representative of the northern Midwest and the results of his study could be applied across the region. His work provides a snapshot of the conversion of wet prairie, wetlands, and poorly drained depressions to cultivated land in the middle of the 20th century.

Methods

Burns used land survey notes, maps, as well as soils and vegetation to determine the original extent of wet prairie. In his thesis, the implementation of artificial drainage was determined from the drainage records recorded by Blue Earth County. Engineer's maps and descriptions were used to delineate the drainage systems. Finally, Burns had sample farms from within the county he used to document the different types of drainage networks used on different types of soils. He showed detailed drainage techniques for various soil conditions as well as the results of drainage upon agricultural land use, crop patterns, field patterns, and land valuation.

Findings

The importance of Bert Burn's thesis in our analysis is the fact that his analysis occurred midway between when drainage started occurring in Minnesota until the present. Also, his analysis is a snapshot of drainage in the 1950's when sub-surface drainage (tile) started being heavily used on agricultural lands. The dry periods of the 1930's and the two World Wars were over. Better economic conditions combined with a wetter period than the 1930's yielded a need for drainage to improve the land available for farming and increase production of agricultural areas.

Natural drainage within Blue Earth County was considered by Burns in his thesis as poor because of two reasons. The first reason is the level topography caused by the large scale ponding of glacial melt waters over the drift plain which occurred within the county. The second reason is the relative low porosity of the heavy prairie soils which is caused by the very considerable silt and clay content. In Burns study, about 58% of the county area can be classified as poorly drained land by the soil survey of the time.

Crop patterns appear to have been affected markedly by the development of artificial drainage. Without drainage, the wet areas could not be reliably used for row-crops. Wet lands, when drained, at first could be used for pasture and dairying, but as cash crops became more important economically, the wet lands were used for cash crops. Figure 25 shows the progression of a sample farm as wet areas were drained and fields were squared off to create larger areas for more efficient cultivation and harvest. Most of the land drained was former wet prairie, characterized by level topography, shallow sloughs, and a heavy silt and clay content. Drainage constituted a significant degree of land improvement. When released from the limitations of the wetness, the wet prairie became some of the most productive soils of the county, equaling or surpassing many soils of better natural drainage.

Three important points from Burn's thesis are evident in his conclusions. One, a sizable area of formerly poorly drained prairie which was used largely for wild hay or pasture has been added to the total area of tillable land within the county. Secondly, drainage resulted in a shift from non-tillage crops to tillage crops. Third, the value of artificial drainage and its effect on the productivity of land resulted in increased land valuation of drained lands as compared to undrained lands.

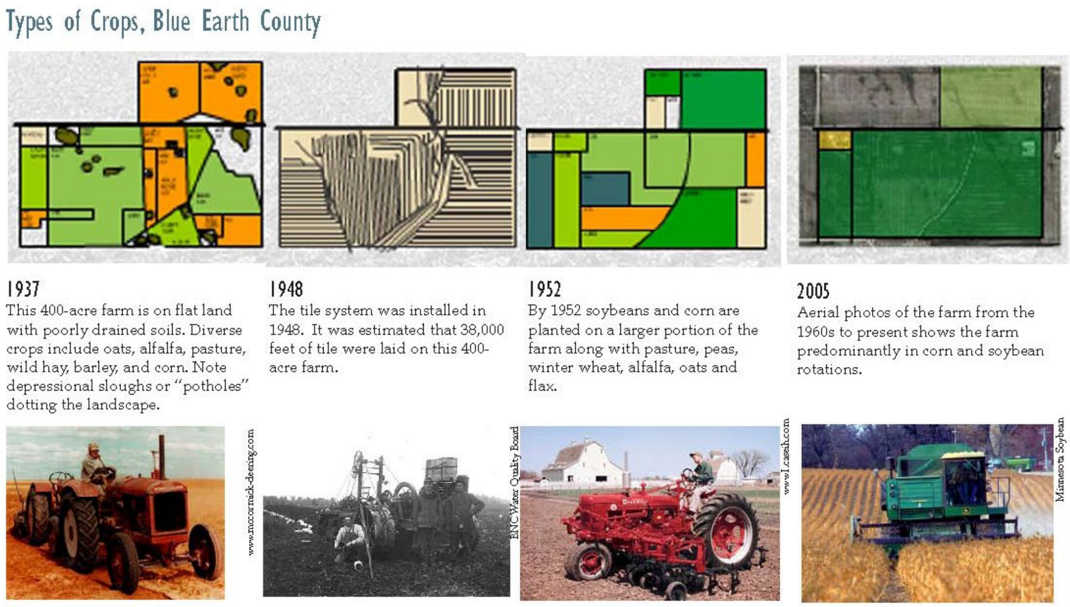


Figure 25. Sample Farm from Bert Burn's Thesis. Progression of land use on the sample farm and the mapping of tile. The removal of wet areas leads to larger, less irregular fields, and a conversion from small grains, hay and pasture to row-crops such as corn and soybeans

2.1.3 Surrogate Watersheds: Blue Earth and Martin County

Existing data summarized from the Seven Mile creek watershed and Bert Burn's thesis provides a good starting point to quantify trends and extent of artificial drainage installation. To expand our understanding we looked at two different county administered systems, Martin County and Blue Earth County, and used these as surrogate watersheds.

Blue Earth County is essentially a region of gently rolling ground moraine that was deposited by the Late Wisconsin Des Moines lobe, the last glacier to advance over southern Minnesota. The surface relief of the ground moraine descends from three directions, converging from the east, west, and south toward the north central portion of the county. This general slope gave direction to the present drainage pattern. Many of the nearly flat areas of the ground moraine are artificially drained to improve agricultural conditions. The highest surface elevation, about 1190 feet mean sea level, is located in the northeast corner of the county. The lowest elevation, about 750 feet mean sea level, is located in the north central portion of the county where the Minnesota River leaves Blue Earth County to the north. The maximum total relief is approximately 440 feet. The local relief ranges from 10 to 30 feet, except along major river valleys where relief may be as much as 240 feet.

Martin County is in south central Minnesota, and contains portions of the Des Moines and Blue Earth river watersheds. The county has intensive artificial drainage with over a 100 county administered drainage systems throughout Martin County. While these county administered drainage systems do not include all the private systems put in by landowners, Martin County, because of the larger number of drainage systems and the topography of the county, is an excellent surrogate watershed to study the timeline of drainage.

Martin County is a region of gently rolling ground moraine that was deposited by the Late Wisconsin Des Moines lobe, the last glacier to advance over southern Minnesota. The surface relief of the ground moraine descends from the west and south toward the north and east. This general slope gave direction to the present drainage pattern. Many of the nearly flat areas of the ground moraine are artificially drained to improve agricultural conditions. The maximum total relief is approximately 360 feet. Local relief ranges from 10 to 30 feet, except along portions of lake chains where relief may be as much as 80 feet.

Methods

Artificial drainage networks were assessed by looking at the installation patterns across the county and by quantifying wetland loss across the eastern part of the county. The data for the installation of the county administered systems comes from the Public drainage atlas, Blue Earth County, Minnesota, published in 1979.

If we look at the history of drainage as described below, we get a sense of how important drainage was in the early part of the 20th century and how precipitation patterns can affect the need for drainage or not. The following is an excerpt from the publication, “Understanding Minnesota Public Drainage Law – 2002 Overview for Decision-makers”, by the Association of Minnesota Counties.

When the United States was settled, there were approximately ten million acres of vegetated wetlands - or "swamp lands" as they were called - in the area that eventually became the state of Minnesota. They covered about one-fifth of the state's total land area. The Swamp Lands Acts of 1850 and 1860 granted 65 million acres of United States swamp lands to 15 western states, including Minnesota. The grant was intended to ensure that wetlands would be drained, as they were considered to have no value in their natural, marshy condition.

Settlement in Minnesota moved north and west from the Mississippi River in the 1850s. Except for small scale private party and railroad bed drainage, there was not much actual drainage activity.

The first comprehensive public drainage act in Minnesota was passed in 1887. This act provided for a petition process, overview by county commissioners, and the appointment of viewers to survey, locate and prepare a report on the proposed drainage ditch. If the report conformed to the statute; the commissioners could establish the ditch. The act also provided for the payment of damages from the county treasury, the letting of a contract for construction, and the assessment of benefits against the lands to be benefited by its construction. This early drainage law established a process that is remarkably similar to the approach still followed in Minnesota drainage law today.

In 1893, the Red River Drainage Commission was formed to deal with ditches tributary to the Red River. Four years later, in 1897, a three-member Drainage Board of Commissioners was established by the legislature and appointed by the governor. This marked the beginning of state drainage activity.

From 1900 through 1915, there was a proliferation of drainage activity in Minnesota. The State Drainage Commission was formed and it began the construction of drainage systems close to larger trade centers and the railroads. Roads were under construction, and road ditches provided drainage for these new transportation arteries. The state commission conducted regular inspections to ensure that counties fulfilled their duty to repair and maintain the state-funded drainage systems. With the support of the public, the state encouraged drainage of land to enhance its taxable value and productivity.

Around 1916, drainage activity decreased for a number of reasons, including World War I federal policies, a ten-year drought, floods, agricultural depression, tile failures and a change in public and political attitudes toward drainage. The severe flooding of 1918 and 1919 caused the legislature to authorize the establishment of drainage and flood control districts and drainage and conservancy districts. After the end of WWI, land values and agricultural commodity prices rose, but due to high costs, drainage work was primarily limited to improvements and repairs of existing projects. With the advent of the agricultural depression in the mid-1920s, farm prices declined. The drought of the 1930s began, drainage activities again decreased, and existing systems fell into disrepair.

By 1938, normal rainfall returned, and the demand for drainage increased as agricultural prices rose. The existing systems were in poor condition, and the 1945 legislature enacted a bill addressing repairs and improvements. The increasingly confusing drainage laws led the 1947 legislature to authorize district courts and county boards to establish drainage systems after receiving a valid petition. State and township drainage authority was eliminated.

Agricultural prosperity continued during the 1950s, existing drainage systems were repaired and improved, and new systems constructed. Federal programs aided this effort. Drainage by the use of drain tile became widespread.

Installation dates for individual drainage network were taken from county records and integrated into a GIS dataset to define a timeline of drainage installation. The number of systems was recorded by year and the results were analyzed to determine the periods of greatest installation in the Blue and Martin counties

The second analysis, evaluating drainage of wetlands and depressional areas in Martin County and the eastern part of Blue Earth County involved using the Restorable Wetlands Inventory (RWI) layer from the Ducks Unlimited. Aerial photography from the years 1939, 1991, 2003, and 2010 along with the Original Plat Maps of 1855 were used as reference to determine the land use occurring in the polygon of the RWI. The analysis looked at whether the polygon contained evidence of water, vegetation, signs of cultivation or impervious surface. Each polygon was analyzed for the years 1855, 1939, 1991, 2003, and 2010 for these different land uses and was recorded in the GIS attribute table. For Martin County, only the polygons in the area within the Blue Earth and Watonwan River watersheds were analyzed. The resulting data was analyzed for patterns. This analysis is similar to that presented in section 1.1.4 earlier. A benefit of using the Restorable Wetlands

Inventory polygon is that we are comparing the same polygons across the different time periods and the majority of the land use type in that polygon was recorded. .

Findings

With Blue Earth County being a region of gentle rolling ground moraine, the natural topography creates areas where water is going to pool. Whether this water drains or remains on the landscape is dependent on the soil type as well as having an outlet for the water to flow. Where soils inhibited the water to seep into the soil, the need for drainage was required to make the landscape available, either for pasture or for cultivation. As shown in the Figure 26, the installation of open ditch systems occurred mostly in the time frame of 1897 to 1931. A few reasons for this time frame are evident. As stated in the description above, in 1897, the State Drainage Commission was started and drainage activity began in earnest. Also, the advent of mechanized methods of digging ditches became available in the early 1900's. Of the 110 systems listed on the graph, 85 systems were created in the time period of 1897 to 1931. The spatial extents of these systems have not been analyzed but the overall percentage in numbers reflect the vastness of drainage activity in the early 1900's.

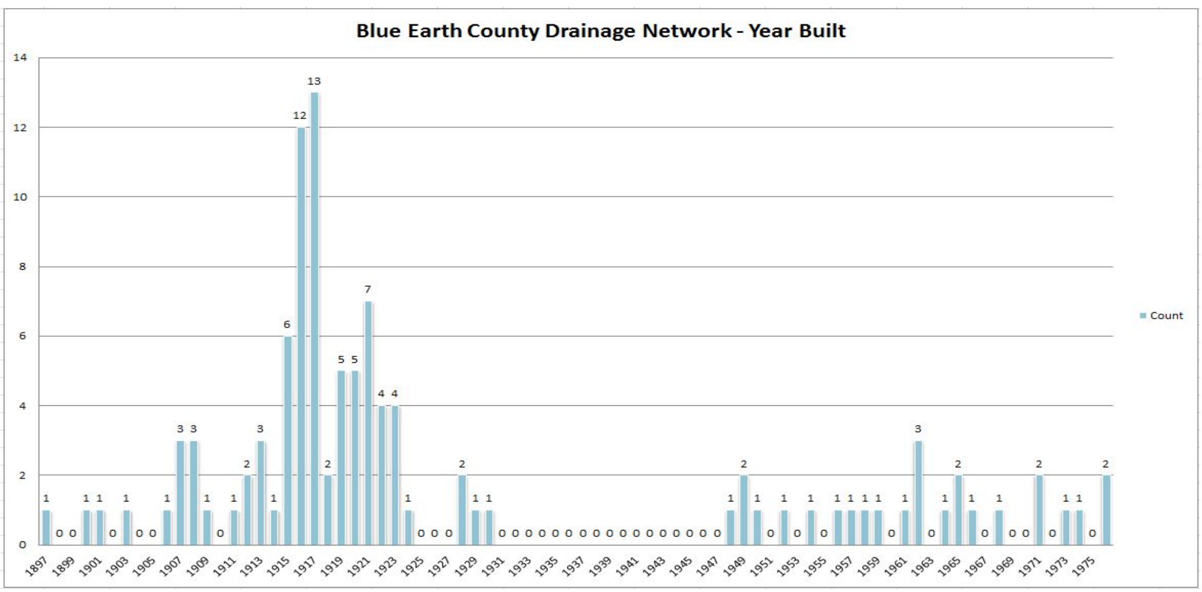
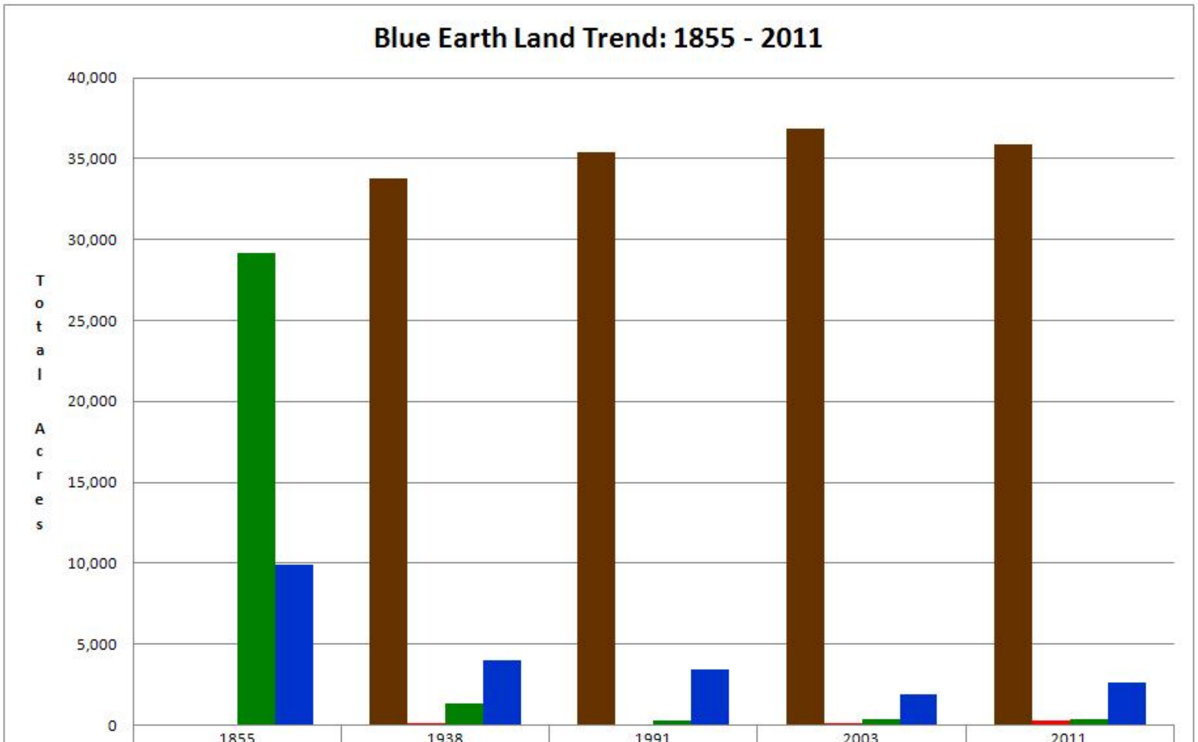


Figure 26. Time trend of installation of open channel drainage systems ("ditches") for Blue Earth County.

Wetland loss and land conversion trends are shown in Figure 27. Historic plat maps created from original land surveyor notes in 1855 can only be used to distinguish wet prairie and wetlands from other land types, but still provide an estimate of the amount of wetlands at onset of modern agriculture. In our analysis of the RWI, we marked the 1855 polygons as either "wet" (wet prairie and wetlands) or "vegetation", thereby lumping prairie, forest, and other native vegetation into a single category. By 1938, most of the native vegetation and about half of the wetlands have been converted to cropland. The drainage of wetlands continues through 1991 and 2003, and by 2003 less than 20% of the original wetlands remain. This data demonstrates that while drainage of wetlands was intense in the early 20th century, the drainage continued throughout the century with significant wetland losses occurring in last decade: i.e. 1991-2003. A small increase in the amount of wet areas occurs between 2003 and 2011 as a result of conversion and restoration programs. This trend was seen in the Seven Mile Creek study area as well.



	1855	1938	1991	2003	2011
cropland	0	33,742	35,391	36,832	35,908
developed	0	4	0	107	254
vegetation	29,185	1,363	291	319	315
wet	9,931	4,008	3,434	1,858	2,639

Figure 27. Land Trends in Blue Earth County based on Restorable Wetlands Inventory Polygons for selected years.

Martin County follows a similar pattern as Blue Earth County. Because Martin County is a region of gentle rolling ground moraine, the natural topography creates areas where water is going to pool. Residence of water in this landscape is dependent on the soil types as well as having an outlet for the water to flow. Where soils inhibited the ability of water to seep into the soil, the need for drainage was required to make the landscape and soil available for row-crops. We mapped the sloughs, marshes, wetlands and any discernible feature that was originally mapped on the 1855 plats. Not surprisingly, when the sloughs, marshes and wetlands are overlaid with the drainage network, the drainage network falls directly on these low areas in a majority of the county.

In Martin County, construction of open channel drainage networks (i.e. ditches) occurs mostly in the early 1900's with most of the ditches installed prior to 1925 (Figure 28). Of the 148 systems listed on the figure, 117 systems were created in the time period of 1904 to 1925. The extent (e.g. total length) of these systems has not been analyzed but the overall percentage in numbers reflects the vastness of drainage activity in the early 1900's. These early systems were mostly surface drainage systems connecting low areas to low areas and then eventually to a natural river system. However, there were some early clay tile systems put into use. In our analysis, we did not differentiate which system was open or tile, we were mostly looking at the date they were installed. A few reasons for this time frame are evident. As stated in the Blue Earth description, in 1897, the State Drainage Commission was started and drainage activity began in earnest. Also, the advent of mechanized methods of digging ditches became available in the early 1900's.

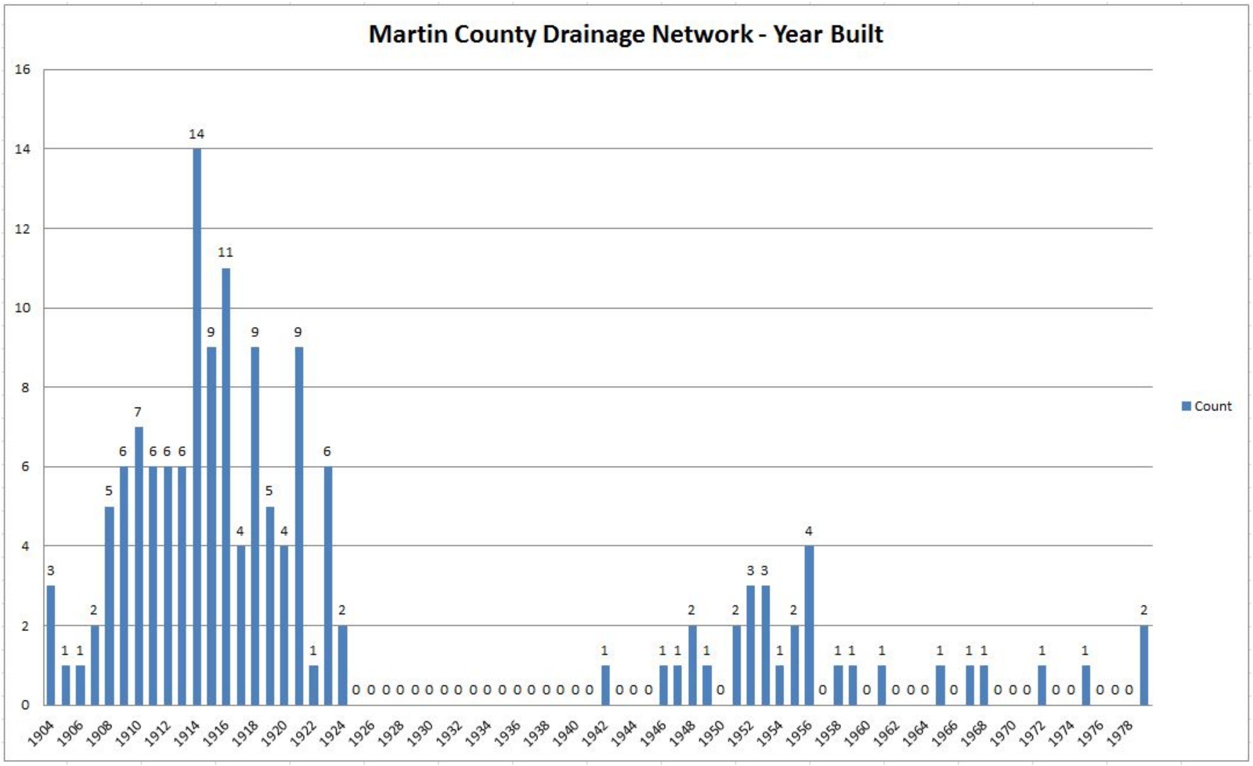
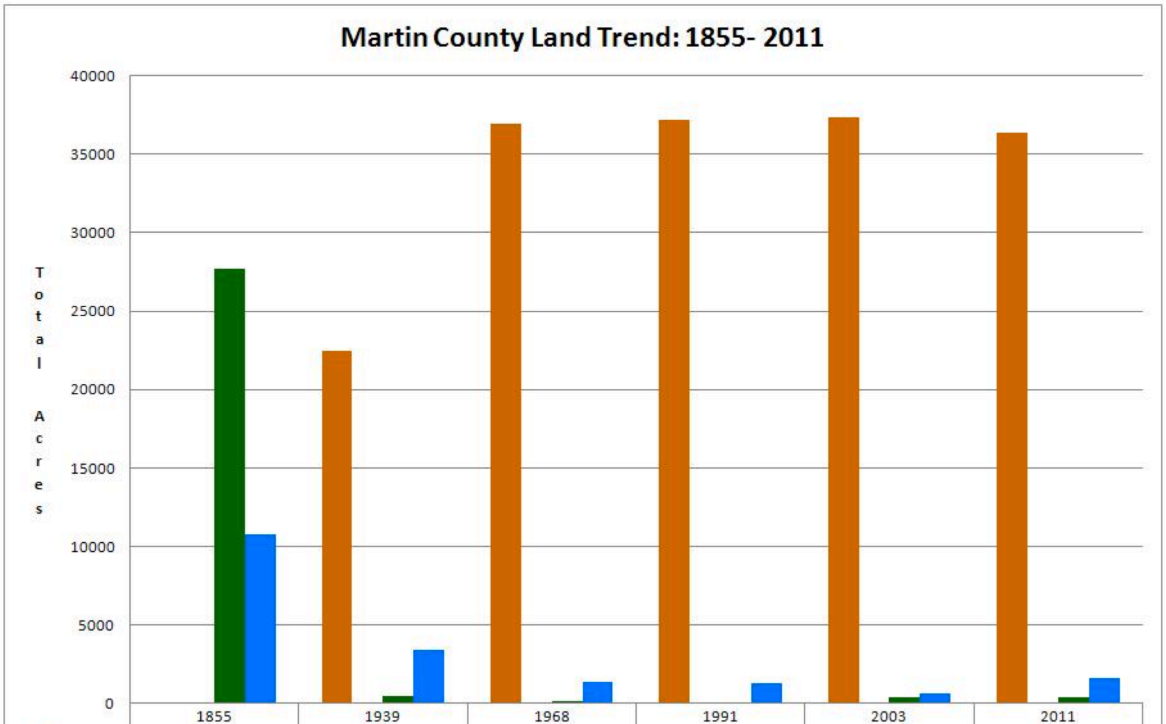


Figure 28. Installation trend of open channel drainage systems in Martin County.

Wetland loss and land conversion trends for Martin County are shown in Figure 29. The trends are almost identical to those in Blue Earth County. By 1939, most of the native vegetation and about half of the wetlands have been converted to cropland. The drainage of wetlands continues through 1968, 1991 and 2003, and by 2003 less than 10% of the original wetlands remain.



	1855	1939	1968	1991	2003	2011
cropland	0	22,493	36,934	37,161	37,380	36,399
developed	0	1	8	6	13	29
vegetation	27,679	462	162	20	416	416
wet	10,779	3,388	1,355	1,271	650	1,613

Figure 29. Land Trends in Martin County based on Restorable Wetlands Inventory polygons for selected years.

RESULT 2: COMPARATIVE ASSESSMENT OF HYDROLOGIC CHANGES DUE TO TILE DRAINAGE

Deliverable	Completion Date
1. Quantification of changes in 14 hydrologic parameters in 21 watersheds.	July 2010
2. Comparative assessment of watersheds to determine the effect of artificial drainage and climate on changes in hydrology.	July 2012
3. Correlation between trends in artificial drainage and acceleration of sediment accumulation rates in Lake Pepin.	July 2012

Summary Budget Information for Result 1: **Trust Fund Budget: $ 150,000**
Amount Spent: $ 150,000
Balance: $ 0

Deliverable	Completion Date	Budget	Status
1. Quantification of changes in hydrologic parameters in 21 watersheds.	July 2010	$ 50,000	100%
2. Comparative assessment of watersheds to determine effect of drainage and climate on hydrology	July 2012	$ 75,000	100%
3. Correlation between trends in drainage and sediment accumulation rates in Lake Pepin	July 2012	$ 25,000	100%

FINAL REPORT SUMMARY:

Result 2: Deliverable 1.
QUANTIFICATION OF CHANGES IN HYDROLOGIC PARAMETERS

Note: The original workplan included 23 watersheds for assessment. After reviewing available data for all watersheds, it was determined that the flow records in two watersheds had more than 15 years of missing data, and could not be reliably used.

2.1.1 CHANGES IN FLOW, RUNOFF RATIO AND PRECIPITATION

The hypothesis examined in this study-*have rivers become more erosive*- requires that flow has increased over time. If flow volume or flow characteristics have not changed, it is improbable that the rivers would have become more erosive. Thus, the first endeavor is to quantify the annual and seasonal changes in flow volume. To compare changes in flow volume (i.e. discharge) among watersheds, it is necessary to correct for watershed size.

Water yield, which is flow divided by watershed area, is the parameter used to compare changes in river discharge between the study watersheds.

Water yield = Flow / Watershed area. (eq. 1)

The second basic parameter that is useful for comparing changes in hydrology between watersheds is runoff ratio. Runoff ratio describes the proportionality between river flow and precipitation on a watershed scale and is simply water yield divided by precipitation (eq. 2). In other words, runoff ratio is the fraction of precipitation that ultimately leaves the watershed via river discharge. Among non-hydrologist the term runoff ratio is sometimes misinterpreted to mean surface runoff. This is an unfortunate association with the word runoff. Runoff ratio does not equate to surface runoff, but rather includes all infiltration, groundwater, and surface runoff that contribute to river flow. Runoff ratio essentially normalizes flow to precipitation and is a semi-quantitative first step toward correcting for changes in flow caused by changes in rainfall.

Runoff Ratio = Water yield/Precipitation (eq. 2)

Methods

Changes and trends in water yield, runoff ratio and precipitation were estimated using data from long-term monitoring stations. Daily flow records (m^3/day) starting in 1940 were obtained from USGS monitoring stations at the outlet of each watershed (USGS, 2010). Data gaps of days to months exist for some study watersheds. Gaps were evaluated on a monthly basis and only months that possessed at least 25 valid flow days were used in the study. Total monthly flow for each year was calculated by multiplying the mean of the valid daily flows by the number of days in the month. Monthly data were aggregated into bi-monthly (May-June, July-August, September-October) and annual time periods. The bi-monthly flow aggregates were chosen because May and June together comprise an important focal period for examining the ET effects from cropping changes. Consistent with the May-June focus, the annual dataset ran from the previous year's July to the current year's June, i.e. a June water year. Water yield for each watershed was calculated by dividing flow by the respective watershed area (eq. 1). This normalization to watershed area allows direct water balance comparison to precipitation and ET.

Spatial patterns of precipitation can vary considerably over a watershed such that using a single precipitation monitoring station to represent an entire watershed may introduce significant uncertainty. Moreover, every precipitation station has periods when no data were collected. To better account for spatial variation and to create a complete precipitation record, daily data from multiple precipitation stations were interpolated using the ordinary kriging methodology to produce daily area-weighted precipitation depths for each watershed. In all, 59 precipitation stations from the National Weather Service Cooperative Observer Program (COOP) were used for the interpolation. Climate data were downloaded from the Utah State University Climate Center website (USU, 2010). The interpolation was conducted using PCP_SWAT (Zhang and Srinivasan, 2009), an ArcGIS 9.2 extension written for the SWAT hydrologic model (Arnold *et al*., 1998). Daily interpolated precipitation values were summed on a monthly basis for analysis.

Most time-series data in this study were found to have non-normal distributions. Therefore, trends were evaluated using non-parametric methods. The data set was split into two equal time periods: 1940 to 1974 and 1975 to 2009 and the Mann-Whitney U test (also known as the "Wilcoxon-rank-sum test") was used to evaluate differences. All analyses were conducted with the R statistical software using the R function *stats*:*wilcox.test (*R Development Team, 2010*)*. This method, comparing two time periods, is similar to the approach used by others (Lenhart *et al*., 2011; Wang and Hejazi, 2011) and is less sensitive to end points when estimating magnitude of change. Kendall-Tau analysis of the continuous record gave similar results, confirming the watersheds with significant trends.

Results

In over half of the watersheds, water yield and runoff ratio show large and significant increases in the spring (May-June), with much smaller changes in the fall (Sept-Oct) (Figure 30). In those watersheds with statistically significant trends, May-June water yields and runoff ratios have increased by 45-200% since the middle of the 20^{th} century (Figures 30 and 31). This two-month increase in water yield accounts for about one-third of the total annual increase in water yield. Equally important is the observation that water yield and runoff ratio show no significant increases in about half of the watersheds (Figure 31). Given the close spatial proximity of the watersheds, the observation that only some show changes in hydrology suggests a local land-use effect rather than a regional rainfall driver.

Several studies have shown increasing precipitation and river discharge over the past century (Nangia *et al*., 2010; Novotny and Stefan, 2007; Zhang and Schilling, 2006), but efforts to decouple rainfall from multiple land-use changes as drivers of hydrologic trends have been incomplete. For the watersheds in this study, annual precipitation over the two time periods increased by less than 15%, with the changes highly skewed by season

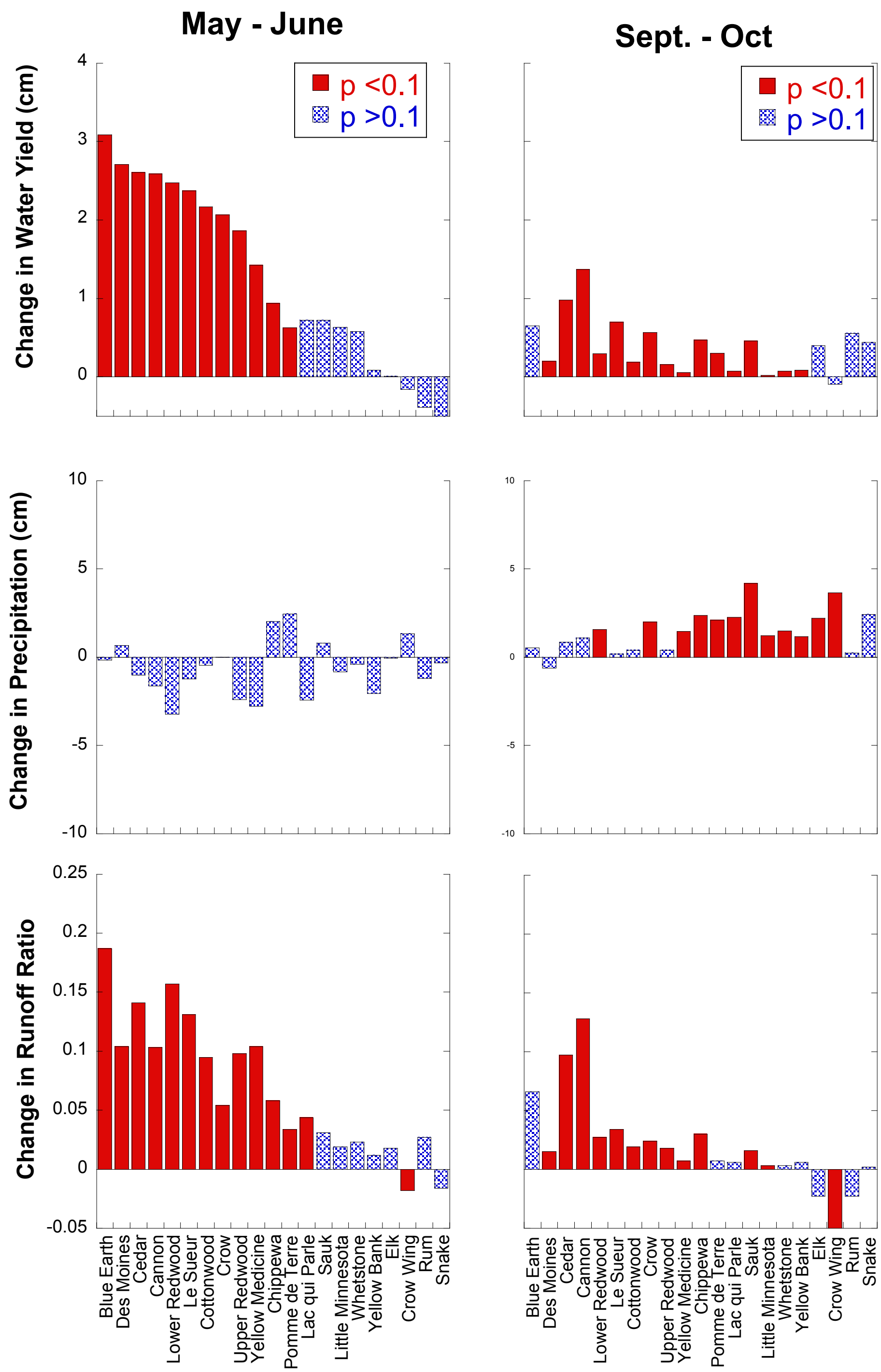


Figure 30. Seasonal changes in water yield (flow volume/watershed area), precipitation, and runoff ratio (water yield/precipitation) for 21 watersheds tributary to the upper Mississippi River. Changes represent the difference between median values for two 35-year periods (1940-1974 and 1975-2009). Blue bars denote watersheds with no significant change in flow. Annual changes follow a similar pattern, with water yield and runoff ratios increasing by >50% in watersheds with significant trends (Fig 31).

(Figure 30). In particular, May-June precipitation has been constant or has decreased since 1940. The fact that the largest changes in water yield and runoff ratio occur during May-June, a period with no increase in precipitation, strongly implies that seasonal changes in river hydrology are not the result of increases in precipitation. Conversely, in the Sept-Oct period, when there is an increase in precipitation, water yields and runoff ratios show only small changes. Drivers of the changes in flow are examined in section 2.2.1 below.

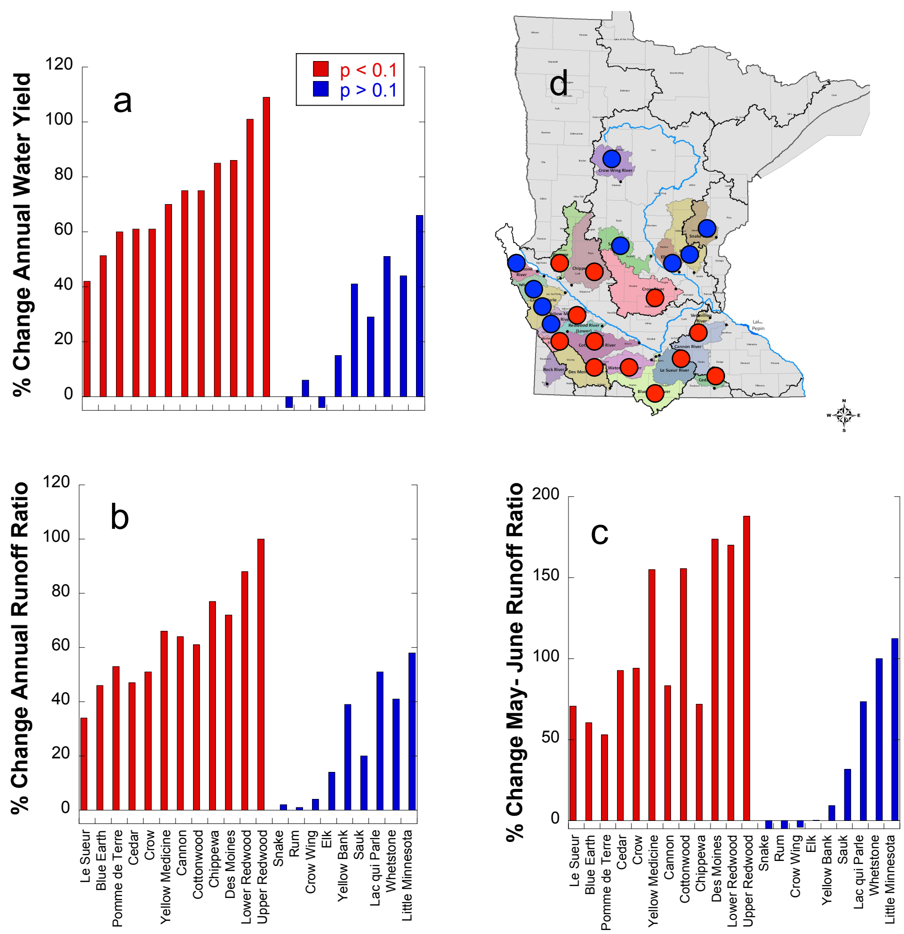


Figure 31. Percentage change in annual water yield (a), annual runoff ratio (b), and seasonal –May-June– runoff ratio for all 21 study watersheds. Red bars and dots denote watersheds with statistically significant changes. Watersheds in blue had no significant changes in flow. The distribution of watersheds with statititically significant changes in runoff ratio (flow normalized to precipitation) is not random (d), hinting that climate alone cannot be the sole driver of the large observed increases in flow. Changes in annual water yield and seasonal runoff ratio are based on changes in median values between the the two time periods. To minimize effects of yearly antecedant conditions, change in annual runoff ratio was calculated from the total water yield divided by the total precipitation for each 35 year time period.

2.1.2 CHANGES IN FLOW CHARACTERISTICS

It is clear from the analyses presented above that hydrology has changed markedly in many of the 21 watersheds in this study. To get a better idea as to the nature of these flow changes it was proposed that the Indicators of Hydrologic Alteration (IHA) trend analyses be conducted. The IHA was developed to identify long-term flow changes (Richter et al, 1996) that can attributed to watershed hydrologic alteration rather than natural variation, with its primary focus being the biotic impact of flow changes. However, many of the analyses can also be relevant to studies of hydrology and sedimentation. Results of the IHA trend analyses, referred to as parameters, range from changes in low, medium and high flow rates to changes in the characteristics of these flows such as frequency, duration and flashiness.

Methods

The IHA analyses are run from a dedicated software program available from the Nature Conservancy. Daily flow records for each watershed are imported into the software in comma-separated (.csv) format. Analyses may be run in parametric or non-parametric mode. Since the normality of flow data across all watersheds is this study was not consistent, it was deemed necessary to use only the non-parametric mode. Thus, in all cases, the output parameters represent changes in medians between the first (1940-1974) and second (1975-2009) periods. IHA analyses also generated flow duration curves for all watersheds for periods 1 and 2.

Results

Table 2 shows percent changes in shorter-to longer-term moving average flows; 1-day minimums and maximums represent the annual lowest and highest (peak) flows for given watershed, respectively. What is clear from these results is that low flows, i.e., base, winter, and late summer flows, have increased, sometimes substantially, in all but a few watersheds. Conversely, while annual peak flows have not changed consistently or substantially, the 7- and 30-day maximums have. In watersheds with an increase in annual flow volume, the 7- and 30-day maximums have increased 10-60 percent. In watersheds with no increase in annual flow, 7- and 30-day maximums have generally decreased by 10-30 percent. Table 2 also includes the median Julian day of minimum and maximum annual flows. Date of maximum annual flows varied somewhat but show little trend with regard to a significant seasonal shift. However, minimum annual flows in many watersheds exhibited a shift from winter to late summer. It is unclear the extent to which this may be important or the specific mechanisms involved (i.e., higher flow in winter or lower flow in late summer or combination of both) but warrants further investigation.

Table 2. Percent changes in annual minimum (base flow) and short-term "maximum" flows from period 1 (1940-1974) to period 2 (1975-2009) expressed in terms of changes in 1-, 7-, and 30-day moving averages. Values calculated using Indicators of Hydrologic Alteration (IHA) analyses. Red values denote statistically significant changes using 90% confidence interval, values in black are non-significant. NA denotes cases where minimum flow was zero in the period 1.

Watershed	1-day min chg%	7-day min chg%	30-day min chg%	Julian Day of 1-day min Per.1	Julian Day of 1-day min Per.2	1-day max chg%	7-day max chg%	30-day max chg%	Julian Day of 1-day max Per.1	Julian Day of 1-day max Per.2
Blue Earth	275	51	46	26	9	21	25	24	140	122
Cannon	159	92	99	15	215	-3	14	34	94	150
Cedar	46	42	38	22	214	-7	12	48	95	127
Chippewa	743	657	348	17	18	79	52	55	104	101
Cottonwood	150	127	153	24	30	29	12	57	99	118
Crow	142	150	132	5	45	30	28	44	107	111
Crow Wing	0	-2	3	205	234	-28	-27	-22	114	119
Des Moines	333	239	150	19	48	45	46	45	102	134
Elk	10	6	14	49	226	-2	-7	-2	103	119
Lac Qui Parle	NA	NA	586	28	214	-1	6	25	99	106
Le Sueur	80	88	112	32	245	44	39	47	122	121
Little Minnesota	NA	NA	NA	17	240	13	19	58	101	110
Lower Redwood	350	400	392	37	68	35	42	51	99	105
Pomme De Terre	150	159	101	27	18	34	41	74	99	90
Rum	9	13	9	18	27	-20	-14	-2	107	120
Sauk	95	104	81	12	17	-12	-10	5	104	120
Snake	35	41	39	46	224	-37	-33	-17	129	118
Upper Redwood	NA	NA	443	37	68	10	7	9	99	105
Whetstone	200	200	150	40	216	-1	22	21	98	97
Yellowbank	NA	275	200	28	215	64	23	25	100	94
Yellow Medicine	50	100	102	30	225	-12	6	27	101	112

Further IHA analysis explored trends that might be relevant to changes in river erosivity, presumably, those focusing on changes in the frequency, duration and magnitude of so-called "channel-forming flows". These flows are generally accepted to be those at or above bankfull, defined by a recurrence interval between 1 and 2 years. We took a conservative approach with respect to what constituted a channel forming flow, and selected a 2-year return period for use in the IHA analysis. Results show that the median annual frequency and peak flow rate of 2-year or greater events have not changed consistently across study watersheds (Table 3). Flashiness could also be an indicator of erosivity. A change in flashiness can be inferred from IHA parameters that measure slopes changes on the rising and falling limbs of the hydrographs of 2-year or greater flows. Results show that rise and fall rates have decreased significantly in most watersheds, thereby suggesting a decrease in flashiness; and when coupled with increased duration it suggests hydrographs for 2-year or greater flows have become flatter and wider.

The duration of these events is also an important characteristic of flow change. However, the IHA 2-year event duration parameter offers ambiguous or incomplete evidence for evaluating changes in river erosivity as it counts duration from the start to the end of the event (base flow to peak to base flow recession) rather the duration that the flow equaled or exceeded the 2-year return period flow. Given these shortcomings in this IHA method, we used a more traditional approach to evaluate duration of 2-year flow using flow duration curves (FDC).

FDCs integrate many of the IHA parameters and provide the means for better judging changes in all flow ranges. IHA analyses generated FDCs for all 21 study watersheds. Changes in duration of 2-year and 10-year return period flows were used as indicators of change in channel-forming flows. The IHA calculated the 2- and 10-year flow rates from peak flow frequency analysis of period 1 (1940-1974). Changes in duration of these flows were determined by plotting the specific flow rate versus the percent exceedance in the first and second periods. The difference between the first and second period percent exceedance for a given flow rate equals the change in duration. An example FDC for the Blue Earth watershed is shown below (See Figure 32). From the dashed lines in this figure, it is evident that the duration of 2-year return period flow (6,590 cfs) has at least doubled in the 1975-2009 period in the Blue Earth watershed. However, the duration of 10-year or greater flows (greater or equal to ~20,000 cfs) has actually decreased in this recent period. This is illustrated by the divergence of FDCs at 0.1% or less exceedance values (Figure 32). Figure 33 shows changes in 2-year and 10-year flows in all 21 study watersheds resulting from flow duration analysis. Results show

Table 3. Percent changes in annual median 2-year flow characteristics from period 1 (1940-1974) to period 2 (1975-2009). Values calculated using Indicators of Hydrologic Alteration (IHA) analyses. Red values denote statistically significant changes using 90% confidence interval.

Watershed	2-yr flow peak chg%	2-yr flow riserate chg%	2-yr flow fallrate chg%
Blue Earth	-9	-27	-47
Cannon	-14	-60	-56
Cedar	-6	-65	-68
Chippewa	14	-57	-19
Cottonwood	11	-76	-15
Crow	26	-57	-22
Crow Wing	-2	73	-29
Des Moines	-15	10	-28
Elk	-11	-53	-37
Lac Qui Parle	17	-42	-29
Le Sueur	-13	-66	-27
Little Minnesota	0	-42	-17
Lower Redwood	13	27	-11
Pomme De Terre	5	1	-18
Rum	10	-34	-28
Sauk	19	-46	8
Snake	-4	-44	-30
Upper Redwood	12	-13	-30
Whetstone	57	-43	16
Yellowbank	37	-48	3
Yellow Medicine	44	-16	-49

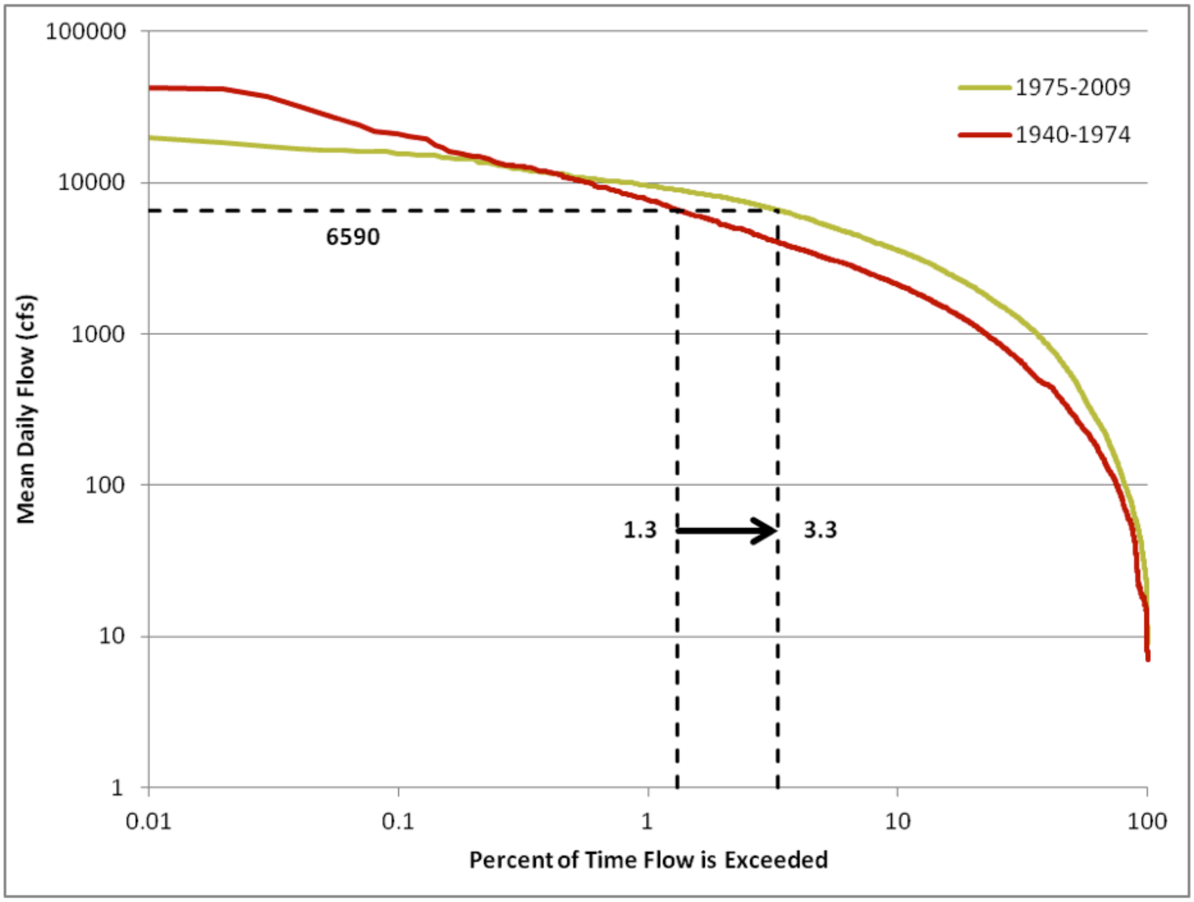


Figure 32. Flow duration curves for Blue Earth watershed for study periods 1940-1974, 1975-2009. Dashed lines denote that the 2-year retun flow (6,590 cfs) was exceeded 2.5 times more frequently in period 2 vs. period 1 (3.3% vs. 1.3%). The fact that the curves intersect and diverge at approximately 15,000 cfs and greater shows frequency of large flood events has decreased in the second period.

the duration of 2-year flows increased in all but four watersheds and this duration has more than doubled in half of the watersheds. Interestingly, in the watersheds with a 2-year flow duration increase, the duration of 10-year flows did not increase to the same extent and actually decreased in five watersheds. These are important distinctions for characterizing changes in the frequencies of flood flows and their potential impact on river erosivity.

The IHA analyses demonstrate that flows have changed in most watersheds in several important ways: (1) base flows have increased, (2) peak flows and flashiness associated with channel-forming flow events (e.g., 2- and 10-year return period) have not increased but, (3) the durations of channel-forming flow events has increased (figure 33). These results are counter to some of the generalizations that are often assumed to result in intensively drained systems. Some watershed managers assume that "tile drainage" increases peak flow and the flashiness of the flow. In our study watersheds, neither characterization was found to be true, however the duration of high flows, notably the bankfull flows, was found to have increased. The significant increases in duration of high flow events coupled with the seasonal and annual increases in total flow are critical parameters, potentially creating more erosive rivers.

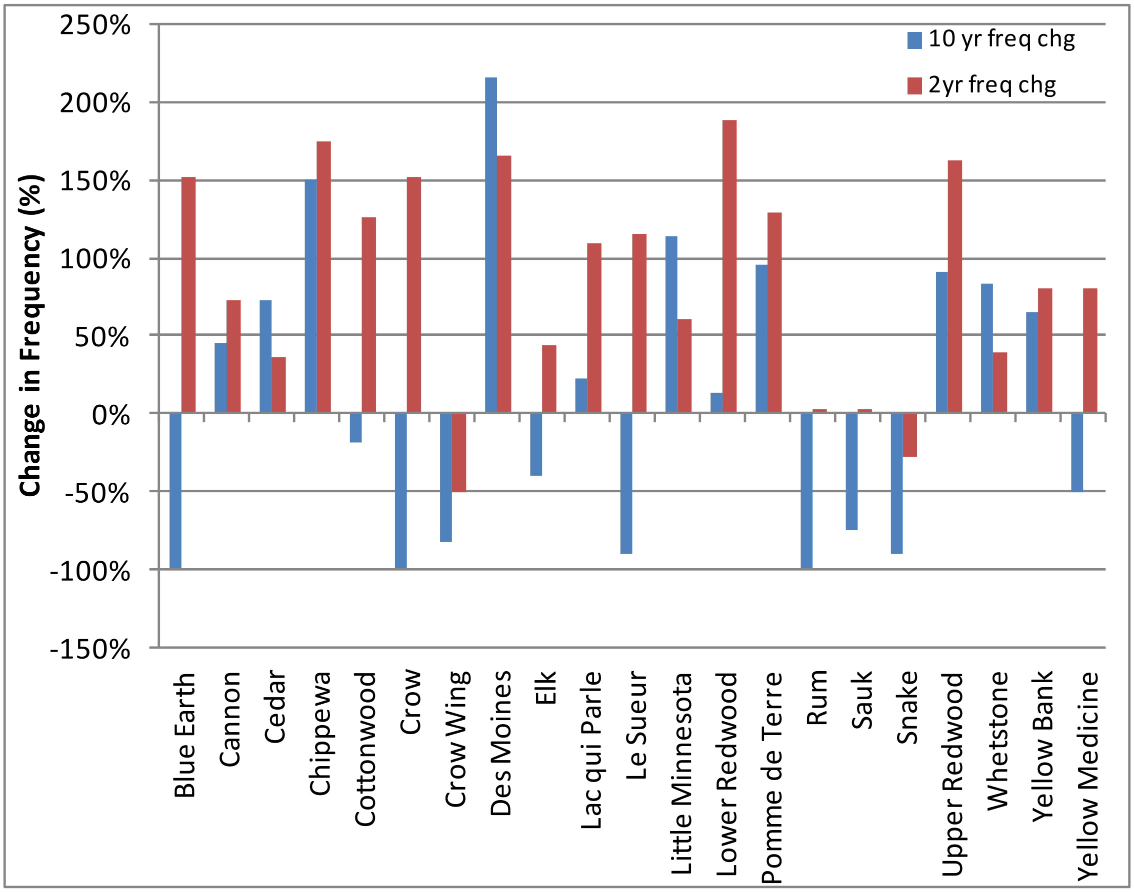


Figure 33. Changes in the frequency (i.e., duration) of 2- and 10-year return period flows in study watersheds. Results show 2-year flow durations increased in most watersheds while 10-year flow durations both increased and decreased.

2.1.3 Changes in Rainfall Intensity

Another possible factor for increased river flow is an increase in rainfall intensity. Increased intensity can result in greater surface runoff for a given depth of rainfall. Therefore, even in cases where total watershed precipitation has not increased, increases in rainfall intensity could be a contributor to increased flows.

Methods

Changes in annual rainfall intensity were analyzed for three event types: 1 inch/hour and 2 inch/day at individual COOP National Weather Service stations, and 1.75 inch/day for the kriged precipitation records generated for each study watershed ("kriged watershed"). These depth-durations represented events with a return period of approximately nine months (0.75 year). Statewide COOP station return periods were determined using the work of Huff (1992). Kriged watershed return periods were calculated within this study using frequency analysis. Analysis of hourly events used 87 stations with records from 1948-2009, and daily events used 59 stations with data from 1940-2009. Change in intensity was defined as a change in the frequency of a given depth-duration event over the period of analysis. The non-parametric Kendall-Tau test was used to determine a change in frequency at the 90% confidence level.

Results

Results of the analysis are shown in Table 4 and Figure 34. Significant increases in event frequency were found in only 5% and 12% of the hourly and daily COOP stations, respectively, while significant decreases were found in 14% and 7%, respectively. No watershed showed a significant increase or decrease in kriged watershed intensity. These results suggest that significant increases in the intensity of the three event types have not occurred during the period of analysis. Perhaps most importantly, the fact that kriged watershed rainfall intensity has not increased or decreased suggests that localized changes in intensity shown in Figure 34 are smoothed out at the watershed scale. Given the lack of change in rainfall intensity it is reasonable to conclude that increases in rainfall intensity are not a driver of increased river flows over the period 1940-2009.

Table 4. Results of Rainfall Intensity Trend Analysis

Type	Number of stations or watersheds	Event depth / duration	Stations or watersheds with sig. increase	Stations or watersheds with sig. decrease
COOP hourly	87	1 inch/1 hour	4	12
COOP daily	59	2 inch/1 day	7	4
Kriged watershed	21	1.75 inch/1 day	0	0

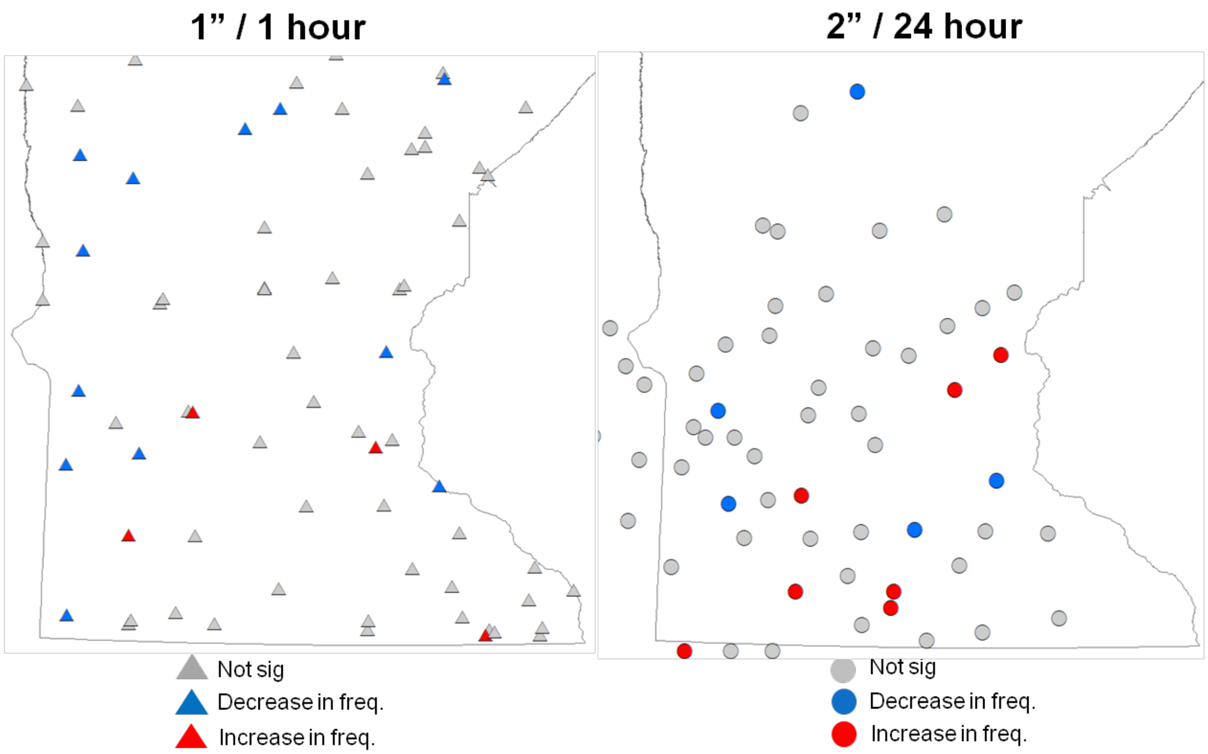


Figure 34. Changes in annual hourly and daily rainfall intensity defined as the change in frequency of 1 inch/1 hour and 2 inch/ 24 hour events, respectively, using the non-parametric Kendall-Tau test at the 90% confidence level. Results show no consistent trend in intensity indicating increases in intensity are not likely factors in observed flow increases.

2.1.4 Estimation of Changes in Potential Evapotranspiration

Evapotranspiration (ET) accounts for nearly three-fourths of Minnesota's annual water budget. In other words, most of the precipitation that falls on the landscape goes back into the atmosphere through ET. Understanding how ET has changed over time is critical to understanding how and why hydrology has changed over time. Crop conversions and artificial drainage can both affect river flow by altering evapotranspiration (ET) from the watershed. Conversion of small grains, pasture, and hay to soybeans changes the evaporative losses in the spring. The former are actively growing in the early spring and "consume water" (returning it to the atmosphere through ET) much earlier than soybeans. Artificial drainage can alter hydrology by changing water residence on the landscape and reducing the amount of time for water to be lost through ET. Changes in temperature, solar radiation and rainfall also affect annual ET. Changes in ET due to crop conversion and climate can be estimated from standard methods evaluating evaporative potential (PET). Changes in ET due to artificial drainage are less straightforward and are examined in the next section.

Method

PET was calculated using specific crop coefficients as defined by the Food and Agriculture Organization of the United Nations (FAO, 1998), the areal proportion of each crop, and an estimate of daily reference ET (RET) (see the SI). RET was calculated by Utah State University (USU, 2010) and downloaded from their climate datasets. PET was calculated by multiplying RET by crop or vegetation coefficients using the FAO method (FAO, 1998).

$$PET = RET \times fc_i \times A_i \qquad \text{(eq 3)}$$

Where fc_i is the crop coefficient for crop(i) and A_i is the areal proportion of that crop in a particular watershed in given year. Yearly crop distributions were calculated using data from the National Agricultural Statistics Service (NASS, 2010) for the years 1940-2009. RET (mm/day) was calculated using the Hargreaves and Samani equation (Hargreaves and Samani, 1985).

$$RET = 0.0023\ (T_{mean} + 17.8)\ (T_{max} - T_{min})^{0.5}\ R_a \qquad \text{(eq 4)}$$

where T_{mean} is monthly mean temperature (C^o), T_{max} - T_{min} is the difference between the daily maximum and minimum temperatures and R_a is extraterrestrial radiation (mm/day). RET was calculated by Utah State University (USU, 2010) and downloaded from their climate datasets.

Table 5. Changes in median and mean values for hydrologic parameters between two 35 year time periods, 1940-1974 and 1975-2009 (June water year). Significance of change was evaluated using the non-parametric Mann-Whitney U test. Significance using the parametric t-test on mean values is shown for comparison. Medians are less sensitive to outliers and were used to evaluate the significance of changes over time. However, to account for the effects of antecedent conditions or delayed response to climate conditions, cumulative amounts (e.g. cumulative annual water yield) divided by the number of years of measurement (e.g. 35 years) were used to in annual water budget calculations, i.e. mean values were used in the annual water budget calculations described in the main text by equations 5-10 .

	Annual Water Yield				**Annual Precip**				**Annual Runoff Ratio**				**Annual PET**			
Watershed	Change Median (cm)	Mann-Whit p value	Change Mean (cm)	t-test p value	Change Median (cm)	Mann-Whit p value	Change Mean (cm)	t-test p value	Change Median (cm)	Mann-Whit p value	Change Mean (cm)	t-test p value	Change Median (cm)	Mann-Whit p value	Change Mean (cm)	t-test p value
Blue Earth	9.33	0.043	10.13	0.011	1.84	0.579	2.47	0.455	0.14	0.014	0.10	0.006	-1.45	0.027	-1.76	0.019
Cannon	9.53	0.000	10.84	0.000	7.13	0.094	4.90	0.087	0.09	0.000	0.10	0.000	-2.10	0.049	-1.35	0.086
Cedar	9.61	0.001	9.98	0.000	10.10	0.020	7.43	0.023	0.08	0.000	0.09	0.000	-0.93	0.159	-1.33	0.137
Chippewa	4.20	0.000	4.44	0.000	2.89	0.239	2.92	0.230	0.06	0.000	0.06	0.000	0.22	0.770	0.17	0.846
Cottonwood	5.81	0.003	5.88	0.003	9.44	0.022	5.67	0.052	0.07	0.005	0.07	0.002	-1.36	0.211	-0.73	0.367
Crow	6.67	0.004	5.61	0.002	8.53	0.077	4.82	0.088	0.09	0.004	0.06	0.002	-1.54	0.014	-1.98	0.019
Crow Wing	0.06	0.718	-0.69	0.534	2.37	0.734	-0.02	0.993	-0.01	0.479	-0.01	0.434	-1.96	0.178	-0.85	0.347
Des Moines	5.79	0.012	6.97	0.002	8.73	0.040	5.52	0.064	0.08	0.007	0.08	0.002	-0.34	0.044	-1.80	0.058
Elk	1.81	0.259	2.48	0.148	-3.93	0.816	1.02	0.707	0.03	0.188	0.03	0.138	2.11	0.000	2.63	0.000
Lac qui Parle	2.23	0.087	2.61	0.028	2.30	0.910	0.07	0.976	0.04	0.054	0.04	0.022	-2.35	0.060	-1.40	0.124
Le Sueur	6.11	0.025	6.13	0.027	5.94	0.094	5.17	0.102	0.06	0.017	0.06	0.017	-2.67	0.021	-1.71	0.027
Little Minnesota	2.54	0.048	2.26	0.040	4.92	0.174	2.83	0.245	0.03	0.044	0.03	0.046	-1.89	0.156	-0.61	0.523
Lower Redwood	6.74	0.000	8.70	0.000	5.50	0.034	4.64	0.083	0.09	0.000	0.11	0.000	0.46	0.198	1.33	0.097
Pomme de Terre	2.37	0.017	2.72	0.005	2.18	0.170	2.86	0.203	0.03	0.015	0.04	0.005	0.03	0.891	-0.14	0.874
Rum	2.93	0.487	1.05	0.534	-4.50	0.290	-2.35	0.408	0.05	0.328	0.02	0.269	-2.86	0.051	-1.19	0.144
Sauk	3.52	0.023	3.00	0.024	4.53	0.071	5.25	0.056	0.04	0.019	0.04	0.028	2.75	0.002	2.59	0.001
Snake	1.51	0.853	-0.89	0.739	-5.70	0.557	-0.94	0.751	0.02	0.836	0.00	0.964	-1.07	0.994	0.67	0.511
Upper Redwood	4.43	0.004	6.71	0.001	2.99	0.225	2.95	0.263	0.07	0.003	0.09	0.001	1.14	0.023	2.06	0.011
Whetstone	0.58	0.296	1.99	0.060	1.71	0.555	1.18	0.636	0.02	0.239	0.03	0.065	-0.67	0.508	-0.30	0.719
Yellow Bank	0.07	0.428	1.81	0.097	0.84	0.672	0.74	0.749	0.01	0.379	0.02	0.105	-0.65	0.637	-0.17	0.836
Yellow Medicine	2.71	0.011	3.96	0.005	1.14	0.374	1.76	0.484	0.04	0.004	0.05	0.003	-2.50	0.039	-1.46	0.115

To simplify the method, crop types were summarized into five classes: corn, soybeans, small grains (composed of barley, flax, oats, rye and wheat), alfalfa hay and non-agricultural (composed of all remaining land uses). Daily watershed PET was estimated using the following steps: (a) mean monthly crop coefficients were calculated for the five crop classes according to FAO growth curves, (b) daily aggregate crop coefficients were determined by multiplying each monthly crop class coefficient by the corresponding yearly crop class areal proportion, and (c) PET was calculated by multiplying aggregate crop coefficient by daily RET. Because crop distributions have changed over time (e.g., less small grains, more soybeans) PET was evaluated on a yearly basis. Yearly crop distributions were calculated using data from the National Agricultural Statistics Service (NASS, 2010) for the years 1940-2009. The crop data were compiled for all counties within the study area. ArcGIS 9.2 was used to calculate annual area-weighted crop distributions at the watershed scale from the county level data. This calculation yielded watershed proportions of each crop class for each year in the study period.

Several important assumptions were required to implement this PET calculation approach: (i) FAO crop growth curves (i.e., days to maturity, harvest, senescence, etc.) were the same regardless of watershed, (ii) planting dates for corn, soybeans and all other crop classes were 4/25, 5/10 and 4/1, respectively, regardless of year or watershed, (iii) the non-agricultural crop class coefficient was the mean of FAO warm- and cool- season grass crop coefficients.

Results

Estimation of changes in PET for the two time periods is summarized in Table 5. The cropping trend in the watersheds was the conversion of small grains, hay, and pasture to corn and soybeans (figure 16.)The method outlined above was sensitive to this trend, and therefore a relatively large decrease in May-June PET (driven by conversion to soybeans) was predicted. However, the predicted May-June decrease was offset somewhat by a predicted July-August increase (due to peak corn and soybean FAO crop coefficients being greater than those in the small grain class), resulting in a small decrease in predicted annual PET. This decrease in PET is consistent with the work of Schilling (Schilling *et al*., 2008; Zhang and Schilling, 2006) conducted in agricultural watersheds of Iowa. The seasonal influence of changes in ET on seasonal flow patterns was beyond the scope of this study but warrants additional investigation.

Result 2: Deliverable 2.

COMPARATIVE ASSESSMENT OF WATERSHEDS TO DETERMINE EFFECT OF DRAINAGE AND CLIMATE ON HYDROLOGY.

INTRODUCTION

Our seasonal and multi-watershed comparisons (Section 2.1.1 and Figures 30, 31) lead to several important conclusions: first, river flow during the early growing season has increased dramatically in certain watersheds, and second, the increase is not proportional to changes in precipitation. The comparative design strategy in this study is powerful and raises the question, why do some watersheds show large hydrologic changes, while others nearby and experiencing the same climatic vagaries do not?

Examination of land-use changes among the watersheds sheds light on why some and not others have experienced such large changes in hydrology. The change in runoff ratio is highly correlated with the magnitude of mid-century crop conversion to soybeans in each watershed (Figure 35a). Conversion to soybeans encompasses two important mechanistic drivers leading to more water entering the rivers – changes in crop ET, and reduction in ET from depressional areas owing to expansion of artificial drainage. Separation of these two components of the water budget is important for effective mitigation of flow and sediment impairments.

Conversion to soybeans has largely displaced forage crops and small grains that actively grow early in the spring and reduce available soil moisture through ET. In contrast, soybeans do not begin consuming water through ET until nearly a month later because they are planted in late spring. The conversion to soybeans thus changes the seasonal loss of upland ET, allowing a greater proportion of precipitation to enter the rivers.

Yields of corn and soybeans benefit greatly from enhanced subsurface drainage, and it is not surprising that 20th century drainage intensification is coincident with the crop conversion trends (Blann *et al.*, 2009; Dahl and Allord, 1996; Kuehner, 2004). The concurrent trends of crop conversion and drainage over the past 70 years confound the ability to draw cause and effect relationships to changes in flow. The amount of poorly drained soil in a watershed is a crude surrogate for the amount of artificial drainage and predicts changes in runoff ratio (Figure 35b) nearly as well as predicted by conversion to soybeans (Figure 35a). These two relationships demonstrate that correlative trends are only a first step in understanding changes in flow, and a rigorous water balance is necessary to quantify the role of each driver.

Artificial drainage, which includes ditching, sub-surface tiling with and without surface inlets, and wetland drainage, affects water yield in two fundamental ways: by permanent decreases in residence time of water on the landscape (thereby reducing evaporative losses) and through continuous incremental installation of sub-surface tile and the attendant one-time reduction in soil profile storage. Although sub-surface pattern tiling continues to be installed on the landscape, changes in storage are probably a minor component of long-term water budgets. For example, if sub-surface tile were incrementally installed over 35 years, lowering the water table by a maximum of 1.25 m (the depth of tile installation) across a watershed with 50% poorly drained soils (an upper value for our watersheds, see SSURGO, 2009) and drainable porosity of 30 percent, this would produce an increase in annual water yield of only ~0.5 cm. This rough calculation is a maximum estimate, and demonstrates that while changes in storage are not zero, they are small. For the purpose of this study, small changes in storage due to drainage are indistinguishable from the larger effect of evaporative losses due to artificial drainage and are thus combined into the single term, $\Delta ET_{drainage}$.

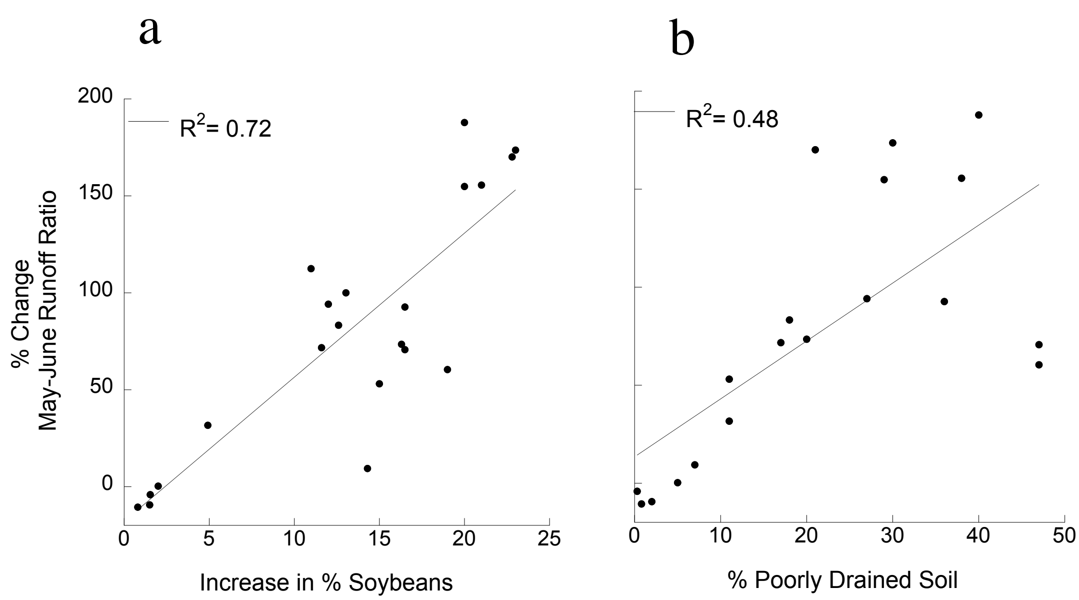


Figure 35. Relationship of conversion to soybeans (a) and poorly drained soils (b) to increases in May-June runoff ratio. The amount of cultivated land that is classified as poorly drained is a crude surrogate for the amount of artificial drainage expected in a watershed. For runoff ratio and conversion to soybeans, change over time is expressed as the difference between the median value of the two time periods: 1940-1974 and 1975-2009. Both conversion to soybean and amount of poorly drained soil correlate well with changes in runoff ratio, making specific cause and effect relationships difficult to disentangle.

The larger impact of artificial drainage on the hydrologic budget is through reduction in ET losses from depressional areas (loss of residence time). These depressions range from former wetlands with significant residence time to extensive ephemeral ponded water in fields. In all cases artificial drainage reduces the amount of time that water is on the landscape and can be lost to ET. Artificial drainage continues to be installed to enhance crop yields on these poorly drained areas, and in much of the Midwestern corn-belt 30-80% of the land is estimated to have some form of tile drainage (Sugg, 2007). Our estimates for the loss of depressional areas using the Restorable Wetlands Inventory (USFWS a, 2011; USFWS b, 2011) datasets show that watersheds with poorly drained soils and a high percentage of cultivated land have high losses of depressional areas (Section 1.1.4, Figure 14). In these watersheds nearly all of the natural wetlands and depressional areas have been altered by drainage, representing a profound hydrological modification of up to 20% of the total watershed area (Figure 14).

2.2.1 Apportionment of Changes in Water Yield.

To separate and quantify the role of crop conversion, rainfall and drainage as drivers of changes in flow it is necessary to construct a water balance model. In general, we used the first time period, 1940-1974, to calibrate the relationship of flow to PET and rainfall, and then applied this model to the 1975-2009 time period to estimate the amount of flow that should result from rainfall and PET conditions in the second time period. With changes in climate and crop conversion accounted for in PET and rainfall measurements, the difference between the estimated flow and measured flow can be attributed to artificial drainage.

Method

Over the long-term (years to decades) changes in river flow can be expressed fundamentally as a function of precipitation and ET (Wang and Hejazi, 2011)

$$\Delta Q = \Delta P - \Delta ET \quad \text{(eq. 5)}$$

where changes in mean annual water yield (ΔQ) and precipitation (ΔP) between the two periods (1940-1974 and 1975-2009) are measured values. Recognizing that there are multiple mechanisms for ET, this expression can be expanded to:

$$\Delta Q = \Delta P - \Delta ET_{climate} - \Delta ET_{crop} - \Delta ET_{other} \quad \text{(eq. 6)}$$

Total evapotranspiration can change over time due changes in precipitation, temperature and solar radiation ($\Delta ET_{climate}$) or because of changes in vegetation due to crop conversions (ΔET_{crop}). ET_{other} represents changes to the water budget that are not captured in the estimation of $ET_{climate}$ or ET_{crop}. The watersheds in this study have negligible irrigated land and minimal population changes upstream of the monitoring stations (UMN, 2010), but many have extensive artificial drainage networks (Sugg, 2007). Thus, in the absence of any other drivers to ET, it is reasonable to hypothesize that ET_{other} is the result of drainage, and

$$\Delta ET_{other} \cong \Delta ET_{drainage} \quad \text{(eq. 7)}$$

Changes in actual ET cannot be measured directly, but a relationship between calculated PET and measured water yield for the first time period can be developed and used to predict Q in the second period. The difference between the predicted and measured water yield in the second period is the change in water yield due to non-crop, non-climate factors. To evaluate the contributions of climate and

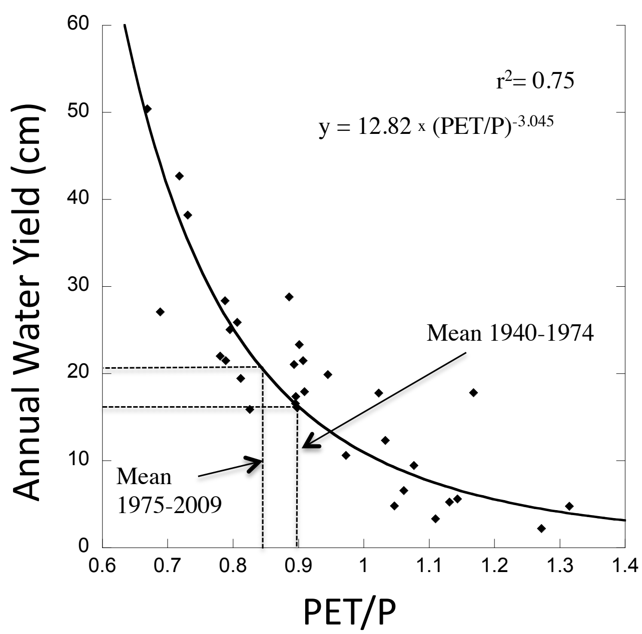


Figure 36. Calibration of the response of water yield to climate, precipitation, and cropping characteristics using annual values for the initial 35 year period (1949-1974): an example for the Blue Earth watershed. The mean PET/P ratio changed from 0.9 to 0.85 from the first period to the second (dashed lines). Applying this change in PET/P to the calibration curve, predicts a 3.35 cm increase in annual water yield in the second time period due climate and crop conversions combined.

crop-ET to changes in flow, we first calibrated the relationship of water yield to PET and precipitation (P) over the initial 35-year period (1940-1974) (see Figure 36 for example). This relationship is non-linear and can be expressed as a unique power function for each watershed:

$$Q = A \times (PET/P)^{-B} \qquad \text{(eq. 8)}$$

where A and B are empirical coefficients, and Q is the predicted annual water yield. Change in water yield due to crop conversion and changes in climate between the two time periods ($\Delta Q_{climate + crop}$) is estimated by solving equation 8 using the mean PET/P ratio for each period and subtracting the two values (Equation 9). To estimate a representative PET/P ratio for a 35-year period, mean PET/P is defined as cumulative PET divided by cumulative P for each time period.

$$\Delta Q_{climate + crop} = A \times ((PET/P)^{-B}_{75\text{-}09} - (PET/P)^{-B}_{40\text{-}74}) \qquad \text{(eq. 9)}$$

This method, using a calibrated response to PET/P in one time period to apportion changes in a second time period, is similar to that used by Wang and Hejazi (2011), but here directly relates PET and P to measured water yield.

The change described by equation 9 can be further apportioned between climate and crop conversion using the relative changes in the variables used to calculate the PET:P ratio. The combined change in water yield ($\Delta Q_{climate + crop}$) predicted by changes in PET and P is proportional to changes in P, RET and fc and can be partitioned between climate and crop by comparing the relative changes in the three variables (equations 10 and 11)

$$\Delta Q_{crop} = \Delta Q_{climate + crop} \text{ x } [\ \%fc/(\%RET + \%P + \%fc)] \qquad \text{(eq.10)}$$

$$\Delta Q_{climate} = \Delta Q_{climate + crop} \text{ x } [(\%RET + \%\ P)/(\%RET + \%P + \%fc)] \qquad \text{(eq. 11)}$$

Where %RET and %P are the relative changes in RET and P respectively between the two time periods. Because PET is RET multiplied by each areally weighted crop coefficient, the relative change in mean crop coefficient (%fc) is simply the mean PET:RET of period two divided by the mean PET:RET ratio of period one.

The change in water yield due to drainage is then estimated by difference from the measured total change in water yield ($\Delta Q_{measured}$) between the two periods.

$$\Delta Q_{drainage} = \Delta Q_{measured} - \Delta Q_{climate} - \Delta Q_{crop} \qquad \text{(eq.12)}$$

Results

The method used in this study to apportion increases in water yield shows that changes in precipitation (climate) and crop ET account for only a fraction of the total change in water yield (Figure 37). In our study watersheds, PET/P changes by less 10% between 1940-1974 and 1975-2009, and this relatively small change in climate and crop conversion is simply not enough to account for a >50% increase in water yield. The surplus water yield is a consequence of other changes to ET, namely large reductions in depressional ET resulting from artificial drainage. While changes in annual water yield vary considerably among the 21 watersheds, on average more than half of the change is attributable to drainage (Figure 37). Three of our watersheds were also studied by Wang (2011) with comparable results, where less than half of the increase in water yield observed from 1948-2003 could be explained by climate alone. Our study offers additional insight into the non-climate drivers of change.

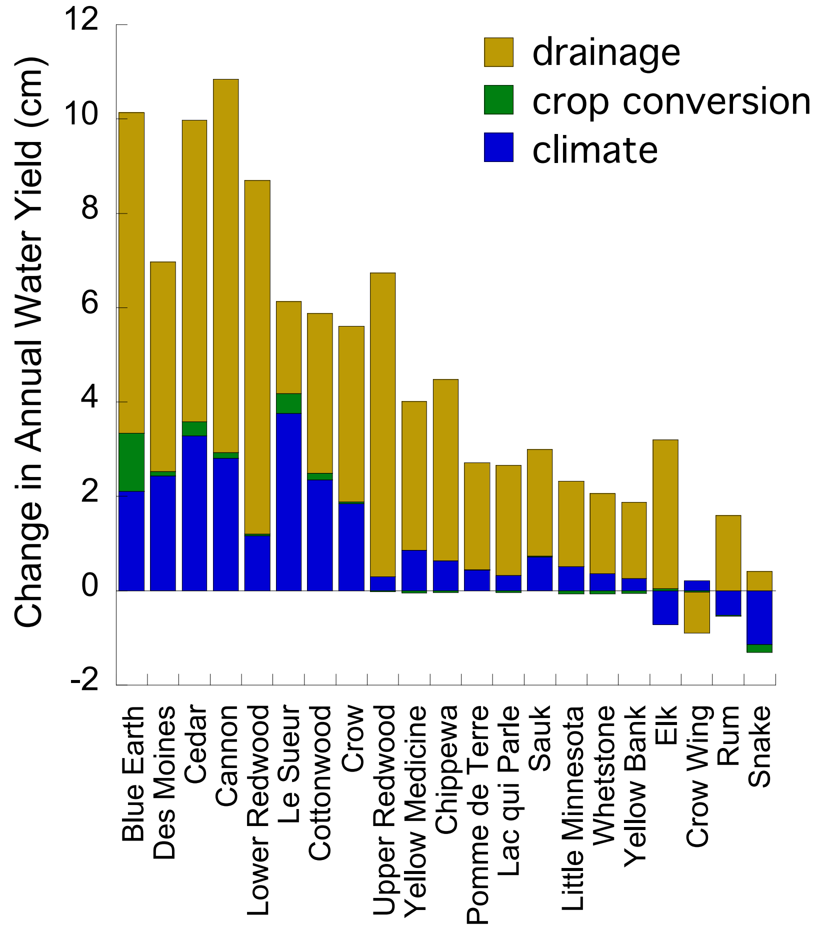


Figure 37. Apportionment of changes in mean annual water yield for each watershed. In rivers with significant changes in flow, climate and crop conversions account for less than half of the total change in water yield. Excess water yield is the portion that cannot be attributed to changes in crop-ET and climate and is hypothesized to result from artificial drainage ($\Delta Q_{drainage}$).

The total change in water yield not accounted for by climate and crop conversion represents the excess water yield that must result from other drivers – specifically, artificial drainage, as we hypothesize above. A principle purpose of artificial drainage is to facilitate agricultural practices by reducing the amount of time water is ponded in a field. The success of drainage in meeting this intent is unquestionable. Quickly routing ponded water through drainage systems reduces the amount of time available for ET and increases the proportion of precipitation that ends up as river flow. This attribution is supported by the correlation of excess water yield with the estimated loss of wetlands and depressional areas in each watershed (r^2 = 0.6; Figure 38). This relationship strongly suggests that artificial drainage – the rapid removal of water from depressional areas, which significantly reduces depressional ET – is a major driver of increased river flow. This analysis cannot define which forms of artificial drainage or pathways are most important. What is clear is that precipitation that was once lost to ET is now being transported to the rivers.

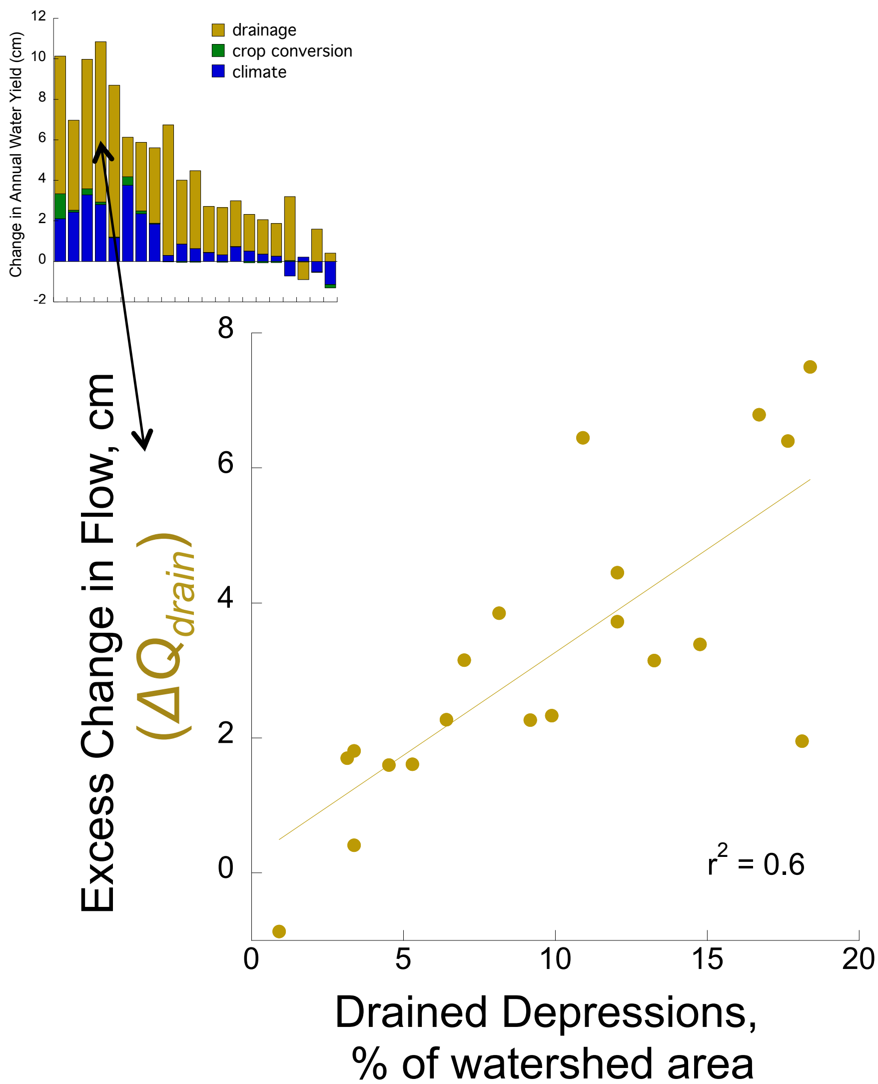


Figure 38. Correlation between the increase in water yield attributed to drainage ($\Delta Q_{drainage}$) and the loss of depressional areas. The increase in water yield that could not be attributed to climate or crop conversions was hypothesized to result from artificial drainage (see figure 37). While correlative, the strong relationship between drained depressional areas and $\Delta Q_{drainage}$ offers supporting evidence for this hypothesis- that drainage is a driver of increased flow. Estimation of drained depressional areas is discussed in Result 1.1.4

Result 2: Deliverable 3

CORRELATION BETWEEN TRENDS IN DRAINAGE AND SEDIMENT ACCUMULATION RATES IN LAKE PEPIN.

2.3.1 RELATIONSHIP OF CHANNEL WIDENING TO CHANGES IN FLOW

In the results above we confirm that about half of the rivers in this study have had significant increases in flow and changes in hydrologic characteristics over the past 70 years. This means that these rivers have potentially become more erosive, but the flow changes alone do not prove this assertion. To support this assertion it is important to document actual changes in erosive features along the rivers. Increases in stream channel width are one possible outcome of increased flows and provide measureable evidence of changes in river erosivity. A river that has had a stable flow regimen over a long period will have a channel width that is in equilibrium with this flow. It may have eroding banks but this will be balanced by depositional point bars and the net channel width over a given reach will not change. If flows increase, the stream will need to adjust to this new energy and this may result in either downcutting, channel widening, or changes in sinuosity. For this study, we quantified channel widening for several watersheds using historical aerial photography dating back to the late 1930s. Channel widening estimates were done with assistance from Dr. Patrick Belmont, Utah State University and Dr. J. Wesley Lauer, Seattle University.

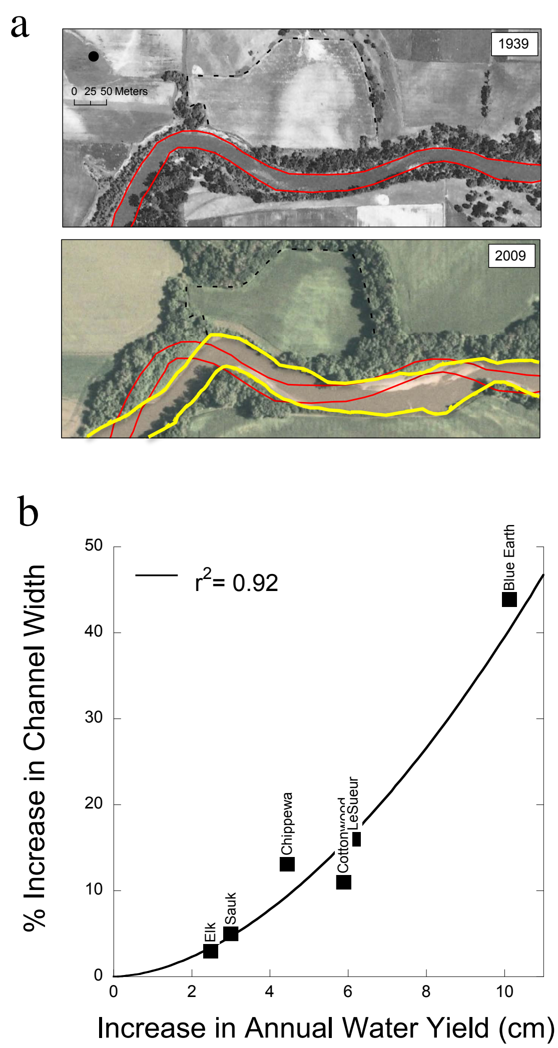


Figure 39. Channel widening related to increases in flow. (a) Photos show widening on the Blue Earth River. Red line is the bankfull width in 1939; yellow line is 2009. (b) Widening is the percent change in mean width between the two time periods (1940-1974 vs. 1975-2009) and is strongly related to the increase in annual water yield. The four rivers with the greatest amount of widening are all tributaries to the Minnesota River, which has experienced a 33% increase in mean channel width over the same time period.

Methods

Channel width was measured by digitizing polygons representing the active channel, defined by vegetation boundaries, on historic and recent air photos. Polygons were approximately ten meander bends long and the area of each polygon was divided by polygon length to obtain a reach-average width. Measurements were made on a minimum of four and as many as 12 sets of air photos for each location (Table 6). Each location had a set of air photos dating back to 1937-1939, which provides the oldest channel width measurement used in this study. Multiple air photo sets were available between 2000 - 2010 for most locations, providing multiple constraints on modern channel widths as well as an estimate of uncertainty associated with bank classification. Typical channel widths for tributaries ranged from 30-60 m for tributary channels and 85-105 m for the mainstem Minnesota River. Typical reach lengths ranged from approximately 5 -10 km.

Results

Table 6. Channel widening summary for six study watersheds and the mainstem Minnesota River. Numbers in parentheses are one standard deviation of all measured channel widths for a time period.

Reach Name	Midpoint Coordinate	Photograph Years	Mean Bankfull Width (m) Pre-1975	Mean Bankfull Width (m) Post- 1975
Minnesota R.@ Jordan	93°37'29"W, 44°42'49"N	1937, 1940, 1951, 1963, 1964, 1991, 2003, 2004, 2005, 2006, 2008, 2009	82.8 (8.3)	105.5 (2.8)
Minnesota R. @ Ft. Snelling	93°27'46"W, 44°48'23"N	1937, 1940, 1951, 1960, 1962, 1967, 1971, 1991, 2003, 2004, 2005, 2006, 2008, 2009	74.4 (5.8)	90.4 (1.1)
Minnesota R. @ Judson	94°7'34"W, 44°10'56"N	1938, 1949, 1950, 1958, 1964, 1971, 1991, 2003, 2004, 2005, 2006, 2008, 2009	56.4 (9.7)	85.4 (7.3)
Cottonwood R.	94°32'33"W, 44°17'11"N	1938, 1955, 1991, 2003, 2004, 2005, 2006	35.6 (3.7)	39.5 (1.4)
Le Sueur R.	94°01'51"W, 44°06'26"N	1939, 1949, 1950, 1958, 1964, 1971, 1991, 2003, 2004, 2005, 2006, 2008	39.0 (4.6)	45.3 (2.7)
Blue Earth R.	94º05'52"W, 44º01'59"N	1939, 1949, 1973, 1991, 2003, 2004, 2005, 2006, 2008, 2009	35.8 (1.9)	51.5 (3.3)
Chippewa R.	95º47'43"W, 45º05'57"N	1938, 1956, 1991, 2003, 2006, 2008, 2009, 2010	30.7 (1.1)	34.7 (1.5)
Sauk R.	94º19'37"W, 45º 29'8" N	1938, 1958, 1978, 2004	31.2 (2.1)	32.9 (0.7)
Elk R.	93º40'20"W, 45º20'56"N	1939, 1953, 1991, 2009	40.4 (3.0)	41.8 (0.5)

Changes in channel width for six tributaries and three reaches along the mainstem of the Minnesota River are presented in Table 6. For the six watersheds quantified, channel widening was related to the historic increase in water yield (Figure 39), which in turn is a function of crop conversion in general, and artificial drainage in particular. Rivers that experienced only small changes in water yield have responded with similarly small changes in channel width, while those with large increases in water yield have increased their widths by 10-42%.

Figure 39 presents a strong relationship between changes in water quantity (water yield) and channel widening but does not describe which flows are responsible for the instability. However, examination of flow duration curves (see Result 2.1.2) in watersheds with significant increases in annual water yield shows that nearly all flow regimes have increased since 1940 (Figure 32 for example). The excess water yield is manifest not only as increases in baseflow as shown by studies in other agricultural watersheds (Schilling and Helmers, 2008; Zhang and Schilling, 2006) but also as increases in the duration of high flows (Figure 33). Interestingly, the very highest flows, those with exceedance probabilities of <0.1 percent have not increased over the 70 year record.

The results presented here clearly demonstrate that changes in flow have increased river erosivity, however it is not clear which flows (high flows, flow volume, high flow duration) need to be managed in order to reduce channel widening. The relationship between changes in flow volume and flow rate as conditions for channel widening warrants further investigation.

2.3.2 Correlation to Lake Pepin Sediment Trends

These changes in hydrology have important water-quality consequences: increased river erosion including stream-channel widening, which results in greater sediment export and increased river turbidity. The increase in sediment loading over the past century is reflected in sediment cores from Lake Pepin. Not only have sediment loads increased since the onset of modern agriculture (Engstrom *et al*., 2009), but over 50% of the present-day load is from non-field sources (Belmont *et al*., 2011; Johnson *et al*., 2009; Schottler *et al*., 2010). Importantly, over 40% of this sediment load is delivered in the May-June period (MCES, 2010). These observations are consistent with the seasonal increases in flow and channel widening documented here.

Source apportionment coupled with sediment accumulation rates in Lake Pepin suggest that eroded inputs from streambanks and channel bluffs has increased nearly 5X over pre-European settlement conditions (Schottler *et al*., 2010). The observed increase in sediment loading from near channel sources was a basis for the hypothesis that rivers have become more erosive over time. While there are multiple causes for this change, the hydrologic and channel widening changes shown in this study are correlated with the increases in sediment loading to Lake Pepin, thus implicating artificial drainage in combination with climate as an important driver of increased suspended sediment loading.

Results

Figure 40 highlights four key time trends that illustrate the linkage between artificial drainage and Lake Pepin sediment loads. Although the relationships in figure 40 are correlative, they are mechanistically linked and offer strong supporting evidence that artificial drainage has created more erosive rivers with increased suspended sediment loads. The linkage presented in figure 40 fits together as follows:

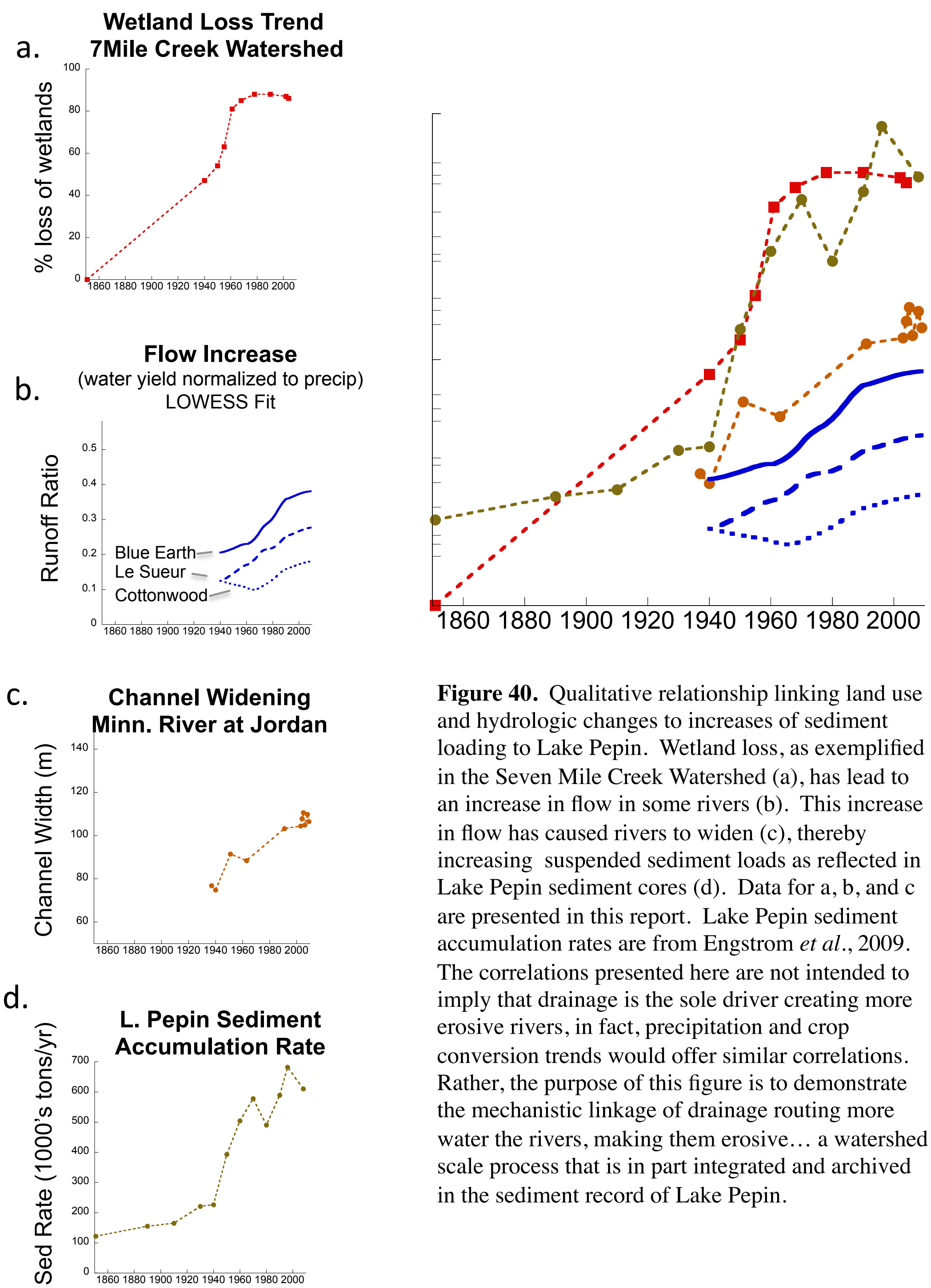


Figure 40. Qualitative relationship linking land use and hydrologic changes to increases of sediment loading to Lake Pepin. Wetland loss, as exemplified in the Seven Mile Creek Watershed (a), has lead to an increase in flow in some rivers (b). This increase in flow has caused rivers to widen (c), thereby increasing suspended sediment loads as reflected in Lake Pepin sediment cores (d). Data for a, b, and c are presented in this report. Lake Pepin sediment accumulation rates are from Engstrom *et al*., 2009. The correlations presented here are not intended to imply that drainage is the sole driver creating more erosive rivers, in fact, precipitation and crop conversion trends would offer similar correlations. Rather, the purpose of this figure is to demonstrate the mechanistic linkage of drainage routing more water the rivers, making them erosive… a watershed scale process that is in part integrated and archived in the sediment record of Lake Pepin.

Wetland loss. Artificial drainage reduces residence time in wetlands and depressional areas, thereby reducing ET from the landscape and routing this water to the rivers. In other words, because of artificial drainage, a greater proportion of precipitation is routed to the rivers rather than returned to the atmosphere through ET. Wetland loss in Seven Mile creek (see Result 1.2.1, and Figure 40a) was used to illustrate this time trend.

Runoff Ratio. With a greater proportion of precipitation routed to the rivers, seasonal and annual flow volumes increase. LOWESS fits of trends in the runoff ratio of the Cottonwood, LeSueur, and Blue Earth rivers illustrate how the proportionality between flow and precipitation has increased over the last 70 years (Figure 40b). These rivers were chosen for this illustration because they supply over one-third of the annual sediment load to the Minnesota River.

Channel Widening. Increases in river flow lead to channel widening. The trend in channel widening along the Minnesota River at Jordan mirrors the change in runoff ratio of the major tributaries (Figure 40c).

Pepin Sediment Loading. Channel widening increases the total suspended sediment load in the rivers. Time trends in annual suspended loads are reflected in the accumulation rates recorded in Lake Pepin sediment cores (Figure 40d).

The information presented in figure 40 cannot be used to quantify the amount of sediment loading caused by artificial drainage, and is not meant to imply the drainage is the sole driver of changes in sediment load. The purpose of this exercise was to show that mechanisms linking drainage, flow and channel widening are consistent with the time trends in Lake Pepin and support the hypothesis that drainage has created more erosive rivers.

CONCLUSIONS

Increased flow and sediment loading from our study watersheds is a serious problem for the Minnesota and upper Mississippi rivers, where such changes have been noted but without adequate explanation. The findings presented in this study have implications for the entire intensively cultivated corn belt of the Midwest USA, where former wetland depressions have been drained, and in general wherever agricultural drainage has reduced water residence on the land surface. Twentieth century crop conversions and the attendant decreases in ET from depressional areas due to artificial drainage have combined to significantly alter watershed hydrology on a very large scale, resulting in more erosive rivers. While the widening we document cannot continue indefinitely, particularly if future increases in discharge are modest, chronically high discharges could result in essentially permanent increases in sediment supply originating from the toe of bluffs and from the erosion of high streambanks through natural bank migration processes.

Apportionment of causes of changes in flow in this study and others tend to focus on annual measurements. The seasonal differences highlighted in Figure 30 deserve additional investigation, as the effects of climate versus land-use could be different at different times of the year. This point becomes especially salient as strategies to manage excess water and channel widening develop. While the impact of agriculture on the world's rivers is highly variable (Walling and Fang, 2003), the results from this study offer an important lesson: crop conversions that require artificial drainage pose a risk to riverine water quality. Efforts to mitigate excessive sediment loads and turbidity must include strategies to manage watershed hydrology and reverse conditions contributing to higher river flows.

ACKNOWLEDGEMENTS

We thank the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources and the Minnesota Pollution Control Agency, Section 319 program for funding this project. We appreciate the contribution of Drs. Patrick Belmont (Utah State University, Utah) and J. Wesley Lauer (Seattle University, Washington) for their assistance in estimating channel widening. These channel width estimate are the product of excellent GIS the work by their students: Caitlyn Echterling, Jenny Graves, Justin Stout and Shannon Belmont. We also thank Dr. Xuesong Zhang for his assistance in creating the kriged watershed precipitation dataset.

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V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel:	$ 112,200
Contracts:	$ 150,000
Equipment/Tools/Supplies:	$ 2,800
Other (Graduate Student stipend):	$ 35,000

TOTAL TRUST FUND PROJECT BUDGET: $ $ 300,000

Explanation of Capital Expenditures Greater Than $3,500: None

VI. PROJECT STRATEGY:

A. Project Partners:

Result 1 will be contracted to Minnesota State University-Mankato, Water Resources Center. Staff in the MSU-Water Resources center has extensive experience in delineating and mapping artificial drainage systems. The Water Resources Center (WRC) at Minnesota State Mankato was created in 1987 to serve as a regional center for environmental research and information exchange. The WRC staff has completed drainage inventory projects for the Blue Earth River Basin and a drainage ditch buffer study for the Board of Water and Soil Resources. The WRC has also been coordinating numerous TMDL projects and have several ongoing research studies involving the hydrologic, nutrient, and bacterial influences of tile on water quality.

B. Project Impact and Long-term Strategy:

Findings from this project will be paramount in guiding statewide decision making on water quality issues statewide and will directly affect implementation strategies for turbidity TMDLs. Results will provide some of the first watershed scale quantification on the effect of tile drainage on hydrology.

C. Other Funds Proposed to be spent during the Project Period:

The Minnesota Pollution Control Agency (MPCA) will provide $300,000 in matching funds secured from EPA sponsored section 319 funds. This matching money will be distributed between the SCWRS and MSU-WRC, with 60% of the funds going to the SCWRS.

D. Spending History:

Funding from MPCA ($297,000) Lake Pepin TMDL to fingerprint sediment sources. Original funding to develop sediment fingerprinting method provided by LCMR, 1999, $350,000.

VII. DISSEMINATION:

Results of this study have been submitted for publication to the journal Hydrological Processes and have been accepted pending final review. Summaries and findings and implications of this study have been presented at more than 30 technical meetings in Minnesota and nationally. Many of these presentations have been in conjunction with local watershed groups, and have an audience of County Commissioners, farmers, SWCD staff, and agricultural consultants. These meetings have been highly successful at delivering the findings of this study to people who are directly involved in watershed management but are less likely to attend scientific meetings or read scientific journals.

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports were submitted in February and August of 2010, 2011 and 2012. The above document is submitted as the final report for this project.

IX. RESEARCH PROJECTS: Original Research addendum is available upon request

Project Title: Intensified Tile Drainage Evaluation

Project Manager Name: Shawn Schottler

Trust Fund Appropriation: $ 300,000

2009 Trust Fund Budget	**<u>Result 1 Budget:</u>**	**Amount Spent Previous**	**Amount Spent this period**	**Total Amount Spent**	**Balance 8-1-11**	**<u>Result 2 Budget:</u>**	**Amount Spent previous**	**Amount Spent this period**	**Total Amount Spent**	**Balance 8-1-11**	**TOTAL BUDGET**	**TOTAL BALANCE**
	Quantification of extent of artificial drainage					Comparative assessment of hydrologic changes						
BUDGET ITEM												
PERSONNEL: wages and benefits Shawn Schottler (30% time, 3 yrs = $74,400) Jim Almendinger (25% time, 2 yrs= $37,800)						112,200	105,000	7,200	112,200	0	112,200	0
Explanation of Benefits: FTE's only = 28% Medical: Single ~$200/month, Family ~720/month Retirement- Employer Contribution = 4% of salary												
Contracts												
Professional/technical (Minnesota State University-Mankato; Water Resource Center. Responsible for completing Result 1)	150,000	103,806	46,194	150,000	0						150,000	0
Supplies lab supplies						2,800	2,000	800	2,800	0	2,800	0
Other **Graduate Student stipend**						35,000	35,000	0	35,000	0	35,000	0
COLUMN TOTAL	**$150,000**	$103,806	$46,194	**$150,000**	**$0**	**$150,000**	$142,000	$8,000	**$150,000**	**$0**	**$300,000**	**$0**

2010 Project Abstract
For the Period Ending June 30, 2012

I. PROJECT TITLE: A Citizen-Based Approach to Stormwater Management: Raingardens to Improve Impaired Waters

PROJECT MANAGER: Becky Rice
AFFILIATION: Metro Blooms
MAILING ADDRESS: P.O. Box 17099
CITY / STATE / ZIP: Minneapolis, MN 55417
PHONE: (612) 865-0248
E-MAIL: becky@metroblooms.org
WEB SITE: www.metroblooms.org

FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: ML 2009, Chap.143, Sec.2, Subd. 5e

APPROPRIATION AMOUNT: $ 279,000.00

The long term success in reducing impairments to local water bodies will require better citizen-based approaches to increase public awareness and affect behavior change. This project demonstrates a fast-paced approach to citizen engagement for the installation of raingardens within a 28-acre area that drains to Powderhorn Lake (Minneapolis). A paired watershed study was undertaken to evaluate the effectiveness of raingardens in reducing runoff and pollutant loads generated solely on private property.

230 community members participated in project installation events and activities demonstrating the connection between runoff and water quality of Powderhorn Lake. Approximately 50% of homeowners in the test neighborhood received a free raingarden for a total of 125 project-installed raingardens. Two congregations also installed raingardens and permeable pavement strips in their parking lots. Youth and young adult job programs excavated and planted the majority of gardens. More than 70,000 sq. ft. of impervious area was redirected to a stormwater best management practice (BMP). Additionally, 50% of participants also exhibited behavior change by taking voluntary steps to reduce run off from their property (redirecting downspouts, installing rainbarrels, or additional raingardens).

Performance was measured by monitoring the quality and quantity of stormwater discharged to Powderhorn Lake from the test and control sites and comparing results. Minneapolis Park and Recreation Board installed and maintained equipment for three years, providing stormwater runoff characteristics before and after raingarden installation.

Fewer water quality samples were collected than planned due to challenges posed by the urban storm sewer system and climatic conditions. While the paired watershed analysis results do not show a statistically significant outcome, the few water quality samples collected in 2011 provide promise that the test neighborhood efforts could have reduced pollutant loads when compared with the control area. Continued stormwater monitoring is planned in both areas (funded by the City of Minneapolis).

Project Results Use and Dissemination

The project has continued to engage others in similar efforts across the Twin Cities metropolitan area, including 14 additional Neighborhood-of-Raingardens style projects led by Metro Blooms and another 170+ raingardens installed.

Neighborhood of Raingardens is also a film produced by University of Minnesota's Mark Pedelty, and funded by the Institute on the Environment. The film gives an introduction to raingardens and stormwater runoff and highlights the Powderhorn Park project. It aired on the MN Channel (TPT MN) on April 22, 2011 at 7:30pm, with repeats on April 23, 2011 at 1:30am and 7:30am, and during the month of June. The film has been shown at neighborhood events and co-ops and is available to be viewed online or for download at www.raingardenmovie.org.

Metro Blooms has a created a Powerpoint presentation on the project, which has been presented to the Watershed Partners and Blue Thumb partners, as well as staff of the Ramsey Washington Metro Watershed District. We will be presenting our project at the2012 Water Resources Conference, a state-wide event that showcases innovative, practical, and applied water resource engineering solutions, management techniques, and current research about Minnesota's water resources.

All project partners received a copy of the final report and executive summary. All project participants received a copy of the executive summary with accompanied raingarden maintenance brochure. The full report and executive summary are available on our website at www.metroblooms.org/neighborhood-of-raingardens.org. Additional copies of the executive summary will be made available at outreach events and upon request, while supplies last.

Environment and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report: August 31, 2012
Final Report: June 30, 2012
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2012

I. PROJECT TITLE: A Citizen-Based Approach to Stormwater Management: Raingardens to Improve Impaired Waters

Project Manager: Becky Rice
Affiliation: Metro Blooms
Mailing Address: P.O. Box 17099
City / State / Zip: Minneapolis, MN 55417
Telephone Number: (612) 865-0248
E-mail Address: becky@metroblooms.org
FAX Number: N/A
Web Site Address: metroblooms.org

Location: *Powderhorn Park Neighborhood, Minneapolis, Hennepin County*

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$ 279,000.00**
	Minus Amount Spent:	**$ 276,159.56**
	Equal Balance:	**$ 840.44**

Legal Citation: ML 2009, Chap.143, Sec.2, Subd. 5e

Appropriation Language: $279,000 is from the trust fund to the commissioner of natural resources for an agreement with Metro Blooms, in cooperation with Minnehaha Creek Watershed District and the city of Minneapolis, to install and evaluate the effectiveness of raingardens on improving the impaired water of Powderhorn Lake in Minneapolis. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. FINAL PROJECT SUMMARY:

Education and action influenced community members to improve Powderhorn Lake water quality.

Citizen Engagement Methods Key to Successful Outcomes

- Enlist local champions of stormwater management to reach out to community members.
- Use a combination of outreach methods: workshops, mass mailings, door knockers, neighborhood home meetings, and canvassing.
- Include multi-lingual staff and community members to engage non-english speaking community members.
- Use a non-profit organization for outreach and implementation to offset skepticism associated with a private firm or city-led effort.
- Provide an economic incentive and a well-crafted, educated message.

Project Vision
The long-term success in reducing impairments to urban lakes and waterways will require better citizen-based approaches to increase public awareness and effect behavior change. A coordinated plan is also required that focuses efforts on areas and stormwater management practices providing the best benefits to the impaired receiving waters. This project evaluated community outreach approaches through a pilot study of the fast-tracked installation of over 100 raingardens in a 28-acre sub-watershed draining to Powderhorn Lake, Minneapolis. Stormwater best management practices (BMPs) were restricted to installations on private property. Stormwater monitoring was also integrated into the project to assess whether reductions in pollutant loadings or volume could be detected and provide support for future water quality improvement plans for Powderhorn Lake.

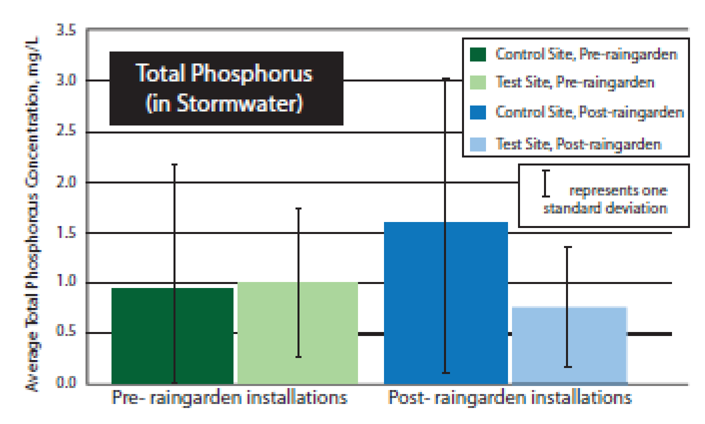
Citizen-Based Approach to Stormwater Management – Neighborhood of Raingardens
The term "Neighborhood of Raingardens" was created to define the collective approach to implementing stormwater management practices clustered in neighborhood areas. The goal is to educate citizens on the ways they can have a positive effect on the local water quality through a variety of methods such as: raingardens, permeable pavers, green roofs, rain barrels, native plantings, boulevard plantings and yard maintenance. Raingardens serve as a visible tool and 'hook' to gain citizen interest and encourage neighbor participation. The large-scale community participation process not only teaches participants about water quality protection, but it also builds a stronger and more beautiful community through increased community outreach.

Methods
The project was developed through three phases: citizen engagement, design, and installation. Measurement activities preceded and occurred throughout the project.

Participant Process
Metro Blooms' general approach to citizen-based stormwater management projects involves the property owner throughout the process. For this project, the property owners were presented the large incentive of free design and installation services, as well as free garden plants and materials. Because this was a fast-paced project, it was difficult for most property owners to be involved in the installation process, but local youth teams assisted and institutional properties held events that engaged numerous community members.

Measurement
Performance was measured by monitoring the water quality and quantity of stormwater discharged to Powderhorn Lake from the area with raingardens (test site) and a neighboring watershed without raingarden installations (control site) and comparing the results from the two sites. Minneapolis Park and Recreation Board (MPRB) installed and maintained equipment for three years to provide stormwater runoff characteristics before and after the raingardens were installed. Surveys, site assessments, and maintenance activities were also used to evaluate the effectiveness of the Neighborhood of Raingardens in improving Powderhorn Lake water quality.

Results
Monitoring in urban storm sewers has its challenges and coupled with the climatic conditions for the project period, fewer water quality samples were collected than planned. While the paired watershed analysis results do not show a statistically significant outcome, the few water quality samples collected in 2011 provide promise that the test neighborhood efforts could have reduced pollutant loadings when compared to the control area.



Other project measurements demonstrate that education and action influenced community members to improve Powderhorn Lake water quality. Over 230 people participated in project events and over 130 large bags of debris were collected in maintenance activities. In addition, post-survey results of participating property owners indicated that 76% enhanced their garden with additional plants, landscape materials or art. Over 50% implemented additional BMPs in their yard, such as adding a rain barrel or additional raingardens.

Future Plans

- Continue stormwater monitoring (City of Minneapolis is funding 2012 monitoring by MPRB).
- Further develop Metro Blooms' volunteer-based, raingarden evaluation program to provide added incentive for continued maintenance of raingardens.
- Focus new urban projects on maximizing backyard runoff capture with multiple types of BMPs.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Neighborhood and Institution Approach

Description: Promote and host Neighborhood of Raingardens approach through construction services for residential, faith-based and educational organizations.

This task involved the following activities: 1) Workshop coordination and facilitation, 2) residential site review and Raingarden design, 3) Raingarden installation, 4) pre and post-installation stormwater audit, 5) assessment products, including participation records and year-end surveys to citizens installing a raingarden (Result 2 incorporates these products in project reports), and 6) Project management related to coordinating workshops, landscape designers, installation, and record keeping.

Final Report Summary:

This project evaluated community outreach approaches through a pilot study of the installation of over 100 raingardens within a five-week period in a 28-acre sub-watershed draining to Powderhorn Lake, Minneapolis. Stormwater best management practices (BMPs) were restricted to installations on private property. In addition to directing over 70,000 square feet of runoff from impervious surfaces to bio-infiltration areas (raingardens) the project engaged 230 community members and increased their awareness of how their actions affect the water quality of their neighborhood lake. Community members were involved at various levels of commitment, including: reading literature distributed as part of the project, attending or hosting a workshop, door-knocking in the neighborhood to recruit project participants, meeting with a designer, and participating in installation, maintenance and community clean-up activities. Findings of this project can be applied to similar urban areas and provide a basis to target citizen-based improvements of highest benefit to our water resources.

The term “Neighborhood of Raingardens” was created to define the collective approach to implementing stormwater management practices clustered in neighborhood areas. The goal is to educate citizens on the ways they can have a positive effect on the local water quality through a variety of methods such as: raingardens, permeable pavers, green roofs, rain barrels, native plantings, boulevard plantings, yard and gutter clean up and maintenance. Raingardens serve as a visible tool and ‘hook’ to gain citizen interest and encourage neighborhood participation. The large-scale community participation process not only teaches participants about water quality protection, but it also builds a stronger and more beautiful community through increased community outreach.

The Powderhorn Lake Neighborhood of Raingardens project specifically explored several different techniques to recruit residents and institutional property owners to install raingardens and implement other stormwater management practices on their private property. For example, one method is to have resident host a neighborhood raingarden party. A small workshop-style presentation introduces stormwater and water quality concepts, and residential practices to improve water quality. In the case of this project, significant incentives included free consultation, design, installation and plantings funded by this project. In addition to citizen engagement, this project required specific design and installation processes, which are also documented in this report.

The Powderhorn Lake Neighborhood of Raingardens project was developed to reach several goals. Foremost was to evaluate methods of citizen engagement and maximize community involvement. Given the “free” incentive of a raingarden, the focus of the best management practices was on the installation of a raingarden and education about water quality protection. In most cases, a raingarden provided a BMP with a high runoff capture volume for a specific property. For some properties, other practices may have been more effective, but were not implemented because of site, budget, and homeowner constraints, except at institutional and specific properties during the second year.

Another project goal was to maximize runoff capture. This goal was restricted by the requirement to install raingardens and other stormwater practices exclusively on private property. The inability to capture runoff from sidewalks and streets limited the stormwater runoff pollutant load and volume reduction possible with this project.

Amendment Request July 1, 2010: Upon revisiting their budget, the MPRB monitoring crew identified $10,000 more in their budget than needed to complete the planned monitoring for this project. At the same time, the MPRB identified that an additional $10,000 was needed to allow us to contract with the Mississippi River Green Team program to plant approximately 70 of 100 test area raingardens. This amendment will improve the quality of installed raingardens. The original plan for the property owners to plant raingardens was problematic for a number of reasons: 1) Scheduling plantings around work schedules required was not possible in most cases, and 2) Scheduling, training and supervising the work of the Green

Team helped ensure a timely planting, and the quality of planting in terms of placement and health of the plants. This change compromises our goal to involve property owners, but we are compensating by making property owners aware of the scheduled planting time, asking them to participate if they are able, and coordinating one volunteer planting date for the final 30 raingardens -- inviting the whole neighborhood to participate in a planting celebration lead by Metro Blooms landscape designers and Hennepin County Master Gardeners.

Amendment Approved: August 25, 2010

Amendment Request December 31, 2010: After reaching our goal for number of installed gardens, we are revising our budget to request an additional $5,084 for Ecoscapes. This budget increase will allow us to perform work that requires expertise and equipment that the MCC crew does not have including installation of permeable pavers, channel drains and curb cuts to allow rain to flow to installed raingardens. By targeting our resources on a few properties with large impervious surfaces, we expect to achieve significant reductions in stormwater runoff.

In our planning for this project we had identified that a large percentage of the test area was impervious (more than 90%), with large parking lots and rooftops. We had not identified a solution for disconnecting these surfaces. The installations that we have planned for 2011 represent the solutions that we have identified. They are a result of closer inspection of each site and on-site consultation with a property owner that expressed an interest in finding a stormwater solution.

Amendment Approved: March 31, 2011

Amendment Request: June 1, 2011: After conducting a thorough onsite evaluation of the test watershed, combined with outreach to engage select property owners for additional installations on their property we created an installation plan and budget that will accomplish the final project installations.

Our amendment request is to transfer the $16,437 from Result 2 to Result 1 for the completion of installations that will have a significant stormwater capture capabilities.

Amendment Approved: June 14, 2011

Summary Budget Information for Result 1: **Trust Fund Budget: $ 204,877.00**
Amount Spent: $ 201,046.68
Balance: $ 830.32

Deliverable	**Completion Date**	**Budget**
1. Neighborhood of Raingarden installations (0 – 75 raingardens) October 2009 (50 – 150 raingardens)October 2010 (0 – 50 raingardens) October 2011	Oct 2011	$197,677
2. Participation records	October 2012	$ 4,200
3. Year-end survey results w/onsite evaluation	June 2012	$ 3,000

Deliverable 1. Neighborhood of Raingarden Installations

Workshop Coordination and Facilitation
Raingarden Workshops in Powderhorn. During the stormwatershed audit we distributed flyers to almost every household in the test area – we had a total of 5 people at two workshops. Of those five, three agreed to host parties in their yards. After this experience we decided to refocus our promotions to canvassing and raingarden parties.

Raingarden Parties. Over the summer we scheduled 4 hosted raingarden parties, where a property owner/participant agreed to invite their neighbors to their yard for our one hour introduction to the project, raingardens, and to sign up participants for an onsite consultation.

Canvassing. We scheduled four nights in August. Michael Keenan, Carlos Zhingre and Metro Blooms staff led groups of Landscape Design Assistants and volunteers as we canvassed the neighborhood – knocking on doors, and talking with residents in their yard and on the streets about the project. We asked them to sign up for an onsite consultation.

More than half of the conversations were in Spanish. Educational materials were translated our adopted tag line for this project. Construye un Jardin de Liuvias. Restaura el Medio Ambiente. Colabora con una “Minga”, which means: Build a raingarden, Save the environment and Join a Minga. A Minga is a group that gathers to do charitable works for the community.

Residential Site Review and Raingarden Design
Of the 63 property owners identified in our final test area at December 31, (20 were just outside the final test area), our Landscape Design Assistants were able to complete 56 onsite consultations, stormwater management plans, and raingarden designs.
Each participant will receive a copy of their stormwater management plan (SWMP) and raingarden design. The SWMP provides a variety of options, in addition to our planned raingarden installation, that the participant may adopt to manage their stormwater onsite. Our assumption and goal is that once participants learn about stormwater runoff’s role in the degradation of their local water body, Powderhorn Lake, and learn their own role in improving the water quality of the lake, they will voluntarily adopt additional practices. This assumption will be tested at the end of the project period through a follow-up stormwatershed assessment.

Raingarden Installation
Native Plant Propagation: We started working with the MPRB Teen Team Works and the Mississippi River Green Team to propagate native plants for our raingardens. We purchased some native perennials and received a large donation of both cultivars and natives. Metro Blooms Landscape Design Assistants directed the youth crews to propagate through cuttings and thinnings of the donated plants. All plants were planted in organic potting soil in one gallon pots to allow them to grow and develop their root structure for planting in 2010.

Michael Keenan led the crew to build a shade structure for our nursery at the Minneapolis Park and Recreation Board’s JD Rivers Children’s Garden on Glenwood at Vincent Avenue North (just east of Theodore Wirth Park). The supports and shade cloth will protect our shade loving natives from the harsh sun in the open field. Much of Powderhorn is shady, with many trees. The new transplants were bedded in 2 inches of mulch and then tucked in all around with mulch to the rim of the pot in an effort to protect them through the winter.

In the late fall we received two additional large donations of perennials – approx. 250 flats (4,400 – 1 inch and 4 inch pots) of cultivars from Dragonfly Gardens and approximately 40 gallon pots of natives from MN Native Landscapes. These are over-wintering in staff's backyard with instruction from Dragonfly on how to overwinter plants in their nursery pots – covered in two feet of mulch. We expect approximately 10 – 15% die-off and will do an inventory again in the spring at/after transplanting to gallon pots.

By December 2009, we were over-wintering approximately 4,600 raingarden perennial natives and cultivars for the project (approximately 30 per garden). We will continue to seek donations and plan to buy more natives to add to the mix, but hope to use the funding we don't use on plants to purchase more landscaping supplies – especially materials for downspout redirection and channel drains to divert water from hard surfaces toward our raingardens.

Workshop Coordination and Facilitation

In March, the first episode of *A Neighborhood of Raingardens* a film produced by University of Minnesota's Mark Pedelty was previewed at the Institute on the Environment. The film gives an introduction to raingardens and stormwater runoff and highlights the Powderhorn Park project. It aired on the MN Channel (TPT MN) on 4/22 at 7:30pm, with repeats on 4/23 at 1:30am and 7:30am, and during the month of June. It has provided us a useful tool to introduce participants to raingardens and the project.

We continued to host raingarden parties at participants' homes - 4 parties from January through June with 46 in attendance, and generating 6 new participants for the project. More than a recruitment tool, these parties were raingarden educational events, and a chance to discuss installation details with property owners who were already signed up to participate. They also helped to build community among participants.

On April 24, 2010 Earth Day, we hosted an event at the Powderhorn Park Recreation Center. Project participants were invited to review their plans with Metro Blooms designers. We aired the Neighborhood of Raingardens film for about 25 residents.

Working with Blue Thumb, we hosted the National Geographic's Expedition Blue Planet in Powderhorn Park on July 4, 2010 to highlight water quality improvement efforts and the Powderhorn Lake project. The event was promoted to test area residents with an offer of a free t-shirt and native plants for all those who showed up at our booth. At the end of the day, the remaining native plants were donated to Metro Blooms for the project.

On July 19, 2010 we hosted a community meeting for Powderhorn Lake participants at All God's Children church (a participating congregation). About 40 participants showed up to discuss the logistics of the installations, view the film, review their plans with the landscape designers, and sign waiver forms.

Residential Site Review and Raingarden Design

By July 15, 2010 of 100 test-area participants signed up for installation in August, we've completed all of the onsite consultations, 85 raingarden designs, with 15 remaining designs needed.

We are experiencing a lot of no-shows for onsite consultations, which we have to reschedule. When we started the project, our onsite consultation sign-up sheets stated that property owners who did not show-up for their scheduled consultations would be ineligible to participate in the project. After struggling to identify participants over the past year, we eliminated this statement and were willing to reschedule appointments – sometimes multiple reschedules. Now that we have met a project threshold of 100 participants, and as we plan for 2011 installations, we will reconsider ways to reduce our no-show rate.

As the installation date approaches, we are hearing from participants who want to make plant changes to their designs. We try to accommodate as much as possible, and meet with many homeowners to discuss changes. Changes are possible when we can easily get the plant, or already have it in stock, but are not possible when the request is for something that is not native.

Additional design adjustments also happen when marking the garden, slightly moving it because the LDA who designed it didn't correctly place the garden. Having many different LDAs with varied experience on the project is good experience for our LDAs, but has created excess confusion and time spent reviewing and changing design and plant selection.

A lot of property owners do not have downspouts, and the landscape designers encourage homeowners to get them installed and directed to the raingarden. In 7 of the 16 gardens installed in June, homeowners re-directed their downspouts to the garden. Three of these, installed new or replaced old gutters and downspouts.

A portion of the people are interested in incorporating their new raingarden with other landscaping they are planning in their yard – which means more coordination for us, but we think it is a good sign in terms of long term maintenance of the gardens.

The soil condition seems to be very porous and relatively nutrient rich. It is ideal for hand excavation. Infiltration rates are very high to begin with.

Unfortunately, there have been few opportunities for raingardens in the back half of the properties, largely due to the fact that it is really built up with garages and driveways and most people are not willing to give up their driveway.

The church properties are receiving and deserving of more planning and resources. It includes involving the congregation in plan approval as well as attention and resources to drain a large parking lot into the raingarden.

At the July 4 Expedition Blue Planet event we received approximately 1,500 additional native plugs that were leftover from this event. These will also be used where possible in our Powderhorn gardens.

Raingarden Installations: Working with Ecoscapes for excavation and the Mississippi River Green Team for planting, from June 14 – 17 we installed 16 raingardens within the original test area, but just outside the final Powderhorn test area. These properties were signed up to participate in the project before the monitoring sites were changed in 2009. Project partners determined that we have resources to install these gardens without affecting our monitoring results. The installations have served as a model for residents of the test area, and also served as a test run for the installation of 100+ gardens in August.

Partners Meeting: On June 24, 2009 the Powderhorn Partners held a kick-off meeting for the project. We agreed to delay excavation of the raingardens until 2010 when we will have adequate pre-test data. A partner list with contact information is attached (exhibit 1). This group is the project advisory team and many have roles in the project implementation.

The partner group met again on December 9 for a project update and particularly to review the monitoring data and make a decision about timing for excavation in 2010. We agreed to delay excavation until August 2, which would allow time to install 150 raingardens in 2010 and still give us time to collect more rain event data that we felt we needed for an adequate pre-test analysis.

Outreach: Over the winter, Metro Blooms gathered address and other data and built relationships with the Powderhorn Park and Central Neighborhood Associations and used their help to establish an e-mail mailing list, gather address information and built a mailing list for the project. The initial outreach packets were mailed out in February with the intended project launch and initial on-site consultations scheduled to begin in April. This method got the outreach and planning process started and resulted in 50-60 initial participants. It also revealed the challenges involved in engaging a demographically diverse community.
Outreach methods used to enlist participants in the project included the following:

> Florence Hill is a 90+ year old , long term resident of the neighborhood and an early project supporter who volunteered her time to promote the project. She hosted the first Metro Blooms garden party, which was also the most successful. She volunteered time as a door to door canvasser, and her presence as a neighbor helped many residents overcome their suspicions and concerns about the project. She also helped organize activities such as garden tours. Her involvement in the project generated participation from at least 30 of the 122 property owners who installed a raingarden.

- Door to door visits (in teams),
- neighborhood e-mail lists and web forums,
- garden parties,
- mass mailings (no name),
- direct mailings (using resident's names),
- project flyers and door knob hangers,
- face to face community events,
- dedicated Hispanic outreach,
- onsite consultations,
- neighbor referrals, and
- phone calls.

Successes of each method
Direct door to door visits: Door to door recruitment took place in the early evening on weeknights and during the morning on weekends. The efforts took place in the 2 weeks prior to project meetings to attract new participants. There were four door to door recruiting efforts in Powderhorn that took place involving Metro Blooms staff and volunteers. Also U of MN Journalism students also canvassed the neighbor to generate participation (Student volunteers from UMN were helpful, but due to lack of detailed knowledge of the project, often led to the spread of misinformation). Each effort lasted about 3 hours and was able to reach about 20-30 homes per hour.

Out of 20-30 residences visited about 10-15 were home during those times and about 1 in 3 signed up. The survey indicated that others who did not immediately sign up at the door were more likely to participate. There were 2-3 follow up attempts to recruit those missed in previous canvassing efforts before the final target number was met. Many homeowners were aware of the project before being visited. This made the canvassing more effective as it already had more legitimacy than other door-to-door efforts.

This method got the most people enrolled (according to the post-installation survey). We attribute this level of success to the preliminary mailings and e-mail efforts to spread the word about the project. Many of the residents were already aware of the project when the door to door teams arrived, meaning that this method resulted in prompting the decision to participate for many of the residents. Door knocking was the most effective approach but was also very time intensive. The greatest success resulted from pairings that included a neighborhood resident or volunteer and a Metro Blooms staff. This allowed for the neighbor to attest to the validity of the project and the staff member to answer questions about the process. Metro Blooms created hangers that rested on the doors of the homes visited during the canvassing.

We maintained a project database that kept track of whether or not contact had been made with specific homeowners and their reaction (excited, bothered, hostile). This meant that the homes were not canvassed multiple times.

Neighborhood E-mail lists and Web Forums were the least time intensive, but also did not prove to be particularly effective in generating support for the project. E-mail messages resulted in relatively low rates of return and were not a reliable way to communicate information to project participants due to language, age, and access barriers.

Mass mailings in the early spring of 2010 were the most costly process. This involved assembling a mailing list, printing materials hand stuffing envelopes, and paying for postage. This approach in and of itself was not particularly effective in generating participation, but as it preceded the door to door canvassing many participants were aware of the project when approached in person, resulting in greater openness to participation. We found that people disregarded form letters but were more likely to respond to letters that addressed them by name with a hand written envelope. This personal touch tended to take more time, but yielded better results.

Fliers and Door Hangers: These methods proved to be effective ways to catch the eye of neighborhood residents either as an advertisement on the door of a visited home or when the participant went to church or a commonly frequented establishment. This was a cheap method that required little labor, but also did not seem to yield striking results in terms of direct response from the door hangers.

Face to face community meetings: This method of engaging the community was most successful in communicating technical information about the project. Often, written communications or graphic mailings went unread or failed to inform the population about project timing and goals. Face to face meetings with church congregations, neighborhood groups, and garden parties proved to be an effective way to clear up misconceptions, answer questions, and clearly communicate technical information.

A large map showing the different lots participating in the project was the one that drew the most interest from community members. People reacted to the quantitative display of information on the map and were very interested in technical information that showed the connection between their property and the lake.

Garden parties, in which a resident invites their neighbors over for a party to discuss the project, had mixed results in terms of engaging people. The first party was hosted by Florence Hill, a well-known and long-term neighborhood activist. The party was very effective and well attended (28) with all property owners in attendance signing up to participate in the project. Subsequent events had very poor attendance overall (1-2 at each event). The characteristics of the host seemed to be critical in terms of whether the garden parties were a success or not. Low attendance may have been due to the hosts' lack of relationships in the neighborhood or lack of experience or effort to turn-out folks for an event.

Neighbor volunteers and referrals: The willingness of some neighborhood residents to become strong supporters and advocates of the project resulted in greater trust and legitimization of the outreach process as friends and neighbors proved more willing to trust and commit to the project when they knew someone that was invested in the project and its goals.

Phone calls as a tool for initial recruitment resulted in suspicions that this project was some sort of scam. Whereas, the use of follow up phone conversations was very effective in encouraging people to participate once they had heard about the project. It gave them a way to actively voice their concerns and have their questions answered.

Overall the best process seemed to be an initial broad outreach using electronic media, widely distributed fliers, and to a lesser extent - mass mailings. This mass outreach "primes the pump" by generating a baseline level of familiarity with the project and to reach early supporters. With this level of outreach we were able to reach engaged community members who then were able to provide referrals and access to audiences such as church congregations, community organizations, and gardening clubs. These groups are ideal venues for spreading the word of mouth information about the project and establishing true community engagement. Following the engagement of these key groups the next step is to conduct more targeted outreach based on analysis and mapping techniques. This can include direct mailings, and most preferably door to door canvassing.

Language was definitely a barrier to reaching members of recent immigrant communities. Metro Blooms produced materials for Spanish speaking individuals, but found that these materials did not generate good returns. Our experience indicated that there was greater suspicion of the mailings and community outreach materials, either as a scam or as a way to catch immigrants. Face to face outreach to Spanish speaking persons was much more successful.

Recommended approach to recruit property owners based on lessons learned.

- Start broad and then narrow the focus
- Clear and simple communications from a trusted source
- Use graphics not text
- Ensure that efforts are coordinated and are kept on track

Among the primary factors that influenced recruitment, a FREE raingarden was the largest factor, followed by concern for Powderhorn Lake.

The principle reasons property owners chose not to participate had to do with lack of interest in gardening, general disbelief in the premise of the project, concerns about long term maintenance, and unwillingness to give up space.

There were very few property owners (3) that initially agreed to participate and received an onsite consultation and then choose not to receive a garden. The primary reasons that gardeners backed out of the project was due to extenuating circumstances(a house burned down), difficult personalities (excessive demands, repeated design changes), or changes in homeownership during the project.

Onsite Consultation and Design Approval: Landscape Designers would first meet the homeowner with an onsite consultation, and spend an hour discussing what they saw with their property from a stormwater perspective as well as from a landscaping perspective. The designer also asked the homeowner individual questions about their property, (things they have seen during rainstorms, areas where water has ponded, drainage problems, water in the basement, etc.). From the information gathered from site observation and discussion with the property owner, designers would decide on a garden location before leaving. After the onsite consultation, designers would complete both a stormwater plan and a raingarden design for each property. Each would be sent to the property owner for approval. Almost all designs were approved. Certain homeowners required a little more diplomacy, in which case Michael Keenan, Metro Blooms Lead Designer, would usually provide another onsite consultation to ease their worries. Michael then marked the garden location on each property prior to installation. This also gave the property owner another opportunity to approve or disapprove the design. Installation usually followed the marking within a week. In most cases, Michael had a follow up conversation with each property owner to discuss notable details of the installation, maintenance requirements, and next steps in the project.

Installation:
The test watershed was comprised of an area 1.5 blocks long by 6 blocks wide with early 250 properties. We were planning to install 122 gardens. In an attempt to be as systematic as possible, we planned to move North to South on each block and from West to East (toward the park) across the test area. Communication with the homeowners about their planned installation date was critical. We created a prototypical process in June and we were now able to simulate the larger install and anticipate scheduling complications from several variables such as weather, truck problems, or crew scheduling issues. Originally, we wanted to include homeowners in the installation process, but this proved to be much too time intensive and too cumbersome to fit into our excavation window.

Limiting factors for the installation process

- All soil and turf were removed by hand, people can only remove so much
- All materials had to be delivered and transported by two 1 ton trucks and two hydraulic dump trailers
- Some of the installations were in very small spaces, limiting the crew’s progress
- Many times the truck and trailer could not park very close to the excavation site, requiring long distances to be traveled with soil
- Soil excavation takes much longer than planting, which requires a head start for the excavation crew
- Time was wasted waiting for the soil truck and trailer to dump refuse soil
- Some excavations yielded unforeseen buried objects and lines (buried concrete, electric lines, compacted gravel)

The installation process
Two separate crews were utilized (a crew for soil excavation and mulching and a crew for planting). The excavation crew included 5-7 members of the Conservation Corps of

Minnesota supervised by myself. The planting crew included 20 members of the Mississippi River Green Team, a youth crew led by two supervisors and two landscape designers from Metro Blooms.

First, the sod was removed with a sod kicker. All sod was wheel-barrowed to the trailer. In some cases, the property owner requested to keep the sod to use elsewhere in the yard. Second, the soil excavation began. Shovels were used to remove the soil to a 6" depth on average. Some installations required creation of an earthen berm to hold water in the garden or a drainage channel to divert runoff to the garden. Each property possessed its own intricate requirements for drainage and water conveyance. The level and landform of each garden was checked by me with a laser transit. After the grades were close to finished, the bottom of the basin garden was de-compacted and amended with compost when necessary. Shovels were used to turn the soil over to a depth of at least 18" to insure adequate infiltration. Excavated soil was also wheel barrowed to the trailer. All soil and sod was trucked the MPRB tree and soil site at Fort Snelling, 5.5miles away. The garden was immediately mulched after excavation to avoid any problems with erosion.

After mulching, the garden waited to be planted. In some cases the garden would be planted as much as a week after excavation. Soil excavation took about 3 times as long as planting which required careful planning. As a result, we began excavation about one week prior to the start of planting to create a pool of gardens ready to plant. Additionally, the planting crew was scheduled in two separate periods which allowed the excavation crew to create another pool of gardens to plant after the planting crew had caught up halfway through the project. The excavation crew was able to excavate an average of 5 gardens per day while the planting crew was able to plant nearly 15 gardens a day.

The Planting Process
The 20 member crew was split into two, each with a supervisor and a Metro Blooms designer. Plants were delivered to each site either the morning of planting or the night prior. At each site, the designer would lay out the plants within each garden. After layout, the youth crew would begin planting the garden. This activity provided several insights for the youth crew. First, they learned about the basics of planting. Also, they played educational games with their designer and supervisor related to native plants and identification. The designer would check the planting for quality and the crew would move on to the next garden. Each member was also given opportunity to lay out a garden with the designer. By the end of the project, each youth crew member was able to lay out a garden and to identify nearly every plant in it.

System to track plants
We had to keep a running inventory of our stock and what was to be ordered at all times. After all designs were completed, we had a comprehensive plant list for the project. However, several property owners decided to change their garden's palette at the 11th hour. We tried to accommodate as best we could. We also had difficulty locating certain plants. Turtlehead *Chelone glabra*, and Blue Flag Iris *Iris versicolor*, became nearly impossible to find from a MN native nursery at the time of install. Lucius Jonett was the point person in charge of the plant inventory and delivery system. He kept a detailed inventory in his hands (literally) during the entire project. As Michael excavated a couple blocks to the east of the planting crews, slight changes in form and shape were constantly necessary for the gardens which often meant plant changes as well. Lucius and Michael were constantly communicating these changes. From the master inventory, Lucius would prepare a delivery ticket for each property. This was used to locate the plants at our nursery, load the truck, and deliver to each respective property. The ticket was left with the plants and was double

checked by the designer before planting. In certain cases, we had a surplus of plants and in other cases, plants were missing. This required a change ticket for the next day. We tried to create somewhat of a paper trail for each garden. This allowed us, as a team, to ensure that all required tasks had been completed before moving on.

Excavation by hand vs. heavy equipment
In the Powderhorn Park Neighborhood, many of the spaces where gardens were installed are very tight and excavation equipment simply wouldn't fit. When you bring large equipment onto a lawn, sod has to be replaced invariably, which would have slowed our progress. Also, heavy equipment has a soil compaction factor which would inhibit infiltration elsewhere. The goal of the project was to make the neighborhood more pervious. For the majority of the project, a crew of 5-7 people armed with spade shovels and sod kickers was the optimal tool.

Heavy equipment was used in a few instances. Five raingardens were built at churches to capture surface runoff from their parking lots. Three of these five were built with the help of an excavator. Much of the soil around a parking lot is heavily compacted and is very difficult to dig by hand. Also, the scale of these gardens was much larger to accommodate the scale of the much larger drainage area.

Soil removed, mulch applied, MN native plants planted
Overall, 200 yards of soil was removed. 175 cubic yards of shredded hardwood mulch was applied to 122 gardens. Nearly 15,000 plants were installed.

Final Installations and Maintenance
In June 2011, Metro Blooms organized events for volunteers and Powderhorn participants to get to know the project, receive training and assistance to install boulevard gardens to capture stormwater, and to check in to see how the gardens were doing. Volunteers and participants were asked to join us on Saturday, June 11th for a day-long event in the neighborhood to maintain gardens planted in 2010 and to install new boulevard gardens.

On May 28, 2011 we toured the Powderhorn project. Powderhorn participants and volunteers were paired with Metro Blooms Landscape Designers and given a list of raingardens to visit, talk about how their gardens are doing, and make appointments for June 11th installation and maintenance.

Then on June 4, volunteers were trained on how to install boulevard gardens, do downspout redirection, and other water capturing features. Volunteers also assisted Metro Blooms staff in marking project locations and conducting preliminary site visits and follow-up meetings.

On June 10, volunteers assisted in preparation for the Powderhorn raingarden maintenance event. We met at All God's Children Church and assembled boulevard garden packages for boulevard tolerant plantings that will have interest and beauty and are divisible by 100 square foot areas.

Lastly on June 11, 2011, Powderhorn maintenance event volunteers assembled to assist participants with re-planting efforts, downspout redirection, and boulevard garden creation. Metro Blooms board and fundraising committee hosted a luncheon at Mount Olive Church: preparing bratwurst hot-dogs, chips, and sodas for all volunteers, neighborhood participants, and staff.

Throughout the week of June 13th – 17th: Staff and volunteers provided assistance with re-planting, downspout redirection, and re-mulching assistance as they were available.

A total of 23 new boulevards were and 5 new raingardens were installed by residents and volunteers with staff oversight.

We also worked with contractor, Ecoscapes to install:

- At the home of Florence Hill, a rubber razor across the 300 sq. ft. of gravel driveway and 683 sq. ft. garage and redirect run off to a raingarden.
- At Mount Olive Church, a 480 sq. ft. permeable strip at the driveway entrance to the parking lot to disconnect 3,444 sq. ft. of parking lot.
- All God's Children: a 185 sq. ft. permeable strip to disconnect 3,348 of parking lot.

Raingarden Installation.
Following the final and maintenance event in June, landscape designers visited the gardens from time to time to deliver extra plants, conduct check-up visits, provide one-on-one maintenance training, and other follow-up with property owners regarding their gardens.

Information Consolidation and Presentation
The final weeks of the year were spent in gathering project data for the final report, preparing presentations for groups interested in learning more about the project, and creating maps for the final report. Michael Keenan presented the citizen engagement successes and struggles to staff of the Ramsey Washington Metro Watershed District who had struggled with a citizen engagement project of their own.

Final Project Planning
Also in late 2012, were looking ahead to 2012 to consider how best to utilize remaining funds, given the likelihood that there will be significant plant loss in some of the gardens.

Raingarden Workshop – Powderhorn Recreation Center
A raingarden workshop, sponsored by the City of Minneapolis, was hosted in June 2012 at the Powderhorn Recreation Center to introduce 33 property owners around the lake to the beauty and benefits of raingarden and how to install one in their yard.

Raingarden Maintenance Events
In May, we hosted a maintenance training event at All God's Children Church, with free replacement plants to attendees, as well as onsite consultations and maintenance assistance - 12 households participated. In addition, landscape design staff led a crew of Conservation Corps of Minnesota members to maintain and replant the parking lot raingardens of All God's Children and Mt. Olive Lutheran church.

Raingarden Maintenance Literature
A final report of the project results accompanied a Raingarden Maintenance Brochure that was mailed to all project participants, thanking them for participating in the project and asking them to maintain their gardens and to share their information with friends and neighbors.

Permanent Project Sign at the Artstop Gardens

Though our surveys indicate that some participants remain quite indifferent to the water quality benefits and beauty of their raingarden, others have become true water stewards and raingarden enthusiasts. Including our first Raingarden Party Hostess, Florence Hill, who allowed us to install a permanent project sign on the property adjacent to her home that she has set aside for the neighborhood, and which she calls “the Artstop Garden.”

> “Hello...Just a update from the Artstop Garden...the raingarden sign is doing just fine and getting good attention! Thank you for all of your work in making this great contribution to our green space happens! -- *Florence and neighbors*”

Deliverable 2: Participation Records

Stormwatershed Audit. The Mississippi River Green Team also completed a Stormwatershed Audit of the test area. Michael Keenan presented a raingarden workshop to teach the students about raingardens. Rusty Schmidt trained the team on an audit tool modified for an urban environment based on a stormwatershed audit tool created by the Washington Conservation District (see attached). Metro Blooms Landscape Design Assistants led the Green Team as they completed the assessment of every property in our test and control area. A copy of the tool is attached. The data has not been analyzed, but will be used as another pre-test measure to determine the impact of stormwater education and participant initiated stormwater management practices beyond the project installed raingardens. As they walked the neighborhood, they also distributed flyers about the upcoming workshops to inform the community about the Neighborhood of Raingardens Project, and upcoming raingarden workshops in the area.

Participants: By year end 2009, the net result of our promotions, raingarden parties and canvassing was a total of 63 property owners who signed up to participate in the project, this included two congregations: Mount Olive Lutheran Church and All God’s Children, both on 31st Avenue in the test area.

We set July 15 as our deadline to sign up for participation in the August installations. Our numbers for August installations continue to go up and down, but remain around 100. Recent properties to sign up for participation include properties owned by Urban Homeworks, who were contacted by Councilmember Elizabeth Glidden to encourage their participation.

A small number of sites will receive two raingardens, so the final number of raingardens will be slightly higher than the number of participants. We assume that the number of participants will continue to dip as the last few designs and waiver forms will likely include the people who have been most loosely involved with the project. We expect numbers to go back up as wavering or skeptical residents see the gardens being installed.

Of participating properties, 11 are rental units, and 6 are owned by non-profit organizations. Another 3 properties are churches, which leaves about 80% of our participants as homeowners.

We estimate 75% owner-occupied properties in the test area, only slightly lower than the estimated 80% among participants. If these numbers are correct, we have a 50% participation rate among owner-occupied properties.

We estimate that 8 current participants are in primarily Spanish-speaking households. This is out of an estimated 36 Spanish-speaking households, or just under one quarter of the Spanish-speaking households in the test area. If the overall rate of Spanish-speaking households in the neighborhood is around 16%, our participation rate for this group is half that at 8%.

As anticipated, encouraging participation has been more challenging among rental property owners, non-profit property owners, businesses, and non-English speaking households.

Result 2: Monitoring, Data Analysis and Reporting

Description:
This task involved the watershed monitoring, data assessment, and reporting activities of the project. Monitoring was performed at two sites for the project duration. Monitoring activities included: installing and maintaining the equipment, collecting and analyzing samples, and managing the data, including quality control of reported results.
The effectiveness of citizen-based stormwater management programs was documented through two reports: “Evaluation of Three Citizen-Based Approaches to Stormwater Management” and “A Citizen-Based Approach to Improve Powderhorn Lake Water Quality”. The first report compares and analyzes the effectiveness of the existing, Neighborhood of Raingardens, and institution-based approaches. The second report documents the monitoring and paired watershed analysis results comparing targeted neighborhood Raingarden installations to a control area (no raingardens). Additional reports provided through this task included the biannual progress reports and final report to LCCMR. Project management of work and quality control/assurance for the assessment elements of the project are an integral part of this task.

Final Project Summary
Stormwater monitoring was the key driver for the project schedule. The three year period was selected to provide as much time as possible to collect an adequate number os samples to establish the runoff characteristics of the watershed in a test and control area before and after the raingardens were installed.

Monitoring in urban storm sewers has its challenges, and these sites and climatic conditions provided various issues resulting in insufficient data to statistically show that the Powderhorn Lake Neighborhood of Raingardens improved the water quality of the runoff going to Powderhorn Lake. However, the few water quality samples collected in 2011 provide promise that the test neighborhood efforts could have reduced total phosphorus and total suspended solids loadings when compared to the control area.

In the paired watershed analysis, same storm event data are compared in the calibration and the treatment period. The regression analysis results show that the BMP did not influence the runoff volume. The result is not surprising, given that only 10% of the impervious area was directed to a BMP. The impervious areas in the public right-of-way dominate the land use and the ability to redirect enough volume from private properties. There is not enough data to provide a statistically significant regression result for total phosphorus and total suspended solids.

The City of Minneapolis will continue to support the monitoring at the same test and control sites as in the past three years. The MPRB will be using new instrumentations to improve efficiencies in downloading data and checking for equipment problems.

Amendment Request: 06/01/11: MPRB staff reviewed their remaining budget and planned expenditures that would be billed to the project. An estimated $16,437 in unallocated expenses related to sample collection and administration of the project were included in the original budget, but will not be billed to the project. This will result in an in-kind contribution of the same amount from MPRB to the project. This amendment request is to transfer that amount ($16,437) from Result 2 to Result 1.

Amendment Approved: June 14, 2011

Summary Budget Information for Result 2: **Trust Fund Budget: $ 74,123.00**
Amount Spent: $ 74,112.88
Balance: $ 10.12

Deliverable	Completion Date	Budget
1. Installation/maintenance of equipment (2 sites@3 yrs.)	May 2009[1]–Jun 2012	$21,563
2. Monitoring data management	Ongoing[1]	$ 2,000
3. Evaluation Report 1: Draft/Final, Evaluation Report 2: Draft/Final	May 2012/Jun 2012	$50,560

[1]Pre-project and portion funded in-kind by City of Minneapolis and MPRB

Background

The Minneapolis Park and Recreation Board was responsible for monitoring the storm sewers for flow volume and hydrograph sample collection for TSS (Total Suspended Solids) and TP (Total Phosphorus), and reporting the resulting data.

Deliverable 1: Installation/maintenance of equipment

Two locations were outfitted for monitoring on 9/11/09 at 31st Street East and Elliot Avenue South, and at 35th Street East and Columbus Avenue South in Minneapolis. The monitoring equipment was installed upstream in 24" reinforced concrete pipes (RCP) at these two locations.

The weather station data was measured using a Davis Weather Wizard III station located at 38th Street West and Bryant Avenue South and is downloaded daily.

Methods
Events measured for the project were defined as precipitation greater than 0.10" at the station.

Each pipe location was monitored with ISCO stormwater equipment:

1. 2150 datalogger (new)
2. 2105 control module (new)
3. digital low profile AV probe
4. 24 bottle multiplexed auto-sampler (either a 3700 or 6712) complete with 3/8" ID vinyl tubing and standard intake strainers.

Following installation flow pacing was adjusted for each watershed. Flow volume and hydrograph sample collection for TSS and TP were collected. Dataloggers were downloaded every two weeks or whenever there was more than 0.10" of precipitation. This definition was loosened when the sites were moved in September in order to collect more samples.

The laptop database was de-fragmented and backed-up each month to the MPRB network.

Data Products

The data presented by the MPRB include:

1) A "raw" unedited electronic copy of the database of each site for the time monitored.
2) Copies of all field notes.
3) A copy of weather/precipitation measurements from the MPRB weather station along with a table of monitored events.
4) All laboratory values for the event (TSS and TP) samples monitored.

Data Collection Challenges

At the project initiation in May 2009, two 36" RCP were chosen at 33rd Street East and 10th Avenue South (test), and at 35th Street East and 12th Avenue South (control) in Minneapolis. Installation was completed on 6/3/2009. The test site was found to have significant problems with standing water, decaying organic debris and sand deposition in the pipe, which prevented accurate measurement of stormwater. Minneapolis Public Works attempted to remedy the problems by cleaning the pipe, but this was not successful.

In late summer, two new monitoring locations were chosen at 31st Street East and Elliot Avenue South, and at 35th Street East and Columbus Avenue South. The monitoring equipment was installed in 24" RCP at these new locations on 9/11/09. Once installed one of the brand new 2150 dataloggers with area velocity probe had to be sent back to the manufacturer for repair under warrantee. This necessitated borrowing like equipment from ISCO and re-installing it. Some storm events were missed.

In late fall heavy leaf litter or sand covered the area velocity probe at 31st and Elliot which necessitated switching from direct volume measurement to a Manning's equation for calculating volume. When uninstalling the monitoring equipment 11/30/09 it was noted that both of the new sites had significant sand accumulation around the AV probes. There was no sand noted at these sites during installation 9/11/09. In future monitoring it will be necessary to offset the AV probes approximately 1 inch to avoid sedimentation.

The problems with site conditions and equipment coupled with dry conditions resulted in few monitoring events of paired sites (control and test) in 2009. Efforts will be focused to clean monitoring sites and install equipment as early in the spring as possible to collect 2010 runoff data before rain gardens are installed.

In 2009 the number of site visits:

- 35th/Columbus (35th/12th) – 34 site visits
- 31st/Elliot (33rd/10th) – 32 site visits

For 2010, the monitoring equipment was installed on 4/7/10 at 35th and Columbus, and on 4/8/10 at 31st and Elliot. The tipping bucket rain gauge was installed mid-April on top of the Powderhorn Recreation Center. All the equipment appears to be working fine. The only notable event was 6/26-27/10 we had ~2.5" of rain and experienced surcharging in the pipes and flooded out some of the equipment which made collecting samples of the storm impossible. The good news is that nothing was damaged.

The 2010 storms we have thus far include:

Date (storms end)	31st & Elliot	35th & Columbus	Powderhorn Gauge Precip. (in)
3/1/10	X	X	-Snowmelt
4/15/10	X	X	~1.19
5/8/10	X	X	~0.71
6/2/10	X	X	~0.15
6/11/10	X	X	~0.90
7/5/10	X	X	~0.66

Installation
In 2010 the two locations were outfitted for monitoring on 4/8/10 at 31st Street East and Elliot Avenue South, and 4/7/10 at 35th Street East and Columbus Avenue South in Minneapolis. The monitoring equipment was installed in 24" and 30" reinforced concrete pipes (RCP) at 31st and Elliot and 35th and Columbus, respectively. Both sites were outfitted with two 2150 dataloggers, two low profile A/V probes, one 2105 control module and a flow paced ISCO auto sampler.

In 2010 the precipitation data was measured using an Onset Hobo datalogger and a Nova Lynx tipping bucket (1/100th of inch) located on the large flat roof of the Powderhorn Park Recreation Center, 3400 15th Ave South, Minneapolis. The equipment was installed on 4/12/10 and removed on 11/19/10.

Methods
Events measured for the project were defined as precipitation greater than 0.10" and separated by 8 hours.

Each pipe location was monitored with ISCO stormwater equipment:

5. Two (2) 2150 dataloggers
6. 2105 interface control module
7. Two (2) digital low profile AV probes (one invert, one offset)
8. 24 bottle multiplexed (96 samples) auto-sampler (either a 3700 or 6712) complete with 3/8" ID vinyl tubing and standard intake strainers.

Following installation flow pacing was adjusted for each watershed. Flow volume and hydrograph sample collection for TSS and TP were collected. Dataloggers were downloaded every two weeks or whenever there was more than 0.10" of precipitation and samples collected.

The field laptop database was de-fragmented and backed-up each month to the MPRB network.

Data Products
The data presented by the MPRB include:

5) A "raw" unedited electronic copy of the database of each site for the time monitored.
6) Copies of all field notes.
7) A copy of weather/precipitation measurements from the MPRB weather station along with a table of monitored events.

8) All laboratory values for the event (TSS and TP) samples monitored.
9) All associated QAQC sampling data e.g. monthly performance standards, equipment blank, field blanks, etc.

Data Collection Challenges

In 2009 debris and sedimentation over the invert A/V probes necessitated in 2010 a second A/V probe to be installed but offset slightly up the side of the pipe. This configuration allowed the most accurate level data from the invert and velocity data from the offset probes to be collected. This set up appeared to work well for accurately flow pacing the samplers.

The persistent sedimentation over the invert area velocity probes may have added to excessive power consumption as the buried invert velocity probe continually searched for a signal. The dattalogger batteries were changed both in June and August.

When uninstalling the monitoring equipment 11/12/10 it was noted again that both sites had significant sand accumulation around the invert AV probes. There was no sand noted at these sites during installation 4/7-8/10.

In 2010 the number of site visits:

Ï 35th/Columbus – 36 site visits

Ï 31st/Elliot – 35 site visits

Summary of the preliminary review of 2010 monitoring data for the test and control sites for the project.

Table XX. Precipitation event data and samples collected in 2010. A precipitation event is defined as being greater than 0.10 inches and separated by 8 hours. Rain gage located at 3800 Bryant Ave. S., Minneapolis, MN.

Event	Start Date/Time	End Date/Time	Precip (inches)	Duration (hours)	Intensity (in/hr)	Sample Type	31st & Elliot	35th & Columbus
+1	3/1/2010	n/a	n/a	n/a	n/a	grab	X	X
2	4/15/2010 200	4/15/2010 545	0.47	3.75	0.125	composite	X	X
3	5/5/2010 1645	5/8/2010 245	0.67	58.00	0.012	composite	X	X
4	6/1/2010 1515	6/2/2010 630	0.16	15.25	0.010	composite	X	X
5	6/25/2010 5:45	6/25/2010 7:30	2.05	1.75	1.171	composite	X	X
6	7/5/2010 14:00	7/5/2010 23:15	0.61	9.25	0.066	composite	X	X
7	8/12/2010 2030	8/13/2010 515	1.15	8.75	0.131	composite	X	X
8	8/31/2010 330	8/31/2010 615	0.46	2.75	0.167	composite	X	X
9	10/24/2010 145	10/24/2010 315	0.47	1.50	0.313	composite	X	X
10	10/25/2010 1615	10/26/2010 1615	1.01	24.00	0.042	composite	X	X
		Totals	**7.05**				**10**	**10**

+ snowmelt event
n/a = not applicable
X = event sampled

Key Findings at Project Mid-Point

- Over 20% of the runoff from impervious surfaces in the test area was redirected to
- rain gardens.
- Data collected to date looks promising to provide the data required for a statistical
- paired watershed analysis. An assessment of the performance of the rain gardens to
- reduce runoff and pollutant loadings to Powderhorn Lake will require the 2011
- monitoring season data.

Runoff Directed to Rain Gardens

- Over 20% of the runoff from impervious surfaces in the test area was redirected to rain gardens.
- Exhibit A shows the relationship of total area to impervious area in the test watershed and what has been redirected to rain gardens.
- Statistics
  - Total Test Watershed Area = 1, 241,500 sf
  - % of impervious area to total area = 58% impervious areas such as sidewalks streets, rooftops, driveways, and parking lots; source: City's GIS database)
  - Number of properties with rain gardens in test area = 102
  - Total area of properties with rain gardens = 550,000 sf
  - Impervious area in properties with rain gardens = 270,000 sf (49%)
  - Impervious area redirected to rain gardens = 56,000 sf
- The installation of rain gardens on 102 properties in the test area redirected runoff from approximately 56,000 sf of impervious surface. This accounts for a 21% decrease in impervious surface runoff from the properties that installed rain gardens. Extrapolating this to the total test area of 28.3 acres (1, 241,500 sf) and using the City's GIS-based estimate of 58% of total area as impervious, the impervious area redirected to rain gardens as a percent of the total impervious area for the test watershed is 8%.

Monitoring Findings

What we learned from the 2010 stormwater monitoring.

- Moving the monitoring location for the test and control sites provided us a more optimum test and control area to compare performance.
- Reducing the size of the test and control area watersheds will increase our ability to assess performance with the monitoring data.
- The test and control watersheds have similar runoff event characteristics as shown by comparing storm event flows for April 15, 2011 and September 22, 2011
- Having similar runoff characteristics reduces the inherent variability in comparing runoff from different watersheds and storm events which improves the ability to measure a difference in runoff between the test and control areas.
- The collection sites still contained sand/grit and debris, but the use of the invert and offset probes at the levels set in the pipe provided for accurate flow monitoring and sample collection.
- The new monitoring sites provide better site conditions for accurate data collection; however, there are still limitations at these sites with characterization of high intensity storm events. The 2010 summer and fall saw several 1-inch or greater storm events with intensities that caused the storm sewers to surcharge. The surcharge events prevented the ability to collect water quality samples during those events as water filled the manhole and submerged the equipment. The data loggers still recorded flow during this time.
- Flow during portions of the peak storm periods is not accurate during surcharging. For some events, estimated flows or total storm volume will be
- made, but some storm events will be excluded from analysis. Exhibit D summarizes the results from select storm events and Exhibit E provides the precipitation record.

Recommendations for 2011 Monitoring

It was recommended that our project team work with the MPRB to identify the optimum times to collect water quality samples. We should target storms with higher volumes with less intensity.

Methods
FlowLink 4 files obtained from the MPRB for 2010 sampling were merged with the rain gage data collected at the Powderhorn Lake center monitoring station. The data were reviewed to compare the readings obtained for precipitation, invert level, invert velocity, offset level, offset velocity, battery power, and sampling times.

The objectives of this preliminary data review included: (1) Review precipitation with flow monitoring and nearby precipitation records to confirm new rain gage is suitable for use in analysis, (2) compare invert and offset probe records and select method for all data analysis, (3) compare test and control hydrographs to expectations based on runoff area, and (4) compare selected pre- and post-rain garden installation (BMP) storm event runoff volumes. The pre-installation period is defined by Fall 2009 and April-August 2010 rain events and the post-installation period extends from September 2010 through 2011.

The analysis of pre- and post BMP runoff to compare the performance of the rain gardens cannot be performed until the 2011 monitoring season is complete. The analysis (paired watershed analysis) requires a significant number of rain events to make a statistically significant conclusion. Select hydrographs were compared to show the variability in rain events and the need to compare a range of rain events to assess performance. Metro Blooms staff reviewed the stormwater management plans for each property owner and compiled the impervious area redirected to rain gardens.

For 2011, 31st and Elliot flow data, MPRB discovered had a significant ISCO software issue mid-summer that kept the site from sampling and collecting accurate flow totals 7/15/11 to 8/24/11. The long downtime for the equipment occurred because staff did not know it was a software issue until they replaced all of the equipment -one piece at a time (and then waited for the next storm). After the problem was fixed it (by re-imaging the datalogger) we had a significant drought lasting through the end of summer and through the fall. As a result, very few paired data sets were captured following the final June installation and maintenance events.

A preliminary data check (10% data check) indicated that none of the 2011 chemical data should be marked suspect as the lab passed all of its monthly blind performance standards.

Deliverable 2: Monitoring Data Management

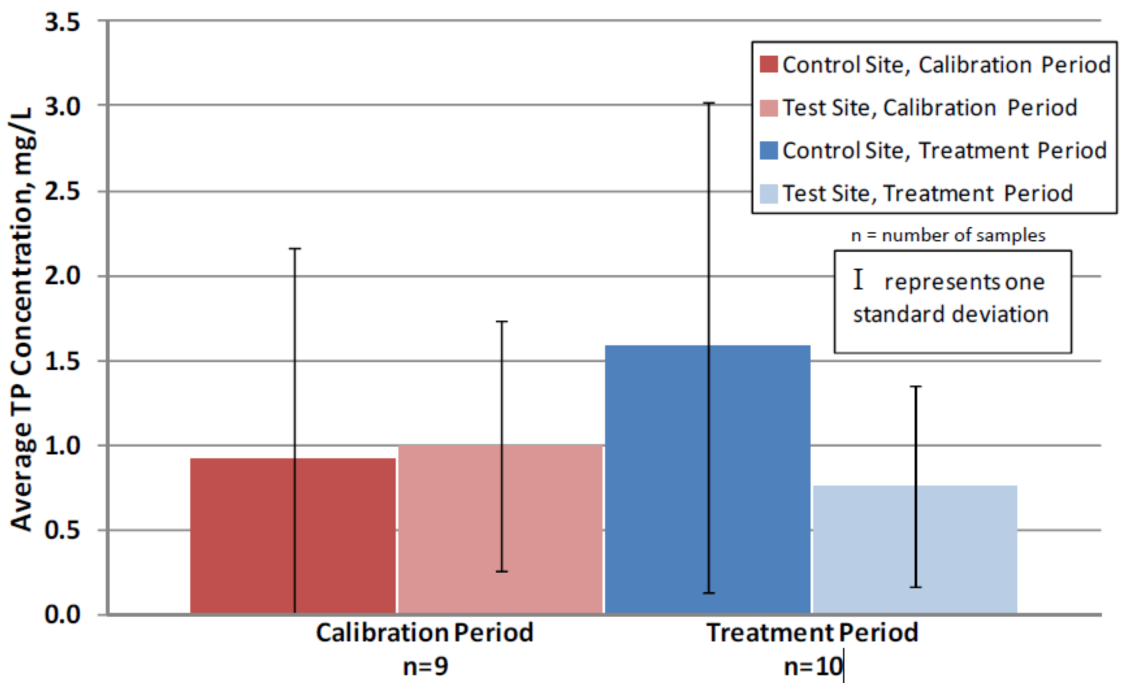
As monitoring data became available, Craddock Consulting Engineers (and later SEH Engineers where Patti Craddock became an employee) began preparation for efficient use of data provided by the Minneapolis Park and Recreation Board, and to prepare for analysis and use in project reports, including preparing precipitation data for incorporation with monitoring data.

Deliverable 3: Evaluation Reporting
Performance was measured by monitoring the water quality and quantity of stormwater to see if there was a measureable difference in the pollutant loadings going to Powderhorn Lake from the area with raingardens (test site) and a similar watershed without raingarden installations (control site).

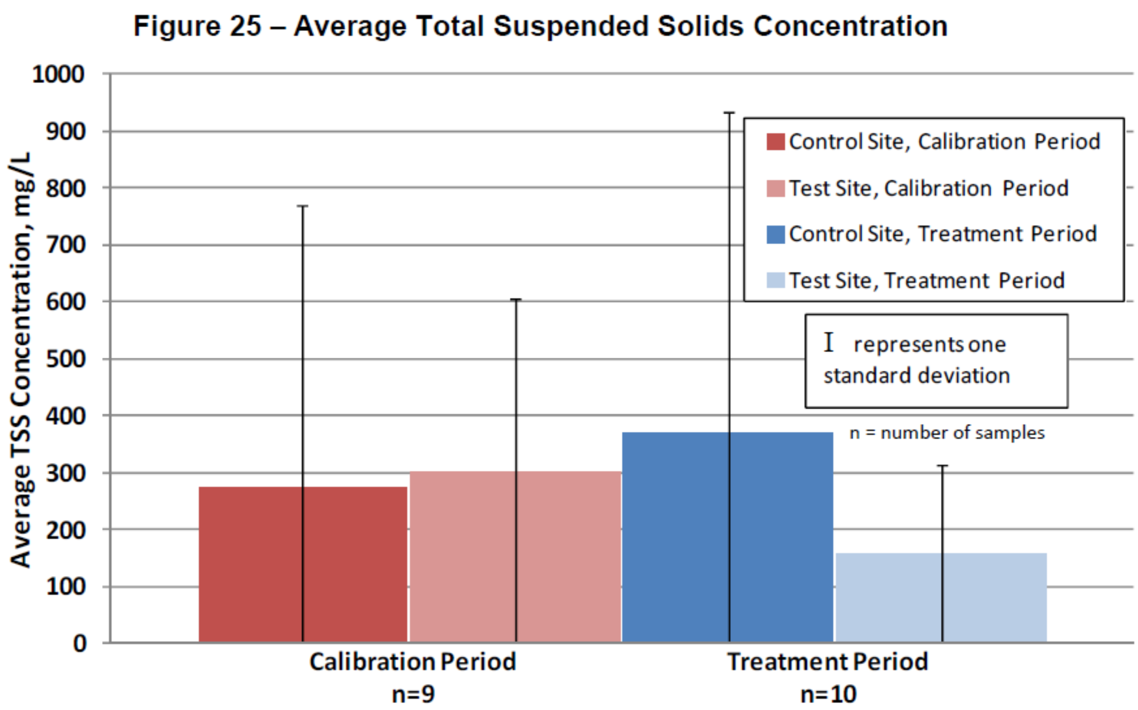
Measured Results

Monitoring in urban storm sewers has its challenges, and these sites and climatic conditions resulted in less samples than planned. While the paired watershed analysis results are inconclusive and do not show a statistically significant outcome, the few water quality samples collected in 2011 provide promise that the test neighborhood efforts could have reduced total phosphorus and total suspended solids loadings when compared to the control area. Figures 25 and 26 present the average total phosphorus and total suspended solids concentration results. As shown by the error bars, there is a wide variation in samples.

Figure 24 – Average Total Phosphorus Concentration



In the paired watershed analysis, same storm even data are compared in the calibration and the treatment period. The regression analysis results show that the BMP did not influence the volume of runoff. This result is not surprising, given that only 10% of the impervious area was directed to a BMP. The impervious areas in the public right-of-way dominates the land use and the ability to redirect enough volume from private properties. There were not enough data to provide a statistically significant regression result for total phosphorus and total suspended solids.



While the monitoring data may not statistically tell the story, the fact that 45 households participated in maintenance days and over 132 bags of debris were collected is significant and indicates that education and action influenced community members to improve Powderhorn Lake water quality. In addition 76% of survey respondents indicated that they further enhanced their garden with plants, landscape materials or art. At least 56% implemented additional BMPs in their yard (e.g. adding a rain barrel or additional raingarden).

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $ 77,140 – This includes $30,540 for a newly created position of program coordinator at Metro Blooms. It is a part-time, 0.3 FTE position. The program coordinator monitored and recruited participants, monitored schedules and budgets. It includes $13,400 for a newly created position as neighborhood coordinator (.125 FTE). It also includes newly created positions as Metro Blooms Landscape Designers. It was a part-time, .2 FTE position ($26,000). The Landscape Designers provided onsite supervision at all excavations, raingarden workshop presentations, onsite consultations, raingarden design and oversight. Administrative Assistant this was an expansion of .05 FTE of an existing position for data entry and reporting for this project ($7,200)

Contracts: $ 156,773 - Partner contracts include identified partners: 1) $27,750 - Minnesota Conservation Corps (Raingarden excavation – Mon - Thurs), 2) $13,900 - Ecoscapes (Raingarden excavation), 3) Minneapolis Park and Recreation Board: Monitoring - $ 23,563 and Green Team (youth crew for landscape services) - $20,000, 4) $20,400 – Landscape Design and Architecture (LDA) Students from U MN for landscape design services, 5) $1,100 - Rusty Schmidt, for onsite consultation training and technical review, 6) $48,000 - Craddock Consulting Engineers and SEH Engineers, data assessment, evaluation report preparation, and technical review, and 8) $2,060 – Latino community workshop and installation organizing.

Educational Materials and Final Report: $ 12,350 – Raingarden workshop educational packet, promotional door-hangers for Powderhorn residents, display materials, and raingarden signs, including a permanent interpretive sign for self-guided tours. Also includes evaluation report composition, printing and binding.

Native Plant Supplies $11,250

Landscaping Tools/Supplies: $15,737 – This includes shovels and rakes, mulch and compost, and periodic rental of excavation equipment, as needed. It also includes materials for the redirection of downspouts including pipe extensions, catch-basins, and grates, and materials for installation permeable pavement and channel drains and other materials to redirect stormwater to raingardens.

Travel: $ 3,250 – Travel costs related to in-town mileage ($.51- $.585 per mi), primarily for staff and landscape designers traveling to the Powderhorn.

TOTAL TRUST FUND PROJECT BUDGET: $ 279,000

VI. PROJECT STRATEGY:

A. Project Partners: Multiple project partners, many providing matching funds and in-kind services, delivered this project. Each partner brings invested team members looking for answers and sustainable programs to achieve their organization's water quality goals.

Metro Blooms is the lead organization with technical assistance and evaluation provided by Craddock Consulting Engineers.

The following organizations (contact person) will be significantly involved:

- City of Minneapolis - (Lois Eberhart), Technical review for the project was provided by Lois Eberhart, City of Minneapolis Surface Water & Sewers Administrator. The City will also provided GIS services and pre-project monitoring activities to provide an adequate pre-test data set.
- Minneapolis Park Recreation Board - (Tim Brown, P.E., Michael Perniel and Deb Pilger), MPRB, provided monitoring services for the Powderhorn Lake study.
- Minnehaha Creek Watershed District - (Udai Singh and Julie Westerland), Technical review for the project was provided by Udai Singh, MCWD's water quality specialist, and by Julie Westerlund and Leslie Yetka, education and communications manager.
- Minnesota Conservation Corp - (Brian Miller), Young Adult Program excavated and assisted with the installation of raingardens.

B. Project Impact and Long-term Strategy: The organizing approach has had a direct benefit to Powderhorn Lake, an impaired water body in Minneapolis and within the MCWD. The study results have been integrated into adaptive management by the City, MPRB, and MCWD for achieving TMDLs. It was recognized in the recently adopted TMDL for Lake Nokomis.

The publicity for the Powderhorn Lake Neighborhood of Raingardens program led to similar effort in neighborhoods throughout the Twin Cities metropolitan area. Metro Blooms has completed smaller scale Neighborhood of Raingardens projects in the following Minneapolis neighborhoods: Victory, Cleveland, Diamond Lake, Linden Hills, Lynnhurst, Audubon, Holland, Bryant, and Bryn Mawr, as well as, the Schmidt Lake neighborhood in the City of Plymouth. We also have projects in-progress or planned in the Holland neighborhood, East Lake of the Isles neighborhood, with the City of Bloomington, around Lotus Lake in Chanhassen, and around Lake Nokomis in Minneapolis.

The project has in increased awareness in the metro area about urban runoff and the impact the private citizen can have on water quality. The organizing approach has been applied to urban areas across the Twin Cities metropolitan area, and adopted by cities and watersheds who are implementing the approach without our involvement.

C. Other Funds Proposed to be Spent during the Project Period: $115,500

Minnehaha Creek Watershed District: $25,500 Matching Support ($15,000 approved, year 1, $5,500 approved year 2, $5,000 approved year 3). Minneapolis Park and Recreation Board: (Green Team) $10,000 and (Unallocated Expenses of data collection and project administration) $16,437 Matching Program Support, McKnight Foundation: $80,000 Operating Support

D. Spending HIstory: not applicable

VII. DISSEMINATION:

A Neighborhood of Raingardens a film produced by University of Minnesota's Mark Pedelty was previewed at the Institute on the Environment. The film gives an introduction to raingardens and stormwater runoff and highlights the Powderhorn Park project. It aired on the MN Channel (TPT MN) on April 22, 2011 at 7:30pm, with repeats on April 23, 2011 at 1:30am and 7:30am, and during the month of June. The film has been shown at neighborhood events and co-ops and is available to be viewed online or for download at www.raingardenmovie.org.

Metro Blooms gave a presentation on the project to the Watershed Partners and Blue Thumb partnerships, collaborations of water resource professionals and private contractors. In addition, we will be presenting our project approach and study results on October 17 at the Water Resources Conference, a state-wide event that showcases innovative, practical, and applied water resource engineering solutions, management techniques, and current research about Minnesota's water resources.

All project partners received a copy of the final report and executive summary. All project participants received a copy of the executive summary with accompanied raingarden maintenance brochure. The full report and executive summary will be available on our website at www.metroblooms.org. Additional copies of the executive summary will be made available at outreach events and upon request, while supplies last.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports were submitted for the periods ending December 2009, July 2010, December 2010, July 2011, and December 2011. A final work program report and associated products was submitted between July 30 and August 15, 2012 as requested by the LCCMR.

IX. RESEARCH PROJECTS: not applicable

Reimbursement Request – Invoice Summary Spreadsheet - Part 2

Project Title: CITIZEN-BASED APPROACH TO STORMWATER

Legal Citation: Laws of Minnesota 2009, Chapter 143, Section 2, Subdivision 5e.

Budget for Results from Work Program	Approach)			Reporting)			Project Total		
Budget Item	Budget	Amount Spent	Ending Balance	Budget	Amount Spent	Ending Balance	Budget	Amount Spent	Ending Balance
	Neighborhood Approach			**Monitoring, Data Analysis and**					
BUDGET ITEM - Total for 3 Years									
Personnel: Wages and Benefits									
Sam Geer, MLA,project coordinator (0.2 FTE)	30,540	30,540.00	-				30,540	30,540.00	-
Bryan Pynn (.125 FTE neighborhood coordinator)	18,890	18,890.00	-				18,890	18,890.00	-
Michael Keenan, Lead Landscape Design Assistant (.2 FTE)	26,000	26,000.00	-				26,000	26,000.00	-
Deborah Jopp (.05 FTE), data entry and reporting	7,200	7,200.00	-				7,200	7,200.00	-
Contracts									
Minnesota Conservation Corp, excavation of raingardens	27,750	27,510.00	240.00				27,750	27,510.00	240.00
Ecoscapes, excavation of raingardens	11,900	11,900.00	-				11,900	11,900.00	-
Minneapolis Park and Recreation Board									
Stormwater Monitoring, Water Quality and Volume				23,563	23,563.00	-	23,563	23,563.00	-
Green Team, youth crew	20,000	20,000.00					20,000	20,000.00	-
Landscape Design Assistants	20,400	20,400.00	-				20,400	20,400.00	-
Rusty Schmidt, Onsite consultation training and technical review	850	850.00	-				850	850.00	-
Craddock Consulting Eng, Data Asess, Report Prep, Tech Review				48,000	48,000.00	-	48,000	48,000.00	-
Carlos Zinghre: Latino community	2,000	2,000.00					2,000	-	
experimental design, monitoring				60	60.00		60	60.00	-
Capital equipment over $3,500[8]									
Educational Materials -	12,350	11,963.62	386.38	2,500	2,489.88	10.12	14,850	14,453.50	396.50
Native Plant Supplies - propagation and supplies	12,790	12,735.53	54.47				12,790	12,735.53	54.47
Landscaping supplies and equipment (less than $3,500)	10,957	10,807.53	149.47				10,957	10,807.53	149.47
Travel expenses in Minnesota	3,250	3,250.00	-				3,250	3,250.00	-
Column Total	**204,877**	**204,046.68**	**830.32**	**74,123**	**74,112.88**	**10.12**	**279,000**	**276,159.56**	**840.44**

A Citizen-Based Approach to Stormwater Management:

Raingardens to Improve Impaired Waters

Final Report

Powderhorn Lake
Minneapolis, Minnesota

LCCMR Project 09-05e

June 29, 2012

In Association with:

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A Citizen-Based Approach to Stormwater Management::

Raingardens to Improve Impaired Waters

Final Report
Powderhorn Lake Minneapolis, Minnesota

Prepared for:

Legislative-Citizen Commission on Minnesota Resources

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Prepared by:

Metro Blooms
P O Box 17099
Minneapolis, MN 55417
651.699.2426

In Association with:

Short Elliott Hendrickson Inc.
3535 Vadnais Center Drive
Saint Paul, MN 55110-5196
651.490.2000

City of Minneapolis, Minneapolis Park & Recreation Board,
Minnesota Conservation Corp and Minnehaha Creek Watershed District

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Acknowledgements

This study was conducted by Metro Blooms, a private nonprofit volunteer-based educational organization which seeks to partner with other organizations, businesses, professional associations, local governments and watershed districts to promote environmentally sound gardening and landscaping practices to improve the health of our land and water resources. Funding for this project was recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR) from the Environment and Natural Resources Trust Fund.

This project was delivered by numerous partners, many with in-kind contributions. Metro Blooms wishes to acknowledge and thank the following organizations for participating in this study:

Minneapolis Park and Recreation Board – stormwater monitoring and in-kind contributions related to management for monitoring and Mississippi River Green Team (youth worker) and technical review

City of Minneapolis – in-kind contributions for monitoring, technical review, and GIS services

Minnesota Conservation Corps – excavation

Short Elliot Hendrickson – paired watershed analysis, partner meeting facilitation, and report preparation

Minnehaha Creek Watershed District– in-kind contributions for technical review

Minnesota Pollution Control Agency– in-kind contributions for technical review

Mark Pedelty, University of Minnesota (and students) – in-kind contributions for documentary production and promotions

Mississippi River Green Team - youth in summer jobs program cared for and planted raingardens

Hennepin County Master Gardeners and many volunteers - participated in door-knocking, installation and maintenance activities

Ecoscapes – excavation and installation (pavers, drains, gutter realignments)

Dragonfly Gardens - contributions of native and other perennial plants

Patio Town - contribution of permeable pavers

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Education and action influenced community members to improve Powderhorn Lake water quality.

- The Powderhorn Lake neighborhood implemented best management practices to reduce stormwater runoff to Powderhorn Lake by directing 70,000 square feet of impervious area to bio-infiltration basins (raingardens).
- 230 community members were involved in activities related to implementation of water quality protection practices.
- 125 raingardens were installed through a fast-track design and construction process.
- Multiple community cleanup events were held which resulted in over 130 large bags of leaves and debris from entering the lake.

fast facts

125 raingardens installed

230 community members involved

50% property owners (non-rentals) participated in test area

> 70,000 square feet of impervious area redirected

> 15,000 native perennials planted

how? Citizen Engagement Methods Key to Successful Outcomes

- Enlist local champions of stormwater management to reach out to community members.
- Use a combination of outreach methods: workshops, mass mailings, door knockers, neighborhood home meetings, and canvassing.
- Include multi-lingual staff and community members to engage non-english speaking community members.
- Use a non-profit organization for outreach and implementation to offset skepticism associated with a private firm or city-led effort.
- Provide an economic incentive and a well-crafted, educated message.

why? Project Vision

The long-term success in reducing impairments to urban lakes and waterways will require better citizen-based approaches to increase public awareness and effect behavior change. A coordinated plan is also required that focuses efforts on areas and stormwater management practices providing the best benefits to the impaired receiving waters. This project evaluated community outreach approaches through a pilot study of the fast-tracked installation of over 100 raingardens in a 28-acre sub-watershed draining to Powderhorn Lake, Minneapolis. Stormwater best management practices (BMPs) were restricted to installations on private property. Stormwater monitoring was also integrated into the project to assess whether reductions in pollutant loadings or volume could be detected and provide support for future water quality improvement plans for Powderhorn Lake.

Citizen-Based Approach to Stormwater Management – Neighborhood of Raingardens

The term "Neighborhood of Raingardens" was created to define the collective approach to implementing stormwater management practices clustered in neighborhood areas. The goal is to educate citizens on the ways they can have a positive effect on the local water quality through a variety of methods such as: raingardens, permeable pavers, green roofs, rain barrels, native plantings, boulevard plantings and yard maintenance. Raingardens serve as a visible tool and 'hook' to gain citizen interest and encourage neighbor participation. The large-scale community participation process not only teaches participants about water quality protection, but it also builds a stronger and more beautiful community through increased community outreach.

methods

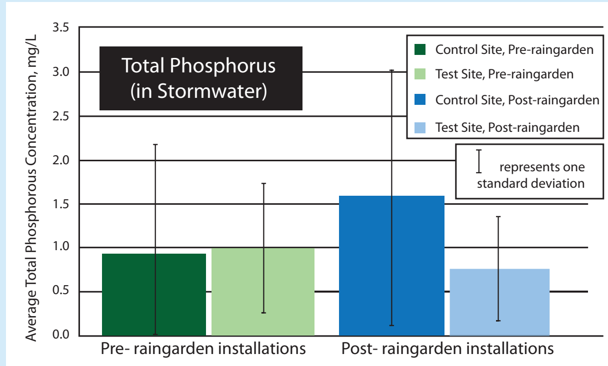
The project was developed through three phases: citizen engagement, design, and installation. Measurement activities preceded and occurred throughout the project.

Participant Process

Metro Blooms' general approach to citizen-based stormwater management projects involves the property owner throughout the process. For this project, the property owners were presented the large incentive of free design and installation services, as well as free garden plants and materials. Because this was a fast-paced project, it was difficult for most property owners to be involved in the installation process, but local youth teams assisted and institutional properties held events that engaged numerous community members.

Measurement

Performance was measured by monitoring the water quality and quantity of stormwater discharged to Powderhorn Lake from the area with raingardens (test site) and a neighboring watershed without raingarden installations (control site) and comparing the results from the two sites. Minneapolis Park and Recreation Board (MPRB) installed and maintained equipment for three years to provide stormwater runoff characteristics before and after the raingardens were installed. Surveys, site assessments, and maintenance activities were also used to evaluate the effectiveness of the Neighborhood of Raingardens in improving Powderhorn Lake water quality.



results

Monitoring in urban storm sewers has its challenges and coupled with the climatic conditions for the project period, fewer water quality samples were collected than planned. While the paired watershed analysis results do not show a statistically significant outcome, the few water quality samples collected in 2011 provide promise that the test neighborhood efforts could have reduced pollutant loadings when compared to the control area.

Other project measurements demonstrate that education and action influenced community members to improve Powderhorn Lake water quality. Over 230 people participated in project events and over 130 large bags of debris were collected in maintenance activities. In addition, post-survey results of participating property owners indicated that 76% enhanced their garden with additional plants, landscape materials or art. Over 50% implemented additional BMPs in their yard, such as adding a rain barrel or additional raingardens.

future plans

- Continue stormwater monitoring (City of Minneapolis is funding 2012 monitoring by MPRB).
- Further develop Metro Blooms' volunteer-based, raingarden evaluation program to provide added incentive for continued maintenance of raingardens.
- Focus new urban projects on maximizing backyard runoff capture with multiple types of BMPs.

Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

List of Tables

List of Figures

Table of Contents (Continued)

List of Appendices

List of Abbreviations

BMP	Best Management Practice
cf	Cubic Feet
ft	Feet
LCCMR	Legislative-Citizen Commission on Minnesota Resources
LDA	University of Minnesota Landscape Design & Architecture Student
MCC	Minnesota Conservation Corps
MCWD	Minnehaha Creek Watershed District
MPRB	Minneapolis Park and Recreation Board
sf	Square Feet
SWMP	Stormwater Management Plan
TP	Total Phosphorus
TSS	Total Suspended Solids

A Citizen-Based Approach to Stormwater Management:

Raingardens to Improve Impaired Waters

Prepared for Legislative-Citizen Commission on Minnesota Resources

1.0 Introduction

1.1 Project Vision

The long-term success in reducing impairments to urban lakes and waterways will require better citizen-based approaches to increase public awareness and effect behavior change. A coordinated plan is also required that focuses efforts on areas and stormwater management practices providing the best benefits to the impaired receiving waters.

This project evaluated community outreach approaches through a pilot study of the installation of over 100 raingardens within a five-week period in a 28-acre sub-watershed draining to Powderhorn Lake, Minneapolis. Stormwater best management practices (BMPs) were restricted to installations on private property. Stormwater monitoring was also integrated into the project to assess whether reductions in pollutant loadings or volume could be detected and provide support for future water quality improvement plans for Powderhorn Lake.

The study results have direct benefits to Powderhorn Lake, a water body in Minneapolis and within the Minnehaha Creek Watershed District (MCWD). In addition to directing over 70,000 square feet (sf) of runoff from impervious areas to bio-infiltration areas (raingardens), the project engaged 230 community members and increased their awareness of how their actions affect the water quality of their neighborhood lake. Community members were involved at various levels of commitment, including: reading literature distributed as part of the project, attending or hosting a workshop, meeting with a designer, and participating in installation and maintenance activities.

The study results will be used by the City, Minneapolis Park and Recreation Board (MPRB), and MCWD for various watershed management strategies. In addition, the findings of this project can be applied to similar urban areas and provide a basis to target citizen-based improvements of highest benefit to our water resources.

1.2 Citizen-Based Approach to Stormwater Management – Neighborhood of Raingardens

The term “Neighborhood of Raingardens” was created to define the collective approach to implementing stormwater management practices clustered in neighborhood areas. The goal is to educate citizens on the ways they can have a positive effect on the local water quality through a variety of methods such as: raingardens, permeable pavers, green roofs, rain barrels, native plantings, boulevard plantings and yard maintenance. Raingardens serve as a visible tool and ‘hook’ to gain citizen interest and encourage neighbor participation. The large-scale community participation process not only teaches participants about water quality protection, but it also builds a stronger and more beautiful community through increased community outreach.

The Powderhorn Lake Neighborhood of Raingardens project specifically explored several different techniques to recruit residents and institutional property owners to install raingardens and implement other stormwater management practices on their private property. For example, one method is to have a resident host a neighborhood raingarden party, as shown in Figure 1. A small workshop-style presentation introduces stormwater and water quality concepts, and residential practices to improve water quality. In the case of this project, significant incentives included free consultation, design, installation and plantings funded by this project. In addition to citizen engagement, this project required specific design and installation processes, which are also documented in this report.

Figure 1 – Neighborhood Raingarden Party Used to Introduce Stormwater Management Practices

The Powderhorn Lake Neighborhood of Raingardens project was developed to reach several goals. Foremost was to evaluate methods of citizen engagement and maximize community involvement. Given the “free” incentive of a raingarden, the focus of the best management practices was on the installation of a raingarden and education about water quality protection. In most cases, a raingarden provided a BMP with a high runoff capture volume for a specific property. For some properties, other practices may have been more effective, but were not implemented because of site, budget, and homeowner constraints, except at institutional and specific properties during the second year.

Another project goal was to maximize runoff capture. This goal was restricted by the requirement to install raingardens and other stormwater management practices exclusively on private property. The inability to capture runoff from sidewalks and streets limited the stormwater runoff pollutant load and volume reduction possible with this project.

1.3 Project Team

This study was conducted by Metro Blooms, a private nonprofit organization which seeks to partner with other organizations, businesses, professional associations, local governments and watershed districts to promote environmentally sound gardening and landscaping practices to improve the health of our land and water resources. Funding for this project was recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR) from the Environment and Natural Resources Trust Fund.

This project was delivered by numerous partners, many with in-kind contributions.

- Minneapolis Park and Recreation Board – stormwater monitoring and in-kind contributions related to management for monitoring, Mississippi River Green Team and technical review
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- Mark Pedalty, University of Minnesota (and students) – in-kind contributions for documentary production and promotions
- Mississippi River Green Team (youth in summer jobs program) – cared for and planted raingardens
- Ecoscapes – excavation and installation (pavers, drains, gutter realignments)
- Dragonfly Gardens - contributions of native and other perennial plants
- Patio Town - contribution of permeable pavers
- Numerous volunteers including: Hennepin County Master Gardeners, University of Minnesota students, residents from the Powderhorn Park Neighborhood & many others

1.4 Study Area

1.4.1 Powderhorn Lake and Watershed Characteristics

Powderhorn Lake is located in an urban residential area south of downtown Minneapolis, Minnesota, as shown in Figure 2. It is a small 11-acre lake within a 77-acre park. Originally a wetland area, it was dredged in the early 1900s to create the lake and park. It is shallow, averaging under 4 feet (ft) in depth with one area around 20 ft deep. It has a watershed of 286 acres (26:1 ratio) and five separate stormwater outfalls discharging to the lake (Figure 3), with no natural open channel tributaries. Water leaving Powderhorn Lake is pumped directly to the Mississippi River, when authorized. Other than the park area surrounding the lake, the watershed is a built-out urban area that is primarily residential, with institutional and commercial properties mixed throughout.

Figure 2 – Powderhorn Lake Location Map

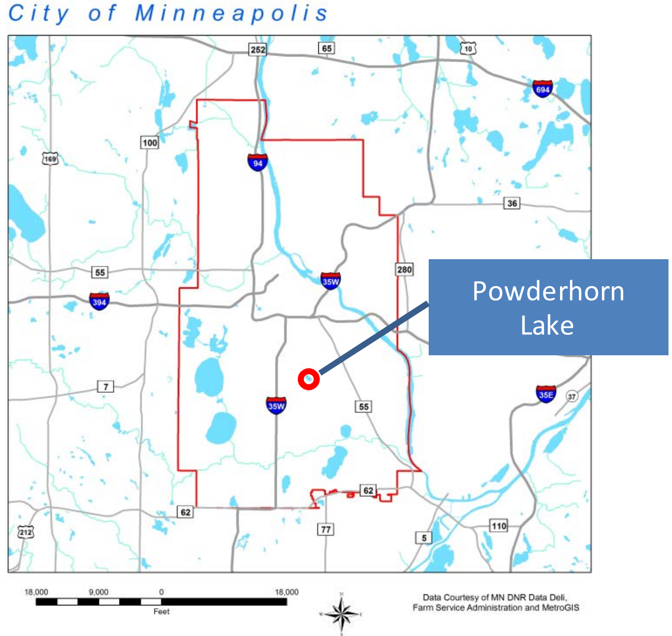
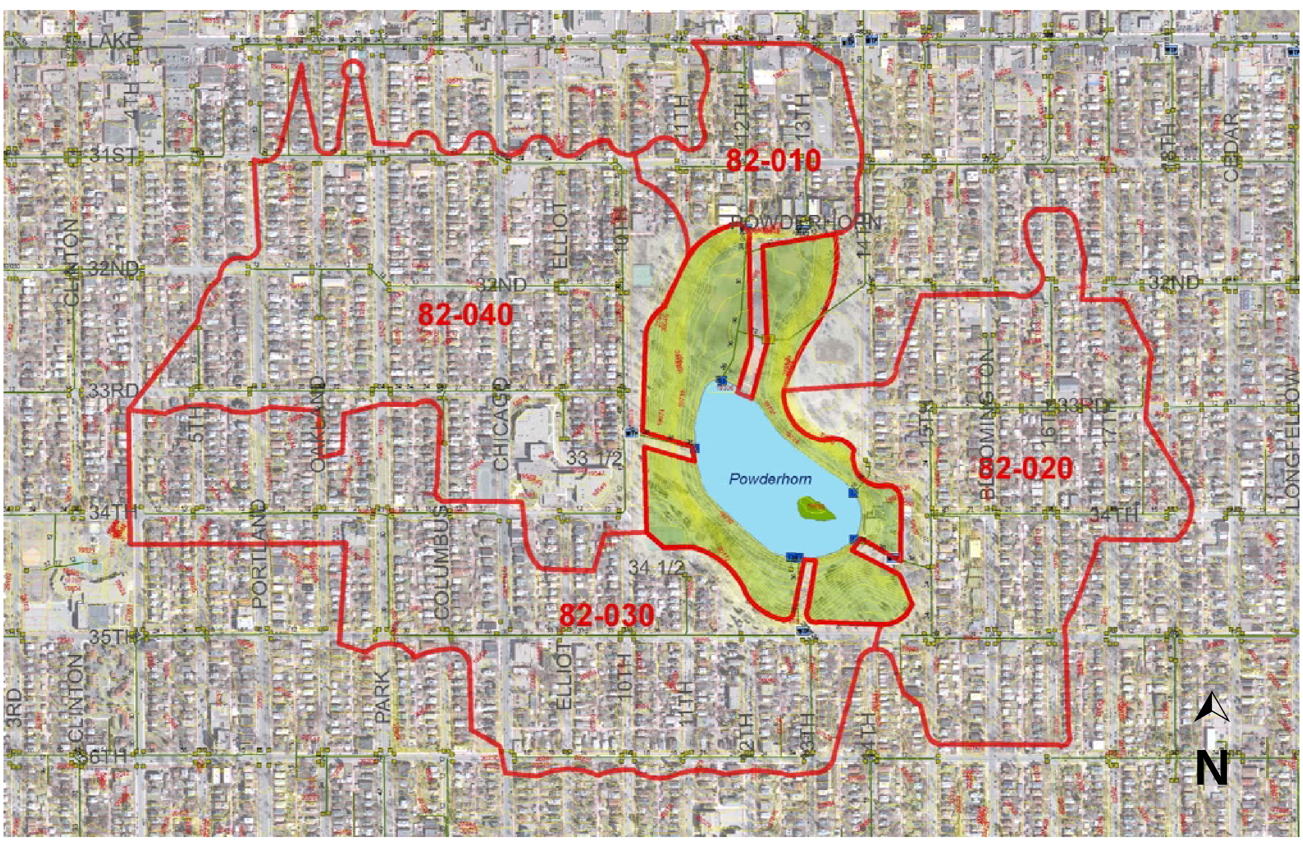


Figure 3 – Powderhorn Lake Sub-Watersheds



1.4.2 Powderhorn Lake Water Quality and Past Improvement Projects

Powderhorn Lake was previously listed by the State of Minnesota as impaired for "nutrient/ eutrophication biological indicators". It was removed from the list of impaired waters in 2012. Several City and MPRB improvement projects and City-wide programs targeted Powderhorn Lake for water quality improvements and include:

- Installation of five Continuous Deflective Separation (CDS) grit chamber units in 2002. These units remove floatables like leaves and garbage and heavier solid particles, such as sand.
- A shoreline restoration and retaining wall construction was completed in 2002. This included removal of concrete sluiceways and planting of native aquatic and shoreline vegetation (Figure 4).
- Alum treatment in 2003. Alum is a chemical that is added to remove soluble phosphorus which forms a precipitant that settles to the lake bottom.
- Aeration during summer and winter since 2003.
- Annual barley straw treatment since 2004. This approach targets microbial communities in the lake, to increase their take up of nutrients as they grow making the nutrients unavailable to algae (Figure 5).
- Implementation of ongoing practices including:
  - Street sweeping during the spring, summer and fall. Winter sweeping is also conducted as weather permits. The Powderhorn Park parking lots are also swept on an approximately 15-day cycle.
  - Goose reduction programs.
  - City stormwater utility program which credits property owners who employ on-site stormwater management practices.
  - Public education programs.

Figure 4 – Shoreline Restoration

Figure 5 – Barley Straw Treatment

1.4.3 Neighborhood of Raingardens Study Area

In 2008, Metro Blooms was working with the City on education programs for residential stormwater management. Metro Blooms was interested in expanding its existing raingarden workshop program to focus on specific areas for engagement. With interest and planning assistance from multiple partners, the concept evolved to this pilot study of methods for fast-tracked installation of residential and institutional property raingardens. The partner team also wanted to measure performance of this collective stormwater management approach and incorporated water quantity and quality monitoring into the project. The Powderhorn Lake area was selected as the site for the study. Additionally, there were residents in the area with interest in raingardens based on previous workshops and outreach activities.

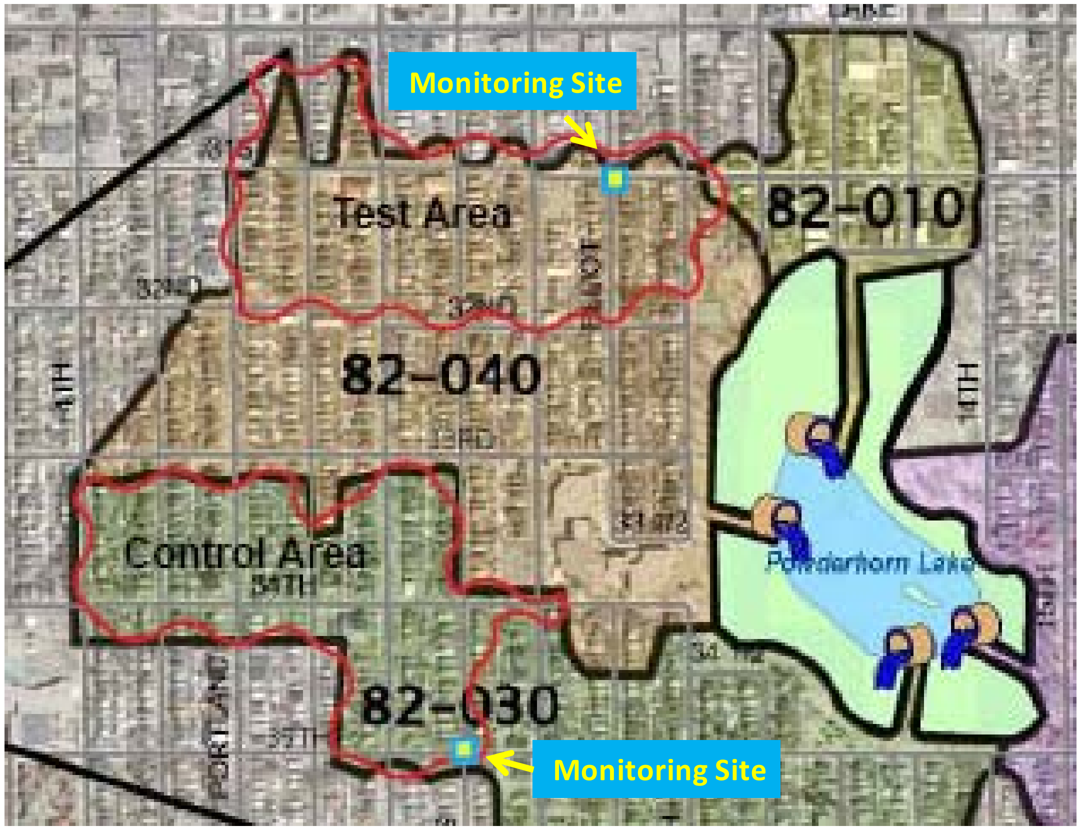
The study was set up to assess the performance of a Neighborhood of Raingardens with a paired watershed analysis. In this analysis, stormwater monitoring is required in both a test and control area. The watershed area with newly installed raingardens and other BMPs is the test area and the one without the accelerated raingarden program is the control area. A review of watershed land use identified two subwatersheds, 82-030 and 82-040, on the west side of the lake with similar characteristics as shown in Table 1. Figure 6 shows the areas of each of these subwatersheds selected for this study.

Table 1 - Powderhorn Lake Watershed Land Use

	Drainage Area 82-040 (Test)				Drainage Area 82-030 (Control)			
Type	Count	Total Area (sf)	Estimated Impervious Area (sf)	% Impervious	Count	Total Area (sf)	Estimated Impervious Area (sf)	% Impervious
Residential Parcels	435	2,261,064	852,059	38%	396	2,069,998	746,954	36%
Non-Residential Parcels	20	388,864	253,773	65%	20	201,254	129,333	64%
Public Right-of-Way	na	1,640,732	1,394,623	85%	na	1,650,891	1,403,257	85%
Total		**4,290,660**	**2,500,455**	58%		**3,922,143**	**2,279,544**	58%

Source: City of Minneapolis GIS database
na = not applicable

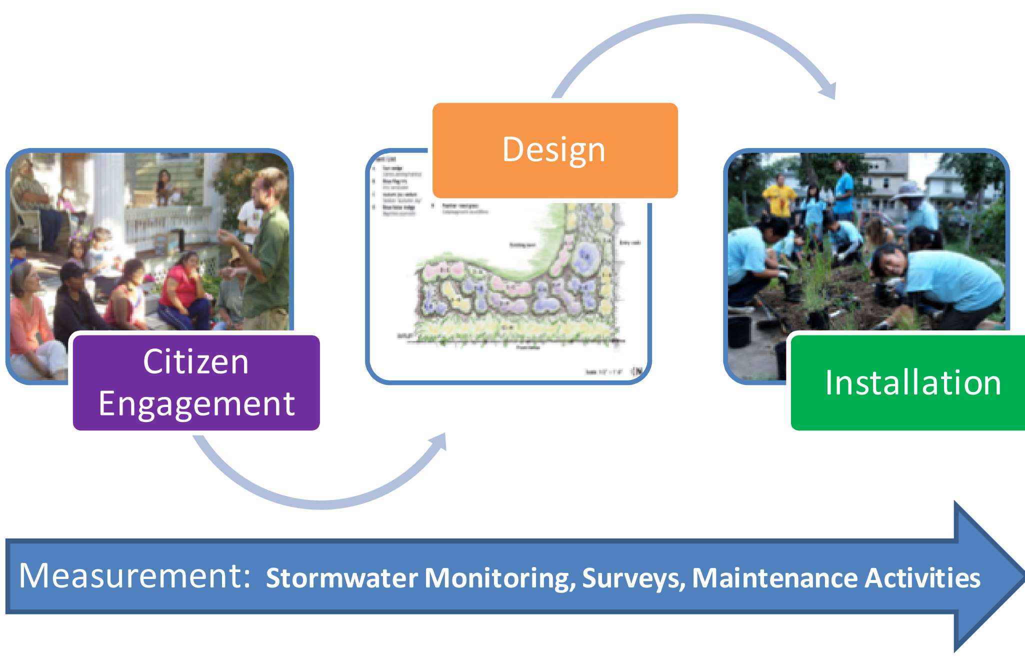
Figure 6 – Test and Control Sub-Watersheds



1.5 Methods

The project was developed through three phases: citizen engagement, design, and installation. Measurement activities preceded and occurred throughout the project, as depicted in Figure 7.

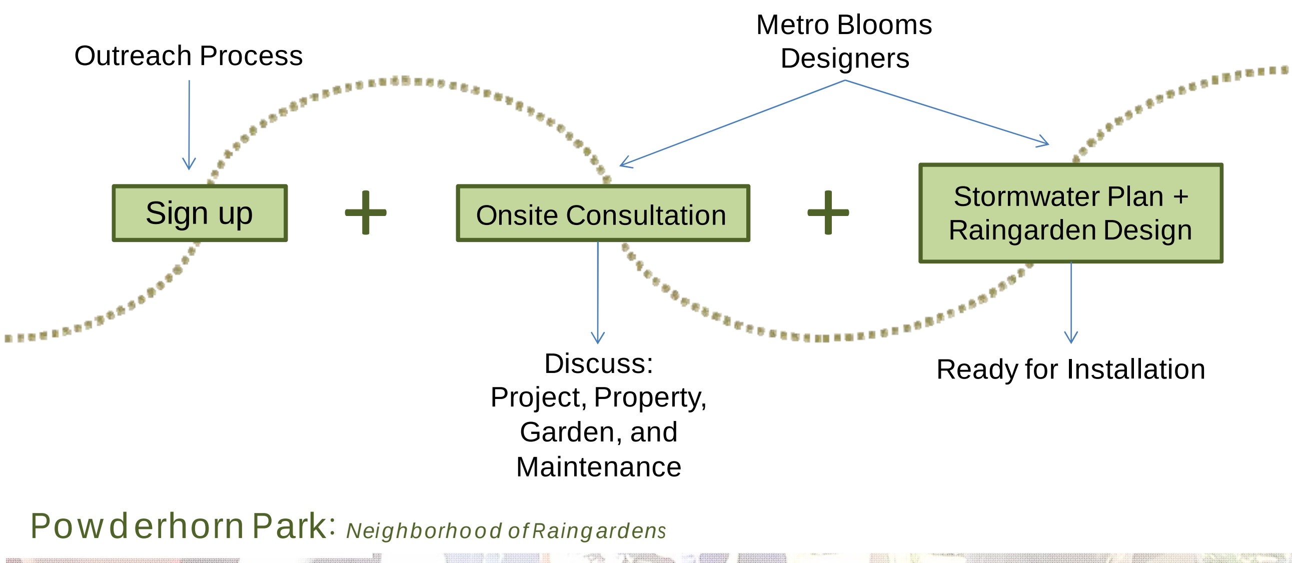
Figure 7 – Project Phases



1.5.1 Participant Process

Metro Blooms' general approach to citizen-based stormwater management projects involves the property owner throughout the process. Figure 8 presents the process and interaction with the participant. For this project, the property owners were presented the large incentive of free design and installation services, as well as free garden plants and materials.

Figure 8 – Participant Process



1.5.2 Project Specific Process Features

The Powderhorn Neighborhood of Raingardens used multiple outreach methods and a fast-tracked design and installation process. The initial plan was to involve property owners throughout the process including installation. Past experience has shown there is more commitment to the cause and longer-term success in maintenance of the garden and other stormwater management practices with involvement. Because the schedule was compressed to accommodate issues with the stormwater monitoring, the gardens needed to be installed in a short period of time. It was too difficult to plan schedules with each property owner to coordinate their involvement in the planting. However, there were some individual and several community and institution property group installations.

1.5.3 Measurement

1.5.3.1 <u>Stormwater Monitoring</u>

A significant part of this project was monitoring the water quality and quantity of stormwater to see if there was a measurable difference in the pollutant loadings going to Powderhorn Lake. The monitoring activities dictated the schedule and selection of the study area and required continual adjustments for the team in all project phases.

Stormwater monitoring to test the performance of a BMP involves:

- Selection of the proper sites to characterize similar drainage areas for test and control watersheds and for optimum monitoring equipment performance.

- Use of equipment that is installed correctly and maintained to ensure accurate data collection.
- Data analysis that involves quality control procedures to report results with statistical confidence.
- Adequate monitoring of watershed storm events before (pre-test or calibration period) and after (post-test or treatment period) the BMP installation, in both the test and a control watershed.

The inclusion of stormwater monitoring in the project put constraints on the specific areas that would qualify for participation in the study. This resulted in turning away interested residents and having to recruit more in the test area. Conversely, the selection of monitoring sites favored certain locations despite site specific features of the collection site that were not optimum (such as proximity of downstream storm sewer connections). Some compromises were made to capture similar watershed characteristics for the test and control basins, as well as neighborhoods indicating there were willing participants.

Monitoring equipment was installed in the storm sewers at two locations to record stormwater flow for the test and control watersheds beginning in Spring 2009 through November 2011. The MPRB installed equipment & collected data for the three year period as shown in Figure 9 for one of the sites. Approximately 10 water quality samples were taken each year and analyzed for total phosphorus and total suspended solids. Equipment was removed in the winter months.

Figure 9 – Monitoring Equipment & Sites

Section 6.3 and Appendix A, Technical Memorandum- Powderhorn Lake Neighborhood of Raingardens Paired Watershed Analysis, provide a detailed accounting of the methods and results

from the stormwater monitoring. Section 2.0 presents the major monitoring activities to document the steps, issues, and successes along with the Neighborhood of Raingardens project phases.

1.5.3.2 Surveys, Site Assessments and Maintenance Activities

Several activities were used to measure progress and performance during the project phases. In the citizen engagement phase, the number of citizens responding to various methods were recorded. A survey was adapted for this project and used in the early citizen engagement phase to provide a stormwatershed audit of the test and control areas. Site assessments were performed by Metro Blooms staff throughout the project to determine if original stormwater management plans were being followed. In addition, maintenance activities were organized in 2011 and 2012, and the number of new plants provided, plus other information recorded provides a measure of the number of properties with continued performance as originally designed.

1.6 Report Organization

This project has a variety of information that provides value for planning future citizen-based stormwater management programs and specific needs for the Powderhorn Lake watershed and similar urban areas. Figure 10 summarizes the organization of the report.

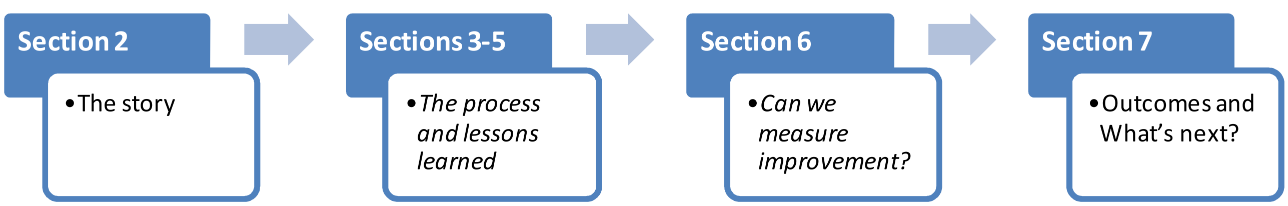
- *First – The story.* It is helpful to view the chronology of the project to understand the different methods used in each project phase and the results and challenges of each phase and the measurement of BMP performance. Section 2.0 tells the Powderhorn Lake Neighborhood of Raingardens story through a project timeline.

- *Second – The process and lessons learned.* Sections 3.0 – 5.0 define the processes that evolved to deliver the citizen engagement, design, and installation phases.

- *Third – Can we measure water quality improvement?* Section 6.0 presents the results of stormwater monitoring, land use and runoff capture changes, site surveys, and maintenance activities.

- *Last – Outcomes and What's next?* Section 7.0 summarizes the project's major outcomes and the opportunities identified to continue to build on the successes of the Powderhorn Lake Neighborhood of Raingardens.

Figure 10 – Report Organization



2.0 Project Timeline

2.1 Overview

This project spanned over three years. Project planning and stormwater monitoring were initiated in the spring of 2009 by the City of Minneapolis to provide as much time as possible for pre-installation monitoring and the ability to quickly mobilize efforts to enlist participants. Mid-2009 to mid-2010 involved outreach education programs, onsite consultations, stormwater management plan preparation, and raingarden design. Over 120 raingardens were installed in 2010, with 106 installed within a five-week period in the test area. Outreach education programs continued over the course of the three years. The 2011efforts focused on maintenance of systems installed in 2010 and new installations with larger capture areas. Figure 11 summarizes the activity for the three-year period and Figure 12 provides a map of the properties participating in the study.

Figure 11 – Project Timeline

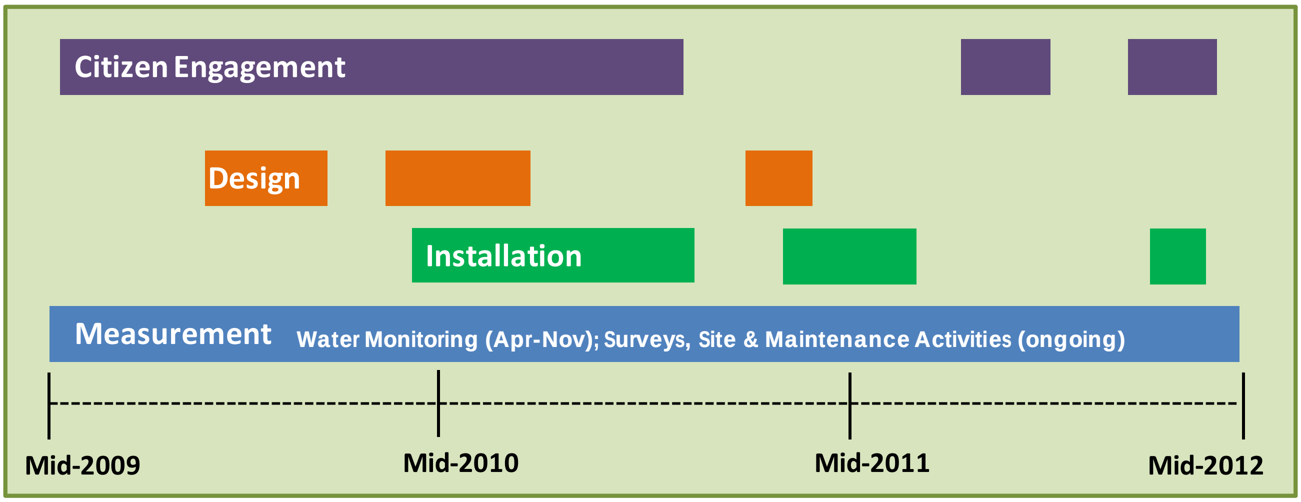
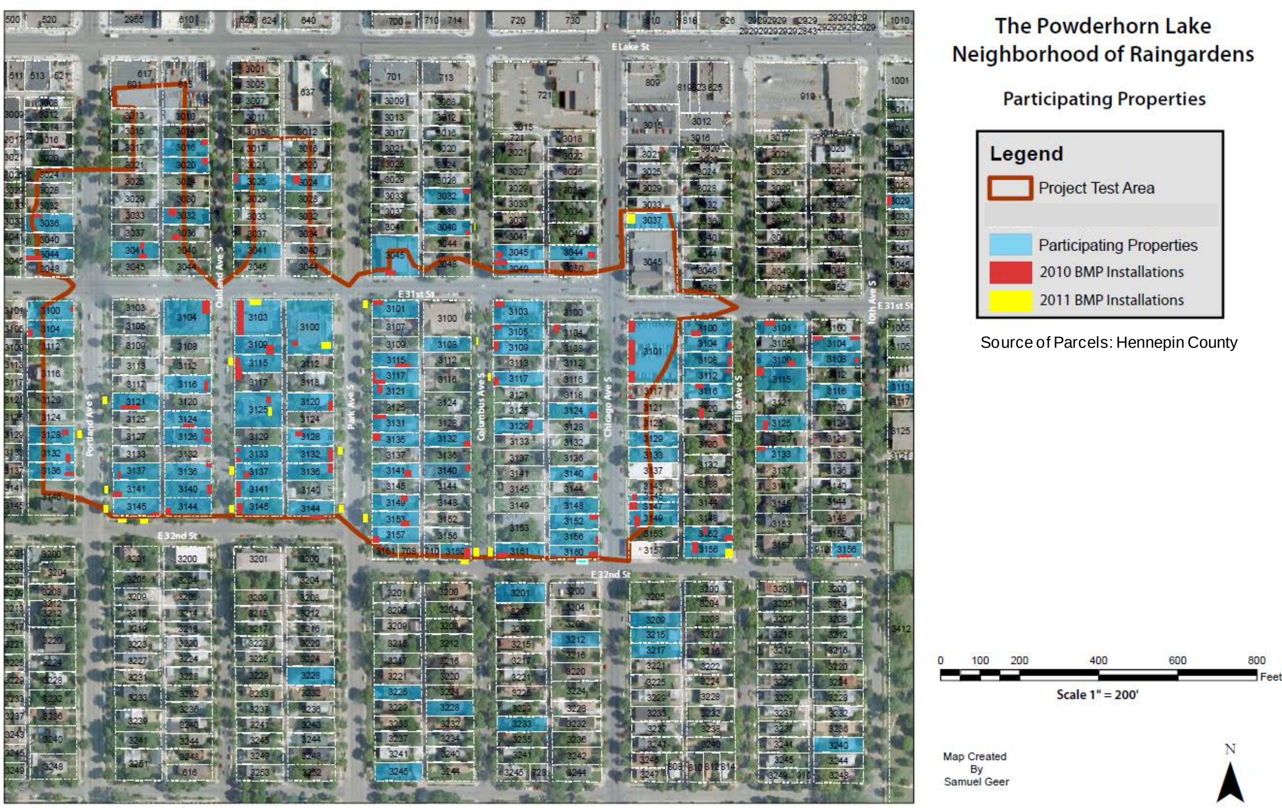


Figure 12 – Raingarden Installations



2.2 Year One: 2009

While the project funding from LCCMR is based on a project initiation date of July 2009, the partner team provided in-kind services so that the project could have a quick start and provide the largest window of time for stormwater monitoring. The City supported the monitoring activities provided by MPRB staff. Partner members investigated sites, selected sites, installed, and begin monitoring of the control and test sites in May 2009. In addition, Metro Blooms staff organized materials and developed a plan for an intense effort for outreach activities.

The preliminary water monitoring data indicated that the test monitoring site was in a reach of the storm sewer pipe that was not ideal for data collection. The early summer was spent cleaning storm sewers and evaluating new locations for the monitoring equipment. The outreach education efforts continued, but with a revised plan for installations to occur in 2010, as opposed to Fall of 2009. The new sites selected (as shown previously on Figure 6) resulted in smaller watersheds for the test and control areas. There were 16 residents that signed up for the project prior to relocation of the test area boundaries. These residents served as a small pilot group in Spring 2010 to optimize the design/installation process prior to the August 2010 installation of 106 raingardens.

2.2.1 Citizen Engagement

The outreach activities in 2009 consisted of the following, as depicted in Figure 13:

- Raingarden Workshops in Powderhorn Neighborhood. Flyers announcing raingarden workshops were distributed to almost every household in the test area. This was done in coordination with the Green Team youth participation and a stormwater audit described in Section 2.2.3 below. This effort resulted in a total of 5 people at two workshops. Of those five, three agreed to host parties in their yards. After this experience, the efforts were refocused on canvassing and raingarden parties.
- Raingarden Parties. Over the summer, four hosted raingarden parties were held, where a property owner/participant agreed to invite their neighbors to their yard for a one hour introduction to the project and raingardens, and to sign up participants for an onsite consultation.
- Canvassing. Metro Blooms led groups of staff and volunteers in canvassing the neighborhood for four nights in August - knocking on doors, and talking with residents in their yard and on the streets about the project, asking them to sign up for an onsite consultation.

More than half of the conversations were in Spanish. Educational materials were translated to the adopted tag line for this project - Construye un Jardin de Liuvias. Restaura el Medio Ambiente. Colabora con una “Minga”. This means: Build a raingarden, Save the environment and Join a Minga. A Minga is a group that gathers to do charitable works for the community.

These activities were augmented with direct mail and other methods. Using Hennepin County property records a database of every property owner in the test area was created, including name and address. A packet of information was mailed to every property owner to describe the project and give them dates for upcoming raingarden parties, and contact information to sign up for an onsite consultation. Using online directories, telephone information was gathered and e-mail addresses were collected through the course of the project. To reach all property owners required a combination of direct mail, telephone calls, e-mail and door-knocking.

Figure 13 – Initial Citizen Engagement Strategies

Raingarden Workshops	Raingarden Parties	Canvassing
▪ 2 Workshops ▪ 5 People Attended ▪ 3 Agreed to Host Raingarden Party ▪ Not an Effective Tool	▪ 4 Raingarden Parties ▪ Friends and Neighbors Invited ▪ ~25 Homeowners Signed Up ▪ Effective Tool ▪ Attracted Residents from Outside of Test Area	▪ 4 Nights of Door-to-Door Canvassing ▪ Staff, LDAs, and Volunteers ▪ ~35 Homeowners Signed Up ▪ Best Method of Contacting Residents within Test Area

2.2.2 Design

Metro Blooms staff completed 56 onsite consultations, stormwater management plans, and raingarden designs for the test area by the end of December 2009. A total of 63 property owners were identified in the test area, with another 20 outside the test area.

Each participant received a copy of their stormwater management plan (SWMP) and raingarden design. The SWMP provides a variety of options, in addition to a raingarden installation, that the participant may adopt to manage their stormwater onsite.

2.2.3 Installation

The installation phase of the project included partnering with volunteers, youth/teen groups, the excavation team partner, Minnesota Conservation Corp, and other contractors in the propagation of plants for installation in 2010.

Metro Blooms initially worked with the MPRB Teen Teamworks and the Mississippi River Green Team (refer to Appendix C for details) to propagate native plants for the raingardens. Native perennials were purchased and a large donation of cultivars and natives was received. Metro Blooms landscape design assistants directed the youth crews to propagate through cuttings and thinnings of the donated plants. All plants were planted in organic potting soil in one gallon pots to allow them to grow and develop their root structure for planting in 2010.

Metro Blooms led the crew to build a shade structure for the nursery at the MPRB's JD Rivers Children's Garden on Glenwood at Vincent Avenue North, just east of Theodore Wirth Park (Figure 14). The supports and shade cloth protect the shade loving natives from the harsh sun in the open field. Much of the Powderhorn neighborhood is shady, with many trees. The new transplants were bedded in 2 inches of mulch and then tucked in all around with mulch to the rim of the pot in an effort to protect them through the winter.

Figure 14 – Propagation Garden Developed by Team Members and Volunteers

In the late fall of 2009, two additional large donations of perennials – approximately 250 flats (4,400 – 1 inch and 4 inch pots) of cultivars were provided by Dragonfly Gardens and approximately 40 gallon pots of natives were provided by Minnesota Native Landscapes. These over-wintered based on instructions from Dragonfly on how to overwinter plants in their nursery pots – covered in two feet of mulch.

By December 2009, approximately 4,600 raingarden perennial natives and cultivars for the project (approximately 30 per garden) were prepared for over-wintering.

2.2.4 Measurement

2.2.4.1 Stormwater Monitoring

With the delayed start in data collection for the 2009 pre-installation rain events, only 5 paired (test and control watersheds) events were collected and of these only 1 had water quality samples. After reviewing the monitoring data, the team agreed to delay excavation until August 2010, which would allow time to install over 100 raingardens in 2010 and obtain more pre-test monitoring results.

The initial results indicated that the control and test areas have similar storm runoff characteristics, which improves the ability to measure differences and possibly require less data for statistical significance. For additional detail see Appendix A.

2.2.4.2 Other Measurement Activities

Stormwatershed Audit. The Mississippi River Green Team completed a Stormwatershed Audit of the test area. Michael Keenan, Metro Blooms, presented a raingarden workshop to teach the students about raingardens. Rusty Schmidt trained the team on an audit tool modified for an urban environment based on a stormwatershed audit tool created by the Washington Conservation District (Appendix C). Metro Blooms designers and University of Minnesota Landscape Design and Architecture Students (LDAs) led the Green Team as they completed the assessment of every property in the test and control area.

The plan was to use the data collected as another pre-test measure to determine the impact of stormwater education and participant initiated stormwater management practices beyond the project installed raingardens. Given the size and experience level of the group doing the assessment, and an initial review of some audit forms, it was determined it would not provide accurate information for the project. However, it is expected to have made an impact on some teen participants in better understanding how their actions affect the water environment.

Participants. By year end 2009, the net result of promotions, raingarden parties and canvassing was a total of 63 property owners signed up to participate in the project, including two faith-based organizations: Mount Olive Lutheran Church and All God's Children, both on 31st Avenue in the test area.

2.3 Year Two: 2010

This period had active involvement in all project phases. Most notable was the installation of 106 raingardens within a five-week period. Also included in this period were over 40 designs and onsite consultation, managing additional requests for design changes, and four significant outreach education events for the project.

2.3.1 Citizen Engagement

Citizen engagement had a boost in March 2010 with the first episode preview of *A Neighborhood of Raingardens*, a film produced by University of Minnesota's Mark Pedelty (Figure 15). The film gives an introduction to raingardens and stormwater runoff and highlights the Powderhorn Park project. It aired on the Twin Cities Public Television MN Channel on April 22nd (with repeat showings) and provided a useful tool to introduce participants to raingardens and the project.

Figure 15 – Neighborhood of Raingardens Documentary Provides Additional Outreach

Raingarden parties continued at participant's homes. Four parties from January through June with 46 in attendance generated 6 new participants for the project. More than a recruitment tool, these parties were raingarden educational events, and a chance to discuss installation details with property owners who were already signed up to participate. They also helped to build community among participants.

On April 24, 2010 Metro Blooms hosted an event at the Powderhorn Park Recreation Center. Project participants were invited to review their plans with Metro Blooms designers. The Neighborhood of Raingardens film was shown to about 25 residents.

Working with Blue Thumb, Metro Blooms hosted the National Geographic's Expedition Blue Planet in Powderhorn Park on July 4 to highlight water quality improvement efforts and the Powderhorn Lake project. The event was promoted to test area residents with an offer of a free t-shirt and native plants for all those who showed up at the Metro Blooms booth. At the end of the day, the remaining native plants were donated to Metro Blooms for the project. (For details refer to http://www.bluethumb.org/natgeo/).

On July 19, Metro Blooms hosted a community meeting for Powderhorn Lake participants at All God's Children church (a participating congregation). About 40 participants showed up to discuss the logistics of the installations, view the film, review their plans with the landscape designers, and sign waiver forms.

By July 15, 2010 over 100 participants signed up to participate.

Figure 16 summarizes the second year citizen engagement strategies.

Figure 16 – Second Year Citizen Engagement Strategies

Mailings

- Mass Mailings (No Name)
- Direct Mailings (Name)
- Project Flyers and Door Hangers
- Hispanic Outreach

Community Events

- Design Workshop
- Community Meeting
- Community Clean Up

Canvassing

- Contact Before Canvassing
- Use Staff, not Volunteers (volunteers often spread misinformation)
- Best Method of Contacting Residents within Test Area

2.3.2 Design

Stormwater management plans and raingarden designs were completed of the106 test area participants signed up for installation in August. Some of the issues and observations associated with the design process include:

- A lot of no-shows for onsite consultations, which needed to then be rescheduled. The initial onsite consultation sign-up sheets stated that property owners who did not show up for their scheduled consultations would be ineligible to participate in the project. After struggling to identify participants over the past year, this statement was eliminated, but resulted in excessive rescheduling, sometimes multiple times for one property owner.

- Requests for plant changes. As the installation date approached, several participants wanted to make plant changes to their designs. While trying to accommodate as many requests as possible, this added labor effort to meet with many homeowners to discuss changes. Additionally, some changes were not possible if the plant was not it in stock.
- Additional design adjustments were also required when marking the garden. This was mainly due to an incorrect design. With the intense design/installation schedule for this project, LDAs with varied experience were involved in the project and extra effort was required to review and change design and plant selection.
- A lot of property owners do not have downspouts, and the landscape designers encourage homeowners to get them installed and directed to the raingarden. In 7 of the 16 gardens installed last June, homeowners re-directed their downspouts to the garden. Three of these installed new or replaced old gutters and downspouts.
- A portion of the people are interested in incorporating their new raingarden with other landscaping they are planning in their yard – which meant more coordination for Metro Blooms, but was also seen as a good sign in terms of long term maintenance of the gardens.
- Unfortunately, there have been few opportunities for raingardens in the back half of the properties, largely due to the fact that it is really built up with garages and driveways and most people are not willing to give up their driveway. It was observed that the backyards often contributed more sediment and other pollutants (i.e. pet waste) than the front yards.
- The church properties require more planning and resources. More time is required to include multiple members in the design plan and more time must be planned for organization approval. In addition, the larger property size takes more time for design and more materials for installation.

2.3.3 Installation

Working with Ecoscapes for excavation and the Mississippi River Green Team for planting, from June 14 - 17, 2010, 16 raingardens were installed within the original test area, but just outside the final test area. These properties were signed up to participate in the project before the monitoring sites were changed in 2009. Project partners determined that there were sufficient resources to install these gardens even though they were not in the test area. The installations served as a model for recruiting more residents in the test area and continuing education of those already recruited. The June installations also served as a test run for the larger August installation.

At the July 4 Expedition Blue Planet event (Figure 17) Metro Blooms received approximately 1,500 additional native plugs that were left over from this event. These were used where possible in the Powderhorn gardens.

The 2011 installation phase highlight was the excavation and planting of 105 raingardens in a five-week period. Section 5.0 provides the details on this accomplishment.

Figure 17 – Expedition Blue Planet Partner for Outreach

2.3.4 Measurement

2.3.4.1 <u>Stormwater Monitoring</u>

The 2010 monitoring season started in April and continued through late November. The equipment performed well, notably with modifications adopted by the MPRB, to provide measurement even with sand and debris build-up on the bottom of the storm sewer where the monitoring probe was located. Unfortunately, the high intensity storms during this year caused the storm sewers to surcharge and accurate data could not be collected for some events. In addition, there were dry periods during this year that limited the storm events for evaluation. The number of paired storm events to characterize the calibration period for 2009-2010 was 33, of which 8 included water quality samples. For additional detail see Appendix A.

2.3.4.2 <u>Other Measurement Activities</u>

Of 100 participating test properties, 11 are rental units, six are owned by non-profit organizations and three properties are churches, which leaves about 80% of the participants as homeowners. Some properties have two raingardens, bringing the total in the test area to 106. It is estimated that the project had a 50% participation rate among owner-occupied properties.

It was estimated that 8 current participants are in primarily Spanish-speaking households. This is out of an estimated 36 Spanish-speaking households, or just under one quarter of the Spanish-speaking households in the test area. If the overall rate of Spanish-speaking households in the neighborhood is around 16%, the participation rate for this group is half that at 8%.

As anticipated, encouraging participation has been more challenging among rental property owners, non-profit property owners, businesses, and non-English speaking households.

2.4 Year Three: 2011 - June 2012

This year was marked with ongoing education of participants with maintenance activities and focusing on management practices with higher capture volumes.

2.4.1 Citizen Engagement

In May and June 2011, Metro Blooms organized events for volunteers and Powderhorn participants to get to know the project, receive training and assistance to install boulevard gardens to capture stormwater, and to check in to see how the gardens were doing. Volunteers and participants were asked to join a group on Saturday, June 11th for a day-long event in the neighborhood to maintain gardens planted in 2010 and to install new boulevard gardens.

On May 28th a tour of the Powderhorn project was given. Powderhorn participants and volunteers were paired with Metro Blooms landscape designers and given a list of raingardens to visit, talk about their garden's performance, and make appointments for the June 11th installation and maintenance day.

On June 4th volunteers were trained on how to install boulevard gardens, do downspout redirection, and other water capturing features. Volunteers also assisted Metro Blooms staff in marking project locations and conducting preliminary site visits and follow up meetings.

2.4.2 Design

Metro Blooms staff prepared designs for general boulevard plantings and new raingardens and other stormwater management systems as described in the next subsection.

2.4.3 Installation

On June 10th volunteers assisted in preparation for the Powderhorn raingarden maintenance event. A group met at All God's Children Church and assembled boulevard garden packages for boulevard tolerant plantings that will have interest and beauty and are divisible by 100 square foot areas.

The Powderhorn maintenance event was held on June 11th. Volunteers assembled to assist participants with re-planting efforts, downspout redirection, and boulevard garden creation. The Metro Blooms Board and Fundraising Committee hosted a luncheon at Mount Olive Church: preparing bratwurst, hot dogs, chips, and sodas for all volunteers, neighborhood participants, and staff.

Throughout the week of June 13th – 17th: Staff and volunteers provided assistance with re-planting, downspout redirection, and re-mulching assistance as they were available.

A total of 23 new boulevards and 5 new raingardens were installed by residents and volunteers with staff oversight.

Ecoscapes installed:

- At the home of Florence Hill, a rubber razor across the 300 square feet (sf) of gravel driveway and 683 sf garage that redirected runoff to a raingarden.
- At Mount Olive Church, a 480 sf permeable strip at the driveway entrance to the parking lot to disconnect 3,444 sf of parking lot.
- All God's Children: a 185 sf permeable strip to disconnect 3,348 sf of parking lot.

2.4.4 Measurement

2.4.4.1 Stormwater Monitoring

Intermittent software equipment problems in 2011 reduced the number of stormwater events available for the paired watershed analysis. Once the software issues were corrected, there was little precipitation to record. It was a very dry mid-summer through fall in 2011. Out of 15 rain events with acceptable flow monitoring data, six included water quality sampling. Unfortunately, the end result was insufficient data to provide conclusive results to measure water quality improvement. Interestingly, the last four water quality samples showed the test site with consistently lower phosphorus and solids concentrations than at the control site. The City is funding monitoring in 2012 to continue the evaluation of stormwater quality. For additional detail see Section 6.0 and Appendix A.

2.4.4.2 Other Measurement Activities

Participation. Several larger groups participated in activities during the last year and a half of the project. It is estimated that 230 community members contributed time to the project.

BMP Assessment. Metro Blooms staff reviewed gardens in 2011 and 2012 as part of the maintenance activities. Of the original 106 raingardens installed in August 2010 only a couple were not operating as designed. In 2011 cosmetic and general maintenance was performed. Another measure of BMP performance is the number of plants replaced in the spring. In 2011 and 2012, approximately 3,600 plants were replaced by Metro Blooms during the scheduled maintenance activities. It is also possible that property owners replaced some plants or provided further improvements on their own.

Clean up and Maintenance Days. Events were held in Spring 2011 and 2012 related to street cleaning and garden maintenance. MCC crews were on-hand to provide edging to remove turf creeping and improve inlets to gardens. Metro Blooms staff and volunteers helped replace plants that died over the winter and coordinated overall neighborhood watershed cleanup.

Post-Project Survey. A survey was sent out to asses participant stormwater management practices and related information.

3.0 Citizen Engagement

3.1 Initial Activities

Prior to project initiation, Metro Blooms gathered address and other data and built relationships with the Powderhorn Park and Central Neighborhood Associations and used their help to establish an e-mail list, gather address information and create a mailing list for the project.

The initial outreach packets were mailed out in February 2009 with the intended project launch and initial on-site consultations scheduled to begin in April. This method got the outreach and planning process started and resulted in 50-60 initial participants. It also revealed the challenges involved in engaging a demographically diverse community.

3.2 Outreach Methods

Outreach methods used to enlist participants in the project included the following:

- door-to-door visits (in teams),
- neighborhood e-mail lists and web forums,
- garden parties,

- mass mailings (no name),
- direct mailings (using resident's names),
- project flyers and door knob hangers,
- face to face community events,
- dedicated Hispanic outreach,
- onsite consultations,
- neighbor referrals, and
- phone calls.

3.3 Method Description and Results

3.3.1 Direct Door-to-Door Visits

Door to door recruitment took place in the early evening on weeknights and during the morning on weekends. The efforts took place in the two weeks prior to project meetings to attract new participants. There were four door to door recruiting efforts in Powderhorn that took place involving Metro Blooms staff and volunteers. University of Minnesota (UMN) journalism students also canvassed the neighbor to generate participation (student volunteers from UMN were helpful, but due to lack of detailed knowledge of the project, often led to the spread of misinformation). Each effort lasted about 3 hours and was able to reach about 20-30 homes per hour.

Out of 20-30 residences visited about 10-15 were home during those times and about 1 in 3 signed up. The survey indicated that others who did not immediately sign up at the door were more likely to participate. There were 2-3 follow up attempts to recruit those missed in previous canvassing efforts before the final target number was met. Many homeowners were aware of the project before being visited. This made the canvassing more effective as it already had more legitimacy than other door-to-door efforts.

This method got the most people enrolled (according to the post-installation survey). We attribute this level of success to the preliminary mailings and e-mail efforts to spread the word about the project. Many of the residents were already aware of the project when the door to door teams arrived, meaning that this method resulted in prompting the decision to participate for many of the residents. Door knocking was the most effective approach but was also very time intensive. The greatest success resulted from pairings that included a neighborhood resident or volunteer and a Metro Blooms staff. This allowed for the neighbor to attest to the validity of the project and the staff member to answer questions about the process. Metro Blooms created hangers that rested on the doors of the homes visited during the canvassing.

Metro Blooms maintained a project database that kept track of whether or not contact had been made with specific homeowners and their reaction (excited, bothered, hostile). This meant that the homes were not canvassed multiple times.

3.3.2 Neighborhood E-mail lists and Web Forums

This method was the least time intensive, but also did not prove to be particularly effective in generating support for the project. E-mail messages resulted in relatively low rates of return and were not a reliable way to communicate information to project participants presumably due to language, age, and access barriers.

3.3.3 Mass Mailings

Mailings in the early spring of 2010 were the most costly process. This involved assembling a mailing list, printing materials hand stuffing envelopes, and paying for postage. This approach in and of itself was not particularly effective in generating participation, but as it preceded the door to door canvassing many participants were aware of the project when approached in person, resulting in greater openness to participation. We found that people disregarded form letters but were more likely to respond to letters that addressed them by name with a hand written envelope. This personal touch tended to take more time, but yielded better results.

3.3.4 Fliers and Door Hangers

These methods proved to be effective ways to catch the eye of neighborhood residents (Figure 18) either as an advertisement on the door of a visited home or when the participant went to church or a commonly frequented establishment. This was a cheap method that required little labor, but also did not seem to yield striking results in terms of direct response from the door hangers.

Figure 18 – Sample Door Hanger

3.3.5 Face-to-Face Community Meetings

This method of engaging the community was most successful in communicating technical information about the project. Often, written communications or graphic mailings went unread or failed to inform the population about project timing and goals. Face to face meetings with church congregations, neighborhood groups, and garden parties proved to be an effective way to clear up misconceptions, answer questions, and clearly communicate technical information.

A large map showing the different lots participating in the project was the one that drew the most interest from community members. People reacted to the quantitative display of information on the map and were very interested in technical information that showed the connection between their property and the lake.

3.3.6 Garden Parties

The use of raingarden parties, where a resident invites their neighbors over for a party to discuss the project, had mixed results in terms of engaging people. The first party was hosted by Florence Hill, a well known and long term neighborhood activist. The party was very effective and well attended (28), with all property owners in attendance signing up to participate in the project. Subsequent events had very poor attendance overall (1-2 at each event). The characteristics of the host seemed to be critical in terms of whether the garden parties were a success or not. Low attendance may have been due to the hosts' lack of relationships in the neighborhood or lack of experience or effort to turn out folks for an event.

3.3.7 Neighbor Volunteers and Referrals:

The willingness of some neighborhood residents to become strong supporters and advocates of the project resulted in greater trust and legitimization of the outreach process as friends and neighbors proved more willing to trust and commit to the project when they knew someone that was invested in the project and its goals.

3.3.8 Phone Calls

Phone calling as a tool for initial recruitment resulted in suspicions that this project was some sort of scam. Whereas, the use of follow up phone conversations was very effective in encouraging people to participate once they had heard about the project. It gave them a way to actively voice their concerns and have their questions answered.

3.4 Summary of Citizen Engagement Methods

Overall the best process seemed to be an initial broad outreach followed by more targeted outreach activities. Broad outreach can be with electronic media, widely distributed fliers, and to a lesser extent - mass mailings. This mass outreach “primes the pump” by generating a baseline level of familiarity with the project and reaches early supporters. With this level of outreach, interested community members were then were able to provide referrals and access to audiences such as church congregations, community organizations, and gardening clubs. These groups are ideal venues for spreading the word of mouth information about the project and establishing true community engagement. After engaging these key groups the next step is to conduct more targeted outreach based on analysis and mapping techniques. This can include direct mailings, and most preferably door to door canvassing.

Language was definitely a barrier to reaching members of recent immigrant communities. Metro Blooms produced materials for Spanish speaking individuals, but found that these materials did not generate good returns. It appeared there was greater suspicion of the mailings and community outreach materials, either as a scam or as a way to catch immigrants. Face to face outreach to Spanish speaking persons was much more successful.

3.5 Recommended Approach

A recommended approach to recruit property owners based on lessons learned:

- Start broad and then narrow the focus.
- Hold community events and workshops early in the process to attract and identify the active and interested residents.
- Deliver clear and simple communications from a trusted source.
- Use graphics and limit text.
- Ensure that efforts are coordinated and are kept on track.
- Offer customized end products.
- Provide adequate resources for face-to-face contact (i.e. door-to-door, neighborhood meetings, faith-based organization meetings), particularly for non-English speaking residents.

3.6 Factors Affecting Recruitment

Among the primary factors that influenced recruitment, a FREE raingarden was the largest factor, followed by concern for Powderhorn Lake.

The principle reasons property owners chose not to participate had to do with lack of interest in gardening, general disbelief in the premise of the project, concerns about long-term maintenance, and unwillingness to give up space.

There were very few property owners (3) that initially agreed to participate and received an onsite consultation and then choose not to receive a garden. The primary reasons that gardeners backed out of the project was due to extenuating circumstances (a house burned down), difficult personalities (excessive demands, repeated design changes), or changes in home ownership during the project.

4.0 Design

4.1 The Design Process

The design process begins when the landscape designers first meet the homeowner with an onsite consultation, and spend an hour discussing their property from a stormwater perspective as well as from a landscaping perspective. The designer also asks the homeowner individual questions about their property, such as things they have seen during rainstorms, areas where water has ponded, drainage problems, and water in the basement issues. From the information gathered from site observation and discussion with the property owner, designers decide on a garden location before leaving. Incorporated in the location decision are basic design guidelines such as the minimum distance from raingarden to a building foundation is 10 ft.

After the onsite consultation, designers complete both a stormwater plan and a raingarden design for each property. Each product is sent to the property owner for approval. Almost all designs were approved. Certain homeowners required a little more diplomacy, in which case the Metro Blooms Lead Designer would usually provide another onsite consultation to ease their worries. The garden location was marked on each property prior to installation. This also gave the property owner another opportunity to approve or disapprove the design. Installation usually followed the marking within a week. In most cases, the designer had a follow up conversation with each property owner to discuss notable details of the installation, maintenance requirements, and next steps in the project.

4.2 Design Products

Each participant received a stormwater management plan and raingarden design similar to the examples provided in Figures 19 and 20.

Figure 19 – Sample Stormwater Management Plan

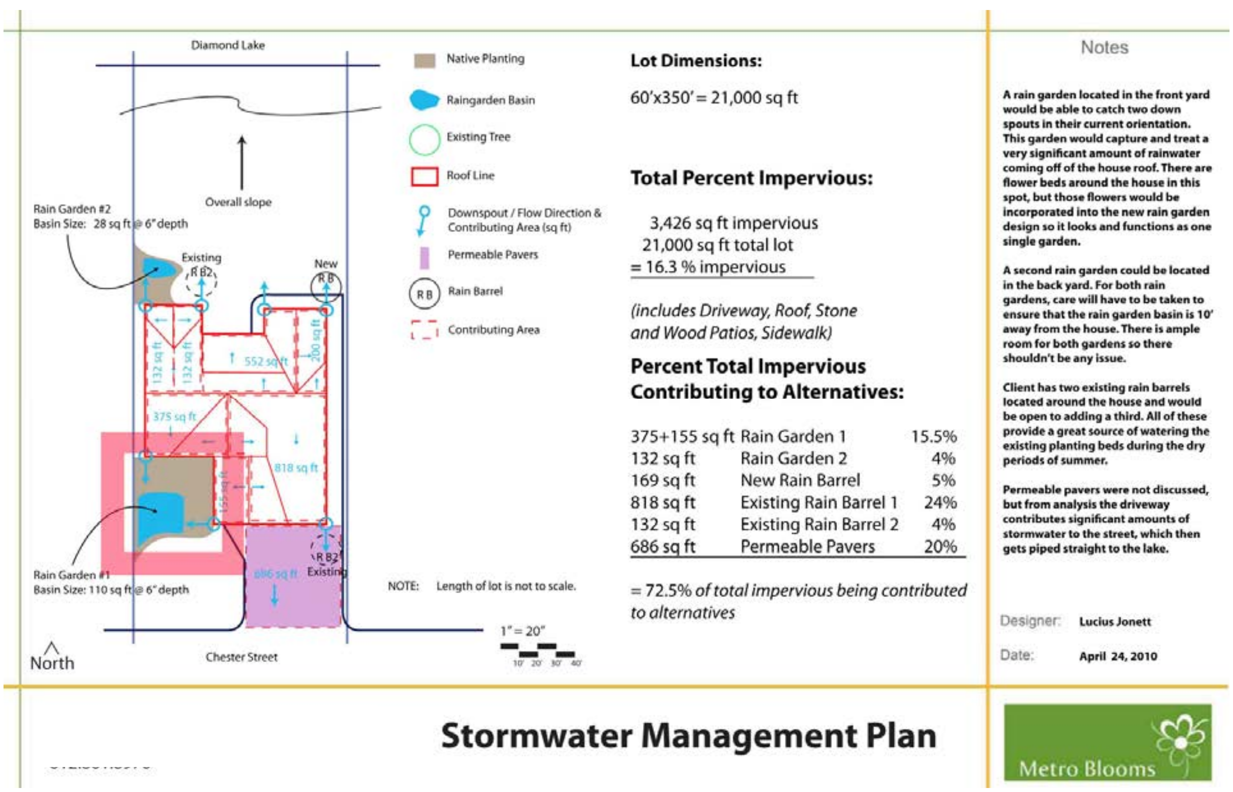
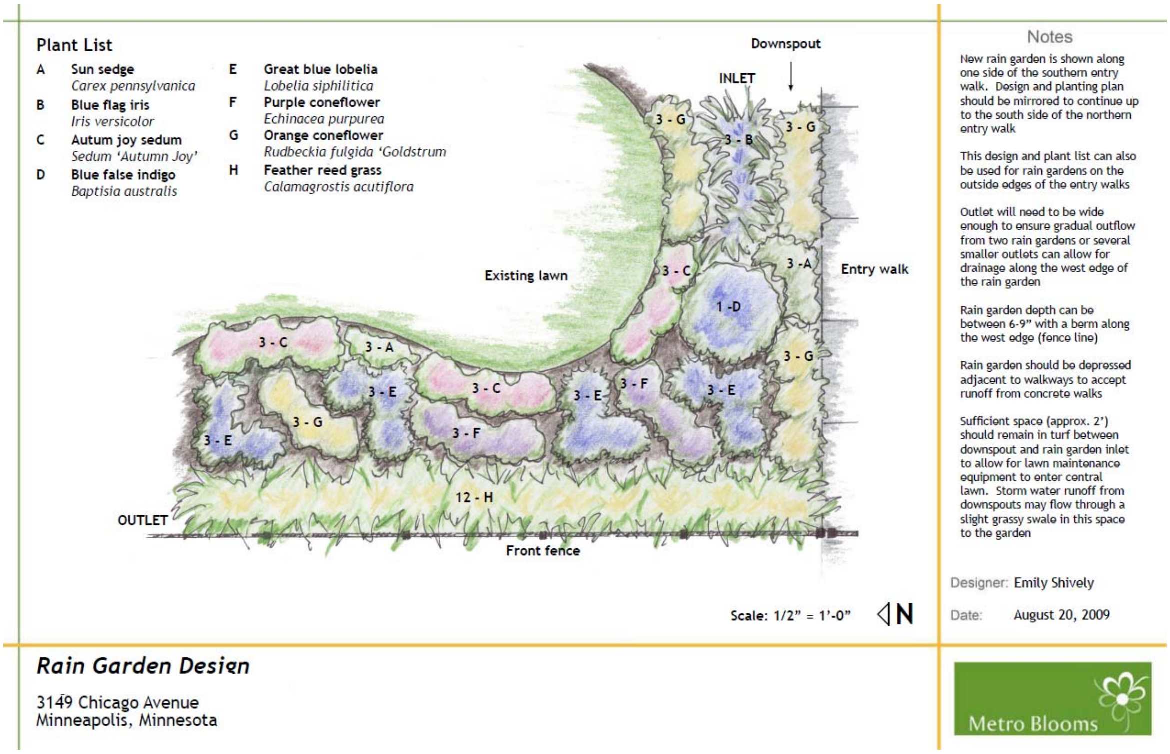


Figure 20 – Sample Raingarden Design

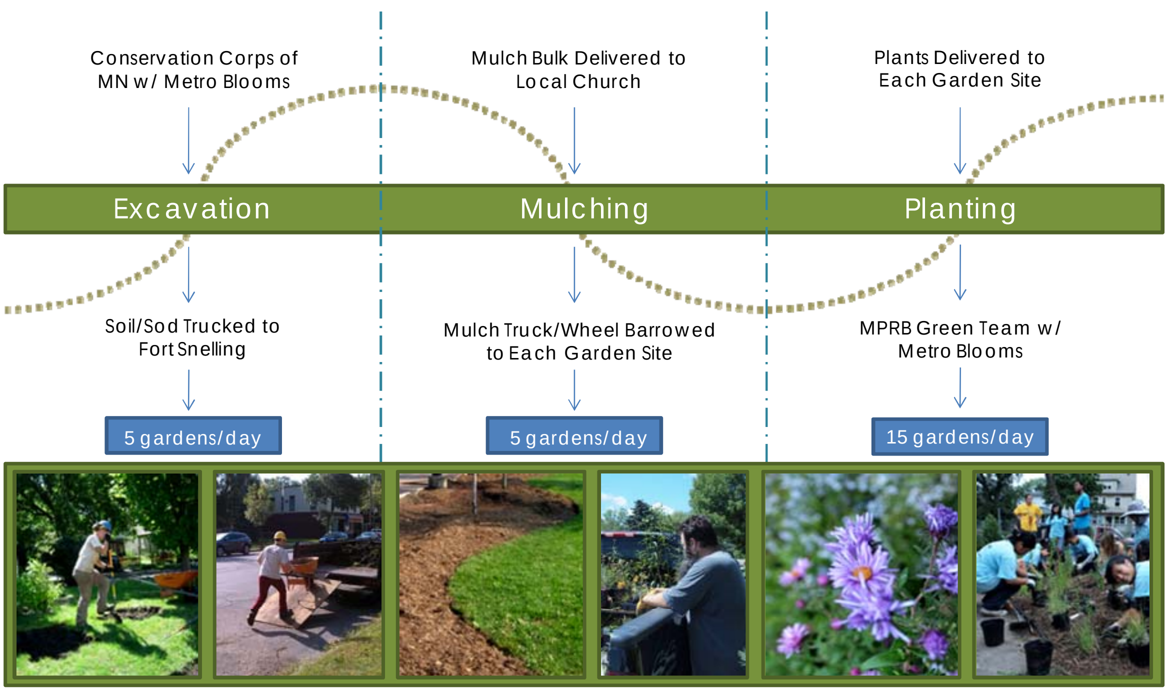


5.0 Installation

5.1 Installation Process

This project required a very organized system to install 106 raingardens in five weeks. Figure 21 presents the process devised to accomplish this task.

Figure 21 – Installation Process



The test watershed was comprised of an area 1.5 blocks long by 6 blocks wide. In an attempt to be as systematic as possible, the plan was to move North to South on each block and from West to East (toward the park). Communication with the homeowners about their planned installation date was critical. A prototype process developed in June was used to finetune needs and establish a plan to accommodate scheduling complications associated with weather, truck problems, or crew scheduling issues. Originally, homeowners were to be included in the installation process, but this proved to be too time intensive and too cumbersome to fit into the excavation schedule.

Two separate crews were utilized (a crew for soil excavation and mulching and a crew for planting). The excavation crew included 5-7 members of the Minnesota Conservation Corps supervised by Metro Blooms. The planting crew included 20 members of the Mississippi River Green Team, a youth crew led by two supervisors and two landscape designers from Metro Blooms.

5.2 Excavation and Mulching

First, the sod was removed with a sod kicker. All sod was wheel-barrowed to the trailer. In some cases, the property owner requested to keep the sod to use elsewhere in the yard. Second, the soil excavation began. Shovels were used to remove the soil to a 6" depth on average. Some installations required creation of an earthen berm to hold water in the garden or a drainage channel to divert runoff to the garden. Each property possessed its own intricate requirements for drainage and water conveyance. The level and landform of each garden was checked with a laser transit. After the grades were close to finished, the bottom of the basin garden was de-compacted and amended with compost when necessary. Shovels were used to turn the soil over to a depth of at least 18" to insure adequate infiltration. Excavated soil was also wheel barrowed to the trailer. All soil and sod was trucked to the MPRB tree and soil site at Fort Snelling, 5.5miles away. The garden was immediately mulched after excavation to avoid any problems with erosion.

After mulching, the garden waited to be planted. In some cases the garden would be planted as much as a week after excavation. Soil excavation took about 3 times as long as planting which required careful planning. As a result, excavation began about one week prior to the start of planting to create a pool of gardens ready to plant. Additionally, the planting crew was scheduled in two separate periods which allowed the excavation crew to create another pool of gardens to plant after the planting crew had caught up halfway through the project. The excavation crew was able to excavate an average of 5 gardens per day while the planting crew was able to plant nearly 15 gardens a day.

5.3 Planting Process

The August 2010 installation was conducted by a 20 member Green Team crew that was split into two groups, each with a supervisor and a Metro Blooms designer. Plants were delivered to each site either the morning of planting or the night prior. At each site, the designer would lay out the plants within each garden. After layout, the youth crew would begin planting the garden. This activity provided several insights for the youth crew. First, they learned about the basics of planting. Also, they played educational games with their designer and supervisor related to native plants and identification. The designer would check the planting for quality and the crew would move on to the next garden. Each member was also given the opportunity to layout a garden with the designer. By the end of the project, each youth crew member was able to layout a garden and to identify nearly every plant in it.

Other plantings were performed by volunteer teams as indicated in Figure 22.

Figure 22 – Planting Process

MPRB Green Team

- Inner City High School Students
- 20 Kids, 2 Supervisors
- 2 Metro Blooms Designers
- 92 Gardens Planted

Volunteer Planting

- 30 People Attended
- Participants, Neighbors, etc.
- 7 Metro Blooms Staff
- 14 Gardens Planted

5.4 System to Track Plants

Metro Blooms kept a running inventory of stock and what was to be ordered at all times. After all designs were completed, we had a comprehensive plant list for the project. However, several property owners decided to change their garden's palette at the last minute. In most cases, accommodations were made, but there was difficulty locating certain plants. Turtlehead *Chelone glabra*, and Blue Flag *Iris Iris versicolor*, became nearly impossible to find from a Minnesota native nursery at the time of installation. One staff member was the point person in charge of the plant inventory and delivery system. This person kept a detailed inventory close at hand during the entire project.

As excavations were completed, slight changes in form and shape were constantly necessary for the gardens which often meant plant changes as well. A separate delivery ticket was prepared for each property. This was used to locate the plants at the Metro Blooms nursery, load the truck, and deliver the plants to each respective property. The ticket was left with the plants and was double checked by the designer before planting. Sometimes, there was a surplus of plants and in other cases, plants were missing. This required a change ticket for the next day. A paper trail for each garden ensured the team that all required tasks had been completed before moving on to another garden.

5.5 Excavation by Hand vs. Heavy Equipment

In the Powderhorn Park neighborhood, many of the spaces where gardens were installed are very tight and excavation equipment simply wouldn't fit. When you bring large equipment onto a lawn, sod often has to be replaced, which would have slowed progress. Also, heavy equipment has a soil compaction factor which would inhibit infiltration elsewhere and be a detriment to the project's goal to capture runoff. For the majority of the project, a crew of 5-7 people armed with spade shovels and sod kickers was the optimal tool.

Heavy equipment was used in a few instances. Five raingardens were built at churches to capture surface runoff from their parking lots (Figure 23). Three of these five were built with the help of an excavator. Much of the soil around a parking lot is heavily compacted and is very difficult to dig by hand. Also, the scale of these gardens was much larger to accommodate the scale of the much larger drainage area.

Figure 23 – All God's Children, Metropolitan Community Church Raingarden - August 2011

5.6 Installation Totals

Overall, 200 yards of soil was removed, 175 cubic yards of shredded hardwood mulch was applied to 122 gardens and over 15,000 plants were installed.

5.7 Limiting Factors

Limiting factors for the installation process:

- All soil and turf were removed by hand, which requires more labor to coordinate and is slower than with machinery
- All materials had to be delivered and transported by two 1 ton trucks and two hydraulic dump trailers
- Some of the installations were in very small spaces, limiting the crew's progress
- Many times the truck and trailer could not park very close to the excavation site, requiring long distances to be traveled with soil
- Soil excavation takes much longer than planting, which requires a head start for the excavation crew
- Time was wasted waiting for the soil truck and trailer to dump refuse soil
- Some excavations yielded unforeseen buried objects and lines (buried concrete, electric lines, compacted gravel)

6.0 Measurement

This section summarizes the project results measured by key project elements.

6.1 Impervious Surface Area Redirected

The Powderhorn Neighborhood of Raingardens project resulted in reducing the storm runoff from over 70,000 sf of impervious area. This includes all the BMPs installed in and outside the test watershed area. In the test area, approximately 53,800 sf of impervious runoff area was redirected from Powderhorn Lake in 2010. Another 16,400 sf was directed to BMPs in 2011.

Assuming that the BMPs were designed to remove up to a 1-inch rain event, it is estimated that for a 1-inch rain event this would result in a decrease of 5,553 cf of water from entering the storm sewer system. This is approximately 0.8% of the estimated runoff from a 1-inch rain event discharging to Powderhorn Lake, based on the total watershed area of 286 acres.

Table 2 summarizes the impervious area statistics for the watershed. The total test watershed area of 1.24 million sf is estimated to have a 58% impervious surface area (City of Minneapolis GIS data for subwatershed 82-040). Of this total area, about 564,000 sf or 45% of privately owned property participated in the study. It is estimated that about 50% of the participating property area is impervious, which equates to an area of 281,000 sf. Overall, about 6% of the total watershed area, or 10% of the total impervious area was directed to a BMP. When considering only the participating properties, approximately 25% of the impervious area of those properties was directed to a BMP.

Table 2 - Neighborhood of Raingardens Test Watershed Impervious Area

Area Description	Area sf	% of Total Watershed Area	% of Participating Property Impervious Area
Total watershed area	1,241,500		
Total impervious area[1]	720,070	58%	
Total participating property area[2]	563,960	45%	
Participating property impervious area[2]	280,962	23%	
Participating property impervious area redirected in 2010	53,783	4.3%	19%
Participating property impervious area redirected in 2011	16,359	1.3%	6%
Participating property impervious area redirected in 2010 and 2011	70,142	5.6%	25%

[1] *Source: City of Minneapolis GIS database*

[2] *Source: Stormwater management plans developed for study*

6.2 Stormwater Monitoring

6.2.1 Background

Stormwater monitoring was the key driver for the project schedule. The three-year period was selected to provide as much time as possible to collect an adequate number of samples to establish the runoff characteristics of the watershed in a test and control area before and after the raingardens were installed. The test approach, methods, and detailed results are provided in Appendix A, Powderhorn Lake Neighborhood of Raingardens Paired Watershed Analysis Technical Memorandum.

6.2.2 Results

Monitoring in urban storm sewers has its challenges, and these sites and climatic conditions provided various issues resulting in insufficient data to statistically show that the Powderhorn Lake Neighborhood of Raingardens improved the water quality of the runoff going to Powderhorn Lake. However, the few water quality samples collected in 2011 provide promise that the test neighborhood efforts could have reduced total phosphorus and total suspended solids loadings when compared to the control area. Figures 25 and 26 present the average total phosphorus and total suspended solids concentration results. As shown by the error bars, there is a wide variation in samples.

Figure 24 – Average Total Phosphorus Concentration

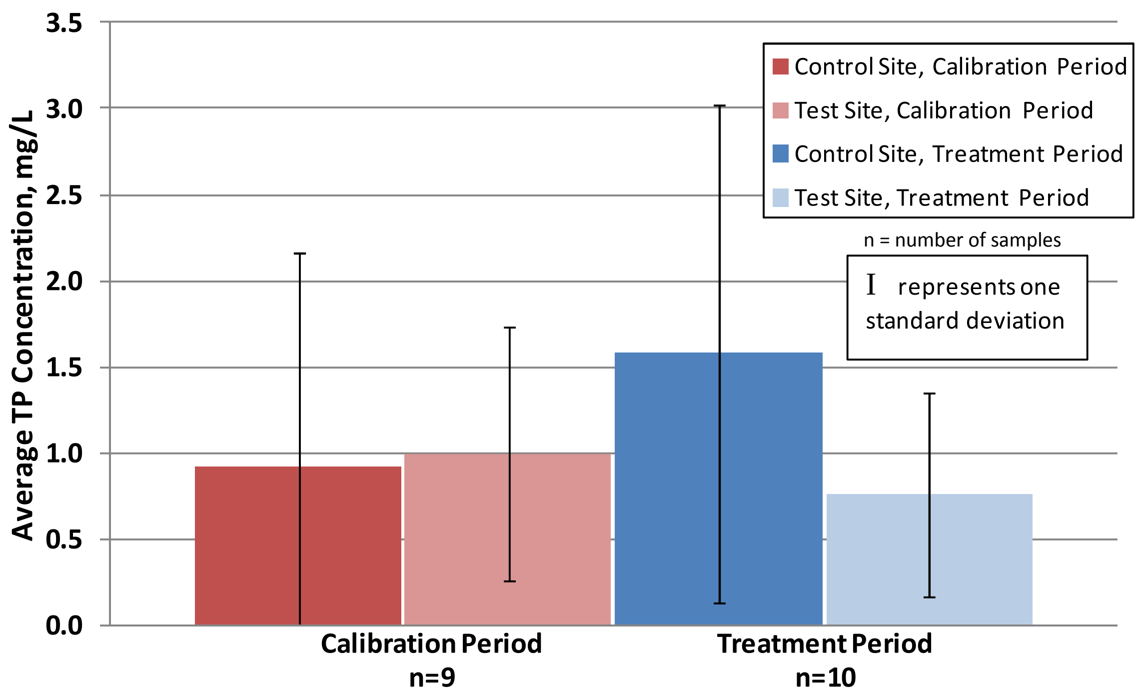
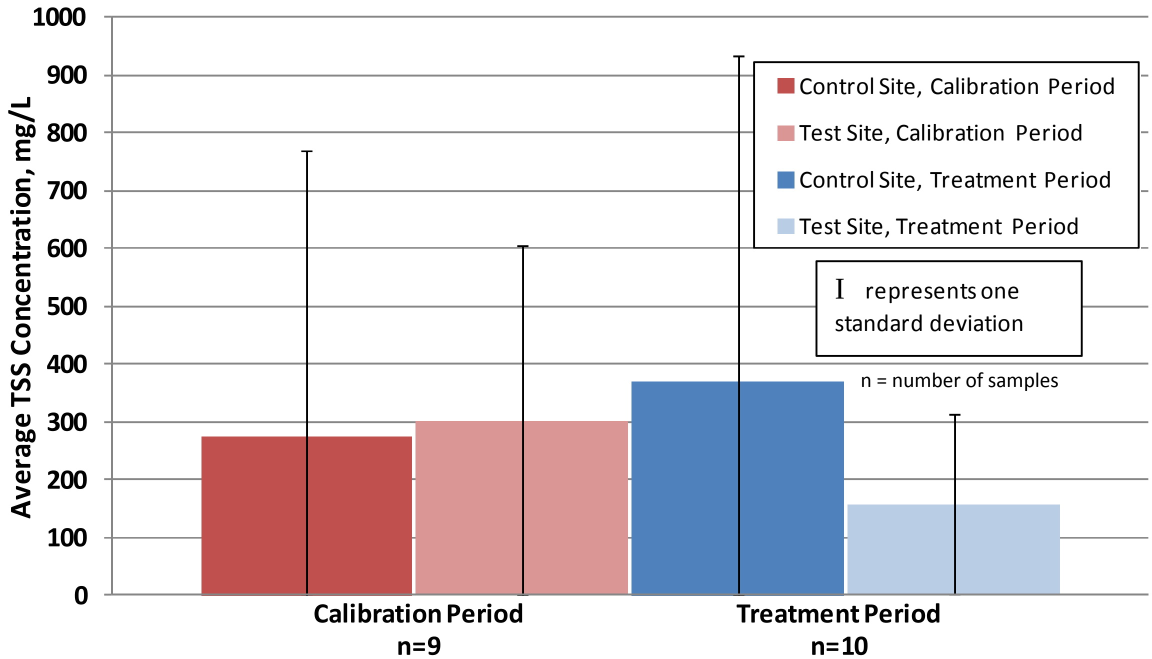


Figure 25 – Average Total Suspended Solids Concentration



In the paired watershed analysis, same storm even data are compared in the calibration and the treatment period. The regression analysis results show that the BMP did not influence the volume of runoff. This result is not surprising, given that only 10% of the impervious area was directed to a BMP. The impervious areas in the public right-of-way dominates the land use and the ability to redirect enough volume from private properties. There were not enough data to provide a statistically significant regression result for total phosphorus and total suspended solids. Appendix A provides the tabular and graphic results.

6.2.3 Future Considerations

The City of Minneapolis will continue to support monitoring at the same test and control sites as in the past three years. The MPRB will be using new instrumentation to improve efficiencies in downloading data and checking for equipment problems.

In addition to more stormwater monitoring, it is recommended that modeling be performed to determine if some storm events that were excluded from the analysis because of surcharging can be estimated and provide additional data points to the data set. The data collected for this project provides a representative set of storm events for model calibration. The water quality sampling in 2012 can include water quality characterization over the course of a storm event for the model calibration. The model results could be used to simulate similar urban watersheds and the potential impacts of citizen-based or other stormwater management practices.

6.3 Participation Records

This project engaged over 230 different people in various project roles. Table 3 summarizes the number of people involved and the number of properties associated with planting, excavating and maintaining gardens.

Table 3 - Events & Participants

Date	Residents	Volunteers	Gardens		
			Planted	Excavated	Maintained
June 2010	15	0	16	16	-
August 2010	101	78	106	106	-
June 2011	4	21	13	13	98
June 2012	8	9	0	0	12
Unduplicated Total	**116**	**101**	**130**	**130**	**98**

6.4 Maintenance Observations

The original designs reflected a large, diverse plant palette. The 2011 and 2012 replacement plant palette was carefully selected to handle the very dry and nutrient poor conditions. Good choices were sedums and wild geraniums. Plants that had dramatic die-off in the gardens were ferns, prairie coreopsis, blue lobelia, and liatris.

Consistent care, especially watering, was very important to the newly planted gardens. Close to 35% of the gardens were consistently cared for and watered. In these gardens plant loss was less than 10%. Another 45% of the gardens were obviously cared for, but the care appeared to be more sporadic and watering less consistent. In these gardens, the plant loss ranged from 20-30%. The remaining 20% of the gardens were poorly maintained by the spring of 2011. For these gardens, where there was more than 80% die-off of plants. The decision was made not to reinvest in replanting of these gardens.

The decision was made early in the June 2010 installations to omit compost from a large portion of the garden installations because it wasn't needed to enhance infiltration and there seemed to be enough nutrients in the soil to support healthy plant growth. In retrospect, the decision to omit compost from the garden installations led to very slow plant growth in the gardens and perhaps was the cause for alot of the die-off witnessed in many of the gardens by the spring of 2011 and 2012.

In some instances, gardens may have been over-mulched, resulting in slowed plant growth in some of the gardens. The reason for heavy mulching was to preserve moisture and inhibit weed growth. However, because the soil drained rapidly, heavy mulching did not provide much benefit for moisture loss in the Powderhorn Lake area. While the mulch did inhibit weed growth, it may also have inhibited plant growth in some gardens.

Table 4 provides a list of the plants purchased and donated for the project. Nearly 12,000 plants were installed in new gardens and over 3,500 plants were used to replace plants that died off and for overall garden improvements in Years 2011 and 2012.

Table 4 - Plants Purchased for the Project

Vendor	Date Received	No. of Plants
Dragonfly Gardens (donation)	2009	5,000
Glacial Ridge	1-Jul-09	654
Gertens	10-Aug-09	6
Dragonfly Gardens	24-Sep-09	152
Landscape Alternatives	22-Oct-09	77
	4-May-10	1,776
	14-Jun-10	462
	7-Jun-10	66
	27-Aug-10	1,913
	16-Jun-10	258
	12-Aug-10	90
	7-Aug-10	52
Dragonfly Gardens	27-Aug-10	108
	Jun-11	1,210
First Planting		**11,824**
Friends School Plant Sale (donation)	May-11	1,500
Dragonfly Gardens	4-May-12	1,016
	15-Jun-12	1,100
Re-planting		**3,616**
Total		**15,440**

6.5 Post-Project Survey Results

A survey conducted in June 2012 provides proof that education and action influenced community members to improve Powderhorn Lake water quality. Approximately 25% of participating property owners responded. While it is likely that those participants responding to the survey are community members with more interest in water quality issues and Powderhorn Lake and results are biased, the items below were selected to demonstrate the number of members making changes in management of stormwater on their property.

Check all that apply:		
Answer Options	Response Percent	Response Count
I enhanced my raingarden with edging, statues, more plants, etc.	76.0%	19
I added another raingarden on my own or through Metro Blooms	12.0%	3
I would like to add another raingarden	32.0%	8
I look forward to upkeep in my raingarden	72.0%	18
The raingarden is suitable just how it was planted	40.0%	10
The raingarden is too much for me to maintain	4.0%	1
I'm not interested in my raingarden	0.0%	0
	answered question	25
	skipped question	2

How many times have you explained your raingarden to neighbors, friends or family?		
Answer Options	Response Percent	Response Count
1-5	24.0%	6
5-10	44.0%	11
10-15	8.0%	2
15-20	4.0%	1
20 or more	20.0%	5
	answered question	25
	skipped question	2

What was the most important reason that you decided to build a raingarden?		
Answer Options	Response Percent	Response Count
Concern for Powderhorn Lake	46.2%	12
Neighbors were building raingardens	3.8%	1
Improving the landscaping of my yard	15.4%	4
Free plants and free raingarden installation	34.6%	9
	answered question	26
	skipped question	1

Beyond the raingarden, what other stormwater strategies have you implemented either from a stormwater plan or on your own?		
Answer Options	Response Percent	Response Count
Redirected downspouts of house	52.2%	12
Redirected downspouts of garage	13.0%	3
Installed a "French drain"	8.7%	2
Installed a rainbarrel	56.5%	13
Installed permeable pavers	8.7%	2
Planted new gardens to reduce turf	56.5%	13
Other (please specify)		5
	answered question	23
	skipped question	4

7.0 Outcomes and Future Plans

The Powderhorn Lake Neighborhood of Raingardens project heralds successes, lessons learned, and ideas to improve on implementation of citizen-based approaches to improve impaired waters.

7.1 Citizen Engagement for Fast-Paced, Focused Implementation

Successes

- Nearly 50% of the property owners residing (excludes rental units) in the test watershed participated in the study. This participation rate speaks to the effectiveness of the multi-faceted outreach education program developed through this study. Metro Blooms also used a flexible and diplomatic approach in the design/installation process to keep property owners participating after they signed up.

- 116 property owners plus an estimated 115 other community members were educated on water quality protection and volunteered in various events for the project.

Lessons Learned

- Factors influencing recruitment
  - At time of installation, 2010: A FREE raingarden was the largest factor that influenced recruitment, followed by concern for Powderhorn Lake.
  - Post Survey, 2012: With 25% property owners responding, 46% identified "concern for Powderhorn Lake" as the most important reason they installed a raingarden, and 35% said it was because of the "free" services provided with the project. It is assumed that those property owners taking time for a survey nearly two years after the installation, are likely those that have the greatest concern for Powderhorn Lake and so the results are biased towards this reason for raingarden installation.
- What Worked
  - Neighborhood Events
  - Door to Door Outreach
  - Garden Parties & Community Events
  - Neighborhood Newsletter and List-serve
  - Help from Local Representative
  - Block Leaders/Community Leaders
- What Didn't Work
  - Email and Phone outreach…initially
  - Workshops
  - Unannounced Canvassing
- Recommended approach to recruit property owners
  - Start broad and then narrow the focus.
  - Community events and workshops attract the active and interested residents.
  - Clear and simple communications from a trusted source.
  - Use graphics and limit text.
  - Ensure that efforts are coordinated and are kept on track.
  - Offer customized end products.

7.2 Design

Successes

- Onsite consultations included additional engagement and commitment to water quality protection.
- Use of graphics with onsite discussion aided in understanding & selection of plant types & overall efficiency of the design process.

Lessons Learned

- Plan for no-shows for onsite consultations.
- Institutional property owners require more planning and resources.

- Plan time to accommodate for owner design changes or make it clear that designs may be difficult to change.
- Put greater emphasis on backyard stormwater capture opportunities. Front yard raingardens were a good option because they were visible and provided additional opportunity for education and engagement with community members.

7.3 Installation

Successes

- 106 raingardens installed in a five-week period (total of 125 in summer 2010).
- Nearly 12,000 plants installed in new gardens developed by project-related staff.
- Over 3,500 plants were installed the second and third years as part of maintenance activities.

Lessons Learned

- Excavation by hand was preferable for this urban environment, except for larger areas and parking lot locations where soil is more heavily compacted.
- Allow time or plan for larger equipment to bring in soil or remove refuse soil in considering efficiencies with work crews.

7.4 Measurement

Sucessess

- Over 70,000 sf of impervious area was directed to a raingarden, permeable pavers, or boulevard garden.
- The involvement of 230 people in numerous activities demonstrates the Powderhorn Lake community's commitment to water quality protection. It also demonstrates the potential for large-scale community stormwater management practices.
- Representative stormwater monitoring of a densely populated urban watershed with applications for projecting the impacts of future BMPs.

Lessons Learned

- Including monitoring in a project adds complexity to the process and requires extra effort for the Neighborhood of Raingardens team objectives.

- Smaller-scale BMP test areas will provide a better measurement for volume reduction and water quality improvements. The results can then be extrapolated to larger areas.

- Replicability of this approach depends on many factors, including consideration of the funding source. The outcomes measured in this project need to be compared to other urban stormwater management projects to assess whether the cost/benefit of this approach is an appropriate use of the funding source as compared to other types of projects.

7.5 Outcomes Summary

7.5.1 Education and action influenced community members to improve Powderhorn Lake water quality.

- The Powderhorn Park community implemented best management practices to reduce stormwater runoff to Powderhorn Lake by directing 70,000 square feet of impervious area to bio-infiltration areas (raingardens).

- 230 community members were involved in activities related to implementation of water quality protection practices.
- 125 raingardens were installed through a fast-track design and construction process.
- Multiple community cleanup events were held which resulted in over 130 bags of leaves and debris from entering the lake.

7.5.2 Citizen engagement methods key to successful outcomes.

- Enlist local champions of stormwater management to reach out to their community members.
- Use a combination of outreach methods: workshops, mass mailings, door knockers, neighborhood home meetings, and canvassing.
- Include multi-lingual staff and community members to engage non-english speaking community members.
- Use a non-profit organization for outreach and implementation to offset skepticism associated with a pivate firm or city-led effort.
- Provide an economic incentive and a well-crafted, educated message.

7.6 Future Plans

- Continue stormwater monitoring (City of Minneapolis is funding 2012 monitoring by MPRB).

- Further develop Metro Blooms' volunteer-based, raingarden evaluation program to provide added incentive for continued maintenance of raingardens.

- Focus new urban projects on maximizing backyard runoff capture with multiple types of BMPs.

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Appendix A

Powderhorn Lake Neighborhood of Raingardens Paired-Watershed Analysis

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MEMORANDUM

TO: Becky Rice/Metro Blooms

FROM: Rebecca Nestingen/SEH
Patti Craddock/SEH

DATE: June 22, 2012

RE: Powderhorn Lake Paired-Watershed Study
LCCMR Project No. 09-05e
SEH No. METRB 116238

Introduction

The purpose of this technical memorandum is to report the results of the paired-watershed study used to measure the effects of raingardens installed in the Powderhorn Lake neighborhood. For further project background refer to *A Citizen-Based Approach to Stormwater Management* (Metro Blooms, LCCMR Project 09-05e, June 2012).

Study Methodology

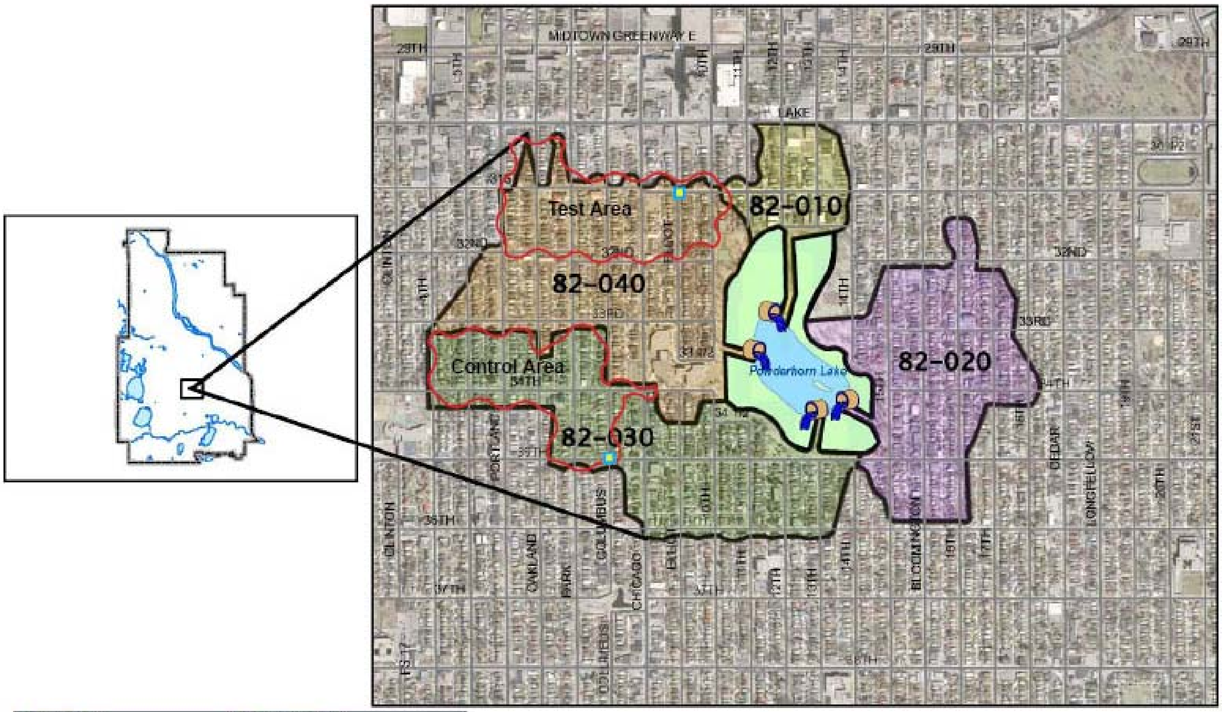
Paired-Watershed Approach

A paired-watershed study design is used to study the effects of implementing best management practices (BMPs) in one watershed, known as the *test* watershed compared to that of another similar watershed known as the *control* watershed. Monitoring is conducted in both watersheds prior to and after implementing BMPs. The monitoring conducted prior to BMP implementation is used to develop a baseline relationship between the paired event-based data observations and this is referred to as the *calibration* period. The monitoring period after BMPs are implemented in the test watershed is referred to as the *treatment* period. Advantages of using the paired-watershed study design are that the control watershed accounts for year-to-year or seasonal variability and the baseline relationship developed in the calibration period accounts for differences between the two watersheds. The schedule of BMP implementation is displayed below in Table 1.

Table 1. Schedule of BMP implementation (Adapted from Clausen and Spooner, 1993)

	Control Watershed	Test Watershed
Calibration Period	No BMPs	No BMPs
Treatment Period	No BMPs	BMPs

The Powderhorn Lake Neighborhood paired watersheds are displayed in Figure 1. The test and control watersheds are 28.3 acres and 32.5 acres, respectively. In summer of 2010, over a five-week period 106 residential raingardens were installed in the test watershed as displayed in Figure 2. Installation ended on August, 31st, 2010. The monitoring period prior to August 31st, 2010 is the calibration period and the monitoring period after August 31st is the treatment period.



Outfall Number	Total Acres	Residential Percentage	Population
82-010	23.5	72%	457
82-020	73.5	94%	1,285
82-030	90.0	91%	1,998
82-040	98.5	85%	1,881
Total	285.51	88%	5,621

City of Minneapolis
Department of Public Works

September 30, 2008

Figure 1. Paired-Watershed Study Area Map

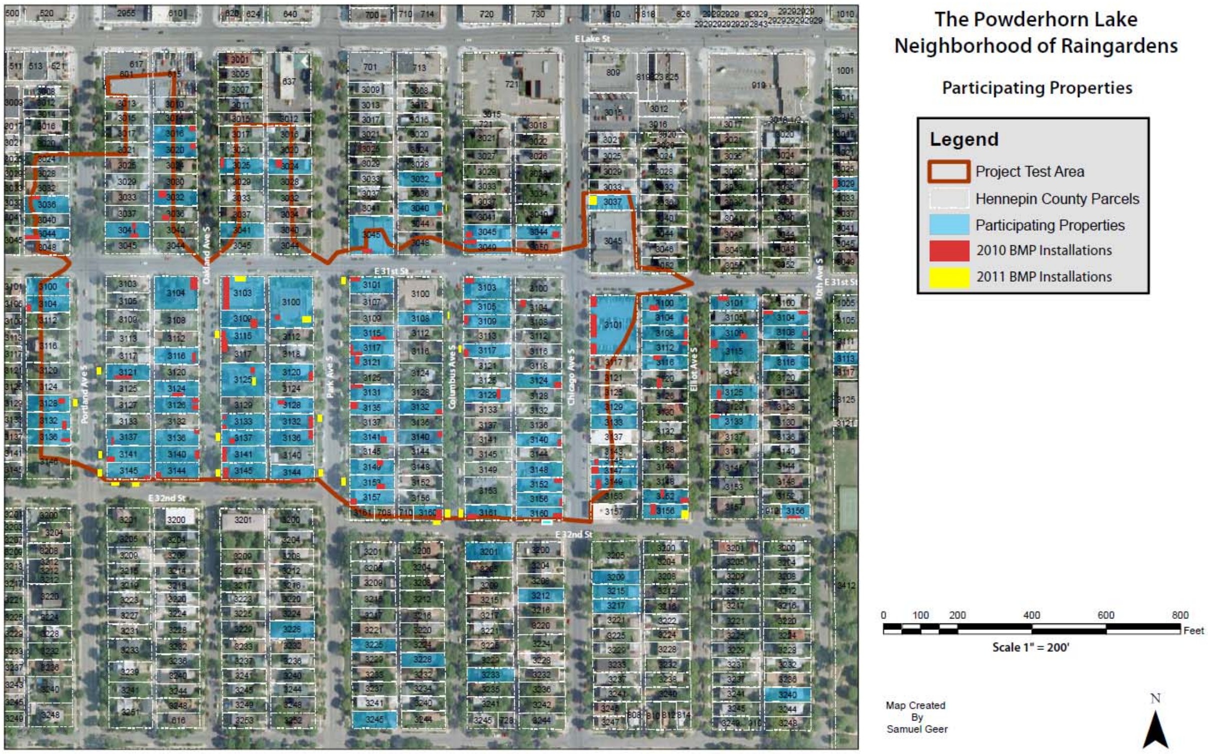


Figure 2. Test Watershed Raingarden Map

Monitoring

Precipitation monitoring was conducted throughout the project duration to define rain events which coincide with flow monitoring. For this project, a rain event was considered a measured rainfall depth greater than 0.10 inches. Rain events were also distinguished from one another by a separation of greater than 8 hours. In 2009, the rainfall was measured by using a Davis Weather Wizard III station located at 38th Street West and Bryant Avenue South. In 2010 and 2011, the precipitation monitoring was conducted using a Nova Lynx tipping bucket (1/100th of an inch) and an Onset Hobo datalogger located at the Powderhorn Park Recreation Center, 3400 15th Avenue South.

Stormwater flow and water quality were monitored using ISCO stormwater equipment. Each monitoring location was outfitted with the following equipment:

- two 2150 dataloggers
- a 2105 interface control module
- two digital low profile AV probes (one invert, one offset)
- a 24 bottle multiplexed auto-sampler (model 3700) complete with 3/8” ID vinyl tubing and standard intake strainers
- multiplex sampling (4 samples per bottle)

At the project initiation in May 2009, two 36” reinforced concrete pipes (RCP) were chosen at 33rd Street East and 10th Avenue South (test watershed), and at 35th Street East and 12th Avenue South (control watershed). The test site was found to have significant problems with standing water, decaying organic debris and sand deposition in the pipe, which prevented accurate measurement. In late summer, two new monitoring locations were chosen at 31st Street East and Elliot Avenue South, and at 35th Street East and

Columbus Avenue South. The monitoring equipment was installed in 24” RCP at these new locations. An example of the flow and water quality monitoring equipment is shown below in Figure 3.

Figure 3. Flow and Water Quality Monitoring Equipment

When uninstalling the monitoring equipment for the 2009 season, it was noted that both of the new sites had significant sediment accumulation around the invert AV probes. Offset AV probes were installed in 2010 and 2011 to avoid sedimentation and interference with accurate flow measurement.

The Minneapolis Park and Recreation Board (MPRB) was responsible for conducting all monitoring throughout the project and reporting the resulting data to SEH for analysis. Precipitation and flow data were reported in Flowlink file format for analysis using Flowlink 5.1 software and the water quality data were reported as a flow-weighted composite concentration.

Data Quality Control and Analysis

The MPRB follows a rigorous quality control and assurance program for sampling protocol and laboratory analysis as detailed in the annual MPRB Water Resources Reports (produced by the Environmental Operations Section).

The data analysis tasks began with a review of the raw precipitation data to define the observed rain events. A flow hydrograph was created and the total flow volume was calculated using Flowlink 5.1 for each rain event. Each hydrograph was scrutinized for erroneous flow data caused by a multitude of factors such as pipe surcharging or equipment malfunction. Rain events which were suspected to have erroneous flow data were omitted from the analysis. The watershed area was used to normalize the volume of flow into a depth of runoff in unit inches. The water quality samples were collected as flow-weighted concentrations and are reported as the representative sample for a complete storm event.

An example hydrograph for one of the calibration period events is shown below in Figure 4. As displayed in the hydrograph, the monitored flows at both sites closely mimic one another indicating that the runoff characteristics for the test and control watersheds are a good match.

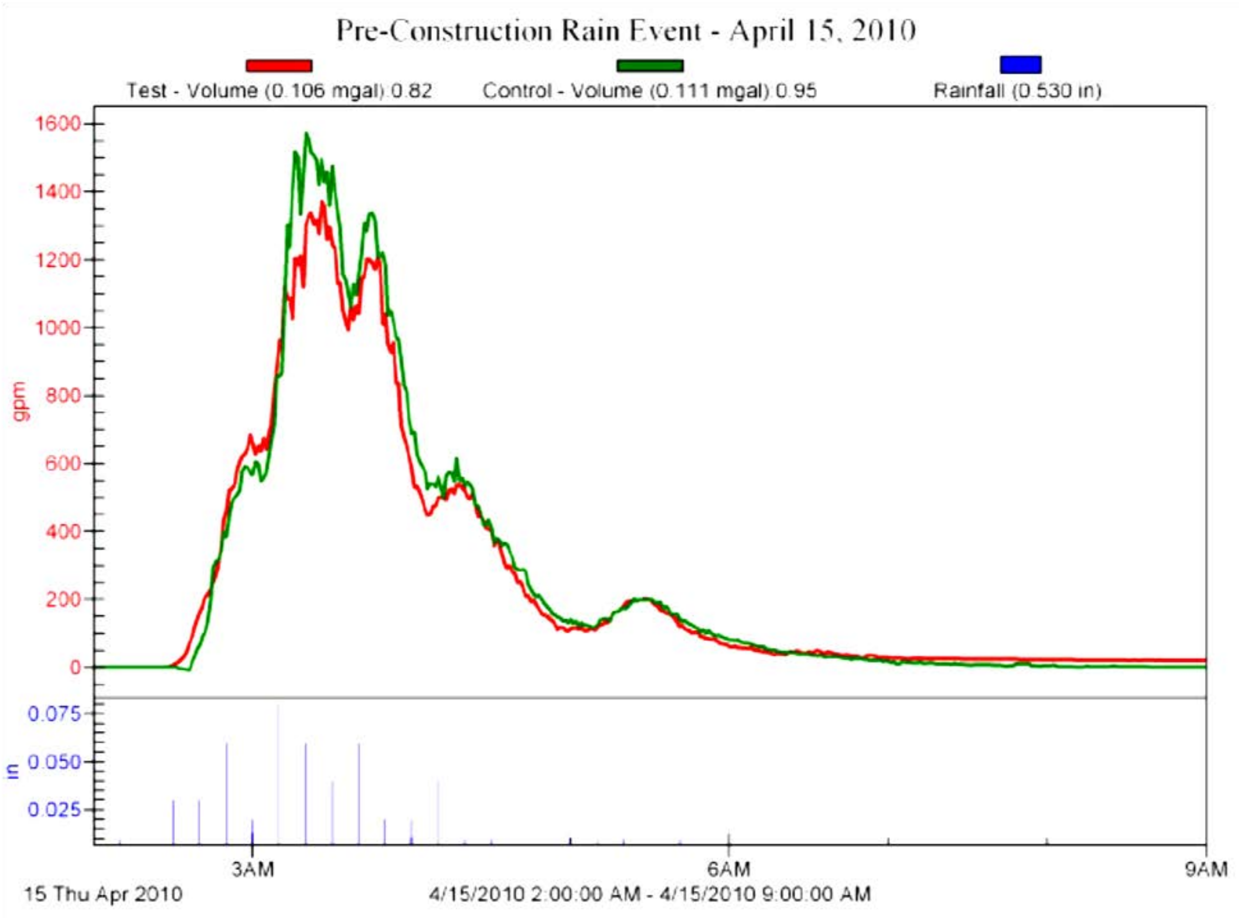


Figure 4. Example Event Hydrograph

Upon compilation of the final flow volume and water quality paired-data observations, linear regressions were derived. The regression significance and the significance of the effect of the raingardens were determined using the statistical test procedures described by Clausen and Spooner in *Paired Watershed Study Design* (1993). Tables 2 and 3 summarize the data calibration period and treatment period data used for the final analysis and individual event hydrographs are attached as Exhibits.

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Table 2. Calibration Period Paired Event Data

			Precipitation		Test Site - 31st & Elliot			Control Site - 35th & Columbus		
Event	Start Date/Time	End Date/Time	Total Depth (in)	Total Duration (hr)	Volume* (inches)	TP Conc. (mg/L)	TSS Conc. (mg/L)	Volume* (inches)	TP Conc. (mg/L)	TSS Conc. (mg/L)
2009-20	9/27/2009 20:45	9/28/2009 2:30	0.11	5.75	0.01			0.02		
2009-21	10/1/2009 6:00	10/3/2009 10:15	1.52	52.25	0.31			0.28		
2009-24	10/12/2009 11:15	10/12/2009 18:00	0.23	6.75	0.01	0.442	16	0.01	0.169	13
2009-25	10/14/2009 22:45	10/15/2009 16:30	0.42	17.75	0.07			0.05		
2009-26	10/21/2009 8:54	10/21/2009 18:45	0.51	9.85	0.09			0.09		
2010-02	4/13/2010 2:38	4/13/2010 9:26	0.59	6.80	0.14			0.13		
2010-04	4/15/2010 2:04	4/15/2010 5:41	0.53	3.61	0.14	0.873	259	0.13	0.594	202
2010-05	4/23/2010 22:30	4/24/2010 12:14	0.50	13.73	0.07			0.06		
2010-06	5/6/2010 20:04	5/8/2010 3:19	0.75	31.25	0.11	0.353	59	0.11	0.280	43
2010-07	5/10/2010 18:45	5/11/2010 18:26	0.81	23.67	0.13			0.12		
2010-08	5/12/2010 16:39	5/13/2010 17:09	0.74	24.49	0.19			0.17		
2010-09	5/22/2010 11:01	5/22/2010 12:21	0.16	1.34	0.02			0.02		
2010-10	5/25/2010 9:21	5/25/2010 21:55	0.37	12.57	0.06			0.06		
2010-11	6/1/2010 10:48	6/2/2010 6:40	0.19	19.86	0.02	0.831	185	0.02	0.983	234
2010-12	6/3/2010 15:30	6/4/2010 4:00	0.41	12.50	0.08			0.08		
2010-13	6/5/2010 12:08	6/5/2010 17:10	0.32	5.03	0.05			0.05		
2010-14	6/8/2010 4:46	6/8/2010 15:58	1.01	11.20	0.18			0.19		
2010-15	6/11/2010 3:28	6/11/2010 14:17	0.92	10.82	0.22			0.22		
2010-16	6/12/2010 12:01	6/12/2010 18:20	0.14	6.31	0.01			0.01		
2010-17	6/14/2010 9:14	6/14/2010 13:18	0.27	4.06	0.04			0.05		
2010-18	6/22/2010 19:40	6/23/2010 15:57	0.50	20.30	0.06			0.08		
2010-19	6/25/2010 16:07	6/25/2010 21:39	3.35	5.53	0.53	1.970	708	0.78	4.160	1578
2010-20	6/26/2010 9:23	6/27/2010 0:13	0.75	14.83	0.13			0.14		
2010-21	7/4/2010 7:30	7/4/2010 16:51	0.15	9.36	0.01			0.01		
2010-22	7/5/2010 14:46	7/5/2010 23:49	0.51	9.05	0.15	2.480	910	0.15	0.561	97
2010-24	7/10/2010 11:31	7/11/2010 3:25	0.23	15.91	0.02			0.01		
2010-25	7/11/2010 15:50	7/11/2010 22:44	0.52	6.90	0.01			0.02		
2010-26	7/14/2010 9:21	7/14/2010 19:54	0.12	10.55	0.02			0.02		

Table 2. Calibration Period Paired Event Data

			Precipitation		Test Site - 31st & Elliot			Control Site - 35th & Columbus		
Event	Start Date/Time	End Date/Time	Total Depth (in)	Total Duration (hr)	Volume* (inches)	TP Conc. (mg/L)	TSS Conc. (mg/L)	Volume* (inches)	TP Conc. (mg/L)	TSS Conc. (mg/L)
2010-27	7/17/2010 15:27	7/17/2010 21:43	1.18	6.27	0.29			0.26		
2010-28	7/21/2010 21:33	7/22/2010 7:39	0.24	10.11	0.01			0.01		
2010-29	7/23/2010 20:02	7/24/2010 3:46	0.62	7.72	0.11			0.12		
2010-32	8/10/2010 0:43	8/10/2010 23:40	2.31	22.95	0.57			0.64		
2010-33	8/12/2010 20:46	8/13/2010 5:13	1.24	8.44	0.26	0.498	201	0.24	0.169	41
2010-36	8/31/2010 3:36	8/31/2010 6:19	0.39	2.70	0.10	0.581	127	0.11	0.484	80

*Storm runoff volume divided by the watershed area monitored.

Table 3. Treatment Period Paired Event Data

			Precipitation		Test Site - 31st & Elliot			Control Site - 35th & Columbus		
Event	Start Date/Time	End Date/Time	Total Depth (in)	Total Duration (hr)	Volume* (inches)	TP Conc. (mg/L)	TSS Conc. (mg/L)	Volume* (inches)	TP Conc. (mg/L)	TSS Conc. (mg/L)
2010-37	9/1/2010 21:33	9/2/2010 7:34	1.08	10.02	0.26			0.27		
2010-38	9/6/2010 12:03	9/7/2010 17:37	0.36	29.56	0.03			0.04		
2010-39	9/10/2010 17:58	9/11/2010 4:30	0.26	10.53	0.04			0.04		
2010-40	9/15/2010 5:17	9/16/2010 0:25	0.98	19.14	0.23			0.23		
2010-42	10/24/2010 1:54	10/24/2010 12:05	0.66	10.19	-	2.040	542	-	1.570	67
2010-43	10/25/2010 14:35	10/27/2010 18:16	1.64	51.69	-	0.506	52	-	0.470	38
2011-05	5/20/2011 10:44	5/21/2011 12:52	1.61	26.14	0.35			0.35		
2011-06	5/22/2011 0:38	5/22/2011 15:33	1.08	14.91	0.28			0.28		
2011-07	5/27/2011 16:57	5/28/2011 1:48	0.27	8.84	0.04			0.04		
2011-08	5/30/2011 8:33	5/31/2011 1:44	0.20	17.18	0.02			0.01		
2011-09	6/10/2011 1:44	6/10/2011 6:37	0.25	4.88	0.02	1.490	169	0.03	4.890	1705
2011-10	6/10/2011 15:59	6/11/2011 1:58	0.18	9.97	0.01			0.02		
2011-11	6/14/2011 16:02	6/15/2011 8:46	1.56	16.73	0.29	0.283	218	0.36	0.429	61
2011-15	6/21/2011 14:08	6/22/2011 7:39	0.84	17.53	0.19			0.21		
2011-16	6/22/2011 19:11	6/23/2011 4:31	0.25	9.34	0.04			0.06		
2011-17	7/1/2011 19:13	7/1/2011 21:25	0.31	2.21	0.04	0.972	248	0.06	3.260	1077
2011-18	7/9/2011 23:23	7/10/2011 7:32	1.16	8.15	0.12	0.279	24	0.21	0.993	285
2011-22	7/15/2011 23:09	7/16/2011 2:49	2.21	3.66	0.53			0.59		
2011-23	7/19/2011 3:16	7/19/2011 3:38	0.36	0.38	0.14			0.14		
2011-31	9/20/2011 22:16	9/21/2011 6:50	0.17	8.57	-	0.451	61	-	1.370	140
2011-33	10/10/2011 16:59	10/10/2011 20:36	0.15	3.62	-	0.335	43	-	1.680	90

*Storm runoff volume divided by the watershed area monitored.

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Results and Discussion

Stormwater Volume Results

The stormwater runoff volume regression results are shown in Figure 5. Each data point on the plot is a paired-event observation with the control watershed volume on the x-axis and the test watershed volume on the y-axis. The colors on the plot differentiate the data points and trendlines between the calibration period and the treatment period. During the calibration period (in which there were no BMPs installed), the runoff from the test watershed is approximately 78% of that of the control watershed as indicated by the slope of the linear regression trendline.

Under ideal experimental conditions the test watershed would decrease during the treatment period from the installation of raingardens, however, the linear regression trendline indicates an increase in runoff volume of the test watershed relative to that of the control as indicated by the trendline slope of 0.91 (i.e. the test watershed runoff volume is 91% of that of the control watershed) - an increase from the slope of 0.78 during the calibration period. This increase, however, is not statistically significant as indicated by the overlap of the confidence intervals as shown in Figure 5. There was too much variability in the data to detect any difference in stormwater runoff volume between the test and control area.

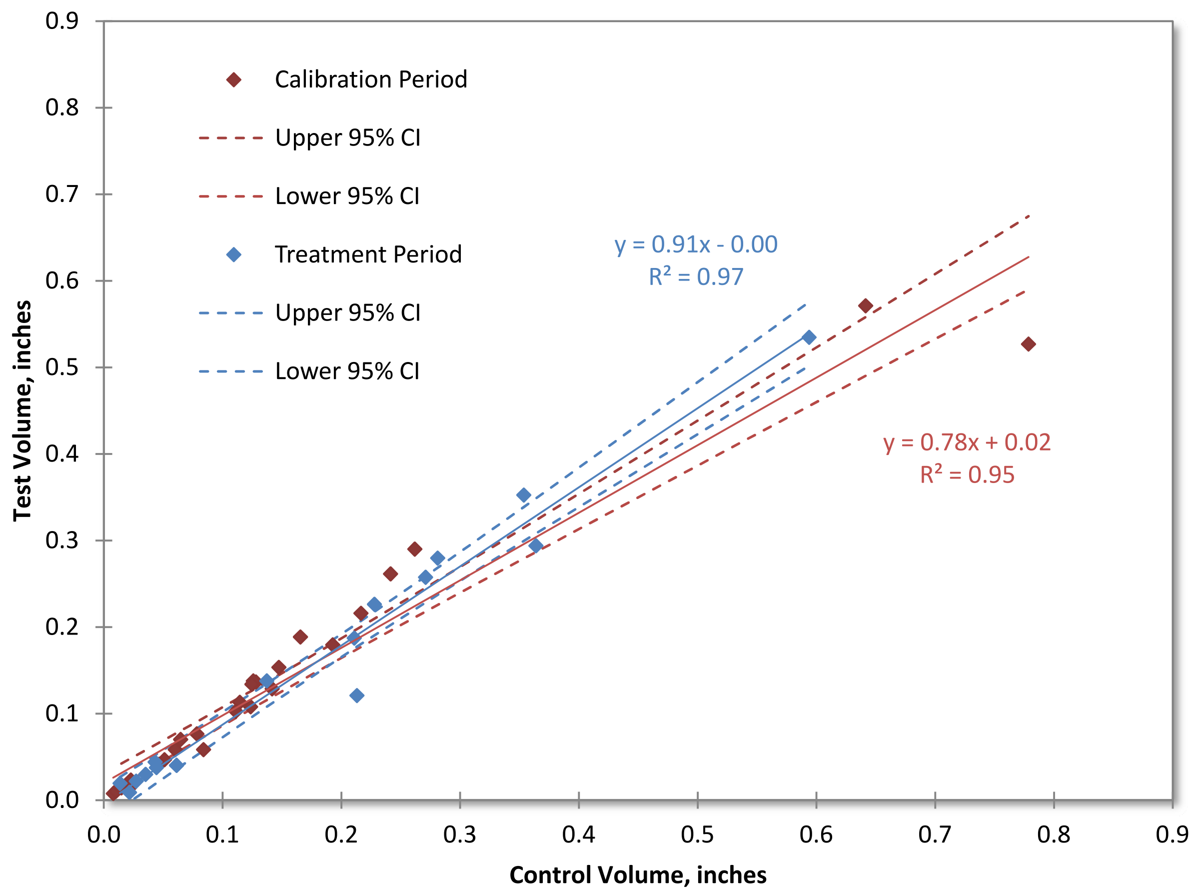

Figure 5. Stormwater Volume Regression Results

Table 4 displays the average stormwater runoff volume by period and watershed. The predicted test value comes from the regression relationship during the calibration period. Comparing the observed and predicted average values of the test watershed there is a 0% change in the runoff volume. Given the amount and variability of the data and that approximately 6% of impervious area in the total watershed area was redirected into raingardens, it was anticipated that there would not be a measurable amount of change in the amount of runoff.

Table 4. Average Runoff Volume (in)

Calibration Period	
Control	0.133
Test	0.123
Treatment Period	
Control	0.174
Test	0.155
Test Predicted	0.155
Change	0%

Stormwater Quality Results

Paired observations for total suspended solids (TSS) and total phosphorus (TP) flow-weighted concentrations were analyzed in the same manner as runoff volume and the regression results are displayed in Figures 6 and 7. Similarly to runoff volume, there is too much variability and too little data to report results with statistical significance as indicated by the confidence intervals. Monitoring equipment software problems during the wettest month of the treatment period coupled with a very dry late summer and fall, limited the number of samples collected.

Although not statistically significant there is a general decrease in TSS and TP concentrations for the test watershed after raingarden installation. Figure 8 and Figure 9 display the average stormwater TSS and TP concentrations by period and watershed. A summary of the average TSS and TP concentrations is shown in Table 5. Overall there was 52% and 37% decrease in average TSS and TP concentrations, respectively.

Table 5. Average TSS and TP Concentrations (mg/L)

Calibration Period	**TSS**	**TP**
Control	275	0.920
Test	301	0.995
Treatment Period	**TSS**	**TP**
Control	369	1.580
Test	158	0.759
Test Predicted	331	1.208
Change	-52%	-37%

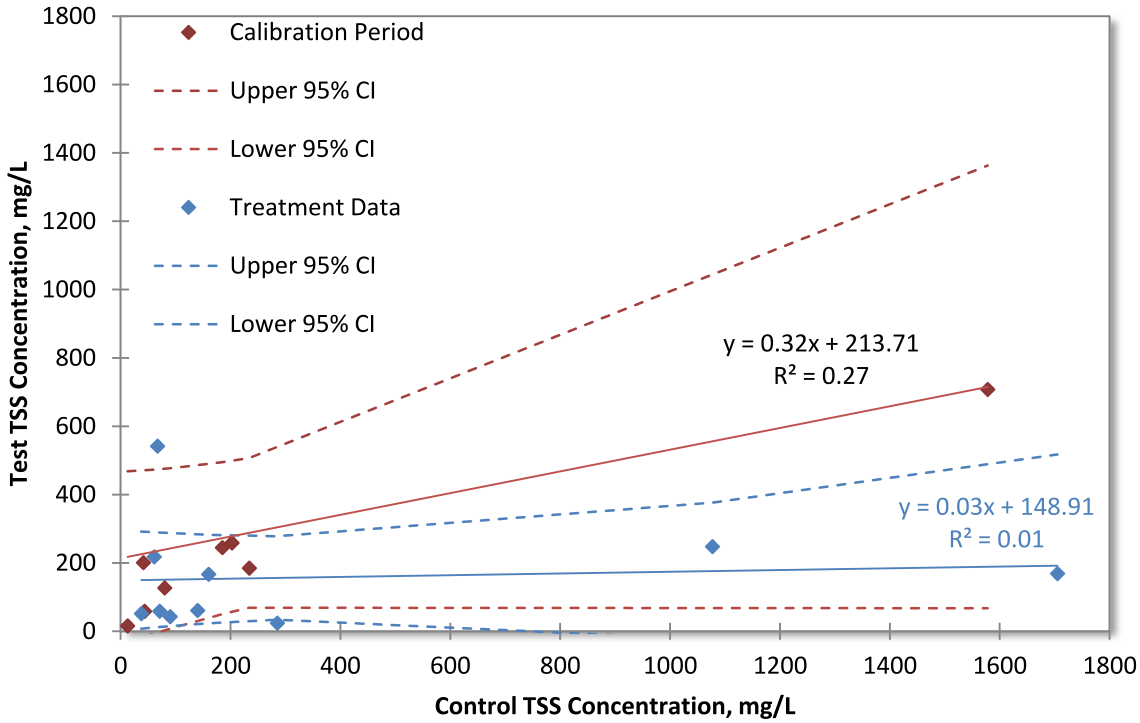

Figure 6. Total Suspended Solids (TSS) Regression Results

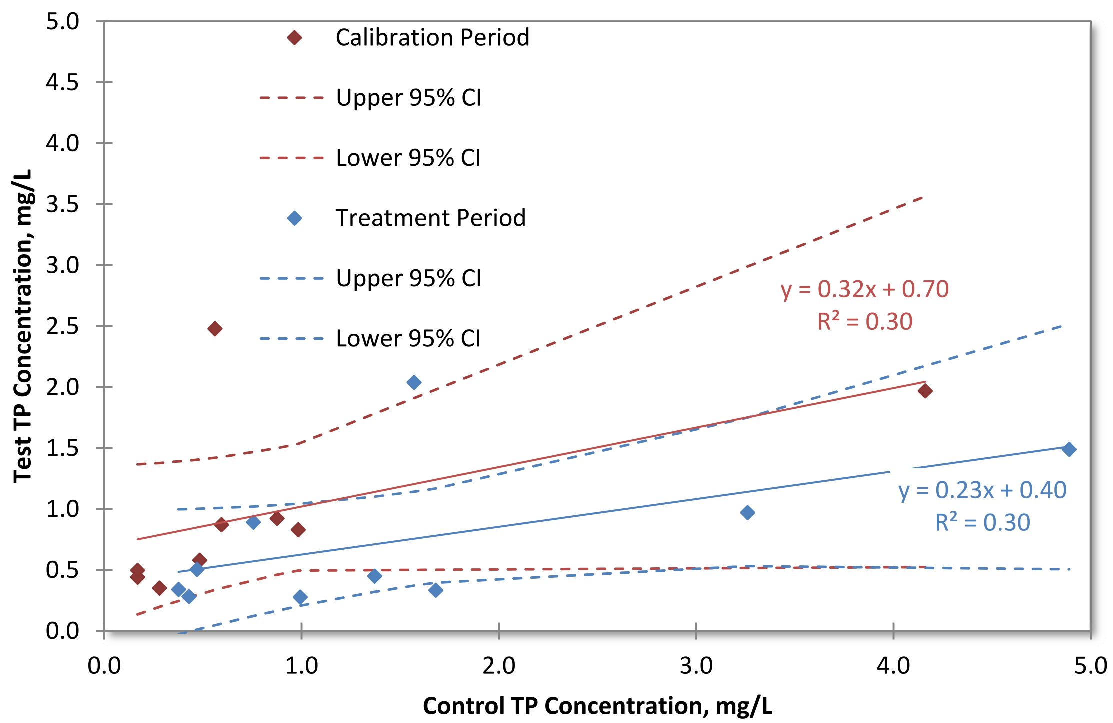

Figure 7. Total Phosphorus (TP) Regression Results

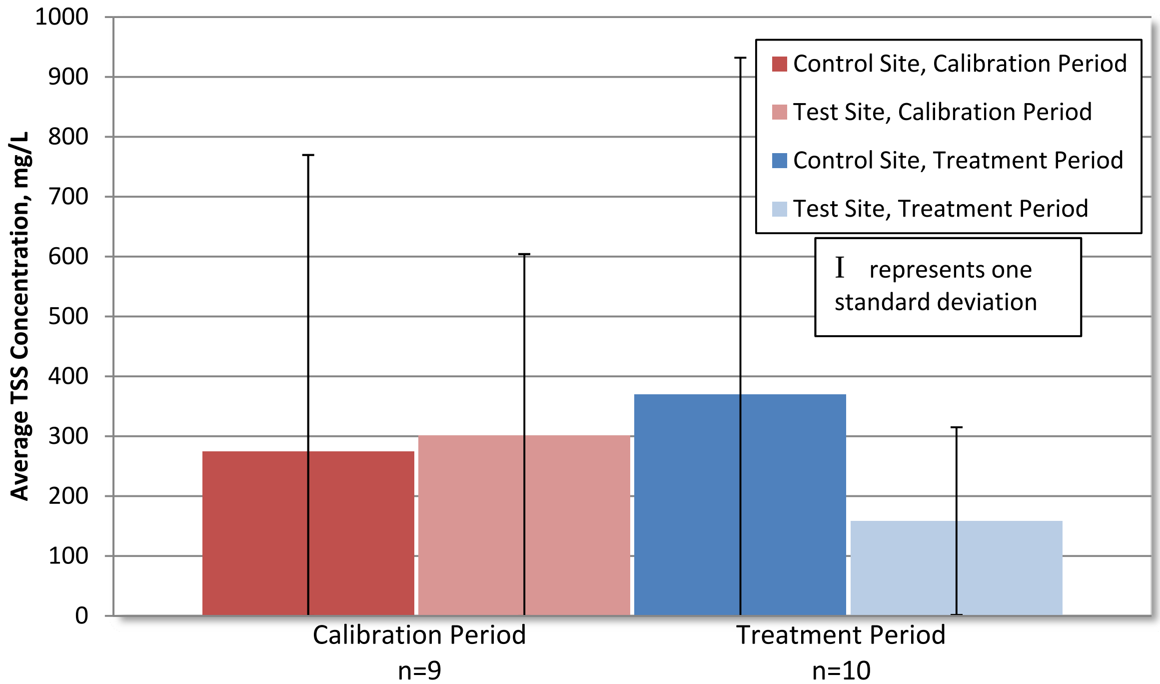

Figure 8. Average TSS Concentrations (n=number of paired samples)

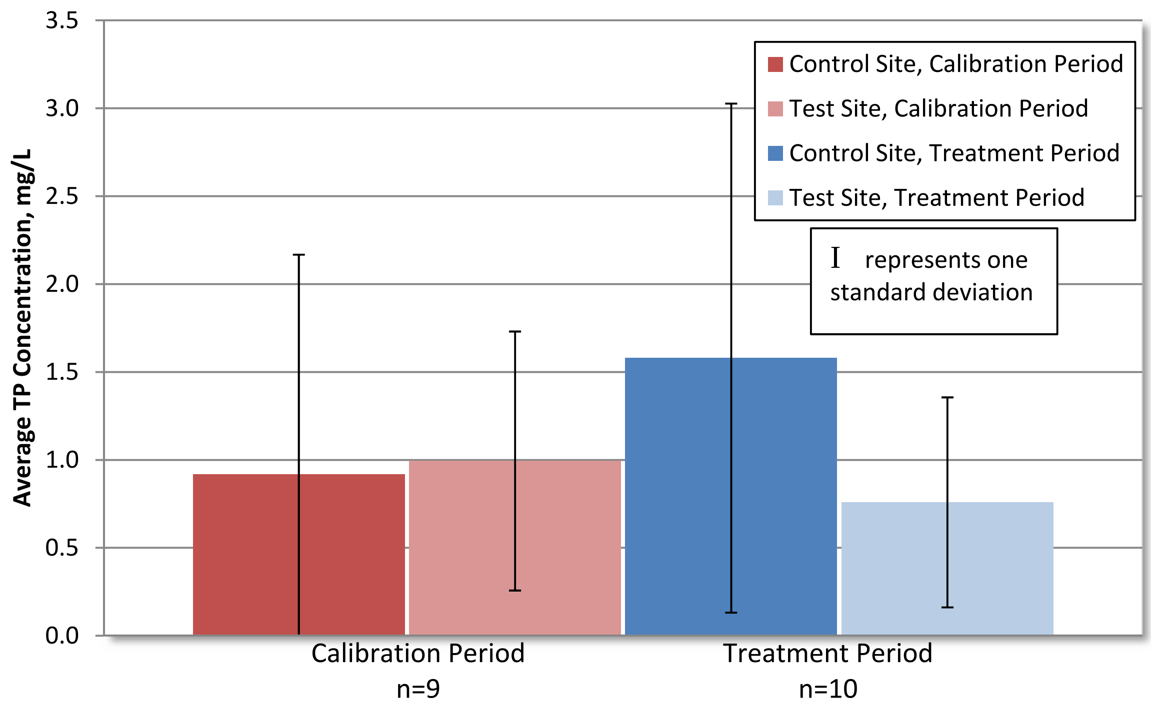

Figure 9. Average TP Concentrations (n=number of paired samples)

Conclusions and Recommendations

Although the study did not conclude with statistically significant results, the data resulting from this study provides a significant data set to which a hydrologic model of the watersheds can be calibrated. With a calibrated hydrologic model, multiple scenarios in which various amounts of impervious area are treated could be explored to determine if efforts such as redirecting alley runoff will provide a reduction in runoff volume.

Continued water quality monitoring could be of value to develop a data set to which a water quality model could be calibrated. In addition to flow-weighted composite concentrations, the TSS and TP concentrations throughout the hydrograph of various representative storm events should be analyzed to support potential water quality modeling efforts. Creating a calibrated hydrologic/water quality model such as P8, would allow for further study of impacts of various treatment scenarios and would be a valuable tool in decreasing the stormwater pollutant loads and improving the water quality of Powderhorn Lake.

References

Clausen, J.C., and Spooner. 1993. Paired Watershed Study Design. Prepared for the U.S. Environmental Protection Agency. Office of Water. Washington, D.C. Report 841-F-93-009.

Metro Blooms. 2012. A Citizen-Based Approach to Stormwater Management. Prepared for the Legislative-Citizen Commission on Minnesota Resources. St. Paul, MN. Project 09-05e.

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Attachment – Exhibits
S:\KO\M\Metrb\116238\4-rprt\FINAL REPORT_062812\Appendix A\CBASM Paired Watershed Study Memorandum_Final_062212.docx

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Exhibits

Paired Event Hydrographs

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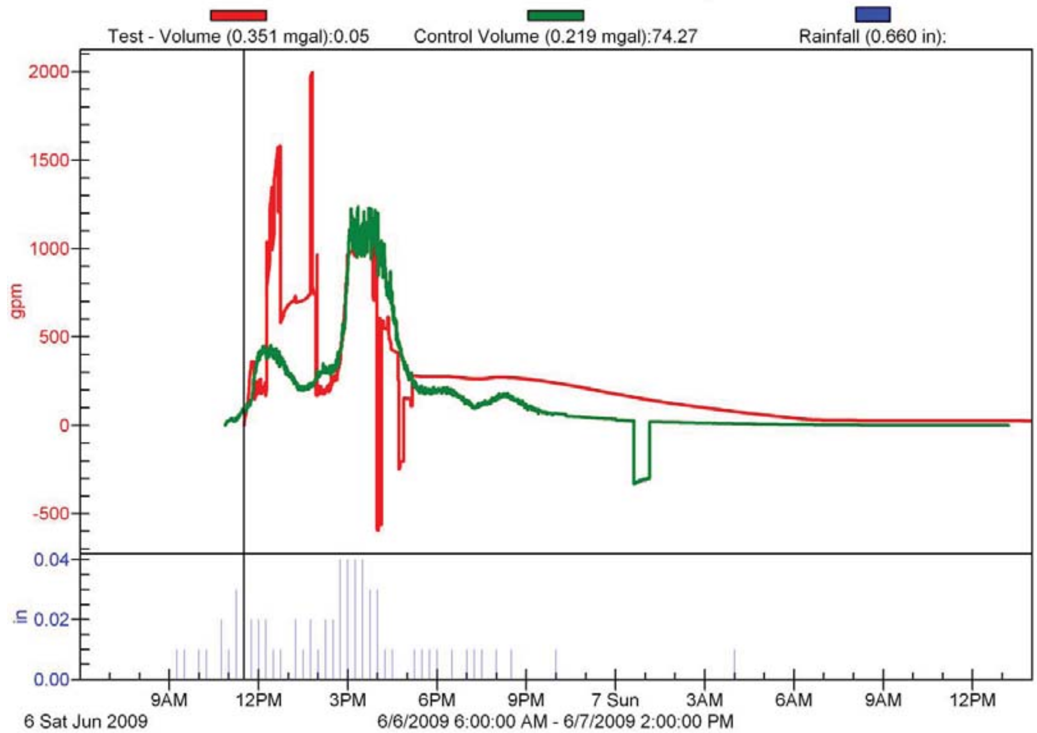
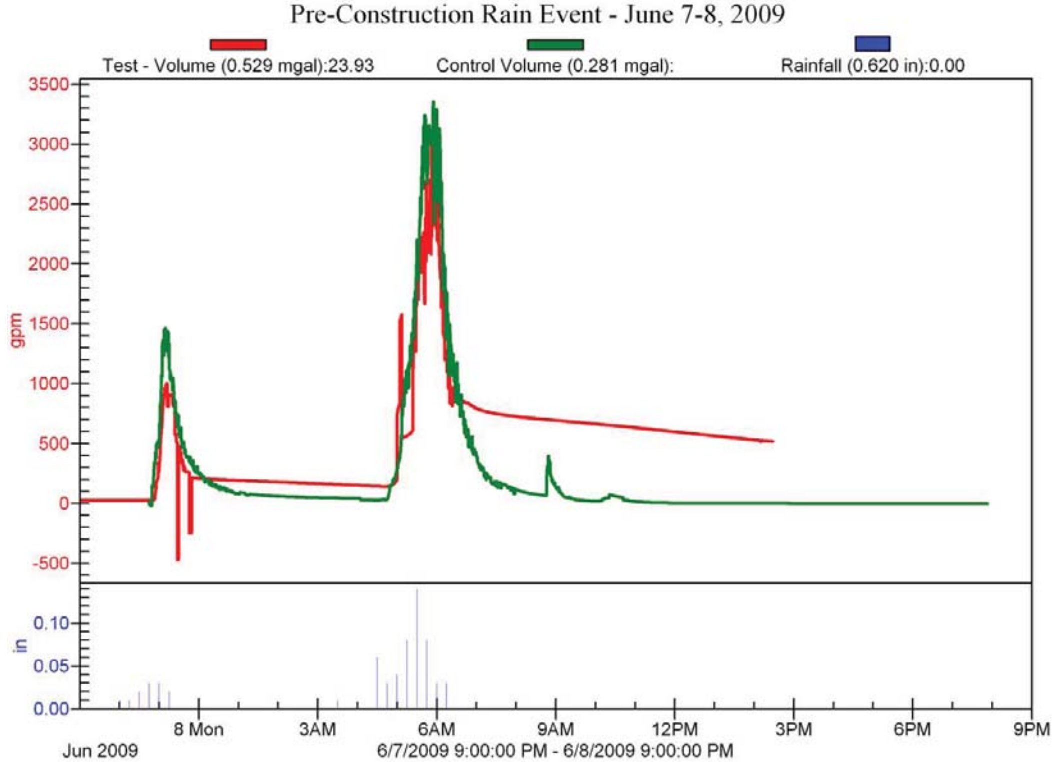
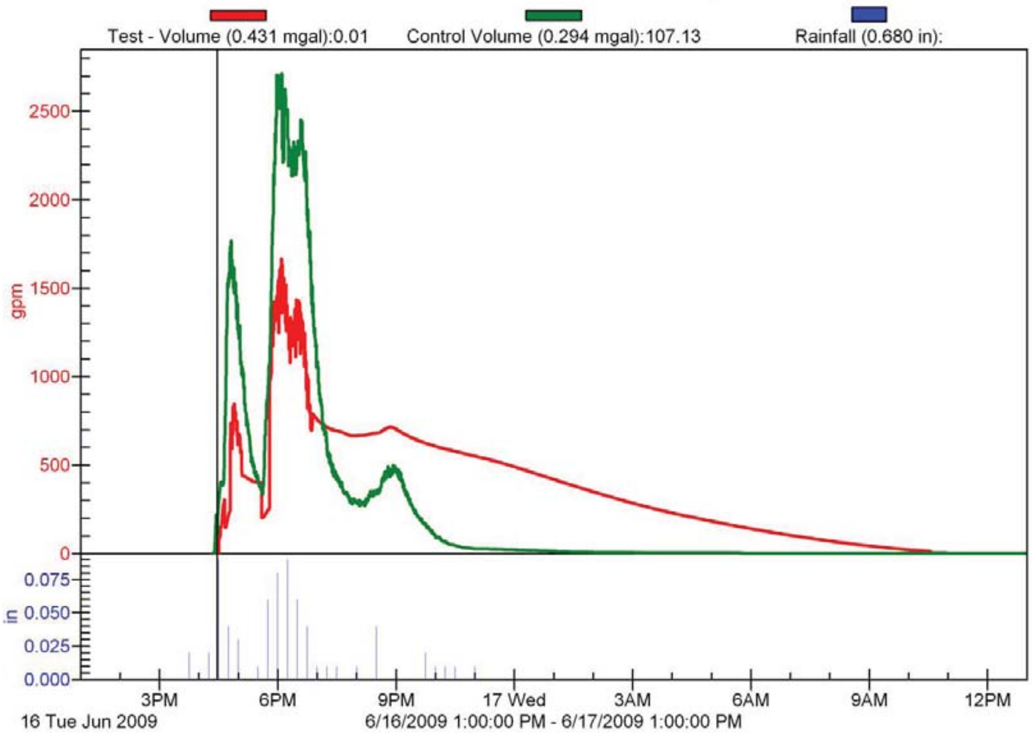
Pre-Construction Rain Event - June 6, 2009



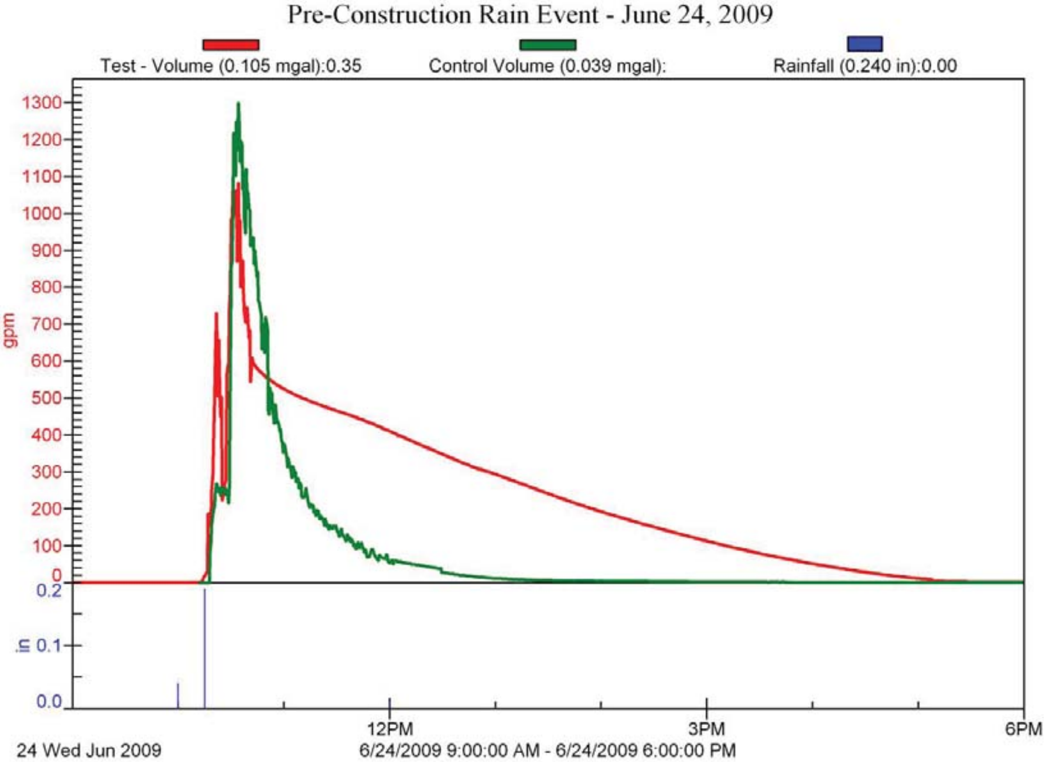
Pre-Construction Rain Event - June 7-8, 2009



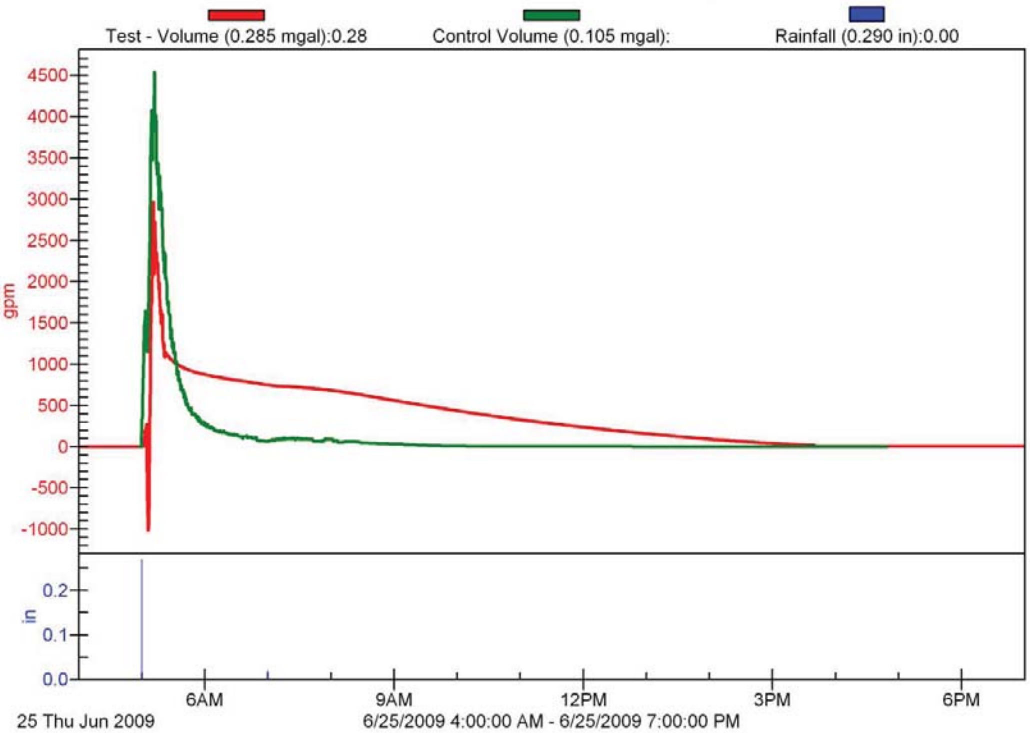
Pre-Construction Rain Event - June 16, 2009



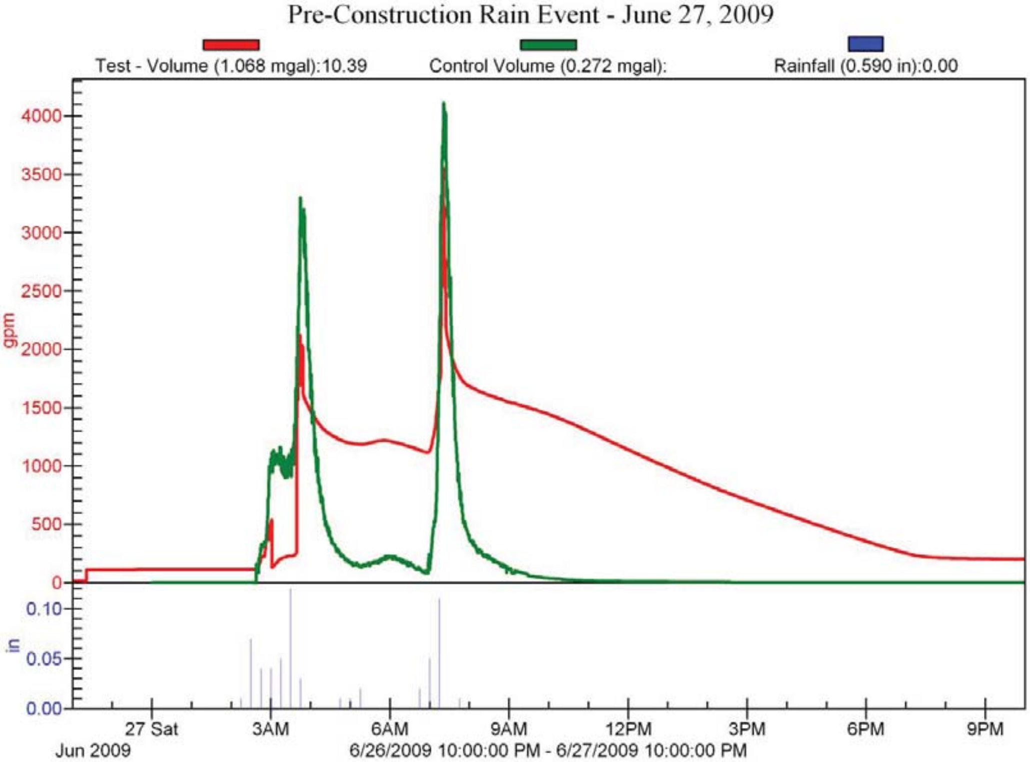
Pre-Construction Rain Event - June 24, 2009

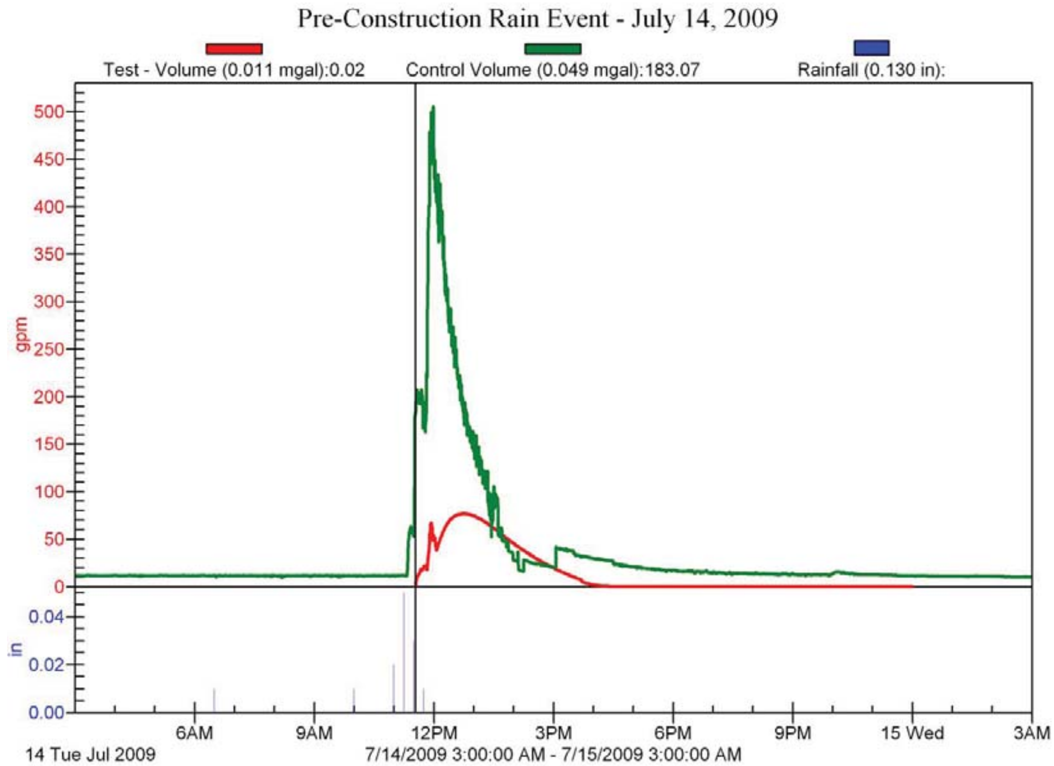


Pre-Construction Rain Event - June 25, 2009

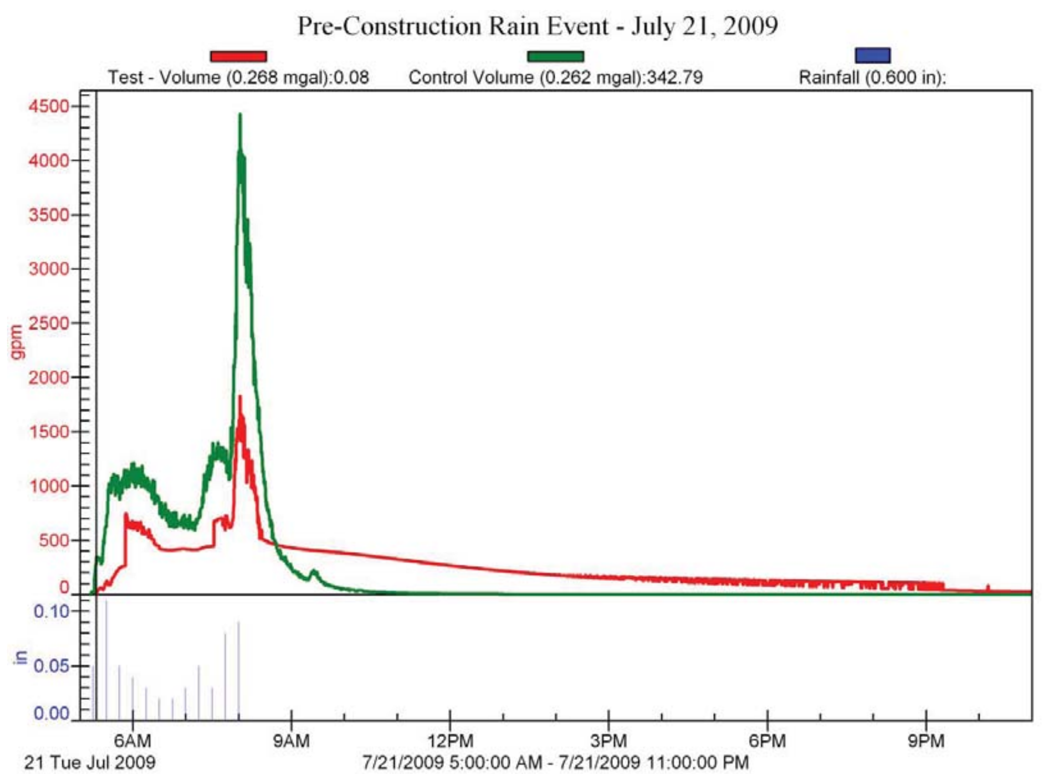


Pre-Construction Rain Event - June 27, 2009

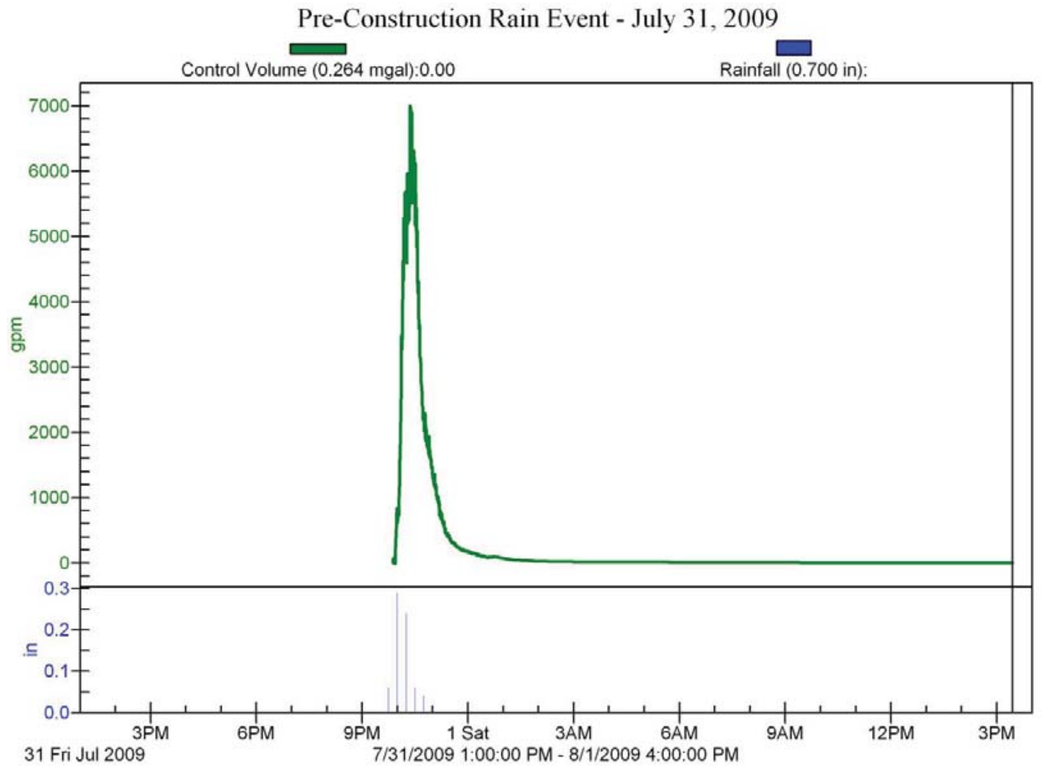




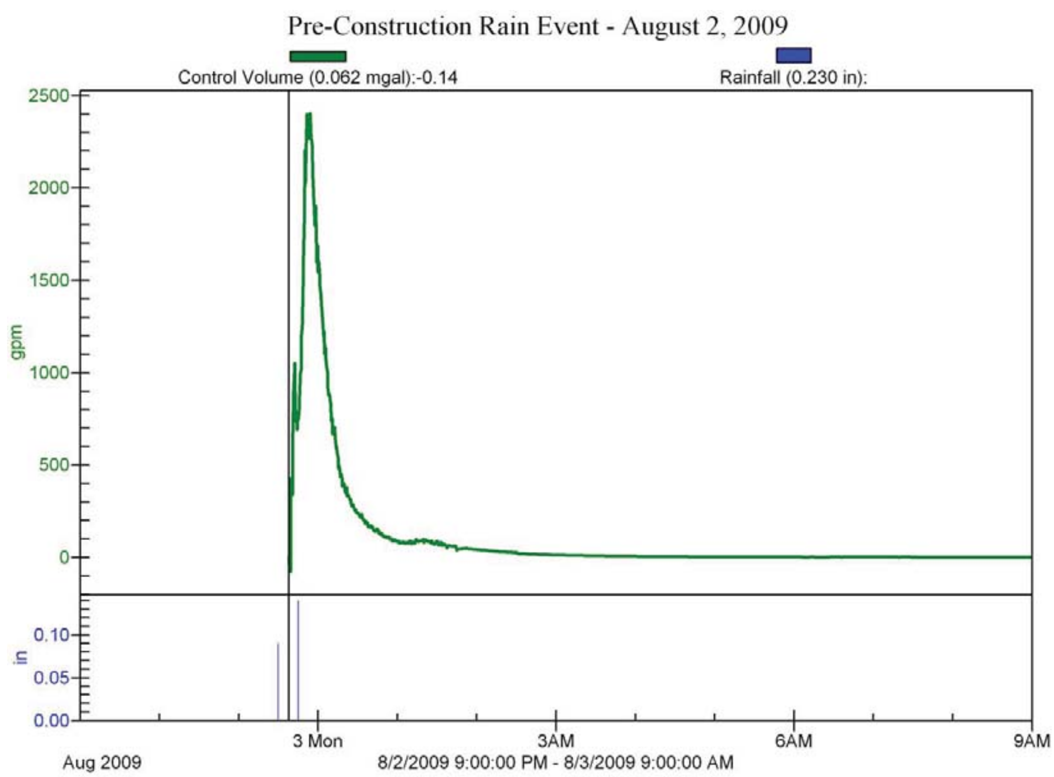
Pre-Construction Rain Event - July 14, 2009
Test - Volume (0.011 mgal):0.02
Control Volume (0.049 mgal):183.07
Rainfall (0.130 in):
gpm
in
500
450
400
350
300
250
200
150
100
50
0
0.04
0.02
0.00
6AM
9AM
12PM
3PM
6PM
9PM
15 Wed
3AM
14 Tue Jul 2009
7/14/2009 3:00:00 AM - 7/15/2009 3:00:00 AM



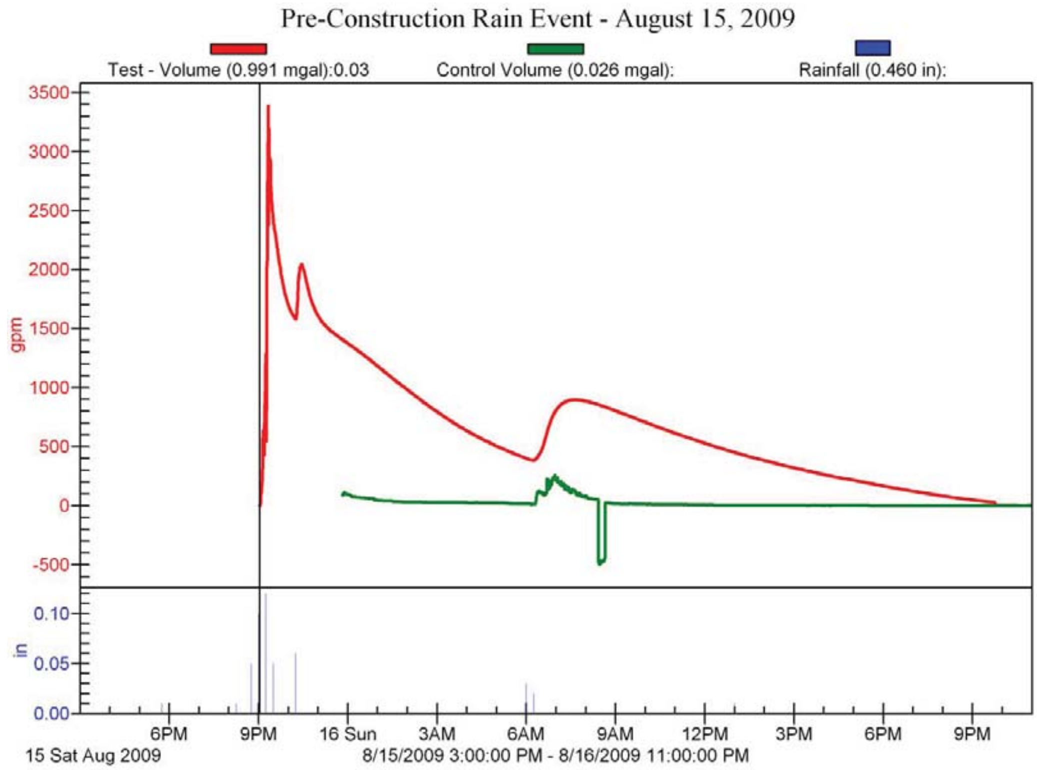
Pre-Construction Rain Event - July 21, 2009
Test - Volume (0.268 mgal):0.08
Control Volume (0.262 mgal):342.79
Rainfall (0.600 in):
gpm
in
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0.10
0.05
0.00
6AM
9AM
12PM
3PM
6PM
9PM
21 Tue Jul 2009
7/21/2009 5:00:00 AM - 7/21/2009 11:00:00 PM



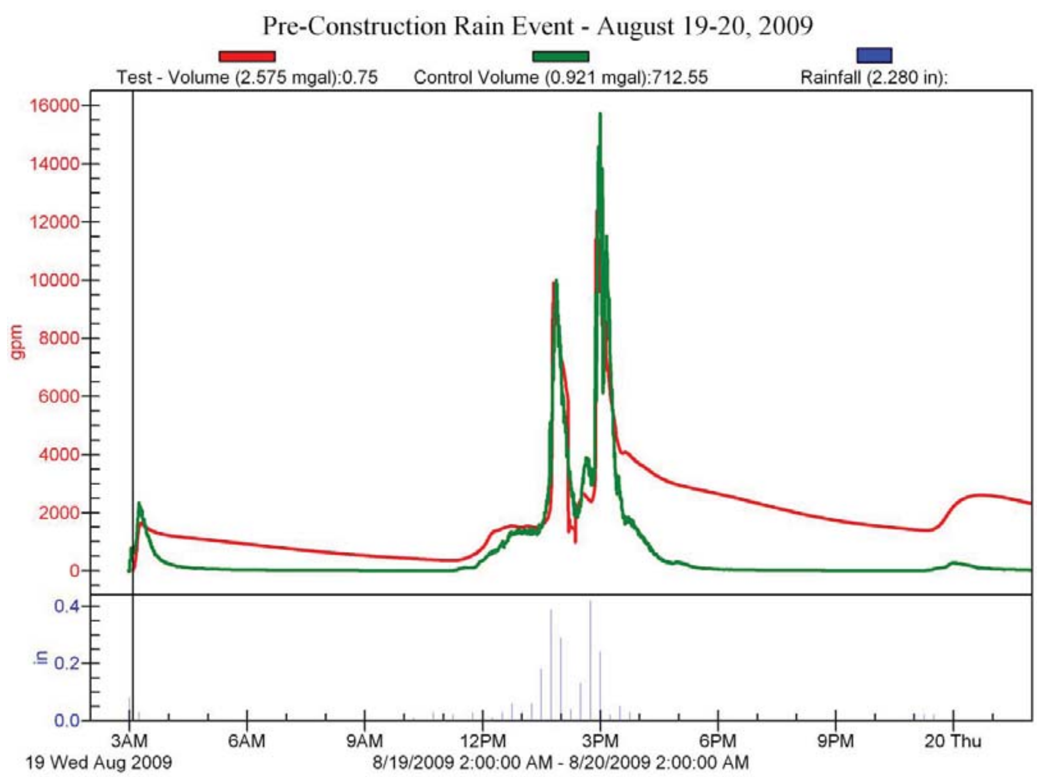
Pre-Construction Rain Event - July 31, 2009
Control Volume (0.264 mgal):0.00
Rainfall (0.700 in):
7000
6000
5000
4000
3000
2000
1000
0
gpm
0.3
0.2
0.1
0.0
in
3PM
6PM
9PM
1 Sat
3AM
6AM
9AM
12PM
3PM
31 Fri Jul 2009
7/31/2009 1:00:00 PM - 8/1/2009 4:00:00 PM



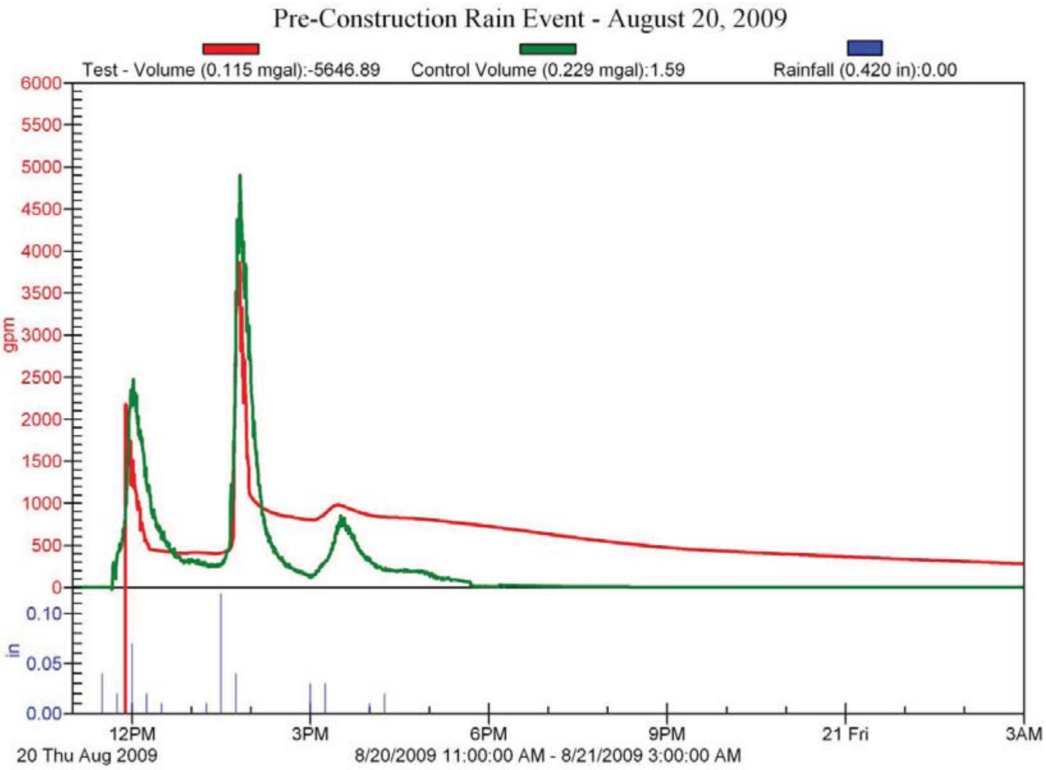
Pre-Construction Rain Event - August 2, 2009
Control Volume (0.062 mgal):-0.14
Rainfall (0.230 in):
2500
2000
1500
1000
500
0
gpm
0.10
0.05
0.00
in
3 Mon
3AM
6AM
9AM
Aug 2009
8/2/2009 9:00:00 PM - 8/3/2009 9:00:00 AM

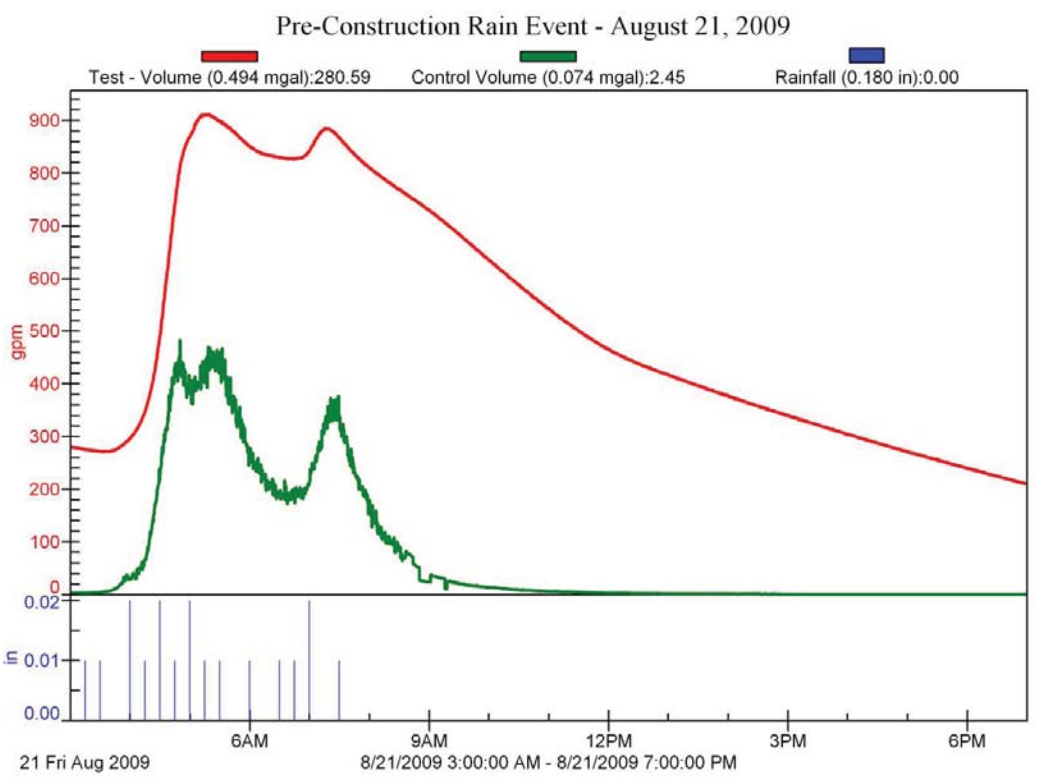


Pre-Construction Rain Event - August 15, 2009
Test - Volume (0.991 mgal):0.03
Control Volume (0.026 mgal):
Rainfall (0.460 in):
gpm
3500
3000
2500
2000
1500
1000
500
0
-500
in
0.10
0.05
0.00
6PM
9PM
16 Sun
3AM
6AM
9AM
12PM
3PM
6PM
9PM
15 Sat Aug 2009
8/15/2009 3:00:00 PM - 8/16/2009 11:00:00 PM

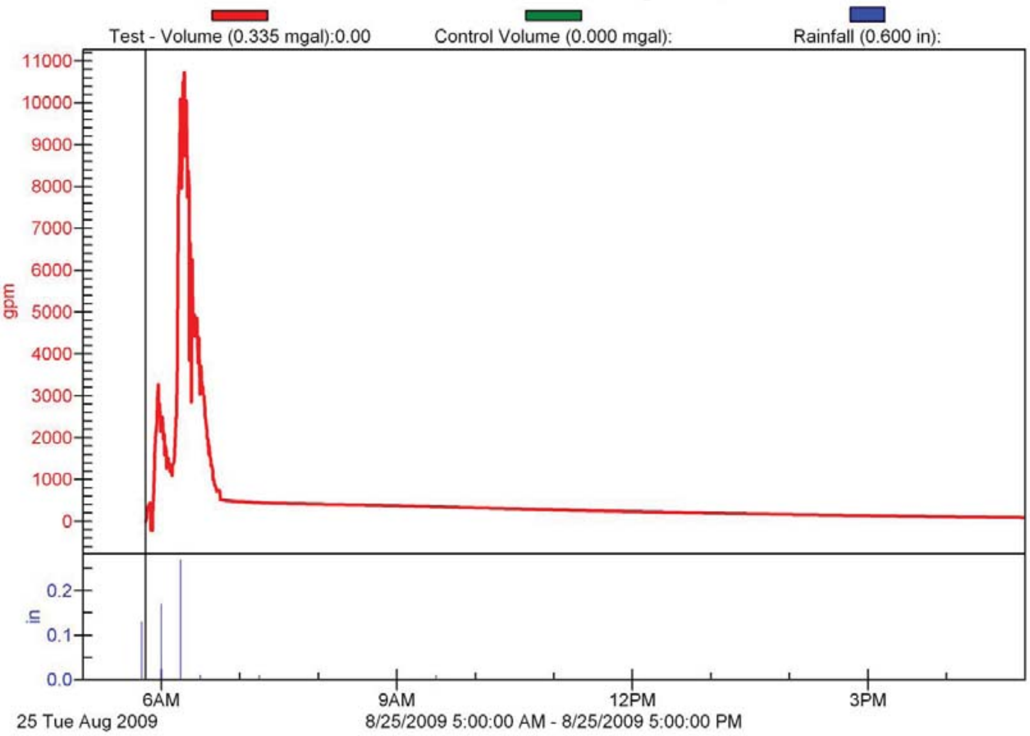


Pre-Construction Rain Event - August 19-20, 2009
Test - Volume (2.575 mgal):0.75
Control Volume (0.921 mgal):712.55
Rainfall (2.280 in):
gpm
16000
14000
12000
10000
8000
6000
4000
2000
0
in
0.4
0.2
0.0
3AM
6AM
9AM
12PM
3PM
6PM
9PM
20 Thu
19 Wed Aug 2009
8/19/2009 2:00:00 AM - 8/20/2009 2:00:00 AM

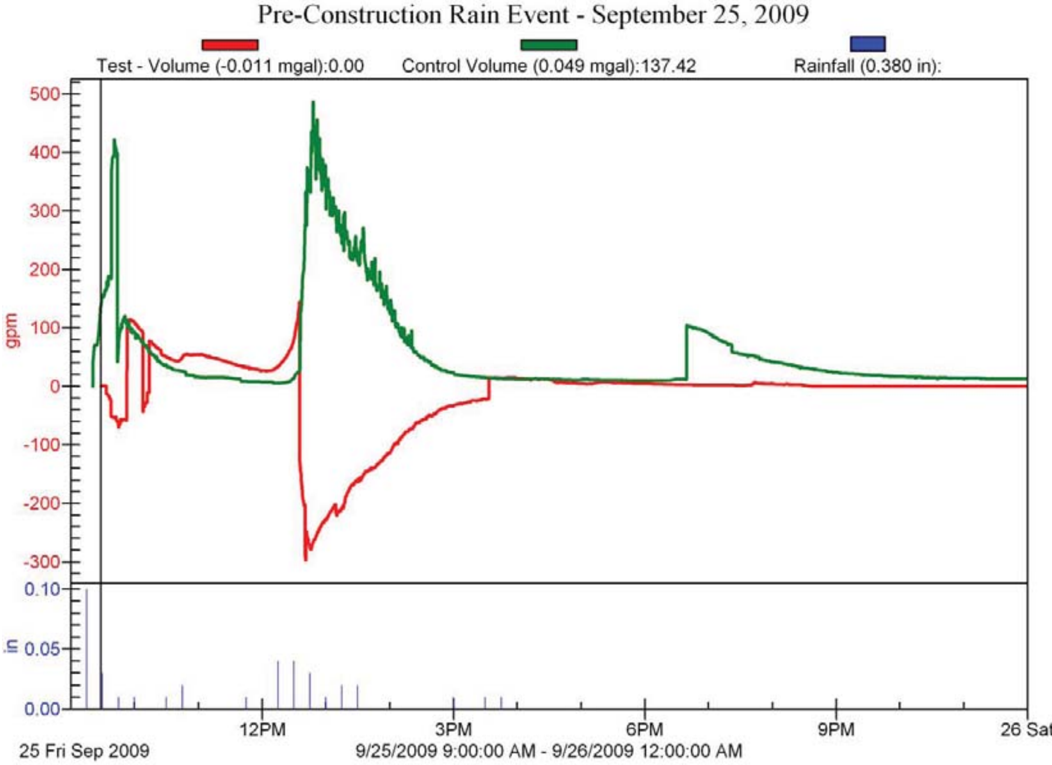

Pre-Construction Rain Event - August 20, 2009
Test - Volume (0.115 mgal):-5646.89
Control Volume (0.229 mgal):1.59
Rainfall (0.420 in):0.00
gpm
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
in
0.10
0.05
0.00
12PM
3PM
6PM
9PM
21 Fri
3AM
20 Thu Aug 2009
8/20/2009 11:00:00 AM - 8/21/2009 3:00:00 AM

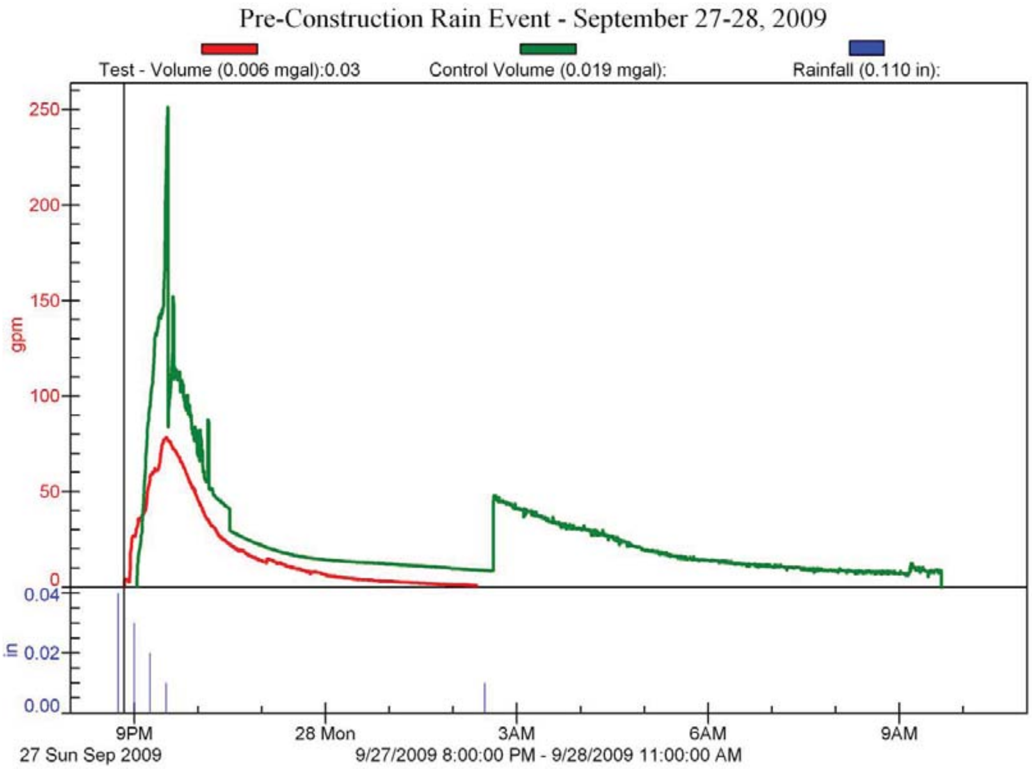

Pre-Construction Rain Event - August 21, 2009
Test - Volume (0.494 mgal):280.59
Control Volume (0.074 mgal):2.45
Rainfall (0.180 in):0.00
gpm
900
800
700
600
500
400
300
200
100
0
in
0.02
0.01
0.00
6AM
9AM
12PM
3PM
6PM
21 Fri Aug 2009
8/21/2009 3:00:00 AM - 8/21/2009 7:00:00 PM

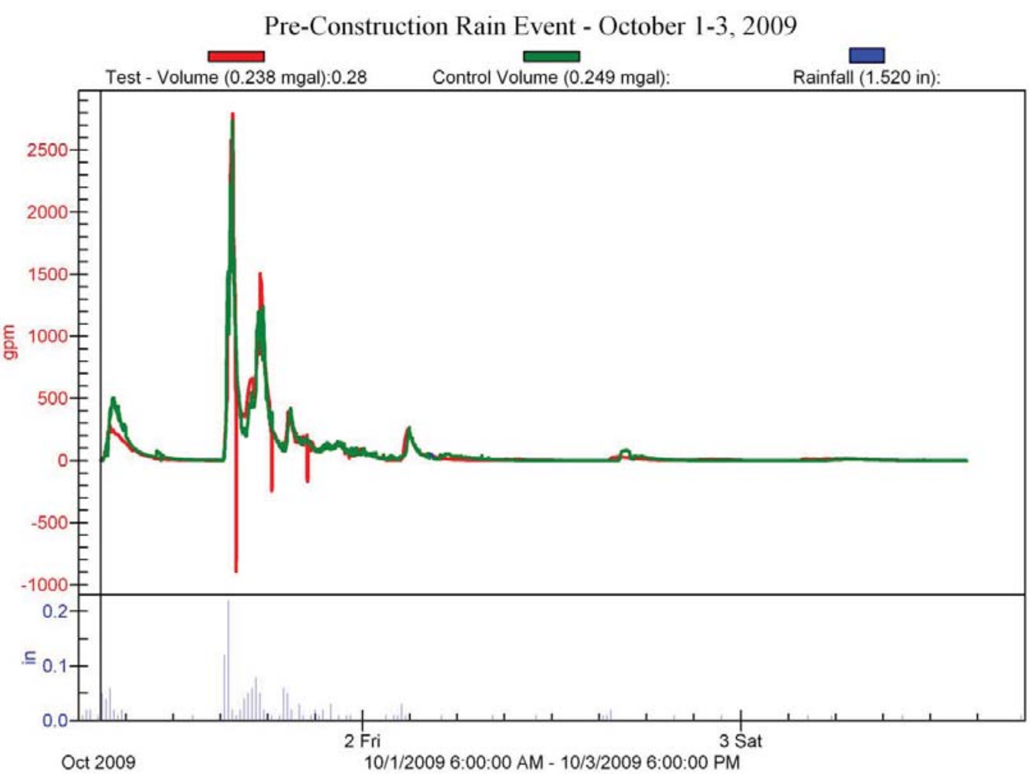
Pre-Construction Rain Event - August 25, 2009



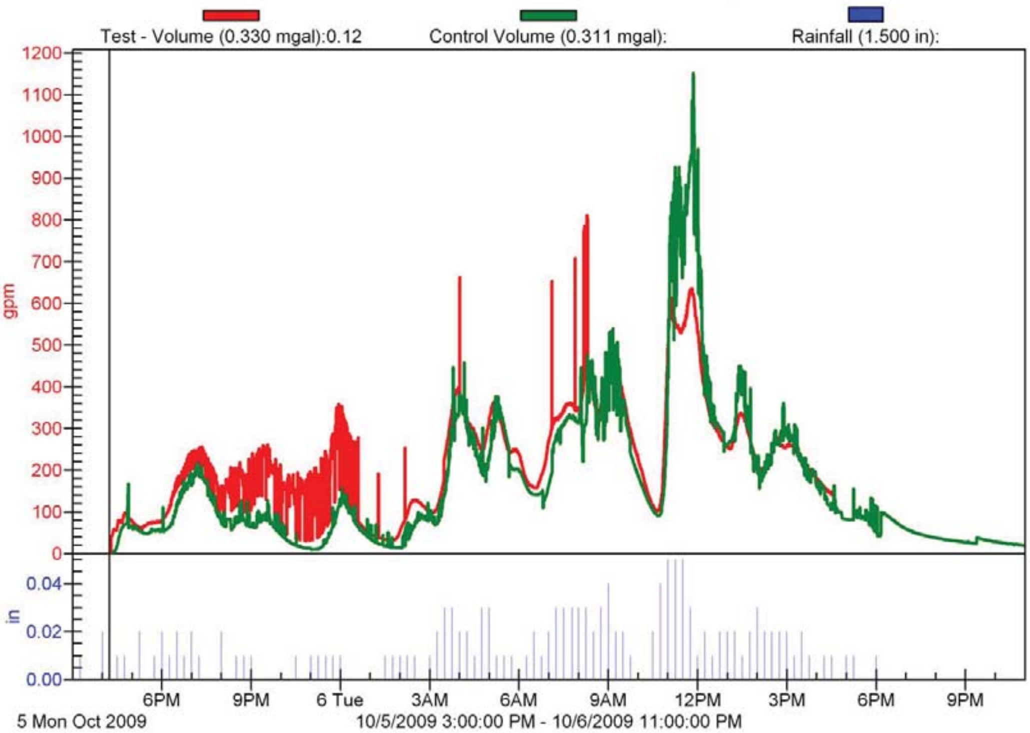
Pre-Construction Rain Event - September 25, 2009



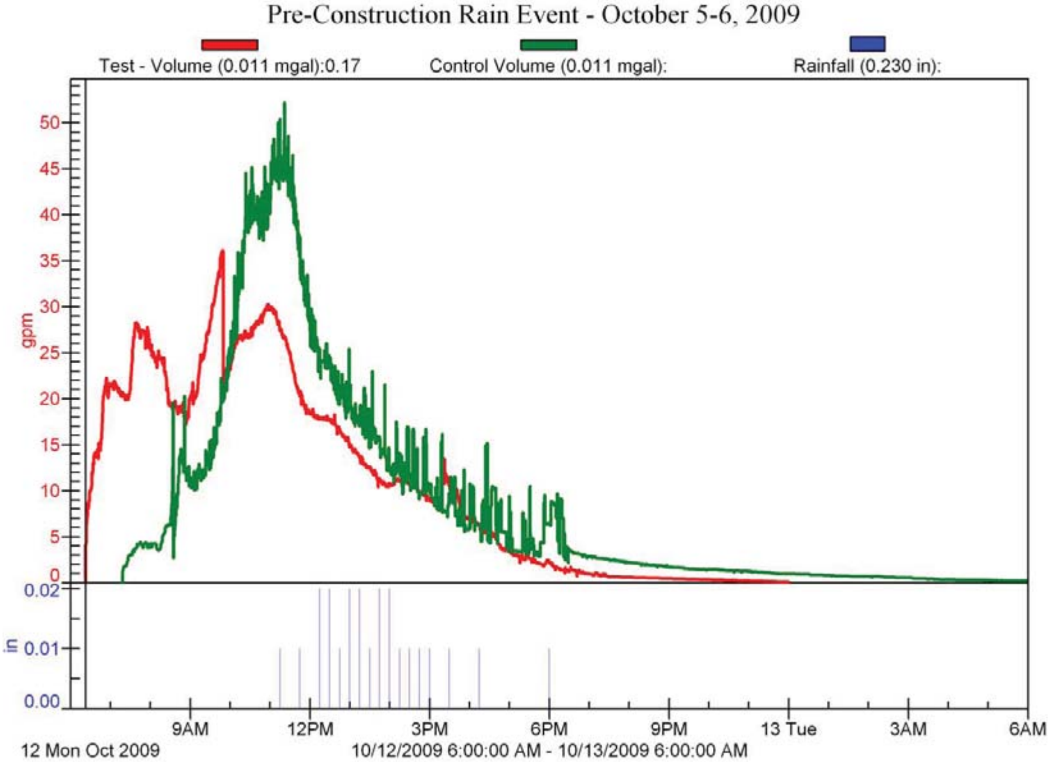

Pre-Construction Rain Event - September 27-28, 2009
Test - Volume (0.006 mgal):0.03
Control Volume (0.019 mgal):
Rainfall (0.110 in):
gpm
250
200
150
100
50
0
0.04
in 0.02
0.00
9PM
28 Mon
3AM
6AM
9AM
27 Sun Sep 2009
9/27/2009 8:00:00 PM - 9/28/2009 11:00:00 AM


Pre-Construction Rain Event - October 1-3, 2009
Test - Volume (0.238 mgal):0.28
Control Volume (0.249 mgal):
Rainfall (1.520 in):
gpm
2500
2000
1500
1000
500
0
-500
-1000
in
0.2
0.1
0.0
2 Fri
3 Sat
Oct 2009
10/1/2009 6:00:00 AM - 10/3/2009 6:00:00 PM

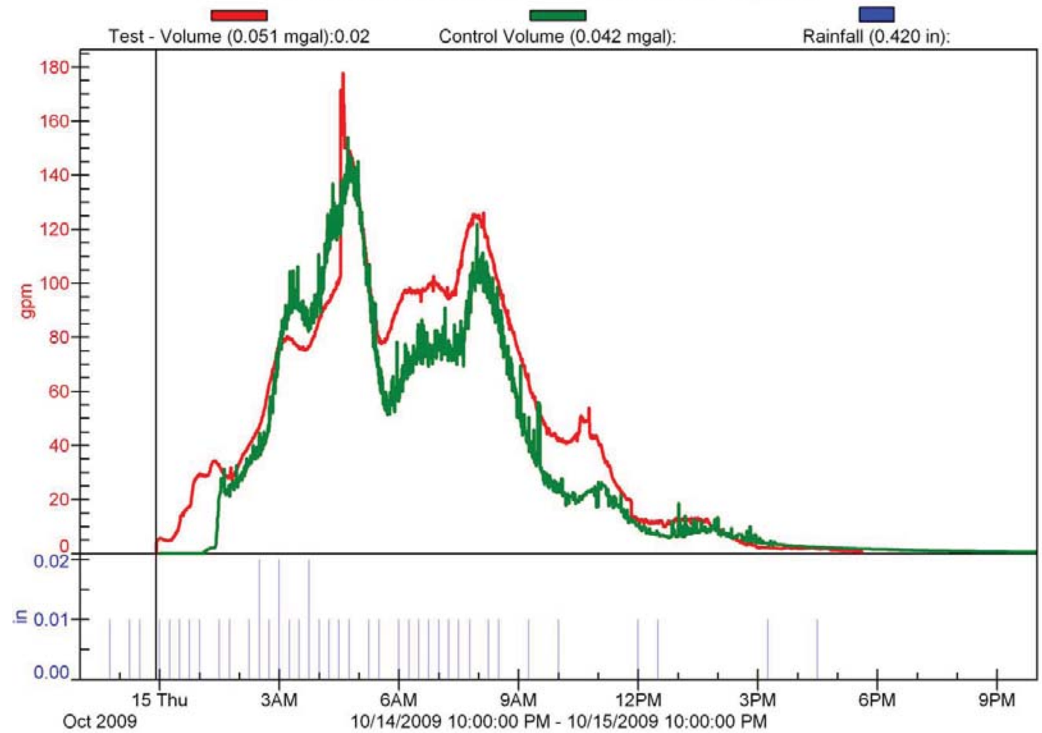
Pre-Construction Rain Event - October 5-6, 2009



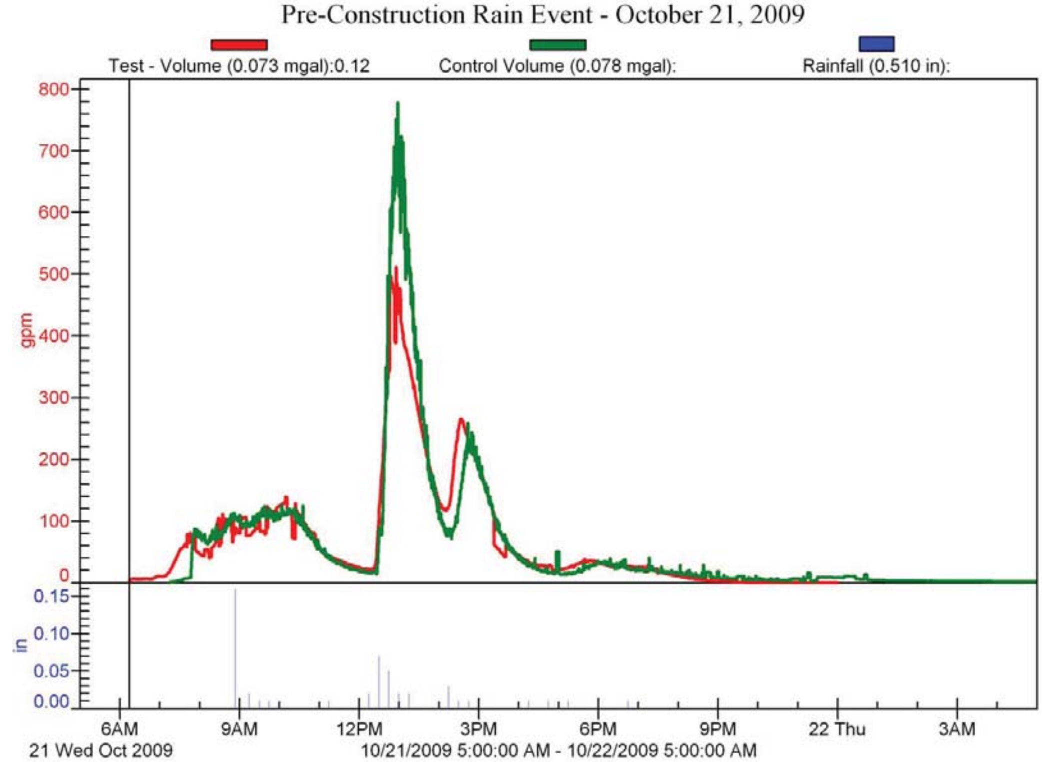
Pre-Construction Rain Event - October 5-6, 2009



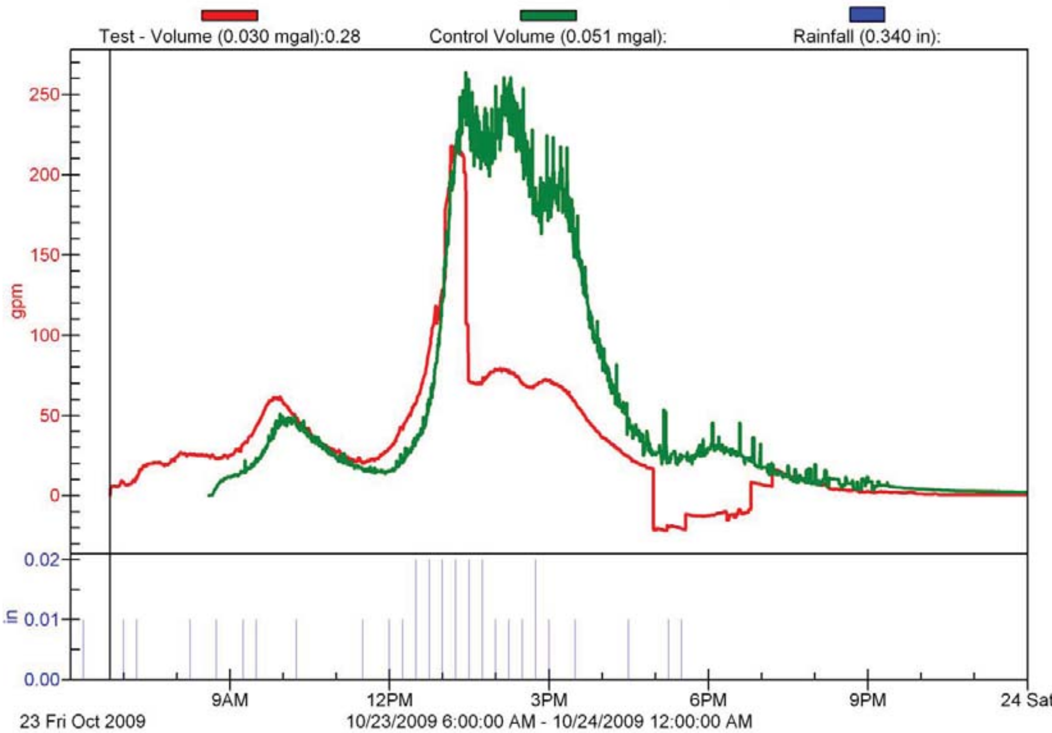
Pre-Construction Rain Event - October 14-15, 2009



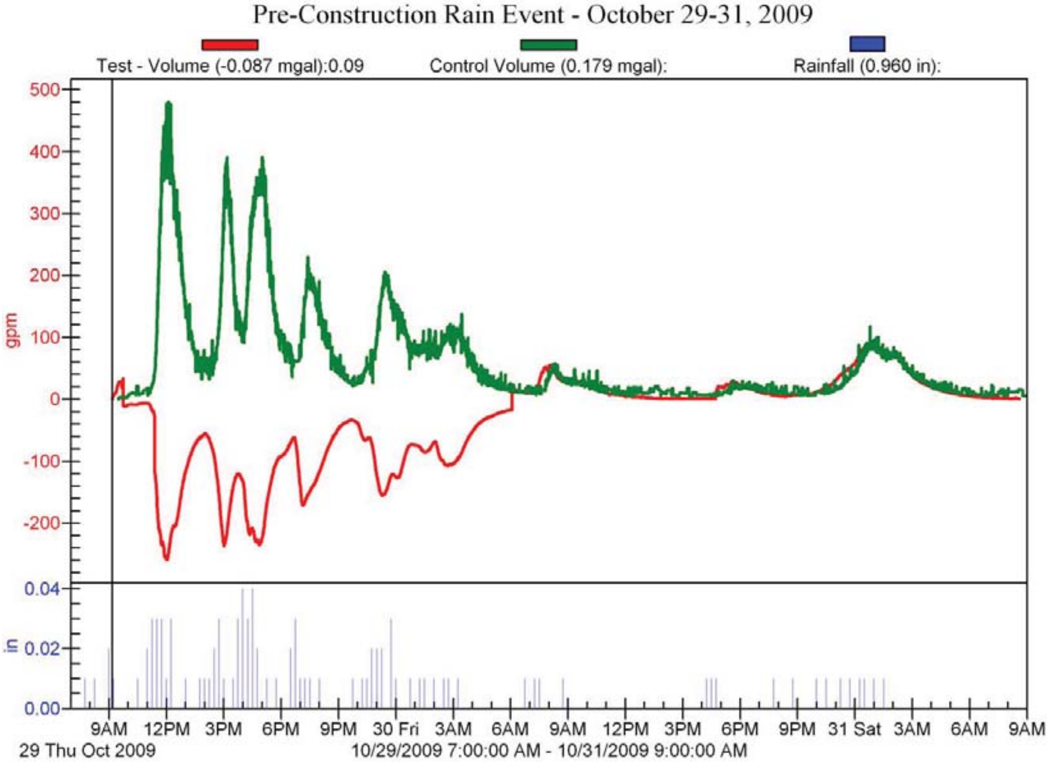
Pre-Construction Rain Event - October 21, 2009



Pre-Construction Rain Event - October 23, 2009

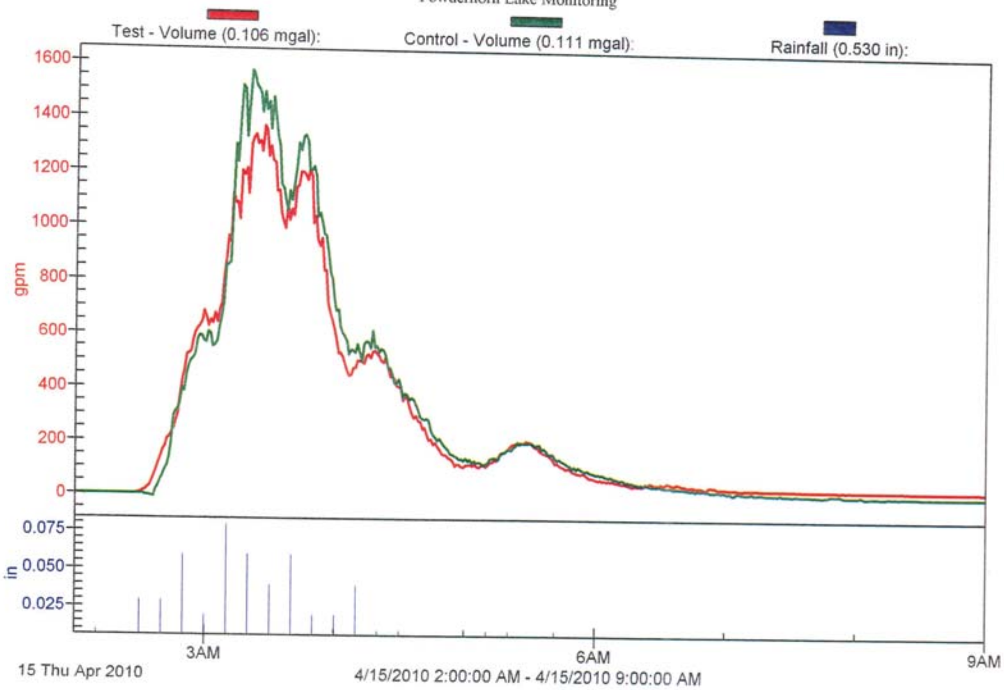


Pre-Construction Rain Event - October 29-31, 2009

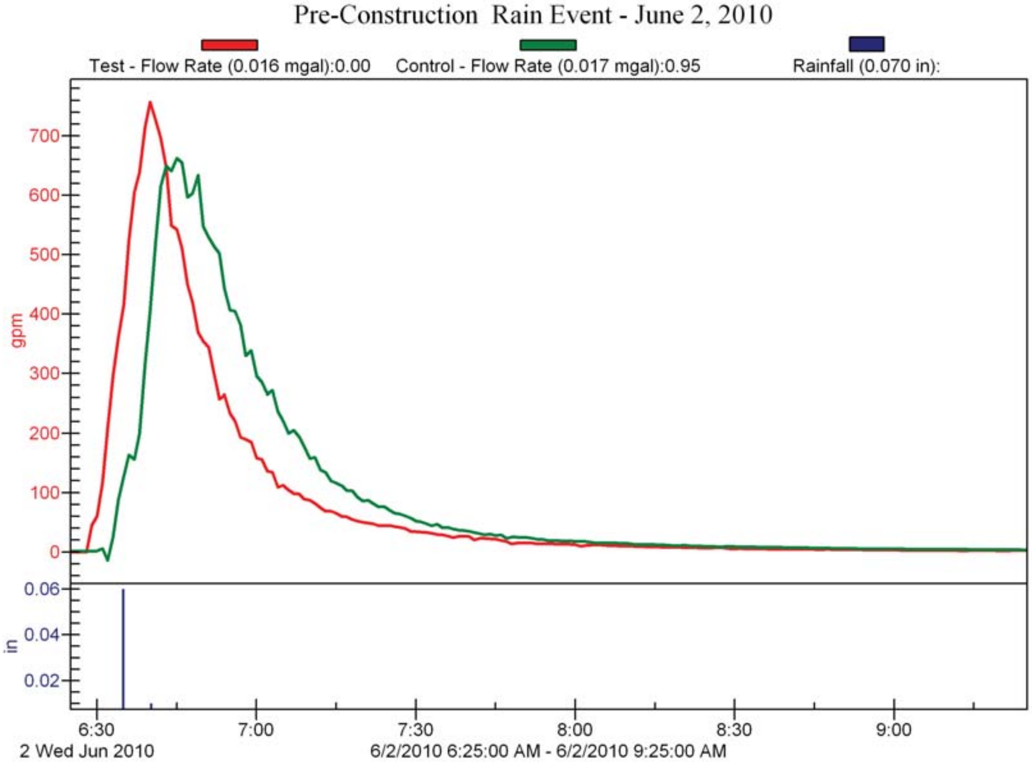


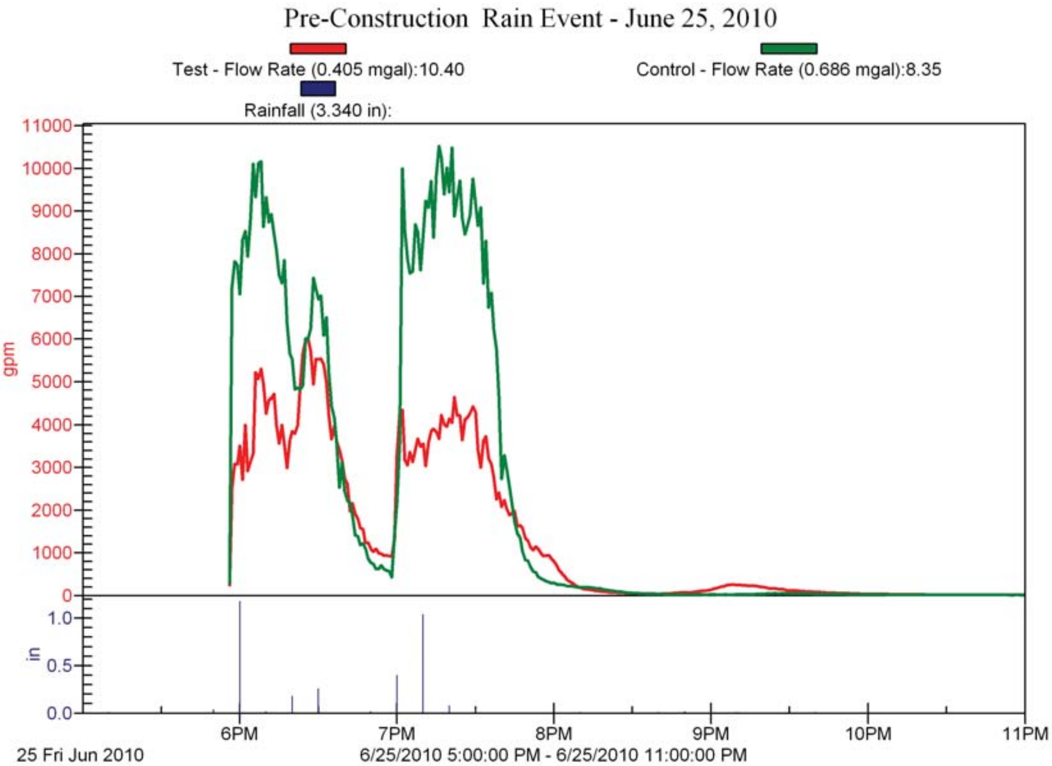
Pre-Construction Rain Event - April 15, 2010

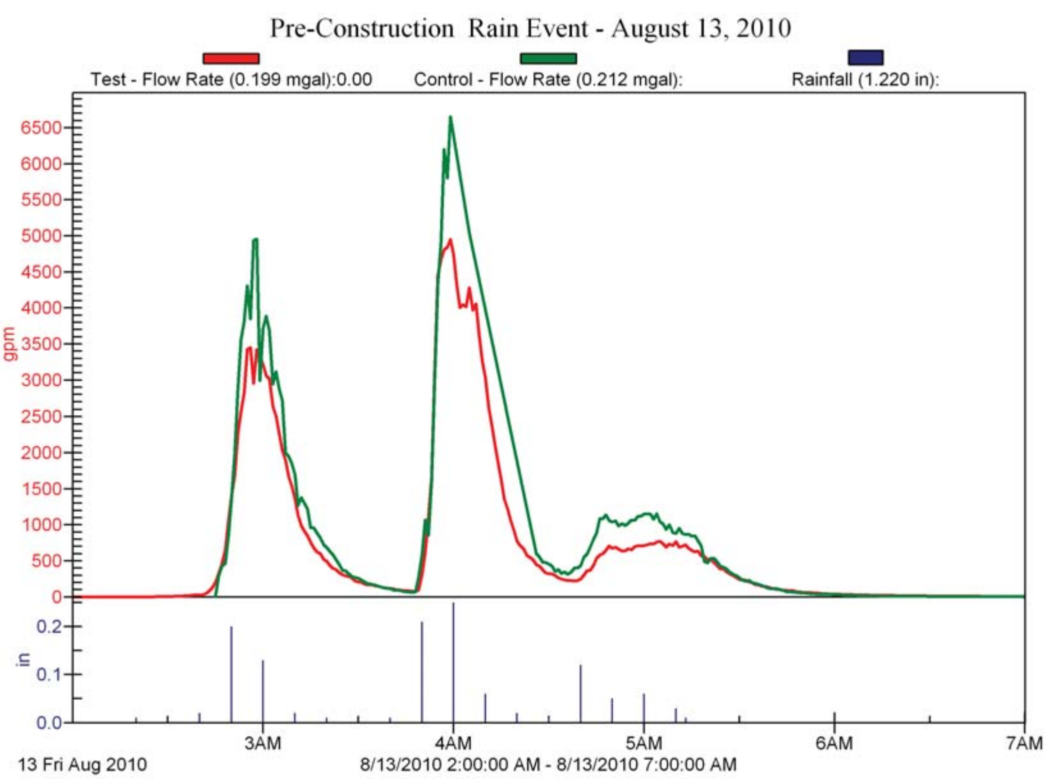
Powderhorn Lake Monitoring

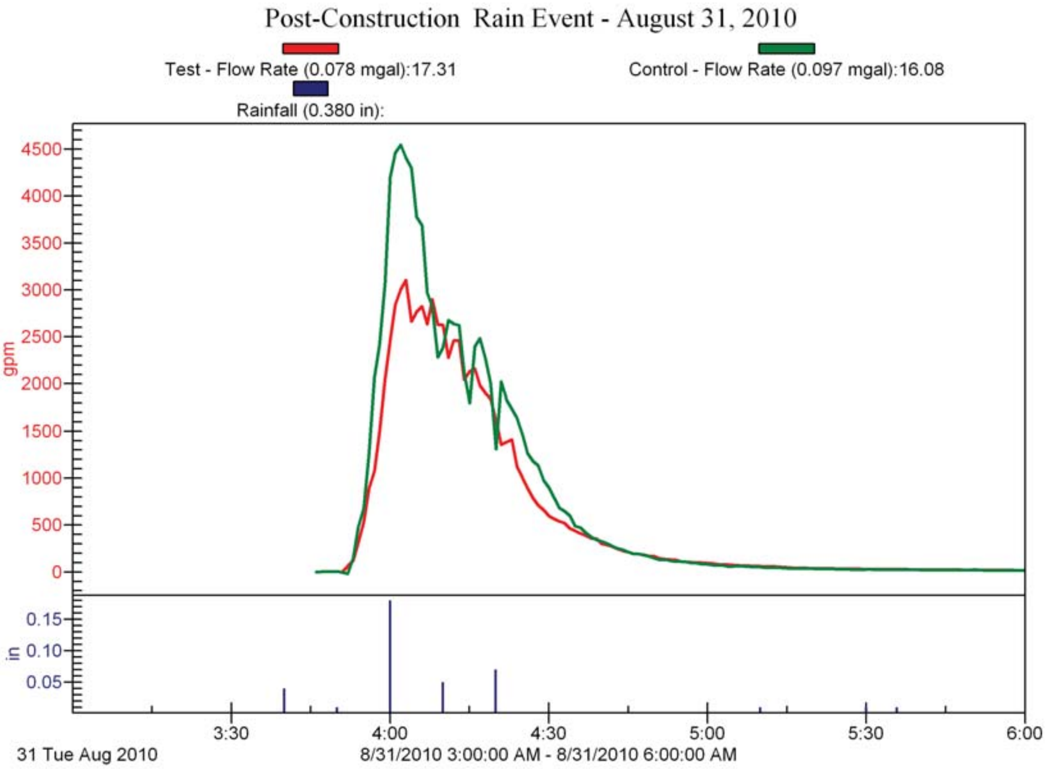


Pre-Construction Rain Event - June 2, 2010

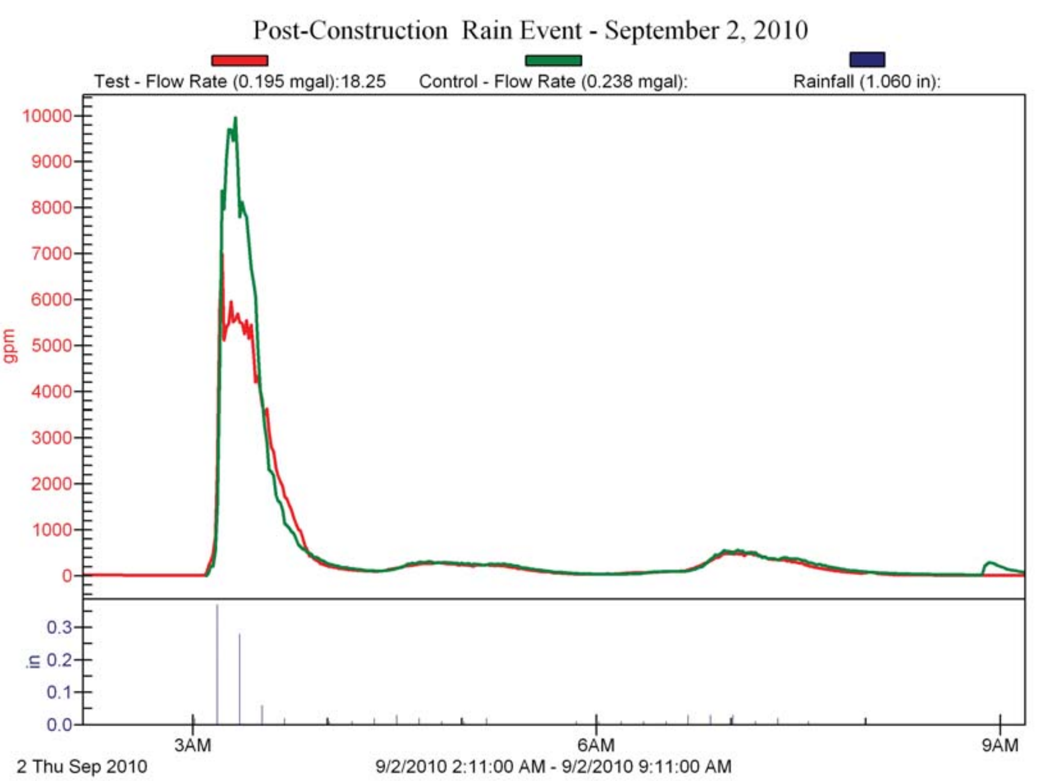



Pre-Construction Rain Event - June 25, 2010
Test - Flow Rate (0.405 mgal):10.40
Control - Flow Rate (0.686 mgal):8.35
Rainfall (3.340 in):
gpm
in
6PM
7PM
8PM
9PM
10PM
11PM
25 Fri Jun 2010
6/25/2010 5:00:00 PM - 6/25/2010 11:00:00 PM


Pre-Construction Rain Event - August 13, 2010
Test - Flow Rate (0.199 mgal):0.00
Control - Flow Rate (0.212 mgal):
Rainfall (1.220 in):
gpm
in
3AM
4AM
5AM
6AM
7AM
13 Fri Aug 2010
8/13/2010 2:00:00 AM - 8/13/2010 7:00:00 AM

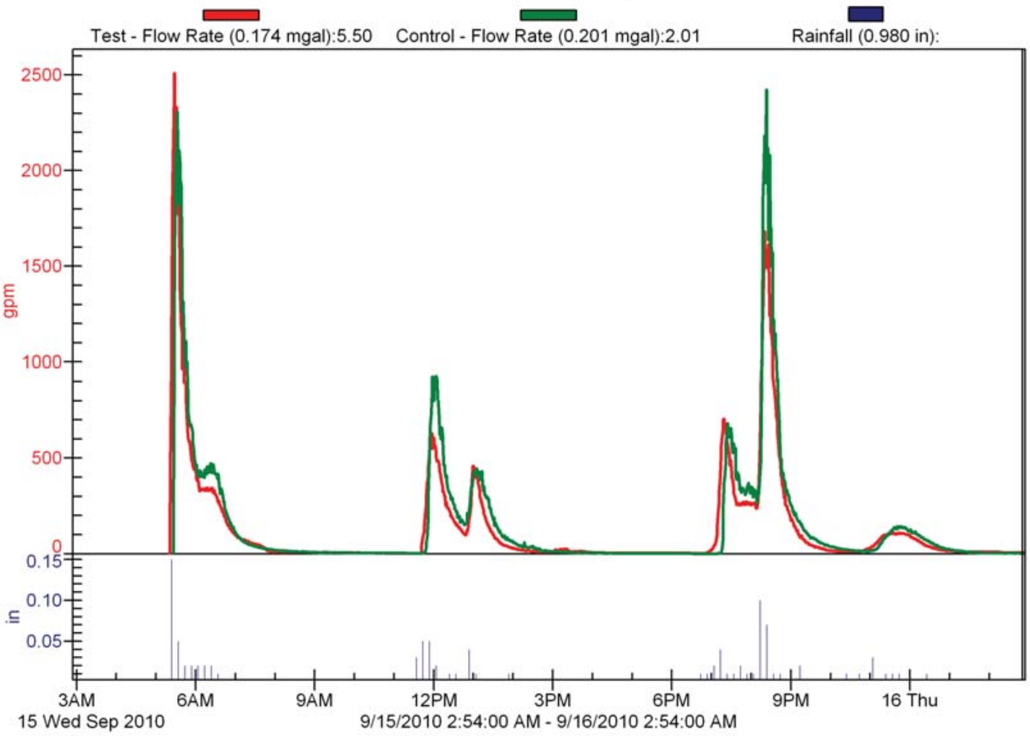


Post-Construction Rain Event - August 31, 2010
Test - Flow Rate (0.078 mgal):17.31
Control - Flow Rate (0.097 mgal):16.08
Rainfall (0.380 in):
gpm
4500
4000
3500
3000
2500
2000
1500
1000
500
0
in
0.15
0.10
0.05
3:30
4:00
4:30
5:00
5:30
6:00
31 Tue Aug 2010
8/31/2010 3:00:00 AM - 8/31/2010 6:00:00 AM



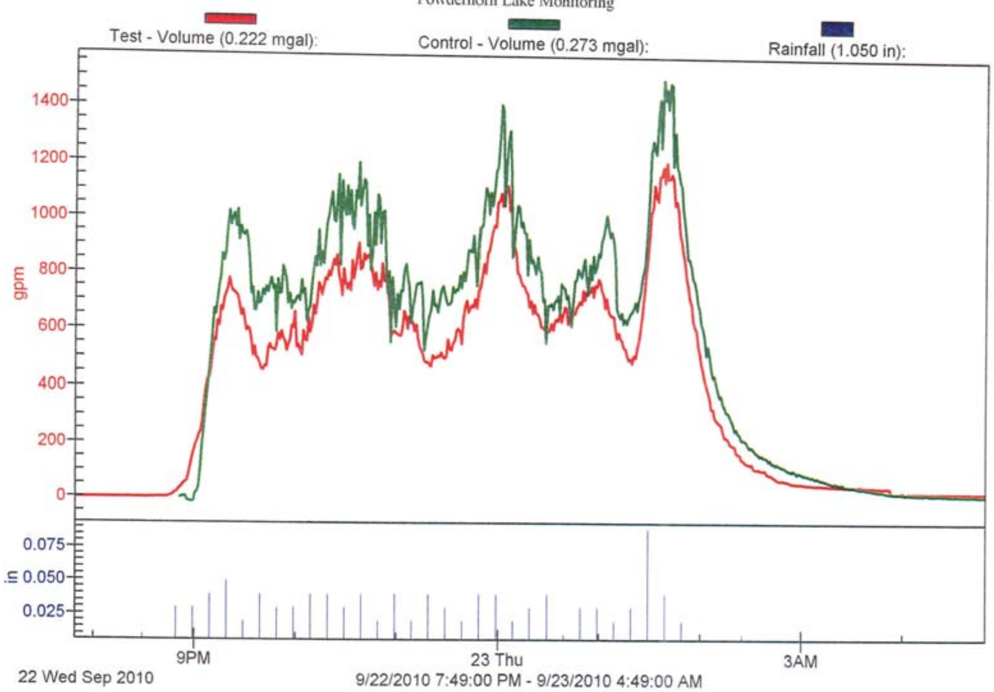
Post-Construction Rain Event - September 2, 2010
Test - Flow Rate (0.195 mgal):18.25
Control - Flow Rate (0.238 mgal):
Rainfall (1.060 in):
gpm
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
in
0.3
0.2
0.1
0.0
3AM
6AM
9AM
2 Thu Sep 2010
9/2/2010 2:11:00 AM - 9/2/2010 9:11:00 AM

Post-Construction Rain Event - September 15, 2010

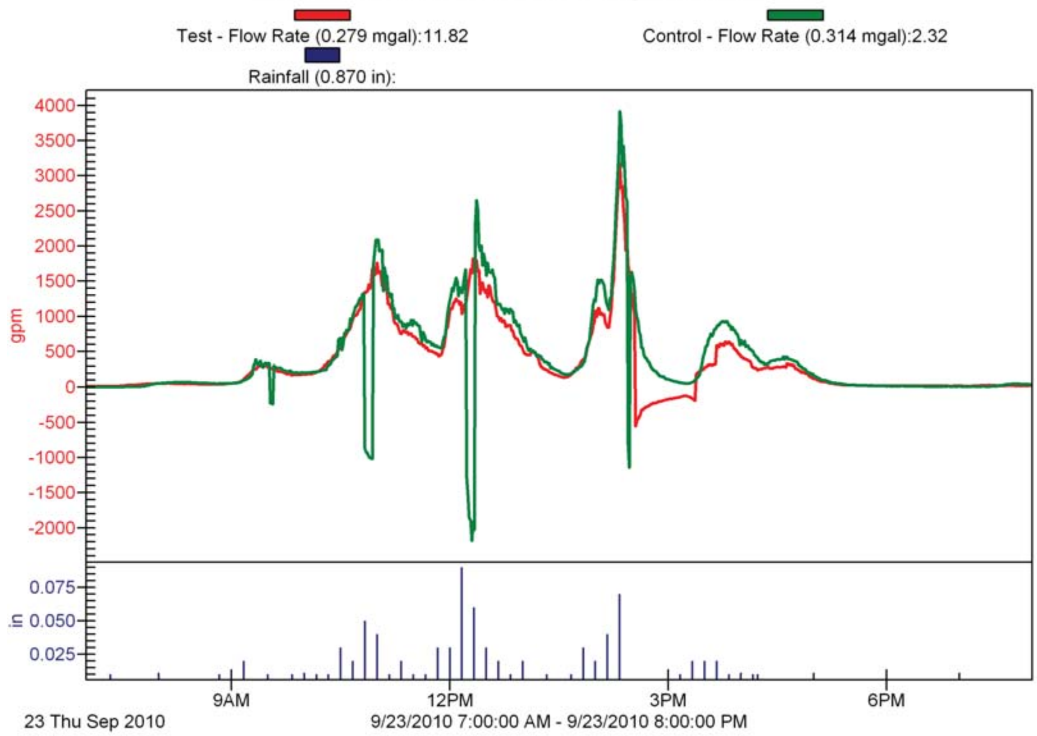


Post-Construction Rain Event - September 22 to September 23, 2010

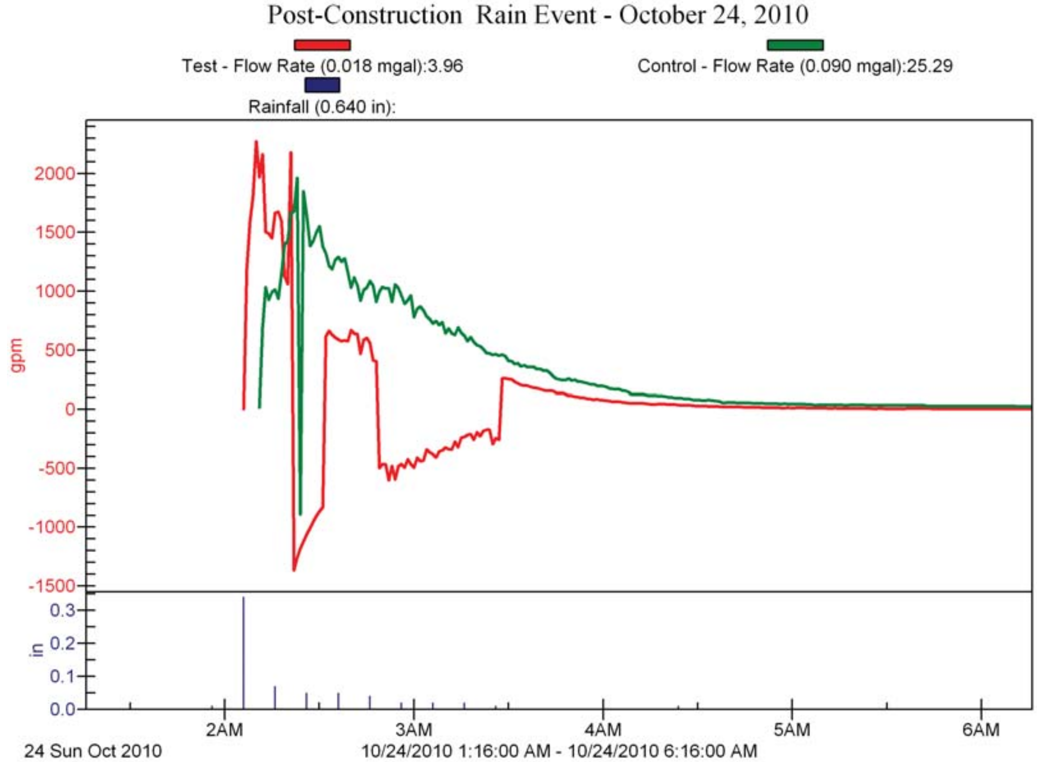
Powderhorn Lake Monitoring

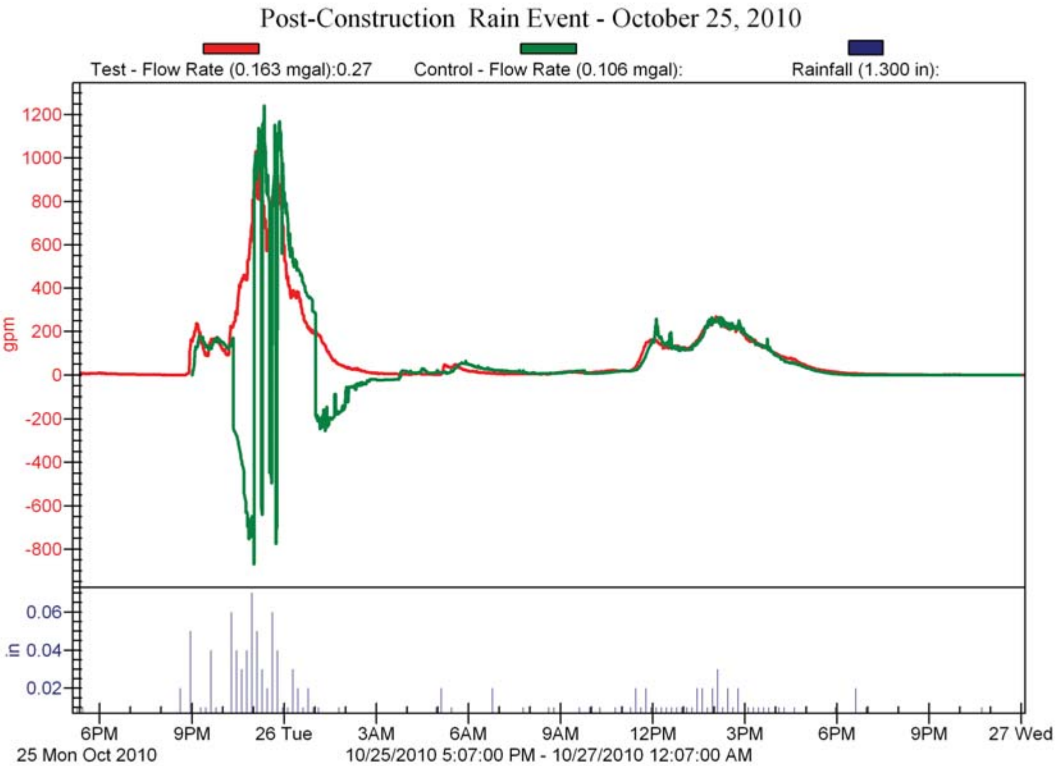


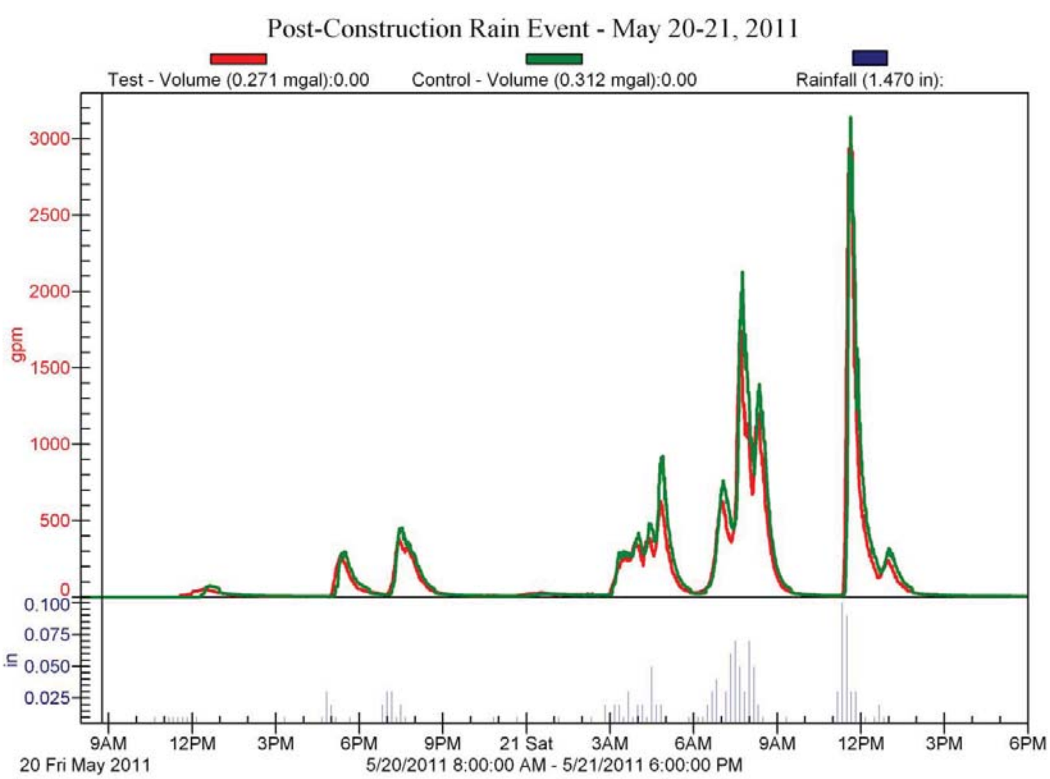
Post-Construction Rain Event - September 23, 2010

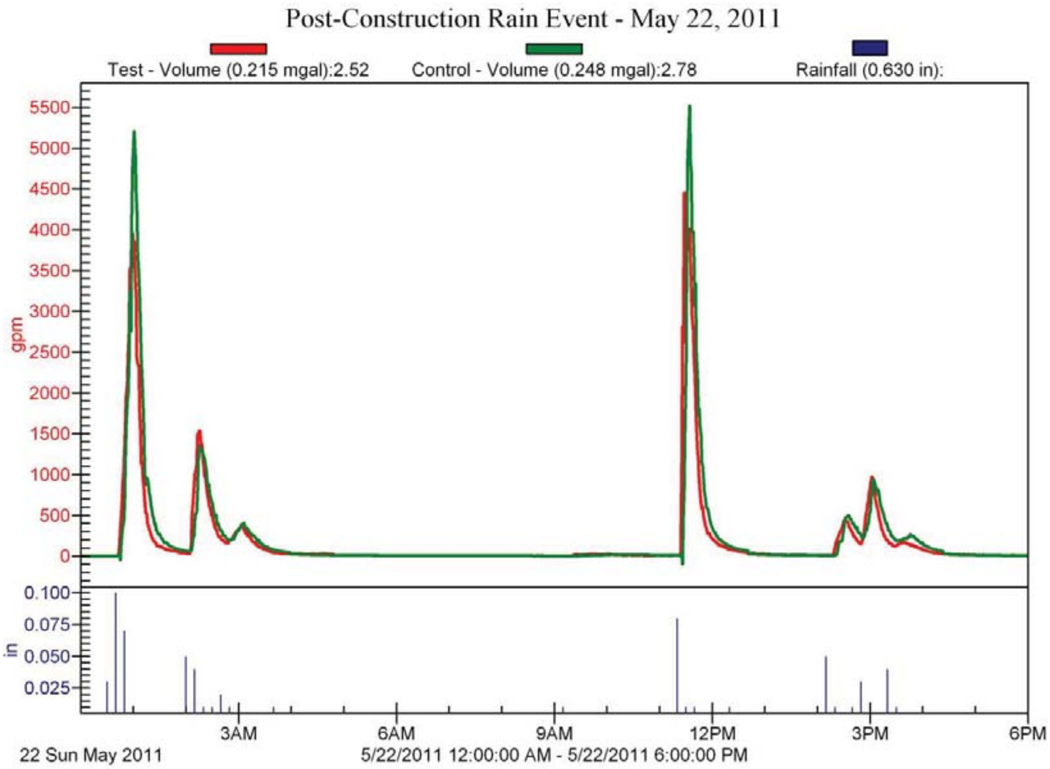


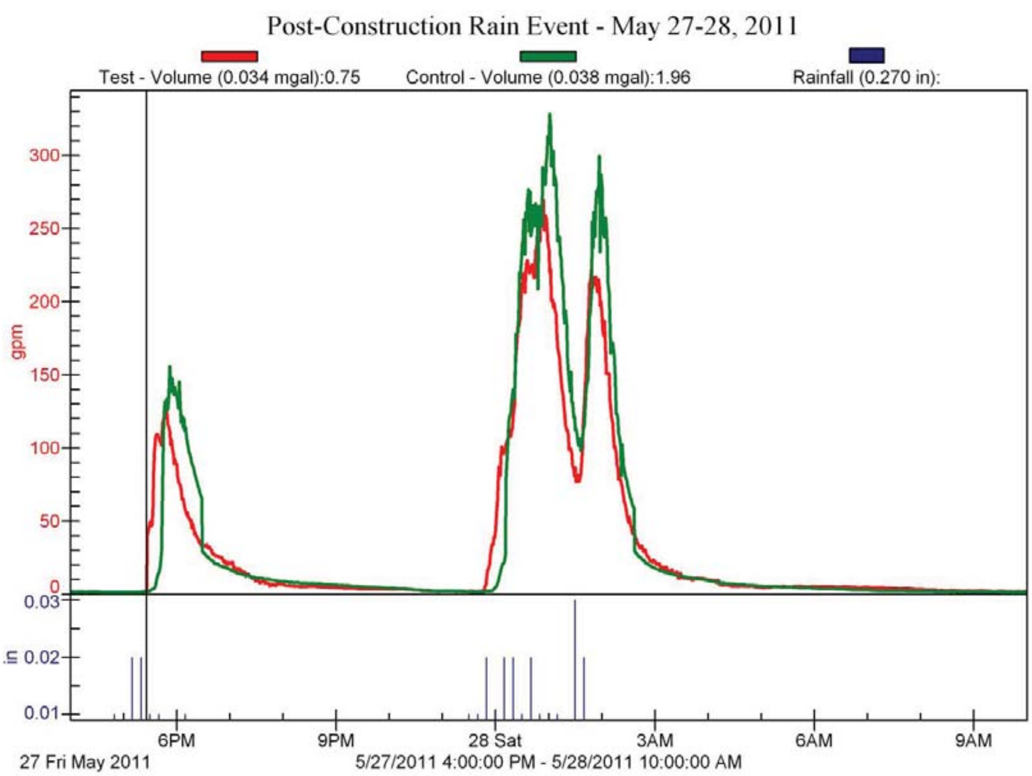
Post-Construction Rain Event - October 24, 2010

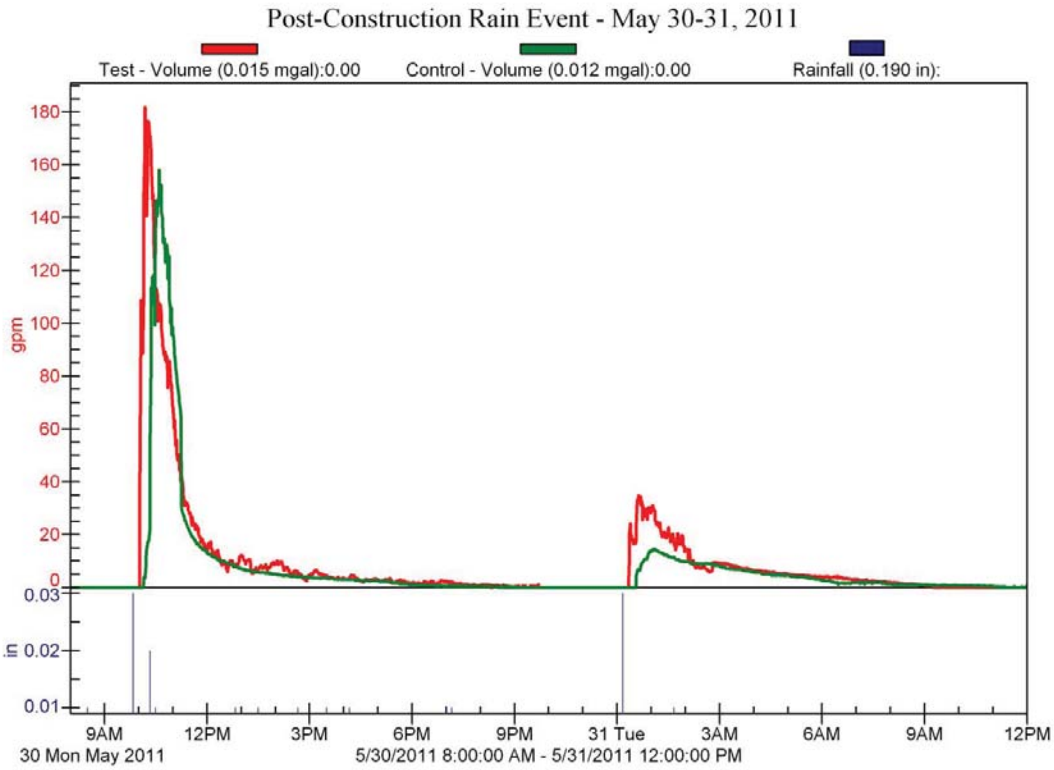


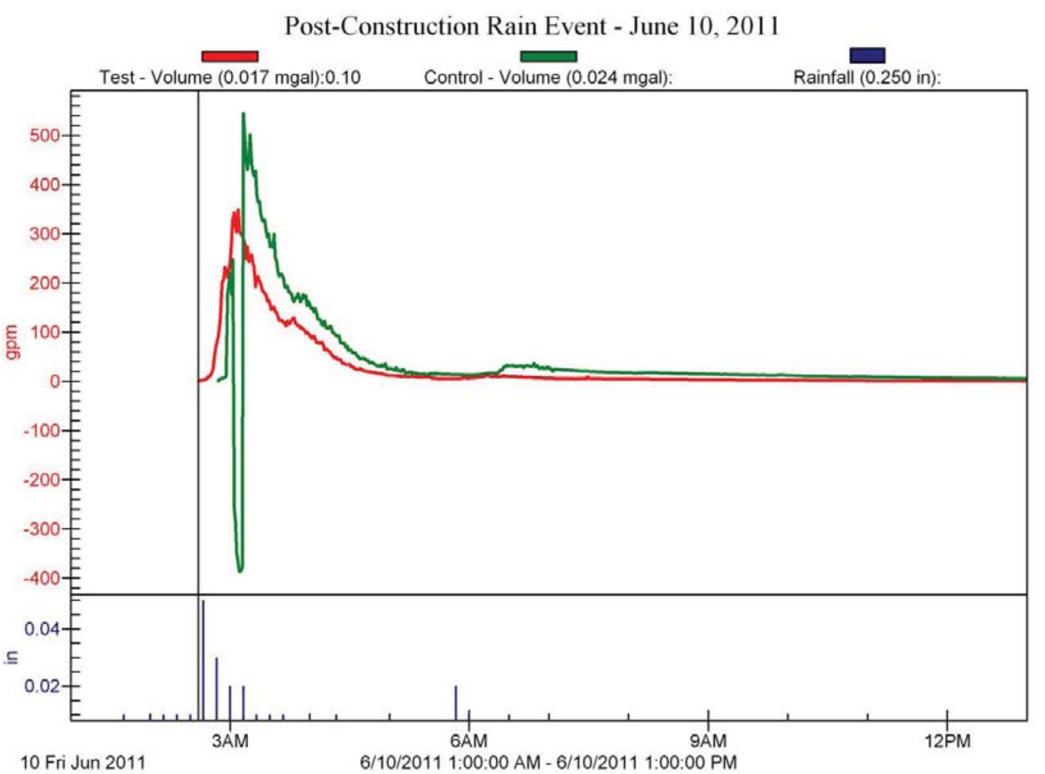

Post-Construction Rain Event - October 25, 2010
Test - Flow Rate (0.163 mgal):0.27
Control - Flow Rate (0.106 mgal):
Rainfall (1.300 in):
gpm
1200
1000
800
600
400
200
0
-200
-400
-600
-800
in
0.06
0.04
0.02
6PM
9PM
26 Tue
3AM
6AM
9AM
12PM
3PM
6PM
9PM
27 Wed
25 Mon Oct 2010
10/25/2010 5:07:00 PM - 10/27/2010 12:07:00 AM


Post-Construction Rain Event - May 20-21, 2011
Test - Volume (0.271 mgal):0.00
Control - Volume (0.312 mgal):0.00
Rainfall (1.470 in):
gpm
3000
2500
2000
1500
1000
500
0
in
0.100
0.075
0.050
0.025
9AM
12PM
3PM
6PM
9PM
21 Sat
3AM
6AM
9AM
12PM
3PM
6PM
20 Fri May 2011
5/20/2011 8:00:00 AM - 5/21/2011 6:00:00 PM

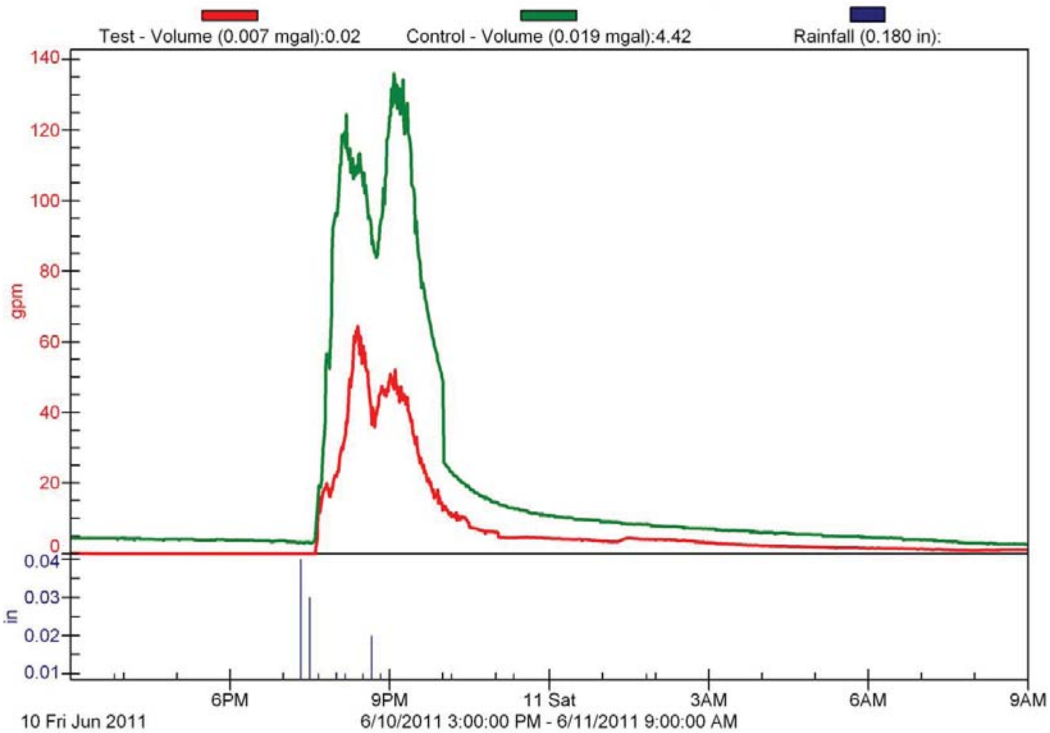

Post-Construction Rain Event - May 22, 2011
Test - Volume (0.215 mgal):2.52
Control - Volume (0.248 mgal):2.78
Rainfall (0.630 in):
gpm
in
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0.100
0.075
0.050
0.025
3AM
6AM
9AM
12PM
3PM
6PM
22 Sun May 2011
5/22/2011 12:00:00 AM - 5/22/2011 6:00:00 PM


Post-Construction Rain Event - May 27-28, 2011
Test - Volume (0.034 mgal):0.75
Control - Volume (0.038 mgal):1.96
Rainfall (0.270 in):
gpm
in
300
250
200
150
100
50
0
0.03
0.02
0.01
6PM
9PM
28 Sat
3AM
6AM
9AM
27 Fri May 2011
5/27/2011 4:00:00 PM - 5/28/2011 10:00:00 AM

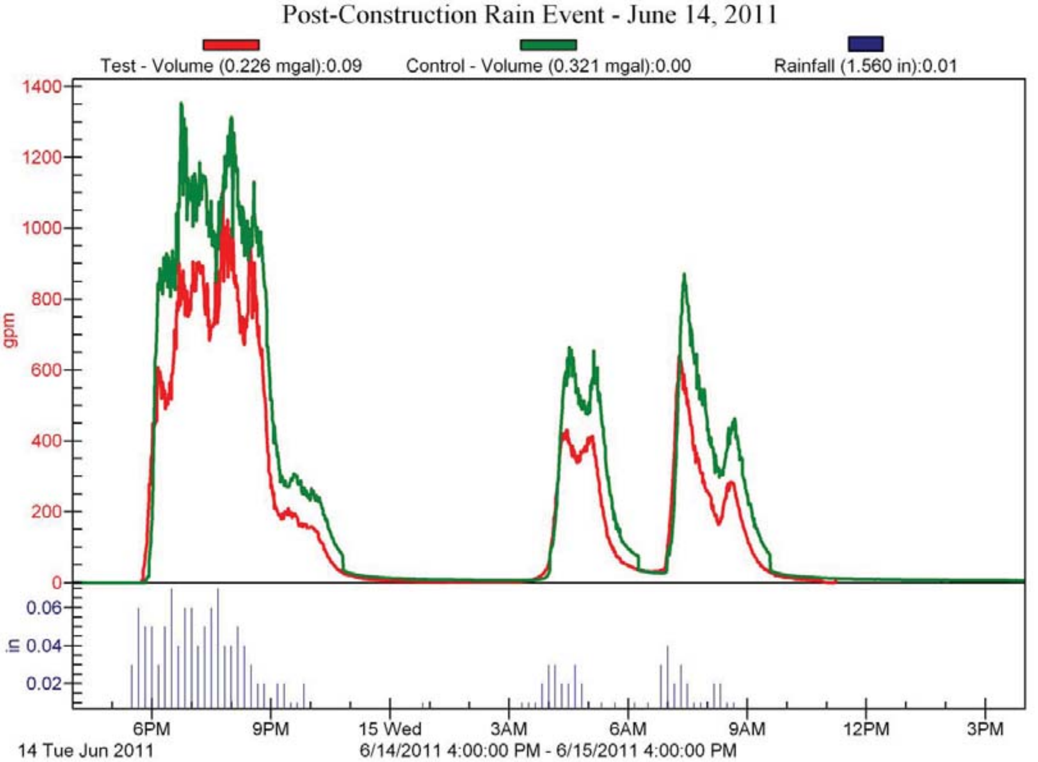

Post-Construction Rain Event - May 30-31, 2011
Test - Volume (0.015 mgal):0.00
Control - Volume (0.012 mgal):0.00
Rainfall (0.190 in):
gpm
180
160
140
120
100
80
60
40
20
0
0.03
in 0.02
0.01
9AM
12PM
3PM
6PM
9PM
31 Tue
3AM
6AM
9AM
12PM
30 Mon May 2011
5/30/2011 8:00:00 AM - 5/31/2011 12:00:00 PM

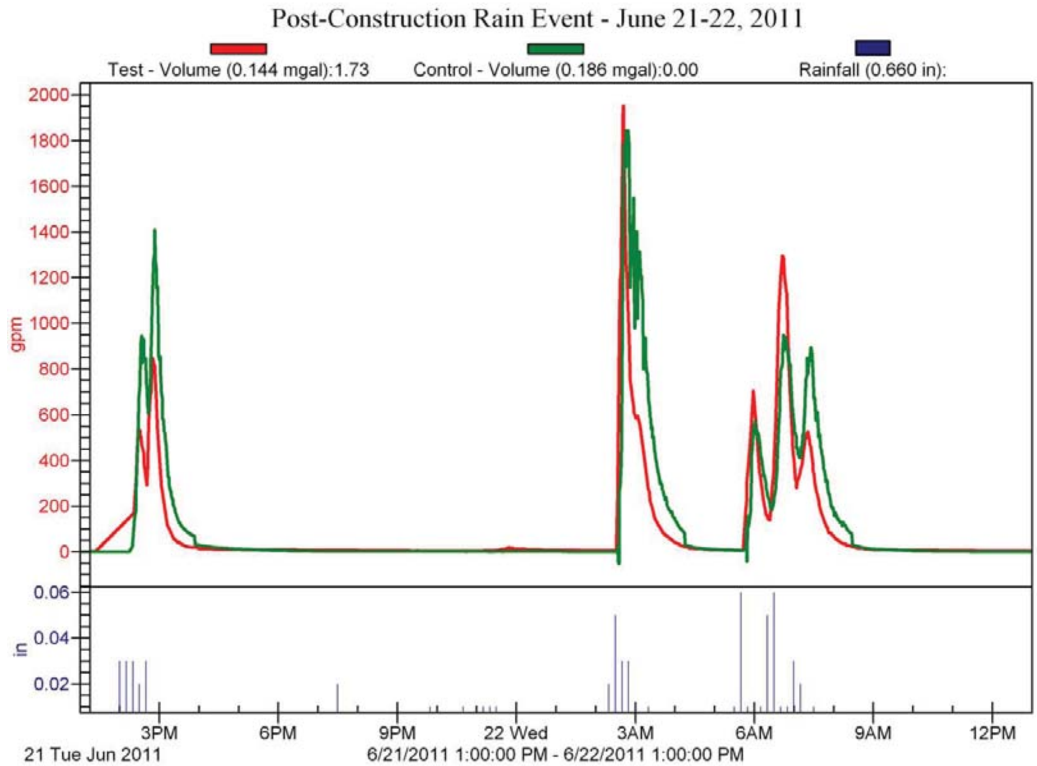

Post-Construction Rain Event - June 10, 2011
Test - Volume (0.017 mgal):0.10
Control - Volume (0.024 mgal):
Rainfall (0.250 in):
gpm
500
400
300
200
100
0
-100
-200
-300
-400
in
0.04
0.02
3AM
6AM
9AM
12PM
10 Fri Jun 2011
6/10/2011 1:00:00 AM - 6/10/2011 1:00:00 PM

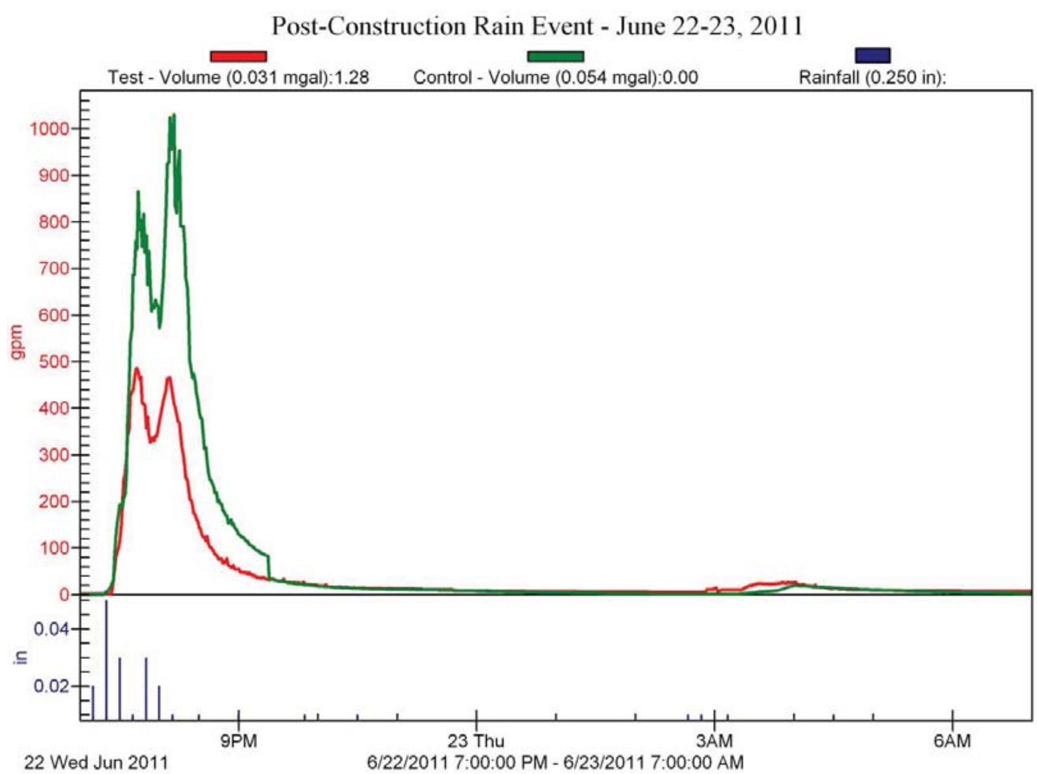
Post-Construction Rain Event - June 10, 2011

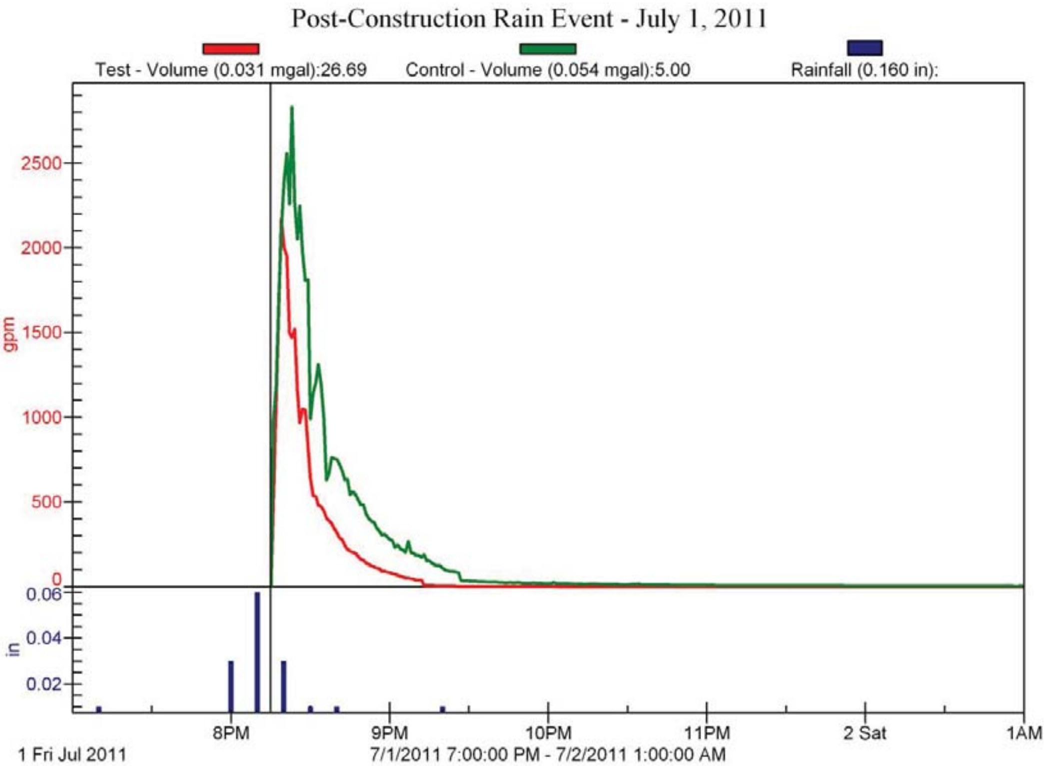


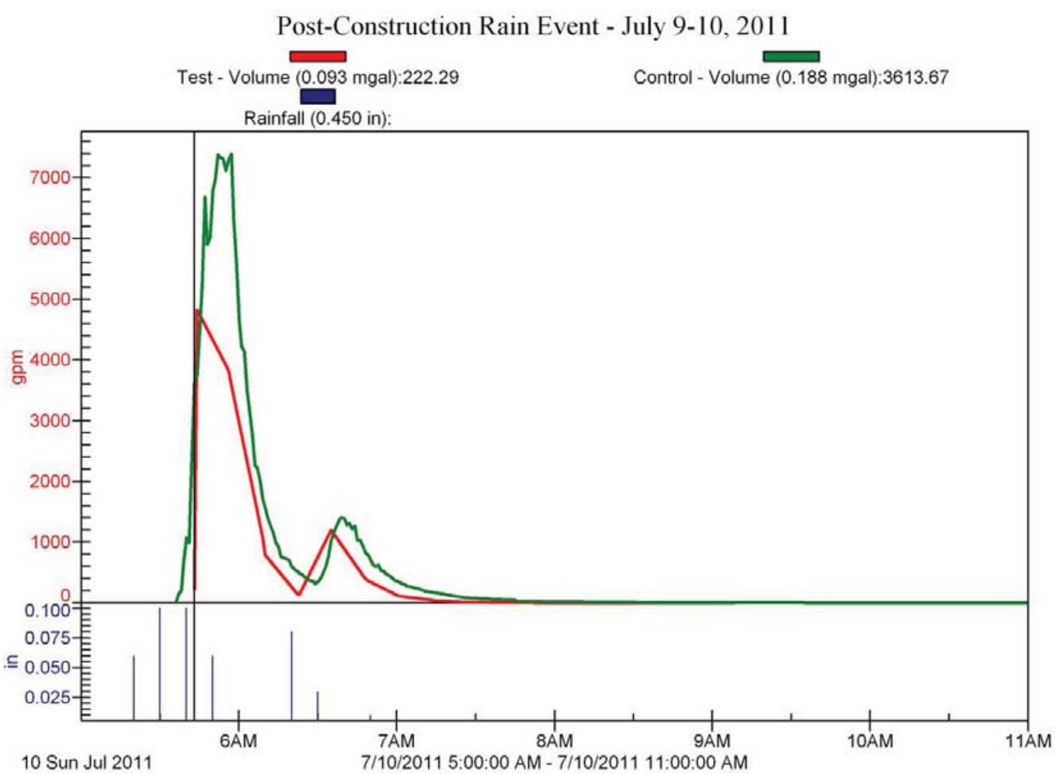
Post-Construction Rain Event - June 14, 2011

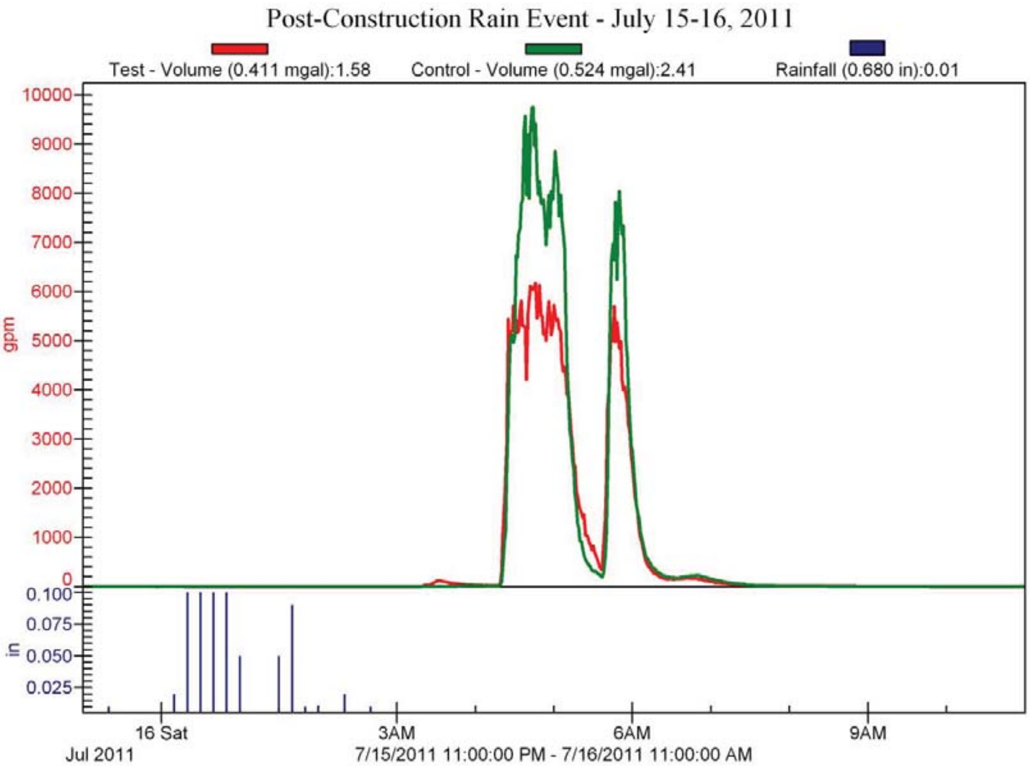


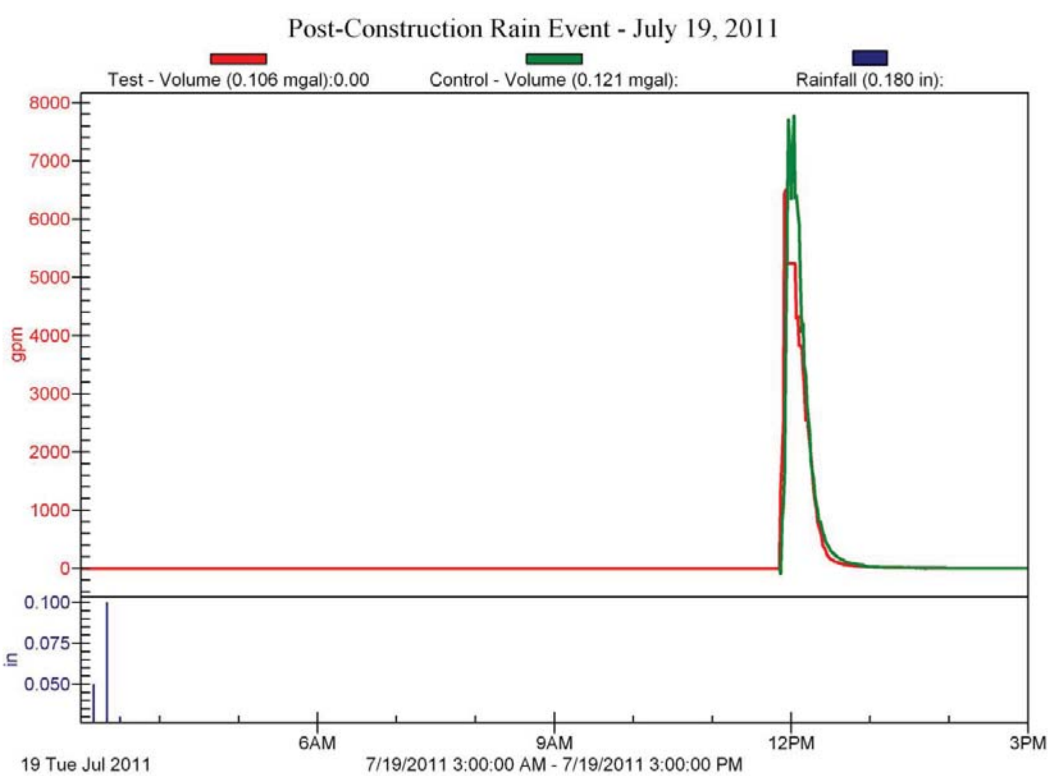

Post-Construction Rain Event - June 21-22, 2011
Test - Volume (0.144 mgal):1.73
Control - Volume (0.186 mgal):0.00
Rainfall (0.660 in):
gpm
in
3PM
6PM
9PM
22 Wed
3AM
6AM
9AM
12PM
21 Tue Jun 2011
6/21/2011 1:00:00 PM - 6/22/2011 1:00:00 PM


Post-Construction Rain Event - June 22-23, 2011
Test - Volume (0.031 mgal):1.28
Control - Volume (0.054 mgal):0.00
Rainfall (0.250 in):
gpm
in
9PM
23 Thu
3AM
6AM
22 Wed Jun 2011
6/22/2011 7:00:00 PM - 6/23/2011 7:00:00 AM


Post-Construction Rain Event - July 1, 2011
Test - Volume (0.031 mgal):26.69
Control - Volume (0.054 mgal):5.00
Rainfall (0.160 in):
gpm
2500
2000
1500
1000
500
0
in
0.06
0.04
0.02
8PM
9PM
10PM
11PM
2 Sat
1AM
1 Fri Jul 2011
7/1/2011 7:00:00 PM - 7/2/2011 1:00:00 AM


Post-Construction Rain Event - July 9-10, 2011
Test - Volume (0.093 mgal):222.29
Control - Volume (0.188 mgal):3613.67
Rainfall (0.450 in):
gpm
7000
6000
5000
4000
3000
2000
1000
0
in
0.100
0.075
0.050
0.025
6AM
7AM
8AM
9AM
10AM
11AM
10 Sun Jul 2011
7/10/2011 5:00:00 AM - 7/10/2011 11:00:00 AM


Post-Construction Rain Event - July 15-16, 2011
Test - Volume (0.411 mgal):1.58
Control - Volume (0.524 mgal):2.41
Rainfall (0.680 in):0.01
gpm
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
in
0.100
0.075
0.050
0.025
16 Sat
Jul 2011
3AM
6AM
9AM
7/15/2011 11:00:00 PM - 7/16/2011 11:00:00 AM


Post-Construction Rain Event - July 19, 2011
Test - Volume (0.106 mgal):0.00
Control - Volume (0.121 mgal):
Rainfall (0.180 in):
gpm
8000
7000
6000
5000
4000
3000
2000
1000
0
in
0.100
0.075
0.050
6AM
9AM
12PM
3PM
19 Tue Jul 2011
7/19/2011 3:00:00 AM - 7/19/2011 3:00:00 PM

Appendix B

Sample Outreach Materials

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Powderhorn Neighborhood of Raingardens

The Story

During the summer of 2010 and spring of 2011, residents of the Powderhorn Park and Central Neighborhoods worked with Metro Blooms to install 130 raingardens as part of the Powderhorn Lake Neighborhood of Raingardens project.

The effort to improve water quality in urban lakes and waterways requires greater public awareness and adoption of environmentally responsible landscape design and management practices. This project engaged 122 property owners to install and maintain raingardens on their property, demonstrating that communities can directly impact local water quality by creating sound stormwater practices as shown here in Powderhorn.

The findings of this project can be applied to similar urban areas and provides a basis to target citizen-based involvement to improve our water bodies.

Where are the gardens?

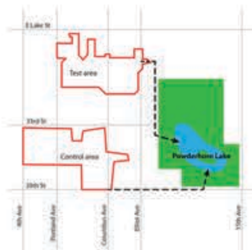
The test area gardens, highlighted in green below, are located between Lake Street on the north, 32nd Street on the south, Portland Avenue to the west and 10th Avenue to the east. Please view the raingardens that are visible from the public sidewalk only.

What is a Raingarden?

A raingarden is designed and planted to capture rainwater so it can infiltrate deep into the soil to help protect and restore water quality. This helps to reduce the amount of stormwater runoff that would otherwise take pollutants from the air, our yards, and the streets and carry them into our lakes, rivers, and wetlands.

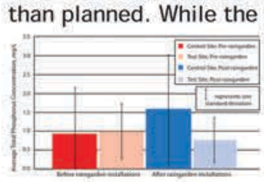
Test and Control Site Watersheds

The project area is a set of properties that drain from a single storm sewer pipe into Powderhorn Lake. A paired watershed study was set up, requiring both a test and control area. The Minneapolis Park and Recreation Board installed monitoring equipment to measure the quality and quantity of stormwater from the test area pipe, comparing data from the pipe in the control area nearby. The project area with the newly installed raingardens and other Best Management Practices (BMPs) is the test area and the one without BMPs is the control area.



What are the measured results?

Monitoring in urban storm sewers has its challenges, and these sites and climatic conditions resulted in less samples than planned. While the paired watershed analysis results are inconclusive and do not show a statistically significant outcome, the few water quality samples collected in 2011 provide promise that the test neighborhood efforts could have reduced total phosphorus and total suspended solids loadings when compared to the control area.



The project was funded by the Minnesota Environment and Natural Resources Trust Fund, and project partners include Metro Blooms, Short Elliott Hendrickson Inc., the City of Minneapolis, Minneapolis Park and Recreation Board, Minnehaha Creek Watershed District, and the Conservation Corps of Minnesota & Iowa.

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND · Metro Blooms · SEH · Minneapolis City of Lakes · Minneapolis Park & Recreation Board · MINNEHAHA CREEK WATERSHED DISTRICT QUALITY OF WATER, QUALITY OF LIFE · conservation corps MINNESOTA & IOWA

Build a neighborhood of Raingardens

Metro Blooms

Free Raingardens

Available to selected homeowners

Metro Blooms will install up to 150 rain gardens at addresses on the enclosed map. With funding provided by the Environment and Natural Resources Trust Fund, this project is a partnership of Metro Blooms, the City of Minneapolis, Minneapolis Park and Recreation Board and Minnehaha Creek Watershed District to determine whether raingardens can improve water quality in Powderhorn Lake.

What is a Raingarden?

A raingarden is a garden designed to catch water running off a rooftop, driveway, or other hard surface and to keep this water from running into the street where it will enter storm drains, polluting our lakes and streams.

What do I get?

- **An on-site consultation with a landscape design assistant**
- **A garden design customized for my yard**
- **Complete garden installation, including plants**

What do I have to do?

- **Attend a raingarden workshop**
- **Be at the property when the raingarden is installed**
- **Participate in the planting, as you are able**
- **Agree to maintain the raingarden for three years**

How do I get started?

Contact Corrie Zoll at corrie@metroblooms.org or call Corrie at 612-871-0740
More information at metroblooms.org

Join us for a Raingarden Party

Your property may be eligible for a complete raingarden installation - AT NO COST TO YOU.

Join Metro Blooms, the City of Minneapolis, Minneapolis Park and Recreation Board, and Minnehaha Creek Watershed District to reduce the pollution in Powderhorn Lake by installing 150 raingardens throughout our neighborhood.

Join us to learn more about the POWDERHORN NEIGHBORHOOD OF RAINGARDENS and how you can participate.

Funding provided by the
Environment and Natural Resources Trust Fund

Host |

Date |

Time |

Place |

Construye un Jardin de Lluvias.
Restaura el Medio Ambiente.
Colabora con una "Minga".
Carlos Zhingre
612-819-5146

Metro Blooms metroblooms.org

Build a neighborhood of Raingardens

Metro Blooms

Construye un Jardin de Lluvias. Restaura el Medio Ambiente. Colabora con una "Minga."

Community Clean Up for Powderhorn Lake!

Just one pound of leaves in the street contains enough phosphorus to bloom ten pounds of algae in Powderhorn Lake.

Your neighbors together with Metro Blooms installed more than 100 raingardens this year. These raingardens are the first step to keep gunk out of Powderhorn Lake.

Help us take the next step. On Saturday, neighbors will clear leaves from curbs and boulevards.

Saturday, October 23
10:00 am to Noon
Meet at All God's Children
31st St. and Columbus

Bring leaf rakes. Welna Hardware donated leaf bags. Metro Blooms will have gloves.
For more information call 651-699-2426.

Metro Blooms **metroblooms.org**

Funding provided by the Minnesota Environment and Natural Resources Trust Fund, City of Minneapolis, Minneapolis Park and Recreation Board, and Minnehaha Creek Watershed District

Join Us!
Powderhorn Lake
Metro Blooms
Community Clean Up

Restaura el Medio Ambiente. Colabora con una "Minga."


A NEIGHBORHOOD OF
RAINGARDENS
The Film Society of Minneapolis/Saint Paul presents a film about a group of Minnesotans who are cleaning up our troubled waters, one yard a time.
September 9, 2011 7:00 P.M.
Saint Anthony Main Theater

Build a Neighborhood of Raingardens

Construye un Jardin de Lluvias.
Restaura el Medio Ambiente.
Colabora con una Minga.

Metro Blooms

Join Metro Blooms,
City of Minneapolis, Minneapolis Park and Recreation Board, and Minnehaha Creek Watershed District as we embark on a mission to reduce the pollution in Powderhorn Lake by installing raingardens throughout your neighborhood.

If you are interested in joining us to build a raingarden on your property the first step is to attend an informational workshop to learn more about the benefits and beauty of raingardens, and how you can participate.

These workshops are free for Powderhorn and Central Neighborhood residents only.

To register please call 651-699-2426, or email info@metroblooms.org.
Be sure to include your name and contact information and bring your neighbor!

Mon | July 13 | 6:30 - 8pm

Powderhorn Neighborhood Association
821 E 35th St Minneapolis

Tues | July 14 | 6:30 - 8pm

Artstop
Corner of 32nd St. and Chicago Ave Minneapolis

Major funding for this project provided by the Environment and Natural Resources Trust Fund

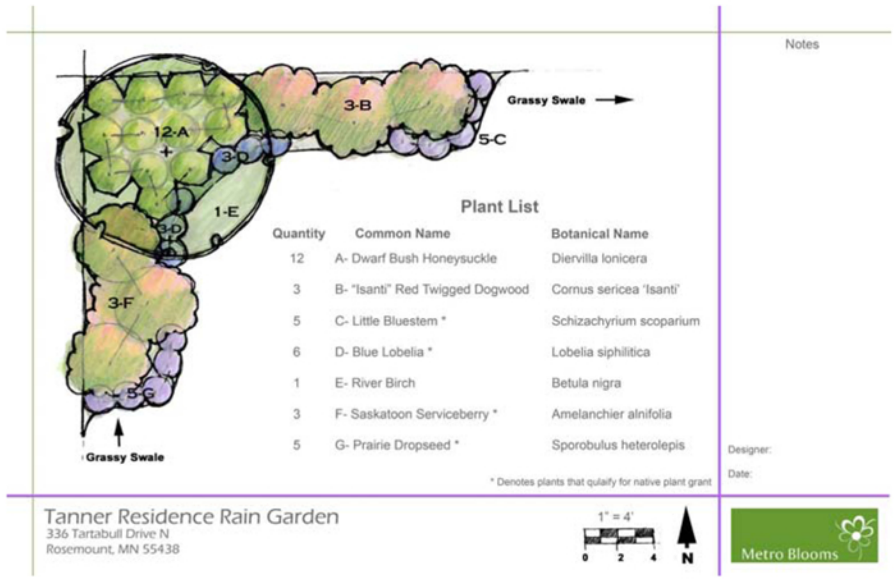
Construye un Jardin de Lluvias. Restaura el Medio Ambiente. Colabora con una Minga.
Carlos Zhingre, zhin0001@umn.edu, 612-819-5146

ONSITE CONSULTATION AND DESIGN
NEIGHBORHOOD OF RAINGARDENS FOR POWDERHORN LAKE

Join Metro Blooms, the City of Minneapolis, Minneapolis Park and Recreation Board, and Minnehaha Creek Watershed District as we embark on a mission to reduce the pollution in Powderhorn Lake

If you are interested in joining us to build a raingarden on your property **the first step is to attend an informational workshop to learn more about the benefits and beauty of raingardens, and how you can participate.**

These workshops (or raingarden parties) are free for Powderhorn and Central Neighborhood residents only. The onsite consultation and raingarden design assistance are available for priority properties as part of a paired-watershed study to determine the impact residential raingardens will have on the water quality of Powderhorn Lake.



The next step is to sign up for an Onsite Consultation: A Metro Blooms Landscape Design Assistant will come to your home for one hour to help take measurements, size and site your raingarden, give advice on native plants and downspout redirection, and address any other stormwater problems you might have before installing a raingarden. These consultations are meant strictly for advice on your landscaping plans and not for manual labor (i.e. digging holes, installation or construction).

Your Landscape Design Assistant will take the information you discuss at your onsite consultation and will create an sketch of your stormwater management plan and raingarden design (see raingarden design example above) with specifications and plant list.

Following your onsite raingarden consultation, your design will be emailed (or mailed) to you.

You will be notified by October 31st if your property has been selected as one of 150 raingardens scheduled for installation beginning the spring of 2010.

Even if you're not selected for installation assistance, we encourage you to consider implementing the recommendations you receive at the onsite consultation and in your stormwater management plan. We will be in your neighborhood for the next couple of years and available to answer questions and provide other assistance, whenever possible.

Construye un Jardin de Lluvias. Restaura el Medio Ambiente. Colabora con una Minga. Carlos Zhingre, | 612-819-5146 | zhin0001@umn.edu

Major funding for this project is provided by the Environment and Natural Resources Trust Fund

Onsite Consultation and Raingarden Design Assistance Waiver Form

My **Onsite Consultation** has been scheduled for ____________________(date),________(time) with:

___________________________________ (LDA assigned).

I understand that I am receiving advice from Landscape Design Assistants from the Metro Blooms Program regarding the possible installation of a raingarden on my property and other stormwater management plans. I understand that these are recommendations only and that Metro Blooms does not warrant that the advice given to me will not result in damage to my -property. I agree that it is solely my decision as to whether or not to implement the recommendations provided and that I am waiving any claim for damages which may result from following the recommendations. Further, I understand that Metro Blooms is not responsible and does not warrant outcomes or plans that result from any possible future services provided independently by a Landscape Design Assistant to me on my property. Lastly, I understand that if I am not present at the scheduled time of my onsite consultation, my participation in the program will be forfeited.

Print Name (Property Owner)____Date________________

Signature (Property Owner)____Date ________________

Phone ___________________________________Email Address ____________________________________

Street Address where raingarden will be installed ____

City, State, Zip ____

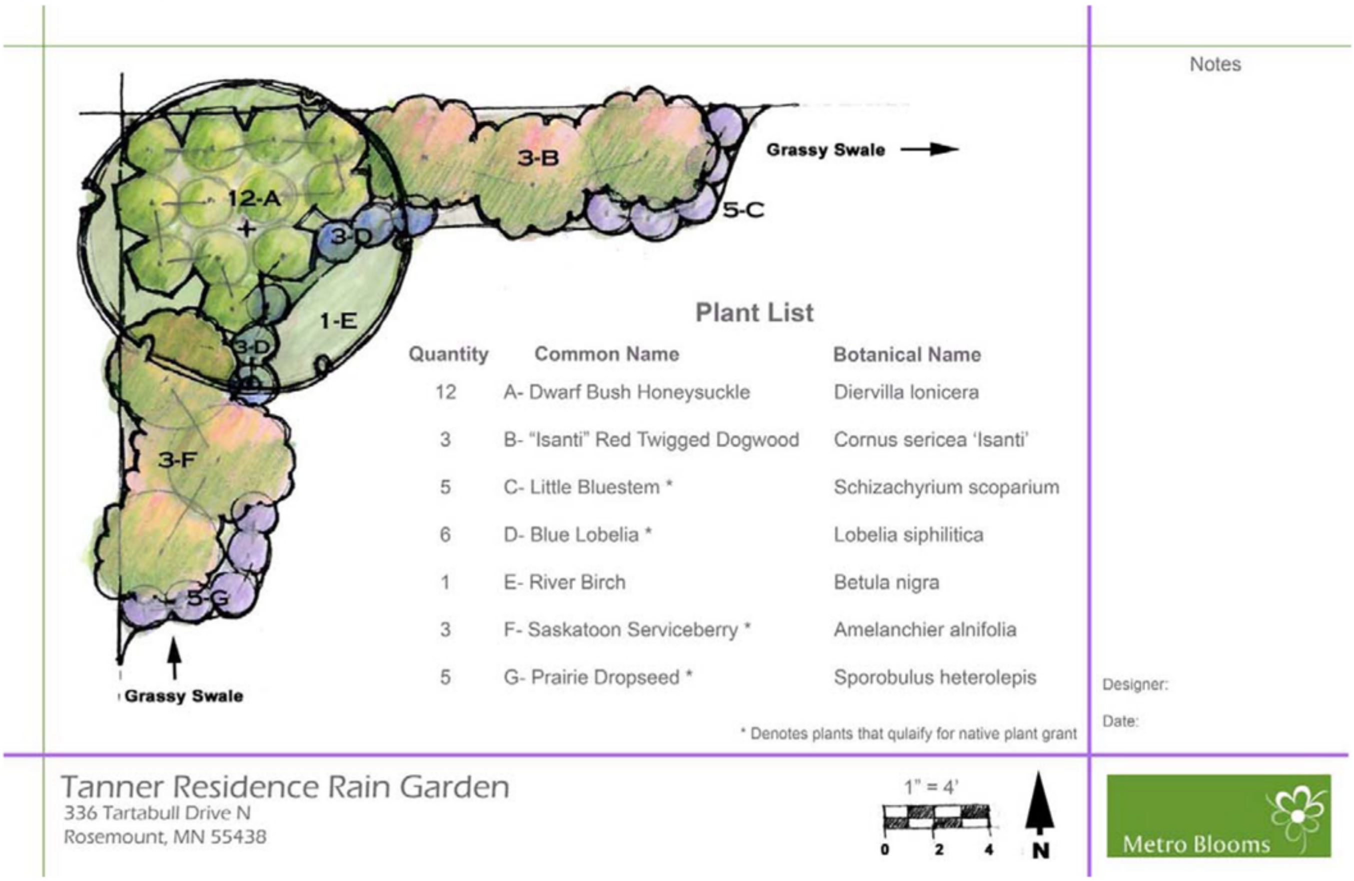
Mail completed form to:

Metro Blooms,
attn: Neighborhood of Raingardens
P.O. Box 17099,
Minneapolis, MN 55417

BARRIO DE JARDIN DE LLUVIAS CONSULTA Y DISEÑO EN SU PROPIEDAD
PARA EL LAGO POWDERHORN

Únete a Metro Blooms, la ciudad de Minneapolis, la Junta de Parques y Recreación de Minneapolis y el Distrito de la Cuenca del Minnehaha Creek en un esfuerzo comunitario, cuya misión es reducir la contaminación en el lago Powderhorn. Si usted está interesado en unirse a esta causa y así juntos construir un jardín de lluvia en su propiedad; **el primer paso será asistir a unos talleres informales. En ellos aprenderá más sobre los beneficios y la belleza de estos jardines, y sobre todo cómo usted puede participar.**

Estos talleres (o fiestas de jardín de lluvias) son gratuitos para los residentes que viven en el Barrio Central y en el área de Powderhorn. Habrá asistencia disponible gratuita en su propiedad para consulta y diseño; siendo estas una prioridad como parte de un estudio de las cuencas hidrográficas-vinculados a determinar el impacto residencial de los jardines de lluvia que tendrá sobre la calidad del agua del Lago Powderhorn.



El siguiente paso es inscribirse para una consulta gratuita en su sitio: Un Asistente de Diseño o Paisajista de Metro Blooms vendrá a su casa durante una hora para ayudar a tomar medidas, determinar el tamaño y el sitio de su jardín, dar asesoramiento sobre las plantas nativas a usar, reubicar los canalones , y sobre todo verificar si existe algunos problemas pluviales que pueda tener antes de instalar su jardín de lluvias.

Estas consultas son exclusivamente para su asesoramiento en jardinería y no para la mano de obra (es decir, cavar agujeros o para la instalación o construcción).
Su Asistente de Diseño o Paisajista tomara la información junto con usted de su sitio y creara un esbozo de

su plan de gestión de aguas pluviales y un diseño de su jardín de lluvias(véase el ejemplo anterior del diseño de un jardín de lluvias) con las especificaciones y lista de plantas.

Tras la consulta in su sitio, su diseño será enviado por correo electrónico (o correo normal) para usted. **Usted será notificado el 31 de octubre, si su propiedad ha sido seleccionada para ser parte de la instalación de 150 jardines de lluvia prevista para el comienzo de la primavera del 2010.** Incluso si no es seleccionado para asistirle en la instalación, le animamos a que considere e implemente las recomendaciones que usted recibió en la consulta hecha en su propiedad y en su plan de gestión de aguas pluviales. Vamos a estar en su vecindario los próximos par de años y estaremos disponibles para contestarle preguntas y proporcionar otro tipo de asistencia, siempre que sea posible.

Construye un Jardín de Lluvias. Restaura el Medio Ambiente. Colabora con una Minga.
Si tiene preguntas contacte a Carlos Zhingre,| 612-819-5146 | zhin0001@umn.edu
Este proyecto es posible gracias al Fondo del Ambiente de Recursos Naturales

Formulario de Consentimiento para Consulta en su sitio para el Diseño del Jardín de Lluvias
La Consulta para Asistencia se ha previsto para________________ (fecha), ________________(tiempo) con:
____________________________________ (Paisajista asignado).
-- --- --------
Yo entiendo que estoy recibiendo el asesoramiento de Asistentes de Diseño Paisajistas del Programa de Metro Blooms con respecto a la posible instalación de un jardín de lluvias en mi propiedad y otros planes de gestión de aguas pluviales. Entiendo que estos son sólo recomendaciones y por tanto Metro Blooms no se garantiza que las recomendaciones dadas a mí no causen daños a mi propiedad. Estoy de acuerdo en que es únicamente mi decisión de aplicar o no las recomendaciones dadas, y que estoy renunciando a cualquier reclamación por daños y perjuicios que puedan provenir de las siguientes recomendaciones. Además, entiendo que Metro Blooms no se responsabiliza y no garantiza los resultados de quizás futuros planes que se obtengan de cualquier futuro servicio prestado por Paisajistas de Diseño Independientes en mi propiedad. Por último, entiendo que si no estoy presente a la hora prevista para consulta en mi sitio, mi participación en el programa no será considerado.

Nombre (Propietario)____________________________________ Fecha_________________
Firma (Propietario)______________________________________Fecha_________________
Teléfono___________________________ Correo electrónico____________________________
Domicilio donde se instalará el jardín de lluvias____________________________________
Ciudad, Estado, Código Postal____

Envie su formulario completo a:

Metro Blooms,
Atención: Barrio de Raingardens
Casilla Postal 17099
Minneapolis, MN 55417

Powderhorn Neighborhood of Raingardens

Construye un Jardin de Lluvias. Restaura el Medio Ambiente. Colabora con una "Minga."

FREE! RAINGARDENS TO ELIGIBLE PROPERTIES

Sign Up Now!

Metro Blooms is working in partnership with the City of Minneapolis, Minneapolis Park and Recreation Board, Minnehaha Creek Watershed District, and with funding from the Environment and Natural Resources Trust Fund.

Metro Blooms

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Weeding

Plants compete with each other for nutrients, light, water, and space. Weeds, when given a chance, almost always win. The easiest thing to do to keep weeds out is to maintain a thick layer of mulch and perform light weeding periodically.

Weeding becomes less demanding as the garden matures. A newly planted garden will need to be weeded often throughout the season, but once established the plants will naturally suppress weed growth. If unruly weeds continually sprout up in the garden, take time to discover their source.

Perennial Plants

Most raingarden plants are perennials that come back year after year. Though hardy, they need a little attention to keep looking their best.

Remove declining flowers from perennials to encourage more flowers and a longer bloom time. This may also help the plants appear tidier. However, towards the end of the season, you may wish to leave seedheads on the plants for winter interest.

To make plants bushier and more compact, pinch young stems back a couple of inches to just above a bud or leaf. You can pinch back a third of the plant at a time to extend the blooming time as well.

Some plants will benefit from more aggressive pruning if they are starting to outgrow their spot. Prune plants after they bloom to reshape the plant and give time for new flower buds to form for next year's blooms.

Robust perennials may outgrow their original planting areas and become crowded. You may need to remove or divide plants. This is best done in the spring before the plant is four inches tall, or after the plant has flowered. To divide them, dig up the entire plant and cut them into sections so that each has roots attached and replant them. If you have extras, share them with a friend or neighbor!

Metro Blooms

www.metroblooms.org
P.O. Box 17099 • Minneapolis, MN • 55417
651-699-2426

The design and printing of this brochure was made possible with the support of the Environment and Natural Resources Trust Fund and the City of Minneapolis.

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Minneapolis City of Lakes

Metro Blooms

A Raingarden Maintenance Guide

Maintaining a Raingarden

Congratulations on installing your new raingarden! The following maintenance guidelines and gardening tips will help you to keep your raingarden looking great year after year.

Raingardens are essentially perennial gardens that also work to protect water quality in our lakes and rivers. With the proper amount of water and regular maintenance, no additional fertilizers or herbicides should be needed; further reducing chemical pollutants in the environment.

As with perennial gardens, there are a few basic tasks that will keep your raingarden looking great. Regular ongoing maintenance will be easier to tackle than waiting until weeds are out of control and perennials have overgrown their space.

Watering

In their first year, young plants need one inch of water per week. Water about twice a week for the first month to help their roots get established. Additional watering may be needed during dry, hot days. As plants mature over the years, they should need less water, though they will benefit from supplemental watering during dry periods. Keep watering into the fall to ensure that plants stay healthy over the winter.

Mulch

Maintaining a 3" layer of double shredded hardwood mulch in your garden is the best defense against weeds. Mulch greatly reduces the germination rate of new weeds and helps the soil stay moist during dry spells. Mulch biodegrades over time, gradually thinning out. To maintain these benefits, apply additional mulch every spring. Keep mulch away from the base of trees and shrubs to protect them from disease and rot.

Spring

Mulch

Start the year off great and apply new mulch in areas that are thin to maintain a 2" layer across the garden. This will help to deter weed growth and hold in moisture.

Cut Last Year's Growth

Remove last year's growth in the spring before new growth emerges to ensure vigorous and uninhibited growth. All removed material may be composted.

Inspection

Prior to the growing season, check all drainage ways (downspouts, underground pipes, and grates) and make sure they are unobstructed and allow water to easily enter the garden basin. Inspect your berm or overflow device to ensure that frost heaving or winter damage has not occurred. Remove any trash, sediment, or excess leaves that may have accumulated in the garden.

Pull Weeds

Cool-season weeds (dandelions, thistle) sprout and set seed by Memorial Day (on a year with normal Spring temperatures). It is imperative that they are pulled prior to setting seed. The longer they persist, the more established the weed population will become. Avoid using herbicides to remove weeds as this often results in harm to desirable garden plants and is detrimental to beneficial insects.

Summer

Pull Weeds

Pull all warm-season weeds (crab grass, creeping charlie, foxtail) and volunteer trees (ash, elm, hackberry, boxelder, buckthorn) prior to the Fourth of July. Monitor weed emergence throughout the growing season and pull as necessary.

Inspection

After large rain events, make sure the garden is draining in less than 24 hours. Always inspect for signs of erosion throughout the season. If erosion occurs, re-grade the eroded area and replant with a clump-forming grass or sedge, such as Side-Oats Grama, 'Karl Foerster' Feather Reed Grass, or Bebb's Oval Sedge. If the erosion continues, place large cobblestones or boulders in the eroded area. This will minimize the incoming water's energy. Pay close attention to the side-slopes of the garden as these areas are susceptible to erosion and may be too steep.

Water

In times of drought, give your garden a drink. This is especially important during the first two years of the garden's life, when plants are establishing their root systems.

Take pictures

Please remember to document your garden and its progress. Send us your pictures and maybe you will become famous!

Fall

Inspection

Check to see if all original plant species are still present in the garden. Fall is a good time to plant replacements or any additional species. Remove leaves from drainage ways to ensure free flow of water into the garden. If a specific plant continually shows poor performance, fall is a good time to re-evaluate its placement and potentially move it. Consider shade/sun tolerance and soil moisture (too wet or too dry) as the main factors of poor performance.

Clean up

Remove excess leaves. A small layer (less than 2") of leaves may be beneficial to the garden as a source of nutrients and will often break down by next year's growing season. Trim shrubs and trees during cool periods of late fall.

Mulch

Add mulch to maintain a 3" depth if necessary.

Perennial Division

Divide any large or overgrown perennials to plant elsewhere in the yard. These plants can be excellent gifts for neighbors and friends.

Deadheading

Leave all non-diseased plant material in the garden over the winter. This provides food and habitat for many species of birds and small mammals. Also, leaving your plants up for the winter can provide winter interest and create scenic value.

Winter

Snow Removal

Do not plow or shovel snow into your rain garden. Excess snowpack on your garden can compact the soil and minimize its infiltration capacity. Mark the boundaries of your garden to ensure that snow plows and shovels don't cause damage. Keep de-icing salt from sidewalks and roads out of the rain garden area. Excessive accumulation of salt in the rain garden can be toxic to your plants.

Next year's plans

Plan your next rain garden installation. Use your available time in the winter to dream up new garden possibilities. Review photos of your raingarden to see if there are any bare spots or plants that have overgrown their space and plan for new plants or dividing existing ones.

Equipment Maintenance

Clean and repair garden tools so that they are in great shape to be put to use in the springtime.

Appendix C

Project Forms and Documentation

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Green Team / Teen Teamworks

http://www.minneapolisparks.org/default.asp?PageID=1168&SearchID=383735

June 2012

The Minneapolis Park and Recreation Board is making great strides in developing management practices that promote "green" thinking. These practices have become an important factor in its summer youth employment program Teen Teamworks.

Teen Teamworks mission is to partner with the community to provide fundamental education and skill building opportunities for youth, preparing them to become contributing members of our society. We provide a safe, structured and secure work experience where participants actively engage in learning and caring for the natural environment as part of the team. The specific goals for youth are to help them gain work skills focused on restoration and conservation of natural areas, education related to the environment with a focus on the Mississippi's watershed and water quality, and exposure to green careers. Other goals are that Teen Teamwork youth will be the next generation of stewards for parks and natural resources and that they will pursue green careers; or if they are not directly in a green career, they will understand how in any job situation, they can still make decisions that positively impact the natural world.

Youth are part of place-based conservation crews working on local restoration and environmental stewardship projects connected to all park properties and improving the water quality of all its lakes and the Mississippi River. These projects include removal of invasive plant species, erosion control, restoration of native landscapes and shorelines, enhancing habitat for native pollinators, and care of storm water treatment sites. Youth learn about watersheds, storm water runoff, bio-engineering, native and invasive plants and insects, best practices related to urban forestry and more.

With an average of 320-350 youth working in Teen Teamworks each summer, they contribute greatly to the safety, maintenance and overall beauty of the Minneapolis Park and Recreation Board.

Best Management Assessment – Onsite Questionaire

Address: ____

General Property Questions

1. Land use	a. Residential b. Apartment c. Business d. Park e. Open Space f. Other
2. Size of City Lot	a. Small (1 normal city lot) b. Medium (1-2 normal city lots) c. Large (More than 2 city lots) ________size, if large (in blocks or lot #s)
3. Number/type of buildings _______#	a. House b. Detached garage c. Shed/out building d. Other
4. Driveway type	a. Blacktop/asphalt b. Concrete c. Pavers d. Gravel e. Other
5. Percentage of property that is impervious	______% (estimate)

General Property Maintenance Questions

6. Groundcover on property	a. Turf ____% b. Gardens _____% c. Native Plants _____% d. Other _____%
7. Number of trees onsite	a. 0 b. 1-2 c. 3-4 d. 5+

General Stormwater Management Questions

8. Describe drainage patterns on site (use aerial photos to make notes, drawings –run-off destination).	
9. Is stormwater runoff being retained onsite?	Yes, if yes how: No, if no how could it be:
10. Does the home have gutters and downspouts?	Yes No
11. Are steep slopes present? (>12%)	Yes No
12. Are there unvegetated/bare areas on site?	Yes No
13. Are there issues related to soil erosion?	Yes No

BMP Priorities On Site

14. Is the site suitable for the following:	a. Raingarden b. Rain barrel c. Native Vegetation planting d. French Drain/Dry Creek e. Pavement Reduction f. Permeable Pavers
15. Raingardens	a. New Easy Raingarden (Priority 1) b. Raingarden placed in existing bed (Priority 2) c. Raingarden in easy location, but overhead trees (Priority 3) d. Not easy, but will work Raingarden (Priority 4)
16. Rain barrels	a. Only a rain barrel can disconnect downspout (Priority 3) b. An extra rain barrel (Priority 4)
17. Native Vegetation Planting	a. Disconnect downspout, but raingarden will not work - Priority 2 b. Only native planting will work – Priority 3 c. Reduction to lawn is only benefit – Priority 4
18. Pavement Reduction	a. Convert pavement to a Raingarden – Priority 1 b. Convert pavement to another pervious system – Priority 2
19. Permeable Pavers	a. Place Grass Pavers – Priority 2 b. Patio – Priority 3 c. Driveway – Priority 4

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2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Minnesota Drainage Law Analysis and Evaluation
PROJECT MANAGER: Louis Smith
AFFILIATION: Smith Partners, PLLP
MAILING ADDRESS: 400 Second Avenue South, Suite 1200
CITY/STATE/ZIP: Minneapolis, MN 55401
PHONE: 612-344-1400
E-MAIL: smith@smithpartners.com
WEBSITE: www.smithpartners.com
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2009, Chap. 143, Sec. 2, Subd. 5f.

APPROPRIATION AMOUNT: $87,000

<u>Overall Project Outcome and Results</u>

The Environment and Natural Resources Trust Fund enabled this study to analyze Minnesota drainage laws and related economic and environmental considerations, and to explore alternative strategies that would best protect both the state's surface waters and the rights of property owners to make beneficial use of their land through drainage. This study presents an overview of the drainage code and related water resource laws; identifies critical issues where potential conflicts between the drainage code and other laws create barriers to successful resource protection; and identifies three prototypical demonstration scenarios (Red River Valley, Minnesota River Valley, and Developing Watershed) to inform the study's analysis of these critical issues.

A study advisory committee composed of individuals from diverse backgrounds and expertise met nine times, from December 2009 through May 2011. We also presented this study to the Minnesota Association of Watershed Districts annual meeting in 2009 and 2010; three times to the Board of Soil and Water Resources Drainage Work Group; and to the Red River Watershed Management Board in June 2011.

Key recommendations include:

- Give drainage authorities more tools and resources for watershed-based planning.
- Give drainage authorities more tools and resources to implement projects with integrated drainage, flood control, conservation and water quality benefits.
- Better integrate effects on wetlands and water quality into drainage authority decisions about drainage system work.
- Provide drainage authorities with more clarity in legal authority to address drainage system alignment, grade, cross section, and hydraulic capacity of bridges and culverts for multipurpose design of drainage system establishment, improvement, or repair.
- Extend the authority to establish a locally based wetland regulatory framework under a comprehensive wetland protection and management plan (CWPMP) to public water wetlands.
- Foster reliability of CWPMP outcomes through coordination of local land use authority and wetland regulatory authority.

The policy recommendations include both pertinent findings, specific recommended actions, and draft legislation.

Project Results Use and Dissemination

This project will be presented at the University of Minnesota Water Resources Conference on October 18-19, 2011, the Annual conference of the Minnesota Association of Watershed Districts on December 2, 2011, and at the Annual Convention for the Minnesota Association of Soil and Water Conservation Districts on December 6, 2011.

Environment and Natural Resources Trust Fund
2009 Work Program Final Report

Date of Report: August 15, 2011
Date of Next Progress Report: Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Minnesota Drainage Law Analysis and Evaluation

Project Manager: Louis Smith
Affiliation: Smith Partners, PLLP
Mailing Address: 400 Second Avenue South, Suite 1200
City / State / Zip: Minneapolis, MN 55401
Telephone Number: 612-344-1400
E-mail Address: smith@smithpartners.com
FAX Number: 612-344-1550
Web Site Address: www.smithpartners.com

Location: Minneapolis, for state-wide application.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**87,000
	Minus Amount Spent:	**$**87,000
	Equal Balance:	**$** 0

Legal Citation: ML 2009, Chap. 143, Sec. 2, Subd. 5f.

Appropriation Language:
$87,000 is from the trust fund to the commissioner of natural resources for an agreement with Smith Partners PLLP to identify and analyze legal and policy issues where the drainage code conflicts with other laws impacting protection of public waters and wetlands.

II. and III. FINAL PROJECT SUMMARY:

<u>Overall Project Outcome and Results</u>
The Environment and Natural Resources Trust Fund enabled this study to analyze Minnesota drainage laws and related economic and environmental considerations, and to explore alternative strategies that would best protect both the state's surface waters and the rights of property owners to make beneficial use of their land through drainage. This study presents an overview of the drainage code and related water resource laws; identifies critical issues where potential conflicts between the drainage code and other laws create barriers to successful resource protection; and identifies three prototypical demonstration scenarios (Red River Valley, Minnesota River Valley, and Developing Watershed) to inform the study's analysis of these critical issues.

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IV. OUTLINE OF PROJECT RESULTS:

Result 1: Legal Analysis

Description: Provide an overview of the drainage code and related state and federal laws concerning wetland conservation, protection of public waters, and water quality. Identify and analyze critical legal and policy issues where the drainage code and potential conflicts with other laws create barriers to successful resource protection.

Summary Budget Information for Result 1: **Trust Fund Budget: $18,020**
Amount Spent: $18,020
Balance: $ 0

Deliverable	Completion Date	Budget
1. Survey of drainage code and related laws	October 2009	$5,440
2. Problem Statement and Critical Issues Identification	October 2009	$2,040
3. Critical Issues Analysis (Preliminary)	March 2010	$3,400
4. Critical Issues Analysis (Final)	November 2010	$7,140

Final Report Summary: June 30, 2011:

This study began with an overview of the drainage code and related water resource laws, specifically tracing the authority to establish and maintain public drainage systems, the evolution of public interest in waters, federal regulation of fill in wetlands, and the allocation of costs to conserve wetlands.

The survey of legal history suggests several ways in which the legal framework to reconcile public interests in drainage and conservation may not be optimal.

First, we are still working largely with a framework enacted in 1883. At that time, the circumstances for which drainage systems needed to account were relatively simple. It could be assumed that stakeholders, fairly uniformly, would consider drainage to be beneficial. Accordingly, feasibility and cost were pretty much the only relevant questions. In addition, drainage and conveyance needs were defined almost exclusively by agricultural land use, and not by urban stormwater management needs or conservation management regimes. The evolution of our land uses, the continued drainage needs and advancement of drainage practices, and current legislative judgments on natural resources conservation all are factors that might recommend adjusting the legal framework.

Second, the present laws governing public drainage and wetland/water quality protection are the result of legislative actions accumulated over the course of more than a century. As a result, the legal framework is not perfectly joined, addresses some aspects in piecemeal fashion, and contains unresolved ambiguities.

Finally, the laws reflect basically two means to mediate drainage and wetland conservation interests. Either (a) the drainage authority establishes an uneasy compromise, in which neither interest is fully realized; or (b) the public at large pays to reserve, for conservation, lands that otherwise could benefit both private and public interests through productive use. It is in the interest of all concerned to identify alternative outcomes.

With this legal survey and understanding of the shortcomings of the current legal framework, the study turned to identify critical issues where potential conflicts between the drainage code and other laws create barriers to successful resource protection. The study advisory committee assisted in identifying five critical issues: 1) implementation of conservation drainage measures in public drainage systems; 2) subwatershed-based planning; 3) updating definitions and use of terms “benefits” and “damages” in the Drainage Code; 4) ensuring that regulatory requirements are clear, consistent, and appropriate; and 5) anticipating the evolution of the Total Maximum Daily Load (TMDL) Program.

Result 2: Demonstration Scenarios

Description: Drainage- resource protection conflicts arise in particular land use settings. We will identify three prototypical scenarios and analyze the economic impacts of various restoration/development/conservation alternatives to inform the critical issues analysis.

Summary Budget Information for Result 2:	**Trust Fund Budget:**	**$36,780**
	Amount Spent:	**$36,780**
	Balance:	**$0**

Deliverable	Completion Date	Budget
1. Identify 3 scenarios with Advisory Committee, e.g. metro suburban, agricultural, and lakeshore development.	November 2009	$ 1,700
2. Build case studies of 3 scenarios.	March 2010	$19,640
3. Analyze development, resource conservation/restoration, costs and benefits.	June 2010	$ 8,500
4. Analyze legal barriers, strategic alternatives in 3 scenarios.	August 2010	$ 6,940

Final Report Summary: June 30, 2011

With intensive involvement of the study advisory committee, we identified three prototypical demonstration scenarios to explore the critical issues further: a) rural agricultural drainage system improvements set in the Red River Valley; b) rural agricultural drainage system repairs and improvements set in the context of impaired waters and TMDLs in the Minnesota River Valley; and c) developing watershed and wetland issues in the metro area. Three engineering firms, Houston Engineering, I & S Group, and EOR, each with particular experience in these settings, then provided technical review of the scenarios in order to assure that they were appropriately representative of the critical issues as they arise in these landscapes.

Dr. Steve Taff, professor of applied economics at the University of Minnesota, provided an economic assessment of scenarios A and B, specifically to assign total economic values to the agronomic and environment services affected by these hypothetical drainage improvement projects.

Having built these demonstration scenarios and completed the technical and economic assessment, the study turned to identifying policy recommendations that these scenarios suggested.

Result 3: Legislative Recommendations

Description: Building on the critical issues analysis from the three demonstration scenarios, develop legislative recommendations.

Summary Budget Information for Result 3:	**Trust Fund Budget:**	**$11,650**
	Amount Spent:	**$11,650**
	Balance:	**$0**

Deliverable	Completion Date	Budget
1. Initial draft of legislative recommendations for Advisory Committee review	September 2010	$5,400
2. Revised draft recommendations based on Advisory Committee review.	October 2010	$2,140
3. Presentation of draft recommendations to 3 regional forums.	November 2010	$2,040
4. Final recommendations.	June 2011	$2,070

Final Report Summary: June 30, 2011:

The study advisory committee and discussion from regional forums provided critical input for the development of the study's policy recommendations. We presented this study to the Minnesota Association of Watershed Districts annual meeting in 2009 and 2010; three times to the Drainage Work Group; and to the Red River Watershed Management Board in June 2011.

Our recommendations may be summarized as follows:

- Give drainage authorities more tools and resources for watershed-based planning.
- Give drainage authorities more tools and resources to implement projects with integrated drainage, flood control, conservation and water quality benefits.
- Better integrate effects on wetlands and water quality into drainage authority decisions about drainage system work.
- Provide drainage authorities with more clarity in legal authority to address drainage system alignment, grade, cross section, and hydraulic capacity of bridges and culverts for multipurpose design of drainage system establishment, improvement, or repair.
- Extend the authority to establish a locally based wetland regulatory framework under a CWPMP to public water wetlands.
- Create replacement alternatives within a CWPMP for a landowner causing wetland impact who may not have a high-valued replacement option on site.
- Coordinate USACE Section 404 jurisdiction with a watershed-based CWPMP or other implementing framework.

- Integrate MnDOT right-of-way, other state-managed lands and local road authority activities within a CWPMP framework.

- Foster reliability of CWPMP outcomes through coordination of local land use authority and wetland regulatory authority.

Our policy recommendations are presented in detail at Section V of the report, and include both pertinent findings and specific recommended actions. More detailed draft legislation to implement these recommendations is included at Appendix A

Result 4: Advisory Committee Facilitation

Description: Recruit and convene Advisory Committee.

Summary Budget Information for Result 4: **Trust Fund Budget: $ 20,550**
Amount Spent: $ 20,550
Balance: $ 0

Deliverable	Completion Date	Budget
1. Identify key stakeholders and recruit advisory committee.	October 2009	$ 2,440
2. Convene and facilitate six (6) meetings of Advisory Committee.	June 2011	$15,240
3. Present Draft Recommendations and report for Advisory Committee review and comment.	June 2011	$ 2,870

Final Report Summary: June 30, 2011: We established the advisory committee and convened nine meetings on the following dates:

Meeting	Date	Agenda
1	12-14-09	Problem Statement; Critical Issues Identification
2	7-21-10	Legal Review; Critical Issues Analysis
3	9-9-10	Scenario A Development
4	10-14-10	Scenario B, Scenario C Development
5	11-30-10	Scenario B Development; Scenario C Policy Issues
6	2-18-11	Scenario C, Analysis
7	3-31-11	Scenario B, Preliminary Economic Analysis
8	5-6-11	Scenario B, Economic Analysis; Scenario A
9	5-26-11	Draft Recommendations

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $ 65,000
Contracts: $21,000
Equipment/Tools/Supplies:
Acquisition, including easements: $
Travel: $
Other: $1,000

TOTAL TRUST FUND PROJECT BUDGET: $87,000

Explanation of Capital Expenditures Greater Than $3,500: None.

VI. PROJECT STRATEGY:

A. Project Partners:

Smith Partners attorneys (Louis Smith, Charles Holtman and Michael Welch) will provide the legal analysis, project management, and advisory committee facilitation, with support from the firm's planner and partnership manager, Faith Cable. Once the three demonstration scenarios are selected, land development specialists will be retained to analyze the costs and benefits of alternatives.

B. Project Impact and Long-term Strategy:
This project has statewide impact, especially where there are existing drainage systems.

C. Other Funds Proposed to be Spent during the Project Period:

D. Spending HIstory:

VII. DISSEMINATION:

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than December 31, 2009; June 30, 2010; December 31, 2010; June 30, 2011. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS:

APPENDIX

PROJECT ADVISORY COMMITTEE

Name	Affiliation
Ray Bohn	Minnesota Association of Watershed Districts
Gary Botzek	Minnesota Conservation Federation
Mark Dittrich	Minnesota Department of Agriculture
Les Everett	University of Minnesota Water Resources Center
Warren Formo	Minnesota Agriculture Water Resources Coalition
Annalee Garletz	Minnesota Association of Counties
Ron Harnack	Red River Watershed Management Board
Al Kean	Minnesota Board of Water and Soil Resources
Rick Moore	MSU-Mankato Water Resources Center
Lance Ness	Minnesota Fish & Wildlife Legislative Alliance
Ron Ringquist	Minnesota Viewers Association
Doug Thomas	Comfort Lake Forest Lake Watershed District
Henry Van Offelen	Minnesota Center for Environmental Advocacy

Attachment A: Final Budget Detail for 2009 Projects

Project Title: Minnesota Drainage Law Analysis and Evaluation

Project Manager Name: Louis N. Smith

Trust Fund Appropriation: $ *87,000*

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(date)*	**Balance** *(6-30-11)*	**Result 2 Budget:**	**Amount Spent** *(date)*	**Balance** *(6-30-11)*	**Result 3 Budget:**	**Amount Spent** *(date)*	**Balance** *(6-30-11)*	**Result 4 Budget:**	**Amount Spent** *(date)*	**Balance** *(6-30-11)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Legal Analysis			Demonstration Scenarios			Legislative Recommendations			*Advisory Committee Facilitation*				
BUDGET ITEM														
PERSONNEL: wages and benefits *(List individual names, amount budgeted and %FTE; add rows as needed)*														
Attorneys & Planner	$18,020	18,020	0	15,780	17,174	-1,394	11,650	11,996	-346	19,550	19,550	0	65,000	-1,740
• Louis Smith														
• Chuck Holtman														
• Michael Welch														
• Faith Cable (Planner)														
*All less than 10% FTE														
Contracts														
Professional/technical *(with whom?, for what?)*				21,000	19,606	1,394							21,000	1,394
Other contracts *(with whom?, for what?) list out: personnel, equipment, etc.*														
Other direct operating costs *(for what? – be specific)*														
Non-capital Equipment / Tools *(what equipment? Give a general description and cost)*														
Office equipment & computers - NOT ALLOWED unless unique to the project														
Capital equipment over $3,500 *(list specific items)*														
Land acquisition														
Easement acquisition														
Professional Services for Acq.														
Printing										550	513	37	550	37
Supplies *(list specific categories)*														
Travel expenses in Minnesota										450	141	309	450	309
Travel outside Minnesota *(where?, for what purpose?)*														
Other *(Describe the activity and cost) be specific-*														
COLUMN TOTAL	**$18,020**	**$18,020**	**$0**	**$36,780**	**$36,780**	**$0**	**$11,650**	**$11,996**	**-$346**	**$20,550**	**$20,204**	**$346**	**$87,000**	**$0**

Smith Partners PLLP
Old Republic Title Building
400 South Second Avenue, Suite 1200
Minneapolis, MN 55401
(612) 344-1400 tel
(612) 344-1550 fax
www.smithpartners.com
www.waterlaws.com

MINNESOTA DRAINAGE LAW ANALYSIS AND EVALUATION

FINAL REPORT

Louis N. Smith
Charles B. Holtman

August 15, 2011

With technical assistance from:

Houston Engineering Inc.

I&S GROUP One firm - start to finish™

EOR water ecology community

Dr. Steve Taff
Department of Applied Economics
University of Minnesota

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

TABLE OF CONTENTS

APPENDICES

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

I. INTRODUCTION AND OVERVIEW

The glacial landscape of Minnesota is the land of 10,000 lakes, a few more wetlands, and a good deal of high groundwater. The state's past and continuing prosperity would not be possible without the ability to make productive use of land by drainage. Roads, settlements, agriculture all have relied, and will continue to rely, extensively on the ability to manage surface and groundwaters through systems of ditch and tile.

But we also have come to appreciate more with time the benefits of protecting our wet environments, the places where ground and surface waters meet. Our recognition grows of the benefits of preserving these areas, both economic and non-economic -- the "ecological services" that these areas provide.

Certainly it is not unusual to encounter competing public values, nor is it unusual that these values may be challenging to reconcile, particularly through the imperfect instrument of the laws. It is good public policy to pause periodically and assess how we are doing.

The LCCMR commissioned this study to analyze Minnesota drainage laws and related economic and environmental considerations, and to explore alternative strategies that would best protect both the state's surface waters and the rights of property owners to make beneficial use of their land through drainage. Such a study requires strong engagement of stakeholders in order to develop creative, integrated solutions to natural resource protection and productive land use.

We established a study advisory committee composed of individuals from diverse backgrounds and expertise. (A list of the study advisory committee members appears at Appendix A.) Many committee members are also members of the Drainage Work Group that advises the Minnesota Board of Water and Soil Resources; we added other advisory committee members to provide for additional perspectives. We exceeded our study's commitments to advisory committee meetings and regional forums. We convened the study advisory committee nine times, from December 2009 through May 2011. We also presented this study to the Minnesota Association of Watershed Districts annual meeting in 2009 and 2010; three times to the Drainage Work Group; and to the Red River Watershed Management Board in June 2011.

This study presents an overview of the drainage code and related water resource laws; identifies critical issues where potential conflicts between the drainage code and other laws create barriers to successful resource protection; and identifies three prototypical demonstration scenarios to inform the study's analysis of these critical issues. This process -- building on a legal review, identification and analysis of critical issues, and exploration of demonstration scenarios – provided the foundation for us to pursue the policy recommendations through a number of review sessions with the study advisory committee and other forums.

Our recommendations may be summarized as follows:

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- Give drainage authorities more tools and resources for watershed-based planning.
- Give drainage authorities more tools and resources to implement projects with integrated drainage, flood control, conservation and water quality benefits.
- Better integrate effects on wetlands and water quality into drainage authority decisions about drainage system work.
- Provide drainage authorities with more clarity in legal authority to address drainage system alignment, grade, cross section, and hydraulic capacity of bridges and culverts for multipurpose design of drainage system establishment, improvement, or repair.
- Extend the authority to establish a locally based wetland regulatory framework under a CWPMP to public water wetlands.
- Create replacement alternatives within a CWPMP for a landowner causing wetland impact who may not have a high-valued replacement option on site.
- Coordinate USACE Section 404 jurisdiction with a watershed-based CWPMP or other implementing framework.
- Integrate MnDOT right-of-way, other state-managed lands and local road authority activities within a CWPMP framework.
- Foster reliability of CWPMP outcomes through coordination of local land use authority and wetland regulatory authority.

Our policy recommendations are presented in detail at Section V of this report, and include both pertinent findings and specific recommended actions. More detailed draft legislation to implement these recommendations is included at Appendix A.

We intend for these recommendations to provide tools for the legislature or local authorities to make policy choices in how best to integrate drainage and natural resource management. Accordingly, the recommendations are the product of robust discussion, but not complete consensus. The recommendations are the responsibility of the authors, and reflect a judgment that they have adequate support among diverse stakeholders to be worthy of consideration.

While the responsibility of making policy recommendations has been assumed by the authors, we must express our gratitude to the members of the study advisory committee, many of whom devoted countless hours to study and deliberation of these issues. We are also grateful for the technical assistance with the demonstration scenarios provided by three engineering firms, Houston

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Engineering, Inc., I & S Group, and EOR, as well as the economic analysis provided by Dr. Steve Taff. The quality of the work presented here is certainly stronger as a result of their participation.

We hope this study provides useful information to the Legislature, and we look forward to continued discussion of the recommendations.

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II. LEGAL REVIEW

The Minnesota Drainage Code must be understood in the context of many water – related statutes. This section of the report surveys the drainage code and related state and federal wetland conservation laws. The section concludes with an assessment of this legal framework and suggests several ways in which its approach to reconciling public interests in drainage and conservation may not be optimal

A. Authority to Establish and Maintain Public Drainage Systems

The drainage law is a means by which a number of adjoining landowners, with relative efficiency, can construct, maintain and equitably share costs for a drainage and conveyance system across multiple parcels of land. The legal framework to accomplish this within the State of Minnesota has not changed very much since 1883, when county commissioners first were authorized to accept petitions and establish public drainage systems. Laws 1883, c. 108. Under this framework, system alignment and dimensions are determined, landowner benefits and damages are estimated by disinterested "viewers," and the county commissioners – and now in many cases watershed district boards of managers – judge whether net benefit will result from the proposed work. If so, assessments are certified to the county auditor and work proceeds. The drainage law prescribes procedures for constructing and expanding drainage systems, performing work on system outlets, and system maintenance.

The relationship of drainage system management and conservation reflects an evolution, over 100 years, of legislative thinking about the public interest in the state's surface waters. This history reflects an evolving legislative judgment about where the boundary lies as between the private "right" to drainage and the public "right" to the natural condition of surface waters, and therefore about how the costs of conservation should be allocated as between landowners and the general public. In recent decades federal law has created a second regulatory overlay. As we will see, the legal framework tends to presume that where drainage and conservation goals intersect, one or both must be compromised, and the framework tends to undermine opportunities to achieve both goals.

B. Evolution of Public Interest in Waters

Already in 1867, it was a misdemeanor to drain a meandered lake, with a fine of as much as five thousand dollars. Laws 1867, c. 40. In 1883, county commissioners were authorized to allow the draining of "shallow, grassy, meandered lakes under four feet in depth" with the concurrence of all riparian landowners. Laws 1883, c. 139. Forty-two years later, the legislature restricted this authority by prohibiting the drainage of any meandered lake without state approval. Laws 1925, c. 415, §2. The state department of conservation was created in 1931, Laws 1931, c. 186, and in 1933 the state's authority to consent to drainage was given to the conservation commissioner. Laws 1933, c.312, §1.

Separately, the legislature's view of those waters meriting protection on behalf of the citizens of Minnesota – designated as "public waters" – was evolving and expanding. As early as 1897, the

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legislature designated as public waters meandered lakes larger than 160 acres and deep enough to support beneficial uses "such as fishing, fowling and boating." Laws 1897, c. 257. In 1937, the "public waters" designation was extended to all streams and lakes, meandered or not, that were "navigable in fact." Laws 1937, c. 468. Then in 1946, this protection was extended to all streams, lakes and other waterbodies "navigable in fact" that provided "substantial beneficial use." 1947 Laws, c. 142. This is the first instance in which the legislature included certain wetlands within the definition of public waters.

In 1955, the legislature enacted the Watershed Act, providing for the creation of watershed districts. Laws 1955, c. 799. Raymond Haik, one of the key drafters of the act, has explained that one of its important goals was to provide for a special purpose local unit of government that could protect wetlands and other water resources in parallel with local drainage authorities (R. Haik, September 30, 2009). While the legislature provided for the establishment of watershed districts for conservation purposes and to protect and improve water quality, it also authorized watershed districts to "improve stream channels for drainage," and "reclaim or fill wet and overflowed land." Minn. Stat. §103D.201, subd. 1, 2(2) and (3).

The new law gave watershed districts the authority "[t]o take over when directed by the district court or county board all judicial and county drainage systems within the district, together with the right to repair, maintain and improve the same." Laws 1955, c. 799, §10(11). But the role of drainage authority was confused by further language providing for watershed districts to construct, improve and repair systems essentially at the direction of the county board or district court, with the latter continuing to exercise the decisionmaking role. Id., §32. Four years later, the legislature clarified that on transfer of authority from the county board or district court, a watershed district would assume all drainage authority powers. Laws 1959, c. 240, §1.

In 1957, the legislature defined the state interest in public waters:

> Subject to existing rights all waters in streams and lakes within the state which are capable of substantial beneficial public use are public waters subject to the control of the state. The public character of water shall not be determined exclusively by the proprietorship of the underlying, overlying , or surrounding land or on whether it is a body or stream of water which was navigable in fact or susceptible of being used as a highway for commerce at the time this state was admitted to the union.

Laws 1957, c. 502. This statement of policy announced that the state's interest in its surface waters did not derive solely from its ownership interest in adjacent land or the bed of the waterbody, nor did it depend on the specific public use of the waterbody for navigation. It endorsed an interest as broad as the "beneficial uses" to which the surface water might be put. At the same time, the status of wetlands was somewhat confused by their omission from the scope of the declaration.

Over this same period consideration of conservation values in drainage proceedings gradually was expanding. The 1937 law expanding "public waters" to all streams and lakes navigable-in-fact also prohibited any change to the "course, current, or cross-section" of any such water without the conservation commissioner's approval. Laws 1937, c. 468, §5.

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Wetlands not considered "lakes" first received protection in drainage proceedings in 1955, when the legislature mandated that conservation values be weighed by drainage authorities in deciding whether to establish, improve or repair drainage systems. The drainage code was amended to require the drainage authority to duly consider "conservation of soil, water, forests, wild animals, and related natural resources, and … other public interests affected" in deciding whether to authorize work on a drainage system. Laws 1955, c. 681, §1. This language remains in the drainage code today. Minn. Stat. §103E.015, subd. 2. It has been supplemented by a further directive to consider conservation interests before construction of any new drainage system, system lateral or improvement, or outlet. Minn. Stat. §103E.015, subd. 1. However, its impact is limited. While a drainage authority might be encouraged to consider these conservation values, the Minnesota Supreme Court has confirmed that judicial enforcement of this exhortation is limited. Titrud v. Achterkirch, 298 Minn. 68, 213 N.W.2d 408 (1973).

In the 1970's there was much legislative interest to advance the cause of the environment. The Minnesota Environmental Rights Act (MERA) was enacted, empowering citizens to challenge any action threatening "pollution, impairment or destruction" of natural resources. Laws 1971, c. 952. Two years later, the Minnesota Environmental Policy Act (MEPA), mirroring the 1969 National Environmental Policy Act, established requirements for environmental review of significant undertakings. Laws 1973, c. 412. Both of these laws remain. In their broad compass, they apply to drainage system work.

More specifically, the decade of the 1970's was a time of intense, and at times complicated, activity by the state legislature and the Department of Natural Resources to refine the category of "public waters" and decide how the interest in protecting these waters should be reflected in drainage proceedings.

In 1973, the legislature returned to the 1957 declaration finding all streams and lakes serving beneficial public uses to be public waters, and expanded it to encompass all "waters of the state," itself broadly defined to include wetlands. (This adjustment established consistency with the 1946 legislation, chapter 146, cited above.) Laws 1973, c. 315, §§2-4. This legislation, importantly, also codified for the first time a long definition of "beneficial public purposes," which included flood management, conservation purposes such as water quality and wildlife habitat protection, and recreational uses such as hunting, fishing and boating. Laws 1973, c. 315, §§2-4.

Three years later, the legislature directed the Department of Natural Resources to inventory and designate as public waters waterbodies serving a "material beneficial public purpose." Laws 1976, c. 83, §7. The administrative challenge of assessing the "beneficial purpose" of each individual waterbody across the state for the purpose of public waters designation, the consequences of that designation, and the resulting discontent of landowners and county boards led the legislature in 1979 to replace the "beneficial purpose" criterion with a set of more objective definitions. Specifically, wetlands to be designated as public waters would now be defined as "types 3, 4 and 5 wetlands, as defined in U.S. Fish and Wildlife Service Circular No. 39 (1971 edition) … which are ten or more acres in size in unincorporated areas or 2-1/2 or more acres in incorporated areas." Laws 1979, c. 199, §3. This remains the definition of public waters wetlands. Minn. Stat. §103G.005, subd. 15a.

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The 1979 law also specifically exempted from the DNR permit requirement drainage system work in watercourses when accomplished in accordance with the drainage code. Laws 1979, c. 199, §15. The effect of this exemption was substantially dampened in 1985, when the drainage code was amended to require DNR approval for any action that would drain a public water. Laws 1985, c. 172, §2. While a formal permit is not required, there is little practical difference between DNR "approval" and a DNR "permit."

In 1991, the legislature decided that the beneficial public uses of wetlands were not restricted to the category of wetlands defined as "public waters wetlands" in the 1979 legislation, and adopted the Minnesota Wetland Conservation Act (WCA). The WCA regulates draining and fill impacts to all wetlands, which are defined as lands possessing, under normal circumstances, the three attributes of hydrology, hydric soils and hydric vegetation. Laws 1991, c. 354, art. 6, §6. The legal framework is similar to that for reviewing proposed impacts to public waters: permission to drain or fill must be obtained from the implementing agency based on a "sequencing analysis" showing that the wetland impact cannot be avoided and has been minimized. If, as a result of this analysis, wetland impact is allowed, lost acreage and wetland functions must be replaced elsewhere. However, the implementing agency is not the DNR, but the local city, town, county or watershed district, and the details of the review process diverge. The WCA includes specific exemptions for work on existing drainage systems, including: (a) maintenance that does not drain wetlands in existence for more than 25 years; (b) work subject to Section 404 of the Clean Water Act but exempted by the U.S. Army Corps of Engineers (USACE) from the permit requirement; and (c) certain work authorized under a Section 404 general permit.

C. **Federal Regulation of Fill in Wetlands**

Parallel federal regulation came into being in 1972. Section 404 of the National Water Pollution Control Act (NWPCA) prohibited placing fill or dredged materials in "waters of the United States" without a permit from the USACE. As defined in the NWPCA and the implementing rules of the USACE and U.S. Environmental Protection Agency, these waters include natural and artificial tributaries of navigable waters, and thus encompass many public ditch systems in artificial or altered natural channels. Similar to state law, Section 404 requires that the placing of fill or dredged material be justified and that the area and impact on waterbody functions be replaced elsewhere.

Although Section 404 applies only to filling activity and not to the removal of sediments or obstructions from ditches, such activities often involve the incidental movement or redeposit of sediments within the channel or spoils placement within jurisdictional areas adjacent to the channel. The 1977 amendments to the NWPCA, also known as the Clean Water Act (CWA), added Section 404 exceptions for incidental fill from drainage ditch maintenance activity. In addition, the CWA authorized the USACE to allow smaller-scale impacts through the expedited mechanism of a "general permit."

Relying on this authority, USACE general permit RGP-03-MN applies to actions such as structure maintenance, stream and wetland restoration, and minor discharges of fill or dredged material. Impacts must be avoided where possible and, except for minor discharges, impact area and functions must be replaced. In addition, present general permit GP-001-MN authorizes all work subject to and authorized by the DNR. Under GP-001-MN, standard conditions require that the

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work be performed with care, but the impact need not be justified and there is no replacement requirement beyond that imposed by the DNR.

D. **Allocating Costs to Conserve Wetlands**

When the legislature directed that public waters be inventoried and designated, it declared that the public should bear the cost of protecting these waters. That is, it obligated the DNR, on receipt of a request to drain a waterbody, to offer to purchase drainage rights (permanently or for a term of years) from the landowner. However, if the offer were made and the landowner declined, the waterbody could be drained only pursuant to DNR approval and only if the public water were "replaced by a waterbasin which will have equal or greater public value." Laws 1976, c. 83, §8.

Legislation in 1979 also directed that if maintenance of an established public drainage system would drain a wetland owned by the state, the public should bear the cost to protect the wetland without interfering with the proper function of the drainage system. Laws 1979, c. 199, §11. See also Laws 1985, c. 172, §52 (the state shall manage certain publicly owned wetlands to avoid interference with drainage proceedings for outlets).

In 1987, the legislature repealed the requirement that the DNR offer to compensate a landowner in exchange for the yielding of the public water wetland drainage right. Laws 1987, c. 357, §20. Since that time, a landowner has had no legal right to drain a public water wetland except pursuant to DNR approval and with replacement.

In that year the legislature also took a small step to adjust how drainage system maintenance costs are allocated. The drainage code was amended to provide that drainage benefit determinations should discount for the likelihood that lands within the benefited area could not be drained due to state and federal regulatory constraints. Laws 1987, c. 239, §74.

Finally, WCA as enacted in 1991 authorized landowner compensation from the Board of Water and Soil Resources if WCA conditions made the proposed action "unworkable or not feasible." Compensation was established by statute as "50 percent of the average equalized estimated market value of agricultural property in the township as established by the commissioner of revenue at the time application for compensation is made." Laws 1991, c. 354, art. 6, §17. A 1994 amendment established alternative compensation at 50 percent of "the assessed value per acre of the parcel containing the wetland, based on the assessed value of the parcel as stated on the most recent tax statement." However, in exchange for compensation, the landowner was required to convey to the BWSR a permanent conservation easement on the land. Laws 1994, c. 627, §10. The compensation formula was further adjusted two years later. Compensation claims under this statute have been very few.

Alongside the traditional regulatory approach, the Minnesota legislature long has offered mechanisms for landowners to voluntarily preserve wetlands for conservation purposes in exchange for some form of compensation: by authorizing public acquisition of land or easements, offering term agreements or granting tax benefits for preserved lands.

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As early as 1925, legislation authorized the game and fish commissioner to acquire land for hunting grounds and game refuges. 1925 Laws, c. 419. In 1951, federal funds were made available to acquire wetlands for state wildlife management areas. In 1953, a tax reduction was extended to those who preserved marshland as wildlife habitat area. 1953 Laws, c. 688. Similar laws followed concerning public acquisition of wildlife areas, 1957 Laws, c. 644, and scientific and natural areas, Laws 1969, c. 470.

In 1976, the legislature, piggybacking on an earlier-enacted federal law, enacted a "water bank" program under which landowners would protect wetlands under 10-year contracts with the state. Laws 1976, c. 83. The year 1979 saw the legislature establishing tax credits for wetlands. Other state and federal programs, enacted since that time and still operating, offer landowner payments in exchange for term agreements to maintain wetlands. The 1991 legislation enacting WCA also established programs to create wetland preserves and wetland preservation areas with willing landowners and authorized programs to work with such landowners on wetland establishment and restoration.

E. **Summary of Legal Framework and Potential Shortcomings**

With this long and complex legislative history, it may be helpful to attempt a succinct summary of the current basic legal framework to reconcile public drainage and wetland conservation. Drainage systems may be constructed, expanded and maintained via procedures that have been generally in place for a century. The drainage authority may approve a new system, new lateral, improvement or system outlet if it finds that the benefits to affected lands exceed the costs and that public interests will not be disserved. It may repair and maintain these systems largely as it judges to be in the interest of landowners benefited by the system, again subject to consideration of public interests.

If this drainage activity would involve wetland fill, drain a wetland or otherwise alter its hydrology, it is first subject to a sequencing analysis. Here, it must be shown that wetland impact cannot be avoided, and that the impact is minimized. Any impact that cannot be avoided must be reduced or eliminated over time or, ultimately, replaced withwetland acreage and biological function elsewhere. By statute, replacement must achieve "no net loss" in wetland public value, as that term is defined at Minnesota Statutes §103B.3355. Where an impact may be substantial or affected wetlands have particularly high value, the drainage authority or the wetland regulatory body may forbid the activity.

- If the affected wetland is a "public waters wetland" as defined at Minnesota Statutes §103G.005 (Type 3, 4 or 5 wetland of at least 10 acres within an unincorporated area or 2.5 acres within an incorporated area), the DNR will review wetland impacts.

- If the wetland does not meet this definition, wetland impacts will be reviewed by the local land use authority or watershed district.

- Separately, if the wetland is within a navigable water, or pursuant to federal law has a sufficient hydrologic connection to such a water, and if fill or dredged material will be placed within it, the USACE will review as well.

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Some drainage system activities, primarily maintenance of existing systems that continue to provide a reasonable level of beneficial drainage, enjoy exemptions from wetland conservation requirements.

All drainage activities also are subject to general environmental standards. These include Minnesota Statutes §103E.015, which directs the drainage authority to consider environmental and other public interests in deciding to proceed with drainage system work; 33 CFR 320.4, authorizing the USACE to engage in a broad "public interest review" during Section 404 permitting; the Minnesota Environmental Rights Act (MERA), under which a public or private plaintiff can challenge a proposed activity as an environmental impairment; and the Minnesota and National Environmental Protection Acts (MEPA, NEPA), which can impose extensive environmental analysis requirements before work may occur.

While this regulatory framework may be procedurally clear, the rules reconciling public drainage and wetland conservation are less well-developed on the allocation of benefits and costs resulting from regulatory decisions. Generally, those who will benefit from the construction or improvement of a drainage system must bear the cost to maintain or replace wetland values under applicable regulations. Conversely, except where a system has fallen extensively out of repair, impacts to wetlands from system maintenance are excused and measures to protect wetlands from those impacts generally fall to the general public. Similarly, landowners that choose to forego otherwise operable drainage of their lands may obtain compensation for doing so from a number of state and federal programs by means of term contracts or permanent easements.

The survey of legal history suggests several ways in which the legal framework to reconcile public interests in drainage and conservation may not be optimal.

First, we are still working largely with a framework enacted in 1883. At that time, the circumstances for which drainage systems needed to account were relatively simple. It could be assumed that stakeholders, fairly uniformly, would consider drainage to be beneficial. Accordingly, feasibility and cost were pretty much the only relevant questions. In addition, drainage and conveyance needs were defined almost exclusively by agricultural land use, and not by urban stormwater management needs or conservation management regimes. Finally, broader social interests, such as those in water quality and wildlife habitat, were not prominent. The evolution of our land uses, the continued drainage needs and advancement of drainage practices, and current legislative judgments on natural resources conservation all are factors that might recommend adjusting the legal framework.

Second, the present laws governing public drainage and wetland/water quality protection are the result of legislative actions accumulated over the course of more than a century. As a result, the legal framework is not perfectly joined, addresses some aspects in piecemeal fashion, and contains unresolved ambiguities.

Finally, the laws reflect basically two means to mediate drainage and wetland conservation interests. Either (a) the drainage authority establishes an uneasy compromise, in which neither interest is fully realized; or (b) the public at large pays to reserve, for conservation, lands that otherwise could benefit both private and public interests through productive use. It is in the interest of all concerned to identify alternative outcomes.

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Beyond merely updating the legal framework to address gaps and ambiguities, it will be even more valuable to discover potential legislative changes to allow both drainage and conservation goals to be better realized. It is important also to recognize that these drainage/conservation judgments now apply to settings that may range from agricultural, to suburban residential, to a mix of land uses served by a single public system.

Increasingly, conditions exist that allow for "win-win" solutions:

- A more comprehensive understanding continues to develop concerning the effects of non-point pollution and hydraulic forces on water quality.
- There is an ever-improving capacity to model and refine hydrologic systems and to evaluate flooding, hydraulic and water quality impacts of those systems.
- Settlement patterns and social values continue to evolve, calling on hydrologic systems to serve multiple land uses and beneficial uses encompassing the functional and the ecological.
- Innovation increases the choices for on- and off-line techniques to incorporate water quality practices into conveyance systems.
- A diversity of drainage authority funding mechanisms allows the costs of hydrologic/conveyance systems to be accurately matched to the varied benefits these systems provide.

Three prior acts of the Legislature foreshadow this direction toward more successful and comprehensive realization of drainage and conservation goals:

In 1991, Minnesota Statutes §103E.701 was amended to state: "Repair of a drainage system may include the preservation, restoration, or enhancement of wetlands; wetland replacement under section 103G.222; and the realignment of a drainage system to prevent drainage of a wetland." Laws 1991, c. 354, art. 10, §2.

Several years thereafter, §103E.011, subdivision 5, was added to affirm that drainage authorities could apply funding mechanisms within their authority other than benefits-based assessments to fund that portion of drainage system work consisting of wetland preservation or restoration, creation of water quality improvements or flood control. Laws 2000, c. 488, art. 3, §27.

And, in 1996, section 103G.2243 was added to the WCA authorizing implementing agencies to create comprehensive wetland protection and management plans (CWPMPs). Laws 1996, c. 463, §33. CWPMPs rest on an assessment of local hydrology and ecology, allow wetland management to be tailored to local conditions, and enable the benefits and impacts of regulatory decisions to be considered on a subwatershed rather than site basis.

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These legislative measures reflect a new approach in which hydrologic system design, sensitive to the watershed setting, can integrate drainage and conservation goals to provide effective drainage for productive use of land while preserving higher-valued ecological resources.

In order to pursue this new approach in greater detail, we turn next to a more detailed identification and analysis of critical legal or policy issues where drainage and resource protection goals conflict.

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III. CRITICAL ISSUES

The authors worked with the study advisory committee and gained input from the Drainage Work Group, the Minnesota Association of Watershed Districts, and the Water Policy Team for the Water Resources Sustainability Framework to identify key issues for this study. From this process, the following five issues emerged as the most critical:

A. Conservation Drainage

"Conservation drainage" is a term of recent coinage that may have different meanings to different people. Here, we use it to refer broadly to structures and techniques incorporated within the drain water collection and conveyance system specifically to manage flows and reduce transport of sediment and pollutants. Conservation drainage includes features such as buffer strips, culvert sizing for temporary in-system storage, side inlet sediment filtration and flow controls, contour tiling and two-stage ditch profile design. Conservation drainage also includes methods to isolate wetlands from drained lands, such as ditch realignment and wetland outlet controls.

These methods reflect how drainage system design and retrofit increasingly integrates ecological concerns. As these methods are shown to be reliable and cost-effective, they bridge the gap between the traditional poles of drainage and wetland preservation. This integration, of course, was foreign when the drainage code was enacted. Therefore, there are questions about the circumstances under which a drainage authority may mandate the incorporation of conservation drainage features into drainage systems. There are also questions about whether the tools exist to incorporate these features and allocate the cost of their installation and maintenance appropriately. Who should pay for their installation and maintenance? Are they a cost of the drainage system, to be included in calculating whether a drainage project should proceed and to be paid by assessing benefited lands? Or do they operate to protect resources benefitting the public, so that they are appropriately funded on a regional, watershed or statewide basis?

With the use of conservation drainage methods, efficiency losses in drainage systems are accepted in order to gain meaningful public conservation and water quality benefits. However, drainage code standards typically reflect a world of absolutes. For example, a drainage authority may approve the impoundment of water within a public system only if it finds that the impoundment "will not impair the utility of the ditch or deprive affected land owners of its benefit." Minn. Stat. §103E.227, subd. 3.

Drainage practitioners traditionally have worked within a grey area in applying this standard. Proposed actions may affect channel elevations under certain precipitation events but not others, or may affect the frequency or duration of elevated water in limited ways. Realigning a ditch may affect drainage, but only very near the realigned section. Conservation drainage, however, is different in that it reflects an actual intent to adjust drainage system hydrology. Accordingly, if these methods are to be explicitly incorporated into the drainage code, the existing standards need to be carefully examined and adjusted, as necessary, to articulate the extent of impact they may have on drainage system function.

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When public drainage systems are constructed and operated so that water resources simultaneously are conserved, sound legislation will afford ditch authorities judgment as to how costs are distributed among lands benefited by a drainage system and the broader publics benefited by conservation. Ditch authorities must have the authority to allocate costs fairly; they also must have the statutory ability to do so.

A fairly recent amendment to Minnesota Statutes §103E.011 authorizes a drainage authority to

> accept and use funds from sources other than, or in addition to, those derived from assessments based on the benefits of the drainage system for the purposes of wetland preservation or restoration or creation of water quality improvements or flood control.

This language, however, refers essentially to grant funds. In itself, it does not create a mechanism for a drainage authority to raise funds by means other than assessing benefited lands. It is important that drainage authorities, whether counties, joint county boards or watershed districts, can raise revenues in a way that allows costs to be allocated consistent with legislatively enunciated policies.

Finally, conservation drainage practices may trigger requirements that may not be appropriate and that could create obstacles to their use. For example, a two-stage channel likely would require that channel banks be regraded, which in turn would require that benefits of the ditch system be redetermined on a parcel basis. Minn. Stat. §103E.715, subd. 6. It is important that additional right-of-way to implement conservation design practices can be acquired efficiently and fairly. However, redetermination of benefits is an administratively burdensome process that would preclude the innovation in most cases. At the federal level, moving soils or incorporating structural features within a conveyance may constitute "filling" requiring permit review under Section 404. It is important that state laws and rules be reviewed for unintended impediments to incorporating beneficial practices. The USACE should be engaged to do the same with respect to its Section 404 program.

B. Subwatershed-Based Planning/Permitting

The subwatershed-based approach uses science and planning to minimize conflicts between water resource conservation and productive use of land. The resource management authority must understand hydrologic and ecologic function within the drainage area. It must identify the areas of substantial ecologic value and the drivers of ecologic health within the subwatershed. And it must understand present and future land uses within the area and the infrastructure needs those uses will prompt.

The goal is both productive use and preservation of hydrologic/ecologic function within the planning area. Implementation occurs through permitting rules (and, ideally, consistent local land use ordinances) that allow for productive land use in locations suited to it and, by mandate or incentive, preserve valued water resources and their function. The subwatershed-based approach also offers more predictability as to permitting outcomes.

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This approach is contrasted with the traditional regulatory framework that looks only at the single parcel proposed for use or development. This narrow focus normally ensures that a conflict between drainage and wetland conservation cannot be resolved. At the same time, it offers no guarantee that the level of protection afforded the resource will correspond with its function within, and value to, the hydrologic and ecologic systems of which it is a part.

Both state and federal wetland laws provide a framework for the subwatershed-based approach.

- The WCA gives BWSR the authority to approve comprehensive wetland protection and management plans (CWPMPs) that establish alternative wetland impact standards set on an area-wide basis. Minn. Stat. §103G.2243; see Minn. Rules 8420.0830.

- Under Section 404 and published USACE regulatory guidance, the USACE may approve Special Area Management Plans that authorize wetland impacts on the basis of a plan and related assurances providing for wetland functions to be replaced and preserved on an area basis.

These tools were not created specifically for areas served by public drainage systems. But they can be used in this context to establish a predictable regime in which a drainage system and the productive land uses that it serves can be maintained.

To facilitate the use of subwatershed-based approaches, we would address specific features of existing authorities that can make the process to obtain approval of subwatershed-based regulatory programs prohibitively time- and resource-consuming, or that stand as obstacles to gaining the most value from these approaches. This effort primarily would concern wetland statutes and regulations, the drainage code less so. As a specific example, the CWPMP statute now applies only to regulating impacts to WCA wetlands and not public waters wetlands. It may be possible to extend this approach to include public waters wetland impacts without legislative action. As another example, a CWPMP framework may be upset by a change in the designation of WCA implementing agency for the area in question.

More substantial obstacles exist at the federal level. One obstacle, for example, is the USACE's limited willingness to forego the required "alternatives analysis" required for project-specific applications. If the alternatives analysis, and the risk of a USACE finding that it does not justify the proposed action, still await each landowner after a SAMP is in place, then the SAMP does not carry nearly as much regulatory certainty as it might. In addition, the cost of performing this analysis reduces the value of a SAMP approach. This and similar issues rest on the fact that while the USACE has established the SAMP vehicle and continues to advance the watershed-based approach in policy documents, permit review still remains almost entirely ensconced within a regulatory framework with a traditional, parcel-specific focus. There is room within federal law to make progress on these matters, but ultimately there are likely to be limits on the extent to which these approaches can be facilitated without changes to that law or to USACE policies adopted at a national level.

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C. Updating Definitions and Use of Terms "Benefits" and "Damages" in the Drainage Code

Key to operation of the drainage code are the benefits and damages that will accrue to specific parcels from drainage system work. The determination of drainage benefits and damages plays three roles in the drainage code:

- First, it is used to judge whether a proposed action will be of overall net benefit, a finding that is a prerequisite to approval by the drainage authority.
- Second, the original determination of net benefit from drainage system construction is a ceiling onsubsequent assessments and expenditures for work on the system.
- Third, it determines how assessments will be apportioned among properties benefited by the drainage system.

The two terms are not found in the general definitions section of the drainage code, Minnesota Statutes §103E.005. Rather they are defined by treatment within the body of the code itself. E.g., Minn. Stat. §103E.315 (describing on what viewers may base benefits determinations and how damages may be calculated). Accordingly, definitions are not comprehensive and are augmented by (uncodified) practices of viewers and court decisions. Practitioners are aware of artifacts within the code that stand in the way of rational drainage system management. For example, a drainage authority may not authorize repair work requested by petition if the cost of that work will exceed the benefits "determined in the original drainage system proceeding." Minn. Stat. §103E.715, subd. 4. A spending limit based on benefits determined a century ago and not adjusted for inflation may not allow for necessary and reasonable work. In summary, revisiting and adjusting the definitions and uses of "benefits" and "damages" under the code likely would have general benefit.

More specifically with respect to wetland conservation, the benefits and damages that drainage authorities must weigh to decide whether drainage system work should be authorized are articulated in the code almost exclusively (apart from state-owned lands, see Minn. Stat. §103E.025) as private benefits and damages accruing to landowners within the drainage area. Benefits and damages to public resources are absent from consideration. See, e.g., Minn. Stat. §103E.315, subds. 5, 6, 8. Indeed, where the code does define public benefit, it does so in a way that may strike the present-day reader as incomplete:

> "Public benefit" includes an act or thing that tends to improve or benefit the general public, either as a whole or as to any particular community or part, including works contemplated by this chapter, that drain or protect roads from overflow, protect property from overflow, or reclaim and render property suitable for cultivation that is normally wet and needing drainage or subject to overflow.

Minn. Stat. §103E.005, subd. 27.

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Drainage authorities are mandated by Minnesota Statutes §103E.015 to consider conservation and other public values as well. However, the statute does not require the effect on these values to be quantified; the amount of "consideration" to be given is left to drainage authority discretion and generally is, at most, supplemental to the "hard numbers" of private benefits and damages.

With drainage and wetland laws both in play, the legislature is delegating to drainage authorities the responsibility to manage public drainage systems to achieve outcomes that best reconcile the public interests in drainage and wetland conservation. The decision making standards prescribed by the legislature therefore should provide for these interests to be fully considered together. Further, drainage management is evolving – or mandated - toward incorporating conservation drainage and other mitigating practices in drainage work. Accordingly, the decision making framework must allow drainage authorities to adjudge when these practices are required, and to what extent, and how their incorporation will affect project benefits, costs and parcel-based assessments.

Integrating water resource benefits and damages into drainage authority decision making is of course easier said than done. Wetlands, in particular, provide numerous functions with public (and private) value, including floodwater retention, water quality treatment, flow dissipation, wildlife habitat, groundwater recharge and economic uses. Upstream drainage systems can disrupt wetland ecology through sediment and pollutant delivery, channel erosion and hydrologic disruption caused by changes from the natural hydrograph. However, how proposed work will affect these phenomena may be very difficult or costly to assess technically and nearly impossible to quantify precisely in terms of monetized public benefit or damage. Nevertheless, an updated approach to defining "benefits" and "'damages"' in the drainage code can help greatly to integrate drainage and conservation goals.

D. Anticipating the Evolution of the Total Maximum Daily Load (TMDL) Program

Typically, work in public drainage systems is not subject to regulatory oversight for water quality and, therefore, does not incorporate measures specifically to limit water quality impacts. Over time, the Total Maximum Daily Load (TMDL) program is likely to change this situation.

The TMDL program, under the federal Clean Water Act, requires the MPCA to identify waters in the state that are not meeting water quality standards, identify pollutant sources contributing to this condition, and determine pollutant load reductions needed to bring the waterbody into compliance with the standards. Then, for each TMDL, the MPCA requires an implementation plan identifying specific actions to be taken to achieve the needed load reductions. For impaired watercourses or receiving waters that are within or downstream of a public drainage system, the drainage system likely is contributing to the pollutant load.

Presently, this process does not tend to result in legally binding obligations on pollutant sources for two reasons. First, implementation plans tend to be general. They identify categories of activity contributing pollutants to the impaired waterbody and categories of actions that can help to reduce pollutant load. Typically, they don't identify specific sources or assign specific pollutant reductions to those sources.

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Second, means to reduce pollutant load identified in implementation plans are not legally binding until they are incorporated into another, legally binding vehicle. Under its stormwater permitting program, the MPCA requires that measures identified in a TMDL implementation plan as applicable to a person or entity subject to a stormwater permit be incorporated into the permit. Drainage authorities that qualify as municipal separate storm sewer systems (MS4s) - those that own or manage stormwater conveyances within certain urban and urbanizing areas named by the MPCA - operate under general stormwater permits and therefore must incorporate load reduction measures as legally binding permit terms. However, for drainage authorities that are not MS4s (most outstate authorities), there is no such vehicle at present.

As TMDL implementation matures, it is likely that implementation plans will become more specific, and that the MPCA will create other vehicles for identified reductions to be imposed in a legally binding way on sources. If this occurs, then the regulatory regime in which drainage authorities operate will become somewhat more complicated and the additional regulatory burdens may need to be addressed within the drainage code.

A drainage authority operates a public drainage system. With respect to activities on the land that drains to the system, the drainage authority's role is limited to enforcing, where it applies, the requirement to maintain a vegetated buffer strip adjacent to the ditch. Minn. Stat. §103E.021, subd. 4. Otherwise, it does not control or regulate activities on the land. At most, in very limited ways and indirectly, the code provides incentives for landowners to limit pollutant movement into a system. E.g., Minn. Stat. §103E.315, subd. 6 (drainage authority may base a parcel's benefits on the sediment it contributes to the system). Actions within the system and this limited enforcement authority certainly can reduce loads to an impaired downstream waterbody. However, much of the load that a drainage channel conveys is best controlled by practices on the land.

Drainage authorities, such as watershed districts, counties or joint county boards, possess other police powers and often use those powers to regulate, outside of the drainage code, activity that may affect ditch systems. However, ordinances or rules typically are focused on protecting the physical integrity of the system by limiting actions that may cause bank erosion or channel instability. To our knowledge, the legal authority and willingness of ditch authorities to use their police powers to regulate adjacent lands for water quality purposes are untested.

As the TMDL program evolves, the MPCA could drive this question by imposing TMDL implementation plan obligations on drainage authorities and looking to those authorities to exercise jurisdiction over land-based activities contributing to pollutant loads carried by the drainage system. There is precedent for this in the obligations that the MPCA general permit imposes on MS4s to regulate stormwater impacts by private landowners within MS4 boundaries.

If there is a legislative desire to anticipate this evolution, the broadest question is whether a drainage authority, as the manager of a part of the state's surface water system, should be legally empowered to secure pollutant load reductions from lands draining to its system. If so, there are choices about the form this may take, ranging from regulation, to the use of financial penalties in assessing landowners for system maintenance and environmental compliance measures, to the authority to work with and provide financial incentives to landowners to improve practices.

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More narrowly, if TMDL implementation does follow this trajectory, the drainage code will need to address how a drainage authority will consider water quality obligations that are a condition of drainage work in assessing the benefits and costs of the work, and how the cost of meeting those obligations will be paid. And it will need to provide the tools that drainage authorities need to allocate those costs fairly to those who should pay them.

A drainage authority's role in implementing a TMDL is further complicated by the fact that the drainage system will drain road right-of-way and lands within one or more municipalities, both under the control of units of government that independently may be MS4 stormwater permittees. Or, this overlapping jurisdiction may allow a drainage authority to simplify its role. Instead of expanding the role of ditch authorities to include responsibility for activities on the land, ditch authorities could look to its road authorities to act under their MS4 permits, and to its municipalities to use their traditional land use authorities to reduce pollutant discharge into the drainage system.

By its assessment structure or structure of charges, a drainage authority could create incentives for municipalities to manage land uses to this end. A model for this exists in the drainage code: project benefits for land within an incorporated area, as well as maintenance costs for systems that serve as municipal stormsewer outlets, may be assessed against the municipality and left for the municipality to apportion among its property owners (Minn. Stat. §§103E.315, subdivision 2; 103E.411).

E. Ensuring Regulatory Requirements are Clear, Consistent and Appropriate

Oversight of drainage system activity for the purpose of wetland conservation occurs primarily through DNR regulation of impacts to public waters wetlands and WCA regulation of impacts to other wetlands. Public water wetlands, characterized more by open and standing water and more susceptible to being meandered, were recognized earlier in the state's history for the public benefits they provide. However, with our present understanding of surface water systems, we no longer presume that a public water wetland is by that fact alone of greater public importance or benefit than a wetland regulated under the WCA.

That these two wetlands fall under the jurisdiction of different regulatory bodies has its explanation in history but perhaps now lacks a compelling scientific rationale. This was implicitly recognized in 2000, when the DNR and local units of government that implement WCA were authorized to shift regulatory jurisdiction between each other. Laws 2000, c. 382, §17. This was intended principally to enhance efficiency and consistency where a proposed activity affects both public water and WCA wetlands.

DNR reviews potential public water wetland impacts under Minnesota Rules Chapter 6115 and less formal policies. WCA wetland impacts are reviewed by local government units pursuant to Board of Water and Soil Resources rules at Minnesota Rules Chapter 8420. The approach in both cases is similar, but there are differences in the details. Also, because DNR review relies to a greater degree on uncodified agency policies, it can be somewhat less predictable.

In addition, the Minnesota Pollution Control Agency (MPCA) reserves the right to exercise parallel authority over wetland impacts. Minn. Rules 7050.0186. And, as noted, if fill or a structure is to be placed in a channel or tile system, there may be USACE jurisdiction under Section 404. It should be

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mentioned, as well, that local land use authorities and watershed management organizations also retain ordinary police power authority to regulate impacts to wetlands under local rules and ordinances. Finally, work in drainage systems for the purpose of wetland conservation may trigger regulatory thresholds under federal water quality permitting by virtue of broad or ambiguous jurisdictional language in federal statutes and regulations. The MPCA implements this permit program by delegation from the U.S. Environmental Protection Agency.

Thus, wetland impacts are subject to the oversight of several different units of government under different statutes and rules. This introduces complexity into an effort to remove legal barriers to reconcile drainage and wetland conservation. To the extent that statutes, rules or policies should be adjusted to remove barriers, it means that several different regulatory authorities need to be engaged, and preferably to adopt similar regulatory approaches.

We have noted the potential value of adjusting the definitions of “benefits” and “damages” under the drainage law to incorporate benefits and damages to public wetland resources that would result from the proposed work. This is important both so that: (a) drainage authority decisions incorporate all relevant benefits and costs; and (b) costs are allocated fairly, as among benefited landowners and as between landowners and the general public. Predictability and consistency among regulatory authorities is important here as well.

The Minnesota legislature, of course, does not have authority over the USACE and its application of federal law under Section 404. However, there is active coordination among the USACE and state authorities, illustrated by a recent memorandum of agreement between the USACE and BWSR agreeing on activities qualifying as wetland impact mitigation and the amount of credit given for those activities. The USACE has within its Section 404 authority a substantial flexibility to facilitate approaches discussed in this report. A process that engages the USACE in developing consistent standards and procedures could be productive for both state and federal regulatory review.

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IV. DEMONSTRATION SCENARIOS

After a review of the drainage code, related water resource laws, and critical issues where the drainage code and potential conflicts with other laws create barriers to successful resource protection, the next step for this study was to identify three prototypical demonstration scenarios. The tension between drainage and conservation goals arise in particular land use settings. The study advisory committee assisted in identifying and developing three scenarios in which to explore these issues further:

SCENARIO A: Rural agricultural drainage system improvements

- aging drainage system;
- improvements in capacity needed;
- redetermination of benefits issues;
- need to analyze costs and benefits in different terms;
- private drainage, lands later brought into system;
- need to explore alternative funding mechanisms.

SCENARIO B: Rural agricultural drainage system and TMDL

- drainage system viewed as pollutant loading source;
- exploring conservation drainage alternatives;
- explore alternative funding mechanisms
- need for early engagement

SCENARIO C: Developing watershed

- beyond single parcel to subwatershed planning;
- comprehensive wetland protection & management;
- identifying high value wetlands, isolation from drainage system;
- integrating drainage system maintenance, improvements.

A. RURAL AGRICULTURAL DRAINAGE SYSTEM IMPROVEMENTS

Agricultural land owners in the Red River Valley have experienced ongoing flooding problems that jeopardize agricultural production and building sites. The flooding also causes temporary ponding on a county highway during larger storm events. The upper reach of the drainage system has an old meandering low-flow channel, and there has been a history of sloughing side slopes.

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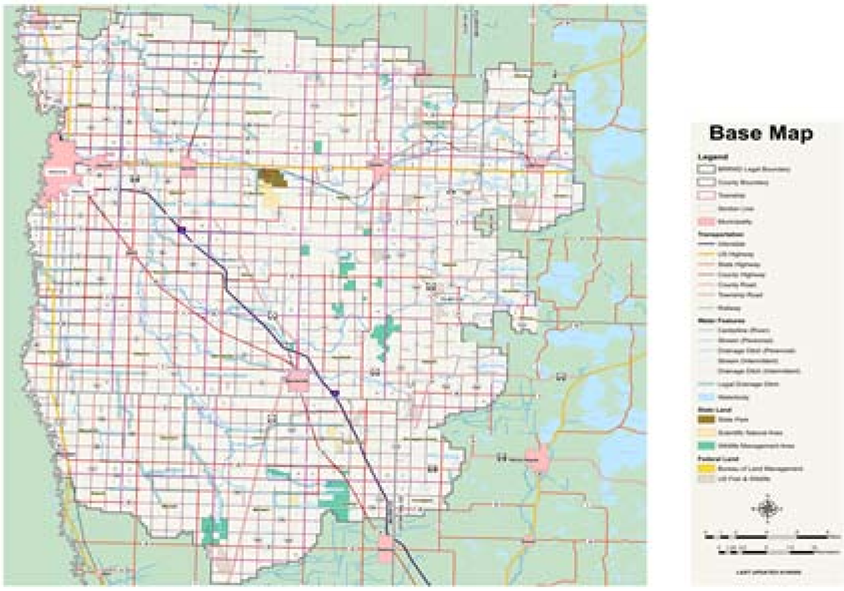
Bison Creek Watershed District



The land owners petitioned the local drainage authority, the Bison Creek Watershed District, to improve and extend Judicial Ditch 5, Branches 2, 3, and 5. All of the land owners along the proposed improvement and extension of Branches 2, 3, and 5 have signed the petition.

The watershed district's preliminary survey of Branch 2, 3, and 5 shows that the grade line of the ditch is nearly flat, that several culverts at the county highway crossing may be undersized, and that fallen trees and brush also impede the flowage in the drainage system. The proposed work would excavate Branch 2, 3, and 5, and extend each of them by another 0.5 mile or more to create a gradeline of at least 0.05% or steeper. Grass buffer strips 16.5 feet wide on each side of the ditch will be established along the entire length of Branches 2, 3, and 5.

The BCWD Engineer's report explores several possible alternatives to the proposed improvement and extension of Branches 2, 3, and 5, including detention of flood waters by resizing culverts, creating new detention basins, and restoring previously drained wetlands. A local chapter of Water for Waterfowl, a conservation organization, has appeared at several meetings to promote the wetland restoration concept. The District Engineer determined that all of these alternatives were less feasible or cost-effective.

The BCWD Engineer prepared a detailed survey report and plans from the proposed improvement and extension of Branches 2, 3, and 5, and submitted them to the Minnesota Board of Soil and Water Resources (BWSR) for an advisory report. The BWSR provided advisory comments, noting that the proposed new culverts and ditch channel capacity seem larger than necessary. The BWSR report also suggests that a two-stage ditch design, consistent with the characteristics of natural streams, would potentially result in reduced erosion and sedimentation, reduced nitrate loads, and also reduced ditch maintenance. A low flow channel designed for a two year return period, and a

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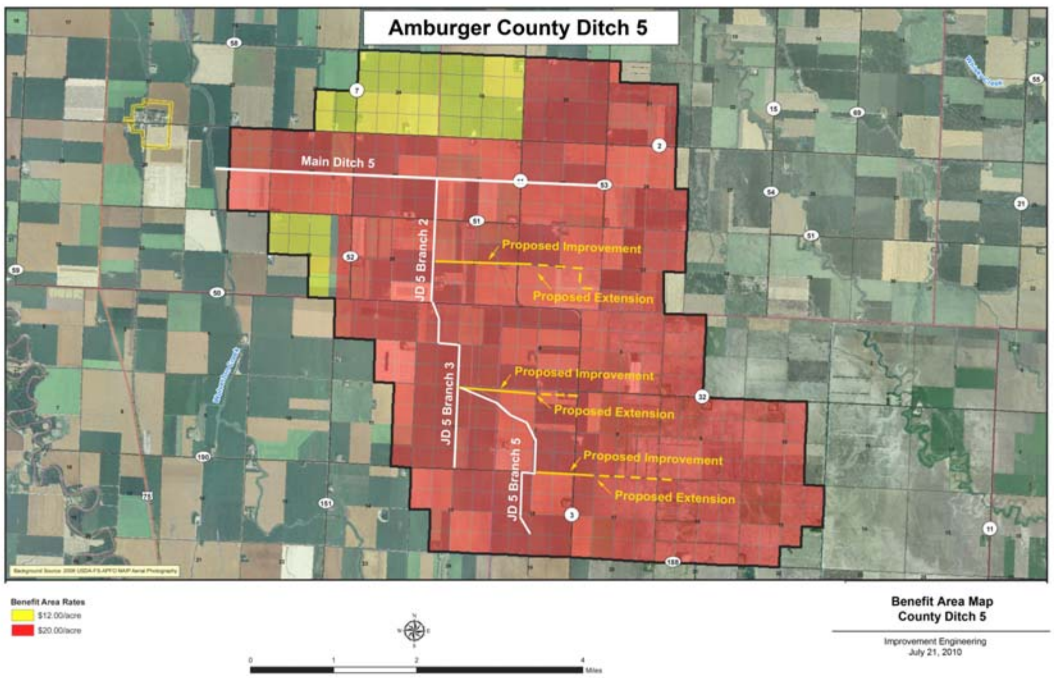
bench placed at that elevation, would manage most of the drainage volume, while the overall ditch could be designed for a five year or greater return period. BWSR also suggests that culvert sizing could be evaluated further to provide more management of downstream peak flows, while still providing adequate drainage in the affected area.



The BCWD Watershed Management Plan includes goals to reduce or alleviate damage caused by floodwaters, to administer and maintain public drainage systems, to protect and improve water quality, to reduce erosion and promote sedimentation management, and to cooperate with other governmental partners to pursue these goals. The BCWD Engineer and Board of Managers recognize that that the BWSR suggestions are consistent with these water management goals of the District, and also have technical merit. County highway improvements are also planned in the future, and the District is exploring how the road work may relate to the drainage project.

Nevertheless, the District is concerned that the conservation drainage suggestions from the BWSR could involve greater cost, or could reduce the efficiency of the drainage system. Some members of the Board of Managers are concerned that the petitioning land owners will strongly object to bearing these increased costs for what they perceive to be the same drainage benefits as the more traditional plan. One of the land owners has also pointed out that erosion and sediment is a much larger problem that involves more than just the owners along Branches 2, 3, and 5.

There are two additional motivations for conservation measures:

- The Red River Watershed Management Board has adopted a retention strategy to achieve 20% reduction in peak flow for the main stem of the Red River, and each

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watershed has a corresponding target reduction; accordingly, the RRWMB has encouraged the BCWD to incorporate retention in this project;

- The Red River Center for Environmental Urgency has brought lawsuits in the past to challenge drainage projects that in their view have adverse environmental impacts; the RRCEU is more recently a collaborator to help find comprehensive solutions; here, the RRCEU is encouraging the BCWD to incorporate retention, conservation drainage, and wetland restoration into the project; the RRCEU also presses for a more rigorous evaluation of the overall environmental impacts of the project and points to the goals of the BCWD plan for further support.

Following further deliberation, the BCWD explores how to incorporate the following additional conservation measures:

- 300 acre retention area, part of which is a wetland restoration that provides both retention and habitat benefits;

    - Perpetual Easement Costs: Straight RIM: $2,000 – $3,000 / acre (say $2,300/acre median); RIM/WRP: $2,500 - $3,700 / acre (median $2,900/acre)
    - Wetland Area Restoration Costs: $600 - $1,000 / acre (use toward the lower side for larger wetland restoration area)
    - Upland Area Restoration Costs: $300 - $400 / acre

- Two stage ditch construction in upper 10% of system; and

- Culvert sizing work in tandem with road authorities and near retention site.

The BCWD also identifies that there are multiple potential funding sources appropriate for these various project elements, as reflected in the following table:

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Project Element	Est. Cost	Funding Sources
Drainage improvements:	1,150,000	Drainage System (DS)
Upper watershed retention basin: and wetland restoration		Watershed Dist/DS
300 acre easement @ $2,600/acre	780,000	
150 acre wetl restor. @ $600/acre	90,000	
150 acre upland rest. @ $300/acre	45,000	
Two stage ditch sections;	40,000	Watershed Dist/DS
Road crossing improvements:	190,000	Road authorities
TOTAL:	2,295,000	

The integrated project combining drainage and retention yields multiple benefits, including peak runoff reduction and pollutant loading reduction. See Houston Engineering Inc. Memorandum of June 23, 2011, Appendix B, and Dr. Steve Taff, Economic Value Assessment, Appendix D.

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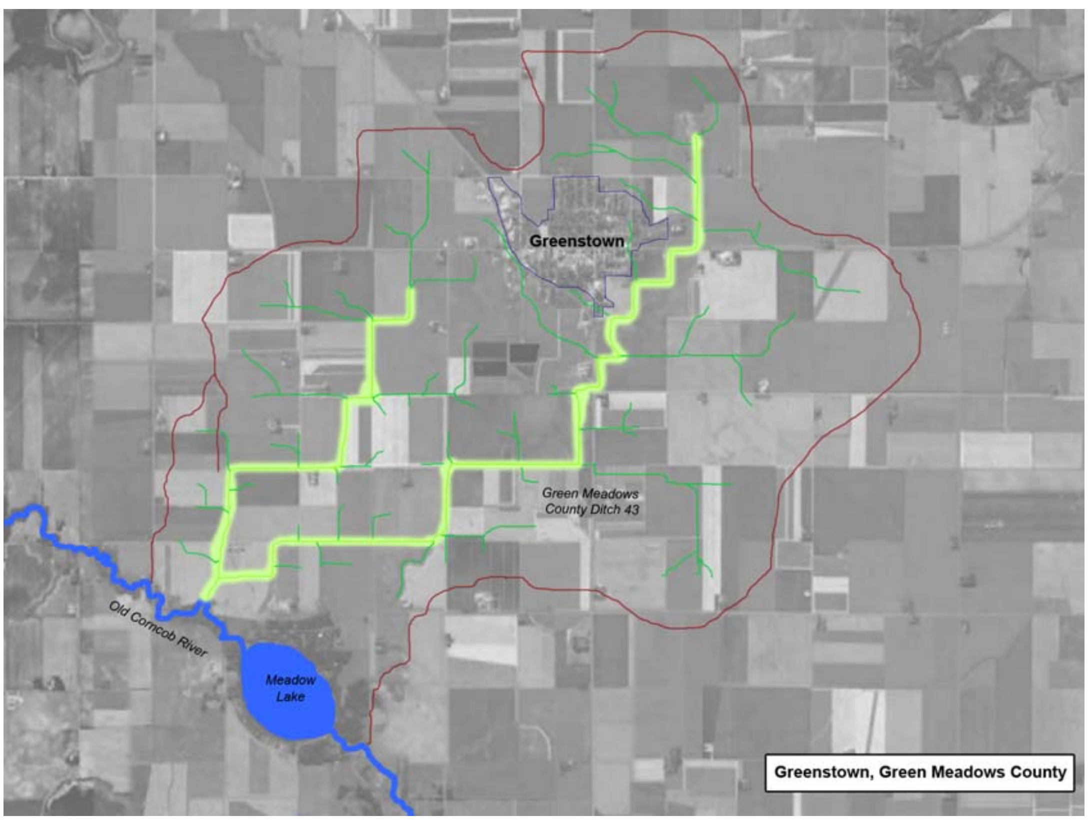
B. RURAL AGRICULTURAL DRAINAGE SYSTEM AND TMDL

Green Meadows County Ditch 43 drains nearly 7,000 acres of gently rolling hills. Ditch 43 constructed originally in 1919, is primarily a tiled system with an open ditch outlet. The ditch discharges into the Old Corncob River, which in turn is a tributary to the Minnesota River.

The land use in this watershed is mostly agricultural. The City of Greenstown is the county seat and is located in the center of the county. The Ditch 43 system has been altered significantly within Greenstown, as portions of the ditch are now either in practical terms abandoned or integrated into the city storm sewer system. The City's storm sewers discharge at several points into the drainage system, and its wastewater treatment lagoons also discharge into Ditch 43. As Greenstown population has grown, the volume of water discharging into Ditch 43 has steadily increased.

Most of the tiled sections of Ditch 43 are now in poor condition and in need of replacement. A number of agricultural land owners in the upper watershed of Ditch 43 are concerned with persistent flooding and crop loss problems. The Natural Resources Conservation Service (NRCS) guidelines generally indicate a minimum drainage coefficient of 0.75 inches per day for field crops in this area, but the existing drainage coefficients are in the range of 0.20 to 0.40 inches per day. The land owners have filed a petition with the Green Meadows County Board of Commissioners, which serves as the drainage authority, for an improvement to the Ditch 43 system in order to provide drainage capacity at the 0.75 inches per day recommended coefficient.



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At the lower portion of the watershed, the Old Corncob River drains into Meadow Lake. Meadow Lake has an active lakeshore homeowner's organization which has helped cabin owners with milfoil problems. A number of Greenstown residents own cabins or fish on Meadow Lake, and they are increasingly concerned about water quality. Many of the septic systems around the lake are outdated. Both Meadow Lake and the Old Corncob River are in the state's impaired waters list. Meadow Lake is impaired for nutrients, and the Old Corncob River is impaired for nutrients and turbidity.

As the TMDL process has begun for the Old Corncob River and Meadow Lake, several other organizations have become involved. Physicians Hunting Pheasants and Doctors for Healthy Ducks are two nonprofit sportsmen's groups which have joined with the Meadow Lake Association to advocate for water quality improvements. They have encountered a fair amount of initial conflict with the Corngrowers Guild and Soybean Society over the nature and causes of water pollution in the lake and river. The water quality advocates are also very concerned that the petition to improve the capacity of Ditch 43 will only make things worse.

Marilyn Goodheart is the local conservationist with the Green Meadows County Soil and Water Conservation District. She has worked for many years with farmers in the county to find cost sharing funds for small conservation projects. She has discussed the Ditch 43 improvement project with many of them, identifying water storage, two stage ditch sections, and other conservation measures that could be incorporated into the project. Most landowners, though, feel that it would be unfair for them to pay the assessments to cover these elements. They tell her that they expect to pay for the costs of improved drainage, but even in a good year, the price of corn doesn't pay them enough to justify bearing the costs of conservation measures, 'just so some fellows from Minneapolis can come hunt ducks once a year in Green Meadows County.'

Improvement & Repair Proceeding I: Traditional Approach

The Green Meadows County Board of Commissioners, acting as the Ditch 43 drainage authority, accepted the improvement petition from the landowners, and directed the Engineer to examine the drainage system and make an improvement report. The Board also noted that some of the proposed work would involve repair to the existing drainage system and therefore directed the Engineer, Charlie Bronson, to identify and allocate the costs of repair to be assessed against the owners of the entire system, and the costs of improvement to the owners benefited by the improvement. The Board also appointed viewers to assess benefits and damages.

The Engineer's Report briefly considered the "environment and land use" criteria of Section 103E.015, and concluded that the proposed work would not result in appreciable adverse impacts. The Board proceeded to hold a first a preliminary and then later a final public hearing on the Engineer's Report and the Viewers' Report. The Department of Natural Resources sent an advisory report that identified some concerns with potential impacts of the project and also highlighted opportunities for conservation measures for which Marilyn Goodheart had been advocating.

While the landowners continued to express their ardent support for the drainage improvements and repairs, the project became a source of big controversy in Green Meadows County. The Meadow

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Lake Association and the other conservation groups lobbied to get state agencies more involved in analyzing the project. Some advocates were talking about somehow using the TMDL process to "stop the Ditch 43 project."

Rodney Strong, the Chair of the County Board, told the crowd gathered for the public hearing that" it doesn't take a genius to see when you have a mess on your hands." He said that, as a farmer himself, he saw the need for drainage improvements, but it seemed like a good idea to pause on the project and see if there would be any chance of a compromise. At Chair Strong's suggestion, the Board tabled the matter for 60 days. He asked Marilyn Goodheart and the county ditch inspector, Greg Ostensen, to get a group together and see if they could come up with a different approach.

<u>General Principles: Commissioner Strong's Wise Counsel</u>

The next morning, Rodney Strong invited Marilyn Goodheart, Greg Ostensen, and Charlie Bronson to the local café for breakfast. He told them that he was getting tired of all of the drainage controversies, he was convinced it was time to try something new and different, and that he wanted the best work that Marilyn, Greg, and Charlie could provide. Commissioner Strong said he would give them some broad principles to work from:

1. *Green Meadows County's economy depends on agriculture.* We need drainage, and we need the drainage repairs and improvements to provide for productive lands, or 'there'll be hell to pay come next election.'

2. *We need to fix the pollution problem for Old Corncob River and Meadow Lake.* We can't argue with the fact that the river and lake are polluted. We need to restore water quality for ourselves, our children, and our grandchildren. And if we don't, sooner or later, some environmental group or state agency is going to make us do it anyway.

3. *We need a plan for the drainage system and the watershed.* The only way we can have drainage and address water pollution is with a good watershed plan that accounts for agricultural land uses, growth at the City of Greenstown, and the needs of natural resources.

4. *Find a way to spread the costs fairly.* You give me a plan that provides for drainage and clean water. Come up with some good ideas on how to pay for it without pinching either the drainage landowners or the general public too much.

5. *Don't confine yourselves to existing law.* What I want most of all is a good plan. We can either find some good drainage lawyers, or better yet, our Green Meadows County legislators are very influential at the Capitol. They can help us with any changes in the law that we need.

Marilyn, Greg, and Charlie told Commissioner Strong that these principles all sounded nice, but he was asking them to "pull a rabbit out the hat." Commissioner Strong took a long sip of coffee, and thought a moment. "Look, I know I'm pushing you folks hard," he said. "But I have been on the County Board for 32 years. I'm really tired of all of the drainage fights. Before I leave office, we're

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going to come up with a better way to do business, and I am counting on you to help me to do that."

"And if you can't, you better say so right now, and I'll go find me someone who is up to the job." Commissioner Strong gave them two weeks to do some homework, and report back.

The New Plan: Combining Conservation and Drainage Improvements

Marilyn, Greg, and Charlie sure enough did their homework and came back to Commissioner Strong with a plan to combine the drainage repairs and improvements with other conservation and water quality measures. The Engineer developed cost estimates for the various project elements, and they developed a basic framework to guide the funding:

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Project Element	Est. Cost	Funding Sources
Drainage repairs:	575,000	Drainage System
Drainage improvements:	210,000	Drainage System
Upper watershed storage basins:	250,000	City SWU/County/DS
Two stage ditch sections;	40,000	County SWU/DS
In-channel sediment storage;	30,000	County SWU/DS
Native grass buffers - open ditch:	30,000	County SWU/DS
Road crossing improvements:	190,000	Road authorities
TOTAL:	1,325,000	

Funding Notes

1. Benefitted landowners should be assessed for the costs of the repair and improvement as appropriate, and also for a contribution, say 10%, of the conservation measures.

2. The upper watershed storage basins are largely to manage impacts from City stormwater, and should be funded through a municipal storm water utility.

3. A "County Stormwater Utility" would likely require legislation, but would create a means of funding the conservation measures. Assessments in this utility could be based on phosphorus contribution from predominant land use types, or estimated volume of runoff. [Many technical details to address here.]

4. A system of incentives should be created for both city and rural land owners to reduce volume of runoff from their property and receive a corresponding credit to reduce assessment.

5. The TMDL could inform the development of the storm water utility in terms of allocating the phosphorus loading to different general sources within the watershed.

6. Assume that state grants may be available but are competitive and thus cannot be counted on as funding sources.

Again, an integrated project combining drainage and conservation measures yields multiple benefits, including significant pollutant loading reduction. See I & S Group Report of May 2011, Appendix C, and Dr. Steve Taff, Economic Value Assessment, Appendix D.

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C. DEVELOPING WATERSHED

1. Background

Eddson County lies at the eastern edge of the metropolitan area. Dander Township was settled in the 1880's and initially was dominated by row cropping and grazing. Between 1900 and 1918, Eddson County constructed a system of public ditches and tile to drain the lower part of the watershed. The system, with a number of private outlets, had mixed success in the peaty sands characterizing this area. The public system is known as Eddson County Ditch (ECD) 8 and outlets into Eddson Creek. **Figure 1** is a map of the area showing the ECD 8 alignment.

There is evidence of ditching and tiling activity on ECD 8 during wet periods over the next fifty years, on private lands and within the public system. Agricultural activity evolved over time to predominantly pasturing, haying and sod production. Homes were built on 40-acre lots. The drainage system continued to provide a measure of beneficial drainage. However, maintenance largely ceased apart from occasional work by the drainage authority to remove deadfall and debris, repair sloughing and localized tile failure, and clean out culverts under public and private ditch crossings.

Scattered urbanization began in the early 1980's, mostly at the top of the system in what was now incorporated as the City of Cosego. A number of parcels were platted and developed in two- and five-acre lots. With Interstate 24 nearby, the area became attractive to urban homeowners looking for lower land costs. The population of Cosego grew to almost 10,000, and in 2002 the Metropolitan Council programmed extension of a regional wastewater interceptor for construction in 2009-10. Property values in Cosego continued to rise and commercial developers eyed the larger parcels in the township visible from I-24.

With the crash of the economy, development largely stopped. When growth inevitably resumes, it may be more moderate. Replacement of less intensive land uses by residential and commercial development may follow a much more gradual trajectory. But the communities would like to be prepared.

The Eddson Creek Watershed District (ECWD) is the drainage authority for ECD 8. It also levies *ad valorem* taxes for water quality and conservation projects, issues permits for development, and is the governmental authority implementing the Minnesota Wetland Conservation Act within both communities.

2. The Land

The lower watershed is rich in surface water resources. The Dander Wildlife Management Area contains a 118-acre Type 3/4 wetland favored by hunters and birders. There are a variety of wetland types following the watershed gradient, with interspersed uplands and isolated depressional wetlands

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in the glacial landscape. Many wetland acres were partly or entirely drained for agriculture, but many have reestablished themselves and others could be restored. **Figure 2** shows wetland and soils conditions within the watershed.

As the watershed rises moderately toward Cosego, there is less water on the landscape but the soils become tighter and less well drained. The ECWD is concerned about downgradient flooding as the higher land develops. Also, it sees a potentially rich wetland resource in the lower watershed that retains high-functioning areas and restoration potential. This resource is at risk of being further fragmented and degraded with development and increased stormwater flows from higher areas. The interstate bisects this area. When the economy improves, local legislators' pressure for interstate access will intensify. Access design within this wet landscape would be challenging.

Several agricultural landowners in the lower part of the system wanted ECD 8 to be cleaned out to reestablish the drainage system as constructed. Development in Cosego, at the upper end of the drainage system, has increased the amount of stormwater flowing into the system and the peak rates of flow. The landowners believed that their lands were taking longer to dry out after rains and that this was due to greater demands on the system from the urban development above. They feared this would only worsen as Cosego continues to develop.

Also, they were hopeful that the economy would rebound in time for their land to serve as their "retirement fund." They wanted to establish the right to as much upland as possible in anticipation of a renewed development interest in their lands.

However, if ECD 8 were excavated to the same depth and dimensions as originally constructed, there would be substantial drainage of the Dander WMA and drainage of other wetlands within or near the system. Many of these wetlands were drained in the earlier part of the 1900's, after the system was constructed and contributing lands were ditched by farmers. But over the course of the past 50 years, the absence of diligent maintenance caused the hydraulic efficiency of the system to decrease. As a result, these surface water features reestablished themselves.

At the same time, extensive peaty inclusions in the area soils raised questions about how predictable the drainage effect of a repair would be within this flat, scattered wetland terrain. And this, in turn, raised another question. Proposed impacts on wetlands, either draining them or filling them for development, would need to go through regulatory review. Some impacts would be subject to review under WCA. Impacts to wetlands qualifying as public waters would require Department of Natural Resources approval. Also, the U.S. Army Corps of Engineers might have authority over some wetland impacts under Section 404 of the Clean Water Act. Given the uncertainty as to how the landscape would respond to an ECD 8 repair, permit review also carried the risk of a complicated technical debate and an uncertain outcome. Questions, then, about the ability to clean out the drainage system, how successful it would be in creating developable upland, and the timing of regulatory approvals suggested that the market value of these lands for development might not be quite what the landowners would like to think.

Finally, local conservationists were concerned about fragmentation of ecological resources in this part of Eddson County. There was fear that property owners would force a drainage repair with substantial wetland impacts and that as development occurred, fragmented wetlands would be filled

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to allow for development sites to be created. Conservationists had allies in the MnDNR and the local chapter of Ducks Unlimited, which were concerned about impacts on the Dander WMA and surrounding habitat.

3. Repair Proceeding I: Conventional Repair

To undertake a repair, the drainage authority first must make certain findings. In short (and a bit oversimplified), owners of lands originally assessed to build ECD 8 may obtain a repair if the economic benefit to their lands from the repair would exceed the cost of the work (Minn. Stat. §103D.715). Because environmental compliance costs are paid by the landowners, the cost of the work includes the cost to replace drained wetlands under state and federal laws.

The ECWD suspected that landowners would have a right to repair. Systemwide repair, just to allow consistent flow through the system, could improve soil moisture conditions without greatly affecting wetlands or triggering large compliance costs. Further, given the transitioning land use, the higher land value for development was likely to justify any repair that would add even modestly to buildable upland.

However, for several reasons the ECWD did not believe a repair proceeding would be the best way to sort out the drainage situation in the subwatershed:

- First, the ECWD could foresee the administrative costs and challenges of a repair proceeding. Assessing landowners' legal right to a repair would begin with the original elevation, dimensions and profile of ECD 8. But the original construction records were incomplete. It was clear that over the course of a century, the ditch was deepened and widened in places, but available records didn't show that the drainage authority approved the work. Without drainage authority approval, these improvements didn't legally "count" and only confused the ability to ascertain the as-constructed baseline.

- Second, under drainage law the cost of the repair would be assessed to benefited landowners in the same proportions as the assessment for the original construction. In 1912, land at the top of ECD 8 required the drainage least and was assessed the least. However, much of that land long had been subdivided. Now it benefitted substantially, by virtue of the need for developed parcels to move water quickly. It seemed clear that in advance of the repair project, the ECWD would need to retain viewers to redetermine the allocation of benefits as among all lands served by ECD 8. This would be an expensive process and would require valuing benefits for agricultural lands, urbanized lands and lands presently in agriculture but likely to be valued for development in the near future.

- Third, additional development in the upper part of the watershed would mean more water moving through ECD 8 and the Dander WMA. The system was designed, 100 years ago, to drain regular, lower-magnitude rainfall events from cultivated soils. However, a system serving urban development needs to manage peak events such as the five-year, 10-year and 100-year events from an area with a high proportion of hard surface. The ECWD

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recognized that ECD 8 was not designed to do this, and that even with a cleanout, the system was limited in its ability to serve urban development.

- Finally, a repair could reinstate beneficial drainage for less-intensive agricultural uses within the lower part of the watershed. But it was not an optimal tool for landowners seeking development value for their land. In conjunction with private tiling, a repair could reduce soil moisture adjacent to system inlets by efficiently conducting away water from ordinary precipitation events. But the original system was not designed to reduce the 100-year flood elevation within a larger contiguous area that determines the footprint of developable land. A repair, then, would benefit continued agricultural use in the lower part of the system, but would be only of limited value for future, more intensive uses of the land.

Ultimately, a repair petition (Minn. Stat. §103E.715) was filed with the ECWD by several landowners in the lower part of the watershed. As required, the ECWD Board of Managers directed its engineer to prepare a repair report showing the repairs and their estimated cost.

The engineer's task was to assess how excavating the ditch to its original depth and dimensions would affect the drainage of adjacent lands, and how much it would cost to do the work. There would be the cost of the excavation itself and the disposal of the dredged sediments. But there also was the uncertain cost to replace wetland resources drained by the maintenance.

WCA and Section 404 both include exemptions that allow wetland to be drained in the process of maintaining public drainage systems:

- Under WCA, type 3, 4 and 5 wetlands that have existed for 25 years may not be drained without replacement, but all other wetlands may. (Cultivated lands also may be drained as well; this exemption did not apply within the ECD 8 subwatershed.) Any wetland meeting the criteria for a "public water" (Type 3, 4 or 5 wetland, at least 2.5 acres in size within Cosego or 10 acres in size within Dander Township, Minn. Stat. §103G.005, subd. 15a) is protected by the DNR and may not be drained without replacement.

- Section 404 also allows wetlands to be drained without replacement, provided the draining is the result of ongoing work on a regularly maintained drainage system. Once wetlands are reestablished within a system in which maintenance has lapsed, they may not again be drained without replacement.

Further, the ECWD could realign the system in places (Minn. Stat. §103E.701, subd. 6). This could reduce drainage of adjacent wetlands and the accompanying cost to replace them. But this would reduce the amount of beneficial drainage, increase construction cost and require additional right-of-way from private landowners. In Eddson County, the ECWD was looking at replacement costs of about $35,000 per wetland acre, reflecting recent payments for banked wetland credits in the county. Alternatively, the ECWD could negotiate with landowners for flowage rights and construct replacement wetland on its own. It would do this most readily by disabling private tiling.

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The second challenge faced by the engineer was to fix the bottom elevation and cross-sectional profile of the ditch channel as it was originally constructed. The engineer obtained core samples of soils beneath the channel bottom and did field work to locate survey benchmarks referenced in the 100-year-old engineer's report. This work cost a fair sum, and some of the evidence was ambiguous, but the engineer felt that its reconstruction of the original system dimensions had a reasonable foundation.

However, any repair that might affect the level of a public water requires that both the DNR and the county conservation district agree on the repair depth (Minn. Stat. §103E.701, subd. 2). At the same time, the public waters law says that if the state owns a public waters wetland on or adjacent to the drainage system, it is responsible for any work needed to protect the wetland while allowing the system to function (Minn. Stat. §103G.225). The ECWD thought that the DNR's financial interest, combined with pressure from its wildlife habitat constituency, might affect its position on an acceptable repair depth. The law was not clear on what happens if there is not consensus on the repair depth; impasse was a possibility.

One additional uncertainty remained. For all of the above reasons, the engineer was certain that a full repair, returning the system to its as-constructed dimensions, could not be justified by the ECWD Board of Managers. He expected, on the other hand, that less extensive work would still improve drainage to an extent and could be cost-justified. However, the statute (Minn. Stat. §103E.701, subd. 1) defines "repair" as a restoration of the system to its original conditions. The ECWD and its engineer were not certain that they had the authority under the petition process to evaluate anything other than a full repair to the original grade and dimensions.

Nonetheless, in addition to a repair to the original grade and profile, the engineer evaluated a second approach. This approach would involve moderate removal of sediment and obstructions sufficient to establish a flow gradient through the system, but without causing impact to wetlands and triggering the substantial replacement cost for that impact. The engineer estimated repair costs by assuming that the DNR would accept a very limited lowering of the Dander WMA or would provide funds to realign some 500 feet of channel to avoid that effect.

Finally, the ECWD faced questions of fairness in how repair costs would be paid. Under the drainage law, costs are paid by benefited landowners in proportion to assessment of the original costs of construction. Original benefits were determined 100 years ago based entirely on the impact of drainage on cultivation. Lands in the lower part of the watershed benefited most and were assessed at higher rates. However, the system now was serving as a stormsewer system for many smaller developed lots on higher ground in Cosego. Further, the Dander WMA and other wetland resources were providing hunting and recreational benefits to many folks from outside of the subwatershed and regionally. More broadly, some argued that preserving the ecosystem served a wide public interest and should be supported by state funds from the DNR or otherwise. This raised the question of whether it was fair to impose all of the costs to preserve these resources on the properties benefited by the drainage system.

4. Outcome: Conventional Repair

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The engineer's modeled outcome of the conventional repair is depicted in **Figure 3**. The wetland impacts and repair costs are included in **Tables 1 and 2**.

The cost of this repair, encompassing an average two-foot depth of excavation through the system, is an estimated $5.57 million. This cost includes a measure of crossing repairs and replacements, with private crossings an expense of the system and public crossings the responsibility of the road authorities. On top of this cost is the cost to replace non-exempt wetland acres. Some 135.2 acres would be drained, and another 12.5 acres partly drained, under the WCA exemption and would not require replacement. However another 232.5 acres of non-exempt Type 3, 4 and 5 wetlands would be partly drained and would require replacement. The replacement cost for this acreage is estimated at $8.14 million.

As **Figure 3** shows, the result of this expense would be to drain or reduce moisture on corridors in proximity to ditch or tile. With inclusions of poorly drained soils throughout the lower part of the watershed, the width of these corridors will vary. Private pattern tiling will extend the scope of drainage for agricultural use, but will not support upland assembly for large-parcel development. As **Figure 3** shows, floodplain will remain distributed throughout the lower watershed absent very aggressive pattern tiling that would not function to control groundwater for more intensive land uses. Therefore, this repair would be compromised in its capacity to enhance land value for development. If an interchange is built at I-24, no WCA exemption will apply and MnDOT will be subject to WCA requirements to explore alignments that limit wetland impacts and replacement obligations.

The conventional repair, further, risked getting caught up in procedural complexity and disagreement.

First, a redetermination of benefits would be needed before the cost of the work could be assessed. The Board of Managers would need to assess relative benefits as between municipal users at the top of the system and agricultural users at the bottom. Determining benefits for development on uncertainly drained lower lands could be contentious. Further, as a result of the redetermination, land for vegetated buffer strips along the ditch would need to be acquired at substantial administrative and potentially legal cost (Minn. Stat. §103E.021).

Second, the conventional repair as modeled would partially drain several public waters wetlands including the Dander WMA wetland. The DNR would be likely to object and disagreement on repair depth could preclude the work or delay it for some time.

5. Outcome: Limited Repair

The engineer's modeled outcome of the limited repair is depicted in **Figure 4**. The wetland impacts and repair costs for this alternative are shown as well in **Tables 1 and 2**.

The limited repair carries a proportionately reduced excavation cost, estimated here at half the material and half the cost of the conventional repair. The repair is defined as that which would provide the greatest extent of positive flow without draining non-exempt wetlands. Therefore, there

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would be no wetland replacement cost. Compared to some $13.71 million for the conventional repair, the cost for the limited repair is estimated at just $2.79 million.

In addition, the limited repair was more likely to avoid objection from the DNR and hunting and conservation interests.

However, as **Figure 4** shows, the moderate effectiveness of the conventional repair, particularly for a transition to more intensive land use in the lower watershed, would be even more compromised by the limited repair. The lateral effect of the cleanout would be more narrow, resulting in less fully drained land and a slightly larger urban-area floodplain, as compared with the conventional repair. This approach also would not help to reconcile the conflict between development and resource protection lurking at the site of the I-24 interchange.

6. Repair Proceeding II: Watershed-Based Management

After receiving the engineer's report, the ECWD Board of Managers paused to ponder the bigger picture. Under a 100-year-old law, it had begun a proceeding limited to the question about how deep to dig a 100-year-old ditch. But the uses of the land and the needs to be served were more complicated now.

An urbanized area at the top of the system was sending storm runoff into the system much more quickly, with little discharge at other times. With further growth, this feature of the watershed's hydrology would be accentuated. It made more sense to control those peaks than to design a conveyance system that would be large enough to contain them but, as a result, would be oversized most of the time. At the bottom of the system, there was a need to manage soil moisture for agricultural use. But there also was a future in which what the conveyance system really would need to do would be to define the 100-year-floodplain and protect land above it by maintaining groundwater separation. All of this, at the same time, recognizing the ecological and other public benefits of the shallow water-land interface.

The Board of Managers asked for further study of the ECD 8 subwatershed to understand how water moves through the watershed and how this could fit with both productive use of the land and the watershed's ecological health.

The engineer modeled watershed hydrology. This included surface flow (hydrologic model), groundwater flow to the drainage system (lateral effect model), and flow within ECD 8 itself from its private segments to its outlet at Eddson Creek (hydraulic model). The engineer did this for present conditions, and also for a future scenario in which both the lower and upper parts of the subwatershed were built out for their planned land uses.

At the same time, the engineer assessed wetlands and areas of former wetland within the watershed for the extent to which they contributed or, with restoration, could contribute to the functioning of the hydrologic system. The engineer used a wetland method approved by the Minnesota Board of Water and Soil Resources to evaluate the wetlands' capacity to:

- Retain flood waters and stormwater

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- Augment low flows
- Trap and assimilate sediments and nutrients
- Provide aquatic, riparian and plant habitat
- Serve public recreation purposes including hunting, fishing and wildlife viewing

(Minn. Stat. §103B.3355.)

Some areas of wetland or restorable wetland were identified as highly valued for their role in the ecologic and hydrologic systems within the watershed. Others were isolated or quite degraded without sound restoration potential. These were identified as less functional. **Figure 2** is a simplified depiction of the results of the wetland functional assessment.

This inventory and assessment was the foundation for a comprehensive wetland protection and management plan (CWPMP). This is an alternative watershed-based regulatory approach authorized under Minnesota Statutes §103G.2243. Under this statute, the ECWD could replace the standard WCA rules at Part 8420 with a tailored set of rules to manage wetland impacts within the defined watershed encompassing the drainage system.

In place of "standard-issue" replacement requirements under the regular WCA rules, the ECWD could fashion rules with incentives to avoid impacts to higher-value wetland resources and to replace impacts to other wetlands in a way that would enhance those resources. In addition, the drainage system alignment also could be adjusted to avoid sensitive wetland/groundwater areas and better serve developable areas (Minn. Stat. §103E.701, subd. 6). The Board of Managers felt that if this approach were coordinated with local zoning and the development intentions of landowners, the system could be managed to:

- Provide the "targeted" drainage needed to consolidate upland and enhance the development value of the lower lands, and

- Allow the ECWD and landowners to collaborate in restoring and preserving higher-value wetland resources where they are best situated in the landscape.

The engineer started from the "limited repair" scenario in the engineer's report. This scenario reflected the most extensive drainage system repair that would provide a net benefit to landowners and so, in theory, be legally approvable. Therefore it constituted the drainage baseline that landowners could expect under conventional drainage law. The ECWD's intent was to define its outcomes and develop its rules in a way that would demonstrate economic benefit to landowners, improved tax base, and an enhanced wetland resource through the use of a CWPMP.

During this time, ECWD staff coordinated with planners for Eddson County as the zoning authority for Dander Township and township officials. This allowed the ECWD to better understand development plans for the lower subwatershed, and gave input to the county and township about guiding development and programming roads to avoid sensitive areas. Any adjustments to the comprehensive land use plans of these authorities would need to be consistent with the Metropolitan Council's plans for wastewater service to Cosego.

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As the ECWD engineer worked with staff to develop a framework, several questions emerged:

- The location of wetland impact and an opportunity to protect or restore high-quality wetland might not co-exist on the same parcel. It would be important to have a mechanism by which a property owner causing wetland impact could contribute to enhancement of high-quality resources even when those resources were located on another property.

  The ECWD considered several ways to do this. In its rule, it could allow wetland replacement credits to be created and "banked" by a landowner, and allow another landowner to purchase them in a private transaction. However, within this single subwatershed there might not be a sufficient "market" and credits might not be available in a timely way. It could collect a fee from a property owner lacking an on-site replacement opportunity and use the funds to perform wetland work itself, by agreement with another property owner or by using eminent domain to acquire flowage rights. Or, the zoning authorities - Eddson County and the City of Cosego - could adopt ordinances allowing development rights to be transferred between parcels. This would allow for owners of higher-valued wetlands to host more extensive protection and restoration efforts and be compensated by increased development value on other lands.

- With CWPMP authority, the ECWD could customize an approach to managing impacts to WCA wetlands. However, the DNR would keep all of its existing jurisdiction in regulating impacts to the Dander WMA wetland and the other public waters wetlands. There was no guarantee that the DNR would agree to the watershed-based regulatory approach of the CWPMP. Also, although it was rarely exercised, the Minnesota Pollution Control Agency held its own authority to regulate wetland impacts (Minn. Rules 7050.0186).

  As far as the ECWD could tell, the public waters wetlands within the watershed could be managed consistent with the CWPMP. The DNR could waive jurisdiction over those wetlands so that they would be treated like WCA wetlands under the CWPMP (Minn. Rules 8420.0105, subp. 2.E). Or, the DNR could adopt a parallel framework for impacts to public waters wetlands consistent with the CWPMP. But this second approach might require a rulemaking process just for the purpose of the ECD 8 watershed.

  Without one of these steps, there would be less ability to separate development and resource areas. Also the CWPMP would be less predictable due to ambiguity in the public waters laws and the DNR's discretion in applying them. The law seemed to make the DNR responsible (at state cost) to take any steps to protect a public waters wetland from draining due to ditch repair (Minn. Stat. §103G.225). However, that would be the case only for public water wetlands on or "adjacent" to ECD 8 (an undefined term) and might or might not apply to wetlands affected by a realigned section of ditch. It also was unclear whether the DNR could require wetland replacement for any impact to a public water wetland subject to this statute.

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This was made even more ambiguous by a statute that provides for the drainage authority to compensate the state for any "taking" of land or water area owned by the state (Minn. Stat. §103E.025). Finally, it was unclear whether the DNR could simply prohibit any repair action that might drain a public waters wetland (Minn. Stat. §103E.701, subd. 2).

- The CWPMP also did not in any way affect federal wetland requirements under Section 404. The ECWD did not know to what extent the USACE would be able or willing to adopt a watershed-based framework consistent with the CWPMP.

  The ECWD was aware of the USACE policy allowing for the creation of Special Area Management Plans (SAMPs). Similar to the CWPMP, a SAMP rests on understanding wetland resources on a hydrologic system basis. Section 404 permit requirements then can be customized to allow for development while protecting important wetland resources. However, the Section 404 regulations require an applicant to evaluate alternative development approaches to avoid the proposed wetland impacts. Typically, this cannot be done until a particular development goal is articulated for a specific parcel. The SAMP works best for a defined area where the zoning authority is steering development. The ECWD was working for strong integration between the CWPMP and the long-range comprehensive land use plans of Eddson County and Cosego, but neither of these zoning authorities intended to drive the market and neither had the resources for the intensive planning exercise the SAMP might require.

  Short of creating a SAMP, in a couple of cases the St. Paul District had coordinated with a watershed district to establish a consistent scheme to measure wetland impacts and credit wetland replacement. The ECWD thought that if the USACE were willing to accept the science underlying the CWPMP, it might agree to a consistent regulatory framework that would help reduce the uncertainty of duplicate regulation. This, in turn, would help preserve the "predictability" valued by landowners under the CWPMP.

- Finally, under WCA, a state agency self-regulates as to wetland impacts on land it controls (Minn. Stat. §103G.005, subd. 10e). If MnDOT were to expand I-24 or construct an access affecting the wetland area, the agency would self-regulate for those impacts and they would not be managed under the CWPMP framework.

Ultimately, the ECWD adopted a CWPMP and a set of wetland rules to implement it. By varying replacement ratios, the rules created a strong incentive to limit impacts to higher-value wetland areas and encouraged replacement for impacts to focus on enlarging and enhancing those areas. The rule required replacement to be within the watershed and gave credit for stormwater peak retention measures such as biofiltration in the upper watershed. The ECWD engaged the USACE and got informal but written concurrence in the replacement framework of the CWPMP rule.

The rule also created a framework for banking credits, although the ECWD Board of Managers was skeptical that this would see much activity. In addition, the rule allowed property owners without access to higher-valued wetland replacement opportunities to pay a fee equal to replacement cost into a fund the ECWD would use to perform wetland protection and restoration work itself.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

The Board of Managers then had the engineer review the repair scenarios. The engineer revised the alternative repair scenario to include two realigned sections to limit wetland drawdown and create larger contiguous upland areas for development. This was the scenario adopted by the Board.

The ECWD now had a framework for the watershed that gave consideration to several sets of interests. It provided drainage system benefits by establishing a repair regime to maintain flow through the system while both creating incentives to manage peak flows in the upper watershed and using floodplain storage to accommodate those flows. It established a wetland management framework that would allow for drainage system realignment and selective wetland fill as lower-watershed uses shifted from agriculture to large-parcel development. And it recognized the public benefits of a healthy wetland resource and created incentives to protect and enhance the resource.

In part, the ECWD would implement the CWPMP by maintaining the drainage system and replacing the wetland loss caused by system maintenance. The CWPMP otherwise would be implemented as urban development in the upper watershed and large-parcel development in the lower watershed progressed. Developers would aggregate upland and wetland resources in pursuit of development plans and would limit peak flow increases in the system by retaining water in the upper watershed for replacement credit. The ECWD could make further choices, in its discretion, to spend funds on independent wetland restoration activities within aggregated wetland resource areas. State funds might be available as well, for example for realignments to avoid impacts to public waters wetlands.

The Board of Managers quickly concluded that it would not be appropriate to require landowners assessed for ECD 8 to fund all of these activities. Further, it determined that its activities to maintain the drainage system for these multiple purposes would be administratively simpler to fund by way of a utility charge system rather than through special assessments under the drainage law. Accordingly, it elected to use several revenue mechanisms:

- A water management district bounding all parcels draining into ECD 8 was created (Minn. Stat. §103D.729). Annual charges would be collected against these properties for all repair and maintenance work on ECD 8 including wetland replacement costs. The Board of Managers determined a methodology to split costs among the developed areas of Cosego and the less intensively used lower watershed parcels.

- The ECWD also planned to charge the upper watershed more specifically for the cost of retention above ECD 8 not accomplished by developers' actions for replacement credit. It intended to work with Cosego and, preferably, allow Cosego to assume responsibility for retention using stormwater charges or development fees.

- Concluding that broader public benefits were involved, the Board also established a policy to use watershed-wide *ad valorem* funds for a part of the wetland preservation work required to minimize impacts from the repair. Other ecosystem work would be funded by landowners as regulatory compliance during development.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

- Finally, the Board of Managers remained uncertain as to the role the DNR would play or the funds it would provide for public waters wetland protection, but any funding would be used to offset local property taxation.

7. Outcome: Watershed-Based Approach

The modeled outcome of the watershed-based approach in shown in **Figure 5.** Wetland impacts and cost estimates for this approach are included in **Tables 1** and **2**.

The watershed-based plan preserves the hydraulic efficiency of ECD 8 at the same level as the limited repair. This is done by utilizing wetland and floodplain storage within expanded wetland corridors and thereby reducing the need to excavate channel materials. The rules establish expectations that allow for isolated, lower-value wetlands within the lower watershed to be filled.

Initially, agricultural lands in the lower watershed were able to continue existing uses by virtue of basic limited repair of the lower system. As property owners transitioned those lands to large-parcel development, they were able to take advantage of replacement ratios in the rules to fill depressional wetlands and replace filled-wetland acres and function. In exchange, wetland and adjacent vegetated buffer within the designated higher-valued corridors were augmented. MnDOT approached interchange construction similarly.

The CWPMP at core is a wetland regulatory structure. The structure creates flexibility that allows drainage capacity to be maintained and allows for land use and development in conjunction with protecting the wetland resource. Beyond the regulatory structure, however, and by virtue of the understanding of watershed hydrology that is the foundation of the watershed-based approach, land use and water management decisions can be better integrated. Stormwater conveyance and peak management needs for the urban area can reflect an understanding of the capacity for natural systems downgradient to assimilate peak flows and nutrients. The city, the watershed district and other public bodies with capital funding can work with landowners to address localized flooding and enhance ecologic resources.

Figure 5 denotes substantial ditch realignments in two locations to circumvent large public waters wetlands, including within the Dander WMA. This is driven by the incentive to limit compliance costs and to avoid administrative delay or impasse. Of the $2.81 million watershed-based approach in **Table 2** for "Compliance & Conservation," $1.99 million represents the cost of these realignments. However, it also is a means to improve the ecologic values of the wetland systems (and, consequently, their public recreational values) by separating these wetlands more decisively from the drainage system.

Table 1 indicates 148.3 acres of impact to exempt wetlands under the watershed-based approach. This reflects CWPMP implementation as shown in **Figure 5**, where the impacts largely result from wetland filling and draining in the process of development by property owners and MnDOT. Much of this wetland impact in fact may not be exempted because it will not be the necessary result of drainage system repair; however, the cost of replacement will be a private or road authority cost, and not a cost to the drainage system. It will be undertaken as a voluntary development decision.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
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Table 2 includes a column titled "Urban Peak Management." This column denotes costs that will be incurred by the City of Cosego and developers to build stormwater retention facilities sufficient to maintain peak runoff rates for the 100-year event under the city's build-out. This cost is reduced to the extent peak flow can be managed in downstream natural systems without ecologic impact. This capacity depends on the attributes of the system in question. Under the watershed-based approach, the ECWD is in a much better position to evaluate this opportunity and to help reduce public costs for runoff management.

Similarly, while some wetland systems release phosphorus into surface waters that flow through them, others can be effective nutrient uptake systems. **Table 2** includes an "Avoided Stormwater Management" column showing a potential benefit of $2.56 million for the watershed-based approach. This number reflects the added flowed-wetland acreage under CWPMP implementation and the assumption of average phosphorus assimilation capacity for those wetlands. This number reflects the potential avoided infrastructure costs for water quality treatment that may be required under a Total Maximum Daily Load, nondegradation requirement or other regulatory obligation for the City of Cosego.

This scenario, and the costs reviewed above, are wholly illustrative. Each watershed - its hydrologic systems and land use needs - will be unique. The chief characteristics of the watershed-based approach are: (a) the foundational understanding of watershed hydrology and land uses and (b) the back-end flexibility to use regulation and capital/project funding to reduce conflicts and optimize both economic and ecologic outcomes. Essential to this is a range of funding authorities that can allow the drainage authority to allocate costs in accordance with benefits. In this scenario, this includes owners of agricultural lands, property owners within the urban area, and the broader publics benefitting from the recreational and ecologic properties of a well-managed hydrologic system.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

FIGURES

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
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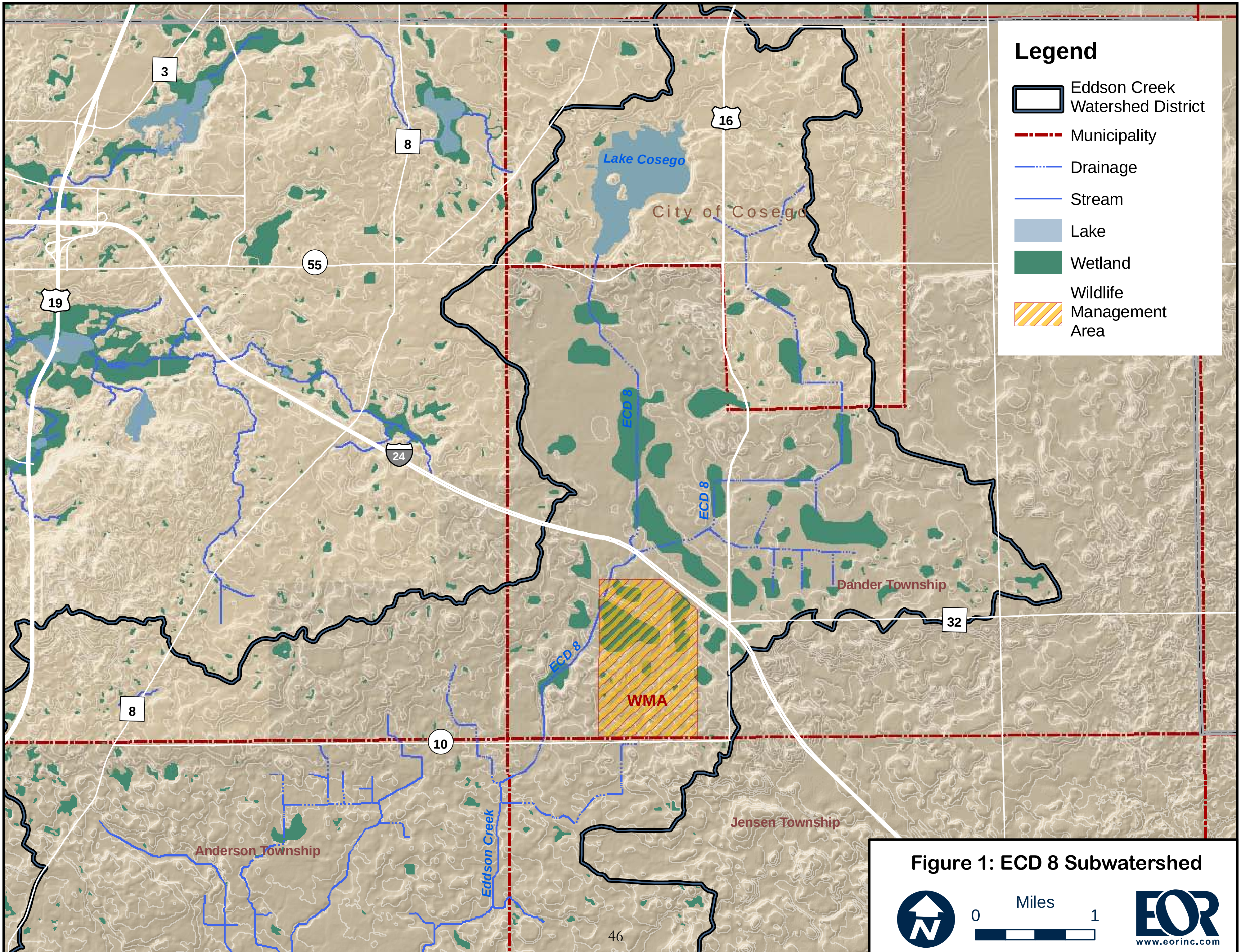

Figure 1: ECD 8 Subwatershed

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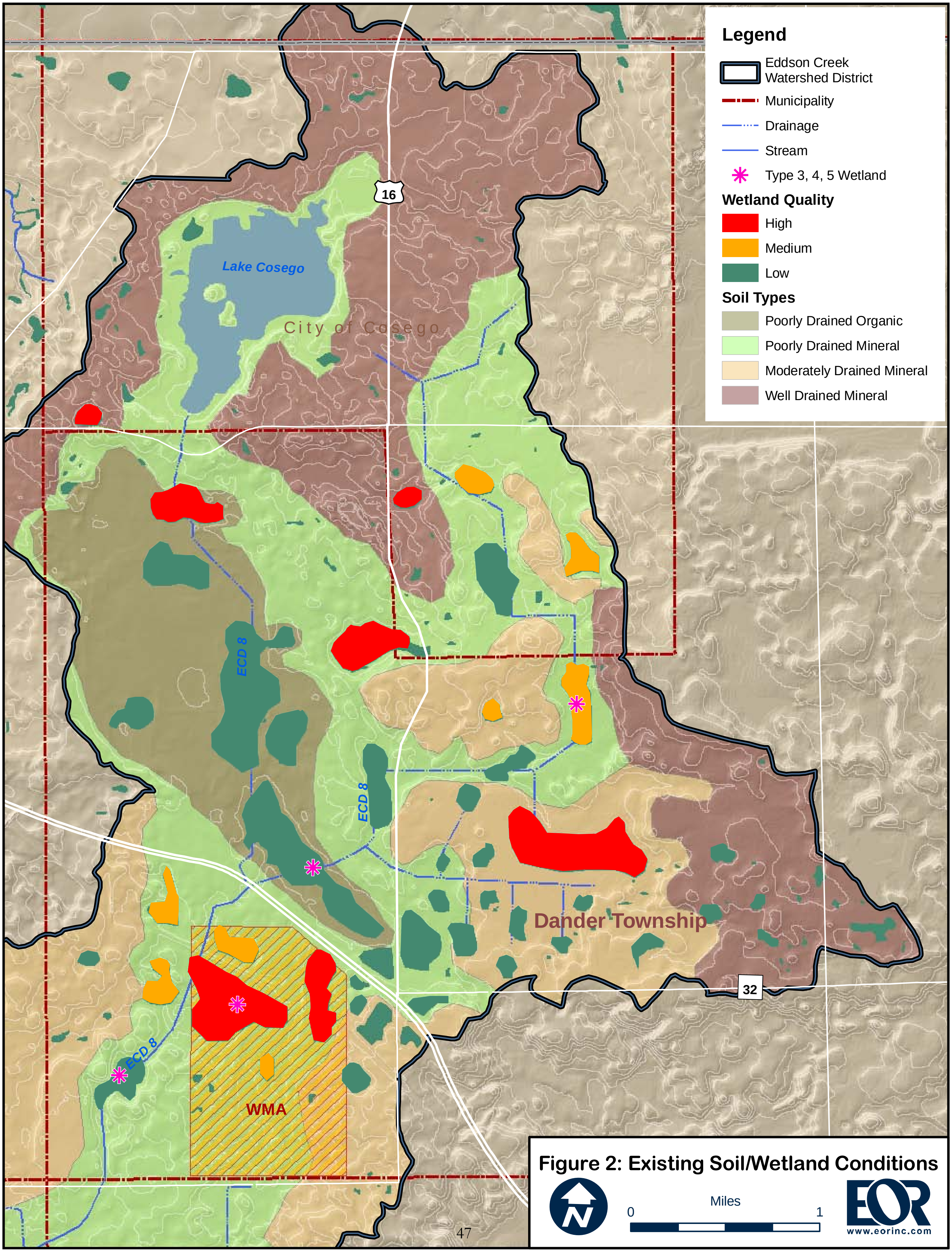

Figure 2: Existing Soil/Wetland Conditions

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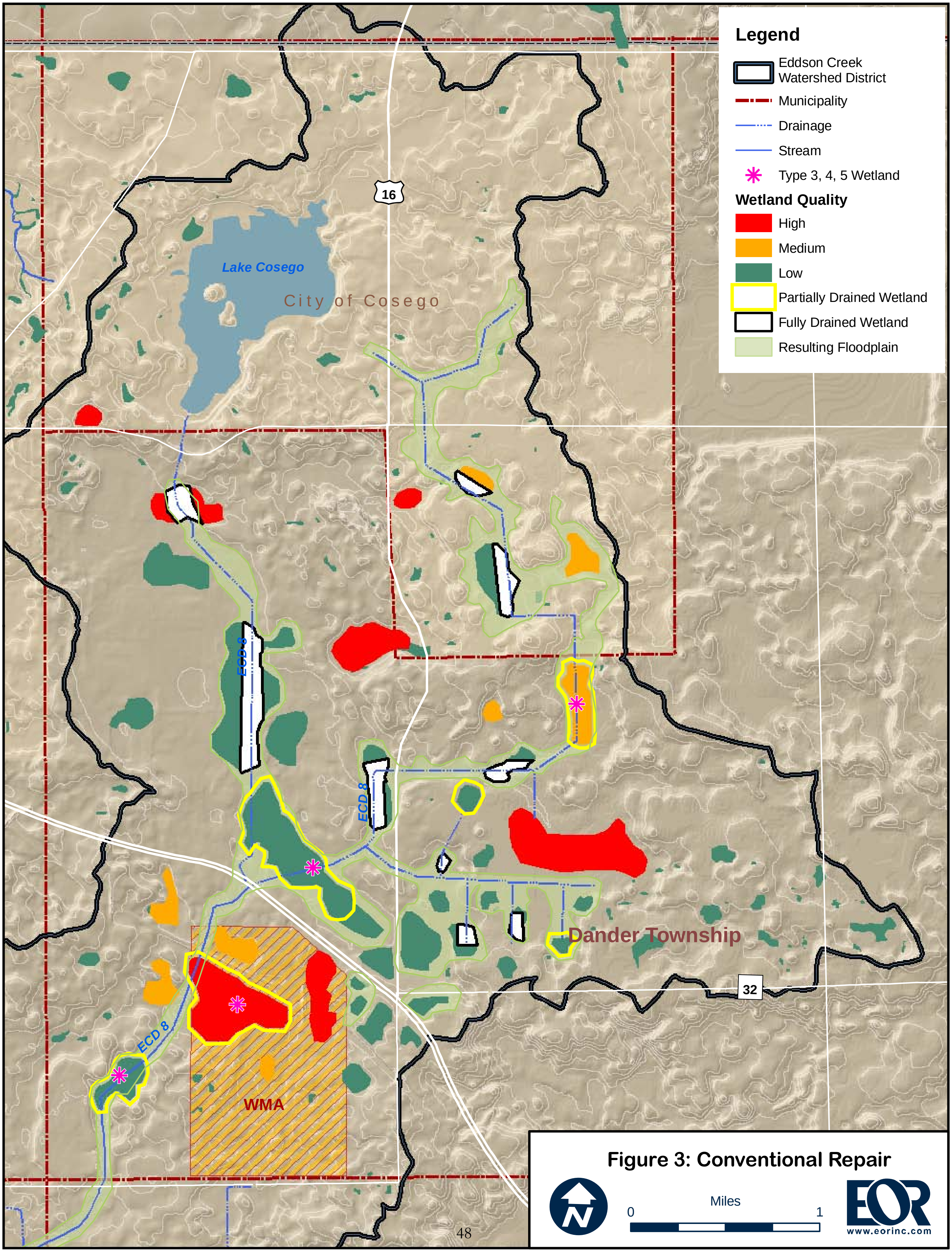

Figure 3: Conventional Repair

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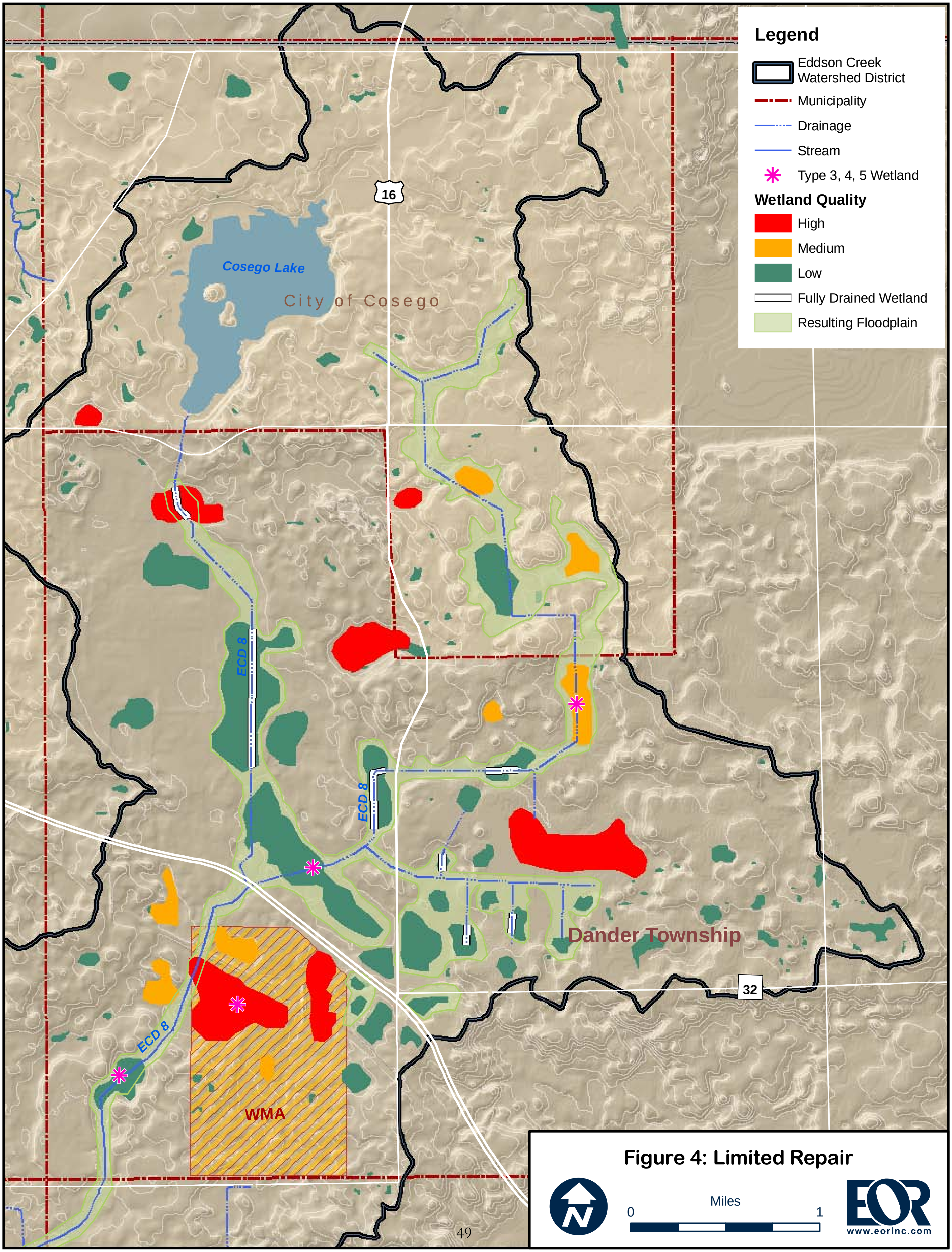

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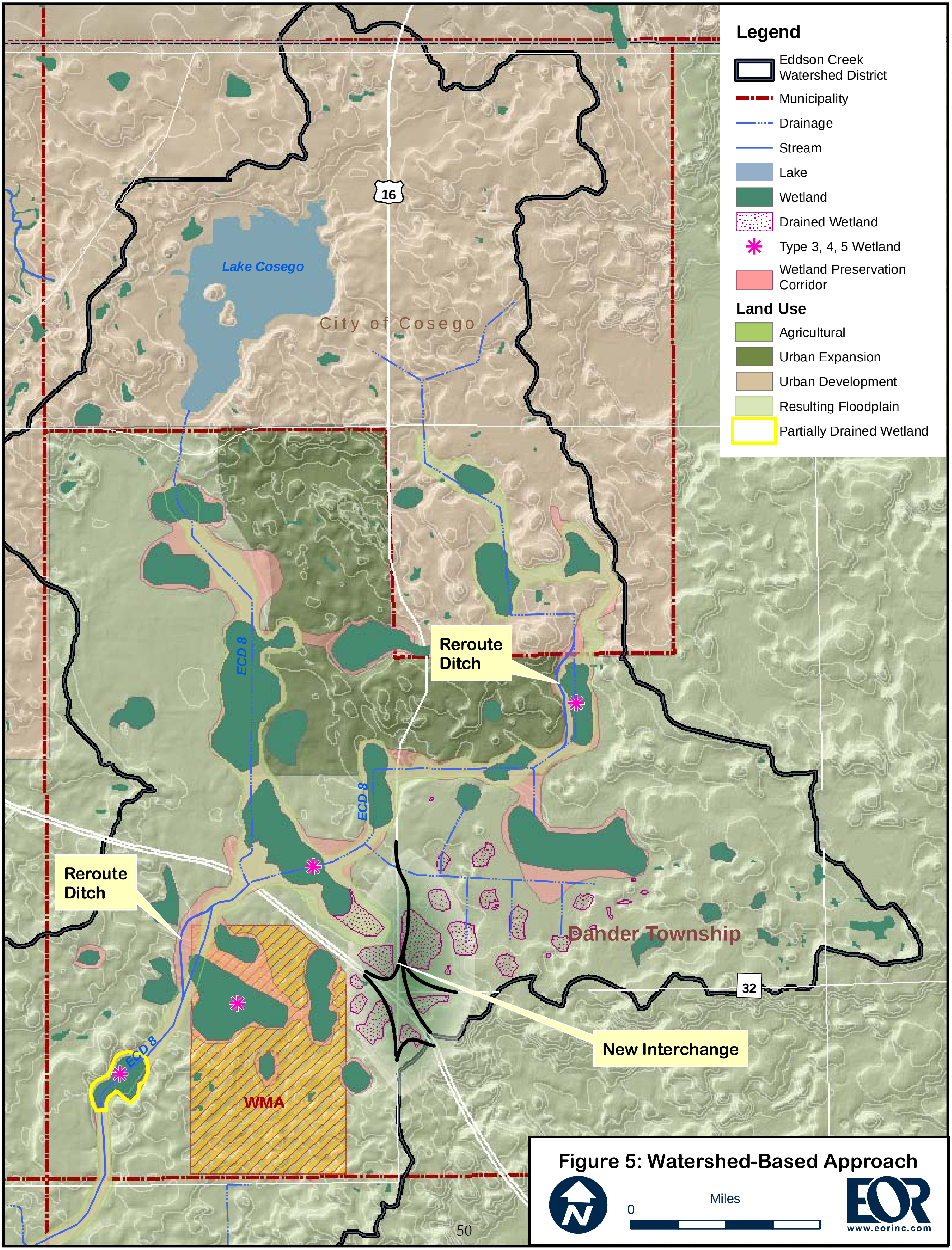

Figure 5: Watershed-Based Approach

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TABLES

Scenario C – Table 1

WATER RESOURCE IMPACTS for REPAIR ALTERNATIVES (acres)			
	EXEMPT WETLANDS[1]		NON-EXEMPT WETLANDS[2]
	DRAINED or FILLED	PARTLY DRAINED[3]	PARTLY DRAINED[3]
CONVENTIONAL REPAIR	135.2	12.5	232.5
LIMITED REPAIR	24.5	0	
WATERSHED-BASED APPROACH	148.3[4]	0	23.5

NOTES

[1] Wetlands that may be drained without replacement obligation under a Wetland Conservation Act statutory exemption.

[2] Public waters wetlands or Wetland Conservation Act type 3, 4, 5 wetlands for which replacement is required.

[3] Partial drainage causing no loss of acreage but loss of wetland resource function. Impact acreage assumed as 50% of partly drained surface area.

[4] Impact acres predominantly from private development upland aggregation rather than drainage system repair.

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Scenario C – Table 2
COST of REPAIR ALTERNATIVES

	DRAINAGE SYSTEM REPAIR	URBAN PEAK MANAGEMENT[1]	AVOIDED STORM WATER MANAGE-MENT[2]	COMPLIANCE & CONSERVATION[3]
CONVENTIONAL REPAIR	$5.57 Million	$2.73 Million	--	$8.14 Million
LIMITED REPAIR	$2.79 Million	$2.83 Million	--	$0
WATERSHED-BASED APPROACH	$0.82 Million	$2.57 Million	($2.56 Million)	$2.81 Million[4]

NOTES:

[1] Facilities that would need to be constructed on or adjacent to upper ECD 8 to provide adequate capacity for urban peak flow management for build-out under City of Cosego comprehensive land use plan. A part of this cost would be defrayed by the capacity of the downgradient wetland/floodplain to absorb peak flows without ecologic deterioration.

[2] Avoided cost of water quality basins that would accompany build-out under City of Cosego comprehensive land use plan due to runoff assimilation capacity of downgradient wetland resources. This cost savings would be for water quality benefits beyond those afforded by peak management (retention) facilities.

[3] For watershed-based approach, includes system reconfiguration (reroutes) to limit wetland impact and replacement cost.

[4] This cost does not include replacement costs for draining or filling of exempt wetland. Much of this impact will not be exempt but will not be a cost of the drainage system. It will be borne by property owners and MnDOT in voluntary action to aggregate upland for development.

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V. RECOMMENDATIONS

Based on the legal review, analysis of critical issues, and exploration of demonstration scenarios, the study team developed the following legal and policy recommendations. The study advisory committee reviewed and refined multiple drafts of the recommendations, and comments from larger group presentations were incorporated as well.

We intend for these recommendations to provide tools for the legislature or local authorities to make policy choices in how best to integrate drainage and natural resource management. Accordingly, the recommendations are the product of robust discussion, but not complete consensus. The recommendations are the responsibility of the authors, and reflect a judgment that they have adequate support among diverse stakeholders to be worthy of consideration.

Several of the recommended actions include *"options to consider."* The authors deem these options to be worthy of further consideration by policy makers, but at this time either lack essential stakeholder support or require further discussion with affected agencies or parties.

Recommendations #1 – 4 address drainage and watershed management, and Recommendations #5-9 address drainage and wetlands management.

DRAINAGE AND WATERSHED MANAGEMENT

Minnesota's drainage laws should be updated to embrace a multipurpose watershed-based approach. Consistent with the legislature's finding in Minnesota Statutes §103A.212 that the state's water resources should be managed from the watershed perspective, the drainage law can integrate more with the other purposes of water policy, such as water conservation, water pollution, preservation and management of wildlife, soil conservation, public recreation, forest management, and municipal planning. A watershed-based approach to managing drainage systems can reduce conflict between public interests in drainage and conservation, and promote more cost effective outcomes. In a developed or developing area, this approach also can provide a framework to reconcile conflict among multiple land uses, limit public and private costs to maintain conveyance systems, and improve conservation outcomes.

RECOMMENDATION #1: Give drainage authorities more tools and resources for watershed-based planning.

Findings: Watershed-based management and regulation may require a significant up-front investment in engineering and scientific study. The cost of such study may not be justifiable in traditional terms to the landowners in the drainage system, particularly if the outcome is not known. If the risk of bearing the cost falls only on the drainage petitioner, and if benefits of the approach are not fully captured by benefitted lands, disincentives to use the approach are created.

Recommended actions:

a. Enact incentives for drainage systems to be included in a watershed-based plans through coordination of existing comprehensive plan, local water management plan, watershed

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management plan and Total Maximum Daily Load implementation plan processes; provide for BWSR performance-based grants (including from Legacy Funds) and a coordination process to eliminate duplication; include incentives for counties to use existing authority to transfer this responsibility to watershed districts where locally preferred and feasible.

b. Enact specific statutory authority in Minnesota Statutes chapter 103D for watershed districts and chapter 103B for counties to provide drainage authorities watershed and subwatershed ad valorem levy and utility charge authorities for the purpose of watershed-based drainage system planning where not otherwise funded by water planning process of chapter 103B. Clarify that the Minnesota Statutes §103B.311 county water planning process must specifically include drainage systems.

c. Specify in Minnesota Statutes chapter 103E that cost of multipurpose watershed-based planning is not to be borne solely by benefitted properties in drainage system.

d. Provide statutory confirmation in Minnesota Statutes §103E.011, subdivision 5, that watershed-based planning activities of drainage authority are eligible for external sources of grant funding.

e. Require that watershed-based plans for drainage systems assess drainage system impacts on water quality, volume and flooding and include prioritized projects to address the same while preserving essential drainage capacity.

RECOMMENDATION #2: Give drainage authorities more tools and resources to implement projects with integrated drainage, flood control, conservation and water quality benefits.

Findings: A drainage authority must be able to allocate implementation costs of multipurpose watershed-based management fairly. Watershed districts can use an ad valorem levy or a stormwater utility to fund these needs, but where a county is the drainage authority and there is no watershed district, funding options may be more constrained. The absence of an appropriate funding mechanism may impose costs in a way that creates a disincentive to act or in a way that creates stakeholder opposition to a watershed-based approach. As a result, a drainage authority seeking to implement a watershed-based approach to projects with multiple benefits may be hampered in its access to timely and equitable implementation funding.

Recommended actions:

a. Establish ad valorem levy authority for watershed districts (in chapter 103D) and counties (in chapter 103B) to help pay for outcomes of watershed-based management plans.

b. Establish subwatershed ad valorem levy authority for watershed districts/counties (chapters 103D/103B) to pay for subwatershed-wide outcomes of watershed-based

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management plans; codify subwatershed units as special taxing districts (Minnesota Statutes §275.066).

c. Establish stormwater utility charge authority for watershed-based system management by counties (chapter 103B) where no watershed district exists to serve as the drainage authority.

d. Create process in Minnesota Statutes chapter 103E to move all or part of a drainage system repair to a utility-based charge system under drainage authority control.

Options to consider:

e. Provide drainage authorities the option to assess the system costs of drainage work with consideration of benefitted-parcel contribution to increasing or decreasing environmental compliance costs.

RECOMMENDATION #3: Better integrate effects on wetlands and water quality into drainage authority decisions about drainage system work.

Findings: Under the drainage code, drainage authority decisions require a quantitative weighing of benefits and costs to property owners but only general consideration of "public benefits," a term that itself is ill-defined in the law. Decisions that best reconcile public interests in drainage and in wetland/water quality protection are served by better integration of those interests in the decisionmaking process. However, public benefits and costs from wetland and water quality impacts are difficult to measure and quantify, and a requirement to do so would be premature.

Recommended actions:

a. Require that engineer's reports for drainage projects and repairs under Minnesota Statutes §§103E.245, 103E.285, 103E.705 and 103E.715 evaluate impacts of proposed work on wetlands, flow conditions, and pollutant transport and means of reducing impacts consistent with drainage system requirements.

b. Clarify that Minnesota Statutes §103E.015, subdivision 2, directing the drainage authority to consider "public utility, benefit or welfare," applies to drainage system repair.

c. Refine the definition of "public benefit" in Minnesota Statutes §103E.005 to include public values of wetlands, downgradient water quality, protection of natural geomorphology, downgradient channel stability, and protection of public infrastructure. Include a definition of "public cost" to refer to the loss of public benefit.

d. (Non-legislative) Foster work to further the understanding of drainage system impacts on wetlands, flow conditions and pollutant transport, and to further the means quantify and value those impacts cost-effectively.

RECOMMENDATION #4: Provide drainage authorities with more clarity in legal authority to address drainage system alignment, grade, cross section, and hydraulic capacity

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of bridges and culverts for multipurpose design of drainage system establishment, improvement, or repair.

Findings: Watershed-based approaches to drainage system projects, repairs and retrofits tend to involve multiple design characteristics and challenges. Under the drainage law, theextent of permissible localized impacts to drainage efficiency from realignment or reconfiguration is uncertain. Often records are insufficient to establish "official" alignment, dimensions and grade of drainage systems established many years ago. Without official alignment, dimensions and grade to serve as a baseline, evaluating proposed realignment or reconfiguration for actual and legal impacts is problematic. Field investigation to establish official alignment and grade is expensive and can be inconclusive.

Recommended actions:

a. Amend consolidation statute (§103E.801) to establish process to "officially designate" drainage system after investigation.

b. Amend realignment/impoundment/repair statutes (§§103E.227, 103E.701) to define range of permissible impacts on hydraulic efficiency (general or localized) when implementing statutes.

c. Provide for mechanisms to allocate costs of technical work for system redesignation and realignment proceedings in same manner as indicated in Recommendations #1 and #2, above.

d. Clarify that a drainage authority may direct that the engineer's report include multiple purposes in design of a drainage project or repair, so long as these purposes are consistent with the applicable watershed-based management plan and approved by the drainage authority.

DRAINAGE AND WETLANDS MANAGEMENT

RECOMMENDATION #5: Extend the authority to establish a locally based wetland regulatory framework under a CWPMP to public water wetlands.

Findings: Technical evaluation and planning can integrate WCA and public water wetlands, but WCA LGU has no authority to manage and regulate public waters in accordance with CWPMP except through case-by-case DNR waiver of jurisdiction. Landowner benefits in the form of expectations/certainty are undermined by preservation of full DNR regulatory prerogative. Benefits of clear, efficient process are undermined by ambiguous Minnesota Statutes §103E.701 language concerning DNR approval of repair. Drainage authority ability to fairly allocate management costs is complicated by uncertainty over the statutory cost to protect public water wetlands affected by drainage system (e.g., §103G.225).

Recommended actions:

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

a. Clarify DNR authority under Minnesota Statutes §§103G.2243 and 103G.245 to (i) programmatically waive jurisdiction to WCA LGU under CWPMPs and (ii) establish a parallel CWPMP framework by agreement with the LGU.

b. Establish an efficient administrative process with record review under Minnesota Statutes §103E.701 to involve DNR in determination of repair depth when public waters may be affected.

c. Revisit Minnesota Statutes §103G.225 and related statutes for clear legislative articulation of when the public shall bear the cost to protect public waters against the impacts of lawful drainage work.

Options to consider:

d. Collapse DNR public water wetland regulatory authority into WCA program by removing public waters wetlands from the purview of Minnesota Statutes §103G.245 and including them under WCA jurisdiction.

RECOMMENDATION #6: Create replacement alternatives within a CWPMP for a landowner causing wetland impact who may not have a high-valued replacement option on site.

Findings: A CWPMP will incorporate incentives to replacement wetlands within particular areas of the watershed to enhance overall wetland value. As a result, certain landowners may be situated with access to higher-valued restoration options and others may not. CWPMP potential is diminished if a landowner is forced to a lower-valued replacement option.

Recommended actions:

a. State authority in Minnesota Statutes §103G.2243 for WCA LGU to establish and manage own watershed-based wetland replacement bank under CWPMP.

b. Affirm in Minnesota Statutes §103G.2243 that a WCA LGU, notwithstanding land use law concerning exactions, may: (i) collect fees in lieu of replacement provided fees are used to create or purchase replacement credits meeting CWPMP requirements; and (ii) require as condition of replacement plan approval that a property owner dedicate an easement allowing public resource restoration work.

Option to consider:

c. Authorize WCA LGU to provide in CWPMP for replacement credit for other water resource benefits including improvements with respect to flow conditions, habitat, pollutant generation and pollutant transport.

RECOMMENDATION #7: Coordinate USACE Section 404 jurisdiction with a watershed-based CWPMP or other implementing framework.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Findings: A conflicting federal regulatory framework can preclude CWPMP outcomes. The USACE's reserved regulatory prerogative under Section 404 of the Clean Water Act can undermine the benefits of a CWPMP by reducing the CWPMP's ability to deliver more certainty in permitting time and outcome. The alternatives analysis requirement under Section 404 adds to CWPMP cost concerns and undermines certainty in permitting time and outcome that are important benefits of a watershed-wide approach.

Recommended actions:

a. (Non-legislative) Further BWSR coordination with USACE to align Section 404 permitting with CWPMPs, including: (i) readier USACE use of programmatic permits, (ii) USACE consideration of "sector-specific" programmatic permits for drainage system maintenance, and (iii) consistent standards and procedures for fee-in-lieu programs.

Options to consider:

b. Enhance tools and resources for WCA LGU and land use authority to collaborate in developing and implementing CWPMP.

c. Direct and facilitate DNR pursuit of delegated Section 404 authority (with BWSR and Department of Agriculture cooperation per §103G.127) for CWPMP areas.

d. Coordinate Minnesota Pollution Control Agency §401review with CWPMP.

RECOMMENDATION #8: Integrate MnDOT right-of-way, other state-managed lands and local road authority activities within a CWPMP framework.

Findings: State agencies may affect higher-valued wetlands or disrupt protected corridors contrary to CWPMP goals. Local road impacts in higher-valued resource areas will be subject to CWPMP disincentives but replacement activity may be outside of plan area and not contribute to desired CWPMP outcomes.

Options to consider:

a. Provide that WCA provision naming state agency as LGU for state-managed lands may be qualified within a CWPMP area by (i) constraints on replacement wetland location as feasible and (ii) authority of LGU to require fee in lieu of replacement outside of CWPMP area.

b. Provide that road replacement under WCA may be qualified within a CWPMP area by (i) constraints on replacement wetland location as feasible and (ii) authority of LGU to require fee in lieu of replacement outside of CWPMP area.

RECOMMENDATION #9: Foster reliability of CWPMP outcomes through coordination of local land use authority and wetland regulatory authority.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Findings: The local land use authority may regulate wetland impacts under local ordinances and inconsistently with the CWPMP framework. The identity of the WCA LGU may shift after CWPMP investment has been completed, and a new LGU may not be committed to the CWPMP framework and expectations created. Property owner collaboration in a CWPMP framework rests on the reliability of created expectations. Early coordination enhances commitment to framework over intended duration of CWPMP implementation.

Options to consider:

a. *State in Minnesota Statutes §103G.2243 that CWPMP rule preempts inconsistent wetland regulation by local land use authority.*

b. *Affirm authority and enhance capacity for local land use authorities to use area-based rather than site-based approaches to planning and development regulation.*

c. *Allow metro area land use authorities to revise comprehensive land use plans under CWPMP framework without Metropolitan Council approval, consistent with broader density parameters set by Council.*

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as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

APPENDIX A

DRAFT LEGISLATION TO IMPLEMENT RECOMMENDATIONS

RECOMMENDATION #1: Provide drainage authorities with more tools and resources for watershed-based planning.

Findings: Watershed-based management and regulation may require a significant up-front investment in engineering and scientific study. The cost of such study may not be justifiable in traditional terms to the landowners in the drainage system, particularly if the outcome is not known. If the risk of bearing the cost falls only on the drainage petitioner, and if benefits of the approach are not fully captured by benefitted lands, disincentives to use the approach are created.

Recommended actions:

> **a. Enact incentives for drainage systems to be included in watershed-based plans through coordination of existing comprehensive plan, local water management plan, watershed management plan and Total Maximum Daily Load implementation plan processes; provide for BWSR performance-based grants (including from Legacy Funds) and a coordination process to eliminate duplication; include incentives for counties to use existing authority to transfer this responsibility to watershed districts where locally preferred and feasible.**

103B.101 BOARD OF WATER AND SOIL RESOURCES.

Subdivision 14. **Local water management coordination.**

The Board of Water and Soil Resources, by resolution, may adopt policies or orders that allow a comprehensive plan, local water management plan, watershed management plan or total maximum daily load implementation plan adopted and approved according to this chapter and chapters 103C, 103D, and 114D to serve as substitutes for one another. To the extent practical, the board shall incorporate a watershed approach and promote the inclusion of public drainage systems in such plans. The board shall work with local government stakeholders to foster mutual understanding and develop recommendations for local water management and related state water management policy and programs. The board may convene informal working groups or work teams to develop information, education, and recommendations.

103B.3369 LOCAL WATER RESOURCES PROTECTION AND MANAGEMENT PROGRAM.

Subdivision 5. **Financial assistance**.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

A base grant may be awarded to a county that provides a match utilizing a water implementation tax or other local source. A water implementation tax that a county intends to use as a match to the base grant must be levied at a rate determined by the board. ~~The minimum amount of the water implementation tax shall be a tax rate times the adjusted net tax capacity of the county for the preceding year. The rate shall be the rate, rounded to the nearest .001 of a percent, that, when applied to the adjusted net tax capacity for all counties, raises the amount of $1,500,000. The base grant will be in an amount equal to $37,500 less the amount raised by the local match. If the amount necessary to implement the local water plan for the county is less than $37,500, the amount of the base grant shall be the amount that, when added to the match amount, equals the amount required to implement the plan. For counties where the tax rate generates an amount equal to or greater than $18,750, the base grant shall be in an amount equal to $18,750.~~ The board may award performance-based grants to local units of government that are responsible for implementing elements of applicable portions of watershed management plans or local water management plans adopted and approved according to this chapter or chapter 103C or 103D. The board may award performance-based grants to local units of government to carry out total maximum daily load (TMDL) implementation plans as defined in section 114D.15 if the board has reviewed and approved the TMDL implementation plan, as requested by a local unit of government, according to the procedures for approving comprehensive plans, watershed management plans, or local water management plans in this chapter or chapter 103C or 103D. The board may award performance-based grants to drainage authorities to complete watershed-based plans for public drainage systems, and to facilitate the transfer, pursuant to section 103D.335, subd. 15, to a watershed district of all joint county or county drainage systems within the watershed district, together with the right to repair, maintain, and improve them.

b. Enact specific statutory authority in Minnesota Statutes chapter 103D for watershed districts and chapter 103B for counties to provide drainage authorities watershed and subwatershed ad valorem levy and utility charge authorities for the purpose of watershed-based drainage system planning where not otherwise funded by water planning process of chapter 103B. Clarify that the Minnesota Statutes §103B.311 county water planning process must specifically include drainage systems.

103B.311 COUNTY WATER PLANNING AND MANAGEMENT.

Subdivision 1.**County duties.**

Each county is encouraged to develop and implement a local water management plan. Each county that develops and implements a plan has the duty and authority to:

(1) prepare and adopt a local water management plan that meets the requirements of this section through section 103B.315;

(2) review water and related land resources plans and official controls submitted by local units of government to assure consistency with the local water management plan; and

(3) exercise any and all powers necessary to assure implementation of local water management plans.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Subdivision 4.**Water plan requirements.**

(a) A local water management plan must:

(1) cover the entire area within a county;

(2) address water problems in the context of watershed units and groundwater systems;

(3) be based upon principles of sound hydrologic management of water, effective environmental protection, and efficient management;

<u>(3a) identify public drainage systems, including existing dams and control structures within those systems, and assess their effect on the hydrologic and hydraulic characteristics of the watershed units in which they are situated, including impacts on water quality, water volumes transported and flooding;</u>

(4) be consistent with local water management plans prepared by counties and watershed management organizations wholly or partially within a single watershed unit or groundwater system; and

(5) the local water management plan must specify the period covered by the local water management plan and must extend at least five years but no more than ten years from the date the board approves the local water management plan. Local water management plans that contain revision dates inconsistent with this section must comply with that date, provided it is not more than ten years beyond the date of board approval. A two-year extension of the revision date of a local water management plan may be granted by the board, provided no projects are ordered or commenced during the period of the extension.

(b) Existing water and related land resources plans, including plans related to agricultural land preservation programs developed pursuant to chapter 40A, must be fully utilized in preparing the local water management plan. Duplication of the existing plans is not required.

103B.325 CONSISTENCY OF LOCAL PLANS AND CONTROLS WITH THE LOCAL WATER MANAGEMENT PLAN.

Subdivision 1.**Requirement.**

Local units of government <u>other than watershed districts and watershed-based organizations formed for the joint exercise of powers under section 471.59</u> shall amend existing water and related land resources plans and official controls as necessary to conform them to the applicable, approved local water management plan following the procedures in this section.

Subdivision 3.**Revision and implementation.**

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Local units of government other than watershed districts and watershed-based organizations formed for the joint exercise of powers under section 471.59 shall revise existing plans and official controls to conform them to the recommendations of the county board and shall initiate implementation of the revised plans and controls within 180 days after receiving the recommendations of the county board, or 180 days after resolution of an appeal, whichever is later.

103B.335 TAX LEVY AUTHORITY.

Subdivision 1.**Local water planning and management.**

(a) The governing body of any county~~, municipality, or township~~ may levy a tax in an amount required to implement sections 103B.301 to 103B.355.

(b) The governing body of any county may establish a special taxing district in the same manner as set forth in 103B.331, subdivision 4, to pay the cost to prepare a local water management plan under 103B.311 and implement watershed-based elements of that plan.

(c) The governing body of any county may establish a water management district or districts in any territory within the county not within the boundaries of a watershed district, if provided for by the local water management plan, for the purpose of collecting revenues and paying the costs of projects implemented under watershed-based elements of a local water management plan. The plan shall describe with particularity the territory or the area to be included in the water management district, the amount of the necessary charges, the methods used to determine charges, the basis for determining that the charges are just and equitable, and the length of time the water management district will remain in force. The water management district may be dissolved by the procedure prescribed for the establishment of the water management district. Ten days prior to a hearing or decision on projects implemented under this section, the county shall provide notice to the city or town within the affected area. The city or town receiving notice shall submit to the governing body concerns relating to project implementation. The governing body shall consider the concerns of the city or town in its decision on the project.

103D.905 FUNDS OF WATERSHED DISTRICT.

Subdivision 9.**Project tax levy.**

(a) In addition to other tax levies provided in this section or in any other law, a watershed district may levy a tax:

(1) to pay the costs of projects undertaken by the watershed district which are to be funded, in whole or in part, with the proceeds of grants or construction or implementation loans under sections 103F.701 to 103F.761;

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(2) to pay the principal of, or premium or administrative surcharge, if any, and interest on, the bonds and notes issued by the watershed district pursuant to section 103F.725; or

(3) to repay the construction or implementation loans under sections 103F.701 to 103F.761.

Taxes levied with respect to payment of bonds and notes shall comply with section 475.61.

(b) A watershed district may levy a tax for payment of costs incurred in preparing a watershed management plan under section 103D.401 and implementing projects in that plan.

(c) A watershed district may establish a special taxing district to pay the cost to prepare a watershed management plan under 103D.401 and to implement watershed-based elements of that plan. The county auditor must be notified of a new special taxing district by July 1 in order to be effective for taxes payable in the following year.

c. Specify in Minnesota Statutes chapter 103E that cost of multipurpose watershed-based planning is not to be borne solely by benefitted properties in drainage system.

103E.011 DRAINAGE AUTHORITY POWERS.

Subdivision 1.**Generally.**

The drainage authority may make orders to:

(1) construct and maintain drainage systems;

(2) deepen, widen, straighten, or change the channel or bed of a natural waterway that is part of the drainage system or is located at the outlet of a drainage system;

(3) extend a drainage system into or through a municipality for a suitable outlet; ~~and~~

(4) construct necessary dikes, dams, and control structures and power appliances, pumps, and pumping machinery as provided by law; and

(5) prepare and adopt watershed-based plans for drainage systems, including an assessment of drainage system impacts on water quality, volume, and flooding, as well as prioritized projects to address such impacts while preserving essential drainage capacity, provided that the cost of preparing such plans shall not be paid solely by assessments based on the benefits of the drainage system.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

d. Provide statutory confirmation in Minnesota Statutes §103E.011, subdivision 5, that such watershed-based planning activities of drainage authority are eligible for external sources of grant funding.

103E.011 DRAINAGE AUTHORITY POWERS.

Subdivision 5.**Use of external sources of funding.**

Notwithstanding other provisions of this chapter, a drainage authority may accept and use funds from sources other than, or in addition to, those derived from assessments based on the benefits of the drainage system for the purposes of <u>watershed-based planning for the drainage system,</u> wetland preservation or restoration, or creation of water quality improvements or flood control. The sources of funding authorized under this subdivision may also be used outside the benefited area but must be within the watershed of the drainage system.

e. Require that watershed-based plans for drainage systems assess drainage system impacts on water quality, volume and flooding and include prioritized projects to address the same while preserving essential drainage capacity.

(See also recommended action 1.c, above, for statutory revision to effect recommended action 1.e.)

103D.401 WATERSHED MANAGEMENT PLAN.

Subdivision 1.**Contents.**

(a) The managers must adopt a watershed management plan for any or all of the purposes for which a watershed district may be established. The watershed management plan must give a narrative description of existing water and water-related problems within the watershed district, possible solutions to the problems, and the general objectives of the watershed district. <u>The plan must identify public drainage systems and assess their effect on the hydrologic and hydraulic characteristics of the watershed units in which they are situated, including impacts on water quality, water volumes transported and flooding.</u> The watershed management plan must also conform closely with watershed management plan guidelines as adopted and amended from time to time by the Board of Water and Soil Resources.

(b) The watershed management plan may include a separate section on proposed projects. If the watershed district is within the metropolitan area, the separate section of proposed projects or petitions for projects to be undertaken according to the watershed

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management plan is a comprehensive plan of the watershed district for purposes of review by the Metropolitan Council under section 473.165.

RECOMMENDATION #2: Provide drainage authorities with more tools and resources to implement projects with integrated drainage, flood control, conservation and water quality benefits.

Findings: A drainage authority must be able to allocate implementation costs of multipurpose watershed-based management fairly. Watershed districts can use an ad valorem levy or a stormwater utility to fund these needs, but where a county is the drainage authority and there is no watershed district, funding optionsmay be more constrained. The absence of an appropriate funding mechanism may impose costs in a way that creates a disincentive to act or in a way that creates stakeholder opposition to a watershed-based approach. As a result, a drainage authority seeking to implement a watershed-based approach to projects with multiple benefits may be hampered in its access to timely and equitable implementation funding.

Recommended actions:

a. **Establish ad valorem levy authority for watershed districts (in chapter 103D) and counties (in chapter 103B) to help pay for outcomes of watershed-based management plans.**

b. **Establish subwatershed ad valorem levy authority for watershed districts/counties (chapters 103D/103B) to pay for subwatershed-wide outcomes of watershed-based management plans; codify subwatershed units as special taxing districts (Minnesota Statutes §275.066).**

c. **Establish stormwater utility charge authority for watershed-based system management by counties (chapter 103B) where no watershed district exists to serve as the drainage authority.**

(In addition to the following, see recommended action 1.b, above, for statutory revisions to effect recommended actions 2.a, 2.b and 2.c.)

275.066 SPECIAL TAXING DISTRICTS; DEFINITION.

For the purposes of property taxation and property tax state aids, the term "special taxing districts" includes the following entities:

(1) watershed districts under chapter 103D;

(2) sanitary districts under sections 115.18 to 115.37;

(3) regional sanitary sewer districts under sections 115.61 to 115.67;

(4) regional public library districts under section 134.201;

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(5) park districts under chapter 398;

(6) regional railroad authorities under chapter 398A;

(7) hospital districts under sections 447.31 to 447.38;

(8) St. Cloud Metropolitan Transit Commission under sections 458A.01 to 458A.15;

(9) Duluth Transit Authority under sections 458A.21 to 458A.37;

(10) regional development commissions under sections 462.381 to 462.398;

(11) housing and redevelopment authorities under sections 469.001 to 469.047;

(12) port authorities under sections 469.048 to 469.068;

(13) economic development authorities under sections 469.090 to 469.1081;

(14) Metropolitan Council under sections 473.123 to 473.549;

(15) Metropolitan Airports Commission under sections 473.601 to 473.680;

(16) Metropolitan Mosquito Control Commission under sections 473.701 to 473.716;

(17) Morrison County Rural Development Financing Authority under Laws 1982, chapter 437, section 1;

(18) Croft Historical Park District under Laws 1984, chapter 502, article 13, section 6;

(19) East Lake County Medical Clinic District under Laws 1989, chapter 211, sections 1 to 6;

(20) Floodwood Area Ambulance District under Laws 1993, chapter 375, article 5, section 39;

(21) Middle Mississippi River Watershed Management Organization under sections 103B.211 and 103B.241;

(22) emergency medical services special taxing districts under section 144F.01;

(23) a county levying under the authority of section 103B.241, 103B.245, or 103B.251;

(24) Southern St. Louis County Special Taxing District; Chris Jensen Nursing Home under Laws 2003, First Special Session chapter 21, article 4, section 12;

(25) an airport authority created under section 360.0426; ~~and~~

(26) any other political subdivision of the state of Minnesota, excluding counties, school districts, cities, and towns, that has the power to adopt and certify a property tax levy to the county auditor, as determined by the commissioner of revenue; and

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(27) any special taxing district created to prepare and implement a local water management plan or watershed management plan under section 103B.231, 103B.311 or 103D.401.

d. **Create process in Minnesota Statutes chapter 103E to move all or part of a drainage system repair to a utility-based charge system under drainage authority control.**

103E.725 COST OF REPAIR.

(a) All fees and costs incurred for proceedings relating to the repair of a drainage system, including inspections, engineering, viewing, and publications, are costs of the repair and must be assessed against the property and entities benefited.

(b) Notwithstanding any other provision of this chapter, the drainage authority may pay for costs of repair by imposition of just and equitable charges and, if a watershed district, may certify charges to the counties with territory within the drainage system for collection by the counties.

(c) Charges may be fixed on the basis of:

(1) drainage benefits conferred;

(2) use of system conveyance capacity;

(3) contribution to repair cost or frequency by virtue of sediment contributed;

(4) contribution to increasing or decreasing environmental compliance costs; or

(4) any other equitable basis including any combination of clauses (1) to (4).

(d) When charges have been appropriated to the repair cost, no charge shall be deemed unreasonable by virtue of the fact that the repair work to be financed has not been commenced or completed, if proceedings for it are taken with reasonable dispatch and the work, when completed, may be expected to have a value reasonably commensurate with the charges.

RECOMMENDATION #3: Better integrate effects on wetlands and water quality into drainage authority decisions about drainage system work.

Findings: Under the drainage code, drainage authority decisions require a quantitative weighing of benefits and costs to property owners but only general consideration of "public benefits," a term that itself is ill-defined in the law. Decisions that best reconcile public interests in drainage and in wetland/water quality protection are served by better integration of those interests in the decisionmaking process. However, public benefits and costs from wetland and water quality impacts are difficult to measure and quantify, and a requirement to do so would be premature.

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Recommended actions:

a. Require that engineer's reports for drainage projects and repairs under Minnesota Statutes §§103E.245, 103E.285, 103E.705 and 103E.715 evaluate impacts of proposed work on wetlands, flow conditions, and pollutant transport and means of reducing impacts consistent with drainage system requirements.

103E.245 PRELIMINARY SURVEY AND PRELIMINARY SURVEY REPORT.

Subdivision 2.**Limitation of survey.**

The engineer shall restrict the preliminary survey to the drainage area described in the petition, except that to secure an outlet the engineer may run levels necessary to determine the distance for the proper fall of the water <u>and to evaluate</u> the impact of the proposed drainage project on the environmental and land use criteria in section 103E.015, subdivision 1. The drainage authority may have other areas surveyed after:

(1) giving notice by mail of a hearing to survey additional areas, to be held at least ten days after the notice is mailed, to the petitioners and persons liable on the petitioners' bond;

(2) holding the hearing;

(3) obtaining consent of the persons liable on the petitioners' bond; and

(4) ordering the additional area surveyed by the engineer.

Subdivision 4.**Preliminary survey report.**

The engineer shall report the proposed drainage project plan or recommend a different practical plan. The report must give sufficient information, in detail, to inform the drainage authority on issues related to feasibility, and show changes necessary to make the proposed plan practicable and feasible including extensions, laterals, and other work. If the engineer finds the proposed drainage project in the petition is feasible and complies with the environmental and land use criteria in section 103E.015, subdivision 1, the engineer shall include in the preliminary survey report a preliminary plan of the drainage project showing the proposed ditches, tile, laterals, and other improvements, the outlet of the project, the watershed of the drainage project or system, and the property likely to be affected and its known owners. The plan must show:

(1) the elevation of the outlet and the controlling elevations of the property likely to be affected referenced to standard sea level datum, if practical;

(2) the probable size and character of the ditches and laterals necessary to make the plan practicable and feasible;

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(3) the character of the outlet and whether it is sufficient;

(4) the probable cost of the drains and improvements shown on the plan;

(5) all other information and data necessary to disclose the practicability, necessity, and feasibility of the proposed drainage project;

(6) consideration of the drainage project under the environmental and land use criteria in section 103E.015, subdivision 1, including impacts of proposed work on wetlands, flow conditions, and pollutant transport in sufficient detail to evaluate these impacts as far downgradient as they are reasonably discernable and to advise the drainage authority of means of reducing the impacts consistent with the conveyance needs of the drainage system; and

(7) other information as ordered by the drainage authority.

103E.285 DETAILED SURVEY REPORT.

Subdivision 10.**Other information on practicability and necessity of drainage project.**

Other data and information to inform the drainage authority of the practicability and necessity of the proposed drainage project must be made available including a comprehensive examination and the recommendation by the engineer regarding the environmental and land use criteria in section 103E.015, subdivision 1, including impacts of proposed work on wetlands, flow conditions, and pollutant transport in sufficient detail to evaluate these impacts as far downgradient as they are reasonably discernable and to advise the drainage authority of means of reducing the impacts consistent with the conveyance needs of the drainage system.

103E.705 REPAIR PROCEDURE.

Subdivision 3.**Drainage inspection report.**

For each drainage system that the board designates and requires the drainage inspector to examine, the drainage inspector shall make a drainage inspection report in writing to the board after examining a drainage system, designating portions that need repair or maintenance of the permanent strips of perennial vegetation and the location and nature of the repair or maintenance. The board shall consider the drainage inspection report at its next meeting and may repair all or any part of the drainage system as provided under this chapter after due consideration of public benefits and costs pursuant to section 103E.015, subdivision 2. The permanent strips of perennial vegetation must be maintained in compliance with section 103E.021.

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103E.715 PROCEDURE FOR REPAIR BY PETITION.

Subdivision 2.**Engineer's repair report.**

If the drainage authority determines that the drainage system needs repair, the drainage authority shall appoint an engineer to examine the drainage system and make a repair report. The report must show the necessary repairs, the estimated cost of the repairs, and all details, plans, and specifications necessary to prepare and award a contract for the repairs. The report also will include an assessment of public benefits and costs pursuant to section 103E.015, subdivision 2, at a level of detail corresponding to the scope of the repair and sufficient to advise the drainage authority of means of reducing public costs consistent with the conveyance needs of the drainage system. The drainage authority may give notice and order a hearing on the petition before appointing the engineer.

Subdivision 4.**Hearing on repair report.**

(a) The drainage authority shall make findings and order the repair to be made if it finds the repair justified after due consideration of public benefits and costs pursuant to section 103E.015, subdivision 2, and:

(1) it determines from the repair report and the evidence presented that the repairs recommended are necessary for the best interests of the affected property owners; or

(2) the repair petition is signed by the owners of at least 26 percent of the property area affected by and assessed for the original construction of the drainage system, and it determines that the drainage system is in need of repair so that it no longer serves its original purpose and the cost of the repair will not exceed the total benefits determined in the original drainage system proceeding.

(b) The order must direct the auditor and the chair of the board or, for a joint county drainage system, the auditors of the affected counties to proceed and prepare and award a contract for the repair of the drainage system. The contract must be for the repair described in the repair report and as determined necessary by the drainage authority, and be prepared in the manner provided in this chapter for the original drainage system construction.

b. Clarify that Minnesota Statutes §103E.015, subdivision 2, directing the drainage authority to consider "public utility, benefit or welfare," applies to drainage system repair.

103E.015 CONSIDERATIONS BEFORE DRAINAGE WORK IS DONE.

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Subdivision 2.**Determining public utility, benefit, or welfare.**

In any proceeding to establish a drainage project, in determining the scope of any repair, or in the construction of or other work affecting a public drainage system under any law, the drainage authority or other authority having jurisdiction over the proceeding must give proper consideration to conservation of soil, water, forests, wild animals, and related natural resources, and to other public benefits and costs, together with other material matters as provided by law in determining whether the project will be of public utility, benefit, or welfare.

> **c. Refine the definition of "public benefit" in Minnesota Statutes §103E.005 to include public values of wetlands, downgradient water quality, protection of natural geomorphology, downgradient channel stability, and protection of public infrastructure. Include a definition of "public cost" to refer to the loss of public benefit.**

103E.005 DEFINITIONS.

Subdivision 24a. **Public cost**.

"Public cost" refers to a loss of public benefit and includes but is not limited to an act or thing that degrades public values of wetlands, water quality, channel stability, natural channel geomorphology or public infrastructure.

Subdivision 27.**Public welfare or public benefit.**

"Public welfare" or "public benefit" includes an act or thing that tends to improve or benefit the general public, either as a whole or as to any particular community or part, including works contemplated by this chapter that drain or protect roads from overflow, protect property from overflow, or reclaim and render property suitable for cultivation that is normally wet and needing drainage or subject to overflow; and works that enhance public values of wetlands, water quality and channel stability and protect natural geomorphology and public infrastructure.

> **d. (Non-legislative) Foster work to further the understanding of drainage system impacts on wetlands, flow conditions and pollutant transport, and to further the means quantify and value those impacts cost-effectively.**

(No legislative text.)

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as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

RECOMMENDATION #4: Provide drainage authorities with more clarity in legal authority to address drainage system alignment, grade, cross section, and hydraulic capacity of bridges and culverts for multipurpose design of drainage system establishment, improvement, or repair.

Findings: Watershed-based approaches to drainage system projects, repairs and retrofits tend to involve multiple design characteristics and challenges. Under the drainage law, the extent of permissible localized impacts to drainage efficiency from realignment or reconfiguration is uncertain. Often records are insufficient to establish "official" alignment, dimensions and grade of drainage systems established many years ago. Without official alignment, dimensions and grade to serve as a baseline, evaluating proposed realignment or reconfiguration for actual and legal impacts is problematic. Field investigation to establish official alignment and grade is expensive and can be inconclusive.

Recommended actions:

> **a. Amend consolidation statute (§103E.801) to establish process to "officially designate" drainage system after investigation.**

103E.801 CONSOLIDATION OR DIVISION OF DRAINAGE SYSTEMS.

Subdivision 1a. **Authority to designate alignment and cross-section**.

If after diligent inquiry a drainage authority finds that records establishing alignment and cross-section of a public drainage system as constructed and thereafter legally modified are incomplete, it may by order designate an alignment and cross-section that it finds to be most reasonably supported by existing records and evidence. The drainage authority's designation may provide for hydraulic continuity from points of terminus to the system outlet and may make a finding of continuous channel right-of-way adequate for that purpose. This designation will not interrupt prescriptive occupation.

Subdivision 2.**Initiation of action.**

The consolidation,-division or designation may be initiated by the drainage authority on its own motion or by any party interested in or affected by the drainage system filing a petition. If the system is under the jurisdiction of a drainage authority, the petition must be filed with the auditor. If the system is under the jurisdiction of a watershed board, the petition must be filed with the secretary of the board.

Subdivision 3.**Hearing.**

(a) When a drainage authority or watershed board directs by resolution or a petition is filed, the drainage authority in consultation with the auditor or secretary shall set a time

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and location for a hearing. The auditor or secretary shall give notice by publication to all persons interested in the drainage system.

(b) The drainage authority may consolidate or divide drainage systems, by order, if it determines that the division of one system into two or more separate systems, the consolidation of two or more systems, the transfer of part of one system to another, or the attachment of a previously abandoned part of a system to another system:

(1) is consistent with the redetermination of the benefited areas of the drainage system;

(2) would provide for the efficient administration of the drainage system; and

(3) would be fair and equitable.

(c) An order to consolidate or divide drainage systems does not release property from a drainage lien or assessment filed for costs incurred on account of a drainage system before the date of the order.

(d) A final drainage authority order designating the alignment and cross-section of a public drainage system constitutes the official system profile. A finding of system right-of-way in such an order is a defense to a trespass claim and will be given due weight in any subsequent court proceeding to establish the existence or nature of a property encumbrance.

b. Amend realignment/impoundment/repair statutes (§§103E.227, 103E.701) to define range of permissible impacts on hydraulic efficiency (general or localized) when implementing statutes.

103E.227 IMPOUNDING, REROUTING, AND DIVERTING DRAINAGE SYSTEM WATERS.

Subdivision 1.**Petition.**

(a) To conserve and make more adequate use of our water resources or to incorporate wetland or water quality enhancing elements as authorized by Minnesota Statutes §103E.011, subdivision 5, a person, public or municipal corporation, governmental subdivision, the state or a department or agency of the state, the commissioner of natural resources, and the United States or any of its agencies, may petition to impound, reroute, or divert drainage system waters for beneficial use.

(b) If the drainage system is under the jurisdiction of a county drainage authority, the petition must be filed with the auditor of the county. If the drainage system is under the jurisdiction of a joint county drainage authority, the petition must be filed with the county having the largest area of property in the drainage system, where the primary drainage system records are kept, and a copy of the petition must be submitted to the auditor of

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each of the other counties participating in the joint county drainage authority. If the system is under the jurisdiction of a watershed district, the petition must be filed with the secretary of the district. The auditor of an affected county or the secretary of a watershed district must make a copy of the petition available to the public.

(c) The petition must contain the location of the installation, concept plans for the proposed project, and a map that identifies the areas likely to be affected by the project.

(d) The petition shall identify the sources of funds to be used to secure the necessary land rights and to construct the project and the amount and rationale for any drainage system funds requested.

(e) The petitioner or drainage authority must also acquire a public waters work permit or a water use permit from the commissioner of natural resources if required under chapter 103G.

Subdivision 3.**Procedure to establish project.**

(a) After receiving the petition and bond, if required, the drainage authority must appoint an engineer to investigate the effect of the proposed installation and file a report of findings.

(b) After filing of the engineer's report, notice must be given and a public hearing held as provided in section 103E.261.

> (c) If at the hearing it appears from the engineer's report and other evidence presented that the project will be of a public or private benefit and that it will not substantially impair the utility of the drainage system or substantially deprive an affected land owner of its benefit without that land owner’s consent, the drainage authority shall make an order modifying the drainage system, to include the amount, if any, of drainage system funds approved for the project at the discretion of the drainage authority, and issue an order authorizing the project.

103E.701 REPAIRS.

Subdivision 1.**Definition.**

The term "repair," as used in this section, means to restore all or a part of a drainage system as nearly as practicable to the same condition as originally constructed and subsequently improved, including resloping of ditches and leveling of waste banks if necessary to prevent further deterioration, realignment to original construction if necessary to restore the effectiveness of the drainage system, and routine operations that may be required to remove obstructions and maintain the efficiency of the drainage system. "Repair" also includes:

(1) incidental straightening of a tile system resulting from the tile-laying technology used to replace tiles;

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(2) replacement of tiles with the next larger size that is readily available, if the original size is not readily available; and

(3) incorporation within a drainage system of a measure to limit the wetland or water quality impacts of the repair, provided that any increase in hydraulic efficiency from the measure is local and insubstantial.

Subdivision 6. **Wetland restoration and water quality protection.**

Repair of a drainage system may include the preservation, restoration, or enhancement of wetlands; wetland replacement under section 103G.222; the realignment of a drainage system to prevent drainage of a wetland; and the incorporation of measures to reduce channel erosion and otherwise reduce pollutant transport within the channel and receiving waters.

c. Provide for mechanisms to allocate costs of technical work for system redesignation and realignment proceedings in same manner as indicated in Recommendations #1 and #2, above.

(See Recommended Actions 1 and 2 for statutory language to effect Recommended Action 4.c.)

d. Clarify that a drainage authority may direct that the engineer's report include multiple purposes in design of a drainage project or repair, so long as these purposes are consistent with the applicable watershed-based management plan and approved by the drainage authority.

103E.011 DRAINAGE AUTHORITY POWERS.

Subdivision 5. **Incorporation of wetland and water quality protection; Use of external sources of funding.**

A drainage authority may incorporate into public drainage systems measures to reduce the wetland and water quality impacts of such systems as identified in the engineer's report or as otherwise specified in an adopted watershed-based plan of a watershed district or county. Notwithstanding other provisions of this chapter, a drainage authority may accept and use funds from sources other than, or in addition to, those derived from assessments based on the benefits of the drainage system for the purposes of wetland preservation or restoration or creation of water quality improvements or flood control. The funding authorized under this subdivision may be used outside the benefited area but within the watershed of the drainage system.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

RECOMMENDATION #5: Extend to public waters wetlands the authority to establish a locally based wetland framework under a CWPMP.

***Findings*:** Technical evaluation and planning can integrate WCA and public water wetlands, but WCA LGU has no authority to manage and regulate public waters in accordance with CWPMP except through case-by-case DNR waiver of jurisdiction. Landowner benefits in the form of expectations/certainty are undermined by preservation of full DNR regulatory prerogative. Benefits of clear, efficient process are undermined by ambiguous Minnesota Statutes §103E.701 language concerning DNR approval of repair. Drainage authority ability to fairly allocate management costs is complicated by uncertainty over the statutory cost to protect public water wetlands affected by drainage system (e.g., §103G.225).

a. Clarify DNR authority under Minnesota Statutes §§103G.2243 and 103G.245 to (i) programmatically waive jurisdiction to WCA LGU under CWPMPs and (ii) establish a parallel CWPMP framework by agreement with the LGU.

103G.2243 LOCAL COMPREHENSIVE WETLAND PROTECTION AND MANAGEMENT PLANS.

Subdivision 2.**Plan contents.**

A comprehensive wetland protection and management plan may:

….

<u>(5) incorporate the terms of a general permit issued by the commissioner governing work in public waters within the plan area</u> .

103G.245 WORK IN PUBLIC WATERS.

Subdivision 3.**Permit application.**

Application for a public waters work permit must be in writing to the commissioner on forms prescribed by the commissioner. The commissioner may issue a state general permit to a governmental subdivision or to the general public for classes of activities having minimal impact upon public waters under which more than one project may be conducted under a single permit. <u>Activities conducted within the framework of a comprehensive wetland protection and management plan approved by the Board pursuant to Minnesota Statutes §103G.2243 may constitute a class of activities for the purpose of this subdivision.</u>

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

b. Establish an efficient administrative process with record review under Minnesota Statutes §103E.701 to involve DNR in determination of repair depth when public waters may be affected.

103E.701 REPAIRS.

Subdivision 2.**Repairs affecting public waters.**

Before a repair is ordered, the drainage authority must notify the commissioner if the repair may affect public waters. If the commissioner disagrees with the repair depth or cross-section, the engineer, a representative appointed by the director, and a soil and water conservation district technician must jointly determine the repair depth and cross-section using soil borings, field surveys, and other available data or appropriate methods. This determination shall define the limit of the repair unless within 30 days of receipt the drainage authority or commissioner initiates a contested case proceeding under sections 14.57 to 14.66. In such a proceeding, the administrative law judge shall decide permitted repair depth on the basis of a preponderance of the evidence but shall give substantial weight to the determination. The report of the administrative law judge constitutes a final decision in the case, as provided in section 14.62, subdivision 4. Costs for determining the repair depth beyond the initial meeting of the representatives and for the administrative proceeding must be shared equally by the drainage system and the commissioner. The determined repair depth must be recommended to the drainage authority. The drainage authority may accept the joint recommendation and proceed with the repair.

c. Revisit Minnesota Statutes §103G.225 and related statutes for clear legislative articulation of when the public shall bear the cost to protect public waters against the impacts of lawful drainage work.

(Statutory language is not offered here, as this recommendation requires a legislative policy decision concerning how the cost to protect public waters from impacts of drainage system work should be allocated as between the drainage system and the public.)

RECOMMENDATION #6: Create replacement alternatives within a CWPMP for a landowner causing wetland impact who may not have a high-valued replacement option on site.

Findings: A CWPMP will incorporate incentives to replacement wetlands within particular areas of the watershed to enhance overall wetland value. As a result, certain landowners may be situated with access to higher-valued restoration options and others may not. CWPMP potential is diminished if a landowner is forced to a lower-valued replacement option.

Recommended actions:

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

a. State authority in Minnesota Statutes §103G.2243 for WCA LGU to establish and manage own watershed-based wetland replacement bank under CWPMP.

103G.2243 LOCAL COMPREHENSIVE WETLAND PROTECTION AND MANAGEMENT PLANS.

Subdivision 2.**Plan contents.**

A comprehensive wetland protection and management plan may:

(1) provide for classification of wetlands in the plan area based on:

(i) an inventory of wetlands in the plan area;

(ii) an assessment of the wetland functions listed in section 103B.3355, using a methodology chosen by the Technical Evaluation Panel from one of the methodologies established or approved by the board under that section; and

(iii) the resulting public values;

(2) vary application of the sequencing standards in section 103G.222, subdivision 1, paragraph (b), for projects based on the classification and criteria set forth in the plan;

(3) vary the replacement standards of section 103G.222, subdivision 1, paragraphs (f) and (g), based on the classification and criteria set forth in the plan, for specific wetland impacts provided there is no net loss of public values within the area subject to the plan, and so long as:

(i) in a 50 to 80 percent area, a minimum acreage requirement of one acre of replaced wetland for each acre of drained or filled wetland requiring replacement is met within the area subject to the plan; and

(ii) in a less than 50 percent area, a minimum acreage requirement of two acres of replaced wetland for each acre of drained or filled wetland requiring replacement is met within the area subject to the plan, except that replacement for the amount above a 1:1 ratio can be accomplished as described in section 103G.2242, subdivision 12; ~~and~~

(4) in a greater than 80 percent area, allow replacement credit, based on the classification and criteria set forth in the plan, for any project that increases the public value of wetlands, including activities on adjacent upland acres; and

(5) establish a bank for replacement credits generated and to be applied within the plan area and administered by the local government unit under terms specified in the plan.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

b. Affirm in Minnesota Statutes §103G.2243 that a WCA LGU, notwithstanding land use law concerning exactions, may: (i) collect fees in lieu of replacement provided fees are used to create or purchase replacement credits meeting CWPMP requirements; and (ii) require as condition of replacement plan approval that a property owner dedicate an easement allowing public resource restoration work.

103G.2243 LOCAL COMPREHENSIVE WETLAND PROTECTION AND MANAGEMENT PLANS.

Subdivision 2.**Plan contents.**

A comprehensive wetland protection and management plan may:

(1) provide for classification of wetlands in the plan area based on:

(i) an inventory of wetlands in the plan area;

(ii) an assessment of the wetland functions listed in section 103B.3355, using a methodology chosen by the Technical Evaluation Panel from one of the methodologies established or approved by the board under that section; and

(iii) the resulting public values;

(2) vary application of the sequencing standards in section 103G.222, subdivision 1, paragraph (b), for projects based on the classification and criteria set forth in the plan;

(3) vary the replacement standards of section 103G.222, subdivision 1, paragraphs (f) and (g), based on the classification and criteria set forth in the plan, for specific wetland impacts provided there is no net loss of public values within the area subject to the plan, and so long as:

(i) in a 50 to 80 percent area, a minimum acreage requirement of one acre of replaced wetland for each acre of drained or filled wetland requiring replacement is met within the area subject to the plan; and

(ii) in a less than 50 percent area, a minimum acreage requirement of two acres of replaced wetland for each acre of drained or filled wetland requiring replacement is met within the area subject to the plan, except that replacement for the amount above a 1:1 ratio can be accomplished as described in section 103G.2242, subdivision 12; and

(4) in a greater than 80 percent area, allow replacement credit, based on the classification and criteria set forth in the plan, for any project that increases the public value of wetlands, including activities on adjacent upland acres;

(5) provide that a fee may be paid to the local government unit in lieu of replacement under terms providing for the fee to be used to increase wetland values within the plan area and to reasonably reflect the cost of replacing the wetland values being lost; and

(6) require as a condition of replacement plan approval that a property owner dedicate the right to manage hydrologic and vegetative conditions within priority wetland and associated upland areas; there must be an essential nexus between the dedication and the public purpose sought to be achieved by the dedication and the burden of the dedication must bear a rough proportionality to the need created by the proposed activity.

RECOMMENDATION #7: Coordinate USACE Section 404 jurisdiction with a watershed-based CWPMP or other implementing framework.

Findings: A conflicting federal regulatory framework can preclude CWPMP outcomes. The USACE's reserved regulatory prerogative under Section 404 of the Clean Water Act can undermine the benefits of a CWPMP by reducing the CWPMP's ability to deliver more certainty in permitting time and outcome. The alternatives analysis requirement under Section 404 adds to CWPMP cost concerns and undermines certainty in permitting time and outcome that are important benefits of a watershed-wide approach.

Recommended actions:

> **a. (Non-legislative) Further BWSR coordination with USACE to align Section 404 permitting with CWPMPs, including: (i) readier USACE use of programmatic permits, (ii) USACE consideration of "sector-specific" programmatic permits for drainage system maintenance, and (iii) consistent standards and procedures for fee-in-lieu programs.**

(No statutory change.)

RECOMMENDATION #8: Integrate MnDOT right-of-way, other state-managed lands and local road authority activities within a CWPMP framework.

Findings: State agencies may affect higher-valued wetlands or disrupt protected corridors contrary to CWPMP goals. Local road impacts in higher-valued resource areas will be subject to CWPMP disincentives but replacement activity may be outside of plan area and not contribute to desired CWPMP outcomes.

(No statutory change.)

RECOMMENDATION #9: Foster reliability of CWPMP outcomes through coordination of local land use authority and wetland regulatory authority.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Findings: The local land use authority may regulate wetland impacts under local ordinances and inconsistently with the CWPMP framework. The identity of the WCA LGU may shift after CWPMP investment has been completed, and a new LGU may not be committed to the CWPMP framework and expectations created. Property owner collaboration in a CWPMP framework rests on the reliability of created expectations. Early coordination enhances commitment to framework over intended duration of CWPMP implementation.

(No statutory change.)

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

APPENDIX B

TECHNICAL INFORMATION – HOUSTON ENGINEERING

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

MEMO
(External Correspondence)

HoustonEngineering Inc.

To: Louis Smith,
Smith Partners

Date: June 23, 2011

Cc: File Project No. 117261-001

From: Greg Bowles, P.E. Greg Bowles

Nancy Stowe, P.E. Nancy Stowe

Subject: Scenario A - Wetland Restoration Hydrologic and Nutrient Removal Analysis

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Introduction

Agricultural land owners in the Red River Valley have experienced ongoing flooding problems that jeopardize agricultural production, building sites and cause temporary flooding of roadways during larger storm events. Feasible methods of flood control are being considered which will provide future flood protection, as well as benefit to habitat. Scenario A is a hypothetical scenario that was created to investigate how a drainage system might be modified to provide flood control and environmental benefits through wetland restoration. It seems important to note that the function of a drainage system is the drainage of land for agricultural production. Drainage systems can of course also provide some flood control benefit, but normally the open channel of a drainage system is design to convey a much smaller (usually less than 10-year and often less) runoff event than an open channel designed for flood control purposes (usually a 100-year event). Field surface drainage is designed for event smaller conveyance.

The purpose of this analysis is to estimate the hydrologic and nutrient removal benefits of a hypothetical wetland restoration area constructed as a component of a "fictitious" or idealized public drainage system. Several assumptions were necessary to define the watershed and for sizing the wetland restoration area. Agricultural areas typically have ditch drainage systems, and one method of creating a wetland restoration area is to construct an impoundment across the ditch system (i.e., on channel rather than off-channel). For the purposes of analyzing Scenario A, the impoundment was assumed to be on-channel and create a wetland restoration surface area of 75 acres that has an average normal pool depth of 2 feet and an additional bounce of 1 foot resulting from runoff from the 10-year, 24-hour return period event. The wetland restoration is further assumed to be designed with 225 acres of upland buffer corresponding to a 3:1 upland area to wetland area ratio. The drainage area to the wetland restoration area is assumed to be 1,875 acres (3 sq. mi.) corresponding to a 25:1 drainage area to wetland area ratio.

Methodology

Hydrologic models for existing and for proposed conditions (after the wetland restoration) were completed for the 2-year (2.20 inches), 10-year (3.40 inches) and the 100-year (5.00 inches), 24 hour storm events using a HydroCAD model. The model was created assuming the runoff from the entire 1,875 acre drainage area flows to the restored wetland area via sheet flow, shallow concentrated flow, and channelized flow through a ditch system. The slope of the terrain within this drainage area is assumed to be very flat and have a slope of 2 feet per mile. This terrain slope was used in calculating a time of concentration of 543 minutes which was used in the existing and proposed model. Soil within the Red River Valley is assumed to be type B soil for agricultural lands and type C soil for the upland buffer area surrounding the wetland restoration area. The entire 1,875 acre existing watershed was modeled with a curve number (CN) of 78 (row crop, straight row, good, HGC B). The proposed watershed was modeled with a composite CN of 78 which included 1,500 acres using a CN of 78 (row crop, straight row, good, HGC B), 225 acres using a CN of 71 (meadow, non-grazed, HGC C) and 75 acres using CN of 98 (water surface). The wetland restoration impoundment was designed as a two stage 70-foot long weir (first stage) to allow for a bounce of one foot for the 10-year, 24 hour storm event, and a 200-foot long weir (second stage) to allow for a bounce of 1.4 feet in the 100-year, 24 hour storm event. This bounce criteria of one foot for the 10-year, 24 hour storm event is commonly used by Ducks Unlimited in their wetland restoration designs. Modeling analysis assumed the normal water elevation of the wetland restoration area is the same elevation as the outlet elevation of the impoundment and that there is free discharge downstream. If the scenario included a downstream channel that controlled the flow, the peak runoff rate reduction would be less than the modeled results. The hydrologic model results of existing and proposed conditions are shown in **Table 1**.

Pollutant loading and removal for the hypothetical watershed and restored wetland was performed using version 3.4 of the P8 model – Program for Predicting Polluting Particle Passage thru Pits, Puddles, & Ponds (http://wwalker.net/p8). It was used to estimate the total suspended sediment (TSS), total phosphorus (TP), and total kjeldahl nitrogen (TKN) components of the long-term mass balance.

In order to understand the long-term variability in pollutant loading in the watershed, a 50-year (1961 to 2010) model simulation was carried out. The P8 model requires user input relative to local precipitation and temperature, watershed characteristics, water quality parameters, and treatment device geometry. Hourly precipitation and daily temperature data were obtained at the Minneapolis-St. Paul airport, as it has sufficient data to perform long-term model simulations since the percent of the load removed is primarily of interest. As in the HydroCAD model, the impervious fraction in the watershed was assumed zero, and a CN of 78 was applied. The wetland was assumed to provide 150 AF of permanent pool and 75 AF of flood pool and have a 70-foot long weir as an outlet. The wetland was modeled as a pond in the P8 model and assigned a particle removal scale factor of 3 to account for the effects of vegetation on particle removal rates. Since the wetland was modeled as an on-channel pond, there was no pollutant removal assumed for the upland buffer area.

The simulated weighted average annual pollutant loads, as well as the removal occurring in the hypothetical restored wetland, as predicted by the P8 model, are shown in **Table 2.**

Results

Peak existing and proposed runoff rates for the 2-, 10- and 100-year, 24 hour storm events are shown below.

Table 1 – HydroCAD Modeling Results for Scenario A

Storm Event	Existing Peak Runoff Rates Before Wetland Restoration	Proposed Peak Runoff Rates after Wetland Restoration	Peak Runoff Rate Reduction (%)
2-YR Runoff Event (cfs)	99	63	36%
10-YR Runoff Event (cfs)	246	179	27%
100-YR Runoff Event (cfs)	483	433	10%

Model assumptions:

- Drainage area of 1,875 acres
- Type B soils in agricultural area and type C soil within the wetland buffer area
- CN value = 78 for row crop (straight, good), 71 for meadow (non-grazed), 98 for restoration water surface
- Time of Concentration = 543 minutes (65 min. sheet flow, 250 min. shallow concentrated flow and 228 min. channel flow)
- Slope of terrain is flat (2'/mile)
- Wetland restoration pool has surface area of 75 acres, live storage of 1' and dead storage of 2'.
- Wetland restoration outlet is a two stage outlet with a width of 70 feet and 200 feet. The outlet is sized for a 1' bounce at the 100-year, 24 hour storm event and a 1.4' bounce at the 100-year event.
- Normal water elevation of the wetland restoration area is the same elevation as the outlet elevation of the impoundment.

The results indicate the wetland restoration area will create a peak runoff reduction of 36% for the 2-year, 27% for the 10-year, and 10% for the 100-year, 24 hour storm events. The results also indicate that the wetland restoration area will not change the peak flood volume for this particular scenario. The percentage reductions have not been converted to stage and the change in the area inundated. Therefore an estimate of the area protected by adding storage is not possible.

Table 2 - P8 Modeling Results for Scenario A (based on 50-year period of record)

	Loading Before Wetland Restoration Treatment (lbs/yr)	Loading After Wetland Restoration Treatment (lbs/yr)	Removal (lbs/yr)	Removal Percent (%)
Total Suspended Solids (TSS)	168,294	65,345	102,949	61%
Total Phosphorus (TP)	523	353	170	32%

Total Nitrogen (TKN)	2,331	1,669	662	28%

Model assumptions:

- Drainage area of 1,875 acres
- Minneapolis-St. Paul precipitation records
- No impervious area
- Weir discharge coefficient - 2.66
- Particle Removal Factor = 3 (recommended for vegetation)
- Otherwise P8 defaults

APPENDIX C

TECHNICAL INFORMATION – I & S GROUP

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

INTRODUCTION

Green Meadows County Ditch No. 43 (***"Ditch 43"***) is located within Green Meadows County near the City of Greenstown and generally flows from south to northeast eventually draining into the Old Corncob River. The contributing watershed to Ditch 43 contains primarily of agricultural land usage and also drains most of the City of Greenstown. Ditch 43 was originally constructed in 1919 and has undergone improvements as recently as 1975. Additional improvements to Ditch 43 are currently under construction and will provide increased conveyance and water quality benefits through the use of grass buffers lining the ditch, two stage ditch, and two (2) detention ponds. These improvements are outlined in ***Figure 1***.

This analysis details the anticipated pollutant removals for three contaminants as a result of the improvements to Ditch 43. Namely, the pollutants studied are Total Suspended Solids (***"TSS"***), Total Phosphorus (***"TP"***), and Total Nitrogen (***"TN"***).

METHODOLOGY

Based on data obtained from the Nation Urban Runoff Program, existing agricultural pollutant loading was determined for TSS, TP, and TN. From an article titled "Pollution From Urban Storm Water Infiltration", existing urban concentrations for TSS, TP, and TN were determined for urban runoff. These values are empirical and represent only an estimation of typical values given the source of the runoff.

Because the treatment practices are deemed either a storm water pond or vegetative filter, the Minnesota Stormwater Manual was referenced to determine the expected percent removal of TSS, TP, and TN for these particular treatments. From these percent removals, an anticipated treated pollutant concentration was determined and the annual pollutant removal was calculated accordingly.

Due to the nature of the data collected from the National Urban Runoff Program, the only contributing factor to the amount of pollutant generated from the adjoining land use was the number of acres treated by the particular BMP; i.e. existing/future flows generated via modeling were unnecessary to compute the annual pollutant removal. Using this data, the annual pollutant removals for the Surge Pond, Two Stage Ditch, and Grass Buffers were calculated.

The estimated urban runoff concentrations determined from "Pollution From Urban Storm Water Infiltration" was provided in a format which necessitated hydrologic and hydraulic modeling. As such, two (2) 6-month storm events were simulated and an annual volume of water passing through the City Pond was obtained and used to compute the annual pollutant removal by the City Pond.

The theoretical Total Maximum Daily Limit (***"TMDL"***) that could be imposed on the system at the downstream end of the future ditch was determined utilizing two (2) 6-month storm events and the existing/treated pollutant concentrations. The flows and concentrations were routed throughout the treatment system and the resulting pollutant concentrations were established at the downstream end of the project. This result represents the lowest TMDL that could be imposed before additional treatment practices would need to be implemented.

ENVIRONMENTAL OUTPUTS

For the described treatment practices, TSS, TP, and TN removals were estimated given the anticipated annual rainfall. These removals were determined for the City Pond, Surge Pond, Two Stage Ditch, and Grass Buffer treatments.

City Pond

The City Pond ultimately treats most of the storm water runoff generated by the City of Greenstown. Approximately 295 acres of land characterized as urban and producing 12 ac-ft annual rainfall runoff drains into this basin. Based on empirical data, it is estimated that the storm water runoff entering the pond possesses a TSS concentration 65 mg/L, TP concentration 0.350 mg/L, and TN concentration 2.0 mg/L. Upon treatment of the storm water, it is anticipated that the TSS, TP, and TN concentrations will be reduced to 10 mg/L, 0.175 mg/L, and 1.4 mg/L, respectively, as outlined in ***Table 1***. The subsequent annual removal of pollutants by the City Pond is 1775 lbs. TSS, 5.7 lbs. TP, and 19.4 lbs. TN, as described in ***Table 2***.

Surge Pond

The Surge Pond treats storm water runoff generated by the portion of the watershed south of the Surge Pond. Included in this runoff are the previously treated flows from the City Pond. In determination of the contaminant removal, the flows treated by the City Pond were not included. Approximately 1395 acres of land classified as agriculture and producing 95 ac-ft annual rainfall runoff empties into the Surge Pond. It is estimated that the storm water runoff entering this pond possesses a TSS concentration 8.5 lbs/ac-yr, TP concentration 0.035 lbs/ac-yr, and TN concentration 14 lbs/ac-yr. Upon treatment of the storm water, it is anticipated that the TSS, TP, and TN concentrations will be reduced to 1.3 lbs/ac-yr, 0.018 lbs/ac-yr, and 9.8 lbs/ac-yr, respectively, as outlined in ***Table 1***. The subsequent annual removal of pollutants by the Surge Pond is 10,045 lbs. TSS, 23.7 lbs. TP, and 5,860 lbs. TN, as described in ***Table 2***.

Two Stage Ditch

The Two Stage Ditch treats storm water runoff generated by the portion of the watershed generally within the center of the catchment. Included in this runoff are the previously treated flows from the City Pond and Surge Pond. As was the case previously, the determination of the contaminant removal neglected the flows treated by the City Pond and Surge Pond. Approximately 260 acres of additional land classified as agriculture and producing 60 ac-ft annual rainfall runoff empties into the Surge Pond. It is estimated that the storm water runoff entering this portion of the ditch possesses a TSS concentration 8.5 lbs/ac-yr, TP concentration 0.035 lbs/ac-yr, and TN concentration 14 lbs/ac-yr. Upon treatment of the storm water, it is anticipated that the TSS, TP, and TN concentrations will be reduced to 1.3 lbs/ac-yr, 0.018 lbs/ac-yr, and 9.8 lbs/ac-yr, respectively, as outlined in ***Table 1***. The subsequent annual removal of pollutants by the Two Stage Ditch is 1,880 lbs. TSS, 4.5 lbs. TP, and 1,095 lbs. TN, as described in ***Table 2***.

<u>Grass Buffers</u>

The Grass Buffers treat storm water runoff generated by the portion of the watershed generally at the downstream portion of the catchment. Included in this runoff are the previously treated flows from the City Pond, Surge Pond, and Two Stage Ditch. The determination of the contaminant removal neglected the flows previously treated by other methods. Approximately 330 acres of additional land classified as agriculture and producing 2,250 ac-ft annual rainfall runoff passes through the portion of Ditch 43 containing Grass Buffers. Important to note, because the Grass Buffers are only capable of treating overland flow, a vast majority of the runoff generated in this area goes untreated. This is due to much of the runoff being captured by field drainage tile and routed to Ditch 43 without treatment. As such, only 300 feet of the portion of land adjacent to Ditch 43 extending out from the ditch was included as part of the treated calculation. It is estimated that the storm water runoff entering this portion of the ditch possesses a TSS concentration 8.5 lbs/ac-yr, TP concentration 0.035 lbs/ac-yr, and TN concentration 14 lbs/ac-yr. Upon treatment of the storm water, it is anticipated that the TSS, TP, and TN concentrations will be reduced to 1.9 lbs/ac-yr, 0.018 lbs/ac-yr, and 9.1 lbs/ac-yr, respectively, as outlined in ***Table 1***. The subsequent annual removal of pollutants by the Grass Buffers is 345 lbs. TSS, 0.9 lbs. TP, and 255 lbs. TN, as described in ***Table 2***.

<u>TOTAL MAXIMUM DAILY LIMITS</u>

The system of storm water treatments utilized throughout the drainage ditch results in TSS, TP, and TN concentrations of 20 mg/L, 0.154 mg/L, and 1.73 mg/L, respectively, before the confluence with the Old Corncob River. In the event that a TMDL were imposed on this waterway, the treated water emerging from the pond and grass buffer treatment system will not exceed the TMDL provided the following:

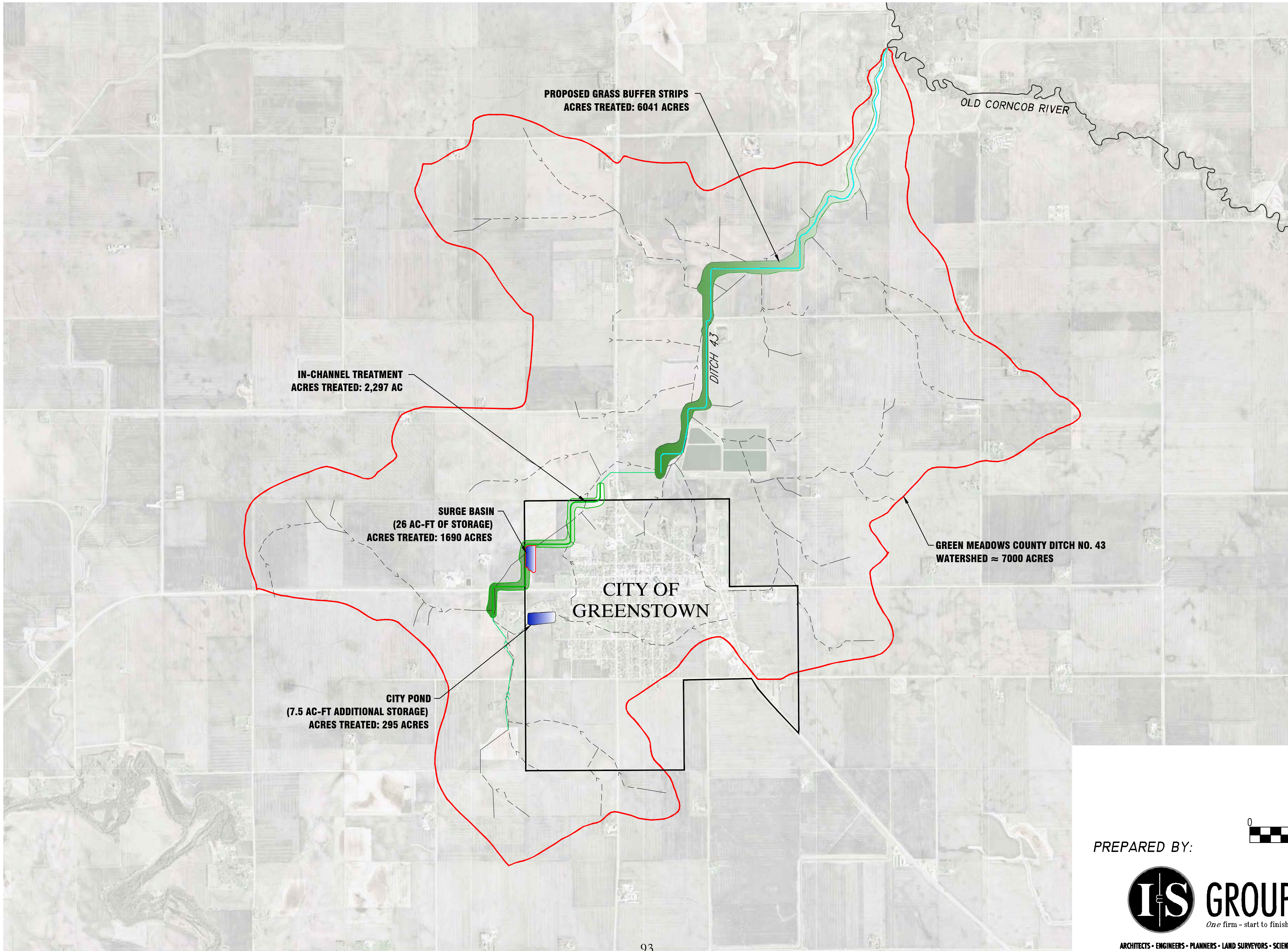
- TSS TMDL ≥ 20mg/L

- TP TMDL ≥ 0.154 mg/L
- TN TMDL ≥1.73 mg/L

If a TMDL was imposed for a particular pollutant below the concentrations listed, additional treatment measures would need to be implemented to ensure compliance.

FIGURE 1. GREEN MEADOWS COUNTY DITCH NO. 43 IMPROVEMENTS

GREEN MEADOWS COUNTY, MINNESOTA



PREPARED BY:

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Faribault, Minnesota: 507-331-1500
Mankato, Minnesota: 507-387-6651
Web: www.is-grp.com

PROJECT NO. 11-13378 CAD FILE NAME 13378 LCCMR EXHIBIT PLOT DATE 5/16/2011 DRAWN BY JP

TABLE 1
GREEN MEADOWS COUNTY DITCH NO. 43
ESTIMATED WATER QUALITY POLLUTANT CONCENTRATIONS BEFORE/AFTER TREATMENT

Pollutant Concentration Summary						
Treatment*	**Total Suspended Solids Concentration Before Treatment (lbs/ac-yr)**	**Total Suspended Solids Concentration After Treatment (lbs/ac-yr)**	**Total Phosphorus Concentration Before Treatment (lbs/ac-yr)**	**Total Phosphorus Concentration After Treatment (lbs/ac-yr)**	**Total Nitrogen Concentration Before Treatment (lbs/ac-yr)**	**Total Nitrogen Concentration After Treatment (lbs/ac-yr)**
City Pond**	65**	10**	0.35**	0.175**	2.0**	1.4**
Surge Pond***	8.5	1.3	0.035	0.018	14.0	9.8
Two Stage Ditch***	8.5	1.3	0.035	0.018	14.0	9.8
Grass Buffers***	8.5	1.9	0.035	0.018	14.0	9.1

*Treatment removal efficiency based on the Minnesota Stormwater Manual.

**Existing pollutant concentrations based on research by Mikkelsen et al. published in 1994.
Pollutant removal derived from the volume of water produced by two simulated six-month rainfall events.
Concentrations listed in mg/L.

***Existing pollutant concentrations based on data collected as part of the National Urban Runoff Program.

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TABLE 2
GREEN MEADOWS COUNTY DITCH NO. 43
ESTIMATED WATER QUALITY POLLUTANT REMOVAL PER YEAR

Pollutant Removal Summary					
Treatment*	**Watershed Area (ac.)**	**Total Flow Treated (ac-ft)**	**Estimated Total Suspended Solids Removal (lb.)**	**Estimated Total Phosphorus Removal (lb.)**	**Estimated Total Nitrogen Removal (lb.)**
City Pond**	295	12	1,775	5.7	19.4
Surge Pond***	1,395	95	10,045	23.7	5,860
Two Stage Ditch***	260	60	1,880	4.5	1,095
Grass Buffers***	330	2,250	345	0.9	255

*Treatment removal efficiency based on the Minnesota Stormwater Manual.

**Existing pollutant concentrations based on research by Mikkelsen et al. published in 1994.
Pollutant removal derived from the volume of water produced by two simulated six-month rainfall events.

***Existing pollutant concentrations based on data collected as part of the National Urban Runoff Program.

APPENDIX D

ECONOMIC ANALYSIS

June 29, 2011
To: Louis Smith, Smith Partners
From: Steven J. Taff

Assessing the total economic value of drainage improvement projects

My task was to think through a relatively transparent and practical procedure to assign total economic values to the agronomic and environment services affected by a given drainage improvement project—Scenarios A and B in the LCCMR project. To an economist, "total economic value" is the sum of monetized changes in all service flows. This is in contrast to "market value," which captures only that money value of actual transactions. Total economic value is one way economists attempt to capture the cost of "externalities," those effects of an action that aren't considered by economic actors (acting under a strict financial calculus) in their decisions.

To properly estimate total economic value, we require valuations for both market and the extra-market impacts of an action. The former is usually simpler, because there exists both a history of market prices and an apparatus for deciding upon "proper" market prices for many activities. In the case of drainage improvements, the Engineering Report and the Viewers' Report (available only for Scenario B) both assign economic values to the market effects of the proposed improvement, using techniques accepted in both professional and judicial circles.

To estimate the value of non-marketed effects, such as changes in water quality or in wildlife habitat, economists have developed a range of tools that can elicit peoples' implicit valuations about these changes. This presupposes, however, that we have at hand a complete set of measures of the physical changes in the environment: how much more water pollution, how much less habitat. These physical measures are not commonly obtained in engineering or viewers' reports. Consequently, for the present effort, we asked the engineers to estimate these numbers.

A drainage project, by its nature, is expected to change both the timing and volume of water flows through the system by changing the retention capacity of various lands through the system.

In Scenario A, the water quality improvement measures include a large retention basin, part of which will be restored to wetland, and a two-stage ditch structure in the upper reaches of the watershed. In Scenario B, the improvement measures consist of increasing the size of the receiving ditch and, simultaneously, retarding the rate of flow by installing intervening surge ponds. In addition, Scenario B calls for increasing the size of buffer areas along the ditch.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

In both scenarios, the retention basin/ponds can be thought of as a change in land use—modeled here as a change from cropland to wetland or grassland. The two-stage ditch, by its design, also results in land use changes by reducing cropland and increasing buffer strips and the bench of the ditch itself. The retention basin/ponds, in retarding the flow of water, are expected to have certain pollution reduction effects, notably in the removal of Nitrogen, Phosphorus, and suspended solids from the system. The buffer areas in Scenario B, by intercepting overland flows, will also reduce these pollutants to some extent. All land use changes will have carbon sequestration impacts.

In the attached models, I work through all these calculations for Scenarios A and B independently, making use of the engineering reports (for both) and the viewers' report for the latter, as well as project advisory team members' suggestions. The result is a complete set of measured physical changes in each system: water flow, pollutant levels, land use changes, and crop production (which is covered in acquisition costs).

In each scenario, I calculate the magnitude distribution of total costs and benefits of the proposed drainage system improvements without and with "water quality improvements," which term I use as shorthand for all changes in environmental services.

To assign dollar values to each of the services, I make use of existing literature on the economics of environmental services and of on-going research in these areas. None of my work creates "new numbers;" rather, it arrays dispersed information in a framework that can be used to assess drainage improvement projects from a perspective wider than is traditional.

I calculate the change in total economic value (for the agronomic and environmental services measured here) of adding water quality improvement measures to a drainage project already proposed. This way, we can compare the costs of these additional measures to their benefits. Not all environmental services are measured here, so the total benefits I estimate are not complete: they could be lower but would likely be higher than that I report, if we were to obtain physical measures of additional environmental services (in a subsequent effort).

Differences between the two arrays are thus the costs and benefits of the water quality improvements themselves.

Assumptions:

Many of the elements in the spreadsheet are self-evident, and specific items are commented. Here are a few that are common to both scenarios:

Project Life: 25 years (consistent with that implicit in Viewers' Report for Scenario B and applied also to Scenario A)

Discount/Interest rate: 5% (consistent with that assumed in the Viewers' Report for Scenario B and applied also to Scenario A). Used in annualizing one-time capital costs. As is customary in

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these reports, all values are in current (2010) dollars. Because inflation is assumed to affect all activities equally over time, it does not have to be explicitly modeled.

Drainage improvements: Project engineers say that drainage improvements without water quality improvements stuff would be "more expensive". I assume 10% more than the amount shown in the Engineering Report for both scenarios. These costs are allocated to the benefitted owners in the system. I treat all local governments as system owners, because benefits are assigned to them in the Viewers' Report.

Drainage repairs: This expenditure is what is needed to keep the system going at its *original* (pre-improvement) design level. These costs are paid by all owners in the system.

Upper watershed storage basins (Scenario B only): I assume that none of the proposed drainage or water quality improvements affect the pollution dispersion capacity of the city's wastewater treatment plant.

Viewers' Report

While I show a summary of the Viewers' Report for Scenario B (both for the Improvements and for the associated Redetermination) for reference, the current version of the model does not make use of most of these numbers. Scenario A does not have a viewers' report. Only the overall benefits estimated with and without the water quality improvements enter into our final calculations. Ron Ringquist, advisory group member, estimates a 5-10% increase in benefits for the WITH situation, because the water quality improvements increase drainage efficiency at upper end of the system. I assume this increase is 10% for both scenarios.

Environmental services

Houston and I&S provide estimates of changes in Phosphorus, suspended solids, Nitrogen, and land cover for the addition of the water quality improvements to their respective drainage plans. I converted their estimates to standard international weights, because the economic values for unit changes of these environmental services are generally in such units. I credit all estimated changes to the water quality improvement portion of the projects.

The Houston report estimates changes in peak flow for Scenario A, but we lack a ready total economic value estimate for changes in this parameter. Instead, for Scenario A, I estimate the economic value of the reduction in flood damages, based on a very approximate value of flood damages associated with a 100-year event in that watershed. I assume that the wetland restoration portion of the retention basin will qualify as "wetlands" and that the entire basin will provide carbon sequestration benefits because of land use change. Wetland habitat values are already captured in the wetland value.

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The I&S report estimates changes in peak flow and peak elevation for Scenario B, we do not have to put a dollar value on them because the project is designed to have identical flow and elevation values with and without the water quality improvements. I assume that both surge ponds will qualify as "wetlands" and that both the ponds and the buffer areas will provide carbon sequestration benefits because of land use change. The buffer areas will also provide habitat benefits. Wetland habitat values are already captured in the wetland value.

Unit value of environmental services

I make use of existing unit values, localized to southern or western Minnesota where possible. Although these numbers are known to be widely variable, but I report only point estimates here. The spreadsheet permits subsequent users to enter different values, if known/asserted.

Phosphorus: In forthcoming work by Pennington and Dalzell (pers. comm.), Phosphorus reductions are estimated to be "worth" $274/kg. This number is probably the most uncertain of all of those used in the present report, but it is similar to that used in Kovacs et al.

Suspended sediments: Hanson and Ribaudo suggests $6-7/ton of avoided sediment in water bodies in this area.

Carbon sequestration: I use $62/Mg, the 33% level for the distribution of avoided carbon release through land use change from Tol.

Nitrogen: In forthcoming work by Pennington and Dalzell (pers. Comm.), Nitrogen reductions from changing crop land to grass land are estimated to be $2/kg. This is similar, on average, to that used in Kovacs et al.

Wetlands: I use Brander et al. fresh water marsh median value, adjusted to 2010 dollars.

Habitat: I use the average cost (in 2010 dollars) of Minnesota DNR Scientific and Natural Area purchase costs, from Kovacs et al.

Value of environmental series from water quality improvements

Each of the changes in physical flows estimated by the engineers are multiplied by the unit values discussed above to give estimated annual economic value of the changes in the flow of environmental services created by the water quality improvement additions to the drainage project. In Scenario A, Phosphorus and flood damage reduction are the largest environmental service values. In Scenario B, Nitrogen and Phosphorus values are dominant.

Distribution of costs

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

This section of the model summarizes and annualizes the initial cost arrays, breaking them down into two classes of payers: system owners (which class includes local governments) and the broader public. In Scenario B nearly all the costs are to be paid by system owners, while in Scenario A the State is a major financial participant. These costs—and measured drainage and environmental benefits—could have been broken down into a finer mesh of recipients (such as lake owners, hunters, taxpayers, etc.), but such detail was beyond the scope of this project.

Annual change from water quality improvement

Here I simply group all calculated *annual* costs and benefits from adding the water quality improvements to the drainage project. For Scenario B, the system owners pay $13,750 (including the cost reduction in the drainage project itself) and non-local public entities pay $2,700. Everyone, including system owners, gains $12,404 in increased environmental services. For Scenario A, the values are $1,925 *less* for system owners, $42,975 for non-local entities, and $53,915 for environmental services.

Recommendations

To add information to the drainage authority's decision context, the State might consider requiring a few additional elements to the engineering report. These could be made consistent and routine by standardizing some of the numbers and procedures to be used.

I further suggest that all engineering reports, in addition to the current practice of estimating changed peak levels and flows at the outlet, be required also to calculate changes in pollutants (Nitrogen, Phosphorus, and suspended solids) and a change matrix in land use (X acres from crop to grass, Y acres from grass to ponds, etc.). The specific calculation protocols could be developed through a statewide body such as the Drainage Work Group, which is already in operation. The result would be similar to the attached spreadsheet table Environmental Services, described above.

At the same time, the State should develop, through the Drainage Work Group, a "standard environmental service unit value" schedule similar to that used in the attached spreadsheet, adjusted for regional conditions.

The Engineer's specific project estimated environmental services changes could then be combined with the official State unit values for the locality to come up with a total economic value for environmental services provided by the proposed project. This number would then be available to the drainage authority and to the State in the consideration of drainage system improvement proposals.

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

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Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

Scenario A

watershed size	38,400
all prices in 2010 dollars	
project life	25
discount rate	0.05

Engineer's report

drainage without conservation measures

	improvement owners	non-government system owners	city	county	township	total system owners	lakeshore owners	lake users	state	public total	TOTAL
drainage repairs						-				-	-
road crossing improvements				190,000		190,000				-	190,000
drainage improvements	1,265,000					1,265,000				-	1,265,000
retention area easements						-				-	-
wetland restoration extra cost						-				-	-
upland restoration extra cost						-				-	-
two-stage ditch sections						-				-	-
TOTAL	1,265,000	-	-	190,000	-	1,455,000	-	-	-	-	1,455,000
annual payment	63,250	-	-	9,500	-	72,750	-	-	-	-	72,750

drainage with conservation measures

	improvement owners	non-government system owners	city	county	township	total system owners	lakeshore owners	lake users	state	public total	TOTAL
drainage repairs						-				-	-
road crossing improvements				171,000		171,000				-	171,000
drainage improvements	1,150,000					1,150,000				-	1,150,000
retention area easements	78,000					78,000			702,000	702,000	780,000
wetland restoration extra cost	9,000					9,000			81,000	81,000	90,000
upland restoration extra cost	4,500					4,500			40,500	40,500	45,000
two-stage ditch sections	4,000					4,000			36,000	36,000	40,000
TOTAL	1,245,500	-	-	171,000	-	1,416,500	-	-	859,500	859,500	2,276,000
annual payment	62,275	-	-	8,550	-	70,825	-	-	42,975	42,975	113,800

Environmental services

		quantity of environmental service (at outlet)		
		drainage without conservation measures	drainage with conservation measures	change from without to with (calculated)
TMDL	Phosphorus (kg/yr)	230.5	155.9	75
	suspended solids (t/yr)	81.2	31.5	50
non TMDL	Carbon sequestration (Mg/yr)	-	77	77
	Nitrogen (kg/yr)	1,026.8	735.9	291
	wetlands (acres)	-	75.0	75
	habitat (acres)	-	225.0	225
non-environment externality	peak flow (cfs)	483.0	433.0	50.0

Unit value of environmental services

TMDL	Phosphorus $/kg	274
	suspended solids $/ton	7
non TMDL	Carbon sequestration $/Mg	62
	Nitrogen $/kg	2
	wetlands $/acre/yr	61
	habitat $/acre/yr	20
non-environment externality	peak flow $/cfs	

pennington crop to prairie

mean SS $/a/y	5.42	mean P $/a/y	71.7
mean SS t/a/y	0.828	mean P kg/a/y	0.262
SS $/t	6.5	P $/kg	273.7
mean C $/a/y	15.8	mean N $/a/y	
mean C Mg/a/y	0.256	mean N kg/a/y	
C $/t	61.7	N $/kg	#DIV/0!

Value of environmental services from conservation measures

		change from without to with conservation measures
TMDL	Phosphorus	20,400
	suspended solids	326
non TMDL	Carbon sequestration	4,740
	Nitrogen	570
	wetlands	4,573
	habitat	4,556
non-environment externality	flood damamge	18,750
TOTAL		53,915

single-event flood damage	187,500
percent reduction in peak flow	0.1

Annual expenditures	drainage without conservation measures owners	public	TOTAL	drainage with conservation measures owners	public	TOTAL	changed without to with conservation measures owners	public	TOTAL
drainage repairs	-	-	-	-	-	-	-	-	-
road crossing improvements	9,500	-	9,500	8,550	-	8,550	(950)	-	(950)
drainage improvements	63,250	-	63,250	57,500	-	57,500	(5,750)	-	(5,750)
retention area easements	-	-	-	3,900	35,100	39,000	3,900	35,100	39,000
wetland restoration extra cost	-	-	-	450	4,050	4,500	450	4,050	4,500
upland restoration extra cost	-	-	-	225	2,025	2,250	225	2,025	2,250
two-stage ditch sections	-	-	-	200	1,800	2,000	200	1,800	2,000
TOTAL EXPENDITURES	72,750	-	72,750	70,825	42,975	113,800	(1,925)	42,975	41,050

annual change from conservation measures	
drainage improvement costs to system owners	(6,700)
cost of water quality improvements to system owners	4,775
cost of water quality improvements to non-local public entities	42,975
environmental services	53,915

Scenario B

all prices in 2010 dollars

project life	25
discount rate	0.05

Engineer's report

drainage without water quality improvements

	drainage improvement owners	non-government system owners	city	county	township	total system owners	lakeshore owners	lake users	state	public total	TOTAL
drainage repairs		575,000				575,000				-	575,000
road crossing improvements				190,000		190,000				-	190,000
drainage improvements	231,000					231,000				-	231,000
upper watershed storage basins						-				-	-
two-stage ditch sections						-				-	-
in-channel sediment storage						-				-	-
native grass buffers--open ditch						-				-	-
TOTAL	231,000	575,000	-	190,000	-	996,000	-	-	-	-	996,000
annual payment	11,550	28,750	-	9,500	-	49,800	-	-	-	-	49,800

drainage with water quality improvements

	drainage improvement owners	all system owners	city	county	township	total system owners	lakeshore owners	lake users	state	public total	TOTAL
drainage repairs		575,000				575,000				-	575,000
road crossing improvements				190,000		190,000				-	190,000
drainage improvements	210,000					210,000				-	210,000
upper watershed storage basins	25,000		125,000	100,000		250,000				-	250,000
two-stage ditch sections	4,000			36,000		40,000				-	40,000
in-channel sediment storage	3,000					3,000			27,000	27,000	30,000
native grass buffers--open ditch	3,000					3,000			27,000	27,000	30,000
TOTAL	245,000	575,000	125,000	326,000	-	1,271,000	-	-	54,000	54,000	1,325,000
annual payment	12,250	28,750	6,250	16,300	-	63,550	-	-	2,700	2,700	66,250

Viewers report

Improvement	"market impact"	improvement rate	"benefit value"	acres/feet	"potential benefits"	"gross benefits"	system average efficiency rate	"net benefits to landowners"	
township								904	
city									
county								419	
state								1,638	
road benefits								2,961	
city									
a	2,480.0	0.6	1,488.00	100	248,000	148,800	0.17	25,198	0.17
b	2,100.0	0.85	1,785.00	167	350,700	298,095	0.17	50,481	
c	815.0	0.9	733.50	1,087	885,905	797,315	0.17	135,020	
d	375.0	0.9	337.50	361	135,375	121,838	0.17	20,632	
e (tile)	1.5	0.9	1.35	3,450	5,175	4,658	0.17	789	
land benefits								232,121	

total benefits from drainage improvements	235,082
total benefits from drainage improvements with conservation measures	258,590

Redetermination	"market impact"	improvement rate	"benefit value"	acres/feet	"potential benefits"	"gross benefits"	system average efficiency rate	"net benefits to landowners"	
township								20,113	
city									
county								54,660	
state								66,504	
road benefits								141,277	
city					1,285,000	858,000	0.79	678,544	
a	2,480.0	0.6	1,488.00	215	533,200	319,920	0.79	253,007	0.79
b	2,100.0	0.85	1,785.00	511	1,073,100	912,135	0.79	721,356	
c	815.0	0.9	733.50	3,366	2,743,290	2,468,961	0.79	1,952,562	
d	375.0	0.9	337.50	881	330,375	297,338	0.79	235,147	
e (tile)	1.5	0.9	1.35	118,900	178,350	160,515	0.79	126,942	
land benefits								3,967,558	
total benefits FROM REPAIRS								4,108,835	

Environmental services

		quantity of environmental service (at outlet)			
		drainage without conservation measures	**drainage with conservation measures**	**change from without to with (calculated)**	**change from without to with (I&S)**
TMDL	Phosphorus (kg/yr)			16	16
	suspended solids (t/yr)			7	7
non TMDL	Carbon sequestration (Mg/yr)			9	
	Nitrogen (kg/yr)			3,279	3,279
	wetlands (acres)			7.0	7.0
	habitat (acres)			29.9	29.9
non-environment externality	peak flow (cfs)	747.0	747.0	-	
	peak elevation (feet)	986.3	986.3	-	

Unit value of environmental services

TMDL	Phosphorus $/kg	274
	suspended solids $/ton	7
non TMDL	Carbon sequestration $/Mg	62
	Nitrogen $/kg	2
	wetlands $/acre/yr	61
	habitat $/acre/yr	20
non-environment externality	peak flow $/cfs/yr	
	peak elevation $/ft/yr	

pennington crop to prairie

mean SS $/a/y	5.42	mean P $/a/y	71.7
mean SS t/a/y	0.828	mean P kg/a/y	0.262
SS $/t	6.5	P $/kg	273.7
mean C $/a/y	15.8	mean N $/a/y	
mean C Mg/a/y	0.256	mean N kg/a/y	
C $/t	61.7	N $/kg	#DIV/0!

Value of environmental services from water quality improvements

		change from without to with conservation measures
TMDL	Phosphorus	4,320
	suspended solids	46
non TMDL	Carbon sequestration	582
	Nitrogen	6,427
	wetlands	424
	habitat	605
non-environment externality	peak flow	-
	peak elevation	-
TOTAL		12,404

Annual expenditures	drainage without conservation measures owners	public	TOTAL	drainage with conservation measures owners	public	TOTAL	changed without to with conservation measures owners	public	TOTAL
drainage repairs	28,750	-	28,750	28,750	-	28,750	-	-	-
road crossing improvements	9,500	-	9,500	9,500	-	9,500	-	-	-
drainage improvements	11,550	-	11,550	10,500	-	10,500	(1,050)	-	(1,050)
upper watershed storage basins	-	-	-	12,500	-	12,500	12,500	-	12,500
two-stage ditch sections	-	-	-	2,000	-	2,000	2,000	-	2,000
in-channel sediment storage	-	-	-	150	1,350	1,500	150	1,350	1,500
native grass buffers--open ditch	-	-	-	150	1,350	1,500	150	1,350	1,500
TOTAL EXPENDITURES	49,800	-	49,800	63,550	2,700	66,250	13,750	2,700	16,450

annual change from water quality improvement	
drainage improvement costs to system owners	(1,050)
drainage improvement benefits to system owners	1,175
net cost of water quality improvements to system owners	14,800
cost of water quality improvements to non-local public entities	2,700
environmental services	12,404

APPENDIX E

STUDY ADVISORY COMMITTEE

Name	Affiliation
Ray Bohn	Minnesota Association of Watershed Districts
Gary Botzek	Minnesota Conservation Federation
Mark Dittrich	Minnesota Department of Agriculture
Les Everett	University of Minnesota Water Resources Center
Warren Formo	Minnesota Agriculture Water Resources Coalition
Annalee Garletz	Minnesota Association of Counties
Ron Harnack	Red River Watershed Management Board
Al Kean	Minnesota Board of Water and Soil Resources
Rick Moore	MSU-Mankato Water Resources Center
Lance Ness	Minnesota Fish & Wildlife Legislative Alliance
Ron Ringquist	Minnesota Viewers Association
Doug Thomas	Comfort Lake Forest Lake Watershed District
Henry Van Offelen	Minnesota Center for Environmental Advocacy

Meeting	Date	Agenda
1	12-14-09	Problem Statement; Critical Issues Identification
2	7-21-10	Legal Review; Critical Issues Analysis
3	9-9-10	Scenario A Development
4	10-14-10	Scenario B, Scenario C Development
5	11-30-10	Scenario B Development; Scenario C Policy Issues
6	2-18-11	Scenario C, Analysis
7	3-31-11	Scenario B, Preliminary Economic Analysis
8	5-6-11	Scenario B, Economic Analysis; Scenario A
9	5-26-11	Draft Recommendations

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund
as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Ballast Water Technology Testing and Sampling in Freshwater
PROJECT MANAGER: Rebecca Walter, MPCA;
Principal Investigator, Allegra Cangelosi (NEWMI)
AFFILIATION: Minnesota Pollution Control Agency
MAILING ADDRESS: 520 Lafayette Road North
CITY/STATE/ZIP: St. Paul, MN 55155
PHONE: 651 757-2807
E-MAIL: Rebecca.walter@state.mn.us
WEBSITE: www.pca.state.mn.us
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 6a

APPROPRIATION AMOUNT: $300,000

Overall Project Outcome and Results

Safe and effective ballast water treatment (BWT) is the best way to prevent ship-mediated introductions of invasive species in the Great Lakes. However, knowing whether a proposed BWT works in freshwater, and whether it is used properly by a ship is a difficult challenge for the Minnesota Pollution Control Agency (MPCA) and other regulators. BWTs with International Maritime Organization (IMO) approval have never been tested in natural fresh water, and there are no agreed methods for monitoring ballast discharge from ships. This project assisted the MPCA through accomplishing a) IMO-consistent freshwater validations of two promising BWTs at the Great Ships Initiative (GSI) freshwater testing facility, and 2) design, installation and demonstration of a credible and feasible ballast discharge sampling method for Great Lakes ships. The IMO-approved PureBallast system (AlfaLaval), performed well in tests overseas, but did not function effectively in the GSI test, likely due to clogging by freshwater filamentous algae (see http://www.nemw.org/GSI/GSI-LB-F-A-2.pdf). This outcome informs MPCA that IMO-approval does not by itself assure freshwater effectiveness. The other BWT tested, a lye-based system aimed at US lakers, performed better (see http://www.nemw.org/GSI/GSI-LB-F-A-3.pdf), warranting refinement and shipboard testing. The project's ship sampling system proved a) applicable to the Great Lakes fleet, as demonstrated by project installation plans for 10 ships; b) cost-effective, as demonstrated by installations on 5 ships; and c) feasible, as demonstrated by sampling exercises on 2 ships. A detailed guidebook (see http://www.nemw.org/GSI/ballastDischargeMonitoringGuidebook.pdf) equips MPCA with the project method. All sample ports are permanent installations. The remaining four installations and seven tests will take place in 2012 using Department of Transportation, Maritime Administration funds. GSI will collect and analyze data on live organisms in ballast water discharge sampled in 2011 and 2012, and will post outcomes on the GSI website (http://www.greatshipsinitiative.org) and forward them to the MPCA.

Project Results Use and Dissemination

Final reports on ballast treatment tests performed pursuant to this grant, and the guidebook developed for ship discharge sampling, have been posted on the GSI public website (www.greatshipsinitiative.org). The project forwarded final reports on ballast treatment performance tests to the United States Environmental Protection Agency (USEPA) Science Advisory Board which reported to the USEPA and the USCG on availability of ballast treatment technology in 2011. NEMWI presented the sampling method developed through this project to an international gathering of ballast discharge researchers and regulators (Global R&D Forum and Exhibition on Ballast Water Management in a session on ballast treatment testing and compliance monitoring in Istanbul Turkey in the fall of 2011), and will submit the guidebook as a manuscript for the conference proceedings.

Environment and Natural Resources Trust Fund 2009 Work Program
Final Report

Date of Final Report:	November 23, 2011
Date of Work Program Approval:	June 16, 2009
Project Completion Date:	June 30, 2011
PROJECT TITLE:	Ballast Water Technology Testing and Sampling in Freshwater
PROJECT MANAGER:	Rebecca Walter, MPCA; Principal Investigator, Allegra Cangelosi (NEWMI)
AFFILIATION:	Minnesota Pollution Control Agency
MAILING ADDRESS:	520 Lafayette Road North
City / State / Zip:	St. Paul, MN 55155
Telephone Number:	651 757-2807
E-mail Address:	Rebecca.walter@state.mn.us
Fax Number:	
Web Site Address:	www.pca.state.mn.us
Location:	Northeast Region; St. Louis, Lake, Cook Counties; City of Duluth and others

Total Trust Fund Project Budget:			
	Trust Fund Appropriation	**$**	**300,000**
	Great Lakes Protection Acct	$	66,000
	Minus Amount Spent:	**$**	**366,000**
	Equal Balance:	**$**	**0**

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 6a

Appropriation Language:
$300,000 is from the trust fund and $66,000 is from the Great Lakes protection account to the commissioner of the Pollution Control Agency in cooperation with the Department of Natural Resources to conduct monitoring for aquatic invasive species in ballast water discharges to Minnesota waters of Lake Superior and to test the effectiveness of ballast water treatment systems.

Final Project Summary (Abstract)
Safe and effective ballast water treatment (BWT) is the best way to prevent ship-mediated introductions of invasive species in the Great Lakes. However, knowing whether a proposed BWT works in freshwater, and whether it is used properly by a ship is a difficult challenge for the Minnesota Pollution Control Agency (MPCA) and other regulators. BWTs with International Maritime Organization (IMO) approval have never been tested in natural fresh water, and there are no agreed methods for monitoring ballast discharge from ships. This project assisted the MPCA through accomplishing a) IMO-consistent freshwater validations of two promising BWTs at the Great Ships Initiative (GSI) freshwater testing facility, and 2) design, installation and demonstration of a credible and feasible ballast discharge sampling method for Great Lakes ships. The IMO-approved PureBallast system (AlfaLaval), performed well in tests overseas, but did not function

effectively in the GSI test, likely due to clogging by freshwater filamentous algae (GSI, 2011a; attached as Appendix A). This outcome informs MPCA that IMO-approval does not by itself assure freshwater effectiveness. The other BWT tested, a lye-based system aimed at US lakers, performed better (GSI 2011b; attached as Appendix B), warranting refinement and shipboard testing. The project's ship sampling system proved a) applicable to the Great Lakes fleet, as demonstrated by project installation plans for 10 ships; b) cost-effective, as demonstrated by installations on 5 ships; and c) feasible, as demonstrated by sampling exercises on 2 ships. A detailed guidebook (GSI, 2011c, attached as Appendix C) equips MPCA with the project method. All sample ports are permanent installations. The remaining 4 installations and 7 tests will take place in 2012 using Department of Transportation, Maritime Administration funds. GSI will collect and analyze data on live organisms in ballast water discharge sampled in 2011 and 2012, and will post outcomes on the GSI website (www.greatshipsinitiative.org) and forward them to the MPCA.

Outline of Project Results
This project helped prepare the MPCA for implementation of its ballast water discharge permit by providing hardware design and sampling methods and actual sample port installations for monitoring live organisms in ballast water discharge from ships in the Great Lakes. This project also generated important new information on treatment technology performance in fresh water to assist the MPCA in approving technologies between 2011 and 2016. In addition, this project influenced international, federal and other Great Lakes states' efforts to prevent the introduction and spread of invasive species.

Result 1: Install and trial inline sampling devices on ten ships, develop a methods guidebook for effective ship discharge monitoring, and categorical data on ballast biological constituents of subject ships.

Results from this part of the study build Minnesota's capacity to monitor ships' discharges into Minnesota ports (i.e., Duluth, Two Harbors, Taconite Harbor, Silver Bay) for invasive species. Launch of this portion of the LCCMR grant was delayed by about 12 months in hopes of consolidating GSI project activity with other national and international ship discharge monitoring methods development efforts. Two groups internationally, the IMO and the International Standards Organization (ISO), had indicated that they too would be developing proposed standard approaches to ship discharge monitoring at the time the grant was awarded to NEMWI. Meanwhile, the United States Coast Guard (USCG) had begun an internal review and development process for the same purpose, though not focused on fresh water ships. Initially, it appeared that the best way to optimize project effort would be to adopt and trial on Great Lakes ships methods recommended by the USCG, IMO and ISO, which according to those organizations were to be issued imminently. As it turned out, these governmental processes encountered delays. Rather than continue to await the output of the design stage of these efforts, GSI undertook its design effort independently, in consultation with these national and international groups. By doing so, the LCCMR-funded GSI project ultimately provided important input into the national and international design processes, accelerating their progress. At the same time, it provides invaluable information on how ship discharge monitoring can work in practice.

Once the effort fully launched, GSI readily developed a proposed ballast discharge sampling design for standard, consistent and representative measurement of live organism densities in ballast discharge across Great Lakes-relevant ship types, and for a variety of purposes, including compliance monitoring, ship board type approval testing, and research. The GSI design is intentionally a low-technology (i.e. affordable) approach to make ship discharge monitoring readily available across Great Lakes ships. The design was peer-reviewed by ship owners, federal and state officials and international ballast discharge sampling experts, and revised prior to finalization. GSI then tested the approach on a number of ships.

The Guidebook for installation and use of this sampling approach is contained in Appendix C. Sampling events, data collection and analysis using these sample port installations will continue into 2012 with MARAD support. These results will be forwarded to the MPCA and published on the GSI website (www.greatshipsinitiative.org) for public viewing as they are finalized during 2012.

Also as a result of this project, ballast discharge sample port installation is well underway for the Great Lakes fleet. GSI completed inspections, reports, fluid mechanics, and drawings for ten ships as of November 2011. The ten Great Lakes relevant ships span subject to engineering design effort through this project span the range of sizes, types and designs that ply the Great Lakes, including four Canadian lakers, four US lakers, and two salty vessels.

The sample ports have been installed on five of the ten ships so far, and four more installations are pending in the near future. The completed installations are on the Indiana Harbor and the Edwin H. Gott (American Steamship and Keystone Shipping Company, respectively), the Niagara (Canada Steamship Lines), the Herbert C. Jackson (Interlake Steamship Company) and the Federal Hunter (Fednav Limited). The Oberstar is on track for installation, and the Tim S. Dool is poised to install pending resolution of unrelated ship equipment issues that are causing delays. CSL has decided to install the sample port on a sister ship (the Richelieu) instead of the Saguenay, still using the GSI design and installation guidelines and report, in support of CSL plans to install a BWTS on the Richelieu in the near future for certification testing purposes. The Polsteam's Isolda or a sister ship will receive the installation at the first dry-docking opportunity. One of the ships was removed from the study after GSI completion of the inspection and report due to a finding that explosion proof equipment would be necessary (James R. Barker, Interlake Steamship Company).

So far, GSI has trialed its sampling approach on two US laker ships (Indiana Harbor and Edwin H. Gott). A sampling date of December 3, 2011 is in place for the Canadian laker Niagara. GSI deployed a team to conduct sampling exercises three additional times, in 2011 but delays and weather obstructed their completion. Sampling events on remaining ships will occur in 2012 using MARAD funds.

Ship Name	Ship Type	Inspected	Report Submitted to Ship Owner	Flanges Installed	Test Date
Niagara	Canadian Laker	11/17/2010	Yes	Yes	12/3/2011***
Saguenay*	Canadian Laker	11/17/2011	Yes	No*	
M/V Tim S. Dool	Canadian Laker	1/19/2011	Yes	Yes	
M/V Indiana Harbor	US Laker	1/8/2011	Yes	Yes	8/18/2011
Edwin H. Gott	US Laker	2/6/2011	Yes	Yes	10/7/2011
Str. Herbert C. Jackson	US Laker	2/7/2011	Yes	Yes	
M/V James R. Barker**	US Laker	2/28/2011	Yes	No	
M/V Hon. James L. Oberstar	US Laker	4/6/2011	Yes	Pending	
Federal Hunter	Salty	N/A****	N/A****	Yes	
Isolda	Salty	4/26/2011			

*Sample Flanges to be installed on sister ship Richelieu instead; **Removed from study due to requirement of explosion-proof equipment;***Tentative sample date;****Installed by ship owner per GSI guidelines.

The GSI project achieved the target (as revised and approved by LCCMR in April 2011) of 10 installation inspections and designs in the project period, and this design and installation work was more than adequate to inform development of the sampling system and methods guidebook required for this project. GSI has presented the sampling methods developed through this project at the Global R&D Forum and Exhibition on Ballast Water Management in a session on ballast treatment testing and compliance monitoring in Istanbul Turkey in the fall of 2011. The installations, which are on-going, are facilitating ship-based BWTS testing on Great Lakes relevant-ships. For example, the Indiana Harbor and the Richelieu will host treatment system installations within a year, whose performance can be monitored using these sample ports. These GSI sampling ports also will deliver quality information on an on-going basis to the State of Minnesota on the nature of biota in ballast discharge generally. GSI will forward all such data to the State of Minnesota, and will post it for public access through the GSI website, as it is collected and analyzed during 2012.

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$ 156,000**
	Amount Spent:	**$ 146,551**
	Balance:	**$ 9,449**
	Final Payment to E&O	**$ - 9, 449**
	Balance:	**$ 0**

The remaining amount in Result 1 will be paid to the Insurance Company for Errors and Omissions Insurance. The balance in the Total Project Balance is zero because this $9,449 is ear marked.

Result 2: Land-Based Testing of Promising BWTS at GSI's Freshwater RDTE Facility

NEMWI, through the GSI project, operates the only ambient fresh water ballast water treatment testing facility in the world. The GSI testing facility, funded largely by MARAD and other DOT funds, is located in the Duluth/Superior Harbor and benefits greatly from technical support from the University of Wisconsin, University of Minnesota and AMI Consulting Engineers. During the project period, GSI tested two BWTSs that have received or are likely to seek final approval under international guidelines.

NEMWI first lined up the Sedna System by Hamann, an IMO-approved treatment system, for testing under this grant in 2009, but Hamann withdrew its application just prior to testing as a result of newly discovered problems with residual toxicity in cold water systems. (The company has just re-contacted GSI for testing in 2012 using a revised treatment process which is designed to eliminate this toxicity problem). GSI then lined up respected marine technology vendor Alfa Laval for tests on its PureBallast® BWTS. This BWTS was the first system to receive IMO approval, and is suitable for use on Canadian lakers and salty vessels that visit the Great Lakes. The treatment method employs filtration and a UV-based advanced oxidation system. It does not employ an active substance, *per se*, but produces lethal radicals that kill organisms and then degenerate after a short period of time. GSI conducted preliminary trials at the bench scale to assure that the discharge met state and federal water quality requirements, and then proceeded to plan, implement and analyze land-based tests. In addition to the IMO-approved version of the BWTS, Alfa Laval requested trial of an updated version that optimizes operational conditions. The same BWTS unit had just received IMO certification testing at a Norwegian land-based facility (NIVA) in brackish and salt water prior to shipment to GSI.

The land-based fresh water tests at GSI of the optimized PureBallast® BWTS took place in summer, 2010. GSI testing yielded a negative outcome for treatment performance in freshwater. The treatment process encountered filter performance problems early in the test regime under ambient conditions of Duluth-Superior Harbor, and never successfully completed valid IMO tests. GSI then conducted a set of research and development trials to help the treatment developer determine the root cause of the operational problem, and to help diagnose why GSI's negative results differed from NIVA's positive results. Attachment A contains the final report on treatment performance which covers all of these trials. While disappointing, this negative testing outcome is extremely important to progress toward effective BWTSs in the Great Lakes. It signals the need for ambient freshwater testing under highly transparent circumstances to avoid unwarranted confidence in poorly functioning systems. It also helps treatment developers better understand how to design successful and effective treatment processes applicable to the Great Lakes.

The second treatment system subjected to land-based testing at GSI under this grant was a lye (NaOH) based system. The BWTS, developed by United States Geological Survey scientists, is contemplated specifically for use by the United States laker fleet. GSI conducted preliminary bench tests on the proposed process with positive outcomes, and a ship owner expressed interest in the treatment concept, so larger scale land-based testing was well warranted. The treatment process was not ready for certification testing, so the tests performed by GSI were in the research and development category, providing the treatment developer with a better sense of treatment performance during the process development stage.

This lye-based treatment process involves raising the pH of the ballast water significantly, holding the pH at that high level for an exposure period, and then neutralizing the pH using carbon dioxide gas prior to discharge. The tests showed the treatment system to be promising but still in need of additional development and refinement to fully answer all questions of residual toxicity and biological effectiveness. The final report on this testing is provided as Attachment B. Since completion of these GSI land-based tests, the treatment system has been installed at the pilot scale on a laker ship (MV Indiana Harbor) and will undergo further technical development prior to a prospective full-scale installation on the same ship for United States Coast Guard's (USCG) Shipboard Technology Evaluation Program (STEP) or type approval.

In short, the testing conducted using LCCMR funds underscored the importance of rigorous fresh water testing at the land-based scale using ambient assemblages to determine performance prospects of a BWTS in the Great Lakes, irrespective of IMO approval. The testing also corroborated promising bench scale tests findings on the NaOH BWTS performance, and the need for further development and testing to refine this system. In both cases, the work expedited development of BWTSs that could prove effective and safe in fresh water, and helped establish the degree to which other testing facilities in the world may be providing findings relevant to Minnesota waters.

Summary Budget Information for Result 2:	**Trust Fund Budget:**	**$ 210,000**
	Amount Spent:	**$ 210,000**
	Balance:	**$ 0**

Project Results Use and Dissemination

Final reports on ballast treatment tests performed pursuant to this grant, and the guidebook developed for ship discharge sampling, have been posted on the GSI public website (www.greatshipsinitiative.org). The project forwarded final reports on ballast treatment performance tests to the United States Environmental Protection Agency (USEPA) Science Advisory Board which reported to the USEPA and the USCG on availability of ballast treatment technology in 2011. NEMWI presented the sampling method developed through this project to an international gathering of ballast discharge researchers and regulators (Global R&D Forum and Exhibition on Ballast Water Management in a session on ballast treatment testing and compliance monitoring in Istanbul Turkey in the fall of 2011), and will submit the guidebook as a manuscript for the conference proceedings.

TOTAL TRUST FUND PROJECT BUDGET:

Contracts: $ 366,000 for Northeast Midwest Institute (lead for Great Ships Initiative)

See Attachment A – Budget Sheet.

Attachment A: Budget Detail for 2009 Projects (Final Project Submittal 12/2011)

Project Title: Ballast Water Technology Testing and Sampling in Freshwater

Project Manager Name: Rebecca walter

Trust Fund Appropriation: $ *366,000 ($300,000 from Trust fund/ $66,000 from Great Lakes Protection Account)*

2009 Trust Fund Budget	**Result 1 Budget:**	**Result 1 Budget Revised 5/3/2011**	**Amount Spent** *(12/31/2010)*	**Balance** *(March/2011)*		**Result 2 Budget:**		**Result 2 Budget**	**Amount Spent** *(March 2011)*	**Balance** *(March 2011)*
	Identify and trial inline sampling devices and methods on ships					Evaluation of ballast water treatment systems performance in fresh water				
BUDGET ITEM										
Contracts										
Professional/technical contract with Northeast Midwest Institute for project management and subcontracts*	156,000		156,000	0				$210,000	174,829	-174,829
COLUMN TOTAL	**$156,000**		**$156,000**	**$0**				**$210,000**	**$174,033**	**-$174,033**
	Budget		Amount Spent continued:	Balance continued		***Result 2 Contract with NEMWI:**		**Budget**	**Amount Spent**	**Balance**
NEMWI subcontract to AMI Engrg	$35,000		$ 32,003	$2,997		1. Participation agreements with at least two treatment technology vendors and submittal of applications for discharge permits, if needed	NEMWI	$10,000	$ 10,000	$ -
NEMWI subcontract to AMI Engrg	$96,000	$69,577	$ 72,909	($3,332)		2. Biological sampling and testing protocols consistent with international and domestic guidelines	NEMWI	$10,000	$ 10,000	$ -
NEMWI	$25,000		$ 25,000	$ -		3. Conduct treatment tests on two and up to three treatment systems at GSI facility	NEMWI Subcontract for biological sampling, analysis and results write-up: UW-Superior: $90,000; UM-Duluth: $45,000	$135,000	$ 135,000	$ -
Contract with Insurance Company	$0	$26,423	$ 16,639	$9,784		4. Report detailing treatment test procedures, biological results of samples collected and analyzed, and results analysis. Includes budget of $1000 for Travel/ Meetings by NEMWI staff	NEMWI	$55,000	$ 55,000	$ -
	$156,000		Dec	$9,449		**COLUMN TOTAL**		**$210,000**	$ 210,000	$ -

Final Report of the Land-Based, Freshwater Testing of the AlfaWall AB PureBallast® Ballast Water Treatment System

March 17, 2011

Principal Investigator:

Allegra Cangelosi, NEMWI

Research Team:

Lisa Allinger, NRRI, UMD
Mary Balcer, PhD, LSRI, UWS
Lana Fanberg, LSRI, UWS
Steve Hagedorn, LSRI, UWS
Tom Markee, LSRI, UWS
Nicole Mays, NEMWI
Christine Polkinghorne, LSRI, UWS
Kelsey Prihoda, LSRI, UWS
Euan Reavie, PhD, NRRI, UMD
Deanna Regan, LSRI, UWS
Donald Reid, Consultant
Elaine Ruzycki, NRRI, UMD
Heidi Saillard, LSRI, UWS
Tyler Schwerdt, AMI Engineering
Heidi Schaefer, LSRI, UWS
Matthew TenEyck, LSRI, UWS

Final Report of the Land-Based, Freshwater Testing Of the AlfaWall AB PureBallast® Ballast Water Treatment System

March 17, 2011

Allegra Cangelosi
Principal Investigator and Director
Great Ships Initiative
Northeast-Midwest Institute
50 F St. NW, Suite 950
Washington, DC 20001
Phone: 202-464-4007
Email: acangelo@nemw.org

Approved for Release:

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PI Signature

March 17, 2011.

TABLE OF CONTENTS

SUMMARY OF TABLES

EXECUTIVE SUMMARY

The Great Ships Initiative (GSI) provides independent, no-cost performance verification testing services to developers of ballast treatment systems and processes at a purpose-built, land-based ballast treatment test facility located in the Duluth-Superior Harbor of Lake Superior (Superior, WI). GSI test protocols are consistent with the requirements of the International Maritime Organization's International Convention for the Control and Management of Ships Ballast Water and Sediments (IMO, 2004) and the United States Environmental Protection Agency's (USEPA's), Environmental Technology Verification Program (ETV; NSF, 2010). GSI procedures, methods, materials and findings are also publicly accessible on the GSI website (www.greatshipsinitiative.org).

In August through October 2010, GSI conducted freshwater, land-based tests on three versions of the AlfaWall PureBallast® ballast water treatment system (BWTS). One version (hereafter referred to as v.1) of the PureBallast® BWTS received Type Approval by Det Norske Veritas (DNV) on behalf of the Norwegian Administration in June of 2008, following successful land-based testing at the Norwegian Institute of Water Research (NIVA). The second version (v.2), designed to conserve power relative to the first, was still undergoing IMO certification testing, and had completed successful land-based tests at NIVA immediately prior to testing at GSI during early summer 2010. The third version was a hybrid of versions 1 and 2, hereafter referred to as version 3 (v.3). The BWTS v.3 combined the 40 μm filtration of PureBallast® BWTS v.2 with the advanced oxidation system of PureBallast® BWTS v.1.

The GSI Test Plan for the AlfaWall PureBallast® BWTS, hereafter referred to as the GSI Test Plan, called for evaluation the PureBallast® BWTS v.2 consistent with IMO G8 and G9 guidelines for its ability to: (a) successfully treat ballast water without interruption, (b) meet IMO D-2 discharge standards after a five day holding time, and (c) discharge water after the five day retention period that is environmentally benign (i.e., no residual toxicity). Additional research and development testing of v.1 was also planned. However, the PureBallast® BWTS (both v.1 and v.2) encountered mechanical filter failures such that no valid trials (i.e. meeting IMO and ETV threshold conditions) were completed. Instead, GSI tested the hybrid version of the AlfaWall BWTS (v.3) under a set of GSI source water conditions less challenging than those required by IMO and ETV, strictly for research and development purposes. As an addition to the research and development trials of the PureBallast® BWTS v.3 at the GSI Land-Based RDTE Facility, a set of observations on living organisms in sample water 24 hours post discharge from treatment and control retention tanks was incorporated into the revised test protocol to detect any delayed effects of the BWTS.

The PureBallast® BWTS v.3 performed without interruption during the first two trials under less challenging conditions than required by IMO and ETV. During the third and final trial, the PureBallast® BWTS v.3 encountered a filter failure, and the trial was stopped and restarted under ambient Duluth-Superior Harbor conditions. No residual toxicity was detected in the discharge waters of the PureBallast® BWTS v.3. The BWTS did not effectively reduce live organism densities in the two regulated size classes despite the fact that ambient densities were well below IMO and ETV testing intake thresholds. Part of the problem likely resided with filter ineffectiveness given filamentous algal forms in Duluth-Superior Harbor water. At the same time, very low ambient UV transmittance of Duluth-Superior Harbor water (naturally caused by tannins) during these tests likely impeded effectiveness of the advanced oxidation system. These two conditions also likely account for discrepancies between performance outcomes at GSI versus NIVA. Globally, the risk of very low UV transmittance conditions is not unique to Duluth-Superior Harbor, but it is relatively rare and can be anticipated in advance. Thus, this problem could be mitigated with management practices such as open ocean BWE in combination with treatment. Conditions present in Duluth-Superior Harbor likely leading to filter malfunction, on the other hand, may be relatively common to many fresh water and brackish water harbors.

ACKNOWLEDGMENTS

The authors would like to express our sincere gratitude to the Great Ships Initiative (GSI) Advisory Committee which provides invaluable input to the GSI Principal Investigator. We also wish to thank the ten United States and Canadian Great Lakes Ports which launched the GSI, and the Great Lakes Protection Fund which supported the initial scoping exercise. We sincerely thank the United States Department of Transportation, Maritime Administration, and National Oceanic and Atmospheric Administration for their substantial financial and in-kind support for the construction of the state-of-the-art GSI land-based testing facility. We thank the United States and Canadian St. Lawrence Seaway organizations, the Legislative Citizens Commission on Minnesota Resources, the University of Wisconsin-Superior, and the City of Superior for their active financial and/or in-kind support for GSI operations.

1.0. INTRODUCTION

In September and October 2010, the Great Ships Initiative (GSI) conducted land-based tests on three versions of the AlfaWall AB PureBallast® BWTS (i.e., v.1, v.2, and v.3). The GSI Test Plan (Appendix 1) called for evaluation of the PureBallast® BWTS v.1 and v.2 consistent with International Maritime Organization (IMO) G8 and G9 guidelines for their ability to: (a) successfully treat ballast water without interruption, (b) meet IMO D-2 discharge standards after a five day holding time, and (c) discharge water after the five day retention period that is environmentally benign (i.e., no residual toxicity) pursuant to United States Environmental Protection Agency (USEPA) water quality criteria. However, the PureBallast® BWTS (both v.1 and v.2) encountered mechanical filter failures such that no valid trials (i.e. meeting IMO and ETV threshold conditions) were completed. Instead, GSI tested a hybrid version of the AlfaWall BWTS (v.3) under a set of GSI source water conditions less challenging than those required by IMO and ETV, strictly for research and development purposes.

1.1. The Great Ships Initiative

GSI is a regional effort devoted to ending the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System and globally. In support of that goal, GSI has established superlative freshwater ballast treatment evaluation capabilities at three scales—bench, land-based, and on board ship.

GSI awards its independent status-testing services to developers of ballast water treatment systems (BWTSs) and processes determined to be promising. GSI status-testing is performed at the scale appropriate to the state of development of the target treatment system, with the goal of facilitating the rapid progression of meritorious BWTSs through the research, development, and approval processes to a market-ready condition.

GSI has no involvement, intellectual or financial, in the mechanics, design or market success of the actual treatment systems it tests. To ensure that GSI tests are uncompromised by any real or perceived individual or team bias relative to test outcomes, GSI test activities are subject to rigorous quality assurance and quality control (QAQC) procedures and documentation (GSI, 2010a and 2010b). This QAQC attention also assures high quality and credible evaluation findings.

GSI has worked to standardize and calibrate its protocols to evaluate the performance of BWTSs with IMO guidelines, USEPA Environmental Technology Verification (ETV) protocol, and other test facilities. GSI test protocols are as consistent with the requirements of the IMO Convention for the Control and Management of Ships Ballast Water and Sediments (IMO, 2004) and United States federal requirements (NSF, 2010) as practicable. In particular, GSI testing directly supports IMO G8 and G9 evaluations. GSI procedures, methods, materials and findings are also not proprietary, and are accessible on GSI's public website: www.greatshipsinitiative.org.

1.2. The AlfaWall AB PureBallast® Ballast Water Treatment System

AlfaWall AB of Tumba, Sweden, is a joint venture company of Alfa Laval AB and Wallenius Water AB. Together these two companies have developed the PureBallast® BWTS. The PureBallast® BWTS involves filtration using a 40 or 50 μm screen filter, implemented during ballast uptake operations only, followed by a patented advanced oxidation treatment (Wallenius AOT™) involving ultraviolet (UV) radiation and a catalyst. The Wallenius AOT™ is the main stage of treatment and is applied during both ballasting and deballasting. The PureBallast® BWTS AOT can be scaled by connecting one to ten components in parallel to achieve flow rates between 250 and 2500 m^3/hr; the capacity of each component is 250 m^3/hr.

The original PureBallast® BWTS version (hereafter referred to as v.1) received Type Approval Certification by Det Norske Veritas (DNV) on behalf of the Norwegian Administration on June 27, 2008. This version entailed filtration at 50 μm and AOT using 20 UV lamps per one AOT reactor. The filter is cleaned using automatic back flushing, and is bypassed during deballasting operations. The PureBallast® BWTS v.1 is commercially available and to date there have been approximately 80 systems sold to a large variety of ship owners and for many different types of vessels, e.g., car carriers, Ro-Ros, container carriers, bulk carriers, general cargo carriers, drilling vessels, supply vessels, LPG tankers, bitumen tankers, etc.

The second more energy efficient version (v.2) was undergoing IMO Type Approval evaluation at the time of the GSI testing reported here, and the GSI tests were to become part of the system's land-based testing portfolio (see Test Plan in Appendix 1). The same prototype unit subjected to evaluation at GSI had been subjected to land-based testing in salt and brackish water at the NIVA test facility in Norway immediately prior to shipment to GSI. This version, modified from the PureBallast® BWTS v.1 to enhance energy efficiency, entailed automatic backflush filtration during ballasting at either 40 μm or 50 μm, combined with 12 lamps per one AOT reactor. Like the PureBallast® BWTS v.1, the filtration system is bypassed during deballasting.

The third version (v.3), ultimately subjected to the GSI testing reported here, is a hybrid of versions 1 and 2. This version combined the 40 μm automatic backflushing filter of PureBallast® BWTS v.2 with the 20-lamp AOT reactor of PureBallast® BWTS v.1. Again, filtration was performed during uptake only.

1.3. Treatment Performance Requirements in Regulation D-2

The International Convention for the Control and Management of Ships Ballast Water and Sediments was adopted by consensus at a Diplomatic Conference at IMO in London on February 13, 2004. Annex D-2 of the Convention relates to ballast water performance standards for ships conducting ballast water management, including use of a BWTS to effectively treat the ballast water. The regulation states that ships conducting ballast water management shall discharge:

- Less than 10 viable organisms per m^3 greater than or equal to 50 μm in minimum dimension;

- Less than 10 viable organisms per mL less than 50 μm in minimum dimension and greater than or equal to 10 μm in minimum dimension; and
- Discharge of the indicator microbes shall not exceed the specified concentrations. The indicator microbes, as a human health standard, include, but are not be limited to:
  - Toxicogenic *Vibrio cholerae* (O1 and O139) with less than 1 colony forming unit (cfu) per 100 mL or less than 1 cfu per 1 gram (wet weight) zooplankton samples;
  - *Escherichia coli* - less than 250 cfu per 100 mL;
  - Intestinal *Enterococci* - less than 100 cfu per 100 mL.

1.4. Relationship of GSI Testing to G8 and G9 Requirements in IMO Convention

The fundamental approach of GSI is to conduct independent, scientifically-sound, rigorous, and quality assured evaluations of BWTSs. At the same time, GSI seeks immediate relevance of its freshwater, land-based testing to regulatory processes such as those outlined in the IMO Convention and those under development domestically in the United States and Canada. To that end, GSI protocols are rooted in the essential features of the IMO G8 guidelines for testing, and the USEPA ETV protocols. All aspects of the testing infrastructure (e.g. flow rate, retention tank size, sample size, sample collection, analysis equipment and data logging) are directly consistent with these requirements. GSI also formally partners with the Maryland-based Maritime Environmental Resource Center (MERC), and other test facilities to assure that GSI freshwater land-based testing can be directly complemented by comparable brackish/salt water testing.

With respect to physical/chemical and biological characteristics of the intake stream, GSI is fortunate in that its feed water source (i.e., the Duluth-Superior Harbor of Lake Superior) naturally meets many of the IMO G8 and USEPA ETV requirements for intake organism densities and physical/chemical conditions during the testing season (June to October, see Table 1). For those parameters that often do not naturally meet the IMO G8 and USEPA ETV requirements (i.e., total suspended solids, mineral matter, particulate organic carbon, and phytoplankton), GSI has the ability to augment intake water to achieve recommended IMO/ETV parameter levels (Table 1). IMO and ETV consistent tests at GSI tests are only conducted when parameters that may occasionally fall below the challenge water requirements (i.e., zooplankton and heterotrophic bacteria) are sufficiently high. In addition, GSI will not conduct tests involving a UV system when DOCs, which are naturally high in Duluth-Superior Harbor, exceed 20 mg/L, though no ceiling is indicated in IMO or ETV guidelines. GSI conducts and documents frequent monitoring of water chemistry and biology to predict valid run conditions for GSI, IMO G8 and USEPA ETV performance evaluation/certification test trials.

Table 1. Comparison of USEPA ETV and IMO G8 Recommended Challenge Conditions to Ranges of Various Physical/Chemical and Biological Parameters in Ambient Water from Duluth-Superior Harbor (June – October).

Parameter	USEPA ETV[1]	Recommended IMO G8[2]	Duluth/Superior Harbor Ambient Ranges
Temperature (°C)	4 – 35	–	4 - 30
Salinity (ppt)	< 1	Two salinities, >10 ppt difference	0 – 1
Total Suspended Solids (mg/L)	Min. 24	> 50	< 1 – 40
Mineral Matter (mg/L)	Min. 20	No Requirement	<1- 40
Particulate Organic Carbon (mg/L)	Min. 4	> 5	< 0.1 – 3
Dissolved Organic Carbon (mg/L)	Min. 6	> 5	6 – 30
Transmittance at 254 nm (%)[b]	No Requirement	No Requirement	14.0 – 68.5
Zooplankton (> 50 μm/m^3)	Min. 100,000	> 100,000	100,000 - 3,000,000
Phytoplankton (10 - 50 μm/mL)	Min. 1000	> 1,000	25 – 4,500
Heterotrophic Bacteria (MPN[a]/mL)	Min. 1000	> 10,000	100 - 10,000

[a]MPN = Most Probable Number
[b]Measured on filtered Duluth-Superior Harbor water samples (May 2009 to October 2010).

2.0. METHODS

The following section describes how each physical, chemical and biological parameter and variable was sampled and analyzed during the PureBallast® BWTS trials at GSI. Additional details on GSI's standard operating procedures (SOPs) can be found at www.greatshipsinitiative.org. All SOPs relevant to the PureBallast® tests, as amended, also are listed by analysis category in Appendix 3. Any deviations from these SOPs during the performance of the PureBallast® tests were minor and did not affect data quality. More detail on these deviations is available upon request.

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1 U.S. Environmental Protection Agency (USEPA), Environmental Technology Verification Program. Generic Protocol for the Verification of Ballast Water Treatment Technologies. Version 5.1. September, 2010.
2 IMO MEPC 57, Annex 3: Revised Guidelines for Approval of Ballast Water Management Systems (G8). April 4, 2008.

2.1. Experimental Design and Set-Up

The GSI Test Plan (Appendix 1) for tests on PureBallast® v.1 and v.2 was consistent with IMO G8 and USEPA ETV requirements for land-based testing in freshwater. As such, the GSI test facility was fully validated and prepared to conduct two consecutive sets of five, five-day tests (starting with PureBallast® v.2) contrasting treated discharge and control discharge meeting IMO and ETV testing challenge condition thresholds and quality assurance rigors. GSI began with intake water amended with total suspended solids (TSS), particulate organic carbon (POC), and phytoplankton to assure that all tests met challenge water conditions in the IMO G8 guidelines throughout the trial series (see Appendix 1 for GSI Test Plan and Appendix 2 for details on the PureBallast® v.1 and v.2 commissioning trials). However, due to filter failures during the PureBallast® v.2 commissioning (see Appendix 2), the GSI tests were conducted on a PureBallast® v.3, using challenge water augmented with TSS and phytoplankton but at lower concentrations (see §2.1.2., Table 4) than described in the original GSI Test Plan (Appendix 1). The GSI PureBallast® Test Plan (Appendix 1) was revised and down-sized to a set of three, 48-hour trials with the goal of research and development testing rather than IMO land-based certification testing.

The research and development performance evaluation of the PureBallast® BWTS v.3 involved physical, chemical, and biological characterization of water upon ballasting (uptake/intake of water), as well as, enumeration, sizing, and live/dead analysis of organisms in control and treated discharge water after a two-day, in-tank holding time. In addition, to detect any delayed mortality effects associated with the AOT, live/dead analysis of zooplankton was conducted after holding control and treatment discharge water in collection tubs overnight, with analyses conducted the next morning. The objective of the performance evaluation trials was not to compare the treatment discharge to the IMO or ETV standards, but to compare the control and treatment discharge in order to gauge the relative effectiveness of the PureBallast® BWTS v.3. Table 2 shows the schedule of the three tests, including the sequence of intake operations (simultaneous control and treatment) and discharge operations (sequential, treatment then control).

Table 2. Timing of Intake and Discharge Operations, and Sample Collection Times for the Three PureBallast® v.3 Ballast Water Treatment System Trials at the GSI Land-Based Facility in 2010.

<table>
<tr><th rowspan="2">Trial</th><th rowspan="2">GSI Test ID</th><th rowspan="2">Treatment</th><th colspan="6">Timing of Operation</th></tr>
<tr><th colspan="2">Intake</th><th colspan="2">Discharge</th><th colspan="2">Delayed Mortality Sample Drain</th></tr>
<tr><td rowspan="2">A</td><td rowspan="2">10-A3-1</td><td>Treatment</td><td rowspan="2">27 September</td><td rowspan="2">12:17-13:03</td><td rowspan="2">29 September</td><td>10:03-10:48</td><td rowspan="2">30 September</td><td>08:15-08:39</td></tr>
<tr><td>Control</td><td>12:38-13:24</td><td>09:45-10:08</td></tr>
<tr><td rowspan="2">B</td><td rowspan="2">10-A3-2</td><td>Treatment</td><td rowspan="2">28 September</td><td rowspan="2">10:19-11:06</td><td rowspan="2">30 September</td><td>10:31-11:15</td><td rowspan="2">01 October</td><td>08:30-08:52</td></tr>
<tr><td>Control</td><td>12:48-13:34</td><td>10:00-10:25</td></tr>
<tr><td rowspan="2">C</td><td rowspan="2">10-A3-3</td><td>Treatment</td><td rowspan="2">01 October</td><td rowspan="2">10:45-11:06; 11:55-12:19</td><td rowspan="2">03 October</td><td>10:14-10:58</td><td rowspan="2">04 October</td><td>09:00-09:23</td></tr>
<tr><td>Control</td><td>12:03-12:49</td><td>10:15-10:39</td></tr>
</table>

2.1.1. The GSI Land-Based Research, Development, Testing, and Evaluation (RDTE) Facility

GSI tests reported here evaluated the biological efficacy of PureBallast® BWTS at GSI's purpose-built, Land-Based Research, Development, Testing, and Evaluation (RDTE) Ballast Treatment Test Facility located in Superior, WI in the Duluth-Superior Harbor of Lake Superior (Figures 1-3). Key features of the facility include:

- Four x 200 m^3 matched retention tanks with internal agitation for experimental water;
- Matched control and treatment intake flows up to 341 m^3/hour;
- Highly automated flow and pressure control, monitoring and data logging;
- A freshwater estuary with plentiful aquatic life as a water intake source;
- Capacity to augment intake water to intensify challenge conditions;
- Semi-automated and validated facility sanitation prior to trials;
- High quality in-line or in-tank sampling and/or spiking;
- On-site laboratory space for live analysis of organisms ≥10 and <50 μm and ≥ 50 μm size classes;
- Capacity to test treatment systems that operate on intake, discharge, in-tank, or combinations thereof;
- Off-site whole effluent toxicity (WET) testing; and
- Easy plug-in connections for treatment systems.

Figure 1. Location of the GSI Land-Based RDTE Facility in Superior, Wisconsin.

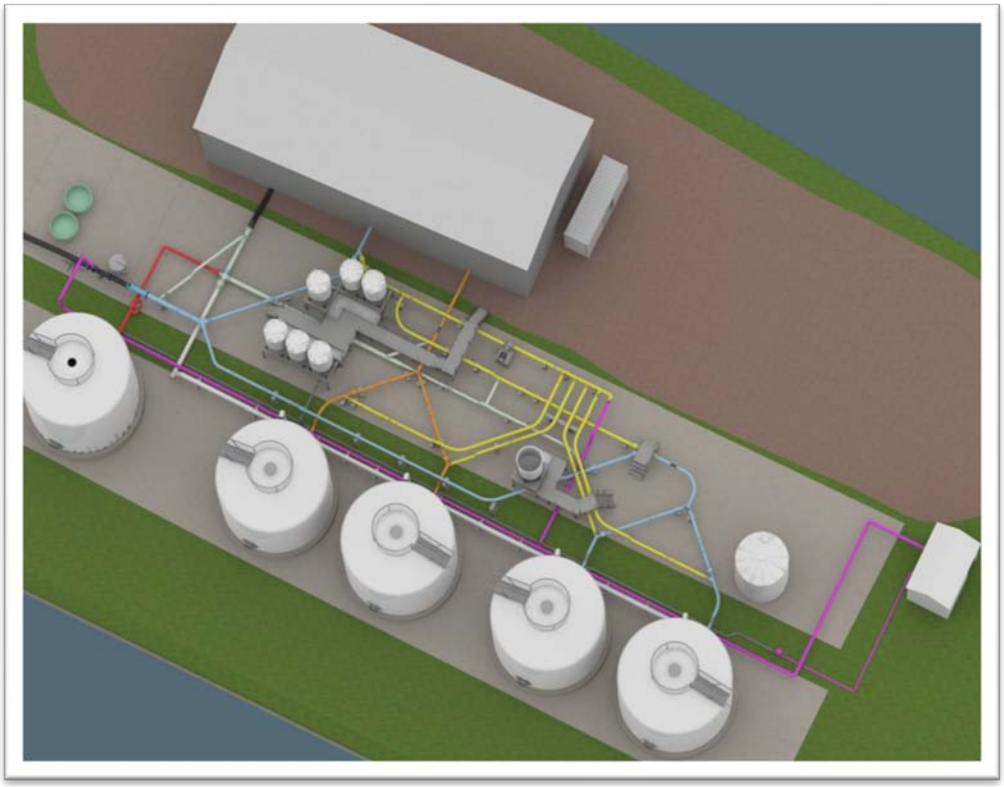

Figure 2. Computer-Generated Rendering of the GSI Land-Based RDTE Facility.

Figure 3. Photo of the GSI Land-Based RDTE Facility.

GSI's Land-Based RDTE Facility draws raw intake water from Duluth-Superior Harbor at rates from 400 m^3/hr to 680 m^3/hr. This main flow of intake water can be augmented with solids and/or phytoplankton just prior to being split into control and treatment tracks (see injection points A and B; Figure 4).

A Y-split in the intake piping simultaneously channels one half of the flow (200 m^3/hr to 340 m^3/hr) to a treatment track and the other half (also 200 m^3/hr to 340 m^3/hr) to a matched control track (Figure 4). The treatment track directs water through the experimental BWTS and into a 200 m^3 cylindrical treatment retention tank (Figure 4). The control track by-passes the treatment system and channels water directly into a matched control retention tank (Figure 4).

After a retention period, water is discharged sequentially from the treatment and control retention tanks at 200 m^3/hr to 340 m^3/hr. The water is directed either back to the harbor, to a 260 m^3 wastewater storage tank for subsequent discharge to the sewer, neutralization, or circulated to a second set of matched facility retention tanks (Figure 4).

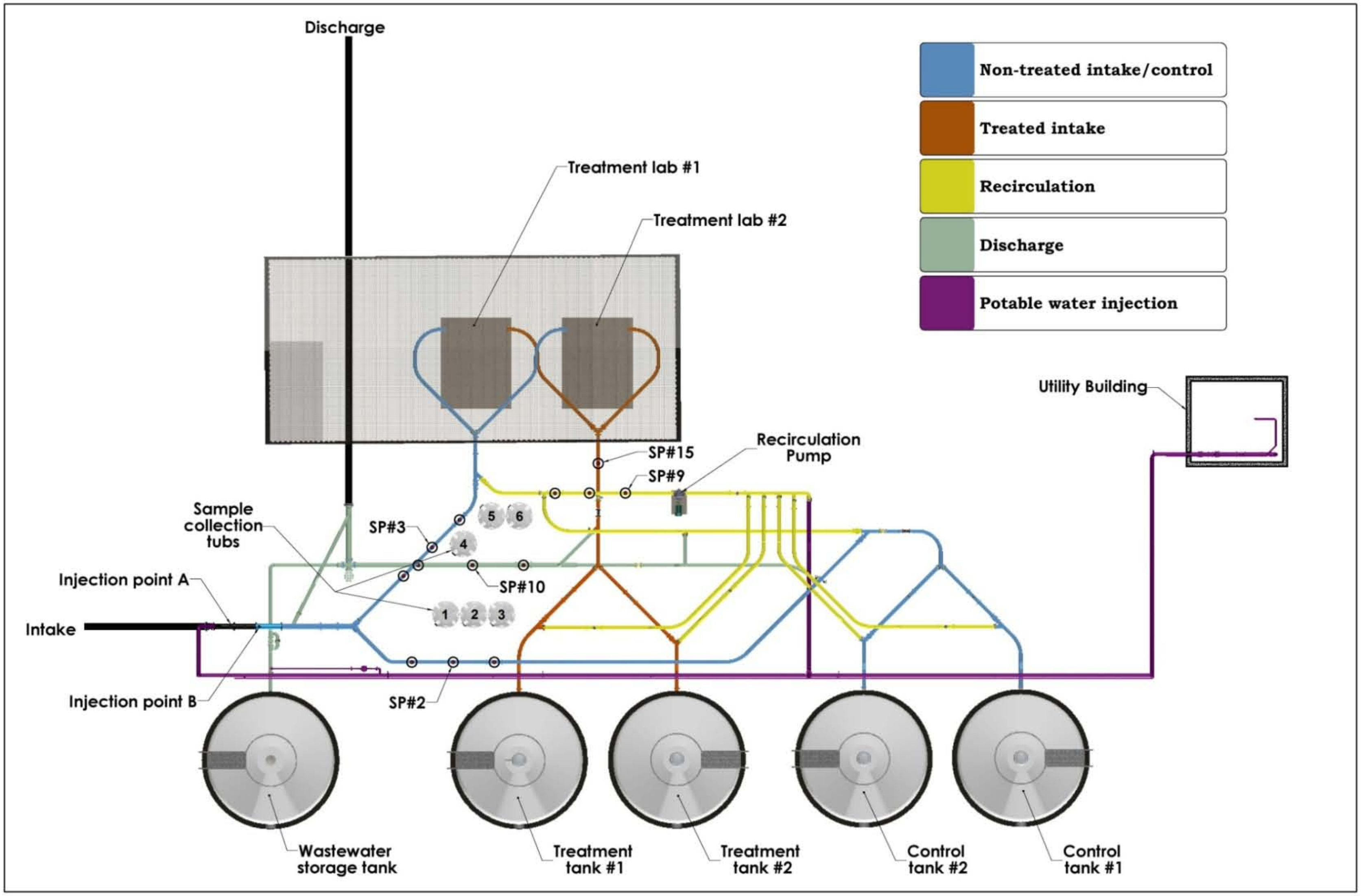

Figure 4. Simplified Schematic of the GSI Land-Based RDTE Facility Showing Location of Sample Points, Sample Collection Tubs, Injection Points, Retention Tanks, and Treatment and Control Tracks. Note: Main intake and discharge lines are coded black.

Water is sampled continuously throughout ballasting operations (i.e., intake, recirculation or discharge) through in-line sample points (SPs). Intake sampling takes place at paired intake sample points (SP#2 and SP#3) on the control and treatment tracks, respectively, and immediate post-treatment sampling occurs at SP#15 (Figure 4). Typically, discharge biological sampling is conducted at SP#9, with samples for water quality analysis collected at SP#10 (Figure 4), although these can be reversed as required by test design. All these SPs, with the exception of SP#15, consist of three identical sample ports spaced at regular intervals in a length of straight pipe consistent with IMO guidelines. One sample port is used at SP#15. Each port is fitted with a center-located, elbow-shaped pitot tube (90^{o}) which samples the water (Figure 5). This pitot design is based on a design developed and validated analytically by the U.S. Naval Research Laboratory in Key West, Florida. The design and lay-out of these replicate sample ports was also validated empirically at GSI, and shown to produce equivalent, representative and unbiased samples of water flow. Other SPs (with single sample ports), not shown in Figure 4, are used for facility calibration experiments.

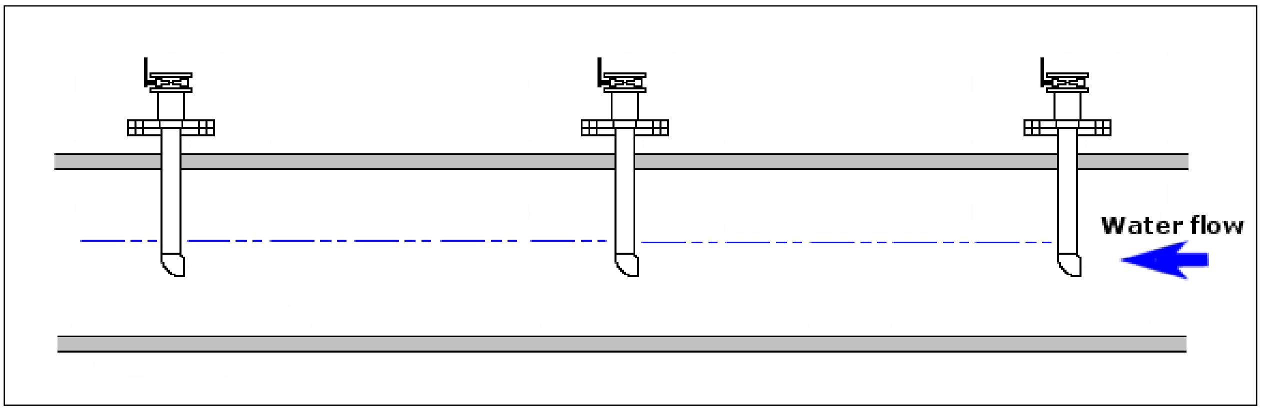

Figure 5. Simplified Schematic of a Sample Point (SP), Showing the Three Sample Ports.

Sample water drawn by sample ports is transferred simultaneously and continuously throughout ballasting operations (intake, recirculation or discharge) from the sample ports to replicate 3.8-m^3 sample collection tubs via clean 3.8-cm (internal diameter; ID) flexible hoses and automated flow-controlled pneumatic diaphragm valves. The sample collection tubs, pictured in Figure 4, connect to the sample ports in the arrangement detailed in Table 3. Though the same tubs serve as collection mechanisms for sample flow from more than one pitot, only one such pitot is used at a time during any given sample collection event. The naming convention for an individual pitot is: “SP number” plus “sample port letter”. Sample collection tubs are labeled numerically 1-6.

Table 3. Intake and Discharge Sample Points (SPs) and their Corresponding Sample Port Pitots and Sample Collection Tubs.

	INTAKE							DISCHARGE					
	SP#2			SP#3			SP#15	SP#9			SP#10		
Sample Port Pitot	a	b	c	a	b	c	a	a	b	c	a	b	c
Sample Collection Tub	1	2	3	4	5	6	6	3 & 6	2 & 5	1 & 4	3 & 6	2 & 5	1 & 4

An on-site mobile field laboratory (Figure 6) and stationary laboratory (Figure 7) provide space to support time sensitive analyses associated with the GSI land-based tests, including live analysis of phytoplankton and zooplankton. The laboratories are climate-controlled, and have enough bench space to allow for simultaneous analysis of samples by multiple personnel.

Figure 6. The GSI Mobile Field Laboratory.

Figure 7. The GSI Stationary Laboratory.

2.1.2 Challenge Conditions and Injection Procedures

The GSI Test Plan (Appendix 1) called for use of ambient harbor water and organism assemblages amended with Fine Arizona Test Dust (ISO 12103-1, A2; nominal 0-80 μm particle size; Powder Technology Inc.; Burnsville, MN, USA), Micromate (Micronized Humate Product for Liquid Suspension; Mesa Verde Resources; Placitas, NM) and concentrated algae harvested from the Duluth-Superior Harbor to assure IMO-consistent concentrations of TSS, POC, and live phytoplankton. Due to PureBallast® BWTS v.1 and v.2 filter failures during the commissioning period, target challenge conditions were revised downward and the use of Micromate to augment POC was discontinued. Revised target levels for the PureBallast® BWTS v.3 performance evaluation appears in Table 4.

During the PureBallast® BWTS v.3 performance evaluation, ambient Duluth-Superior Harbor water conditions were employed as the physical/chemical challenge conditions, except that Fine Arizona Test Dust was added to the facility intake water to achieve 25 mg/L TSS (half the IMO required level) for all the trials (Table 4). Mineral matter, defined as the difference between TSS and POC, was also augmented through the addition of Fine Arizona Test Dust (Table 4). The solids injection procedure is detailed in *GSI/SOP/LB/G/O/5 – Procedure for Injecting Organisms and Solids into the GSI Land-Based RDTE Facility*. The Fine Test Dust was sterilized at the Lake Superior Research Institute (LSRI) of the University of Wisconsin-Superior prior to injection by baking in an oven at 190 °C for one hour. TSS were measured frequently in Duluth-Superior Harbor during the 2010 testing season, which allowed close approximation of the ambient TSS on the day of each test trial. The weight of Fine Test Dust to be used in the Solids Injection System (SIS) tank was determined based on recent measurements in order to augment the intake water to achieve the desired intake concentration of TSS. The SIS tank was filled with harbor water, sterile Fine Test Dust was poured into the SIS tank slowly to prevent clumping, and the dust was mixed for a minimum of 20 minutes prior to the start of the trial. The test dust mixture was injected into the intake water for the entire duration of the fill at a constant rate using a peristaltic pump located at Injection Point A (Figure 4).

Biological challenge conditions were also largely ambient, except that organism densities in the smaller of the two plankton size classes (i.e., $\geq 10\ \mu$m and $< 50\ \mu$m) were augmented to achieve a density of 1000 cells/mL on intake (Table 4). The solids and phytoplankton injection systems are kept separate to reduce the risk of interference. The phytoplankton injection procedure is detailed in *GSI/SOP/LB/G/O/5 – Procedure for Injecting Organisms and Solids into the GSI Land-Based RDTE Facility*. One to two days prior to the test trial, phytoplankton from the Duluth-Superior Harbor was collected and concentrated using 50- to 80-μm plankton nets towed from an outboard-powered boat. The concentrated phytoplankton was stored at the GSI Land-Based RDTE Facility in holding ponds equipped with aeration systems for less than 48 hours. Prior to injection, holding pond water containing concentrated phytoplankton was mixed, sampled, and analyzed for viable cell density. In addition, a sample of Duluth-Superior Harbor water was collected to determine the ambient viable cell density. Based on the density of cells in the holding ponds and ambient intake water, the volume of phytoplankton concentrate that was needed to achieve the desired density in intake water was calculated. This volume was added to the Organism Pressure Injection System (OPIS) vessel. The OPIS vessel was pressurized to 25 psi greater than the target system pressure. The phytoplankton concentrate was added at a constant rate to the intake water via the pressure differential for the entire duration of the intake procedure via Injection Point B (Figure 4). A static mixer, installed in the main intake line just downstream of the two injection systems (SIS and OPIS) and prior to the main system “Y split” (Figure 4), ensured that the concentrations of these additives were equivalent in the control and treatment tracks of the facility. Gentle agitators installed in the control and treatment retention tanks ensured that live organisms, especially less motile organisms that may settle to the bottom of the tank during the retention period, were accounted for to the greatest extent possible in the discharge water analysis (see *GSI/SOP/LB/G/O/7 – Procedure for Maintaining Solids Suspension in the GSI Land-Based RDTE Facility’s Retention Tanks*).

Table 4. Target Physical, Chemical, and Biological Challenge Water Conditions for the PureBallast® BWTS v.3 Performance Evaluation in Comparison to USEPA ETV and IMO G8 Recommended Challenge Conditions.

Parameter	DRAFT U.S. EPA ETV[3]	Recommended IMO G8[4]	Target Values for PureBallast® v.3 Challenge Water
Temperature (°C)	4 – 35	–	4 - 30
Salinity (ppt)	< 1	Two salinities, >10 ppt difference	0 - 1
Total Suspended Solids (mg/L)	Min. 24	> 50	≥ 25 (Amended)
Particulate Organic Carbon (mg/L)	Min. 4	> 5	<0.1 – 3
Dissolved Organic Carbon (mg/L)	Min. 6	> 5	6 – 30
Mineral Matter (mg/L)	Min. 20	--	≥20 (Amended)
Zooplankton (> 50 μm/m^3)	Min. 100,000	> 100,000	>100,000
Phytoplankton (≥ 10 to < 50 μm/mL)	Min. 1000	> 1,000	>1,000 (Amended)
Heterotrophic Bacteria (MPN/mL)	Min. 1000	> 10,000	75 - 10,000

2.1.3. Preventing Cross Contamination

To minimize potential cross contamination of the treatment discharge water between trials, prior to the first trial and after each test trial, the interior of the retention tanks were cleaned according to *GSI/SOP/LB/G/O/3 – Procedure for Cleaning and Verifying Cleanliness of the Retention Tanks and Piping at the GSI Land-Based RDTE Facility*. After each intake and discharge operation, the sampling equipment (sample collection tubs, drain spout hose and nozzle, plankton nets, etc.) was also cleaned according to *GSI/SOPLB/G/O/4 – Procedure for Cleaning Sampling Equipment at the GSI Land-Based RDTE Facility*. The GSI facility lines were flushed with city-supplied potable water. The flushing was undertaken after each facility intake and prior to each discharge operation. After flushing, the thoroughness of the cleaning process was checked by partially filling a randomly selected treatment sample collection tub with

3 USEPA, Environmental Technology Verification Program. Generic Protocol for the Verification of Ballast Water Treatment Technologies. Version 5.1. September, 2010.
4 IMO MEPC 57, Annex 3: Revised Guidelines for Approval of Ballast Water Management Systems (G8). April 4, 2008.

0.5 m^3 of additional potable water, draining that water through a verified-clean plankton net, and examining the filtrate for evidence of residual organisms. The facility was deemed clean only if the rinse water was completely free of live Duluth-Superior Harbor zooplankton visible with a compound microscope at a magnification of 40X to 100X (see *GSI/SOP/LB/G/O/3*). Nets and other sample collection equipment were likewise validated for cleanliness prior to each sampling operation (see *GSI/SOP/LB/G/O/4*).

2.2. Water Quality Analysis

2.2.1. Total Suspended Solids (TSS), including Mineral Matter (MM)

During each trial, samples for TSS analysis were collected during intake and discharge as follows:

- On intake, three 1 L whole water samples were collected from the pre-treatment line (SP #3, Figure 4) at approximately 10, 25, and 40 minutes after the start of the intake procedure.
- On discharge, three 1 L whole water treatment samples were collected at approximately 10, 25, and 40 minutes after the start of the discharge procedure (SP #9, Figure 4). In addition, three 1 L whole water control samples were collected at approximately 10, 25, and 40 minutes after the start of the procedure (SP #9, Figure 4).

Samples were collected in-line rather than from the sample collection tubs to avoid settling of suspended solids. This approach ensured a more accurate measurement of solids and organic carbon in the intake water.

Sample analysis was conducted according to *GSI/SOP/BS/RA/C/8, v.1 – Procedure for Analyzing Total Suspended Solids (TSS)*. The samples were vacuum filtered through pre-washed, dried, and pre-weighed Whatman 934-AH glass fiber filters. After the sample was filtered it was dried in an oven and brought to constant weight. TSS values were determined based on the weight of particulates on the filter and the volume of water filtered.

Quality control measures consisted of collecting and analyzing approximately 10 % of the total number of samples collected from all three trials in duplicate. A TSS reference standard (QCI, 711, ULTRA Scientific) was analyzed on multiple occasions along with TSS samples to confirm the accuracy of the data being generated.

Mineral matter is defined as the difference between TSS and particulate organic matter (measured as POC). Therefore, MM concentrations were determined in each sample collected during these trials on intake following analysis of TSS, and the determination of POC as calculated from the NPOC and DOC concentrations (see §2.2.2.).

2.2.2. Non-Purgeable Organic Carbon (NPOC) and Dissolved Organic Carbon (DOC), and Determination of Particulate Organic Carbon (POC) Concentrations

During these trials, samples for NPOC, DOC, and POC analysis were collected immediately after TSS sample collection during intake only as follows:

- Three, 125 mL whole water samples were collected in glass bottles from the pre-treatment line (SP #3) at approximately 10, 25, and 40 minutes after the start of the operation.

In these tests, NPOC was measured as a surrogate for total organic carbon (TOC), though it may be a slight underestimate of TOC. The analytical instrument used to measure NPOC purges the sample with air to remove inorganic carbon before measuring organic carbon levels in the sample. Thus, the NPOC analysis does not incorporate any volatile organic carbon which may be present in the sample.

Sample analysis was conducted according to *GSI/SOP/BS/RA/C/3, v.1 – Procedures for Measuring Organic Carbon in Aqueous Samples*. Upon arrival at LSRI, an aliquot of the 125 mL sample was filtered through a Whatman GF/F filter and acidified with hydrochloric acid for analysis of DOC. The remaining portion of the sample was acidified with hydrochloric acid and analyzed for NPOC. A Shimadzu Total Organic Carbon Analyzer (Model TOC-5050A; Shimadzu Scientific Instruments, Inc.; Columbia, MD) was employed for analysis of both NPOC and DOC. Concentrations of NPOC and DOC were determined based on a calibration curve developed on the instrument using organic carbon standards prepared from potassium hydrogen phthalate. Reported POC concentrations were determined as the difference between the NPOC and DOC values for a given sample.

Quality control measures consisted of collecting and analyzing approximately 10 % of the samples in duplicate from all organic carbon samples collected during the three trials. A reference standard (#516 Demand, Environmental Resource Associates) was analyzed daily to confirm the accuracy of the data being generated.

2.2.3. Percent Transmittance (%T)

An aliquot of the filtered portion of each sample collected for TSS analysis was analyzed to determine percent transmittance. Sample analysis was conducted according to *GSI/SOP/BS/RA/C/4 – Procedure for Determining Percent Transmittance (%T) of Light in Water at 254 nm*. A spectrophotometer set at 254 nm was used to measure %T of the filtered samples. Deionized water was used as a reference to adjust the spectrophotometer to 100%T, and each filtered sample was measured in a pre-rinsed sample cuvette.

2.2.4. Water Quality Measurements using YSI Multiparameter Water Quality Sondes

Water quality was measured during each trial using calibrated YSI Multiparameter Water Quality Sondes (YSI 6600 V2-4 Sondes; YSI Incorporated; Yellow Springs, OH, USA). The sondes were calibrated prior to each test trial following *GSI/SOP/LB/G/C/4 - Procedure for Calibration, Deployment, and Storage of YSI Multiparameter Water Quality Sondes*. The YSI sondes have multiple probes that are able to measure dissolved oxygen, specific conductivity, salinity, temperature, pH, turbidity, and total chlorophyll. Water quality parameters were measured from approximately 1 L samples of water from each sample collection tub sampled on intake and discharge. Samples were taken immediately following collection of phytoplankton and microbial samples, and each measurement was recorded on pre-printed datasheets. In addition, water quality parameters in the control and treatment retention tanks were measured at mid-depth every 15 minutes during the two-day holding time. Prior to discharge of the respective tanks, the sondes were removed and taken to the mobile laboratory where the data were later downloaded as test files to a laptop computer using EcoWatch® for Windows® Software (v.3.18, 14 April 2006; YSI Incorporated); the files were then translated to MS Excel files, which were stored on a laptop computer in the mobile laboratory and later uploaded to the GSI SharePoint intranet website.

2.3. Viable Organism Analysis

During these trials, sample water for analysis of viable organisms was simultaneously collected from replicate sample ports into identical 3.8 m^3 collection tubs during each intake, treatment discharge, and control discharge operation (retention tank discharge was sequential, treatment then control). Volumes retained were always greater than IMO guideline volumes. The water in each collection tub constituted an independent, time-integrated replicate sample of the 200 m^3 experimental water mass.

2.3.1. Organisms ≥ 50 µm in Minimum Dimension

2.3.1.1. Sample Collection

During the intake operation for each trial (i.e. the filling of the treatment and control 200 m^3 retention tanks), the following time-integrated sample volumes were collected by continuous flow from the intake lines simultaneously:

- Two 2 m^3 sample from the pre-treatment intake line (i.e., Tubs #4 and #5, Figure 4),
- Two 2 m^3 sample from the control intake line (i.e., Tubs #1 and #2, Figure 4), and
- One 2 m^3 sample from the immediate post-treatment intake line (i.e., Tub #6, Figure 4).

During trial discharges the following time-integrated sample volumes were collected by continuous flow:

- Two samples of 2 m^3 each (total volume 4 m^3) were collected from the treatment discharge (i.e., Tubs #4 and #6, Figure 4),
- One 2 m^3 sample was collected from the control discharge (i.e., Tub #1, Figure 4),
- One sample of 2 m^3 was collected from the treatment discharge (i.e., Tub #5, Figure 4) and held overnight for delayed mortality assessment, and
- One 2 m^3 sample was collected from the control discharge (i.e., Tub #2, Figure 4) and held overnight for delayed mortality assessment.

Flow control valves and system logic ensured that sample flow rates were equivalent and proportional to intake and discharge flow rates throughout each operation. Immediately after filling, the phytoplankton and microbial whole-water samples were collected and sonde readings recorded, followed by the zooplankton sample collection. The zooplankton samples were collected by draining the remaining sample volumes (i.e., 2 m^3 minus 5 L of rinse/sonde water and the 1 L phytoplankton and microbial samples) from the sample collection tubs and concentrating through 35 μm (50 μm diagonal dimension) plankton nets into 1 L cod-ends for microscopic examination. See *GSI/SOP/LB/RA/SC/6 - Procedure for Zooplankton Sample Collection*. On intake and discharge, the zooplankton sample collection order was sequential. On intake, the Tub #6 post-treatment sample was collected first, followed by the Tub #4 pre-treatment sample, and then the Tub #1 control. Sample water in Tub #5 and #2 was not concentrated but held as a back-up sample if a replacement was needed due to operational errors in concentration and analysis of water from Tub #1 and #4, respectively. On discharge, treatment samples were collected from Tub #4 and then Tub #6, with Tub #5 collected the following morning for delayed mortality assessment. Control samples were collected from Tub #1, with Tub #2 collected the following morning for delayed mortality assessment.

2.3.1.2. Live/Dead and Size Analysis

All live/dead analysis was conducted according to *GSI/SOP/LB/RA/SA/2 - Procedure for Zooplankton Sample Analysis*, and took place within two hours of collecting and concentrating the individual samples. Microzooplankton (e.g., rotifers, copepod nauplii, and dreissenid veligers) and macrozooplankton (e.g., copepods, cladocerans, and insect larvae.), all generally greater than or equal to 50 μm in minimum dimension, were analyzed simultaneously by separate taxonomists. Microzooplankton subsamples were analyzed in a Sedgewick-Rafter counting chamber by examination under a compound microscope at a magnification of 40X to 100X. Macrozooplankton were analyzed in a Ward's Counting Wheel at a magnification of 20 to 30X using a dissecting microscope. Due to high densities, quantification of zooplankton in intake and control discharge samples required analysis of sub-samples and extrapolation to number per cubic meter. For these samples, a subsample was removed for analysis using a Henson-Stempel pipette. The dead organisms (i.e., those organisms that did not move or respond to stimuli) were enumerated, then all organisms in the sample were killed by adding 50% (v/v) acetic acid solution (for microzooplankton) or Lugol's solution (for macrozooplankton) to the counting chamber/wheel and the total number of organisms was enumerated. The number of live organisms was quantified by subtracting the number of dead organisms from the total number of organisms in the counting chamber/wheel. The post-treatment intake and treatment discharge samples had lower densities allowing for analysis of a greater proportion of the sample.

Therefore, the post-treatment intake and treatment discharge samples were split in half using a Folsom Plankton Splitter. Half of the sample was analyzed for macrozooplankton and the other half was examined for microzooplankton. Only live organisms were enumerated using standard movement and response to stimuli techniques.

Statistical analysis of organisms in the ≥ 50 µm size class was conducted for each trial using SigmaStat, version 3.5 (Systat Software, Inc.; Chicago, IL USA). The density data were not normally distributed, therefore, the data from post-treatment intake, control discharge, treatment discharge, and the control and treatment discharge after 24 hours were log-transformed to achieve a normal distribution and equal variance (ASTM, 2004; Eaton *et al*., 2005; USEPA, 2002). A one-way analysis of variance was used to determine the differences in the mean values among the treatment groups, and the Holm-Sidak method was used to perform pair-wise comparisons between each treatment group. A paired t-test was used to compare the control discharge density to the treatment discharge density. In all cases α=0.050.

Quality assurance measures during these trials included live/dead analysis of one intake and one discharge sample by two separate taxonomists over the course of the three trials. The average percent similarity of taxonomic identification (live organisms only) and the average relative percent difference of the number of live organisms counted were calculated for all second analyses.

2.3.2. Organisms ≥ 10 and < 50 µm in Minimum Dimension

2.3.2.1. Sample Collection

The following whole-water samples were collected during intake for each trial for analysis of live organisms ranging in size from ≥ 10 to < 50 µm in minimum dimension:

- One 1 L sample was collected immediately after filling from the pre-treatment sample collection tub (i.e., Tub #4, Figure 4),
- One 1 L sample was collected from the immediate post-treatment sample collection tub (i.e., Tub #6, Figure 4), and
- One 1 L sample was collected from the control sample collection tub (i.e., Tub #1, Figure 4) and archived.

During discharge for each trial:

- Three 1 L samples were collected, one from each of the three treatment sample collection tubs (i.e., Tubs #4-#6, Figure 4), and
- One 1 L sample was collected from the control sample collection tub (i.e., Tub #1, Figure 4).

The three, 1 L treatment discharge samples were composited for analysis. Analysis of all samples occurred on-site within 1.5 hours of sample collection, with samples stored in coolers during the interim. Prior to analysis, samples were concentrated through 10 µm mesh plankton netting and stored in a 25 mL sample container. See *GSI/SOP/LB/RA/SC/3 - Procedure for Algae/Small Protozoa Sample Collection*.

2.3.2.2. Sample Analysis

All sample analyses were conducted according to *GSI/SOP/LB/RA/SA/1 - Procedure for Algae/Small Protozoan Sample Analysis*. A 2.0 mL subsample of the concentrated sample was transferred to a 5 mL sample container, with 5 μL of fluorescein diacetate (FDA) viability stain stock solution added. The subsample was then allowed to incubate in the dark for 5 minutes. The 2.0 mL incubated sample was mixed and 1.1 mL was immediately transferred to a Sedgwick-Rafter cell, covered and placed on the stage of a compound microscope that was set for simultaneous observation using brightfield and epifluorescence. At least two horizontal transects were counted (an area known to reflect greater than 1 mL of original sample water), aiming for at least 100 entities (i.e., unicellular organism, colony or filament) counted. If time permitted, additional transects were counted to increase statistical power. Single cell entities and cells comprising colonial and filamentous entities were characterized as follows: alive = cells showing obvious green fluorescence from cell contents; dead = cells showing no or very little evidence of green fluorescence from cell contents; and ambiguous = cells or entities that cannot be clearly identified as alive or dead (were uncommon). Records were kept of transect lengths and widths so that the total counted area and volume analyzed could be calculated later.

Entities less than 10 μm in all visible dimensions or greater than 50 μm in minimum visible dimension were not counted. Counting and measurement of all other entities followed standard procedures for individuals (length and width), colonies (e.g., number of cells, cell length and width) and filaments (e.g., number of cells, cell length and width or total filament length if cells could not be discerned). The remaining concentrated sample in the 25 mL container was archived using a preservative (formalin or Lugol's) for long-term storage.

Statistical analysis for the $\geq$ 10- and $<$ 50 μm size class for the three trials was conducted using SigmaStat, version 3.5 (Systat Software, Inc.; Chicago, IL USA). A one-way analysis of variance was used to determine the differences in the mean values among the treatment groups. A paired t-test was used to compare the control discharge density to the treatment discharge density. In all cases α=0.050.

Quality assurance measures included analysis of a portion of the samples by two separate taxonomists using a dual-headed compound microscope (i.e., both taxonomists analyzed the same sample at the same time) and/or subsample analysis of a portion of the samples collected by a single taxonomist (i.e., one taxonomist analyzed two separate aliquots from one sample) over the three trials. The average percent similarity of taxonomic identification and the average relative percent difference of the number of live organisms counted were calculated for all second analyses.

2.3.3. Organisms < 10 μm

Control and treatment samples for these trials were collected and analyzed for heterotrophic bacteria and three specific indicator organisms for waterborne pathogens: total coliform bacteria, *E. coli,* and enterococci.

2.3.3.1. Sample Collection

One liter whole water samples were collected as follows:

- On intake, three samples were collected immediately after filling and collection of the 1 L phytoplankton sample from the pre-treatment sample collection tub (Tub #4, Figure 4), and three were collected from the post-treatment sample collection tub (Tub #6, Figure 4).
- On discharge, three samples were collected from the control sample collection tub (Tub #1, Figure 4) and three were collected from each of three treatment sample collection tubs (one each from Tubs #4-#6, Figure 4).

All samples were collected according to *GSI/SOP/LB/RA/SC/4 – Procedure for Microbial Sample Collection*, and were immediately transported in an insulated cooler to LSRI and analyzed as individual replicates.

2.3.3.2. Sample Analysis

Viable heterotrophic bacteria were enumerated according to *GSI/SOP/BS/RA/MA/1 – Procedure for Quantifying Heterotrophic Plate Counts (HPCs) using IDEXX's SimPlate® for HPC Method*. This method utilizes the IDEXX SimPlate® for HPC Method (IDEXX Laboratories, Inc.; Westbrook, Maine), which is based on IDEXX Laboratories' patented multiple enzyme technology.

The abundance of *E. coli* (*GSI/SOP/BS/RA/MA/4 - Procedure for the Detection and Enumeration of Total Coliforms and E. coli Using IDEXX's Colilert*®) and enterococci (*GSI/SOP/BS/RA/MA/3 - Procedure for the Detection and Enumeration of Enterococcus using Enterolert*™) were determined using Quanti-Tray/2000® with Colilert® and Enterolert™, respectively, which are both based on IDEXX's patented Defined Substrate Technology (DST®; IDEXX Laboratories, Inc.; Westbrook, Maine).

Statistical analysis for the < 10 μm size class for the three trials was conducted using SigmaStat, version 3.5 (Systat Software, Inc.; Chicago, IL USA). A paired t-test was used to compare the control discharge density to the treatment discharge density. In all cases α=0.050.

Quality control samples analyzed for each intake and discharge operation included a media blank and a positive control for *E. coli*/total coliforms and *Enterococcus spp*., and a media blank for heterotrophic bacteria. Quality assurance measures included analysis of at least 10 % of the samples in duplicate from the total number of samples collected over the three trials. The average relative percent difference of all duplicates analyzed during the test trials was calculated separately for *E. coli*, *Enterococcus spp*., and heterotrophic bacteria.

2.4. Whole Effluent Toxicity (WET) Analysis

GSI conducted whole effluent toxicity (WET) testing for a single trial of the PureBallast®, v.3 BWTS. The WET test trial was conducted after the three trials in the biological performance evaluation were completed (i.e., biological performance evaluation trials ended 04 October 2010, and treatment discharge water was collected for WET testing 08 October 2010 from a trial conducted 06 to 08 October 2010). These chronic toxicity evaluations involved three freshwater species as arrayed in Table 5.

Whole effluent toxicity of treatment discharge water was determined using standard USEPA procedures (USEPA, 2002). A 19 L whole water sample was collected following the treatment discharge operation from a treatment sample collection tub in a 19 L, high-density, polyethylene container. The WET test sample was immediately transported to LSRI and was used upon arrival to set up the WET tests. Following initial set up of the tests (described below), the remaining sample water was stored at 4 °C in the dark to retain as much of the initial water quality/chemistry properties as possible, and used as a source of renewal water (once warmed to 25 °C) each day throughout the bioassay. Filtered (i.e., using a Whatman 934-AH Glass Microfiber Filter, 1.5 μm particle retention in liquid) Duluth-Superior Harbor water served as the control. Treatment groups consisted of 0 % treatment discharge water (i.e., all control water), 100 % treatment discharge water (i.e., no control water), and a performance control (i.e., culture water or algae growth media as appropriate). All tests were conducted in temperature-controlled incubators, water baths, or at ambient room temperature following the species specific SOPs listed in Table 5. Differences in mean percent survival, mean dry weight values (for *P. promelas*), mean cell density (for *S. capricornutum*), and mean number of young per female (for *C. dubia*) between the 0 % and 100 % treatment discharge groups were analyzed using SigmaStat, version 3.5 (Systat Software, Inc.; Chicago, IL USA) for statistical significance at α=0.050 using a One-Way Analysis of Variance and a post hoc statistical comparison.

WET tests were initiated with healthy, vigorous organisms. To determine the overall health of the test organisms, reference toxicant tests were performed with the cladoceran, *Ceriodaphnia dubia,* and the minnow, *Pimephales promelas,* prior to the start of each definitive test or at least once per month. In addition, a performance (reference) control was used for all species tested. The performance control consists of the normal culturing conditions for each species, providing the test organisms with the optimal environment for survival, growth, and reproduction. Therefore, the performance control along with the reference toxicant tests, provided verification of the health of the test organisms. To determine the validity of the WET tests, percent survival, dry weights of survivors, mean cell density for algae, and mean number of young per female for the cladocerans in the controls were compared to the test acceptability criteria published in the USEPA's *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (4th edition, 2002). Class I weights were used as a check for the accuracy of the laboratory balance. Daily or weekly calibration of test meters ensured optimal performance. The *P. promelas* drying process was verified by re-weighing a percentage of fish after they had been dried for an additional length of time in the oven.

Table 5. Standard Operating Procedures Relative to Whole Effluent Toxicity (WET) Testing.

GSI SOP Code	Test Type	Test Species	Test Endpoint
GSI/SOP/BS/RA/WET/1	Chronic	Cladoceran (*Ceriodaphnia dubia)*	Survival and Reproduction
GSI/SOP/BS/RA/WET/2	Chronic	Fathead Minnow (*Pimephales promelas)*	Survival and Growth *(growth measured via dry weight)*
GSI/SOP/BS/RA/WET/3	Chronic	Green Alga (*Selenastrum capricornutum)*	Growth *(measured via direct counts of density)*

2.5. Data Management

2.5.1. Data Recording

All biological and chemical data were recorded by hand (using indelible ink) on pre-printed data collection forms and/or in bound laboratory notebooks that are uniquely-identified and were specific to the PureBallast® BWTS tests (i.e., v.1, v.2, and v.3 data were recorded in the sample notebook and forms were stored in the same binder). The types of biological and chemical data collected include: sample collection data (e.g., date, time, and location of collected samples), water quality and chemistry analysis data (e.g., TSS, DOC, and MM concentration), microbial analysis data (e.g., sample preparation, incubation, and direct counts), phytoplankton analysis data (e.g., number of live and number of dead entities), zooplankton analysis data (e.g., sample concentration; number of dead, total, and live organisms), and WET test data (e.g., test set up, direct counts, and test take down). The data that were recorded on pre-printed data collection forms were secured in uniquely-identified three ring binders, specific to the type of data and to the treatment technology. Biological and chemical data that were recorded by hand were entered into either a MS Access Database that was designed, developed, and is maintained by the GSI Database Manager, or the data were entered into a MS Excel Spreadsheet (see *GSI/SOP/G/RA/DM/1 – Procedure for Data Entry, Data Quality Control, and Database Management*).

All electronic data files are stored on the LSRI's secured Local Area Network (LAN) that can be accessed only by relevant GSI personnel. The GSI Database Manager is the single point of control for access to the LSRI LAN. The LSRI LAN is automatically backed up every 24 hours. The electronic data files are also stored on the GSI's internal SharePoint website, which acts as a secondary data backup/storage mechanism. All original raw data are stored in a climate-controlled, secure archive room at the LSRI for five years after this report is finalized.

In-tank water quality data (e.g., temperature, pH, dissolved oxygen, specific conductivity, salinity, turbidity, and chlorophyll-a) was measured every fifteen minutes during each retention period and automatically recorded in a text file, which is later translated to a Microsoft (MS) Excel spreadsheet. Facility data (e.g., flow rates and pressure measurements) were electronically recorded every five seconds during intake and discharge. This data was exported to MS Excel for subsequent analysis, and is stored by AMI Engineers on a secure network, as well as on GSI SharePoint for addition storage and archiving.

A percentage of data that was recorded by hand and entered into MS Access or MS Excel was verified against the original raw data, this also included verification of formulas/calculations (i.e., hand-calculation of data) done using MS Access or MS Excel. The percentage of verified raw data generally depends on the amount of raw data that was generated, and for the PureBallast®, v.3 test ranged from 10 % to 100 % of the original raw data. Data validation is additionally detailed in Section 7 of the GSI Quality Assurance Project Plan (QAPP) for Land-Based Tests (GSI, 2010a). This section also details the acceptable values, where appropriate, for the following quality objectives: accuracy, precision, completeness, comparability, representativeness, and sensitivity.

Following the completion of PureBallast®, v.3 BWTS trials, a thorough review of all data sheets and laboratory notebooks was completed to ensure compliance with the documentation procedures outlined in all relevant GSI SOPs and in the GSI land-based QAPP (GSI, 2010a). A Technical Systems Audit Checklist (TSA) was completed during observation of sample collection and analysis activities, and during the data review. A QAQC Log Book was used to document any additional data verification and validation activities. The TSA checklist and QAQC log book were scanned to electronic format and posted to the GSI SharePoint website.

2.5.2. Data Processing and Storage

All original datasheets were stored in three-ring binders, each with a unique identification code specific to the PureBallast® BWTS tests. All log books were also given a unique identification code specific to the PureBallast® BWTS tests. At least one backup copy (i.e., an electronic copy stored on the GSI SharePoint website) was made of all completed datasheets, and in some cases additional hardcopies were also made. The raw data is in the custody of the appropriate GSI Senior Staff Member, and will be archived by the GSI Senior QAQC Officer at LSRI for a period of at least five years.

A dedicated database designed using the Microsoft Access software suite was used to store, manage and process phytoplankton and zooplankton data. Microsoft Excel was used in conjunction with the database to create various dataset formats for subsequent analysis. Microsoft Excel was also used to store, manage, and process microbial, water chemistry, water quality, and whole effluent toxicity data. Database entry and maintenance was the responsibility of the GSI database management staff. Regular checks for data entry errors were conducted by comparing database records and Excel spreadsheets with the original paper data sheets. This was a manual inspection process and though rather time consuming, was an essential procedure for discovering errors. After examination and quality assurance analysis, the data distribution files from the Access database were posted to LSRI's Local Area Network (LAN) in an organized hierarchical folder system. A backup of the database is also made regularly to avoid any loss of data following computer/electronic glitches. Files were also posted to GSI's SharePoint website to provide a secondary data backup/storage mechanism.

3.0. RESULTS

Three test trials were completed with the GSI facility operating effectively. During one trial (Trial C), the BWTS filter became clogged. This trial was temporarily halted, the filter cleaned and restarted. Results from the three trials and the WET test are presented below.

3.1. Challenge Conditions

3.1.1. Operational Conditions

The PureBallast®, v.3 BWTS encountered similar operating conditions during all three trials (Table 6). The GSI facility and the BWTS operated at a flow rate of 500 m3/hour (or 250 m^3/hour for the control and treatment tracks) for a fill duration of approximately 45 minutes at pressures ranging from 3.1 to 3.6 bars. The system performed continuously during Trial A and Trial B, with filter backwash cycles every 40 to 48 seconds. The flow rate for the treatment track was set to an average of 250 m^3/hour to accommodate the frequent and rapid backwash cycles. During Trial C, the filter operated with a backwash cycle every 40 seconds for the first 20 minutes of flow and then became clogged. In order to salvage BWTS performance data from the trial, the flow was stopped, the facility monitors and BWTS were reset, and the flow was restarted, now without the injection of Arizona Fine Test Dust or phytoplankton. Consequently, Trial C was completed following a brief interruption, and the TSS concentration and phytoplankton density on intake was less than for the previous two trials.

Table 6. Operational Parameters Measured During Intake Operations of the Completed Test Trials of the PureBallast®, v. 3 Ballast Water Treatment System.

Trial	Filter	Backwash Cycle Duration	Fill Duration (min)	Flow Rate (m^3/h)	Pressure (bar)	Engineering Comments
A	40 μm mesh	48 sec	45	250	3.2-3.5	System performed continuously.
B	40 μm mesh	40 sec	45	250	3.1-3.6	System performed continuously.
C	40 μm mesh	40 sec prior to clog; then 8.7 min after restart	45	250	3.3-3.4	Filter clogged 20 min into fill. Fill was stopped, system reset, and fill restarted without injection of Fine Test Dust or phytoplankton.

3.1.2. Physical/Chemical Conditions

A summary of actual physical/chemical conditions of intake and discharge water (where measured) along with the minimum target concentrations appear in Table 7. Overall the TSS and

MM averaged 19.3 mg/L and 19.2 mg/L on intake, respectively. The concentrations for TSS and MM were ≥ 20 mg/L during Trial A and ≥ 25 mg/L in Trial B. Due to the interruption in Trial C noted above, less than the minimum target concentration of 25 mg/L TSS and 20 mg/L MM was achieved for that trial. All other parameters measured were not augmented (i.e., ambient Duluth-Superior Harbor water), and these parameters remained consistent during all three trials.

Table 7. Average Concentration (± Std. Dev.) of Total Suspended Solids (TSS), Non-Purgeable Organic Carbon (NPOC), Particulate Organic Carbon (POC), Dissolved Organic Carbon (DOC), Mineral Matter (MM), and Percent Transmittance (%T) in Challenge Water During Three Trials of the PureBallast®, v.3 Ballast Water Treatment System.

Parameter	Target Concentration	Sample	Trial A	Trial B	Trial C	Summary (*n*=3)
TSS (mg/L)	≥ 25	Intake	20.6 ± 0.8	25.4 ± 0.2	11.9 ± 11.9	**19.3 ± 6.8**
	--	Discharge	10.1 ± 1.6	10.4 ± 1.9	14.0 ± 10.5	**11.5 ± 2.2**
NPOC (mg/L)	Ambient	Intake	19.4 ± 0.1	18.9 ± 0.1	19.2 ± 0.1	**19.2 ± 0.3**
DOC (mg/L)	Ambient	Intake	18.7 ± 0.2	18.8 ± 0.2	19.1 ± 0.0	**18.9 ± 0.2**
POC (mg/L)	Ambient	Intake	0.7 ± 0.3	0.2 ± 0.3	0.1 ± 0.0	**0.3 ± 0.3**
MM (mg/L)	≥ 20	Intake	19.9 ± 1.1	25.3 ± 0.1	12.5 ± 15.2	**19.2 ± 6.4**
%T (254 nm)	Ambient	Intake	15.6 ± 0.1	16.3 ± 0.2	15.9 ± 0.1	**15.9 ± 0.4**
	--	Discharge	15.7 ± 0.4	16.1 ± 0.2	16.1 ± 0.1	**16.0 ± 0.2**

3.1.3. In-Tank Water Quality

Table 8 summarizes the water quality measured in the retention tanks during the two day holding period for each trial. The water quality in the control and treatment retention tanks was very similar during all three trials, with the exception of chlorophyll and dissolved oxygen. The average chlorophyll concentration in the control retention tanks during the three trials was 11.0 μg/L, as compared to the treatment retention tanks with an average of 8.8 μg/L. These water quality data are supported by the biological data, which shows a reduction of phytoplankton density in the treatment as compared to the control discharge. The dissolved oxygen concentration in the treatment retention tanks was higher during the three trials, perhaps due to decreased density of organisms and associated respiration and oxygen demand in the treatment as compared to the control. The average dissolved oxygen concentration in the control retention tanks was 9.21 mg/L (87.6 % saturation), while the treatment tanks had an average of 9.70 mg/L (92.5 % saturation) over all three trials. Again, the water quality data supports the biological data as this increase in dissolved oxygen concentration is coupled with a decrease in organisms in the treatment. There was a decrease in turbidity during Trial C in both the treatment and control retention tanks when compared to the previous two trials. This was due to the termination of the solids injection after the filter clogged.

Table 8. Retention Tank Water Quality (Average ± Std. Dev.) During Trials of the PureBallast® v.3 Ballast Water Treatment System.

Parameter	Retention Tank	Trial A	Trial B	Trial C	Summary (n=3)
Temperature (°C)	Control	13.12 ± 0.07	13.38 ± 0.16	12.64 ± 0.41	**13.05 ± 0.38**
	Treatment	13.32 ± 0.07	13.50 ± 0.13	12.73 ± 0.45	**13.18 ± 0.40**
Specific Conductivity (mS/cm)	Control	0.248 ± 0.000	0.249 ± 0.001	0.254 ± 0.000	**0.250 ± 0.003**
	Treatment	0.249 ± 0.000	0.249 ± 0.000	0.252 ± 0.000	**0.250 ± 0.002**
Salinity (ppt)	Control	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	**0.1 ± 0.0**
	Treatment	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	**0.1 ± 0.0**
pH	Control	7.8 ± 0.0	7.8 ± 0.0	7.8 ± 0.0	**7.8 ± 0.0**
	Treatment	7.7 ± 0.0	7.7 ± 0.0	7.7 ± 0.0	**7.7 ± 0.0**
Turbidity (NTU)	Control	9.6 ± 0.6	9.3 ± 0.6	5.8 ± 0.3	**8.2 ± 2.1**
	Treatment	9.0 ± 0.7	9.0 ± 0.8	5.0 ± 0.3	**7.7 ± 2.3**
Chlorophyll (μg/L)	Control	11.8 ± 0.5	11.2 ± 0.5	10.0 ± 0.5	**11.0 ± 0.9**
	Treatment	9.2 ± 0.3	9.0 ± 0.6	8.3 ± 0.5	**8.8 ± 0.5**
Dissolved Oxygen (% Saturation)	Control	89 ± 0	89 ± 0	85 ± 1	**88 ± 2**
	Treatment	92 ± 1	95 ± 1	91 ± 1	**93 ± 2**
Dissolved Oxygen (mg/L)	Control	9.4 ± 0.0	9.2 ± 0.0	9.0 ± 0.1	**9.2 ± 0.2**
	Treatment	9.7 ± 0.1	9.9 ± 0.1	9.6 ± 0.0	**9.7 ± 0.1**

3.1.4. Water Quality in Sample Collection Tubs

Water quality measurements taken at the time of sample collection from the sample collection tubs during these trials are summarized in Table 9, and show very similar results for control and pre-treatment on intake. This result supports the evenness of the “Y” split of the control and treatment tracks. On intake, the post-treatment sample tub water quality was similar to the control/pre-treatment water quality for all parameters with the exception of specific conductivity and turbidity. The pH in the post-treatment tub was on average slightly lower than the control and pre-treatment intake tubs, however, the range of post-treatment pH values overlap the range of both control and pre-treatment intake pH values. The specific conductivity in the post-treatment sample collection tub (0.225 mS/cm) was on average lower than the control/pre-treatment sample tubs (0.248 mS/cm and 0.249 mS/cm, respectively). In addition, the turbidity was on average higher in the post-treatment sample collection tub (14.6 NTU) as compared to the control/pre-treatment sample collection tubs (9.7 NTU and 9.5 NTU, respectively). On discharge, the control sample collection tub and treatment sample collection tubs had very similar water quality with the exception of chlorophyll. The chlorophyll concentration in the treatment discharge sample collection tubs (10.1 μg/L) was on average lower than in the control sample collection tub over all three trials (12.3 μg/L). This result agrees with the retention tank measurements as well as the biological data that shows a decreased density of phytoplankton in the treatment samples on discharge.

Table 9. Intake and Discharge Sample Collection Tub Water Quality (Average ± Std. Dev.) in PureBallast®, v.3 Ballast Water Treatment System Trials.

Parameter	Operation	Sample Type	Average (n=3)
Temperature (°C)	Intake	Control	**13.44 ± 1.89**
		Pre-Treatment	**13.50 ± 1.91**
		Post-Treatment	**13.59 ± 1.93**
	Discharge	Control	**14.48 ± 1.42**
		Treatment	**13.19 ± 1.62**
Specific Conductivity (mS/cm)	Intake	Control	**0.248 ± 0.003**
		Pre-Treatment	**0.249 ± 0.002**
		Post-Treatment	**0.225 ± 0.001**
	Discharge	Control	**0.245 ± 0.008**
		Treatment	**0.234 ± 0.010**
Salinity (ppt)	Intake	Control	**0.1 ± 0.0**
		Pre-Treatment	**0.1 ± 0.0**
		Post-Treatment	**0.1 ± 0.0**
	Discharge	Control	**0.1 ± 0.0**
		Treatment	**0.1 ± 0.0**
pH	Intake	Control	**7.7 ± 0.1**
		Pre-Treatment	**7.7 ± 0.1**
		Post-Treatment	**7.3 ± 0.4**
	Discharge	Control	**7.8 ± 0.1**
		Treatment	**7.7 ± 0.4**
Turbidity (NTU)	Intake	Control	**9.7 ± 2.5**
		Pre-Treatment	**9.5 ± 2.9**
		Post-Treatment	**14.6 ± 6.8**
	Discharge	Control	**11.2 ± 1.9**
		Treatment	**12.0 ± 2.4**
Chlorophyll (μg/L)	Intake	Control	**10.7 ± 0.7**
		Pre-Treatment	**11.1 ± 1.0**
		Post-Treatment	**10.0 ± 1.5**

	Discharge	Control Treatment	**12.3 ± 0.5** **10.1 ± 0.8**
Dissolved Oxygen (% Saturation)	Intake	Control Pre-Treatment Post-Treatment	**97 ± 2** **96 ± 1** **98 ± 2**
	Discharge	Control Treatment	**96 ± 3** **97 ± 2**
Dissolved Oxygen (mg/L)	Intake	Control Pre-Treatment Post-Treatment	**10.1 ± 0.3** **10.0 ± 0.3** **10.2 ± 0.3**
	Discharge	Control Treatment	**9.7 ± 0.2** **10.1 ± 0.2**

3.1.5. Biological Challenge Conditions

The ≥ 50 μm size class of organisms in the intake water was the ambient assemblage of Duluth-Superior Harbor, and consisted largely of zooplankton. The live organism density on intake for the ≥ 50 μm size class ranged from 15,745/m^3 to 44,787/m^3 across trials with the maximum intake density achieved during Trial B (Table 10). The late season timing of the performance evaluation (i.e., late September to early October) resulted in these values being lower than the target density of > 100,000/m^3. However, the density of live organisms in the control discharge samples were nonetheless quite high, ranging from 19,893/m^3 to 75,071/m^3 with an average of 42,995/m^3 (Table 10), providing ample statistical power for a comparison between control and treatment. The live organism density in this larger size class increased over the two day retention time, which indicates a favorable holding environment in the control retention tank for organisms in the ≥ 50 µm size class.

The microzooplankton community at the test site was dominated by the rotifers Keratella (loricate) and Polyarthra and Synchaeta (illoricate or soft-bodied) which comprised 41 % to 72 % of total density. Bosminid cladocerans and cyclopoid and calanoid copepods were the dominant taxa in the macrozooplankton community. The density of live rotifers (hard- and soft-bodied) increased over the two day holding time in all of the trials.

The live organism density for the ≥ 10 and < 50 μm size class ranged from 221 cells/mL to 687 cells/mL, with an average of 433 cells/mL on intake (Table 10). The phytoplankton injection was terminated after 20 minutes during Trial C due to the BWTS filter clogging, which explains the low density of phytoplankton during this trial. A target density of > 1000 cells/mL was desired for the ≥ 10 and < 50 μm size class; however, this density was not met during any of the trials. This is again due to the seasonal timing of this performance evaluation and the low ambient phytoplankton densities in the Duluth-Superior Harbor during PureBallast®, v. 3 testing. The low ambient densities of phytoplankton were not conducive to collection of the large numbers of concentrated phytoplankton needed for injection on intake. As with the larger size class described above, the organism density in the ≥ 10 and < 50 μm size class increased over the two day hold time during Trials B and C, resulting in control discharge densities with an average of 474 live cells/mL (Table 10); more than adequate to detect a treatment effect live cells/mL (Table 10).

The smaller regulated size class (≥ 10 and < 50 µm) was dominated by phytoplankton entities of diatoms, green algae, blue-green algae, chrysophytes and cryptophytes. Protozoans, including ciliates and flagellates, were also present, comprising up to 3 % of the assemblages in intake samples. Dominant taxa during these trials were *Aulacoseira* spp. (filamentous diatom), *Melosira* spp. (filamentous diatom), *Cyclotella* spp. (single-celled centric diatom), *Fragilaria* spp. (filamentous diatom), filamentous and sheet-forming cyanophytes (e.g., *Oscillatoria*, *Merismopedia*, *Lyngbya*), colonial (coccoid) green algae (e.g., *Gonium* and *Pandorina*), *Cryptomonas*/*Rhodomonas* spp. (single-celled cryptophytes), and other miscellaneous microflagellates.

Table 10. Live Plankton Concentrations (Average ± Standard Error of the Mean, SEM) in Intake and Control Discharge Water in Three Trials of the PureBallast®, v. 3 BWTS and in the Overall Test Cycle.

Live Organism Size Category	Target Density	Sample	Trial A	Trial B	Trial C	Summary (*n*=3)
≥ 50 µm (#/m^3)	>100,000	Intake	20,086	44,787	15,745	**26,872 ± 9044**
	>100	Control Discharge	34,020	75,071	19,893	**42,995 ± 16,549**
	--	Control Discharge (24 Hour Hold)	33,257	56,113	18,454	**35,941 ± 10,954**
≥ 10 and < 50 µm (#cells/mL)	>1000	Intake	399	687	221	**433 ± 136**
	>100	Control Discharge	393	721	308	**474 ± 126**

Microbial organism concentrations (i.e., < 10 µm size class), measured in most probable number (MPN) per volume, in the intake and control discharge samples during the PureBallast®, v.3 trials are provided in Table 11. Total coliform bacteria densities ranged from 246 MPN/100 mL to 305 MPN/100 mL on intake (Table 11). Of the total coliform bacteria on intake, approximately 26 % on average were *E. coli*, which ranged from 38 MPN/100 mL to 116 MPN/100 mL (Table 11). Enterococci ranged from 38 MPN/100 mL to 50 MPN/100 mL on intake (Table 11). Several of the intake samples collected and analyzed for total heterotrophic bacteria were below the limit of detection (i.e., < 200 MPN/mL), therefore, an overall average could not be determined but intake concentrations ranged from < 200 MPN/mL to 2933 MPN/mL (Table 11, Appendix 5). The density of total coliform bacteria, *E. coli*, and enterococci decreased over the retention period (Table 11). This result is not surprising, as Duluth-Superior Harbor water is not a favorable environment for growth of these organisms. Total coliform bacteria density decreased to an average of 179 MPN/100 mL in the control discharge, which was a 36 % reduction in density compared to intake (Table 11). *E. coli* and enterococci densities decreased approximately 50 % on average, for a control discharge density average of 37 MPN/100 mL and 21 MPN/100 mL, respectively (Table 11). Heterotrophic bacteria ranged from < 200/mL to 467/mL in control discharge (Table 11, Appendix 5).

Table 11. *E. coli*, Enterococci, and Total Heterotrophic Bacteria Densities (Average ± SEM) in Intake and Control Discharge from Three Trials of the PureBallast®, v. 3 BWTS, and the Overall Test Cycle.

Microbial Organism	Sample	Trial A	Trial B	Trial C	Summary (*n*=3)
Total Coliform Bacteria (MPN/100 mL)	Intake	288 ± 13	305 ± 37	246 ± 24	280 ± 18
	Control Discharge	177 ± 22	207 ± 34	153 ± 13	179 ± 16
E. Coli (MPN/100 mL)	Intake	38 ± 4	65 ± 0.4	116 ± 16	73 ± 23
	Control Discharge	24 ± 2	33 ± 4	52 ± 2	37 ± 8
Enterococci (MPN/100 mL)	Intake	39 ± 4	50 ± 3	38 ± 9	42 ± 4
	Control Discharge	14 ± 4	23 ± 2	27 ± 7	21 ± 4
Total Heterotrophic Bacteria (MPN/mL)	Intake	2933 ± 2536	<200.00 to 600.00*	<200.00 to 200.00*	Could not Determine
	Control Discharge	<200.00 to 200.00*	467 ± 176	116 ± 15	Could not Determine

*Could not average replicates, as one or more are below the limit of detection (below 200 MPN/mL). See trimmed, raw data in Appendix 5.

3.2. Live Organisms in Treated Discharge

3.2.1. Regulated Plankton, ≥ 50 μm Size Class

The densities of live plankton in the post-treatment intake and treatment discharge from these trials are summarized in Table 12.

On intake, immediately post-treatment, the density of live organisms in the ≥ 50 μm size class ranged from 2,640/m^3 (Trial C) to 9,090/m^3 (Trial B) and averaged 6,232/m^3 (Table 12). This represented an immediate 77 % reduction in live organism density as compared to the intake density. Macrozooplankton observed live in post-treatment intake samples were Bosmina, copepods, and chironomid larvae; while Keratella, Polyarthra, Syncheata, and copepod nauplii were most commonly observed live from the microzooplankton group. Following a two day retention and second pass through the PureBallast®, v.3 BWTS on discharge, the density of live organisms in the ≥ 50 μm size class ranged from 445/m^3 (Trial A) to 1,871/m^3 (Trial B) and averaged 947/m^3 (Table 12), which represents a 96 reduction from the intake live organism density. There was a statistically significant (p<0.05) reduction in live organism density between the post-treatment intake and the treatment discharge (Table 12). Copepods dominated the macrozooplankton observed live in the treatment discharge, but Bosmina and tardigrades were also observed (see Appendix 4 for listing of organisms found in treated discharge). In the microzooplankton group, Keratella were most frequently observed in the treatment discharge; Polyarthra, Syncheata, and other rotifers were also observed (Appendix 4). After a 24 hour hold time in one treatment sample collection tub, there was a further 2 % reduction in mean live organism density as compared to the treatment discharge, but this reduction was not statistically significant, compared to the treatment discharge sampled immediately. Post-discharge, 24 hour retention densities ranged from 288/m^3 (Trial C) to 686/m^3 (Trail B), with an average of 544/m^3 (Table 12). The results of the paired t-test comparing the control and treatment discharge are summarized in Table 13. There was a significant difference (p = 0.003) between the control and treatment discharge, indicating that for the ≥ 50 μm size class, the PureBallast® v.3 BWTS reduces the live organism density in the treated discharge when compared to the untreated discharge.

3.2.2. Regulated Plankton, ≥10 and < 50 μm Size Class

Densities of live organisms in the ≥10 and <50 μm size class immediately post-treatment ranged from 62 cells/mL (Trial C, reduced augmentation) to 379 cells/mL (Trial B), with a test cycle average of 199 cells/mL (Table 12). Live organisms in the post-treatment intake had a similar diversity as that observed for untreated intake samples, although cyanophytes and colonial green algae were not observed. Following a two day retention time and second treatment using the PureBallast®, v.3 BWTS on discharge, the treatment discharge live density ranged from 36 cells/mL (Trial C, non-augmented) to 171 cells/mL (Trial B) and averaged 94 cells/mL (Table 12), for a 78 % reduction in live organism density as compared to the intake density. There was no significant difference (p<0.05) in live organism density between the post-treatment and the treatment discharge (Table 12). Again, diatoms dominated the live organisms found in the treatment discharge, while protozoans, cryptophytes, and dinoflagellates were occasionally observed. Cyanophytes were not observed in treated discharge and there was only one occurrence of a colonial green alga. The results of the paired t-test comparing the control and treatment discharge are summarized in Table 13. There was a significant difference (p=0.05) between the control and treatment discharge, indicating that for the ≥ 10 and < 50 μm size class, the PureBallast® v.3 BWTS reduces the live organism density in the treated discharge when compared to the control discharge.

Table 12. Live Plankton Densities (Average ± SEM) within Regulated Size Classes in Post-Treatment Intake and in Treatment Discharge During Three Trials of the PureBallast®, v.3 BWTS and the Overall Test Cycle. Note: Statistical comparisons were made within each regulated size class, not between size classes. Within each size class, treatment groups with densities having different superscript letters are significantly (p<0.05) different.

Live Organism Size Category	IMO G8 Guideline	Sample	Trial A	Trial B	Trial C	Summary (n=3)
≥ 50 μm (#/m^3)	NA	Post-Treatment Intake	6966	9090	2640	**6232 ± 1898^a**
	<10/m^3	Treatment Discharge	445	1871	524	**947 ± 463^b**
	NA	Treatment Discharge (24 Hour Hold)	657	686	288	**544 ± 128^b**
≥10 and < 50 μm (#cells/mL)	NA	Post-Treatment Intake	155	379	62	**199 ± 94^a**
	<10 /mL	Treatment Discharge	74	171	36	**94 ± 40^a**

Table 13. Summary of Results from Paired t-tests Comparing Control Discharge Densities to Treatment Discharge Densities. Note: The hypothesis tested was that the PureBallast® v.3 BWTS significantly reduces the number of live organisms on discharge in comparison to the untreated, control discharge.

Size Class	Treatment Name	Mean Density (n=3)	Std. Dev.	SEM	t	p	Probability of Trial Resulting in No Difference
≥ 50 μm	Control Discharge	42,995[1] live/m^3	28,663	16,549	17.306	0.003	1 in 333
	Treatment Discharge	947[1] live/m^3	801	463			
≥10 and < 50 μm	Control Discharge	474 cells/mL	218	126	4.422	0.048	1 in 21
	Treatment Discharge	94 cells/mL	69	40			

[1]Data were not normally distributed, and were log-transformed to achieve normal distribution and equal variance prior to performing the paired t-test.

3.2.3. Regulated Organisms, <10 μm Size Class

Immediate post-treatment intake and treatment discharge microbial densities are summarized in Table 14. There was no significant difference between the post-treatment intake and treatment discharge densities for total coliform bacteria, *E. coli*, and enterococci (Table 14). There was an overall average of 5 MPN/100 mL total coliform bacteria in post-treatment intake, as compared to an average of <1 MPN/100 mL in treatment discharge (Table 14). Of the total coliform bacteria measured in post-treatment intake, 20 % were *E. coli* and averaged 1 MPN/100 mL. In treatment discharge, the average *E. coli* density was <1 MPN/100 mL (Table 14). There was no significant difference between post-treatment intake and treatment discharge densities of enterococci, both averaged <1 MPN/100 mL (Table 14). Total heterotrophic bacteria results were variable, and ranged from 54 MPN/mL to 2233 MPN/mL in post-treatment intake samples (Table 14). In Trial A, there were less total heterotrophic bacteria in the treatment discharge (i.e., 246 MPN/mL) as compared to post-treatment intake (i.e., 2233 MPN/mL); however, the opposite result occurred in Trial C (Table 14). The densities appear to be similar in Trial B, although a direct comparison cannot be made because one of the treatment discharge samples was below the limit of detection (< 200 MPN/mL) and an overall average for the test could not be calculated (Table 14, Appendix 5).

For all the groups analyzed in the < 10 μm size class, there was a significant difference ($p<0.05$) between the control and treatment discharge densities, indicating that for the < 10 µm size class, the PureBallast® v.3 BWTS reduces the live organism density in the treated discharge when compared to the control discharge (Table 15).

Table 14. *E. coli*, Enterococci, and Total Heterotrophic Bacteria in Post-Treatment Intake and in Treatment Discharge during Three Trials of the PureBallast®, v.3 BWTS and the Test Cycle Average.

Microbial Organism	IMO G8 Guideline	Sample	Trial A	Trial B	Trial C	Summary (*n*=3)
Total Coliform Bacteria (MPN/100 mL)	N/A	Post-Treatment Intake	8 ± 2	4 ± 1	3 ± 0	**5 ± 2**
	N/A	Discharge	<1	<1	<1	**<1**
E. Coli (MPN/100 mL)	N/A	Post-Treatment Intake	2 ± 1	<1	2 ± 0	**1 ± 0**
	< 250 CFU/ 100 mL	Discharge	<1	<1	<1	**<1**
Enterococci (MPN/100 mL)	N/A	Post-Treatment Intake	<1	<1	<1	**<1**
	< 100 CFU/ 100 mL	Discharge	1 ± 0	<1	<1	**<1**
Total Heterotrophic Bacteria (MPN/mL)	N/A	Post-Treatment Intake	2233 ± 1027	171 ± 21	54 ± 8	**819 ± 708**
	N/A	Discharge	246 ± 27	<200.00 to 400.00*	232 ± 12	**Could not Determine**

*Could not average replicates, as one or more are below the limit of detection (below 200 MPN/mL). See trimmed, raw data in Appendix 5.

Table 15. Summary of Results from Paired t-tests Comparing Control Discharge Densities (MPN/100 mL) to Treatment Discharge Densities (MPN/100 mL) of Live Organisms < 10 μm. Note: The hypothesis tested was the PureBallast® v.3 BWTS significantly reduces the number of live organisms on discharge in comparison to the untreated, control discharge.

Microbial Organism	Treatment Name	Mean Density (*n*=3)	Std. Dev.	SEM	*t*	*p*	Probability of Trial Resulting in No Difference[1]
Total Coliform Bacteria	Control Discharge	179	27	16	11.427	0.008	1 in 125
	Treatment Discharge	0.50	0.00	0.00			
E. Coli	Control Discharge	36.53	13.90	8.02	4.490	0.046	1 in 22
	Treatment Discharge	0.50	0	0			
Enterococci	Control Discharge	21.23	6.56	3.79	5.292	0.034	1 in 29
	Treatment Discharge	0.86	0.13	0.07			

3.3. Whole Effluent Toxicity (WET) Testing

GSI conducted WET tests as part of a separate trial that was conducted after the three valid trials in the test cycle were completed. Each test included a performance control using each species' medium or culture water. In all three WET tests, the performance control met the test acceptability criteria. This indicates that the organisms were healthy prior to test initiation, and that they were not damaged during the test due to handling. In addition, the untreated harbor water controls (0 % Effluent) met the test acceptability criteria for all three species tested. The average *S. capricornutum* density at test termination in the 0 % Effluent group (2,865,625 cells/mL) was slightly higher than the average density in the 100 % Effluent group (2,375,000 cells/mL); however, this difference was not statistically significant (p<0.05, Table 16). Therefore, there was no effect of the treatment discharge water on *S. capricornutum* growth in this trial. There was also no effect of the treatment discharge water on *P. promelas* survival or growth in this trial (Table 17). Finally, there was no effect of the treatment discharge water on *C. dubia* survival or number of young produced per female in this trial (Table 18).

Table 16. Average (±SEM) Final Density of *S. capricornutum* Exposed to PureBallast®, v.3 Treatment Discharge Whole Effluent.

Treatment Group	*S. capricornutum* Density (cells/mL)	Coefficient of Variation (CV %)
Algae Growth Media (Performance Control)	3,935,938 ± 232,407	11.8
0% Effluent (Untreated Harbor Water)	2,865,625 ± 81,070	5.7
100% Effluent	2,375,000 ± 204,825	17.2

Test acceptability criteria: Control flask must exceed 1 * 10^6 cells/mL and not vary more than 20% among replicates.

Table 17. Average (±SEM) *P. promelas* Survival and Dry Weight per Surviving *P. promelas* Exposed to PureBallast®, v.3 Treatment Discharge Whole Effluent.

Treatment Group	Survival (%)	Dry Weight per Survivor (mg)
Laboratory Water (Performance Control)	100 ± 0	0.49 ± 0.01
0% Effluent (Untreated Harbor Water)	98.3 ± 1.8	0.51 ± 0.02
100% Effluent	100 ± 0	0.49 ± 0.01

Test acceptability criteria: 80% or greater survival in the controls; average dry weight per surviving organism in the controls equal to or exceed 0.25 mg.

Table 18. Average (±SEM) Survival and Total Reproduction of *C. dubia* Exposed to PureBallast®, v.3 Treatment Discharge Whole Effluent.

Treatment Group	Survival (%)	Reproduction (No. Young/Female)
C. dubia Culture Water (Performance Control)	100 ± 0	45.8 ± 2.0
0% Effluent (Untreated Harbor Water)	100 ± 0	46.5 ± 1.6
100% Effluent	100 ± 0	46.5 ± 3.9

Test acceptability criteria: 80% or greater survival and an average of 15 more young per female in the controls.

4.0. QUALITY MANAGEMENT

GSI uses a wide variety of quality management documents and records to implement its quality management system. These include quality system documentation (i.e., the GSI Quality Management Plan), project-specific documentation (i.e., Quality Assurance Project Plans), and routine procedures documentation (i.e., Standard Operating Procedures).

4.1 Quality Management Plan (QMP)

Detailed information on the structure and organization of GSI's quality system can be found in the GSI Quality Management Plan (GSI, 2010b). Electronic copies of this document are available upon request. The GSI QMP covers all aspects of GSI's commitment to quality including policies and procedures; criteria for and areas of application; roles, responsibilities, and authorities; assessment and response; and quality improvement. It is the framework for planning, implementing, documenting, and assessing the GSI's quality assurance and quality control (QAQC) activities.

4.2. Quality Assurance Project Plan (QAPP)

Additional information and details regarding the activities undertaken by GSI to assure the quality and credibility of its research at the Land-Based RDTE Facility can be found in GSI's Land-Based Quality Assurance Project Plan (GSI, 2010a). This document is available electronically upon request. The QAPP covers all aspects of quality assurance/quality control (QAQC), including data quality indicators, evaluation processes, performance measures and acceptance criteria; instrument certification and calibration; personnel training requirements; documents and records; data management; and QAQC assessments and response actions.

4.3. Standard Operating Procedures (SOPs)

SOPs are used to implement all GSI test activities. This facilitates consistent conformance to technical and quality system requirements and increases data quality. The SOPs include both programmatic and technical processes and procedures such as organism culturing; operation of the GSI Land-Based RDTE facility; sample collection, labeling, analysis and custody; and health and safety. Appendix 3 provides a list of GSI SOPs relevant to land-based test activities.

5.0. DISCUSSION OF RESULTS

The PureBallast® BWTS v.3 operated without interruption under the natural Duluth-Superior Harbor conditions for two out of the three research and development trials reported here. In the third trial, the BWTS filter clogged and the trial was briefly interrupted while the filter mechanism was reset. In all three trials, live organism densities in the two regulated size classes of plankton in treated discharge were significantly ($p<0.05$) lower than in control discharge, but well above IMO D-2 Standards. Densities of organisms $\geq$ 50 μm in minimum dimension in treated discharge exceeded the IMO standard of 10 live organisms per cubic meter by 2-3 orders of magnitude (445 to 1871/m^3). Live densities in the ≥ 10 and < 50 μm size class exceeded the IMO limits of 10 live cells/mL by 1-2 orders of magnitude (36 cells/mL to 171 cells/mL). Holding the treated discharge for one day at ambient concentration did not result in significant additional die-off of organisms in the ≥ 50 μm size class. The treatment discharge densities of total coliform bacteria, *E. coli*, and enterococci were below the limit of detection (i.e., <1 MPN/mL) (though it should be noted that intake densities were already relatively low). For these three groups, the density of live organisms in the treated discharge was significantly ($p<0.05$) lower than the control discharge. Results from analysis of heterotrophic bacteria were variable, and differences between the treatment and control discharge could not be determined. The WET analysis detected no residual toxicity in the treated discharge.

These GSI testing outcomes relative to plankton are disappointing given the fact that tests performed on the same PureBallast® system components at the Norwegian Institute of Water Research (NIVA) yielded results consistent with the IMO standards. Part of the reason this BWTS discharge did not perform to IMO D-2 limits at GSI clearly had to do with the poor BWTS filter performance. The striking difference in filter function in tests conducted at GSI versus NIVA during the summer of 2010 must have arisen from filter performance sensitivity to something qualitative in the natural intake water conditions at GSI. That is, quantitatively GSI had lower concentrations of TSS, POC and organisms ≥ 10 and < 50 μm than required by IMO, and applied during tests at NIVA. However, NIVA's intake water from the Oslo fjord has naturally low concentrations of organisms in the ≥ 10 and < 50 μm size class. As a consequence NIVA supplements its sparse local ambient organism assemblage with dense concentrations of a single cell cultured organism (*Tetraselmis*). *Tetraselmis* is at the low side of the ≥ 10 and < 50 μm size range, and frequently below it depending on the chosen species, and likely did not present much of a challenge for the 40 μm filter of the PureBallast® BWTS v.2. Meanwhile, the diverse natural assemblage in the ≥ 10 and < 50 μm size range in Duluth-Superior Harbor was dominated by the common protist taxon *Aulacoseira* (previously known as *Melosira)*, a filamentous diatom. Filamentous diatoms are a known clogging issue for filters (Hess *et al.*, 2002).

Had GSI amended its intake water to achieve IMO threshold levels, the problem would have been exacerbated. In contrast to the NIVA approach of using a single celled cultured organism, GSI concentrates natural algae and adds it to the intake stream to meet IMO-required thresholds for the ≥ 10 and < 50 μm size range. In addition, to meet IMO-required TSS levels, GSI uses Arizona Test Dust while NIVA uses Kaolinite-type clay mineral, and these additives have different particle size distributions.

At the same time, very low ambient UV transmittance of Duluth-Superior Harbor water during these tests likely impeded effectiveness of the secondary advanced oxidation treatment (AOT) stage in the BWTS. The PureBallast™ BWTS AOT™ component of the BWTS involves use of ultraviolet radiation, and was designed for water with significantly greater percent transmittance (%T) than was occurring naturally in Duluth-Superior Harbor during these tests. The %T levels at intake were 15.6 - 16.3 %T, extremely low even for Duluth-Superior Harbor, which ranged from 14.2 %T to 68.5 %T (34.1 average %T) during the 2009 and 2010. This latter condition resulted from high concentrations of dissolved organic material, however, and did not contribute to filter malfunction.

Thus two conditions likely account for the poor performance of the PureBallast™ BWTS at GSI and for the discrepancies between performance outcomes at GSI versus NIVA. The question then arises as to whether the GSI conditions under which the two BWTS components (filter and AOT) failed to perform effectively are always difficult for treatment systems and/or rare, i.e. not within the range of normal for harbors visited by ships. With respect to the level of challenge presented by GSI intake water to filters, it should be noted that other treatment system filters have performed effectively at GSI under both natural and IMO-consistent intake water conditions (see www.greatshipsinitiative.org). Thus, the sensitivity of the PureBallast™ BWTS filter to these conditions is not shared across filter types. With respect to the question of rarity of GSI challenge conditions for filtration, at least for the Great Lakes, GSI's intake concentrations of the dominant taxon, filamentous algae, are common in the ambient environment, even at augmented, IMO-consistent levels. For instance, algal monitoring data from near western Lake Erie ports (e.g., Toledo) have revealed cell densities of more than 100,000 cells/mL (Makarewicz, 1993). While much of that assemblage comprises small-celled blue-green algae such as *Anacystis*, more than 1500 cells/mL of that algal load was attributed solely to the taxon *Aulacoseira islandica*. Furthermore, recent monitoring data from Lake Erie indicate spring concentrations of *Aulacoseira islandica* as high as 2284 cells/mL (average = 828 cells/mL) (Reavie, 2009), much higher than that ever observed in even GSI's spiked intake samples. Total algal densities in Lake Erie are consistently higher than 15,000 cells/mL. In the GSI trials reported here using ambient levels of algae, live cells per mL were three orders of magnitude lower (ranging from 221 cells/mL in Trial C, to 399 cells/mL in Trial A).

With respect to the low UV Transmittance in the GSI challenge water during the summer of 2010, the story is quite different. High concentrations of dissolved organic carbon compounds result from run-off from cedar and other bogs containing tannin. The resulting brown coloration of the water often characterize river estuaries in the northern Great Lakes. But the %T levels confronted during the PureBallast™ BWTS tests were low even by Duluth-Superior Harbor standards, which averaged 34.1 %T in 2009-2010. Globally, the likelihood of such low UV transmittance conditions is not unique to Duluth-Superior Harbor, but it is relatively rare. As a practical matter, low %T at a given harbor can be anticipated in advance, such that the challenges to a UV based BWTS that they impose could be mitigated with management practices such as open ocean BWE in combination with treatment.

6.0. CONCLUSIONS

The version of the PureBallast® ballast water treatment system (BWTS) v.3 tested at the Great Ships Initiative (GSI) land-based testing facility in September and October 2010 combined a 40 μm filtration system with an Advanced Oxidation Technology (AOT™). The PureBallast® BWTS v.3 operated without interruption under the natural Duluth-Superior Harbor conditions for two out of the three trials; during the third trial, the BWTS filter clogged and the trial was briefly interrupted while the filter mechanism was reset. In all three trials, live organism densities in the two regulated size classes of plankton in treated discharge were significantly ($p<0.05$) lower than in control discharge, but well above IMO D-2 standards. Densities of organisms ≥ 50 μm in minimum dimension in treated discharge exceeded the IMO standard of 10 live organisms per cubic meter by 2-3 orders of magnitude (445 to 1871/cubic meter). Live densities in the ≥ 10

and < 50 μm size class exceeded the IMO limits of 10 live cells/L by 1-2 orders of magnitude (36 cells/mL to 171 cells/mL). The density of live total coliform bacteria, *E. coli*, and enterococci in the treated discharge was significantly ($p<0.05$) lower than the control discharge. Results from analysis of heterotrophic bacteria were variable, and differences between the treatment and control discharge could not be determined. The Whole Effluent Toxicity (WET) Analysis detected no residual toxicity in the treated discharge. These results differed from findings generated by the Norwegian Institute of Water Research (NIVA) on the same or similar system components. The difference between GSI and NIVA test outcomes can be explained in part by more challenging conditions for filtration at the GSI site, which are not unique to Duluth-Superior Harbor, and which have not led to malfunction of other filters tested at GSI. The difference was also a result of the extraordinarily low UV transmittance of the source water, which posed a greater challenge to the UV-based AOT within the PureBallast® BWTS. GSI UV Transmittance conditions are natural and not unique to Duluth-Superior Harbor, but relatively rare. Low UV transmittance of source water in Duluth-Superior Harbor resulted from high concentrations of dissolved organic material, and did not contribute to filter malfunction.

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APPENDICES

1. **GSI Land-Based Test Plan for the AlfaWall PureBallast® Ballast Water Management System**

2. **Performance Evaluation Summary for Type-Approved and Modified PureBallast® BWTS, and Research and Development Testing of the PureBallast® BWTS.**

3. **List of GSI SOPs Relevant to the Commissioning of PureBallast® v.1 and v.2 and Performance Evaluation of PureBallast® v.3.**

4. **Average Density (per m^3) of Live Zooplankton in Treatment Discharge during the Trials of the PureBallast®, v.3 Ballast Water Treatment System. Organisms are Grouped by Taxa in the ≥50 µm Size Class, Additional Live Organisms <50 µm, and Excluded Live Organisms.**

5. **Average Density (MPN per volume) of Organisms in the ≤10-µm Size Class Intake (Pre- and Post-Treatment) and Discharge (Control and Treatment) during the Trials of the PureBallast®, v.3 Ballast Water Treatment System.**

APPENDIX 1 - GSI Land-Based Test Plan for the AlfaWall PureBallast® Ballast Water Management System.

GSI Land-Based Freshwater Test Plan for the AlfaWall PureBallast® Ballast Water Management System

July 15, 2010

Principal Investigator:

Allegra Cangelosi, NEMWI

Research Team:

Lisa Allinger, NRRI, UMD
Mary Balcer, PhD, LSRI, UWS
Nicole Mays, NEMWI
Tom Markee, LSRI, UWS
Christine Polkinghorne, LSRI, UWS
Kelsey Prihoda, LSRI, UWS
Euan Reavie, PhD, NRRI, UMD
Donald Reid, Consultant
Heidi Saillard, LSRI, UWS
Tyler Schwerdt, AMI Engineering
Heidi Schaefer, LSRI, UWS
Matthew TenEyck, LSRI, UWS

EXECUTIVE SUMMARY

The Great Ships Initiative (GSI) provides independent no-cost performance verification testing services to developers of ballast treatment systems and processes at a purpose-built, land-based ballast treatment test facility located in the Duluth-Superior Harbor of Lake Superior. GSI test protocols are consistent with the requirements of the International Convention for the Control and Management of Ships Ballast Water and Sediments (International Maritime Organization, 2004). GSI procedures, methods, materials and findings are publicly accessible on the GSI website (www.greatshipsinitiative.org).

In August through October 2010, the GSI will conduct land-based tests on two versions of the PureBallast® System. During a series of five consecutive valid trials, a new version of the PureBallast® System (hereafter referred to as "AW 2") will be evaluated for its ability to: (a) successfully treat ballast water without interruption, (b) meet IMO D-2 discharge standards after a five-day holding time, and (c) discharge water after the five day retention period that is environmentally benign (i.e., no residual toxicity) pursuant to United States Environmental Protection Agency water quality criteria. Subsequently, and as time permits, additional trials up to five valid trials will be conducted on the original PureBallast® System, (hereafter referred to as "AW 1") which already has IMO final approval.

GSI land-based fresh water ballast treatment testing draws ambient water from Duluth-Superior Harbor, and amends it for these tests with solids and concentrated harbor phytoplankton to achieve IMO-consistent challenge conditions. Residual toxic effects of whole treated effluent (WET tests) will be evaluated on an array of test species in at least two trials of the AW 2.

1.0. INTRODUCTION

1.2. The Great Ships Initiative

The Great Ships Initiative (GSI)[5] is a regional effort devoted to ending the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System and globally. In support of that goal, the GSI established superlative freshwater ballast treatment evaluation capabilities at three scales—bench, land-based, and on board ship.

The GSI awards its independent status-testing services to developers of ballast treatment systems and processes determined to be promising. GSI status-testing is performed at the scale appropriate to the state of development of the target treatment system, with the goal of facilitating the rapid progression of meritorious ballast treatment systems through the research and development and approval processes to a market-ready condition.

GSI has no involvement, intellectual or financial, in the mechanics, design or market success of the actual treatment systems it tests. To ensure that GSI tests are uncompromised by any real or perceived individual or team bias relative to test outcomes, GSI test activities are subject to rigorous quality assurance, quality control (QA/QC) procedures and documentation. This QA/QC attention also assures high quality and credible evaluation findings.

GSI has worked to standardize and intercalibrate its protocols to evaluate the performance of ballast water treatment systems with IMO guidelines, United States Environmental Protection Agency ETV draft protocols, and other test facilities. GSI test protocols are as consistent with the requirements of the International Maritime Organization's (IMO) Convention for the Control and Management of Ships Ballast Water and Sediments (IMO, 2004) and federal requirements as practicable. In particular, GSI testing directly supports IMO G8 and G9 evaluations. GSI procedures, methods, materials and findings are also not proprietary, and are publicly accessible on the GSI website (www.greatshipsinitiave.org).

Ms. Allegra Cangelosi of the Northeast-Midwest Institute is the Principal Investigator and Manager of the GSI. Researchers from the University of Wisconsin-Superior's Lake Superior Research Institute (LSRI), and the University of Minnesota-Duluth's Natural Resources Research Institute (NRRI), among others, provide critical scientific and technical expertise and implementation services to GSI's biological research activities, and the GSI generally. Dr. Mary Balcer is the project's lead zooplankton ecologist. Dr. Euan Reavie leads all phytoplankton analysis. Mr. Matthew TenEyck leads the bench-testing and Whole Effluent Toxicity (WET) tests. AMI Consulting Engineers provide engineering expertise in support of GSI testing activities. A GSI Advisory Committee comprising top-level officials of key stakeholder groups helps steer the GSI providing crucial assistance in making GSI award decisions and fund-raising. The GSI Advisory Committee includes elected leadership, environmental organizations, port directors and federal officials from the United States and Canada, and industry representatives. The American Great Lakes Ports Association advises the project, assuring that the GSI is

[5] www.greatshipsinitiative.org

meeting the needs of the maritime industry; and coordinating maritime industry and supply chain outreach.

To date, all GSI tests are supported by general project funds which derive from federal, state and port grants and contributions, and in-kind contributions by industry, local government and universities. Over time, GSI will begin to charge treatment developers for a portion of the testing costs associated with type approval testing for United States regulatory purposes. The largest contributor of GSI operating funds is the United States Department of Transportation, including its Maritime Administration, and the Saint Lawrence Seaway Development Organization. GSI also receives significant funds and in-kind contributions from the National Oceanic and Atmospheric Administration, the Canadian St. Lawrence Seaway Management Corporation, the City of Superior, Wisconsin, and approximately ten U.S. and Canadian ports in the Great Lakes.

In August, September and October 2010, the GSI will conduct land-based tests on two versions of the PureBallast® System. During the series of five consecutive valid trials, PureBallast® System will be evaluated for its ability to: (a) successfully treat ballast water without interruption, (b) meet IMO D-2 discharge standards after a five-day holding time, and (c) discharge water after the five day retention period that is environmentally benign (i.e., no residual toxicity) pursuant to United States Environmental Protection Agency water quality criteria.

1.3. The GSI Land-Based RDTE Test Facility

GSI tests evaluate the biological efficacy of a ballast water treatment system at its purpose-built, land-based ballast treatment test facility located in the Duluth-Superior Harbor of Lake Superior (Figures 1-3). The facility draws raw intake water from Duluth-Superior Harbor at 400 m^3/hr to 680 m^3/hr. This main flow of intake water can be amended with TSS and endemic Harbor algae just prior to being split into control and treatment tracks (see injection points A and B; Figure 4).

Figure 1. Location of the GSI's Land-Based RDTE Facility in Superior, Wisconsin.

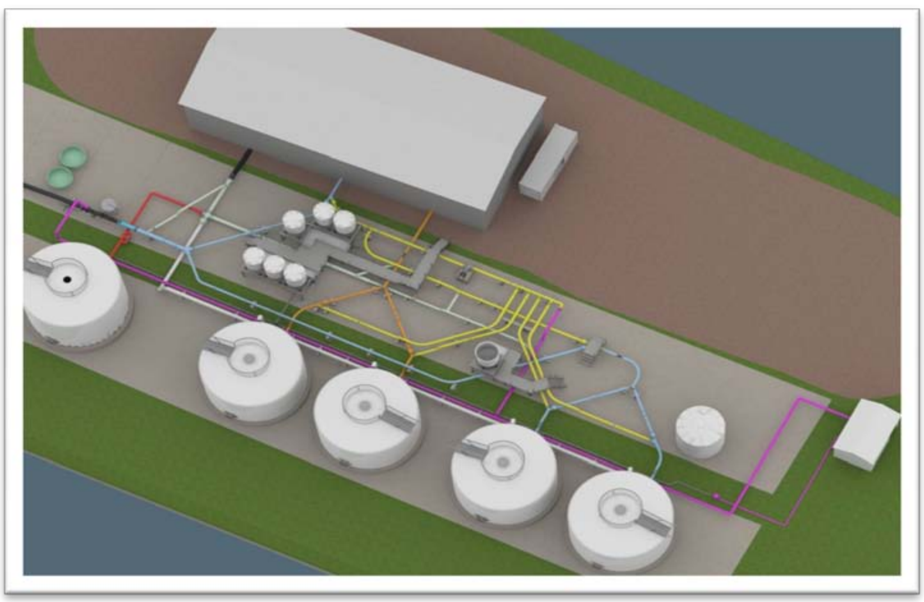


Figure 2. Computer-Generated Rendering of the GSI Land-Based RDTE Facility.

Figure 3. Photo of the GSI Land-Based RDTE Facility.

A Y-split in the intake piping at the facility simultaneously channels one half of the flow (200 m^3/hr to 340 m^3/hr) to a treatment track and the other half (also 200 m^3/hr to 340 m^3/hr) to a matched control track (Figure 4). The treatment track directs water through the experimental treatment system and into a 200 m^3 cylindrical retention tank. The control track by-passes the treatment system and channels water directly into a matched control retention tank (Figure 4). After a retention period, water is discharged sequentially from the treatment and control retention tanks at 340 m^3/hr. The water is directed either back to the harbor, to a 260 m^3 wastewater storage tank for subsequent discharge to the sewer, or recirculated to a second set of facility retention tanks (Figure 5). Information on the facility's validation is available on request.

Water is sampled continuously throughout ballasting functions (intake or discharge) through in-line sample points. Each sample point is made up of one to three identical sample ports with a center-located elbow-shaped pitot tube (90 ^{o}) bent towards the direction of water flow used to sample the water. This pitot design is based on a design developed and validated by the U.S. Naval Research Laboratory in Key West, Florida, and empirically at GSI. Intake sampling uses sample ports at paired intake sample points (SP#2 and SP#3) on the control and treatment tracks (Figure 2). Discharge sampling occurs through sample ports at sampling points SP#9 or SP#10 (Figure 2). All four SPs are made up of three sample ports.

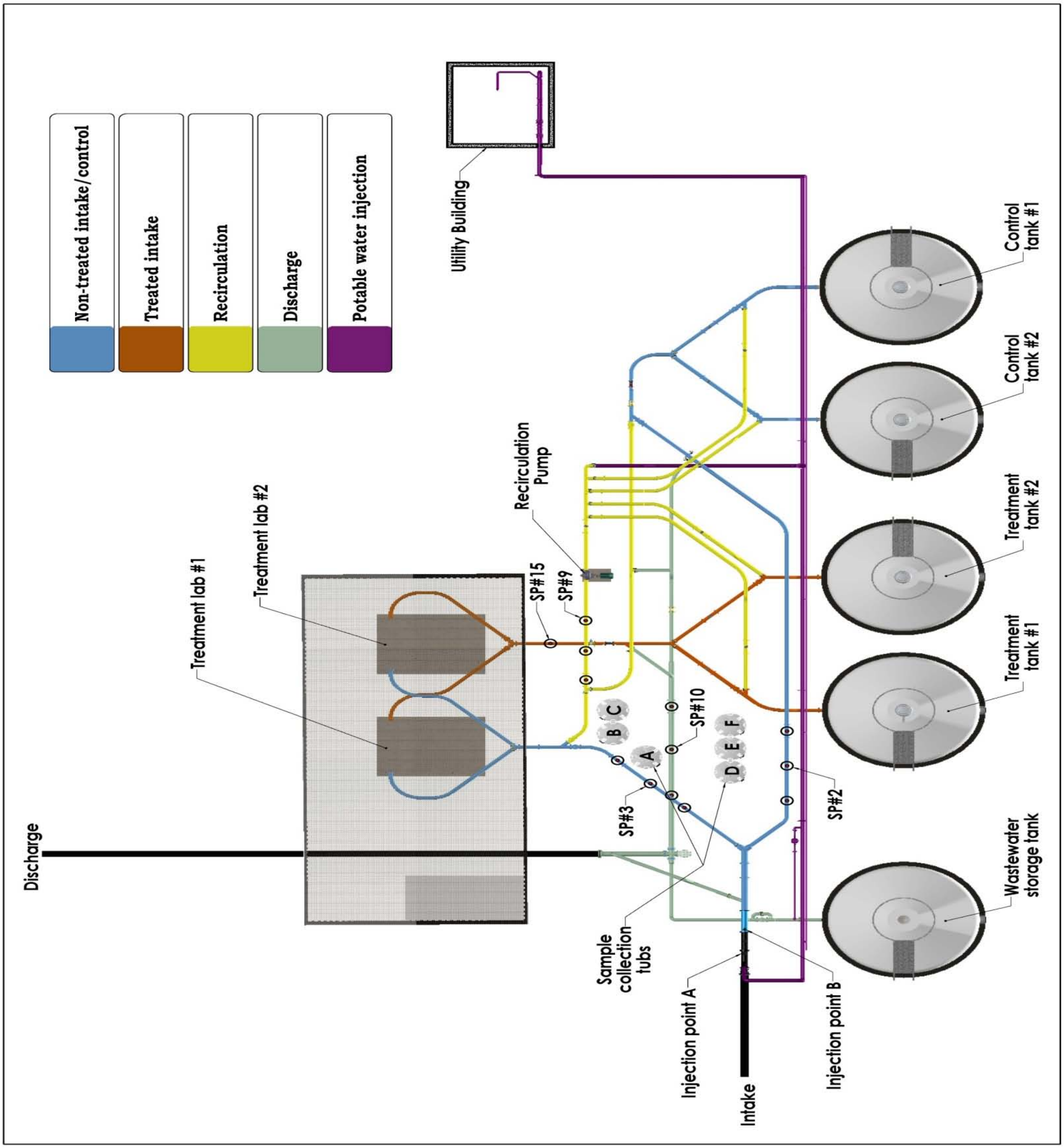


Figure 4. Simplified Schematic of the GSI Land-Based RDTE Facility Showing Location of Sample Points, Injection Points, Retention Tanks, and Treatment and Controls Tracks.

Sample water at a given sampling point (i.e., intake line of the control track, intake line of the treatment track, or the discharge line for the control and treatment tracks) is transferred simultaneously and continuously throughout ballasting operations (intake or discharge) from replicate sample ports to replicate 3.8 m^3 sample collection tubs via clean 3.8 cm ID flexible hoses and automated flow-controlled pneumatic diaphragm valves. Flow control valves and system logic assure that sample flow rates are equivalent and proportional to intake and discharge flow rates throughout each operation. Flow rates are recorded every 5 seconds during the test trials from three locations at automated valves on the control track, treatment track, and on the discharge line. Pressure readings are also recorded every 5 seconds throughout the facility.

An on-site mobile field laboratory (Figure 3a) and stationary structure (Figure 3b) provide bench-scale facilities to support time sensitive assays associated with the GSI land-based tests, including live analysis of phytoplankton and zooplankton. The laboratories are climate-controlled, and have enough bench space to allow for simultaneous microscopic and analytical analysis of samples by multiple analysts.

Figure 3a. The GSI Mobile Field Laboratory.

Figure 3b. The GSI Stationary Laboratory.

1.4. Treatment Performance Requirements in Regulation D-2

The International Convention for the Control and Management of Ships Ballast Water and Sediments was adopted by consensus at a Diplomatic Conference at IMO in London on Friday 13 February, 2004. Annex D-2 of the Convention relates to ballast water performance standards for ships conducting ballast water management, including use of a ballast water treatment system to effectively treat the ballast water. The regulation states that ships conducting ballast water management shall discharge:

- Less than 10 viable organisms per m^3 greater than or equal to 50 μm in minimum dimension;
- Less than 10 viable organisms per mL less than 50 μm in minimum dimension and greater than or equal to 10 μm in minimum dimension; and
- Discharge of the indicator microbes shall not exceed the specified concentrations. The indicator microbes, as a human health standard, include, but are not be limited to:
  - Toxicogenic *Vibrio cholerae* (O1 and O139) with less than 1 colony forming unit (cfu) per 100 mL or less than 1 cfu per 1 gram (wet weight) zooplankton samples;

- *Escherichia coli* - less than 250 cfu per 100 mL;
- Intestinal *Enterococci* - less than 100 cfu per 100 mL.

1.5. GSI Testing to G8 and G9 Requirements in IMO Convention

All current protocols, guidelines and requirements are open to interpretation especially in these early stages of implementation, and few if any facilities meet all requirements in the strictest sense. Accordingly, it is ultimately up to an Administration to decide if the testing conducted by GSI and the system meets their requirements for Type Approval Certification.

The fundamental approach of GSI is to conduct independent, scientifically-sound, rigorous, and quality assured evaluations of ballast water treatment systems. At the same time, GSI seeks immediate relevance of its freshwater land-based testing to regulatory processes such as those outlined in the IMO Convention and those under development domestically in the United States and Canada. To that end, GSI protocols are rooted in the essential features of the IMO G8 guidelines for testing, and the draft ETV protocols under development by the United States Coast Guard and United States Environmental Protection Agency. All aspects of the testing infrastructure (e.g. flow rate, retention tank size, sample size, sample collection and analysis equipment and data logging) are directly consistent with these requirements. It formally partners with the Maryland-based Maritime Environmental Resource Center (MERC) to assure that GSI freshwater land-based testing can be directly complemented by comparable brackish/salt water testing.

With respect to physical/chemical and biological characteristics of the intake stream, GSI is fortunate in that its feed water source naturally meets many of the IMO G8 requirements for intake organism densities and physical/chemical conditions during the testing season (Table 1). However, ambient conditions do fluctuate in all natural systems. Therefore, for these tests, GSI will augment intake water to better assure that initial challenge water conditions meet requirements in the IMO G8 guidelines throughout the trial series. During initial filling of control and test retention tanks, fine grade Arizona Test Dust, particulate organic matter, and concentrated algae harvested from the Duluth-Superior Harbor will be metered into the intake stream before the flow split to the control and treatment tracks. Details on these processes are provided below. Target intake levels of these parameters appear in Table 1.

Table 1. Ranges of Various Physical/Chemical and Biological Parameters in Ambient Water from Duluth-Superior Harbor (June – September) in Comparison to Draft U.S. EPA/ETV and IMO G8 Recommended Challenge Conditions.

Parameter	DRAFT U.S. EPA ETV[6]	Recommended IMO G8[7]	Historic Ranges Duluth/Superior Harbor	Target Values for Augmented Duluth-Superior Water
Temperature (^oC)	4 – 35	–	5 – 25	5 – 25
Salinity (psu)	< 1	Two salinities, >10 psu difference	0 – 1	0 - 1
Total Suspended Solids (TSS, mg/L)	Min. 24	> 50	2 – 21	50
Particulate Organic Carbon (POC, mg/L)	Min. 4	> 5	0.5 – 2.1	≥5
Dissolved Organic Carbon (DOC, mg/L)	Min. 6	> 5	3 – 30	3 - 30
Mineral Matter (MM, mg/L)	Min. 20	--	--	Min. 20
Zooplankton (> 50 μm/m^3)	Min. 75,000	> 100,000	100,000 - 3,000,000	100,000 – 3,000,000
Phytoplankton (10 - 50 μm/mL)	Min. 750	> 1,000	25 – 1,200	> 1,000
Heterotrophic Bacteria (CFU/mL)	Min. 750	> 10,000	> 1,000 MPN/mL	1,000 MPN/mL

6 U.S. Environmental Protection Agency, Environmental Technology Verification Program. DRAFT Generic Protocol for the Verification of Ballast Water Treatment Technologies. March, 2010.
7 IMO MEPC 57, Annex 3: Revised Guidelines for Approval of Ballast Water Management Systems (G8). April 4, 2008.

2.0. METHODS

The GSI land-based evaluation of the PureBallast® System will be carried out in keeping with the methods summarized in this Test Plan and detailed in GSI Standard Operating Procedures. Some refinements may be necessitated by circumstance or opportunity, but these will be carefully noted. The following sections describe how each parameter and variable will be sampled and analyzed during the trials at GSI. Additional details can be found at www.nemw.org/GSI/SOPS.htm. All SOPs relevant to the tests, as amended, also are presented Appendix 2. Any deviations from these SOPs during the performance of the tests will be minor and will not affect data quality.

2.1. Experimental Goals and Design

The PureBallast® System performance evaluation will involve physical and biological characterization of water upon ballasting (uptake/intake of water), and enumeration, sizing, and live/dead analysis of organisms in control and treated discharge water after a five-day in-tank holding time. GSI biological characterizations support direct comparison with the IMO D-2 organism categories and standards. During a series of five consecutive valid trials, the treatment system will be tested for its ability to: (a) successfully treat ballast water without interruption, (b) meet IMO D-2 discharge standards after a five-day holding time, and (c) discharge water after the five day retention period that is environmentally benign (i.e., no residual toxicity) pursuant to United States Environmental Protection Agency water quality criteria. A valid trial will be considered one in which intake challenge conditions and control discharge densities of live organisms meet the IMO G8 guidelines, and in which the facility operated properly.

2.1.1 Treatment System and Test Facility Calibration Trials

GSI will conduct two calibration test runs of the PureBallast® System. The calibration runs are undertaken to assure the facility and the treatment system are operating properly. During these calibration trials, adjustments to the system will be documented only for internal reference by the treatment developer. If there are no such adjustments, and the trials are valid, they will be subsumed into the set of five test trials.

2.1.2. Valid Trials

Once the two calibration trials are complete, if there are adjustments to either the treatment system or the facility, the PureBallast® System and the facility will be set for type approval testing by the treatment developer, and the GSI Facility Manager, respectively, and five valid trials of the PureBallast® System will immediately follow the calibration runs. If no such changes took place, no changes will be made to system or facility settings, and three valid trials of the PureBallast® System will immediately follow the calibration runs. Any further adjustments to either component of the testing (the treatment system or the facility) will be carefully noted and subject to QA/QC documentation.

GSI runs concurrent, but staggered, tests using two sets of matched 200 cubic meter tanks. Treatment and control intake operations for a given trial are always simultaneous, and treatment and control discharge operations are always sequential.

2.1.3. Preventing Cross-Contamination

The GSI facility lines are flushed with potable water using a self-propelled spiral-action water jet mechanism. The operation is undertaken between each facility intake or discharge operation. The thoroughness of the cleansing process is checked by partially filling catchment tubs with potable water and then draining that water through a plankton net and examining the filtrate for evidence of residual organisms. The facility is deemed clean only if the rinse water is completely free of organisms visible with a compound microscope. Nets and other sample collection equipment are likewise validated for cleanliness prior to each sampling operation.

2.1.4. Challenge Conditions

Ambient conditions will be employed as the physical/chemical challenge conditions, except that Fine Test Dust and artificial POM will be added to the facility intake to assure levels are in keeping with IMO G8 guidelines. The solids injection procedure is detailed in GSI/SOP/LB/G/O/5 – *Procedure for Injecting Organisms and Solids into the GSI Land-Based RDTE Facility*. Using TSS as an example, Fine Test Dust (ISO 12103-1, A2; nominal 0-80 μm particle size; Powder Technology Incorporated; Burnsville, MN) is pre-weighed at LSRI, and sterilized by baking in an oven at 190 °C for one hour. One day prior to the test trial, ambient TSS is measured in the Duluth-Superior Harbor. On the day of the test trial, the volume of harbor water to be used in the Solids Injection System (SIS) tank is determined in order to augment the intake water to 60 mg/L TSS, and the SIS tank is filled. The prepared Fine Test Dust is poured into the SIS tank slowly to prevent clumping, and the dust is mixed for a minimum of 20 minutes prior to the start of the trial. The test dust is injected into the intake water for the entire duration of the fill at a constant rate using a peristaltic pump located at Injection Point A (Figure 4).

Biological challenge conditions are largely ambient as well except that organism densities in the smaller of the two plankton size classes (i.e., 10 - 50 μm) are enhanced to assure consistency with IMO G8 required thresholds. The solids and phytoplankton injection systems are kept separate to reduce the risk of interference. The phytoplankton injection procedure is detailed in GSI/SOP/LB/G/O/5 – *Procedure for Injecting Organisms and Solids into the GSI Land-Based RDTE Facility*. One to two days prior to the test trial, phytoplankton entities from the Duluth-Superior Harbor are collected and concentrated using 20 - 50 μm plankton nets. The concentrated phytoplankton entities are stored at the GSI Land-Based RDTE Facility in holding ponds. Prior to injection, the water containing concentrated phytoplankton is mixed, sampled, and analyzed for viable cell density. In addition, a sample of Duluth-Superior Harbor water is collected to determine the ambient viable cell density. Based on the density of cells in the phytoplankton concentrate and ambient intake water, the volume of spiked concentrate that would be needed to achieve a concentration of 1500 cells/mL in intake water is calculated. This volume is added to an Organism Pressure Injection System (OPIS) vessel. The OPIS vessel is pressurized to 25 psi greater than the system pressure. The phytoplankton concentrate is added at a constant rate to the intake water via the pressure differential for the entire duration of the intake procedure via Injection Point B (Figure 4). A static mixer, installed in the main intake line just after the two metering systems (SIS and OPIS) and prior to the main system "Y split" (Figure 4), assures that the concentrations of these additives is equivalent in the control and treatment tracks of the facility. Gentle agitators installed in the tanks assure that that live organisms, especially spiked algal particles that may settle to the bottom of the tank during the retention period are accounted for to the greatest extent possible in the discharge water analysis (SOP to be developed prior to AlfaWall tests.

2.2. Water Quality Analysis

2.2.1. Analysis of Total Suspended Solids (TSS)

Samples for TSS analysis are collected during intake only as follows:

- Three 1 L whole water samples are collected from the pre-treatment line (SP #3, Figure 4) at approximately 10, 30, and 50 minutes after the start of the intake procedure, and
- Three 1 L whole water samples are collected from the post-treatment line at approximately 10, 30, and 50 minutes after the start of the intake procedure (SP #16, Figure 4).

Samples are collected in-line rather than from the sample collection tubs to avoid settling of suspended solids. This approach assured a more accurate measurement of solids and organic carbon in the intake water.

For analysis, the samples are vacuum filtered through pre-washed, dried, and pre-weighed Whatman 934-AH glass fiber filters. After the sample is filtered it is dried in an oven and brought to constant weight. TSS values are determined based on the weight of particulates on the filter and the volume of water filtered.

Quality control sample analysis consists of analyzing approximately ten percent of the samples in duplicate. A TSS reference standard (QCI, 711, ULTRA Scientific) is analyzed on multiple occasions along with TSS samples to confirm the accuracy of the data being generated.

2.2.2. Analysis of Non-Purgeable Organic Carbon (NPOC) and Dissolved Organic Carbon (DOC), and Determination of Particulate Organic Carbon (POC) Concentrations

In these tests, NPOC is measured as a surrogate for total organic carbon (TOC), though it may be a slight underestimate of TOC. The analytical instrument used to measure NPOC purges the sample with air to remove inorganic carbon before measuring organic carbon levels in the sample. Thus, the NPOC analysis does not incorporate any volatile organic carbon which may be present in the sample.

Aliquots of the same samples that are analyzed for TSS are also analyzed for NPOC and DOC. Before the TSS analysis is conducted, aliquots of approximately 50 mL of the sample are transferred to glass bottles and acidified with hydrochloric acid for NPOC analysis. An aliquot of the filtrate from the TSS analysis is transferred to a glass bottle and acidified for analysis of DOC. A Shimadzu Total Organic Carbon Analyzer (Model TOC-5050A) is employed for analysis of both NPOC and DOC. Concentrations of NPOC and DOC are determined based on a calibration curve developed on the instrument using organic carbon standards prepared from potassium hydrogen phthalate. Reported particulate organic carbon concentrations (POC) are determined as the difference between the NPOC and DOC values for a sample.

Quality control sample analysis consisted of analyzing approximately 10 % of the samples in duplicate. A reference standard (#516 Demand, Environmental Resource Associates) is analyzed daily to confirm the accuracy of the data being generated.

2.3. Viable Organism Analysis

Sample water for analysis of viable organisms is simultaneously collected from replicate sample ports into identical 3.8 m^3 collection tubs during each intake or discharge operation. Volumes retained varied with the operation (intake versus discharge) and treatment (control versus treatment), depending upon anticipated organism concentrations, but are always greater than IMO guideline volumes. The water in each collection tub constitutes an independent time integrated replicate sample of the 200 m^3 experimental water mass.

2.3.1. Organisms Greater than 50 µm in Minimum Dimension

2.3.1.1. Sample Collection

During the intake operation, i.e. the filling of the treatment and control 200 m^3 retention tanks, the following time-integrated sample volumes are collected by continuous flow from the intake lines simultaneously:

- 2 - 4 m^3 from the pre-treatment intake line,
- 2 - 4 m^3 from the control intake line, and
- 2 - 4 m^3 from the immediate post-treatment intake line.

During discharge:

- One 2 - 4 m^3 time-integrated sample is continuously collected from the control discharge, and
- Two to three replicate time-integrated samples of 2 - 4 m^3 each (total volume 4 to 9 m^3) are continuously collected from the treatment discharge.

Flow control valves and system logic assured that sample flow rates are equivalent and proportional to intake and discharge flow rates throughout each operation. Immediately after filling, the entire sample volumes are drained from the sample collection tubs and concentrated through 35 μm (50 μm diagonal dimension) plankton nets into 1 L cod-ends for microscopic examination. See *GSI/SOP/LB/RA/SC/6 - Procedure for Zooplankton Sample Collection*.

2.3.1.2. Live/Dead and Size Analysis

Live/dead analysis takes place within two hours of collecting and concentrating the individual samples. Microzooplankton (e.g., rotifers, copepod nauplii, veligers, etc.) and macrozooplankton (e.g., crustaceans), all generally greater than 50 μm in minimum dimension (with the exception noted below) are analyzed simultaneously by separate taxonomists. Microzooplankton subsamples are analyzed in a Sedgewick-Rafter counting chamber by examination under a compound microscope at a magnification of 40X to 100X. Macrozooplankton are analyzed in a Ward's Counting Wheel at a magnification of 20 to 30X using a dissecting microscope. Due to high densities, quantification of zooplankton in intake and control discharge samples requires analysis of sub-samples and extrapolation to the entire sample volume. For these samples, a subsample is removed for analysis using a Henson-Stempel pipette. The treatment discharge samples has lower densities allowing analysis of a greater sample volume. Treatment discharge samples are split in half using a Folsom Plankton Splitter. Half of the sample is analyzed for macrozooplankton and the other half is examined for microzooplankton. The proportion and total concentration of live versus dead organisms is determined using standard movement and response to stimuli techniques.

Quality assurance measures include live/dead analysis of at least 10 % of treatment discharge samples, and 10 % of control intake and discharge samples by two separate taxonomists. The average percent similarity of taxonomic identification and the average relative percent difference of the number of live organisms counted are calculated for all second analyses. These data quality measurements are compared against the data quality objectives outlined in the *GSI Quality Assurance Project Plan (QAPP) for Land-Based Tests* (GSI, 2010), and the percentage of data quality measurements meeting the data quality objectives is determined for microzooplankton and macrozooplankton separately.

Because freshwater zooplankton are in general smaller than their salt and brackish water counterparts, the larger regulated size category (greater than 50 μm in minimum dimension) does not incorporate all live zooplankton that may be present in a freshwater assemblage. This freshwater phenomenon raises special issues with respect to assessing zooplankton densities for the purpose of comparison with the IMO D-2 standard. If individuals of these smaller species occur in discharge samples during these tests, they will be counted, sized and reported, but the data will be kept distinct from tallies directly relevant to regulated size classes. See *GSI/SOP/LB/RA/SA/2 - Procedure for Zooplankton Sample Analysis*.

2.3.2. Organisms 10 – 50 µm in Minimum Dimension

2.3.2.1. Sample Collection

For live analysis of organisms 10 – 50 μm in minimum dimension, one sample of 1 L is collected immediately after filling from the pre-treatment sample collection tub and one sample of 1 L is collected from the immediate post-treatment sample collection tub. During discharge, one sample of 1 L is collected from the control tank via sample collection tub, and three samples of 1 L each are collected from the replicate treatment sample collection tubs. Analysis occurred on-site within 1.5 hours of sample collection, with samples stored in coolers during the interim. Prior to analysis, samples are concentrated through a 10 μm plankton net and stored in a 25 mL sample container. See *GSI/SOP/LB/RA/SC/3 - Procedure for Algae/Small Protozoa Sample Collection*.

2.3.2.2. Sample Analysis

For analysis, a 1.5 mL subsample of the concentrated sample is transferred to a 2 mL sample container, with 4 μL of Fluorescein Diacetate (FDA) stock solution added. The subsample is then allowed to incubate in the dark for 5 minutes. The 1.5 mL incubated algae sample is mixed and 1.1 mL is immediately transferred to a Sedgwick-Rafter cell, covered and placed on the stage of a microscope that is set for simultaneous observation using brightfield and epifluorescence. At least two horizontal transects are counted (an area known to reflect greater than 1 mL of original sample water). If time permits, additional transects are counted to increase statistical power. This results in greater than 100 live cells counted from the pre-treatment intake and control discharge samples, and often fewer than 10 live cells counted in two transects for post-treatment intake and treatment discharge samples. Single cell entities and cells comprising colonial and filamentous entities are characterized as follows: alive = cells showing obvious green fluorescence from cell contents; dead = cells showing no or very little evidence of green fluorescence from cell contents; and ambiguous = cells or entities that cannot be clearly identified as alive or dead (should be uncommon). Records are kept of transect lengths and widths so that the total counted area and volume analyzed can be calculated later.

Entities less than 10 μm in all visible dimensions or greater than 50 μm in minimum dimension are not counted. Counting and measurement of all other entities followed standard procedures for individuals (length and width), colonies (e.g., number of cells, cell length and width) and filaments (e.g., number of cells, cell length and width or total filament length if cells cannot be discerned). The remaining concentrated sample in the 25 mL bottle is archived using a preservative (formalin or Lugol's) for long-term storage.

Quality assurance measures include analysis of at least at least two treatment discharge samples and at least one control intake/discharge sample by two separate taxonomists using a dual-headed microscope (i.e., both taxonomists analyze the same sample at the same time). The average percent similarity of taxonomic identification and the average relative percent difference of the number of live organisms counted are calculated for all second analyses. These data quality measurements are compared against the data quality objectives outlined in the *GSI Quality Assurance Project Plan (QAPP) for Land-Based Tests* (GSI, 2010), and the percentage of data quality measurements meeting the data quality objectives is determined. See *GSI/SOP/LB/RA/SA/1 - Procedure for Algae/Small Protozoan Sample Analysis*.

2.3.3. Bacteria

Control and treatment samples are collected and analyzed for heterotrophic bacteria, two specific indicator pathogens: *E. coli* and enterococci, and viable toxigenic *Vibrio cholerae*.

2.3.3.1. Sample Collection

One liter whole water samples are collected as follows:

- On intake, three are collected immediately after filling from the pre-treatment sample collection tubs, and three are collected from the post-treatment sample collection tubs.
- On discharge, three are collected from a control sample collection tub and three are collected from a treatment sample collection tub.

All samples are collected according to *GSI/SOP/LB/RA/SC/4 – Procedure for Microbial Sample Collection*, and are immediately transported in an insulated cooler to the LSRI and analyzed as individual replicates.

2.3.3.2. Sample Analysis

Viable heterotrophic bacteria are enumerated according to *GSI/SOP/BS/RA/MA/1 – Procedure for Quantifying Heterotrophic Plate Counts (HPCs) using IDEXX's SimPlate® for HPC Method*. This method utilizes the IDEXX SimPlate® for HPC Method (IDEXX Laboratories, Inc.; Westbrook, Maine), which is based on IDEXX Laboratories' patented multiple enzyme technology.

The presence and abundance of *E. coli* (*GSI/SOP/BS/RA/MA/4 - Procedure for the Detection and Enumeration of Total Coliforms and E. coli Using IDEXX's Colilert*®) and enterococci (*GSI/SOP/BS/RA/MA/3 - Procedure for the Detection and Enumeration of Enterococcus using Enterolert*™) are determined using Colilert® and Enterolert™, respectively, which are both based on IDEXX's patented Defined Substrate Technology (DST®).

RNA and DNA colony blots are prepared at the LSRI following *GSI/SOP/LB/RA/MA/6 - Procedure for the Colony Blot Preparation for Enumeration of Culturable Vibrio chloreae*, a procedure in which the RNA or DNA of potential *Vibrio Cholerae*, and a limited number of additional species which may grow on the selective media, is fixed to a filter. Filters which exhibit colony growth are then shipped to the Maryland Pathogen Research Institute at the University of Maryland (College Park, MD) for analysis of potential viable toxigenic *V. cholerae*. Viable toxigenic *V. cholerae* is assayed with a commercial DFA kit specific for serogroup O1 (New Horizons Diagnostics) using monoclonal antibodies tagged with fluorescein isothiocyanate (FITC) (Hasan *et al*., 1994).

Quality control samples include a media blank and a positive control for *E. coli*/total coliforms and *Enterococcus spp*.; a media and peptone-saline diluent blank for heterotrophic bacteria; and a thiosulfate citrate bile salts sucrose (TCBS) agar blank, and DNA, and RNA blanks for *Vibrio spp.* Quality assurance measures include analysis of at least 10 % of the samples in duplicate. The average relative percent difference of all duplicates analyzed during the test trials is calculated separately for *E. coli*, *Enterococcus spp*., heterotrophic bacteria, and *Vibrio spp.* In addition, at least 10 % of the samples are counted by two separate analysts and the average relative percent difference for all second counts is determined. These data quality measurements are compared against the data quality objectives outlined in the *GSI Quality Assurance Project Plan (QAPP) for Land-Based Tests* (GSI, 2010), and the percentage of data quality measurements meeting the data quality objectives is determined.

2.4. Ambient Physical/Chemical Water Conditions Analysis

Temperature, salinity, dissolved oxygen, chlorophyll fluorescence, turbidity and pH are measured every 15 minutes during the test trials by two identical multi-parameter probes (calibrated according to manufactures specifications) placed, one each, into the control and test tanks. A calibrated, hand-held instrument is used to measure temperature, salinity, and dissolved oxygen from the control sample collection tub, the pre-treatment sample collection tub, and post-treatment sample collection tub during intake. In addition, temperature, salinity, and dissolved oxygen are measured during discharge from one control sample collection tub and two or three treatment sample collection tubs. See *GSI/SOP/LB/RA/SC/8 - Procedure for Collecting Physical/Chemical Data and Samples at the GSI Land-Based RDTE Facility*.

2.5. Whole Effluent Toxicity Analysis

GSI's whole effluent toxicity testing involves tests for chronic toxicity involving three freshwater species as arrayed in Table 3. Toxicity tests are conducted on treated water from all five test trials.

Table 3. Standard Operating Procedures Relative to Whole Effluent Toxicity Testing.

GSI SOP Code	Test Type	Test Species	Test Endpoint
GSI/SOP/BS/RA/WET/1	Chronic	Cladoceran (*Ceriodaphnia dubia)*	Survival and Reproduction
GSI/SOP/BS/RA/WET/2	Chronic	Fathead Minnow (*Pimephales promelas)*	Survival and Growth
GSI/SOP/BS/RA/WET/3	Chronic	Green Alga (*Selenastrum capricornutum)*	Growth

2.5.1. Standard Whole Effluent Toxicity Tests

One set of tests—Standard Whole Effluent Toxicity Tests (Standard WET)—measures toxicity following five days storage in the land-based facility's 200 m^3 retention tanks. For these tests, samples are collected for analysis of residual toxicity at discharge. Sample water, stored in large HDPE containers, is immediately transported to the LSRI and is used immediately upon arrival to set up the Standard WET tests. Following initial set up of the tests, the remaining sample water is held at 4 °C in the dark to retain as much of the initial toxicity as possible, and portions of the discharge sample water is warmed to 25 °C each day to serve as renewal water for the bioassay. A dilution series, using Duluth-Superior Harbor water, is run for each species. All tests are conducted in temperature-controlled incubators, water baths, or at ambient room temperature following the SOPs listed in Table 3.

2.5.2. Cold Whole Effluent Toxicity Tests

A second set of trials—Cold Whole Effluent Toxicity (Cold WET) tests—is conducted to estimate the TRC, TRO and toxicity effects on organisms under cold water conditions. Treated water is collected continuously from a sample port just downstream of the treatment system (SP #15) and diverted into a sample collection tub during the filling of the treatment retention tank. A 50 L whole water subsample is extracted and placed in a dark, refrigerator set at 4 ^{o}C for five days, thus simulating cold temperature tank retention. A portion of the sample water is warmed to 25 °C prior to initial set up of the Cold WET assay, and is warmed prior to daily renewal as described above for the Standard WET assay. There is no dilution series for the Cold WET assay; test organisms (*Selenastrum capricornutum, Ceriodaphnia dubia, and Pimephales promelas*) are exposed to 100 % sample water. The Cold WET assay is conducted concurrently with the Standard WET assay following the SOPs listed in Table 3.

2.5.3. Statistical Analysis for WET Assay

Data are analyzed using the Comprehensive Environmental Toxicity Information Systems program (version 1.7, Tidepool Scientific Software, McKinleyville, CA). Data analyses includes normality, homogeneity of variance, one-way analysis of variance (ANOVA), and a suite of tests for comparison between treatment means. Non-normal survival data are transformed using the natural log (EPA, 2002) to normalize the data. The endpoints of the chronic toxicity tests are:

- Lowest Observed Effect Concentration (LOEC), i.e., the lowest concentration in a test with a statistically significant difference in response from the control response.
- No Observed Effect Concentration (NOEC), i.e., the highest concentration in a test for which there is no statistically significant difference in response from that of the control.
- Median Lethal Concentration (LC_{50}), i.e., the concentration resulting in death of 50 % of exposed individuals by a predetermined time.
- Effective Concentration (EC_{25}), i.e., the concentration resulting in inhibiting a biological function (e.g. growth, reproduction) of 25 % of exposed individuals by a predetermined time.

These measures are extrapolations of statistical results to the experimental endpoints. Mean percent survival, mean dry weight values, mean cell density, and mean number of young per female for the laboratory controls and treatments are analyzed with a statistical significance level of 0.05.

2.5.5. Determination of Quality of Test Organisms for WET Assay

Whole Effluent Toxicity tests are initiated with healthy, vigorous organisms. To determine the overall health of the test organisms, reference toxicant tests are performed with *Ceriodaphnia dubia* and *Pimephales promelas* prior to the start of each definitive test or at least once per month. To determine the validity of the Standard and Cold WET tests, percent survival, dry weights of survivors, mean cell density, and mean number of young per female in the controls are compared to the test acceptability criteria published in the U.S. EPA's Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (4th edition, 2002). Class I standardized weights are used as a check for the organism drying process and the performance of the balance. Daily and weekly calibration of test meters ensures optimal performance.

2.6. Data Recording

Biological and chemical data is recorded by hand (using indelible ink) on pre-printed data collection forms and/or in bound laboratory notebooks that are uniquely-identified and are specific to the treatment technology being tested. The types of biological and chemical data collected include: sample collection data (e.g., date, time, and location of collected samples), water quality and chemistry analysis data (e.g., TSS, TOC, and active substance concentration), microbial analysis data (e.g., sample preparation, incubation, and direct counts), phytoplankton analysis data (e.g., number of live and number of dead entities), zooplankton analysis data (e.g., sample concentration; number of dead, total, and live organisms), and whole effluent toxicity test data (e.g., test set up, direct counts, and test take down).

The data that are recorded on pre-printed data collection forms are secured in uniquely-identified three ring binders, specific to the type of data and to the treatment technology. Biological and chemical data that are recorded by hand are entered into either a MS Access Database that was designed, developed, and is maintained by the GSI Database Manager, or the data are entered into a MS Excel Spreadsheet. The electronic data files are stored on the LSRI's secured Local Area Network (LAN) that can be accessed only by relevant GSI personnel. The GSI Database Manager is the single point of control for access to the LSRI LAN. The LSRI LAN is automatically backed up every 24 hours. The electronic data files are also stored on the GSI's internal SharePoint website, which acts as a secondary data backup/storage mechanism. All original raw data from verification testing of each treatment technology are stored in a climate-controlled, secure archive room at the LSRI for five years after the final report is finalized.

In-tank water quality data (e.g., temperature, pH, dissolved oxygen, salinity, turbidity, and chlorophyll-a) is measured every fifteen minutes during each retention period and automatically recorded in a Microsoft (MS) Excel spreadsheet. Facility data (e.g., flow rates and pressure measurements) are electronically recorded every five seconds during intake and discharge. This data is exported to MS Excel for subsequent analysis, and stored by AMI Engineers on a secure network, as well as on GSI SharePoint for addition storage and archiving.

A percentage of data that is recorded by hand and entered into MS Access or Excel is verified against the original raw data, this also includes verification of formulas/calculations (i.e., hand-calculation of data) done using MS Access or Excel. The percentage of verified raw data depends on the amount of raw data that was generated, and ranges from 10 % to 100 % of the original raw data. Data validation is detailed in Section 7 of the *GSI Quality Assurance Project Plan (QAPP) for Land-Based Tests* (GSI, 2010). This section also details the acceptable values, where appropriate, for the following quality objectives: accuracy, precision, completeness, comparability, representativeness, and sensitivity.

3.0. QUALITY MANAGEMENT

3.1. Documents and Records

GSI uses a wide variety of quality management documents and records to implement its quality system. These include quality system documentation (i.e., the GSI Quality Management Plan), project-specific documentation (i.e., Quality Assurance Project Plans), and routine procedures documentation (i.e., Standard Operating Procedures).

3.1.1. Quality Management Plan (QMP)

The GSI QMP details the structure of the GSI's quality system from an organizational perspective. It covers all aspects of GSI's commitment to quality including policies and procedures; criteria for and areas of application; roles, responsibilities, and authorities; and assessment and response. It is the framework for planning, implementing, documenting, and assessing the GSI's quality assurance and quality control (QAQC) activities.

The GSI Senior Quality Systems Officer is responsible for preparing the QMP, with the document based on the U.S. EPA's "*EPA Requirements for Quality Management Plans*" to the greatest extent possible. The QMP is distributed to the GSI PI for review in draft form. Once a draft is finalized, the document is approved and forwarded to GSI senior research personnel and QAQC officers. Draft and final copies of the document are posted to the GSI SharePoint intranet website. The GSI's QMP is valid for a maximum period of five years, with an annual review and revision (as needed) occurring at the end of each calendar year. Copies of this document are available on request.

3.1.2. Quality Assurance Project Plans (QAPP)

The GSI's Land-Based Quality Assurance Project Plan (GSI, 2010) describes the activities undertaken by GSI to assure the quality and credibility of its research at the land-based facility. The QAPP covers all aspects of quality assurance/quality control (QAQC), including data quality indicators, evaluation processes, performance measures and acceptance criteria; instrument certification and calibration; personnel training requirements; documents and records; data management; and QAQC assessments and response actions.

The GSI Senior Quality Systems Officer, in conjunction with the GSI Senior QAQC Officer, is responsible for developing the QAPP. The plans follow the format of the U.S. Environmental Protection Agency's (EPA's) "*EPA Guidance for Quality Assurance Plans*" to the greatest extent possible. Draft QAPPs are distributed to relevant GSI senior research personnel for review and comment. Once a draft is finalized, the documents are then passed on to the GSI PI for review and approval. Draft and final copies of QAPPs are posted to the GSI SharePoint intranet website; the final versions may also be posted to the GSI public website. Once approved, the QAPP is valid for a period of five years, though they are reviewed annually and revised as needed. Copies of this document are available on request.

3.1.3. Standard Operating Procedures (SOPs)

SOPs are used to implement all GSI test activities. This facilitates consistent conformance to technical and quality system requirements and increases data quality. The SOPs include both programmatic and technical processes and procedures such as organism culturing; operation of the GSI Land-Based RDTE facility; sample collection, labeling, analysis and custody; and safety. Appendix 1 provides a list of GSI SOPs relevant to land-based test activities.

GSI SOPs are developed by the relevant GSI senior research personnel in conjunction with the GSI Senior Quality Systems Officer and GSI Senior QAQC Officer. The GSI Senior Quality Systems Officer is responsible for distributing finalized SOPs to the GSI PI for approval. Draft and final copies of all SOPs are posted to the GSI SharePoint website; the final versions are also posted to the GSI public website (www.greatshipsinitiative.org). All GSI SOPs are updated on an as-needed basis.

To date approximately 50 SOPs have been finalized, with many more in draft form or planned. The SOPs follow a common format and include specific QAQC procedures and metrics. GSI SOPs are grounded in published standard methods. They are also consistent with international and domestic guidelines where they exist. All GSI SOPs are subject to periodic review and revision to assure that the most up to date approaches are employed.

3.1.4. Notebooks, Forms and Records

Bound field and laboratory notebooks, each having a unique identification code, are used to record observations, sampling details, and laboratory and field measurements. Notebooks are also used to record instrument and equipment calibration and maintenance information. GSI personnel are responsible for maintaining the notebooks on site, creating electronic copies, and posting to the GSI SharePoint website for storage and archiving.

Specific forms are used to record sample collection and analysis data. All relevant GSI senior research personnel are responsible for ensuring that the forms are correctly filled out. They are also responsible for maintaining the forms on file, creating electronic copies, and posting to the GSI SharePoint website for storage and archiving. In general, hard copies of all forms are stored in three-ring binders, each with a unique identification code.

Specific forms are also used to record sample custody, handling and storage information. Chain of custody forms are employed only when an outside laboratory is contracted to conduct sample analyses. All relevant GSI senior research personnel are responsible for ensuring that the forms are correctly filled out at the time of changes to sample custody, and sample handling and storage. They are also responsible for maintaining the forms on file, creating electronic copies, and posting to the GSI SharePoint website for storage.

In addition, specific forms are used to record operation, maintenance and safety information. The GSI Land-Based RDTE Facility Operations Manager is responsible for ensuring that all forms associated with safety (i.e., confined space entry permit forms, daily safety checklist) and operation and maintenance of the land-based test facility are correctly filled out. It is the responsibility of the GSI Land-Based RDTE Facility Operations Manager to ensure that equipment maintenance and instrument calibration is properly documented, and that forms are maintained on file, and also posted to the GSI SharePoint website for storage.

3.2. Assessment

GSI assesses its quality system on a project by project (or test by test) basis using a variety of tools. The purpose, procedural details, and implementation frequency of each of these assessment tools are outlined below.

3.2.1. Project-Specific QAPP Audits

GSI QAQC Officers assess the implementation of project-specific QAPPs (i.e., the GSI Land-Based QAPP) during each test of a ballast treatment system. At the end of the test duration, the officers provide a report to the GSI Senior Quality Systems Officer and GSI PI. The report includes a Table listing deviations to the specific QAPP associated with the testing. The following Table headings are to be used:

- QAPP Section
- QAPP Page No.
- Description
- Deviation/Inconsistency
- Date
- GSI Personnel
- Reconciliation/Corrective Act

The report also includes an assessment of personnel training requirements and certification, as well as procedures for storing and archiving documents and records; sample labeling, handling and custody requirements; and instrument and equipment maintenance. GSI QAQC Officers post final copies of the QAPP audit reports to the GSI SharePoint website for archiving and storage.

3.2.2. Project-Specific SOP Audits

GSI QAQC Officers assess the implementation of project-specific SOPs during each test of a ballast treatment system. At the end of the test duration, the officers provide a report to the GSI Senior Quality Systems Officer and GSI PI. The report includes a Table listing deviations to the specific SOPs that were used during the testing. The following Table headings are to be used:

- SOP Code
- SOP Title
- Description
- Deviation/Inconsistency
- Date
- GSI Personnel

- Reconciliation/Corrective Act

GSI QAQC Officers post final copies of the SOP audit reports to the GSI SharePoint website for archiving and storage.

3.2.3. Project-Specific Data Recording and Archiving Audits

Following completion of test activities associated with a specific ballast treatment test, GSI QAQC Officers verify data recording and archiving procedures by randomly evaluating data recording forms and field notebooks for completion, compliance and correct storage procedures. This includes the GSI Land-Based RDTE Facility Daily Safety Check List, zooplankton enumeration datasheets, phytoplankton enumeration datasheets, sampling station logs, chain of custody forms, etc. GSI QAQC Officers also undertake regular random data verification checks by comparing electronic records (i.e., in database or Excel format) with raw datasheets (i.e., paper forms). This is a manual inspection process and though rather time consuming, is an essential procedure for discovering errors. Findings are summarized in a report provided to the GSI Senior Quality Systems Officer and GSI PI. Final reports are saved to GSI SharePoint for storage and archiving.

3.2.4. Project-Specific Data Quality Assessments

Following completion and verification of a data set associated with a specific ballast treatment test, GSI QAQC Officers determine if the data quality objectives outlined in the relevant GSI QAPP have been successfully met. Findings are summarized in a series of Tables detailing the data quality indicators by type of analysis, e.g., zooplankton, phytoplankton, microbes, etc. Reports are provided to the GSI Senior Quality Systems Officer and GSI PI; final copies are stored on GSI SharePoint.

3.2.5. Project-Specific Performance Criteria Assessments

Following completion and verification of a data set associated with a specific ballast treatment test, GSI QAQC Officers also determine if the performance criteria outlined in the relevant GSI QAPP have been successfully met. Findings are summarized in a Table detailing the performance criteria and test results. The Table is provided in a report to the GSI Senior Quality Systems Officer and GSI PI. Final copies of the report are saved to GSI SharePoint for storage and archiving.

3.3. Response

GSI quality management personnel convene to discuss quality system audits and assessment outcomes following completion of a specific ballast treatment test. Personnel use the results of audits and assessments to develop recommendations and directives for actions to correct work or data that do not conform to GSI quality standards. They then compile a report listing the recommendations and directives. This report is provided to the GSI PI, relevant GSI senior research team personnel and to those individuals involved in the follow-up to ensure visibility and timeliness. Reports are also posted to the GSI SharePoint website for storage and archiving.

APPENDIX 1. GSI SOPs Relevant to Land-Based Testing.

Note: SOPs are subject to revision and available for download from:
http://www.nemw.org/GSI/protocols.htm

Document Type	Document Code	Title	Scale	Category	Subcategory
SOP	GSI/SOP/G/A/RK/1	Procedure for Record Keeping	General	Administration	Record Keeping
SOP	GSI/SOP/G/RA/DM/1	Procedure for Data Entry, Data Quality Control and Database Management	General	Research Activities	Data Management
SOP	GSI/SOP/G/RA/SC/1	Procedure for Custody of GSI Samples	General	Research Activities	Sample Custody
SOP	GSI/SOP/G/RA/SC/3	Procedure for Labeling Samples Collected at the GSI Land-Based RDTE Facility	General	Research Activities	Sample Custody
SOP	GSI/SOP/BS/RA/WET/1	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to *Ceriodaphia dubia*	Bench-Scale	Research Activities	Residual Toxicity
SOP	GSI/SOP/BS/RA/WET/2	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to the Fathead Minnow (*Pimephales promelas*)	Bench-Scale	Research Activities	Residual Toxicity
SOP	GSI/SOP/BS/RA/WET/3	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to the Green Alga (*Selenastrum capricornutum*)	Bench-Scale	Research Activities	Residual Toxicity
SOP	GSI/SOP/BS/RA/MA/1	Procedure For Quantifying Heterotrophic Plate Counts (HPCs) Using IDEXX's SimPlate® for HPC Method	Bench-Scale and Land-Based	Research Activities	Microbial Analysis
SOP	GSI/SOP/BS/RA/MA/2	Procedure for Assessing Antimicrobial Activity Using Time-Kill Method	Bench-Scale	Research Activities	Microbial Analysis
SOP	GSI/SOP/BS/RA/MA/3	Procedure for the Detection and Enumeration of Enterococcus using Enterolert™	Bench-Scale and Land-Based	Research Activities	Microbial Analysis
SOP	GSI/SOP/BS/RA/MA/4	Procedure for the Detection and Enumeration of Total Coliforms and E. coli Using IDEXX's Colilert®	Bench-Scale and Land-Based	Research Activities	Microbial Analysis
SOP	GSI/SOP/BS/RA/MA/5	Procedure for the Detection and Enumeration of Male-Specific (F+) Coliphage Using Double Agar Layer Technique (DAL)	Bench-Scale	Research Activities	Microbial Analysis
SOP	GSI/SOP/BS/RA/MA/6	Procedure For Colony Blot Preparation for the Enumeration of Culturable Vibrio cholerae and Presence of ctxA Gene	Bench-Scale	Research Activities	Microbial Analysis
SOP	GSI/SOP/BS/RA/MP/1	General Microbiology Preparation Procedures	Bench-Scale	Research Activities	Microbial Analysis
SOP	GSI/SOP/BS/RA/C/1	Procedure for Analyzing the Concentration of Ozone in Water	Bench-Scale and Land-Based	Research Activities	Chemistry

SOP	GSI/SOP/BS/RA/C/2	Procedure for Determining Total Residual Oxidants (TRO) in Water	Bench-Scale and Land-Based	Research Activities	Chemistry
SOP	GSI/SOP/BS/RA/C/3	Procedures for Measuring Organic Carbon in Aqueous Samples	Bench-Scale and Land-Based	Research Activities	Chemistry
SOP	GSI/SOP/BS/RA/C/4	Procedure for Determining Percent Transmittance (%T) of Light in Water at 254 nm	Bench-Scale and Land-Based	Research Activities	Chemistry
SOP	GSI/SOP/BS/RA/C/5	Procedure for Measuring Organic Compounds using High Performance Liquid Chromatography (HPLC)	Bench-Scale and Land-Based	Research Activities	Chemistry
SOP	GSI/SOP/BS/RA/C/6	Procedure for Analyzing Total Residual Chlorine Concentrations in Water	Bench-Scale and Land-Based	Research Activities	Chemistry
SOP	GSI/SOP/BS/RA/C/7	Procedure for Analyzing Hydrogen Peroxide Concentrations in Water	Bench-Scale and Land-Based	Research Activities	Chemistry
SOP	GSI/SOP/BS/RA/C/8	Procedure for Analyzing Total Suspended Solids (TSS)	Bench-Scale and Land-Based	Research Activities	Chemistry
SOP	GSI/SOP/BS/RA/C/9	Procedure for pH Meter Calibration and pH Measurement for Ballast Treatment Systems Utilizing pH as the Active Substance	Bench-Scale and Land-Based	Research Activities	Chemistry
SOP	GSI/SOP/BS/RA/L/1	Procedure for Conducting a Scientific Search of Peer-Reviewed Literature, Including Use of Quantitative Structure Activity Relationships (QSAR)	Bench-Scale	Research Activities	Literature
SOP	GSI/SOP/LB/G/O/1	Procedure for Operating the GSI Land-Based RDTE Facility	Land-Based	General	Operation
SOP	GSI/SOP/LB/G/O/2	Procedure for Sampling and Testing Water Prior to Waste Water Treatment Facility Reception	Land-Based	General	Operation
SOP	GSI/SOP/LB/G/O/3	Procedure for Cleaning the Retention Tanks and Other Equipment at the GSI Land-Based RDTE Facility	Land-Based	General	Operation
SOP	GSI/SOP/LB/G/O/5	Procedure for Injecting Organisms and Solids into the GSI Land-Based RDTE Facility	Land-Based	General	Operation
SOP	GSI/SOP/LB/G/S/1	Procedure for Ensuring Worker Health and Safety at the GSI Land-Based RDTE Facility	Land-Based	General	Safety
SOP	GSI/SOP/LB/RA/SC/1	Procedure for Collecting Biological Sample Water Via In-Line Sample Ports	Land-Based	Research Activities	Sample Collection
SOP	GSI/SOP/LB/RA/SC/2	Procedure for Collecting Biological Samples From Within The Retention Tanks Using A Submersible Pump	Land-Based	Research Activities	Sample Collection

SOP	GSI/SOP/LB/RA/SC/3	Procedure for Algae/Small Protozoa Sample Collection	Land-Based	Research Activities	Sample Collection
SOP	GSI/SOP/LB/RA/SC/4	Procedure for Microbial Sample Collection	Land-Based	Research Activities	Sample Collection
SOP	GSI/SOP/LB/RA/SC/5	Procedure for MS-2 Bacteriophage Sample Collection	Land-Based	Research Activities	Sample Collection
SOP	GSI/SOP/LB/RA/SC/6	Procedure for Zooplankton Sample Collection	Land-Based	Research Activities	Sample Collection
SOP	GSI/SOP/LB/RA/SC/7	Procedure for Preparing Lugol's Solution	Land-Based	Research Activities	Sample Collection
SOP	GSI/SOP/LB/RA/SC/8	Procedure for Collecting Physical/Chemical Data and Samples at the GSI Land-Based RDTE Facility	Land-Based	Research Activities	Sample Collection
SOP	GSI/SOP/LB/RA/SA/1	Procedure for Algae/Small Protozoan Sample Analysis	Land-Based	Research Activities	Sample Analysis
SOP	GSI/SOP/LB/RA/SA/2	Procedure for Zooplankton Sample Analysis	Land-Based	Research Activities	Sample Analysis

Exhibit B
List of Additional Insured

Northeast-Midwest Institute
50 F St. NW
Washington, DC 20001

Lake Superior Research Institute
University of Wisconsin-Superior
P.O. Box 2000
Superior, WI 54880

AMI Consulting Engineers PA
1 East 1st Street, Suite 403
Duluth, MN 55802

Benson Electric Company
1102 North 3rd Street
Superior, WI 54880

Rockwell Automation
4411 Venture Avenue
Duluth MN 55811

JR Jensen Construction Co
814 21st Avenue East
Superior, WI 54880

J C Custom Welding
489 Amos Way Northwest
Bemidji, MN 56601

APPENDIX 2 - Performance Evaluation Summary for Type-Approved and Modified PureBallast® BWTS, and Research and Development Testing of the PureBallast® BWTS.

Prior to performance evaluation of the PureBallast®, v.3 BWTS, GSI conducted commissioning trials on the type-approved PureBallast® BWTS and a modified version of the PureBallast® BWTS, PureBallast® v.2 (testing period was 26 August 2010 to 03 September 2010). In addition, GSI conducted research and development testing (R&D testing) on the filter component of the PureBallast® BWTS. This R&D testing was initiated during the performance evaluation period on 26 August 2010 and 31 August 2010, while the majority of the R&D testing took place from 08 September 2010 to 23 September 2010. One successful commissioning trial was completed on the PureBallast BWTS v.2; the methods, results, and discussion from this test are presented below.

METHODS, RESULTS, AND DISCUSSION

The commissioning trials were conducted according to GSI's SOPs, which can be found at www.greatshipsinitiative.info. All SOPs relevant to the PureBallast® performance evaluation and R&D tests (type-approved PureBallast®, PureBallast® v.2, and PureBallast® v.3), as amended, also are listed by analysis category in Appendix 3.

Experimental Objectives

The objectives of this commissioning trial of the PureBallast®, v.2 BWTS were to characterize the physical, chemical, and biological aspects of the challenge water on intake, as well as, to analyze and quantify live organisms from the regulated size classes (i.e., < 10 μm, ≥ 10 and < 50 μm, and ≥ 50 μm) in the control and treatment discharge water after a specified retention time.

Operational Parameters and Challenge Conditions

Operational parameters, i.e., flow rate, pressure, retention tank volume, and volume sampled were measured continuously every five seconds during intake using in situ sensors and are summarized in Table 16 below. In total, four commissioning trials were attempted and one trial was successfully completed (trial ID code 10-A2-2). The completed commissioning trial was initiated with augmented TSS (to achieve 55 mg/L TSS on intake) and phytoplankton, but ambient POC was used as the challenge conditions. The filter clogged approximately five minutes after the start of injection. As a result, the PureBallast® BWTS was stopped, the filter was refreshed, and the trial was continued with only the phytoplankton injection (there was no solids injection after restart). The sample collection and analysis methods that were used during the completed commissioning trial (10-A2-2) are as previously described for the PureBallast®, v.3 BWTS except that the retention time for this trial was five days and whole effluent toxicity of the treatment discharge was not assessed.

Table 19. Operational log of attempted PureBallast® BWTS (type-approved and modified version) performance evaluation trials and research and development testing. One successful performance evaluation trial (10-A2-2) was completed out of four trials attempted in the test cycle. All trials without an identification code were conducted as part of the research and development testing.

Trial ID	Operation Dates	Filter	Backwash Cycle Duration	Flow Duration (min)	Flow Rate (m^3/hr)	Pressure (bar)	Target TSS (mg/L)	Target POC (mg/L)	Target PP (cells/mL)	Engineering Comments
10-A2-1	26 AUG 10 - Trial Aborted	40 μm	Continuous	25	250	2.2	55	5	1500	After injection started, there was approximately 3 min. of operation before the filter clogged. Backwashing was ineffective.
NA[1]	26 AUG 10	50 μm	Continuous	12	250	2.2	55	Ambient	Ambient	Increased filter mesh size, and reduced POC and PP concentration had little impact. Filter clogged and backwashing was not effective.
10-A2-2	27 AUG 10 – 01 SEP 10	40 μm	100 sec	60	250	2.2	55	Ambient	1500	Filter clogged and backwashing was not effective. TSS injection was stopped, the filter refreshed, and the trial continued.
NA[1]	31 AUG 10	40 μm	Not Recorded	15	250-200	2.2-3.5	25	Ambient	Ambient	Filter was tested at different speeds and different injection amounts. Lower flow rate, increased pressure, and reduced loadings appear to help.
10-A2-3	02 SEP 10 – Trial Aborted	40 μm	Continuous	60	200	3.2	25	5	1500	Lower TSS, higher pressure, and lower flow could not overcome problems associated with PP injection. Two filter candles blew 35 minutes into trial. Pressure differential across treatment dropped from 2.6 bar to 0.9 bar.
10-A2-4	03 SEP 10 – Trial Aborted	50 μm wedge wire	Not Recorded	25	200	3.2	25	5	1500	Lower TSS, higher pressure, and lower flow rate could not overcome problems associated with PP injection. Trial aborted due to filter clogging 3 min. into trial. Filter backwashing had little effect and differential pressure increased rapidly once injection started.
NA[1]	08 SEP 10	15 pcs 50 μm + 5 plugged	Not Recorded	75	200-160	3.2-3.8	Ambient	Ambient	Ambient	Filter operated over 75 min. using ambient harbor water, lower flow rate, and higher pressure. Over time, flow rate dropped and the pressure increased. Backwashes were not effective and pressure differential grew.
NA[1]	08 SEP 10	40 μm	Not Recorded	86	160-110	3.5-3.8	Ambient	Ambient	Ambient	Ambient harbor water, lower flow rate, and higher pressure led to longer duration of operation. Outlet valve on filter is partially closed manually during a backwash, which is effective at reducing the pressure differential over the treatment system.

Trial ID	Operation Dates	Filter	Backwash Cycle Duration	Flow Duration (min)	Flow Rate (m^3/hr)	Pressure (bar)	Target TSS (mg/L)	Target POC (mg/L)	Target PP (cells/mL)	Engineering Comments
NA[1]	21 SEP 10	40 *µ*m	Not Recorded	49	250	3.2-3.6	Ambient	Ambient	Ambient	At 250 m^3/hr, higher pressure, and ambient harbor water[2] the filter performance degraded over time. Backwashes are effective when the effluent valve partially closed manually during backwash.
NA[1]	22 SEP 10	40 *µ*m	40 min	160	250- 230	3.3-3.5	Ambient	Ambient	Ambient	System performed without issue in ambient harbor water[2]. Four successful backwashes at 40 minute intervals.
NA[1]	23 SEP 10	40 *µ*m	40 sec	50	250	3.2-3.5	25	Ambient	Ambient	With 1/2 IMO required TSS in otherwise ambient harbor water[2], system performed without issue. Filter backwashes at 40 sec. cycles.
NA[1]	23 SEP 10	40 *µ*m	40 sec	33	250	3.2-3.5	25	Ambient	Ambient	With 1/2 IMO required TSS in otherwise ambient harbor water[2], system performed without issue. Filter backwashes at 40 sec. cycles.

[1] Not Applicable: This trial was a research and development trial and was not conducted for the purposes of collecting water chemistry/quality or biological data. Therefore, this trial did not receive an identification code.
[2] Well below IMO guidelines for TSS, POC, and phytoplankton density in challenge water

The completed commissioning trial (10-A2-2) was not conducted according to IMO guidelines for challenge water; in addition, the solids injection was terminated after the filter became clogged. The TSS on intake was ambient Duluth-Superior Harbor water averaging 3.2 mg/L (Table 20). The overwhelming majority of the 16.5 mg/L NPOC consisted of DOC (16.4 mg/L), and POC was 0.2 mg/L (Table 20). The water quality parameters measured from the sample collection tubs immediately after phytoplankton and microbial sample collection on intake are similar between all three sample tubs measured (Table 21). The biological challenge conditions are described in Table 22 for all three regulated size classes. There were 239,321 live organisms/m^3 in the ≥ 50 μm size class on intake, which met the target density of >100,000/m^3. The live organism density increased during the five-day retention time to 293,975/m^3 in the control discharge, indicating favorable holding conditions in the control retention tank. In the ≥10 and < 50 m size class, there were 827 live cells/mL on intake, less than the target density of 1500 cells/mL but close to the IMO guidelines for challenge conditions. The live organism density in the control discharge decreased over the five-day retention time to 349 live cells/mL, but met the goal of >100 cells/mL.

The treatment tank water quality was measured automatically every 15 minutes during the five-day retention period. The average temperature and salinity was similar in the control and treatment tank during retention (Table 23). The average specific conductivity was lower in the treatment tank (0.172 mS/cm) than in the control tank (0.201 mS/cm), while the pH was slightly higher in the treatment tank (7.58) as compared to the control tank at an average of 7.48. The average turbidity in the treatment tank, 4.5 NTU, was slightly lower than the control tank (5.7); this result is likely due to the PureBallast® filter and the removal of a portion of the ambient solids from the treatment track on intake. The average total chlorophyll in the treatment tank, 9.5 μg/L, was lower as compared to the control tank at 11.3 μg/L. The biological data supports this reduction, as a reduction in live organisms from the ≥ 10 and < 50 μm size class (consisting mainly of phytoplankton) was seen in the treatment discharge as compared to the control discharge. The reduction of plankton also likely explains the increase in dissolved oxygen in the treatment tank (87.6% and 7.77 mg/L) as compared to the control tank (77.2% and 6.87 mg/L). A similar comparison between treatment discharge and control discharge can be seen in the water quality in the sample collection tubs, which was measured on discharge immediately after the whole-water samples were taken (Table 21).

Table 20. Average (*n*=3, ±std. dev.) total suspended solids (TSS), non-purgeable organic carbon (NPOC), dissolved organic carbon (DOC), particulate organic carbon (POC), and mineral matter (MM) measured during intake. The trial was initiated with TSS augmented to achieve 55 mg/L on intake; however, the solids injection was terminated after the filter became clogged.

Parameter	Target Concentration	10-A2-2
TSS (mg/L)	Ambient	3.2 ± 0.2
NPOC (mg/L)	Ambient	16.5 ± 0.3
DOC (mg/L)	Ambient	16.4 ± 0.3
POC (mg/L)	Ambient	0.2 ± 0.2
MM (mg/L)	Ambient	3.0 ± 0.2

Table 21. Water quality measurements taken from the sample collection tubs immediately after phytoplankton and microbial whole-water samples were collected during intake and discharge. The treatment discharge values are the average (±std. dev.) of the three treatment discharge sample collection tubs.

Parameter	Operation	Sample Type	Value
Temperature (°C)	Intake	Control	**20.06**
		Pre-Treatment	**19.50**
		Post-Treatment	**19.11**
	Discharge	Control	**23.47**
		Treatment	**21.52 ± 0.60**
Specific Conductivity (mS/cm)	Intake	Control	**0.171**
		Pre-Treatment	**0.171**
		Post-Treatment	**0.171**
	Discharge	Control	**0.192**
		Treatment	**0.175 ± 0.003**
Salinity (ppt)	Intake	Control	**0.08**
		Pre-Treatment	**0.08**
		Post-Treatment	**0.08**
	Discharge	Control	**0.09**
		Treatment	**0.08 ± 0.00**
pH	Intake	Control	**7.73**
		Pre-Treatment	**7.79**
		Post-Treatment	**7.72**
	Discharge	Control	**7.57**
		Treatment	**7.41 ± 0.06**
Turbidity (NTU)	Intake	Control	**Not Measured**
		Pre-Treatment	**Not Measured**

		Post-Treatment	**Not Measured**
	Discharge	Control	**10.2**
		Treatment	**6.3 ± 2.7**
Chlorophyll (μg/L)	Intake	Control	**Not Measured**
		Pre-Treatment	**Not Measured**
		Post-Treatment	**Not Measured**
	Discharge	Control	**11.5**
		Treatment	**8.2 ± 0.1**
Dissolved Oxygen (% Saturation)	Intake	Control	**93.4**
		Pre-Treatment	**93.1**
		Post-Treatment	**92.3**
	Discharge	Control	**85.5**
		Treatment	**87.1 ± 1.2**
Dissolved Oxygen (mg/L)	Intake	Control	**8.49**
		Pre-Treatment	**8.55**
		Post-Treatment	**8.55**
	Discharge	Control	**7.27**
		Treatment	**7.68 ± 0.19**

Table 22. Biological challenge conditions on intake and live organism densities in the control discharge in the three regulated size classes. Values reported for the <10 μm size class are the average (±SEM) of triplicate samples collected from the pre-treatment tub on intake and the control tub on discharge.

<table>
<tr><th colspan="2">Live Organism Size Class</th><th>Target Density</th><th>Sample</th><th>10-A2-2</th></tr>
<tr><td colspan="2" rowspan="2">≥ 50 μm (#/m³)</td><td>>100,000 (Ambient)</td><td>Intake</td><td>239,321</td></tr>
<tr><td>>100</td><td>Control Discharge</td><td>293,975</td></tr>
<tr><td colspan="2" rowspan="2">≥ 10 and < 50 μm (#cells/mL)</td><td>>1500 (Augmented)</td><td>Intake</td><td>826.79</td></tr>
<tr><td>>100</td><td>Control Discharge</td><td>349.35</td></tr>
<tr><td rowspan="8">< 10 μm</td><td>E. coli (MPN/100 mL)</td><td rowspan="4">Ambient</td><td rowspan="4">Intake</td><td>657±97</td></tr>
<tr><td>Total Coliforms (MPN/100 mL)</td><td>1458±255</td></tr>
<tr><td>Enterococcus spp. (MPN/100 mL)</td><td>>1254</td></tr>
<tr><td>Total Heterotrophic (MPN/mL)</td><td>3400±551</td></tr>
<tr><td>E. coli (MPN/100 mL)</td><td rowspan="4">Ambient</td><td rowspan="4">Control Discharge</td><td>25 ± 4</td></tr>
<tr><td>Total Coliforms (MPN/100 mL)</td><td>115 ± 10</td></tr>
<tr><td>Enterococcus spp. (MPN/100 mL)</td><td>30 ± 7</td></tr>
<tr><td>Total Heterotrophic (MPN/mL)</td><td>1700 ± 115</td></tr>
</table>

Table 23. Average (±std. dev.) water quality measured from the control and retention tanks during the five-day holding time. Measurements were taken automatically every 15 minutes.

Parameter	Retention Tank	10-A2-2
Temperature (°C)	Control	21.07 ± 1.05
	Treatment	21.24 ± 1.06
Specific Conductivity (mS/cm)	Control	0.201 ± 0.001
	Treatment	0.172 ± 0.001
Salinity (ppt)	Control	0.1 ± 0.0
	Treatment	0.1 ± 0.0
pH	Control	7.48 ± 0.02
	Treatment	7.58 ± 0.02
Turbidity (NTU)	Control	5.7 ± 0.7
	Treatment	4.5 ± 0.6
Chlorophyll (μg/L)	Control	11.3 ± 1.2
	Treatment	9.5 ± 0.6
Dissolved Oxygen (% Saturation)	Control	77.2 ± 1.0
	Treatment	87.6 ± 1.0
Dissolved Oxygen (mg/L)	Control	6.87 ± 0.22
	Treatment	7.77 ± 0.24

Viable Organisms in Treated Discharge

The live organism densities in the three regulated size classes can be seen in Table 24. The ≥ 50 μm size class had 7580 live organisms/m^3 in the treatment discharge as compared to 293,975/m^3 in the control discharge. Although the target density (i.e., IMO guideline) of < 10/m^3 was not met, the treatment discharge density represents a reduction from the pre-treatment intake density of over 96 %. The treatment discharge had 62 live cells/mL from the ≥ 10 and <50 μm size class, as compared to the control discharge density of 349 cells/mL. The treatment discharge density for this size class also did not meet the target density of < 10 cells/mL; however, the density was reduced by 93 % from the pre-treatment density on intake.

Table 24. Live organism densities on intake, immediately post-treatment, and in the treatment discharge in the three regulated size classes. Values reported for the < 10 μm size class are the average (±SEM) of triplicate samples collected from the post-treatment tub on intake and the three treatment discharge tubs.

Live Organism Size Category		Target Density	Sample	10-A2-2
≥ 50 μm (#/m^3)		Ambient	Intake Post-Treatment	**44,974**
		<10	Treatment Discharge	**7,580**
≥ 10 and < 50 μm (#cells/mL)		Ambient	Intake Post-Treatment	**477**
		<10	Treatment Discharge	**62**
< 10 μm	***E. coli*** **(MPN/100 mL)**	Ambient	Intake Post-Treatment	**11 ± 3**
	Total Coliforms (MPN/100 mL)			**28 ± 5**
	Enterococcus spp. **(MPN/100 mL)**			**9 ± 1**
	Total Heterotrophic (MPN/mL)			**>738**
	E. coli **(MPN/100 mL)**	<250	Treatment Discharge	**<1**
	Total Coliforms (MPN/100 mL)	Ambient		**<1**
	Enterococcus spp. **(MPN/100 mL)**	<100		**36 ± 2**
	Total Heterotrophic (MPN/mL)	Ambient		**549±44**

APPENDIX 3 - List of GSI SOPs Relevant to the Commissioning of PureBallast® v.1 and v.2 and Performance Evaluation of PureBallast® v.3.

SOP CODE	SOP TITLE	CATEGORY	SUBCATEGORY
GSI/SOP/G/A/RK/1	Procedure for Record Keeping	Administration	Record Keeping
GSI/SOP/G/RA/DM/1	Procedure for Data Entry, Data Quality Control and Database Management	Research Activities	Data Management
GSI/SOP/G/RA/SC/2	Procedure for Labeling Samples Collected at the GSI Land-Based RDTE Facility	Research Activities	Sample Custody
GSI/SOP/BS/RA/GL/1	Procedure for Verification of Laboratory Balances	Research Activities	General Laboratory
GSI/SOP/BS/RA/WET/1	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to *Ceriodaphia dubia*	Research Activities	Residual Toxicity
GSI/SOP/BS/RA/WET/2	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to the Fathead Minnow (*Pimephales promelas*)	Research Activities	Residual Toxicity
GSI/SOP/BS/RA/WET/3	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to the Green Alga (*Selenastrum capricornutum*)	Research Activities	Residual Toxicity
GSI/SOP/BS/RA/MA/1	Procedure For Quantifying Heterotrophic Plate Counts (HPCs) Using IDEXX's SimPlate® for HPC Method	Research Activities	Microbial Analysis
GSI/SOP/BS/RA/MA/3	Procedure for the Detection and Enumeration of Enterococcus using Enterolert™	Research Activities	Microbial Analysis
GSI/SOP/BS/RA/MA/4	Procedure for the Detection and Enumeration of Total Coliforms and *E. coli* Using IDEXX's Colilert®	Research Activities	Microbial Analysis
GSI/SOP/BS/RA/MP/1	General Microbiology Preparation Procedures	Research Activities	Microbial Procedures
GSI/SOP/BS/RA/C/3	Procedures for Measuring Organic Carbon in Aqueous Samples	Research Activities	Chemistry
GSI/SOP/BS/RA/C/4	Procedure for Determining Percent Transmittance (%T) of Light in Water at 254 nm	Research Activities	Chemistry
GSI/SOP/BS/RA/C/6	Procedure for Analyzing Total Residual Chlorine Concentrations in Water	Research Activities	Chemistry
GSI/SOP/BS/RA/C/8	Procedure for Analyzing Total Suspended Solids (TSS)	Research Activities	Chemistry
GSI/SOP/BS/RA/C/9	Procedure for pH Meter Calibration and pH Measurement for Ballast Treatment Systems Utilizing pH as the Active Substance	Research Activities	Chemistry

GSI/SOP/LB/G/O/1	Procedure for Operating the GSI Land-Based RDTE Facility	General	Operation
GSI/SOP/LB/G/O/2	Procedure for Sampling and Analyzing Treated Water in the GSI Land-Based RDTE Facility's Retention Tanks Prior to Discharge	General	Operation
GSI/SOP/LB/G/O/3	Procedure for Cleaning and Verifying Cleanliness of the Retention Tanks and Piping at the GSI Land-Based RDTE Facility	General	Operation
GSI/SOP/LB/G/O/4	Procedure for Cleaning Sampling Equipment at the GSI Land-Based RDTE Facility	General	Operation
GSI/SOP/LB/G/O/5	Procedure for Injecting Organisms and Solids into the GSI Land-Based RDTE Facility	General	Operation
GSI/SOP/LB/G/O/7	Procedure for Maintaining Solids Suspension in the GSI Land-Based RDTE Facility's Retention Tanks	General	Operation
GSI/SOP/LB/G/C/4	Procedure for Calibration, Deployment, and Storage of YSI Multiparameter Water Quality Sondes	General	Calibration
GSI/SOP/LB/G/S/1	Procedure for Ensuring Worker Health and Safety at the GSI Land-Based RDTE Facility	General	Safety
GSI/SOP/LB/RA/SC/1	Procedure for Collecting Biological Sample Water via In-Line Sample Ports	Research Activities	Sample Collection
GSI/SOP/LB/RA/SC/3	Procedure for Algae/Small Protozoa Sample Collection	Research Activities	Sample Collection
GSI/SOP/LB/RA/SC/4	Procedure for Microbial Sample Collection	Research Activities	Sample Collection
GSI/SOP/LB/RA/SC/6	Procedure for Zooplankton Sample Collection	Research Activities	Sample Collection
GSI/SOP/LB/RA/SC/8	Procedure for Collecting Physical/Chemical Data and Samples at the GSI Land-Based RDTE Facility	Research Activities	Sample Collection
GSI/SOP/LB/RA/SA/1	Procedure for Algae/Small Protozoan Sample Analysis	Research Activities	Sample Analysis
GSI/SOP/LB/RA/SA/2	Procedure for Zooplankton Sample Analysis	Research Activities	Sample Analysis

APPENDIX 4 - Average Density (per m³) of Live Zooplankton in Treatment Discharge during the Trials of the PureBallast®, v.3 Ballast Water Treatment System. Organisms are Grouped by Taxa in the ≥ 50 μm Size Class, Additional Live Organisms < 50 μm, and Excluded Live Organisms.

Test Trials:	Trial A	Trial B	Trial C
Total Vol. Analyzed for MacroZooplankton, m^3:	**2.19**	**2.03**	**2.11**
Total Vol. Analyzed for MicroZooplankton, m^3:	**0.17**	**0.09**	**0.20**
Live Organisms ≥ 50 μm in minimum dimension			
Taxa Group	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**
Calanoid and Cyclopoid Copepods	1.5	1.5	1.5
Bosmina	2.5	2.0	1.5
Chydoridae	1.0		0.5
Chironomid	0.5		
Other MacroZP (Not Specified)		1.0	
Copepod Nauplii	5.5	17.5	
Rotifera	433.5	1785.0	511
Other MicroZP (Not Specified)		66.0	10.5
> 50 μm Total:	**444.5**	**1873.0**	**525.0**
Additional Live Organisms < 50 μm in minimum dimension			
Taxa Group	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**
Chironomid	1.5	0.0	0.0
Trichocerca Rotifer	5.5	0.0	5.0
< 50 μmTotal:	**7.0**	**0.0**	**5.0**
Live Organisms that were Excluded – All Sizes			
Taxa Group	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**
Nematode	3.5	2.5	1.5
Bdelloid	42.5	34.5	25.0
Monostyla/Lecane	79.0	226.5	42.0
Excluded Total:	**125.0**	**263.5**	**68.5**
Additional Organisms from ≥ 10 and < 50 μm – Not Quantified			
Taxa Group	**Observations/ Comments**	**Observations/ Comments**	**Observations/ Comments**
Protozoa (i.e., Vorticella, Codonella, and Other)	Present	Present	Present
Phytoplankton (i.e., Gonium and Other)	Not Observed	Present	Not Observed
Bacteria	Not Observed	Present	Not Observed

APPENDIX 5 - Average Density (MPN per volume) of Organisms in the < 10 μm Size Class Intake (Pre- and Post-Treatment) and Discharge (Control and Treatment) during the Trials of the PureBallast®, v.3 Ballast Water Treatment System.

TRIAL	Sample Location	Sample Tub	Rep.	Total Coliform Density	*E. coli* Density	*Enterococcus spp*. Density
				MPN/100 mL	MPN/100 mL	MPN/100 mL
A	Pre-Treatment	4	1	313.0	44.3	35.5
	Pre-Treatment	4	2	275.5	30.1	46.5
	Pre-Treatment	4	3	275.5	39.9	35.5
	Post-Treatment	6	1 DUP	8.6	< 1.0	1.0
	Post-Treatment	6	1	8.6	4.1	1.0
	Post-Treatment	6	2	5.2	< 1.0	1.0
	Post-Treatment	6	3	11.0	2.0	< 1.0
	Control Discharge	1	1	214.3	27.5	5.2
	Control Discharge	1	2	139.6	24.6	17.3
	Control Discharge	1	3	160.7	19.9	18.7
	Control Discharge	1	3 DUP	193.5	22.8	19.7
	Treatment Discharge	4	1	< 1.0	< 1.0	1.0
	Treatment Discharge	4	1 DUP	< 1.0	< 1.0	1.0
	Treatment Discharge	5	1	< 1.0	< 1.0	1.0
	Treatment Discharge	6	1	< 1.0	< 1.0	1.0
B	Pre-Treatment	4	1	365.4	65.7	51.2
	Pre-Treatment	4	2	235.9	66.3	56.1
	Pre-Treatment	4	2 DUP	387.3	63.1	34.1
	Pre-Treatment	4	3	238.2	64.4	54.6
	Post-Treatment	6	1	3.1	< 1.0	1.0
	Post-Treatment	6	2	5.2	1.0	1.0
	Post-Treatment	6	3	5.1	1.0	< 1.0
	Control Discharge	1	1	275.5	39.9	19.9
	Control Discharge	1	2	172.3	32.3	26.5
	Control Discharge	1	3	172.2	27.9	23.3
	Treatment Discharge	4	1 DUP	< 1.0	< 1.0	1.0
	Treatment Discharge	4	1	< 1.0	< 1.0	< 1.0
	Treatment Discharge	5	1	< 1.0	< 1.0	1.0
	Treatment Discharge	6	1	< 1.0	< 1.0	< 1.0
C	Pre-Treatment	4	1	209.8	111.2	53.8
	Pre-Treatment	4	2	290.9	146.7	37.3
	Pre-Treatment	4	3	235.9	90.9	22.6
	Post-Treatment	6	1	3.1	2.0	< 1.0
	Post-Treatment	6	2	2.0	2.0	< 1.0

TRIAL	Sample Location	Sample Tub	Rep.	Total Coliform Density MPN/100 mL	*E. coli* Density MPN/100 mL	*Enterococcus spp*. Density MPN/100 mL
	Post-Treatment	6	3	1.0	< 1.0	< 1.0
	Post-Treatment	6	3 DUP	5.2	3.1	< 1.0
	Control Discharge	1	1	178.9	55.6	16.9
	Control Discharge	1	2 DUP	150.0	51.2	26.2
	Control Discharge	1	2	133.3	53.8	19.9
	Control Discharge	1	3	137.4	47.1	39.7
	Treatment Discharge	4	1	< 1.0	< 1.0	1.0
	Treatment Discharge	5	1	< 1.0	< 1.0	< 1.0
	Treatment Discharge	6	1	< 1.0	< 1.0	1.0

TRIAL	Sample Location	Sample Tub	Rep.	Total Heterotrophic Bacteria Density MPN/mL
A	Pre-Treatment	4	1	8000
	Pre-Treatment	4	2	600
	Pre-Treatment	4	3	200
	Post-Treatment	6	1	200
	Post-Treatment	6	2	3000
	Post-Treatment	6	3	3500
	Control Discharge	1	1	< 200
	Control Discharge	1	2	200
	Control Discharge	1	3	< 200
	Control Discharge	1	3 DUP	200
	Treatment Discharge	4	1	299
	Treatment Discharge	5	1	231
	Treatment Discharge	6	1	209
B	Pre-Treatment	4	1	< 200
	Pre-Treatment	4	2	200
	Pre-Treatment	4	2 DUP	< 200
	Pre-Treatment	4	3	600
	Post-Treatment	6	1	166
	Post-Treatment	6	2	137
	Post-Treatment	6	3	209
	Control Discharge	1	1	400
	Control Discharge	1	2	800
	Control Discharge	1	3	200
	Treatment Discharge	4	1	200
	Treatment Discharge	4	1 DUP	400
	Treatment Discharge	5	1	200
	Treatment Discharge	6	1	< 200
C	Pre-Treatment	4	1	< 200

TRIAL	Sample Location	Sample Tub	Rep.		Total Heterotrophic Bacteria Density MPN/mL
	Pre-Treatment	4	2		200
	Pre-Treatment	4	3	<	200
	Post-Treatment	6	1		40
	Post-Treatment	6	2		68
	Post-Treatment	6	3		53
	Post-Treatment	6	3 DUP		56
	Control Discharge	1	1		124
	Control Discharge	1	2		137
	Control Discharge	1	3		86
	Treatment Discharge	4	1		248
	Treatment Discharge	5	1		239
	Treatment Discharge	6	1		209

Great Ships Initiative

A Ballast Discharge Monitoring System for Great Lakes Relevant Ships:

A Guidebook for Researchers, Ship Owners, and Agency Officials

NOVEMBER 18, 2011

PREPARED BY:

Allegra Cangelosi, Northeast-Midwest Institute
Tyler Schwerdt, AMI Consulting Engineers
Travis Mangan, Northeast-Midwest Institute
Nicole Mays, Northeast-Midwest Institute
Kelsey Prihoda, Lake Superior Research Institute

ACKNOWLEDGEMENTS

The GSI team wishes to thank the Legislative Commission on Minnesota Resources, the United States Department of Transportation Maritime Administration and the Great Lakes Protection Fund for financial support for the work leading to the development of this Guidebook. We are indebted to the technical teams at the Navy Research Laboratory and Work Groups of the International Maritime Organization Maritime Environment Protection Committee for initial guidelines for effective sampling from ships. Most of all, the GSI project benefited from the participation and assistance of the ship owners and their capable Officers and Crew Members involved in the GSI effort to develop and test these methods. Specifically, we thank the owners, operators, officers and crew of the Niagara, Saguenay, M/V Tim S. Dool, M/V Indiana Harbor, Edwin H. Gott, Str. Herbert C. Jackson, M/V James R. Barker, M/V Hon. James L. Oberstar, Federal Hunter and Isolda.

GSI Team Members:

PRINCIPAL INVESTIGATOR:

Allegra Cangelosi, NEMWI

RESEARCH TEAM:

Lisa Allinger, NRRI, UMD
Mary Balcer, PhD, LSRI, UWS
Lana Fanberg, LSRI, UWS
Debra Fobbe, LSRI, UWS
Steve Hagedorn, LSRI, UWS
Travis Mangan, NEMWI
Nicole Mays, NEMWI
Christine Polkinghorne, LSRI, UWS
Kelsey Prihoda, LSRI, UWS
Euan Reavie, PhD, NRRI, UMD
Deanna Regan, LSRI, UWS
Donald Reid, Consultant
Elaine Ruzycki, NRRI, UMD
Heidi Saillard, LSRI, UWS
Heidi Schaefer, LSRI, UWS
Tyler Schwerdt, AMI Engineering
Tyler Snetting, AMI Engineering
Matthew TenEyck, LSRI, UWS

CONTENTS

Chapter 1: Introduction

Guidebook Purpose

The purpose of this Guidebook is to share with regulatory authorities, ship owners and researchers basic guidelines developed by the Great Ships Initiative (GSI) for collecting and analyzing representative samples of living organisms in ballast discharge from Great Lakes-relevant ships. Specifically, this Guidebook details methods for retrieving quantitative samples from ships to determine live organism densities in three size classes of organisms (equal to or greater than 50 micrometers in minimum dimension, less than 50 micrometers and equal to or greater than 10 micrometers in minimum dimension, and less than 10 micrometers in minimum dimension), water quality parameters, and whole effluent toxicity tests. Methods associated with sample analysis are not currently part of this Guidebook, but GSI Standard Operating Procedures for analysis are the same as for land-based tests of ballast water treatment systems (BWTSs), and can be downloaded from GSI's website (www.greatshipsinitiative.org). It is important to note that the methods described here are preliminary and subject to revision over time. GSI will periodically update this Guidebook and repost new versions on its website over time.

GSI designed these ship discharge monitoring methods for *planned* ship discharge monitoring exercises (these methods would not be suitable to surprise spot checks). As such, the methods in this Guidebook are highly applicable to a wide range of quantitative ballast treatment performance research and validation, including type approval testing and planned treatment performance monitoring events post approval. Any application of these methods to regulatory purposes, however, would require close review and revisions of method specifics per specific regulatory guidelines.

Chapter 1 presents an overview of the GSI ship discharge sampling approach. Chapter 2 describes details of the sample and return port installations necessary for this sampling approach to be used on Great Lakes-relevant ships. Chapter 3 details the set-up and break-down processes for implementing this approach for a sampling event. Chapter 4 provides a discussion of the feasibility of the methods, including their strengths and weaknesses based on GSI trials in the field.

Background on the Great Ships Initiative (GSI)

GSI is a collaborative project led by the Northeast-Midwest Institute (NEMWI) devoted to ending the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System and globally. NEMWI is a Washington, D.C-based non-profit and non-partisan research organization dedicated to the economic vitality, environmental quality, and regional equity of Northeast and Midwest states. In support of that goal, NEMWI has established through GSI a superlative freshwater ballast treatment evaluation capabilities at three scales—bench, land-based, and on board ship. GSI research is carried out collaboratively with contracting entities including the University of Wisconsin-Superior (UW-S), AMI Consulting Engineers, Broadreach Services, and the University of Minnesota-Duluth (UM-D).

GSI testing takes place at the scale appropriate to the treatment's state of development. The goal is to help meritorious BWTSs progress as rapidly as possible to an approval-ready and market-ready condition through supplying rigorous status testing or certification testing of biological efficacy. To assure relevancy of test output, GSI test protocols, generally, are as consistent with the International Maritime Organization (IMO) Convention for the Control and Management of Ships' Ballast Water and Sediments Convention (IMO, 2004) and federal and state requirements as practicable. For example, United States Environmental Protection Agency (USEPA), Environmental Technology Verification (ETV) Program testing is performed consistent with ETV protocols (e.g., NSF International, 2010).

A GSI Advisory Committee comprises top-level officials of key stakeholder groups and provides direct input on GSI award decisions, program direction, finances and fund-raising. The GSI Advisory Committee, which meets three times a year, includes elected leadership, environmental organizations, port directors and federal officials from the United States and Canada, and industry representatives.

GSI's Quality Management Plan (GSI, 2011) outlines the activities that GSI uses to ensure that personnel have the necessary education, qualifications, and experience needed to effectively carry out their specific roles and responsibilities within the project.

Background on GSI Ship Discharge Monitoring Project

GSI received funding from the Legislative Citizen's Commission on Minnesota Resources (LCCMR), the Maritime Administration and the Great Lakes Protection Fund to design, install and test a ship-based ballast discharge sampling approach on the range of commercial cargo ships which ply the Great Lakes. The primary goal of this GSI project was to inform ship owners, researchers and regulators of effective and efficient methods for carrying out ballast discharge monitoring on Great Lakes ships. A secondary goal was to initiate the installation of effective sampling ports on Great Lakes-relevant ships for BWTS testing and monitoring.

GSI developed a proposed sampling approach, which included permanent sample port flange installation guidelines consistent with those of the IMO (IMO, 2004) and the USEPA ETV Program (NSF International, 2010); portable sampling system equipment and methods for shipboard use; and portable sample analysis equipment and methods for port-side use.

GSI personnel visited a range of ships to identify best locations for sample port flanges given a set of the project criteria (see Chapter 2). Sample locations that had potential to meet most or all of these criteria were identified and photographed during the ship visit, and later modeled using computational fluid dynamics (CFD) to determine which location would deliver the most representative sample.

GSI in consultation with the ship owner then selected the best location based on the inspection information, and the ships were then outfitted with sample flanges. GSI then visited the ships to trial and review the GSI sampling approach in real-world applications. This Guidebook provides the method and lessons learned from this project activity. The sample ports will stay in place for possible future use in research and compliance monitoring. Data gathered on living organisms in ballast discharge sampled through this project will be provided to the State of Minnesota and published on GSI's website.

SAMPLING APPROACH OVERVIEW

It is important to note that hardware and personnel alone will not deliver useful sampling exercises. The sampling team must also have a robust and valid test plan and standard operating procedures to accompany any ship sampling exercise. The test plan will describe the objectives of the test, the hypotheses, the experimental design, the analytical methods, and quality control and quality assurance plan for the work. The standard operating procedures will detail specific methods. The GSI website (www.greatshipsinitiative.org) includes test reports on ship-based ballast treatment research providing examples of these documents.

GSI designed the sampling approach described here to be applicable to a range of test plans. It employs simultaneous, in-line and continuous collection of large and small quantities of sample water from subject ballast water discharge to estimate live organism densities and types in and water quality characteristics of that discharge. The method is adaptable to a wide range of sampling intensities and ships with diverse ballast line diameters, and ballast system types.

Details of the sampling approach are provided in subsequent chapters. Fundamentally, the process involves:

- Prior installation of two permanent 4 inch diameter blind flanges in a strategically selected segment of the ship's ballast line (detailed below), and insertion of a temporary sampling pitot in one such flange;
- Space and services on the ship to support sample collection (detailed below);
- A port-based set-up, sampling and ballast team of four people, and nearby analytical space and equipment (detailed below); and
- A time window affording 45 minutes to one hour for sampling system set-up and 45 minutes to one hour for its break-down in addition to the selected sampling period duration.

Figure 1 illustrates the GSI sampling system lay out. In summary, the installation of the blind flanges—a relatively minor permanent change to the ship costing less than $5,000--is completed according to strict location guidelines well before sampling is to occur. At the time of, or just prior to, the sampling event, an elbow shaped sampling pitot is installed in the upstream flange to deliver flow to the sampling system. For zooplankton sampling (i.e., organisms equal to or greater than 50 micrometers in minimum dimension), sample flow from the discharge line is pumped from the sampling pitot at a known flow rate through a plastic line equipped with a flow meter into a 35 micron plankton net that is suspended in a 50 gallon tub with a level transmitter and a bottom discharge flange. The fraction of the ballast line flow pumped through the sample port should remain constant throughout the sampling process. This ratio is monitored using an in-line magnetic flux flow meter on the sample line, and a portable ultrasonic flow meter mounted to the ships ballast piping. A second pump draws spent sample water from the 50 gallon tub through plastic line to the return flange in the ballast line for discharge overboard with other ballast water. The water level in the tub is maintained at near full as the net filters the plankton into a bottom cod-end. A small side stream of the sample water flow (pre-plankton net) is directed into a carboy for whole water samples which can be used to assess water quality, protists (i.e., organisms less than 50 micrometers and equal to or greater than 10 micrometers in minimum dimension), bacteria (i.e., organisms less than 10 micrometers in minimum dimension), and effluent toxicity. Grab samples can be extracted from the line (i.e., hose) feeding into the nets, or through a dedicated side port off the main sample line which can be opened and closed. Sample analysis can take place on-ship, but is easiest to arrange off-ship.

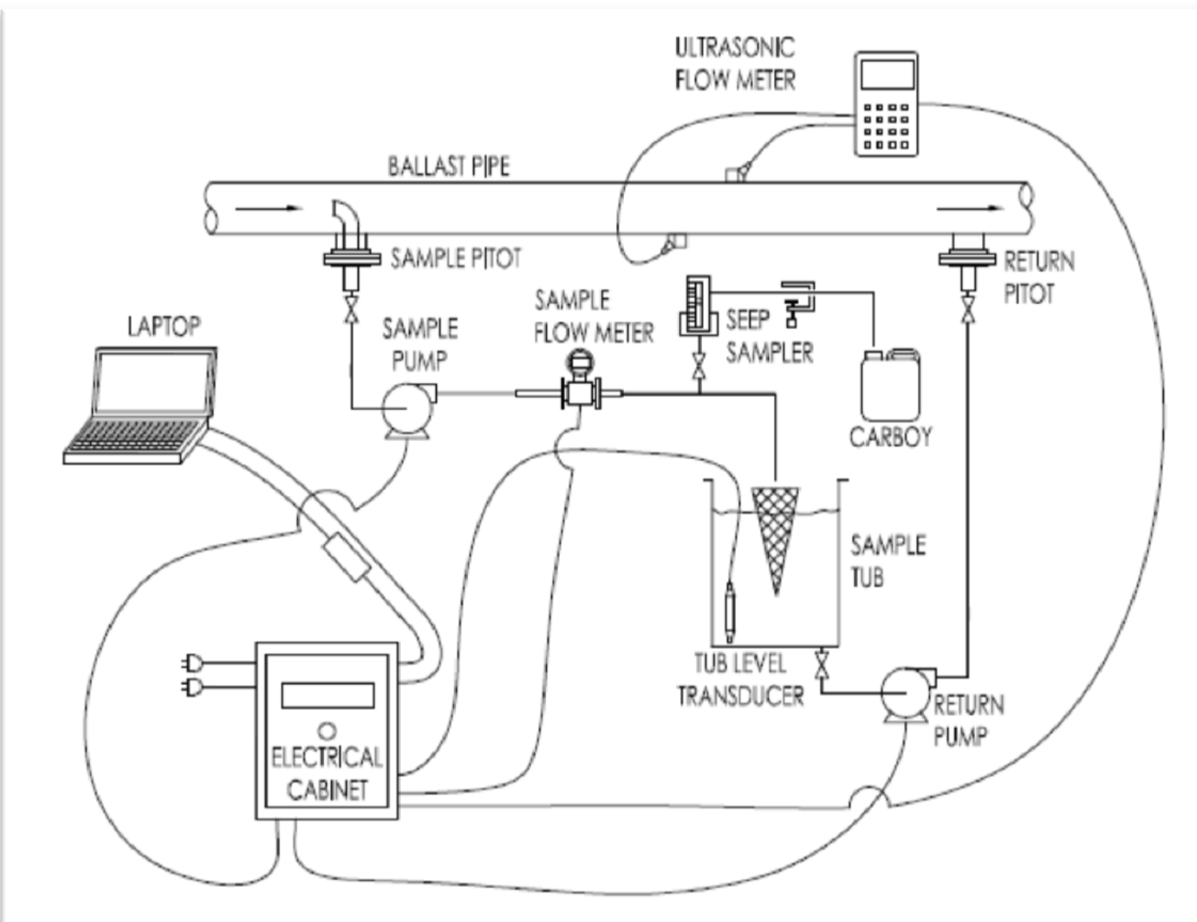


Figure 1. Schematic of the GSI Ship Discharge Sampling System and Component Parts.

CHAPTER 2: SAMPLE PORT/RETURN PORTS

GSI sample ports and return ports are installed as 4 “ 150 # ANSI flanges with blinds. GSI employs stainless steel bent elbow style pitots (Figure 2) installed so that the opening faces into the flow at the center of the pipe. GSI first determines the target sample volume per unit ballast discharge based on experimental design criteria. Then it assures the internal diameter of the pitot opening is large enough to assure that sample water pumped through the pitot will provide that volume, but at a subisokinetic flow velocity that ranges between 44%-25% of the discharge flow velocity of the ship. An isokinetic flow rate occurs within a pitot when the sample water flow velocity is the same as discharge line flow velocity. A subisokinetic velocity means there is a slower flow velocity in the pitot than in the line being sampled. Consistent with recommendations by the United States Coast Guard to maintain a pitot inlet of 1.5-2.0 times the isokinetic diameter(USCG, 2008), GSI assumes that subisokinetic flow helps prevent organism damage by edge interactions with pitot inlet and walls. Assuming most ballast systems are designed for a flow rate of around 10 feet/second, the pitot sizes required to collect a range of volume of sample water per hour is shown in Table 1.

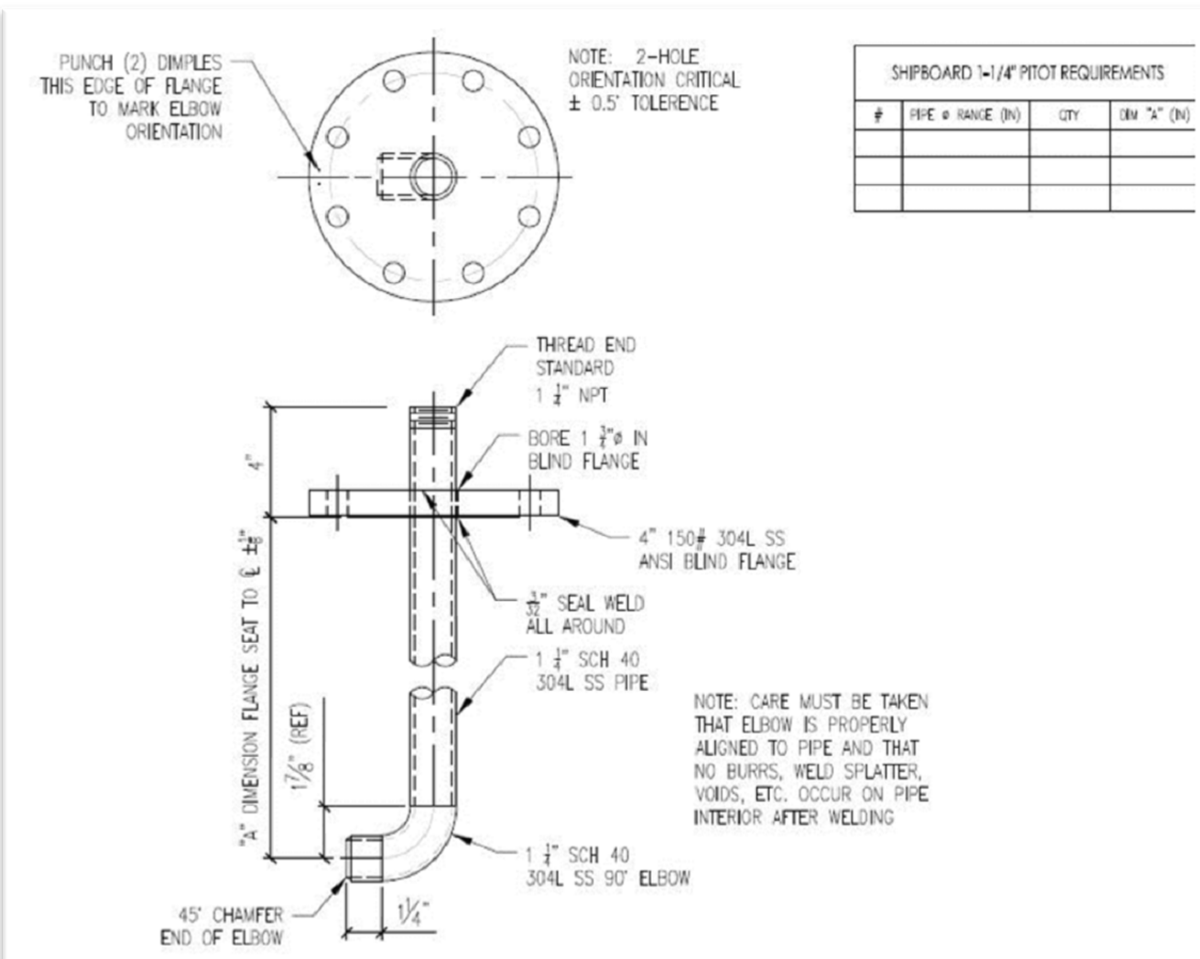


Figure 2. Diagram of Elbow Pitot for Ballast Discharge Sampling.

Table 1. Relationship of Sample Pitot Diameter to Sample Water Flow Rate

Sample Pitot, Flow Rate at 10 ft/sec Ranging From 1.5 - 2.0 Times The Isokinetic Diameter									
Diameter (in)	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4
Flow (Gal/Hr)	359.4 - 202.2	597.8 – 36.3	1066.1 - 599.7	1468.7 - 826.1	2454.2 - 1380.5	3522.5 - 1981.4	5489.7 - 3087.9	7386.9 - 4155.1	9555.2 - 5374.8
Flow (M3/Hr)	1.4 - 0.8	2.3 - 1.3	4 - 2.3	5.6 - 3.1	9.3 - 5.2	13.3 - 7.5	20.8 - 11.7	28 - 15.7	36.2 - 20.3

Step by Step Approach to Pitot Diameter Selection

1. Determine Test Plan Sample Volume/Rate requirements (e.g., the test plan requires 6.0 m^3 in 2 hours or 3.0 m^3/hr).
2. Assure the pump is capable of that flow rate.
3. Consult with the ship engineer to determine ship ballast discharge flow rate (usually around 10 ft./sec., but not always).
4. Select a pitot diameter that assures the flow velocity is in the subisokinetic range of 44 % - 25 % ballast discharge flow rate. If they ballast at 10 ft./sec, table 1 can be used (e.g., For a desired flow rate of 3.0 m^3/hr, per table 1, a 1.25" pitot can be used since its valid range of 4.0-2.3 m^3/hr).

Criteria for Sample Port Location

The location of the sample port is critical to its ability to deliver representative samples of live organisms in ballast discharge. Both fluid dynamic properties of a location, physical access and safety considerations come into play. A suitable location for a return flow port is somewhat simpler as the flow mechanics of the return location are unimportant, but locating it a minimum of two pipe diameters down downstream of the sample port assures that it in no way interferes with the sample port fluid dynamics. GSI uses the criteria detailed in Table 2 to guide GSI selection of sample port location.

Table 2. GSI Criteria for Sample Port Location in a Ship Ballast System.

Criteria	Reason
Single location services all tanks equally.	A single sample point means fewer flanges are needed, and less sampling effort is required.
Long length of straight pipe preceding the sample port.	Long lengths of straight pipe create a “fully developed” flow characteristic, assuring water is well-mixed at the point of sampling, and samples are representative of the discharge.
Locations as close to overboard as possible.	Samples collected closer to discharge will more closely represent the quality of water entering the receiving system.
A suitable adjacent area for sample processing, suitable for technician occupancy, and with accessible light and power supply.	A sample port alone won’t deliver a good sample. Technicians must be able to work in proximity to it to collect and process samples.
Necessary clearances to install the sample pitot.	The sample team or ship personnel must be able to install and remove the pitot without damaging other equipment.
Piping that can be isolated.	Piping around the sample location must be isolated so that the sample equipment can be safely installed or removed.
No explosion or other hazards.	Explosive environments require special equipment to assure safety of the ship, crew and sampling team.

Sample Pitot Locations in Ballast Systems Found on Great Lakes-Relevant Ships Types

A ballast system comprises the pump, sea chests and piping associated with moving ballast water on and off the ship. Most ships have two ballast systems mirrored along the centerline of the ship: one system services the port side tanks and the other the starboard tanks. Thus, most ships require a minimum of two sample points for monitoring ballast discharge. Ballast systems associated with ships in service on the Great Lakes can be quite different from each other, as will the best location for a sample point given the criteria noted in Table 2. During GSI ship inspections, three fundamentally different types of ballast systems were identified:

- Distributed Manifold Ballast System (Figure 3): In a distributed manifold system a single pump or pair of pumps is installed in the engine room with ballast main(s) traveling the length of the ship. Branches off the main service each tank. Flow in or out of the tank is controlled by manual or actuated valves at the ballast tank. This ballast system design typically had straight lengths of pipe suitable for sampling locations in the ship tunnel.

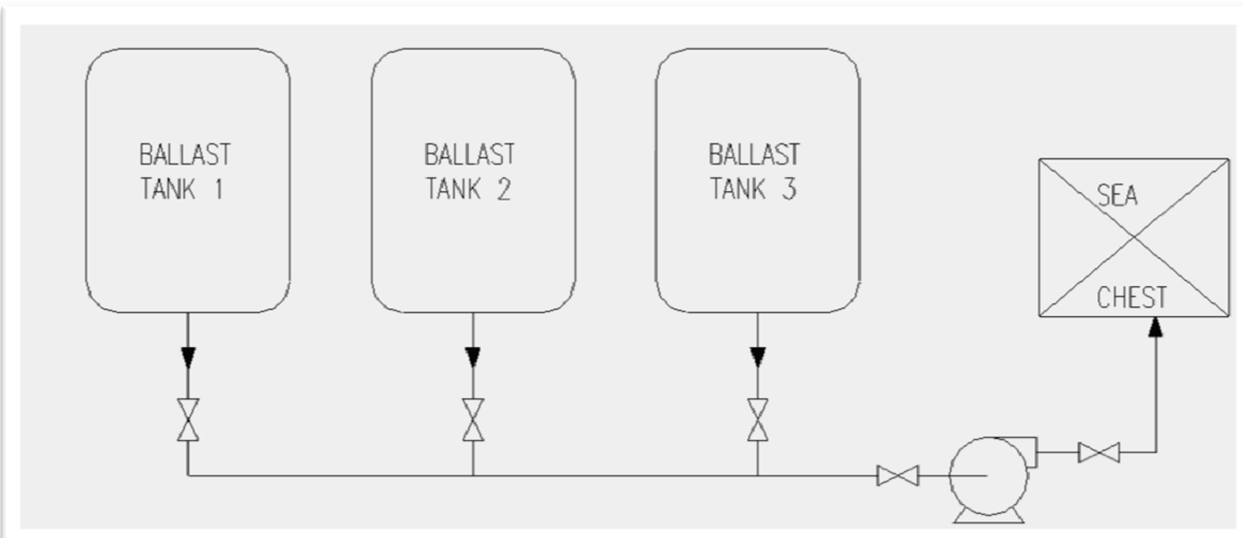


Figure 3. Schematic of Distributed Manifold Ballast System Design.

- Centralized Manifold Ballast System (Figure 4): This ballast system style is similar to a distributed manifold except each ballast tank has an individual line leading back to the engine room; the lines combine prior to the pump. All the ballast system valves are located together in the engine room.

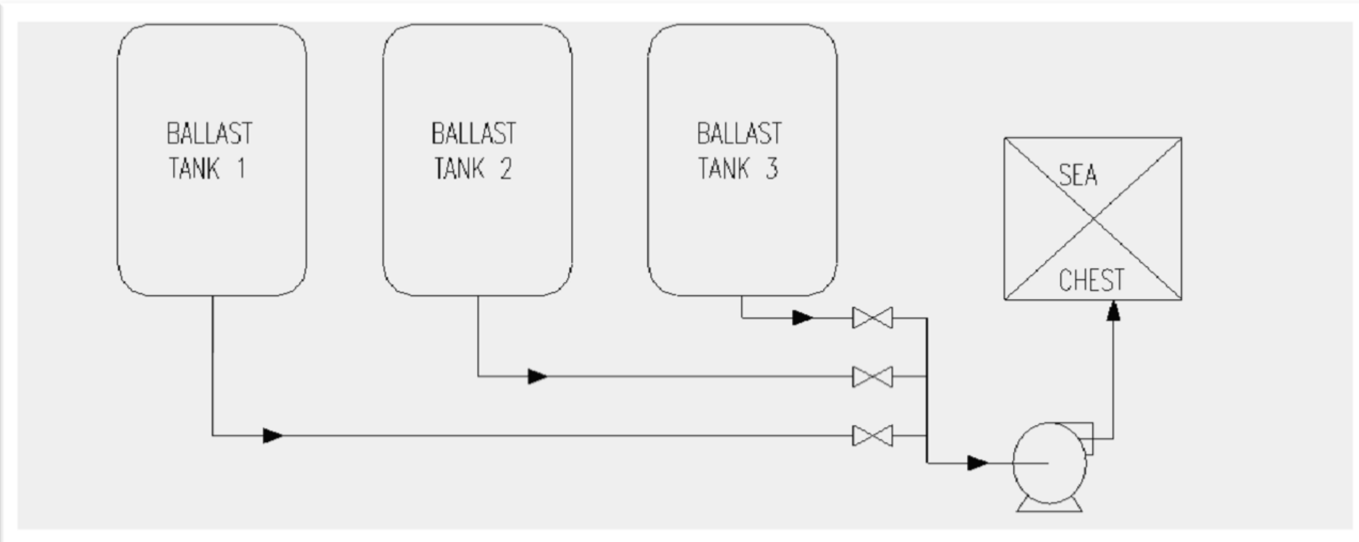


Figure 4. Schematic of Centralized Manifold Ballast System Design.

- Multiple Independent Ballast Systems (Figure 5): Ships with multiple independent ballast systems have no common piping between ballast tanks. Every ballast tank on the ship has a separate sea chest, ballast pump and piping. This style of ballast system is rare within and outside the Great Lakes.

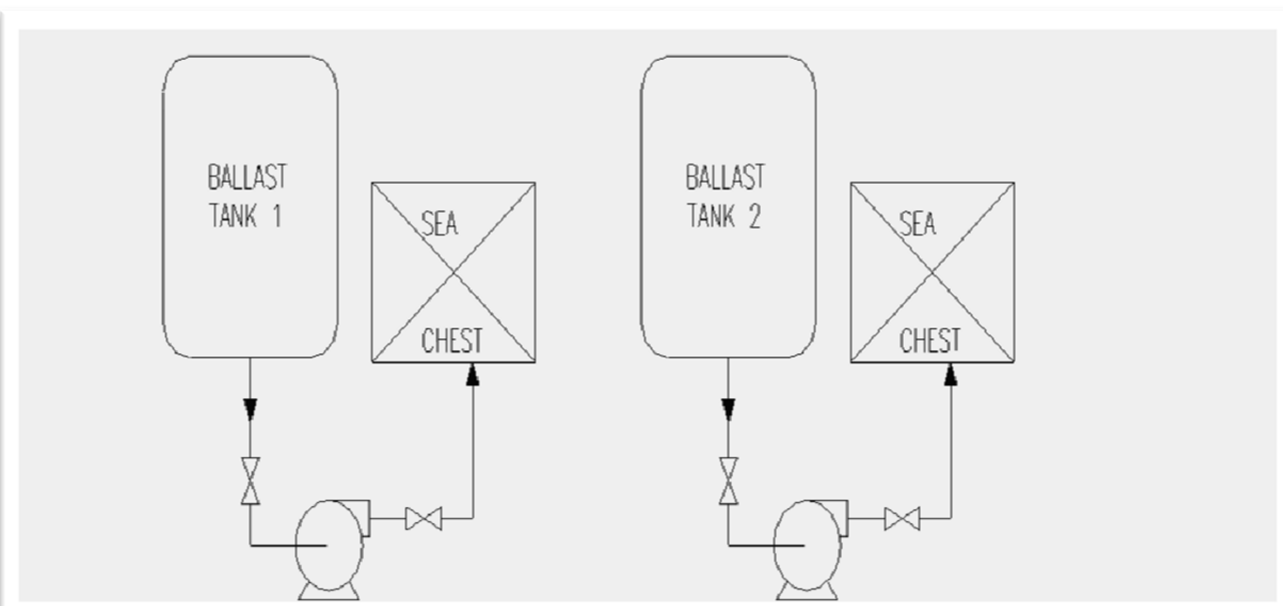


Figure 5. Schematic of Multiple Independent Ballast System Design.

Power Requirements

Power requirements for sample collection systems should be kept to a minimum. The GSI sampling system runs off of two 13 amp 120 volt circuits at 60 hertz. Although it has been easy to find this supply on U.S. and Canadian ships it becomes more difficult with foreign vessels that operate with different electrical standards

Pitot Custody

The GSI team prefers to provide the pitot to the ship master for installation into the flange sometime within a week or two prior to the ship's arrival at the port at which sampling is scheduled. After the sample visit the ship crew returns the pitot to the GSI sample team. GSI does not install sample pitots permanently in the ships in order to assure that bio-fouling inside of the pitot does not bias sampling outcomes, and to assure that structural defects of the pitot will not endanger ship operations. If necessary, GSI can install the pitot on the day of sampling, but this approach expends limited time available for set-up, and sample collection, processing and analysis.

GSI recommends that pitots be owned by the testing agency and loaned to the ship being evaluated. Upon pitot return after a sampling event the GSI team inspects the pitot for any damage. Having the pitot belong to the sample team also puts the responsibility of maintaining a specialized piece of equipment in the hands of those that will need to operate it. The research team can then size the pitot aperture to deliver the desired flow to discharge ratio (i.e., volume of sample water per unit volume of ballast discharge).

Step-By-Step Process for Sample Port Commissioning

In summary, steps employed by GSI to identify and install sample ports on ships are as follows:

1. **Pre-Installation Ship Inspection.** A ship inspection is conducted to identify and document features of sample locations with potential to meet most or all of these criteria. Also possible locations for a return flow port downstream of the sample port, and sample processing, are assessed and identified at this time.
2. **CFD Models.** A qualified engineering firm models potentially suitable locations using computational fluid dynamics (CFD) to determine which locations in fact provide well-mixed samples of ballast discharge (i.e., have fully developed flow or are closest to fully developed flow).
3. **Installation Design to Ship Owner.** Once a location is determined by the sample inspection team the location is submitted to the ship owner for approval, class society review and installation.
4. **Flange Installation.** Once the ship owner and agrees to the design, the ports can be installed with blind flanges.
5. **Pitot Installation.** Prior to a sampling event the blind flange will be removed and replaced with a sample pitot of an appropriate size.

CHAPTER 3: EQUIPMENT, SET UP AND TEAR-DOWN

GSI selected sampling equipment for its reliability and portability. All of the equipment and components of the process described here are no greater than 45 lbs in weight. GSI includes spare parts for critical components in case of component failure during sampling. Set up and tear-down of the sampling system consumes approximately one and one half hours each by two technicians.

SAMPLING SYSTEM COMPONENTS

The following components comprised GSI's sampling system:

Sample Pitot and Sample and Return Port Flange
Manufacturer: Custom designed and manufactured
Model: NA
Description: The flanges are custom made from 4" 304L stainless steel blind flanges. The sample pitot is made from 1-1/4" sch. 40 304L stainless steel pipe. There is a 1-1/4" full port ball valve with plug installed on the outlet of both to prevent leaking. The pitot is a 90 degree elbow section of pipe sized to allow water to be collected from the center of the ballast line. The elbow is mounted in the 4" sample port blind flange. The pitot aperture is sized to deliver 1.5-2 times isokinetic flow from the line being sampled. The return flange is a board flange with threaded nipple welded to match the size of the pitot. Prior to testing the pitot is installed inside the 4" sample port and the return flange is installed on the return port. See Figure 6 for installation example.

Figure 6. Sample Pitot and Sample and Return Port Flange.

Electrical Cabinet
Manufacturer: Various Components assembled by Rockwell Automation
Model: N/A
Description: Contains the PLC, Motor Drives, and other necessary components to monitor and control the system logic. See Figure 7 for installation example.

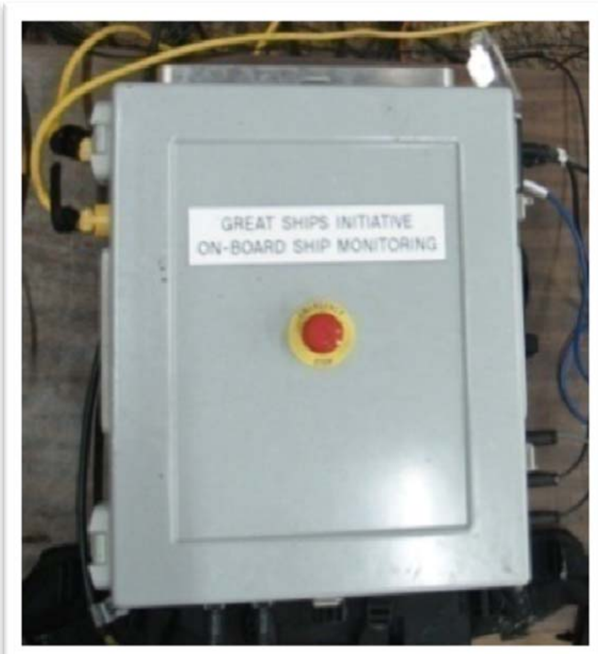


Figure 7. Electrical Cabinet.

Ultrasonic Flow Meter
Manufacturer: Fuji Electronics
Model: FSC w/FSD410B1 transmitters
Description: Sensors use ultrasonic waves to measure the flow velocity in a pipe and calculate the flow rate. This is used to monitor the ballast discharge rate without needing to install anything inside of the ships pipes. Figures 8 and 9 depict example ultrasonic flow meters and flow meter transducers, respectively.

Figure 8. Ultrasonic Flow Meter.

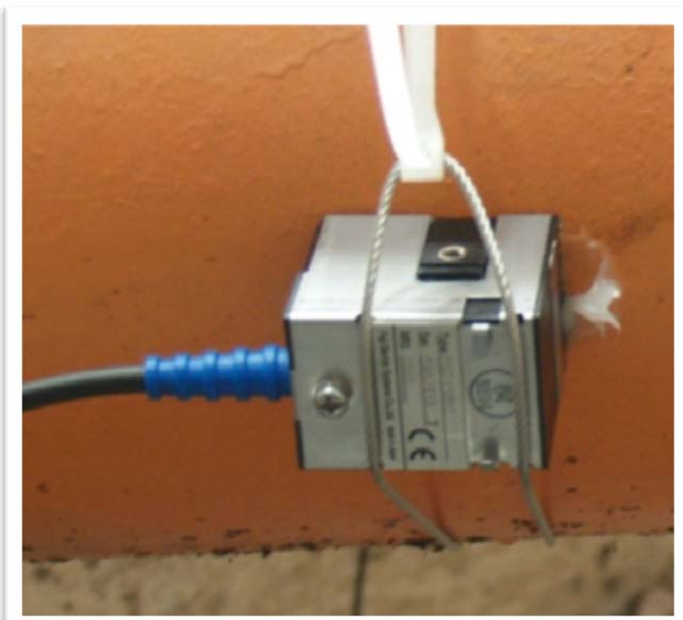


Figure 9. Flow Meter Transducer.

Tub Level Transducer
Manufacturer: Ametek DrexelBrook
Model: 750 Series Well Watcher Submersible Level Transmitter
Description: A transducer (see Figure 10 for an example) is lowered to the bottom of the sample tub where it monitors the level of the water in the tub.

Figure 10. Tub Level Transducer.

Sample Flow Meter
Manufacturer: Yamatake
Model: MTG18A
Description: A two-wire electromagnetic flow meter monitors the flow rate of water being sampled by the sampling system. See Figure 11 for an installation example.

Figure 11. Sample Flow Meter.

Sample Pump and Return Pump
Motor: Dayton 1TRZ6
Pump: Jabsco 777-9001
Coupling: Lovejoy AL095 & 68514471706
Frame: Custom built aluminum
Description: Both sample and return pumps are identical flexible impeller pumps. The sample pump draws the water to from the ships ballast lines and pumps it to the sample tub. The return pump removes the water from the sample tub and pumps it back into the ships ballast lines. See Figure 12 for installation example.

Figure 12. Sample Pump.

Sample Tub
Manufacturer: RubberMaid
Model: 32 Gallon Heavy Duty trash can
Description: The trash can has been modified to include a bulkhead fitting with a valve on the bottom to use as a water outlet, and an adjustable riser to hold the sample nets. See Figure 13 for an installation example.

Figure 13. Sample Tub.

Laptop
Manufacturer: Panasonic Semi-rugged Toughbook
Model: CF-52
Description: The laptop provides the interface for running the Ballast Sampling Program and data logging. The Toughbook provides some splash resistance and fall protection as well as dust protection that is above what a typical laptop would provide. A secondary function of the laptop is to provide access to equipment manual, troubleshooting guides and other useful information while in the field. See Figure 14 for example.

Figure 14. Lap Top.

Human Machine Interface (HMI) Software

The GSI shipboard sample equipment is controlled using FactoryTalk Historian ME. FactoryTalk is a brand of HMI software that includes graphical representation (see Figure 15). Any HMI software used to control sampling equipment should include the following abilities:

1. Control of pump actives through PLC loops,
2. Ability to set sample pump as a percent of ballast line flow,
3. Data Logging and live data display, and
4. Fault and warning notifications.

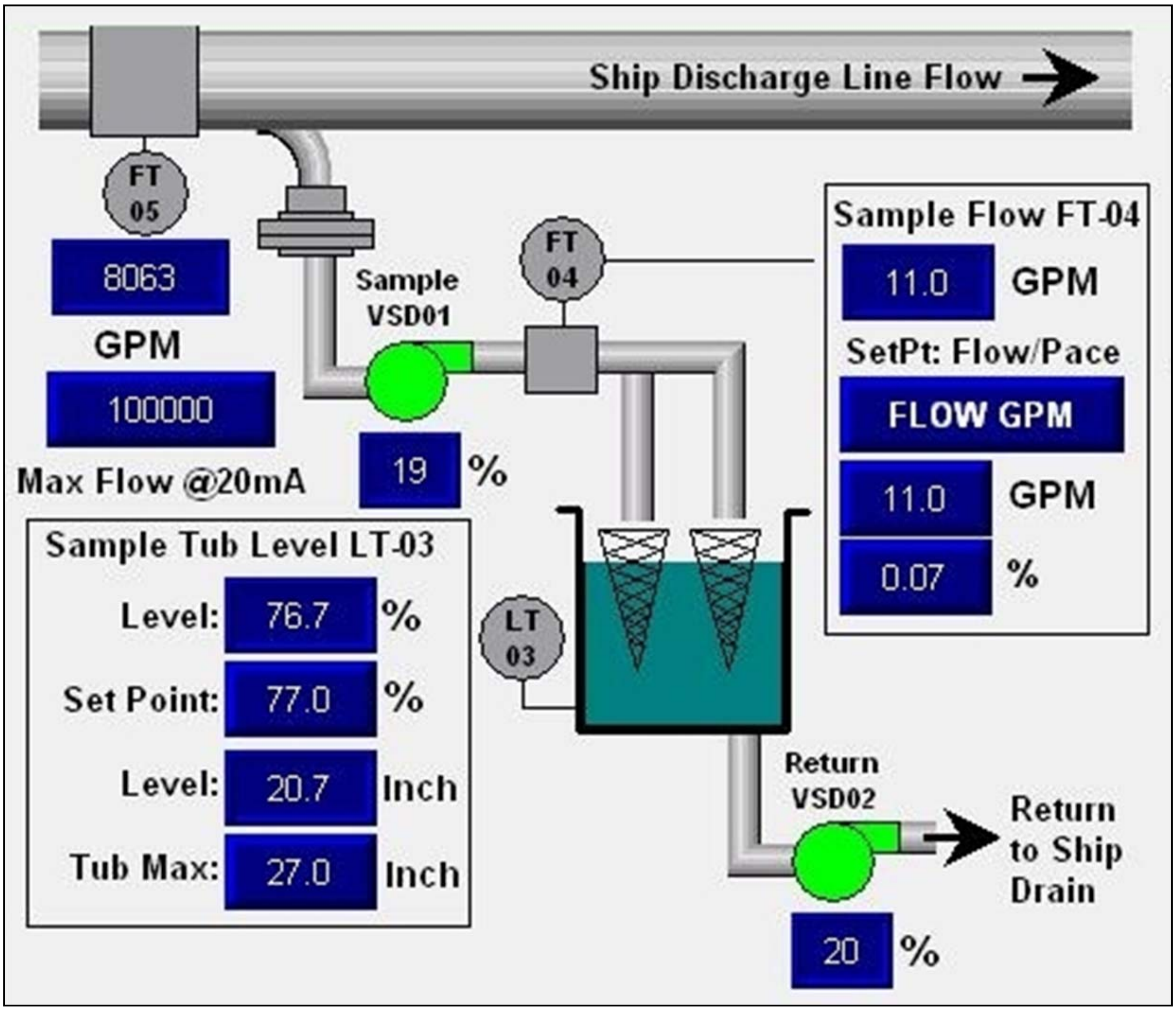


Figure 15. Sample Screen Image from GSI HMI Software.

Sample Gear

Sample gear included the following items:

Plankton Net and Cod-End
Manufacturer: Sea-Gear Corporation
Model: 9000 (30cm, 3:1, 35 micrometer mesh)
Description: Zooplankton samples are collected by concentrating the sample volume through a 35 micrometer mesh plankton net (i.e., 50 micrometers on the diagonal) into a 1 Liter cod-end for analysis. A minimum of one plankton net is required per sample. The plankton nets used by GSI during shipboard sampling were purchased from Sea-Gear Corporation of Melbourne, Florida (Figure 16).

Figure 16. Plankton Net (35 micrometers with Attached 1 Liter Cod-End.

Sample Collection Containers: Carboy, 20 Liter
Manufacturer: ULine
Model: S12768
Description: high-density polyethylene (HDPE) containers for time-integrated sample collection, the type and quantity of which are dependent on the test plan. For example, the time-integrated “seep” sample is collected using a 19 liter HDPE carboy (one per replicate; Figure 17). For collection of whole effluent two time-integrated “seep” samples are collected; one for whole water samples and one for whole effluent toxicity testing. From one time-integrate sample, total suspended solids and percent transmittance subsamples, as well as, whole water

for analysis of protists are collected using HDPE sample bottles (Figure 17). Organic carbon samples (i.e., non-purgeable organic carbon and dissolved organic carbon) are collected using 125 mL glass sample bottles prepared by soaking in Micro-90® Concentrated Cleaning Solution (Figure 17). Microbial samples (a minimum of three subsamples per carboy) are collected using sterile 1 liter polypropylene bottles (not pictured). Extra sample containers should be carried aboard.

Figure 17. Sample Collection Containers used for Shipboard Sampling Events.

Transport Coolers and Ice Packs

Description: To ensure sample integrity, proper sample holding and transport is of the upmost importance. Following sample collection, sample bottles are immediately placed into small sample transport coolers (Figure 18) and are kept cold until they are delivered to the sample analysis personnel by using a minimum of two ice packs per cooler (Figure 18).

Figure 18. Small Sample Transport Cooler with Samples and Ice Packs.

YSI Multiparameter Water Quality Sonde with Data Display and Logging System
Manufacturer: YSI Incorporated (Yellow Springs, Ohio)
Model: YSI 6-Series Model 6600 V2-4 Sonde and YSI 650MDS Data Logging System
Description: Water quality parameters are measured from the time-integrated sample using a YSI Multiparameter Water Quality Sonde (Figure 19). It is recommended that two Sondes be brought onboard in case one of the Sondes is not functioning correctly. The 6600 V2-4 Sonde (Figure 19) was used by GSI and included sensors to measure the following parameters: specific conductivity, salinity, pH, temperature, dissolved oxgen (concentration and percent saturation), turbidity, and total chlorophyll. The measured values are displayed using the YSI 650 MDS data logger (Figure 20).

Figure 19. YSI 6-Series Multiparameter Water Quality Sonde (YSI 6600 V2-4).

Figure 20. YSI 650 MDS Data Logging System.

Standard Operating Procedures, Test Plan, Datasheets and Laboratory Notebooks
Description: A copy of the Test Plan, as well as, the sample collection standard operating procedures must be brought on board during the sampling event and must be readily accessible to the sample collection team. The appropriate datasheets will be identified in the Test Plan and extra datasheets should be brought onboard, along with extra pens (indelible ink only). Data may also be recorded in laboratory notebooks, although pre-printed datasheets are preferred due to the increased efficiency of data recording.

Personal Protective Gear and Dress

The equipment listed below is the recommendation and in most cases the required protective gear for personnel involved with the shipboard ballast sampling and operation of the equipment. The requirements of the vessels or the facilities through which the vessels are accessed may vary and the sample team is expected to follow safety procedures required of the dock or ship, including Occupational Safety and Health Administration (OSHA) requirements.

- Hardhat
- Steel toe boots
- Safety Glasses
- Hearing Protection (ear plugs or muffs, or in some cases both may be advisable)

- Flashlight or headlamp
- Work Gloves
- Work Clothing – work clothing should cover arms and legs, and fit in a manner as to not create a safety hazard. Jewelry (including rings) is not recommended and on many facilities not allowed.
- Transportation Worker Identification Card (TWIC) – Some facilities require for access.

Equipment Set up and Tear-Down

Equipment loading and unloading to and from the ship should be as swift as possible to minimize disruption to ship operations, and to avoid the possibility of needing to re-route entry during the loading. Two to four people can effectively accomplish set up and tear down within 45 minutes to one hour for each operation. It is advisable to have one member of the set-up team assigned to sonic flow meter set-up while the others bring the rest of the gear to the sampling location since flow meter wet up can be time consuming. Make sure that hose unions have the rubber grommet installed and that all connections are proper and snug. Equipment should be laid out with consideration to:

- Keeping walkways clear of wires and other equipment,
- Keeping wires and hoses neat, using wire ties to secure hoses and wiring out of the way, and
- Planning for good work flow.

Once all of the hoses are installed, the valves may be opened on the sample and return ports and at the pumps and sample tub. With the software program in manual mode, verify pump rotation by powering the pump motor for a few seconds while someone checks for rotation. If the pump does not turn, the motor should be disconnected from the electrical cabinet and the guard removed to allow the pump to be manually turned over several times. This usually should require a “Lockout/Tagout” procedure. The guard should then be reinstalled and the pump rechecked.

During equipment tear-down, first close the sample port and return port valves and secure the plugs. GSI’s Ballast Sampling System is designed to automatically empty the sample tub at the conclusion of a test. Depending on the amount of water left in the sample tub, it may be best to place the control program into manual mode and completely drain the sample tub of water, tilting the sample tub to get the water into the drain. The sample lines must be manually emptied into the sample tub. Other tasks are:

- Packing the pump for removal,
- Removing the hoses from the sample pitots via unions,
- Shutting the valve on the return port to prevent any flow that may otherwise push back through the return pump,

- Backing up the data log file separately from the laptop,
- Packing and removing from the vessel the remainder of the hose, wiring, and equipment,
- Conducting a final visual check to assure that all equipment and personal items have been removed, and
- Ensuring that both the Sample and Return port valves are fully closed and the plugs firmly installed.

Chapter 4: Outcomes and Recommendations

Overall the sampling method and supporting equipment performed well during GSI's ship visits. GSI successfully loaded, set up and operated the sampling process described here within a feasible time window, and "left no trace" upon departing the ship, except for the pitot flange, which was removed later by the ship crew.

Costs

The costs of carrying out a sampling event using this method (excluding scientific supplies associated with sample analysis) are detailed in Table 3.

Table 3. GSI Costs Per Sampling Event.

	Cost Factor	Time/Cost
One-Time Costs	Ship Inspection	$1,500
	Installation of flanges in a ship	$2,000-$5,000
	Reuseable Operational Equipment	$45,000
	Biological Sampling Equipment	$500-$2000, depending on Test Plan
	Set up and Tear Down of Sampling Equipment	1.5 – 2 hrs (total) assuming 2-3 staff
Per Sampling Event Costs	Sample Collection Staff Time	TBD, depending on Test Plan
	Staff Travel	TBD, depending on Test Plan

Equipment Performance

Sampling operational equipment performed as expected with the following exceptions:

The Ultra-Sonic Flow Meter on the ships' ballast discharge line performed inconsistently and unreliably, jeopardizing the extent to which representativeness of the sample can be proven. It is important to sample a constant fraction of the ballast line flow through using an in-line magnetic flux flow meter on the sample line, and a portable ultrasonic flow meter mounted to the ships ballast piping. If one of these monitors is inconsistent, there is no direct means to assure that the sample volume and the flow volumes are proportional throughout the sampling process. Without this information, it becomes difficult to translate organisms per unit volume in the sample to organisms per unit volume in the ballast discharge:

$$\frac{Sample\ Flow\ Rate\ (inline\ magnetic\ flux\ flow\ meter)}{Ballast\ Line\ Flow\ Rate\ (portable\ ultrasonic\ flow\ meter)} = Constant$$

The ultrasonic flow meter was also difficult to mount properly. It is highly recommended that ship owners and authorities encourage treatment system developers to include flow meters in their systems that have a proven in situ performance to within 3 %. It is also recommended to have a standardized output connection so that the sample team can make use of that flow meter to facilitate the constant percent sampling necessary for a representative sample.

It was necessary to tune up the PLC Control Loop. Because the sampling equipment is used on a number of different ships each having different arrangements, flow rates and pressures, sometimes it is necessary to fine -tune the automation of the sample system to prevent unstable rates or oscillating rates of the sample flow. It is recommended that the PLC control loop parameters be available, i.e. the Gain, Reset and Rate.

The 32 Gallon heavy duty tub (sample collection barrel) though strong and light was awkward to bring aboard. Attaching backpack straps in the future may remedy this. Delivery of the 19 liter carboys for effluent toxicity testing was improved by placing each carboy inside a frame backpack for navigation from the sampling location to the dock.

Recommendations

Key lessons learned in terms of sample event planning and staffing were:

Scheduling of the sampling event is subject to changes in weather, ship equipment, and port schedules. Even when the ship has docked, the schedule is still subject to change. Depending on each ship and each cargo load, the ballasting and deballasting operation varies and may start and stop at various times, i.e., 6 hours of sampling may actually take 12 hours. Fresh sampling and analysis personnel are essential to quality data. It is recommended that sampling and analysis crew shifts of 24 hours be in place to address schedule contingencies.

Equipment set-up and break-down is easier when shared among several team members. Initially, the engineers were more familiar with the equipment set-up. As more sampling events took place, personnel became familiarized with the set-up and break-down and could therefore provide more support and assistance in those areas.

The ship pumping schedule is subject to variation making "beginning, middle and end" grab samples difficult to plan. The ballast pump (or pumps) move water at a rate that may be faster than the loading of cargo, resulting in starting and stopping of the pump (and therefore sampling). As a result, determining three sets of discrete grab samples spaced approximately near the beginning, middle and end proves difficult. One hour samples seemed to work for all parties (i.e., each sample was one hour of collection). The test plan should require that a certain volume, duration, or number of tanks of ballast water discharge be sampled instead.

Have a dedicated handling and sample transport person. This additional person allows maximum support aboard the ship and efficient delivery of the samples. This person could also return the previous samples' cooler and ice packs to ship personnel, eliminating the need to carry multiple transport equipment aboard the ship.

CONCLUSIONS

The operational method for sampling ship discharge described in this Guidebook is a feasible and cost-effective approach which can yield representative samples for a range of experimental objectives. It appears to be applicable to most ships which ply the Great Lakes. The costs of the exercise are dominated by one-time investment in operational equipment. Installation of sample ports on ships is a relatively minor one-time expense. Costs of deployment of the sampling team and sample analysis are largely dictated by the test plan under consideration, and the number of schedule changes associated with the ship visit.

REFERENCES

GSI (2011). Great Ships Initiative (GSI) Quality Management Plan. Northeast-Midwest Institute, Washington, DC.

IMO (2004). International Convention for the Control and Management of Ships Ballast Water and Sediments. As adopted by consensus at a Diplomatic Conference at IMO, London, England, February 13 2004.

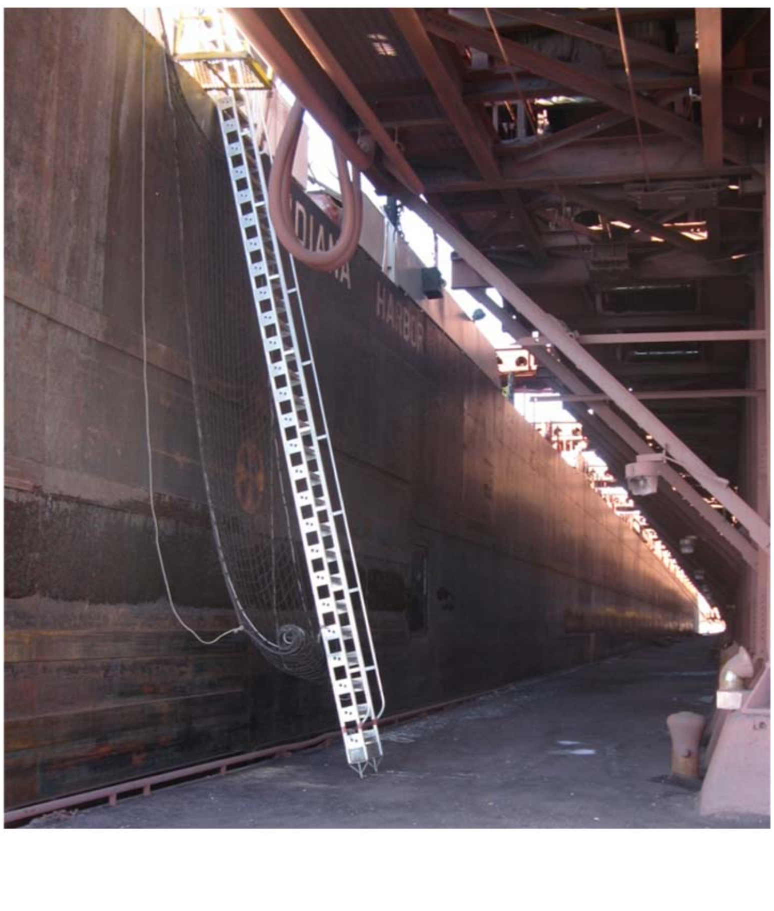
NSF International (September, 2010). Generic Protocol for the Verification of Ballast Water Treatment Technology. Version 5.1. EPA/600/R-10/146. Produced for the USEPA, Environmental Technology Verification Program in Conjunction with U.S. Coast Guard, Environmental Standards Division and U.S. Naval Research Laboratory, Center for Corrosion Science and Engineering. NSF International, Ann Arbor, Michigan.

United States Coast Guard (2008). Analysis of Ballast Water Sampling Port Designs Using Computational Fluid Dynamics. United States Coast Guard, Research and Development Center, Report No. CG-D-01-08. February 2008.

Appendix 1 - MV Indiana Harbor Sample Location Inspection Report

Great Ships Initiative

MV Indiana Harbor Sample Location Inspection



MV Indiana Harbor Sample Location Inspection

Great Ships Initiative
March 14, 2011

Contents

GSI CONTACT:
Tyler Schwerdt, AMI Consulting Engineers P.A.
tyler.schwerdt@amiengineers.com
Ph: (715) 718-2193 Ext. 18
Fax: (877) 761-7058

Purpose of Inspection

In 2010, the Great Ships Initiative (GSI) received funding from the Legislative Citizen's Commission on Minnesota Resources, the Maritime Administration and the Great Lakes Protection Fund to assist in the design, inspection, installation and testing of ballast discharge sampling apparati and processes on 10 commercial cargo ships operating in the Great Lakes. The goal of this GSI project is to develop, test and evaluate best ballast discharge sampling approaches relevant to Great Lakes shipping. As such, the project will install and trial ballast water discharge sampling systems using guidelines and methods developed to be as consistent as possible with those proposed by the International Maritime Organization (IMO), as well as the United States Environmental Protection Agency's Environmental Technology Verification Program. Upon identification of the best possible locations for installation of the proposed ballast discharge sampling approach, GSI in coordination with the ship owners will outfit the vessels with 4" sample ports. After installation, the ships will be visited by GSI research personnel to trial and review the sampling system, and collect biological samples using the sampling system. The sample ports will stay in place for possible future use in research, type approval testing and/or compliance monitoring.

This report summarizes GSI's recommendations for installing a ballast discharge sampling system onboard the MV Indiana Harbor -- a Great Lakes self-unloading bulk freighter operated by American Steamship Company of Williamsville, New York.

Criteria to Guide Selection of Sample Port Location

Among other engineering requirements, sample port locations onboard the target vessels will ideally be at points in the ballast discharge line with fully developed turbulent flow. Most ships will not have a location that meets all criteria, so engineering judgment will guide determinations of the best sample locations available. GSI criteria for sample location include locations that:

- Service all tanks equally by a single sample location is best if available.
- Are preceded by long lengths of straight pipe (USCG, 2008).
- Are close to overboard providing representative discharge samples in terms of proximity to the point of entry into the receiving system.
- Are nearby to a suitable area for sample processing, including adequate space for one 50 gallon open top barrel, sample bottle coolers and a technician.
- Have adequate lighting, power, and potable rinse water.

GSI team members will document through photographs and measurements all sample locations with potential to meet most or all of these criteria during a vessel visit. Each possible location will then be modeled using computational fluid dynamics (CFD) to determine whether there is fully developed flow at that location (that is, water passing that location is in a well mixed state). Also possible locations for a return flow port downstream of the sample port will be assessed; a suitable location for a return flow port is anywhere downstream of the sample port as long as the location does not interfere with the fully developed flow at the sample port.

Ship Description

The MV Indiana Harbor is a Great Lakes self-unloading bulk freighter operated by American Steamship Company of Williamsville, New York. Built in 1979, the vessel has an overall length of 1,000 ft., a beam of 105 ft., and a depth of 56 ft. She is powered by four 3500 HP General Motors Electro Motive Division (EMD) diesel engines and has a deadweight capacity at MS Draft of 80,900 Gross Tons. The vessel is primarily used for long-haul transport of iron ore pellets and western coal on the upper four Great Lakes.

In terms of her ballast system, the MV Indiana Harbor has 18 ballast tanks including forepeak and afterpeak, four ballast pumps at 13,000 gpm each (52,000 gpm total), and a total ballast capacity of 16,424,360 US gallons (62,166 m3)..

MV Indiana Harbor Inspection

GSI personnel from AMI Engineers' Joe Radniecki P.E. and Tyler Schwerdt boarded the MV Indiana Harbor on January 8th, 2011. The vessel was loading iron ore at the CN docks of Two Harbors, MN at the time of the inspection. The engineers received a guided tour of the ship from Chief Engineer Ralph Biggs. Throughout the tour, the AMI representatives completed the attached survey form (Appendix A) in consultation with the ship crew. Important features of the ship's ballast system lay-out also were recorded photographically.

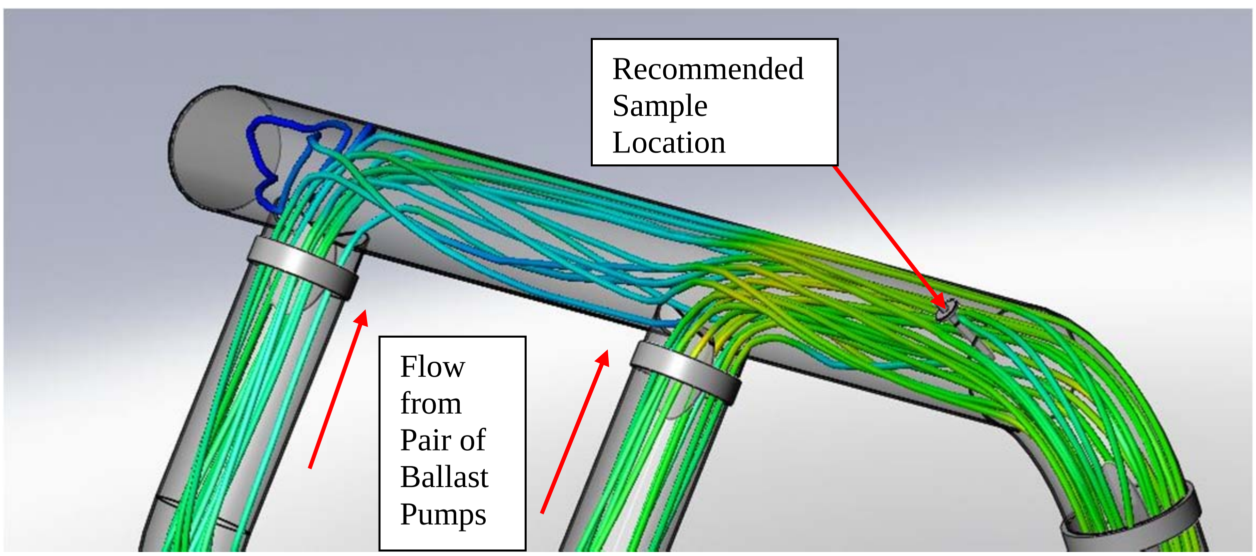
MV Indiana Harbor Ballasting System Description

The starboard and port sides of the MV Indiana Harbor each operate an independent ballast system with the exception of a crossover that can be used to connect the two systems offering redundancy in the case of mechanical failure. The ballast systems are symmetrical around the centerline of the ship. The ballast system for each side of the ship uses the same two pumps run simultaneously for both ballasting and deballasting depending on the valve arrangement. Except for the engine room most of the ships ballast piping is inside of the ballast tanks. Branches from the main line leading to individual tanks loop outside of the ballast tank wall into the ship tunnel for valve access. See the picture to the right. On the interior of the tank the pipe turns 90 degrees downward and terminates in a bellmouth close to the tank floor. The portion of piping inside the tank was not inspected as it was not accessible during the visit.

Findings

The best location for installation of a ballast discharge sampling system onboard the MV Indiana Harbor, i.e. which fits the GSI location criteria, including fluid dynamic recommendations and processing requirements, is in the vessel's engine room at a point in the piping after flows from both pumps have combined. This location can serve one half of the ship's ballast tanks under typical circumstances, and both sides under exceptional circumstances. A photo of the location is shown below looking down the length of the header towards discharge on the starboard side. The photo was taken standing in a suitable sample processing area that is immediately adjacent to the sample collection location.

The area pictured above was analyzed with computational fluid mechanics to insure its acceptability for sampling. Although the flow at this point is not fully developed it is the closest to fully developed available on the existing piping.



Recommendations:

GSI recommends placing the sampling port in the MV Indiana Harbor's engine room downstream of where the two pump flows merge together before discharge on the port side for the following reasons:

Positives
Post-pump location gives a better picture of ballast system induced mortality.
Sample location can service half of the ships ballast tanks from a single location.
Available lighting, power and wash water.
Pipe length and arrangement delivers the closest to fully developed flow available.
Location can be isolated.
Existing sample ports nearby can be used for return flow.
Nearby processing and analysis areas.
Due to installation being on straight length standard sampling port and pitot can be used.
Negatives
Not fully developed flow, but it is the closest to fully developed available.

For the purpose of this project a sampling location servicing the port side of the MV Indiana Harbor from the engine room is sufficient. The sample location on the port side is recommended based on the ships current arrangement. Modifications caused by the addition of a ballast water treatment system may require the sample location(s) to be moved or modified.

Note relevant to upcoming NaOH ballast treatment trials on this ship: If sampling needs to target a subset of ballast tanks such as that planned for summer 2011 to test the NaOH/CO_2 ballast treatment system, it is still recommended to sample at the above location (in the engine room) as opposed to the tunnel proximate to the treated tanks discharge to the ballast system. Installing a sample port closer to a specific set of tanks would require a sample port for each of the targeted tanks. The majority of the ballast piping upstream of the engine room is on the interior of the tanks and inaccessible. The only accessible piping is an elbow such that the standard sample port and pitot design would have to be custom designed and modified.

References

U.S. Coast Guard Research and Development Center / CG-D01-08 (2008), *Analysis of Ballast Water Sampling Port Designs Using Computational Fluid Dynamics.*

Appendix A – MV Indiana Harbor Inspection Survey Form

GSI Ship Monitoring Sample Access Evaluation Sheet

Ship:	Indiana Harbor
Ship Type:	Bulk Carrier
Evaluation Date:	1/7/2011
Evaluation Location:	Two Harbors CN Dock
Contact Person:	Ralph Biggs 312-499-7998
Existing Fluid Analysis of Location:	Yes / No / Available
Existing Treatment System :	Yes / No Describe
Ballast Tank Capacities:	NaOH System available sometime

Access Procedures

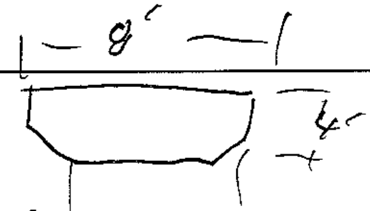
Required PPE / Certifications / Training:

Comments:

Sample Location: engine room	Comments
permitted confined space:	Yes / No
Isolated:	Yes / No 4 valve
Above Water Line In All Draft Conditions:	Yes / No
Most Narrow Location:	
Ship ladder Only Access:	Yes / No
Waste Water Repository:	Ballast Line / Bilge / Other: old Sample port 1.5"
Pump Needed:	Yes / No
110v Power available:	Yes / No Other:
Adequate Lighting:	Yes / No
Suitable For 4" Flange:	Yes / No
2'4" Clear From Pipe Face:	Yes / No
Entering And Tightening Concerns:	Yes / No
Material:	Steel / Other:
Line Size:	
Straight Length:	
Upstream Obstruction: T	151" From Cot T To weld on L
Downstream Obstruction: L	
Location:	Prepump / Postpump
Pressure Range :	
Flow Rate Range:	
Typical Ballasting Duration:	

Sample Location: engine room Comments

Processing Area



Processing Area Dimensions (sketch if irregular):

Space for 2 sample tubs 1.6m H x 1m D and coolers: Yes /No

Max Temp of 85 Deg (30Deg C): Yes /No, If No Max of ____

Distance From Sample Location: 4'

Flat Floor: Yes /No

110v Power available: Yes /No /Other:

Adequate Lighting: Yes / No

Wash Down Water Available Yes / No

Analysis Area

Adjacent to Processing Area: Yes /No

Within 10 Minutes Travel to Processing Area: Yes /No

Area (suggested min 5m x 0.5m sketch if irregular):

Flat Floor: Yes /No

110v Power available: Yes /No /Other:

Adequate Lighting: Yes /No

Wash Down Water Available

Sample Location: Tunnel Comments

Processing Area

Processing Area Dimensions (sketch if irregular): 4' x 15'

Space for 2 sample tubs 1 6m H x 1m D and coolers: Yes /No

Max Temp of 85 Deg (30Deg C): Yes /No , If No Max of ____ not concern

Distance From Sample Location: 0

Flat Floor: Yes /No

110v Power available: Yes /No /Other: Limited lighting

Adequate Lighting: Yes / No

Wash Down Water Available Yes / No

Analysis Area

Adjacent to Processing Area: Yes / No

Within 10 Minutes Travel to Processing Area: Yes /No Same as Belt

Area (suggested min 5m x 0.5m sketch if irregular):

Flat Floor: Yes /No

110v Power available: Yes /No /Other:

Adequate Lighting: Yes /No

Wash Down Water Available No

Sample Location: Tunnel Comments

permitted confined space: Yes /No

Isolated: Yes /No

Above Water Line In All Draft Conditions: Yes /No

Most Narrow Location:

Ship ladder Only Access: Yes /No

Waste Water Repository: Ballast Line / Bilge / Other: downstream

Pump Needed: Yes /No

110v Power available: Yes /No Other: Lantern off 5 light

Adequate Lighting: Yes / No

Suitable For 4" Flange: Yes / No

2'4" Clear From Pipe Face: Yes / No

Entering And Tightening Concerns: Yes /No

Material: Steel Steel / Other:

Line Size: 14"

Straight Length: none

Upstream Obstruction: elbow

Downstream Obstruction: elbow

Location: Prepump / Postpump

Pressure Range :

Flow Rate Range:

Typical Ballasting Duration:

Great Ships Initiative

Final Report of the Land-Based, Freshwater Testing of the Lye (NaOH) Ballast Water Treatment System

May 13, 2011

Principal Investigator:

Allegra Cangelosi, NEMWI

Research Team:

Lisa Allinger, NRRI, UMD
Mary Balcer, PhD, LSRI, UWS
Lana Fanberg, LSRI, UWS
Steve Hagedorn, LSRI, UWS
Tom Markee, LSRI, UWS
Nicole Mays, NEMWI
Christine Polkinghorne, LSRI, UWS
Kelsey Prihoda, LSRI, UWS
Euan Reavie, PhD, NRRI, UMD
Deanna Regan, LSRI, UWS
Donald Reid, Consultant
Elaine Ruzycki, NRRI, UMD
Heidi Saillard, LSRI, UWS
Tyler Schwerdt, AMI Engineering
Heidi Schaefer, LSRI, UWS
Matthew TenEyck, LSRI, UWS

Final Report of the Land-Based, Freshwater Testing of the Lye (NaOH) Ballast Water Treatment System

May 13, 2011

Allegra Cangelosi
Principal Investigator and Director
Great Ships Initiative
Northeast-Midwest Institute
50 F St. NW, Suite 950
Washington, DC 20001
Phone: 202-464-4014
Email: acangelo@nemw.org

Approved for Release:

____

PI Signature

May 13, 2011.

Table of Contents

SUMMARY OF TABLES

EXECUTIVE SUMMARY

The Great Ships Initiative (GSI) provides independent, no-cost performance verification testing services to developers of ballast water treatment systems (BWTSs) and processes at a purpose-built, land-based ballast treatment test facility located in the Duluth-Superior Harbor of Lake Superior (Superior, WI). The GSI is capable of performing testing fully consistent with the requirements of the International Maritime Organization's (IMO's) International Convention for the Control and Management of Ships Ballast Water and Sediments (IMO, 2004) and the United States Environmental Protection Agency's (USEPA's) Environmental Technology Verification Program (ETV; NSF International, 2010). GSI procedures, methods, materials and findings are also publicly accessible on the GSI website (www.greatshipsinitiative.org).

In July 2010, GSI conducted a land-based performance evaluation test of a proposed BWTS developed by researchers from the U.S. Geological Survey's Leetown Science Center in Kearneysville, West Virginia. The proposed system involved application of sodium hydroxide (NaOH, in the same formulation used for lye or caustic soda) to ballast water to raise pH, followed by application of carbon dioxide (CO_2) as a neutralization step prior to discharge of the ballast water to the receiving system. The purpose of the land-based test of this system, consisting of four trials, was status testing for research and development. As such, the testing was based on, though not strictly consistent with, the IMO's G8 Guidelines for Approval of Ballast Water Management Systems (IMO, 2008a), the IMO's G9 Guidelines for Approval of Ballast Water Management Systems that make use of Active Substances (IMO, 2008b), and the USEPA's ETV Program *Generic Protocol for the Verification of Ballast Water Treatment Technology*, v.5.1 (NSF International, 2010).

During the test, the NaOH BWTS was evaluated for its ability to: (a) successfully treat ballast water without interruption, (b) successfully neutralize treated ballast water to achieve Wisconsin Department of Natural Resources (WIDNR) permitting levels for harbor discharge (i.e., pH 6-9), (c) meet discharge target values for water chemistry/quality and biology that are approximately consistent with the IMO Convention's Annex D-2 discharge standards, and (d) discharge water after two- or three-day retention periods that is environmentally benign (i.e., no residual toxicity) pursuant to USEPA water quality criteria.

The NaOH BWTS performed very well operationally and well enough biologically to warrant additional testing at the bench, land and ship-based scales. The system successfully treated ballast water without interruption, and successfully neutralized treated ballast water to achieve WIDNR permitting levels for harbor discharge (i.e., pH 6-9). The BWTS also significantly reduced live organism densities in treated discharge relative to control discharge in all size classes of organisms. Finally, in these tests, the BWTS performance met discharge target values that were approximately consistent with the IMO Convention's Annex D-2 discharge standards, though precision in this estimate was not possible given the research and development testing parameters. The only possible problem that this testing revealed was that the water discharged after two- or three-day retention periods was not entirely environmentally benign (i.e., with no residual toxicity at the 100 % effluent dilution), though the level of residual toxicity in 100 % effluent evident from these tests may not be of regulatory concern.

ACKNOWLEDGMENTS

The authors would like to express our sincere gratitude to the Great Ships Initiative (GSI) Advisory Committee which provides invaluable input and encouragement to the GSI project. We also wish to thank the ten United States and Canadian Great Lakes Ports which launched the GSI, and the Great Lakes Protection Fund which supported the initial scoping exercise. We sincerely thank the United States Department of Transportation, Maritime Administration, and National Oceanic and Atmospheric Administration for their substantial financial and in-kind support for the construction of the state-of-the-art GSI land-based testing facility. We thank the United States and Canadian St. Lawrence Seaway organizations, the Legislative Citizens Commission on Minnesota Resources, the University of Wisconsin-Superior, and the City of Superior, WI, for their active financial and/or in-kind support for GSI operations.

1.0. INTRODUCTION

In July 2010, the Great Ships Initiative (GSI) conducted a land-based evaluation of a proposed ballast water treatment system (BWTS) developed by researchers from the U.S. Geological Survey's Leetown Science Center (Kearneysville, WV). The BWTS involved application of sodium hydroxide (NaOH, in the same formulation used for lye or caustic soda) to ballast water on intake to increase the pH, followed by application of carbon dioxide (CO_2) as a neutralization step prior to discharge of the ballast water to the receiving system. The purpose of the evaluation was status testing for research and development of the proposed NaOH BWTS. The objectives of the evaluation were to determine the ability of the NaOH BWTS to: (a) successfully treat ballast water without interruption, (b) successfully neutralize treated ballast water to achieve Wisconsin Department of Natural Resources (WIDNR) permitting levels for harbor discharge (i.e., pH 6-9), (c) meet discharge target values for water chemistry/quality and biology that are approximately consistent with the IMO Convention's Annex D-2 discharge standards, and (d) discharge water after two- or three-day retention periods that was environmentally benign (i.e., no residual toxicity) pursuant to USEPA water quality criteria. The testing was based on, though not strictly consistent with, the IMO's G8 Guidelines for Approval of Ballast Water Management Systems (IMO, 2008a), the IMO's G9 Guidelines for Approval of Ballast Water Management Systems that make use of Active Substances (IMO, 2008b), and the USEPA ETV *Generic Protocol for the Verification of Ballast Water Treatment Technology*, v.5.1 (NSF International, 2010).

1.1. The Great Ships Initiative (GSI)

Great Ships Initiative (GSI) is a regional effort devoted to ending the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System and globally. In support of that goal, GSI has established superlative freshwater ballast treatment evaluation capabilities at three scales—bench, land-based, and on board ship.

GSI awards independent status-testing services at no-cost to developers of BWTSs and processes determined to be promising. GSI status-testing is performed at the scale appropriate to the state of development of the target treatment system, with the goal of facilitating the rapid progression of meritorious BWTSs through the research and development and approval processes to a market-ready condition.

GSI has no involvement, intellectual or financial, in the mechanics, design or market success of the actual treatment systems it tests. To ensure that GSI tests are uncompromised by any real or perceived individual or team bias relative to test outcomes, GSI test activities are subject to rigorous quality assurance and quality control (QAQC) procedures and documentation (GSI, 2010a; GSI, 2010b). This attention to QAQC also assures high quality and credible evaluation of findings.

GSI has worked to standardize and calibrate its protocols to evaluate the performance of BWTSs with IMO guidelines, USEPA ETV Protocol, and other test facilities. GSI test protocols are as consistent as possible with the requirements of the IMO Convention for the Control and

Management of Ships' Ballast Water and Sediments (IMO, 2004) and United States federal requirements (NSF International, 2010). In particular, GSI testing directly supports the IMO's G8 Guidelines for Approval of Ballast Water Management Systems (IMO, 2008a), the IMO's G9 Guidelines for Approval of Ballast Water Management Systems that make use of Active Substances (IMO, 2008b), and the USEPA ETV Program's *Generic Protocol for the Verification of Ballast Water Treatment Technology*, v.5.1 (NSF International, 2010). GSI procedures, methods, materials and findings are also not proprietary, and are publicly accessible on the GSI's public website: www.greatshipsinitiative.org.

1.2. The NaOH (Sodium Hydroxide, Lye) Ballast Water Treatment System

Researchers from the U.S. Geological Survey's Leetown Science Center in Kearneysville, West Virginia developed the proposed system using sodium hydroxide (NaOH), in the formulation used for lye or caustic soda, for routine use as a BWTS. In 2008, GSI conducted bench-scale testing on the proposed NaOH BWTS and determined that pH levels of 11.5, 12.0, and 12.5 were effective at killing the broad range of aquatic organisms tested; especially adult rotifers (*Brachionus calyciflorus*), the cladoceran *Daphnia magna*, and *Eucyclops* copepods (GSI, 2009). These bench-scale findings were encouraging and land-based testing of a scaled-up model of the NaOH BWTS was proposed and awarded by GSI. Land-based tests utilized a version of the system that first increases the pH of ballast water on intake to pH 12, and then reduces the pH of the discharge water to less than 8.5 (but above 6.5) using carbon dioxide (CO_2). During retention, the ballast water remains at pH 12 and the pH is lowered just prior to discharge by recirculation between a Speece Cone-type carbonator and the ballast tank.

1.3. Relationship of GSI Testing to the IMO Convention's G8 and G9 Guidelines, and the USEPA Environmental Technology Verification Program's Protocol

The fundamental approach of GSI is to conduct independent, scientifically-sound, rigorous, and quality assured evaluations of BWTSs. At the same time, GSI seeks immediate relevance of its freshwater, land-based testing to regulatory processes such as those outlined in the IMO Convention and those under development domestically in the United States and Canada. To that end, GSI protocols are rooted in the essential features of the IMO's G8 Guidelines for Approval of Ballast Water Management Systems (IMO, 2008a), the IMO's G9 Guidelines for Approval of Ballast Water Management Systems that make use of Active Substances (IMO, 2008b), and the USEPA ETV Program's *Generic Protocol for the Verification of Ballast Water Treatment Technology,* v.5.1 (NSF International, 2010). All aspects of the GSI land-based facility testing infrastructure (e.g. flow rate, retention tank size, sample size, sample collection and analysis equipment and data logging) are directly consistent with these requirements. GSI also formally partners with the Maritime Environmental Resource Center (MERC; Solomons, MD), and other land-based test facilities, to ensure that GSI freshwater, land-based testing can be complemented by comparable brackish/salt water testing.

With respect to physical/chemical and biological characteristics of the intake stream, GSI is fortunate in that its feed water source (i.e., the Duluth-Superior Harbor of Lake Superior) naturally meets many of the IMO G8 and the USEPA ETV requirements for intake organism densities and physical/chemical conditions during the testing season (June to October, see Table 1). For those parameters that often do not naturally meet the IMO G8 and USEPA ETV requirements (e.g., total suspended solids, mineral matter, particulate organic carbon, and phytoplankton), GSI has the ability to augment intake water to achieve recommended IMO/ETV parameter levels (Table 1). Other parameters may occasionally fall below the challenge water requirements (i.e., zooplankton and heterotrophic bacteria, see Table 1), but GSI conducts IMO- and USEPA ETV-consistent tests only when they are sufficiently high. Though IMO and ETV protocols do not provide for them, GSI and the treatment system developer may also make a determination to set upper limits on certain water quality parameters, such as DOC concentrations, such that tests will be not be run when concentrations are exceedingly high, and these upper limits are reported in the test report. GSI conducts and documents frequent monitoring of water chemistry and biology to predict valid run conditions for GSI, IMO G8, and USEPA ETV performance evaluation/certification test trials.

Table 1. Comparison of USEPA ETV and IMO G8 Recommended Challenge Conditions to Ranges of Various Physical, Chemical, and Biological Parameters in Ambient[a] Water from the Duluth-Superior Harbor of Lake Superior (June – October).

Parameter	US EPA ETV[1]	Recommended IMO G8[2]	Duluth/Superior Harbor Ambient Ranges[a]
Temperature (°C)	4 – 35	No Requirement	4 - 30
Salinity (ppt)	< 1	Two salinities, >10 ppt difference	0 – 1
Total Suspended Solids (mg/L)	Min. 24	> 50	< 1 – 40
Mineral Matter (mg/L)	Min. 20	No Requirement	<1- 40
Particulate Organic Carbon (mg/L)	Min. 4	> 5	< 0.1 – 3
Dissolved Organic Carbon (mg/L)	Min. 6	> 5	6 – 30
Transmittance at 254 nm (%)[b]	No Requirement	No Requirement	14.0 – 68.5
Zooplankton (≥ 50 μm/m^3)	Min. 100,000	> 100,000	100,000 - 1,100,000
Phytoplankton (≥ 10 and < 50 μm/mL)	Min. 1000	> 1,000	25 – 4,500
Heterotrophic Bacteria (MPN[c]/mL)	Min. 1000	> 10,000	100 - 10,000

[a]Duluth-Superior Harbor ambient ranges were obtained from GSI monitoring data and records from June to October 2007 to 2010
[b]Measured on filtered Duluth-Superior Harbor water samples (May 2009 to October 2010)
[c]MPN = Most Probable Number

2.0. METHODS

Four NaOH BWTS trials took place at the GSI land-based test facility from July 6, 2010 to July 22, 2010. The experimental methods including procedures for sampling and analysis of each physical, chemical and biological parameter and variable are described below. All SOPs relevant to the NaOH BWTS tests are listed by analysis category in Appendix 1. Additional details on GSI's standard operating procedures (SOPs) can be found at www.greatshipsinitiative.org.

1 US Environmental Protection Agency, Environmental Technology Verification Program. Generic Protocol for the Verification of Ballast Water Treatment Technologies. Version 5.1. September, 2010.
2 IMO MEPC 57, Annex 3: Revised Guidelines for Approval of Ballast Water Management Systems (G8). April 4, 2008.

2.1. Experimental Design and Set-up

The NaOH BWTS test involved physical, chemical, and biological characterization of water samples upon uptake/intake of water, as well as, enumeration, sizing, and live/dead analysis of organisms in control and treated discharge water after a two- or three-day, in-tank holding time. The objective of the performance evaluation trials was to compare control (untreated) and treatment discharge in order to estimate the effects of the NaOH BWTS for its ability to: (a) successfully treat ballast water without interruption, (b) successfully neutralize treated ballast water to achieve WIDNR permitting levels for harbor discharge (i.e., pH 6-9), (c) meet discharge target values for water chemistry/quality and biology that are approximately consistent with the IMO Convention's Annex D-2 discharge standards, and (d) discharge water after two- or three-day retention periods that is environmentally benign (i.e., no residual toxicity) pursuant to USEPA water quality criteria.

Table 2 shows the schedule of the four trials, including the sequence of intake operations (simultaneous control and treatment) and discharge operations (sequential, treatment then control).

Table 2. Timing of Intake and Discharge Operations during the NaOH Ballast Water Treatment System Research and Development Trials at the GSI Land-Based RDTE Facility.

Trial	Treatment	Timing of Operation			
		Intake		Discharge	
A	Treatment	06 July 2010	11:08 – 12:08	8 July 2010	10:47-11:40
	Control				13:01-13:55
B	Treatment	09 July 2010	9:02 – 10:01	12 July 2010	10:53 – 11:45
	Control				13:18 – 14:12
C	Treatment	13 July 2010	9:02 – 10:02	16 July 2010	10:03 – 10:57
	Control				12:51 – 13:45
D	Treatment	19 July 2010	9:41 – 10:41	22 July 2010	10:12 – 11:07
	Control				12:33 – 13:27

2.1.1. Experimental Infrastructure: The GSI Land-Based Research, Development, Testing, and Evaluation (RDTE) Facility

The test reported here evaluated the performance of the NaOH BWTS at GSI's purpose-built, Land-Based Research, Development, Testing and Evaluation (RDTE) Ballast Treatment Test Facility located in Superior, WI in the Duluth-Superior Harbor of Lake Superior (Figures 1-3). Key features of the facility include:

- Four x 200 m^3 matched retention tanks with internal agitation for experimental water;

- Matched control and treatment intake flows up to 341 m^3/hour;
- Highly automated flow and pressure control, monitoring and data logging;
- A freshwater estuary with plentiful aquatic life as a water intake source;
- Capacity to amend intake water to intensify challenge conditions;
- Semi-automated and validated facility sanitation between trials;
- High quality in-line or in-tank sampling and/or spiking;
- On-site laboratory space for live analysis of organisms in the $\geq 10\ \mu$m and $< 50\ \mu$m and $\geq 50\ \mu$m size classes;
- Capacity to test treatment systems that operate on intake, discharge, in-tank, or combinations thereof;
- Off-site whole effluent toxicity (WET) testing; and
- Easy plug-in connections for treatment systems.

Figure 1. Location of GSI's Land-Based RDTE Facility in Superior, Wisconsin.

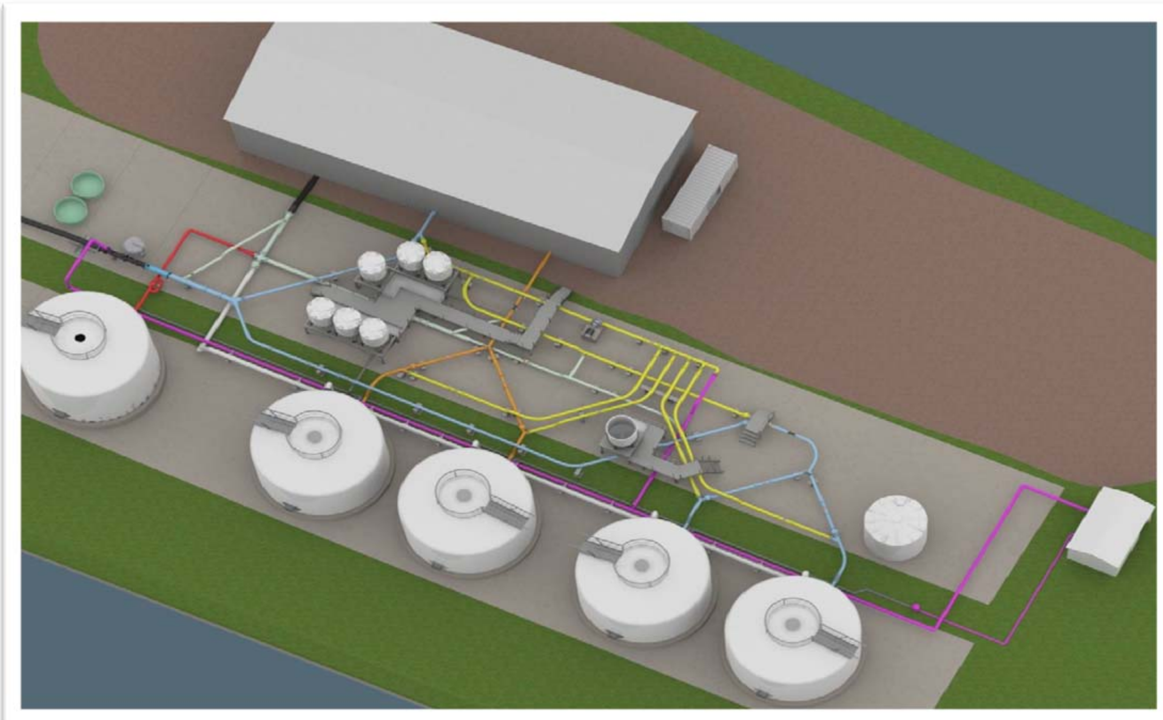


Figure 2. Computer-Generated Rendering of the GSI Land-Based RDTE Facility.

Figure 3. Photo of the GSI Land-Based RDTE Facility.

GSI's Land-Based RDTE Facility draws raw intake water from the Duluth-Superior Harbor at 400 m^3/hr to 680 m^3/hr. This main flow of intake water can be augmented with solids and/or organisms just prior to being split into control and treatment tracks (see injection points A and B; Figure 4).

A Y-split in the intake piping, just after a static mixer, simultaneously channels one half of the well-mixed flow (200 m^3/hr to 340 m^3/hr) to a treatment track and the other half (also 200 m^3/hr to 340 m^3/hr) to a matched control track (Figure 4). The treatment track directs water through the experimental BWTS and into a 200 m^3, cylindrical retention tank (Figure 4). The control track by-passes the treatment system and channels water directly into a matched control retention tank (Figure 4).

After a retention period, water is discharged sequentially from the treatment and control retention tanks at 200 m^3/hr to 340 m^3/hr. The water is directed either back to the Duluth-Superior harbor, to a 260-m^3 wastewater storage tank for subsequent discharge to the City of Superior sewer, neutralization, or circulated to a second set of facility retention tanks (Figure 4).

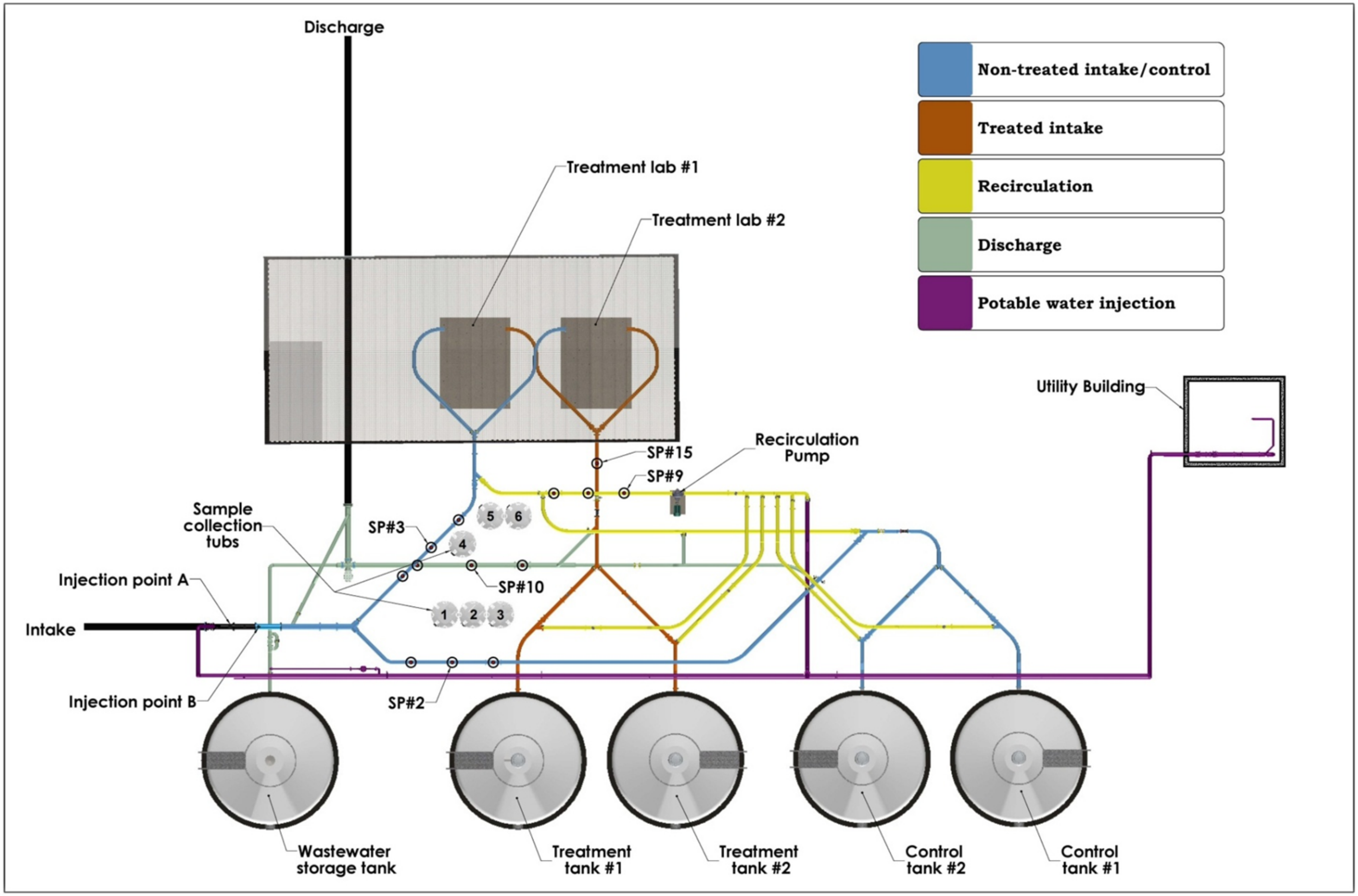


Figure 4. Simplified Schematic of the GSI Land-Based RDTE Facility Showing Location of Sample Points, Sample Collection Tubs, Injection Points, Retention Tanks, and Treatment and Control Tracks. Note: Main intake and discharge lines are coded black.

Water is sampled continuously throughout ballasting functions (i.e., intake, recirculation or discharge) through in-line sample points (SPs). Intake sampling takes place at paired intake sample points (SP#2 and SP#3) on the control and treatment tracks, respectively, and immediate post-treatment sampling occurs at SP#15 (Figure 4). Typically, discharge biological sampling is conducted at SP#9, with samples for water quality analysis collected at SP#10 (Figure 4). All these SPs consist of three identical sample ports spaced at regular intervals in a length of straight pipe consistent with IMO guidelines, with the exception of SP#15, which has only one sample port. Each port is fitted with a center-located, elbow-shaped pitot tube (90^o) which samples the water (Figure 5). This pitot design is based on one developed and validated analytically by the U.S. Naval Research Laboratory in Key West, Florida. The performance of the three identical sample ports at SP #2, 3, 9 and 10 was also validated empirically at GSI, and shown to produce equivalent, representative and unbiased samples of water flow.

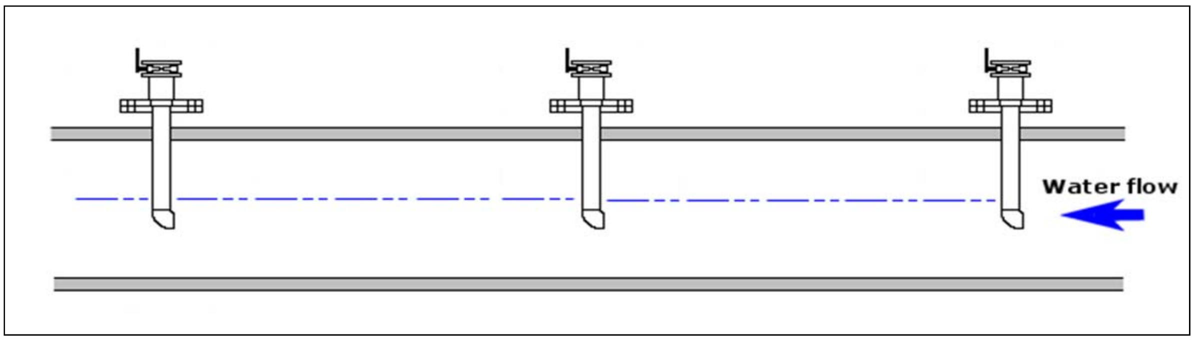


Figure 5. Simplified Schematic of a Sample Point (SP), Showing the Three Sample Ports.

Sample water drawn by sample ports is transferred simultaneously and continuously throughout ballasting operations (intake, recirculation or discharge) from the sample ports to replicate 3.8 m^3 sample collection tubs via clean 3.8 cm (internal diameter) flexible hoses and automated flow-controlled pneumatic diaphragm valves. The sample collection tubs, pictured in Figure 4, connect to the sample ports in the arrangement detailed Table 3. Though the same tubs serve as collection mechanisms for sample flow from more than one pitot, only one such pitot is used at a time during any given sample collection event. The naming convention for an individual pitot is: "SP number" plus "sample port letter". Sample collection tubs are labeled numerically 1-6.

Table 3. Intake and Discharge Sample Points (SPs) and their Corresponding Sample Port Pitots and Sample Collection Tubs.

	INTAKE							DISCHARGE					
	SP#2			SP#3			SP#15	SP#9			SP#10		
Sample Port Pitot	a	b	c	a	b	c	a	a	b	c	a	b	c
Sample Collection Tub	1	2	3	4	5	6	6	3 & 6	2 & 5	1 & 4	3 & 6	2 & 5	1 & 4

An on-site mobile field laboratory (Figure 6) and stationary laboratory (Figure 7) provide space to support time-sensitive analyses associated with the GSI land-based tests, including live analysis of phytoplankton and zooplankton. The laboratories are climate-controlled, and have enough bench space to allow for simultaneous analysis of samples by multiple personnel. All other analyses are conducted in laboratories of the Lake Superior Research Institute (LSRI) of the University of Wisconsin-Superior; approximately three miles from the facility.

Figure 6. The GSI Mobile Field Laboratory.

Figure 7. The GSI Stationary Laboratory.

2.1.2. Challenge Conditions and Organism Injection Procedures

The expected ranges of physical, chemical and biological challenge conditions for the NaOH BWTS test trials appear in Table 4. Ambient Duluth-Superior Harbor water conditions were employed as the physical and chemical challenge conditions during all four trials. Biological challenge conditions were ambient during Trials A-C. During Trial D, organism densities in the smaller of the two plankton size classes (i.e., $\geq$ 10 and < 50 μm) were augmented to achieve greater than 1000 cells/mL on intake and thereby intensify challenge conditions. The phytoplankton injection procedure is detailed in *GSI/SOP/LB/G/O/5 – Procedure for Injecting Organisms and Solids into the GSI Land-Based RDTE Facility*. One to two days prior to the test trial, phytoplankton from the Duluth-Superior Harbor was collected and concentrated using 50- to 80 μm plankton nets towed from an outboard-powered boat. The concentrated phytoplankton was stored at the GSI Land-Based RDTE Facility in holding ponds equipped with aeration systems for less than 48 hours. Prior to injection, holding pond water containing concentrated phytoplankton was mixed, sampled, and analyzed for live cell density. In addition, a sample of Duluth-Superior Harbor water was collected to determine the ambient live cell density. Based on the density of cells in the holding ponds and ambient intake water, the volume of phytoplankton concentrate that was needed to achieve the desired density in intake water was calculated. This volume was added to the Organism Pressure Injection System (OPIS) vessel. The OPIS vessel was pressurized to 25 psi greater than the target system pressure. The phytoplankton concentrate was added at a constant rate to the intake water via the pressure differential for the entire duration of the intake procedure via Injection Point B (Figure 4). A static mixer installed in the main intake line just downstream of the two injection systems (SIS and OPIS) and prior to the main system "Y split" (Figure 4) ensured that the concentration of added phytoplankton was equivalent in the control and treatment tracks of the facility. Gentle agitators installed in the control and treatment retention tanks ensured that live organisms, especially less motile organisms that may settle to the bottom of the tank during the retention period, were accounted for to the greatest extent possible in the discharge water analysis (see *GSI/SOP/LB/G/O/7 – Procedure for Maintaining Solids Suspension in the GSI Land-Based RDTE Facility's Retention Tanks*).

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Table 4. Challenge Water Conditions for GSI Test Trials of the NaOH BWTS.

Parameter	Expected Ranges for GSI NaOH BWTS Challenge Water
Temperature (°C)	Ambient (4 – 30*)
Salinity (ppt)	Ambient (0 – 1*)
Total Suspended Solids, TSS (mg/L)	Ambient (≥ 1 – 40*)
Particulate Organic Carbon, POC (mg/L)	Ambient (< 0.1 – 3*)
Dissolved Organic Carbon, DOC (mg/L)	Ambient (6 – 30*)
Mineral Matter, MM (mg/L)	Ambient (≥ 1 – 40*)
Zooplankton (≥ 50 μm/m^3)	Ambient (100,000 – 1,100,000*)
Phytoplankton (≥ 10 and < 50 μm/mL)	Trial A-C - Ambient (> 25*) Trial D – Concentrated Ambient(≥ 1,000)
Heterotrophic Bacteria (MPN/mL)	Ambient (100 – 10,000 MPN/mL*)

*Duluth-Superior Harbor ambient ranges were obtained from GSI monitoring data and records from June to October 2007 to 2010.

2.1.3. Sodium Hydroxide (NaOH) and Carbon Dioxide (CO_2) Dosing and Operational Parameters

A 50 % by weight sodium hydroxide (NaOH) solution with a specific gravity of 1.53 was metered into the intake water in the treatment track (Figure 4) to achieve a pH of 12. The pH of the treatment water stream was monitored every ten seconds during the entire intake operation (i.e., before, during, and after NaOH injection) using an inline Signet pH sensor with built-in automatic temperature compensation (Georg Fischer Signet LLC; El Monte, CA) that was located downstream of the dosing equipment. The inline pH sensor was calibrated prior to each trial's intake operation according to the manufacturer's instructions, using a two-point calibration with pH 7 and 10 buffers. The NaOH dosing procedure began by partially closing the NaOH flow control valve (valve #9, Figure 8) in the main line of Treatment Lab #2 and opening the valves leading to the dosing pumps (Figure 8). This valve configuration created a pressure differential upon flow commencement that primed the two dosing pumps located in a side stream to the main line. Once the pressure differential reached 8-10 pounds per square inch, both centrifugal dosing pumps were started to provide a combined flow of 30-40 gallons per minute

(GPM). The supply valve from the NaOH tank was then opened and a flow of approximately 0.9 GPM was added into the 30-40 GPM from the dosing pumps by using a Venturi injector. A technician monitored the flow rate of NaOH and maintained it at 0.9 GPM during the dosing procedure. The dosing proceeded until 450 pounds (or approximately 35.2 gallons) of the 50 % by weight NaOH solution had been injected as measured from a Salter/Brecknell model SBI100 electronic scale, then the valve leading from the NaOH tank was closed and a bypass line was opened to flush the injection lines with Duluth-Superior Harbor water. The flushing of the NaOH dosing system continued for the remainder of the intake operation.

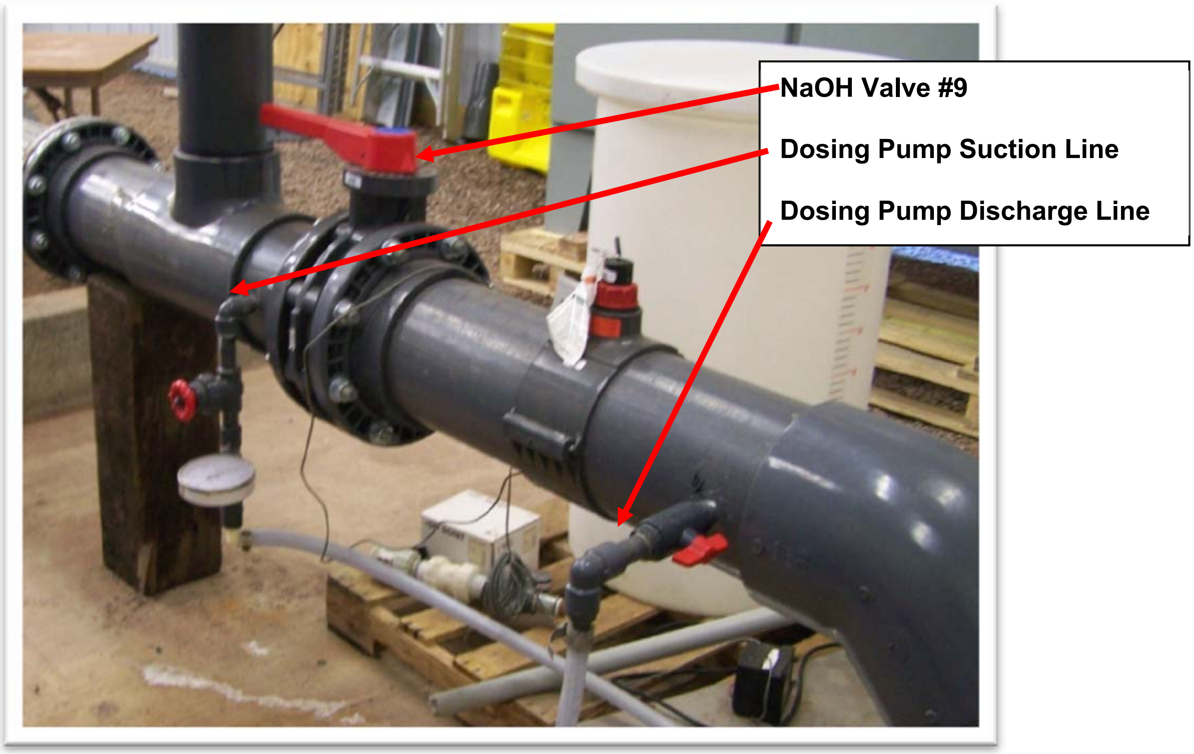

Figure 8. Photo of the NaOH Dosing Procedure Setup in Treatment Lab #2 of the GSI Land-Based Facility's Stationary Laboratory.

Following a two- or three-day retention time, the pH of the treated water was neutralized with carbon dioxide (CO_2) gas. An inline pH meter and Walchem pH sensor (Walchem; Holliston, MA) with built-in automatic temperature compensation were located on the inlet pipe of a Speece Cone; the pH probe was calibrated using fresh pH 7 and 10 buffers as per the calibration procedure outlined in the operator's manual. Water was removed from the treatment retention tank through an outlet centered in the base of the tank and plumbed from the existing 8" steel piping to a 6" diesel pump by flexible 4" PVC piping. The diesel pump drove the pH 12 water through a Speece Cone where the CO_2 gas was injected. The CO_2 was fed into the top of the Speece Cone so the inline rotameter read 15 standard cubic feet per minute (SCFM) which equated to a gas flow of 34 SCFM (by applying a pressure correction factor of 2.268). The pressure in the apex of the cone was kept at 18 pounds per square inch gauge (PSIG) and the flow through the cone was maintained between 560 and 600 GPM using a combination of adjusting the discharge valve on the cone and the pump speed. The CO_2-enriched water was discharged subsurface back into the treatment retention tank using a PVC T-Joint that reduced the 6" feed to two, 3" jets oriented in opposite directions. The CO_2 flow continued at a rate of 15 SCFM until the inline pH probe indicated a pH of 8.5. Following, the flow of $CO_2$was cut off, and the neutralized water continued to recirculate for an additional 10 minutes to ensure the water was well mixed. Prior to the discharge operation, a 1 L sample was collected at mid-depth (i.e., using a Kemmerer Sampler) from the treatment retention tank, and measured using an Orion 3 Star pH Meter and pH Combination Electrode (Thermo Scientific) according to §2.2.1 below, to confirm the pH was 6.5-8.5.

Flow control valves and system logic assured that sample flow rates were equivalent and proportional to intake and discharge flow rates throughout each intake and discharge operation. Flow rates were recorded continuously every five seconds by automated, in-line sensors located on the control track, treatment track, and on the discharge line. Pressure readings were also recorded continuously at multiple points throughout the facility. These data, as well as, other operational and maintenance parameters (e.g., retention tank volume and volume sampled) were measured and recorded continuously using a Human Machine Interface (HMI) installed at the GSI Land-Based RDTE Facility. The HMI has a 15" color touch display and is capable of detailing valve positions, pressure from the pressure meters, fill level of the ballast retention tanks, and flow rates in the control and treatment lines, etc. The HMI console then saved the information to a specific file. An external computer, connected to the HMI, was used to store the data files.

2.1.4. Preventing Cross Contamination

To minimize potential cross contamination of the treatment discharge water between trials, prior to the first trial and after each test trial, the interior of the retention tanks were cleaned according to *GSI/SOP/LB/G/O/3 – Procedure for Cleaning and Verifying Cleanliness of the Retention Tanks and Piping at the GSI Land-Based RDTE Facility*. After each intake and discharge operation, the sampling equipment (i.e., sample collection tubs, drain spout hose and nozzle, plankton nets, etc.) was cleaned according to *GSI/SOP/LB/G/O/4 – Procedure for Cleaning Sampling Equipment at the GSI Land-Based RDTE Facility*. The GSI facility recirculation lines were flushed with potable water from an on-site potable water tank that had been verified to be free of living organisms. The flushing was undertaken after each intake and prior to each discharge operation. The thoroughness of the cleaning process was checked by partially filling a randomly selected treatment sample collection tub with potable water, draining that water through a 35 μm plankton net, and examining the filtrate for evidence of living organisms. The facility was deemed clean only if the filtrate water was completely free of live Duluth-Superior Harbor zooplankton visible with a compound microscope at a magnification of 40X to 100X (see *GSI/SOP/LB/G/O/3*). Nets and other sample collection equipment were likewise validated for cleanliness prior to each sample operation (see *GSI/SOP/LB/G/O/4*).

2.2. Water Quality Analysis

2.2.1. pH

Samples for pH analysis were collected during intake as follows:

- Three 1 L whole water samples were collected from the pre-treatment line (SP #3; Figure 4) at approximately 10, 30, and 50 minutes after the start of the intake procedure (which lasted approximately 57 minutes), and
- One 1 L whole water sample was collected from the treatment retention tank (Figure 4) after it was filled (i.e., using a Kemmerer Sampler) to confirm the pH was approximately 12.

The following samples were collected during discharge:

- Two 1 L whole water samples were collected from the treatment retention tank using a Kemmerer Sampler (Figure 4); one prior to neutralization of the treatment water via CO_2 injection and one after the neutralization procedure was completed,
- One 1 L whole water sample was collected from the treatment line approximately 30 minutes after the start of the discharge procedure via SP #10 (Figure 4, Trials A and B) and SP #15 (Figure 4, Trials C and D), and
- One 1 L whole water sample was collected from the control line approximately 30 minutes after the start of the control tank discharge procedure (SP #10, Figure 4).

Sample analysis was conducted according to *GSI/SOP/BS/RA/C/9– Procedure for pH Meter Calibration and pH Measurement*. Measurements were made using an Orion 3 Star pH Meter and pH Combination Electrode (Thermo Scientific). The pH electrode was calibrated daily prior to use with certified pH buffers 4, 7, and 10. In addition, a pH "Check Buffer" (i.e., pH 12.45 buffer) was used to verify the accuracy of the pH electrode following calibration at pH values greater than the most basic pH calibration buffer (i.e., pH > 10). Prior to Trial A, the Automatic Temperature Compensation (ATC) probe was calibrated; the display temperature was checked weekly during the testing and the ATC probe was recalibrated if needed.

Quality control measures consisted of collecting and analyzing one of the samples from all pH samples collected during the four trials in duplicate.

2.2.2. Total Suspended Solids (TSS), Including Mineral Matter (MM)

Samples for TSS analysis were collected during intake and discharge as follows:

- On intake, three 1 L whole water samples were collected from the pre-treatment line (SP #3; Figure 4) approximately 10, 30, and 50 minutes after the start of the intake procedure.
- On discharge, one or three 1 L whole water samples were collected from the treatment line approximately 30 minutes (i.e., one sample) or 10, 30, and 50 minutes

(i.e., three samples) after the start of the discharge procedure. Samples were collected using SP #10 (Figure 4) for Trials A and B and SP #15 (Figure 4) for Trials C and D. In addition, one or three 1 L whole water samples were collected from the control line approximately 30 minutes (i.e., one sample) or 10, 30, and 50 minutes (i.e., three samples) after the start of the control tank discharge procedure (SP #10, Figure 4).

Samples were collected in-line rather than from the sample collection tubs to avoid settling of suspended solids. This approach assured a more accurate measurement of solids and organic carbon in the intake water.

Sample analysis was conducted according to *GSI/SOP/BS/RA/C/8– Procedure for Analyzing Total Suspended Solids (TSS)*. The samples were vacuum filtered through pre-washed, dried, and pre-weighed Whatman 934-AH glass fiber filters. After the sample was filtered, it was dried in an oven and brought to constant weight. TSS values were determined based on the weight of particulates on the filter and the volume of water filtered.

Quality control measures consisted of collecting and analyzing one of the samples from all TSS samples collected during the four trials in duplicate.

Mineral matter is defined as the difference between TSS and particulate organic matter (measured as POC). Therefore, MM concentrations were determined in each sample collected during these trials on intake following analysis of TSS, and the determination of POC as calculated from the NPOC and DOC concentrations (see §2.2.3.).

2.2.3. Non-Purgeable Organic Carbon (NPOC) and Dissolved Organic Carbon (DOC), and Determination of Particulate Organic Carbon (POC) Concentrations

Samples for NPOC, DOC, and POC analysis were collected immediately after TSS sample collection during intake only as follows:

- Three 125 mL whole water samples were collected from the pre-treatment line (SP #3, Figure 4) approximately 10, 30, and 50 minutes after the start of the operation.

In these tests, NPOC was measured as a surrogate for total organic carbon (TOC), though it may be a slight underestimate of TOC. The analytical instrument used to measure NPOC purges the sample with air to remove inorganic carbon before measuring organic carbon levels in the sample. Thus, the NPOC analysis does not incorporate any volatile organic carbon which may be present in the sample.

Sample analysis was conducted according to *GSI/SOP/BS/RA/C/3– Procedures for Measuring Organic Carbon in Aqueous Samples*. Upon arrival at LSRI, an aliquot of each 125 mL sample was filtered through a Whatman GF/F filter and acidified with hydrochloric acid for analysis of DOC. The remaining portion of the sample was acidified with hydrochloric acid and analyzed for NPOC. A Shimadzu Total Organic Carbon Analyzer (Model TOC-5050A; Shimadzu

Scientific Instruments, Inc.; Columbia, MD) was employed for analysis of both NPOC and DOC. Concentrations of NPOC and DOC were determined based on a calibration curve developed on the instrument using organic carbon standards prepared from potassium hydrogen phthalate. Reported particulate organic carbon (POC) concentrations were determined as the difference between the NPOC and DOC values for a given sample.

Quality control measures consisted of collecting and analyzing two of the samples from all organic carbon samples collected during the four trials in duplicate. A TOC reference standard (NSI Solutions Inc., Raleigh, NC QCI-062, Lot #051210-09) was analyzed once during testing to confirm the accuracy of the data being generated.

2.2.4. Percent (%) Transmittance

An aliquot of the filtered portion of each sample collected for TSS analysis was analyzed to determine percent transmittance. Sample analysis was conducted according to *GSI/SOP/BS/RA/C/4 – Procedure for Determining Percent Transmittance (%T) of Light in Water at 254 nm*. A spectrophotometer set at 254 nm was used to measure %T of the filtered samples. Deionized water was used as a reference to adjust the spectrophotometer to 100 %T, and each filtered sample was measured in a pre-rinsed sample cuvette.

2.2.5. Water Quality Measurements using YSI Multiparameter Water Quality Sondes

Water quality was measured during each trial using calibrated YSI Multiparameter Water Quality Sondes (YSI 6600 V2-4 Sondes; YSI Incorporated; Yellow Springs, OH, USA). The Sondes were calibrated prior to each trial following *GSI/SOP/LB/G/C/4 - Procedure for Calibration, Deployment, and Storage of YSI Multiparameter Water Quality Sondes*. The YSI Sondes have multiple probes that are able to measure the following parameters: dissolved oxygen, specific conductivity, salinity, temperature, pH, turbidity, and total chlorophyll. Water quality parameters were measured from approximately 1 L samples of water from each sample collection tub sampled on intake and discharge. Samples were taken immediately following collection of phytoplankton and microbial samples, and each measurement was recorded on pre-printed datasheets. In addition, water quality parameters in the control and treatment retention tanks were measured at mid-depth every 15 minutes during the two- or three-day holding time. Prior to discharge of the respective tanks, the Sondes were removed and taken to the mobile laboratory where the data were later downloaded as test files to a laptop computer using EcoWatch® for Windows® Software (v.3.18, 14 April 2006; YSI Incorporated); the files were then translated to MS Excel files, which were stored on a laptop computer in the mobile laboratory and later uploaded to the GSI SharePoint intranet website.

2.3. Viable Organism Analysis

During these trials sample water for analysis of viable organisms was simultaneously and continuously collected from replicate sample ports into identical 3.8 m^3 sample collection tubs during each intake, treatment discharge, and control discharge operation (retention tank discharge was sequential, treatment then control). Volumes retained were always greater than volumes recommended in the IMO Convention's G8 guidelines. The water in each sample collection tub constituted an independent, time-integrated, replicate sample of the 200 m^3 experimental water mass.

2.3.1. Organisms ≥ 50 µm in Minimum Dimension

2.3.1.1. Sample Collection

During the intake operation, i.e. the filling of the treatment and control 200 m^3 retention tanks, the following time-integrated sample volumes were collected and analyzed (additional samples were collected but were not analyzed) by continuous flow from the intake lines simultaneously:

- One 2 m^3 sample from the pre-treatment intake line, and
- One 2 m^3 sample from the control intake line.

The pre-treatment and control samples served as replicate intake sub-samples for each trial.

During discharge the following time-integrated sample volumes were collected and analyzed (additional samples were collected but were not analyzed):

- Two time-integrated samples of 2 m^3 each (total volume 4 m^3) were continuously collected from the treatment discharge line, and
- One 2 m^3 time-integrated sample was continuously collected from the control discharge line.

Flow control valves and system logic assured that sample flow rates were equivalent and proportional to intake and discharge flow rates throughout each operation. Immediately after the sample collection tubs were filled, the phytoplankton and microbial whole water samples were collected and Sonde readings recorded, followed by the zooplankton sample collection. The zooplankton samples were collected by draining the remaining volumes (i.e., 2 m^3 minus 5 L of rinse/Sonde water and the 1 L phytoplankton and microbial samples) from the sample collection tubs and concentrating through 35 μm (50 μm diagonal dimensions) plankton nets into 1 L cod-ends for microscopic examination. See *GSI/SOP/LB/RA/SC/6 - Procedure for Zooplankton Sample Collection*. On intake, the zooplankton sample collection order alternated between collecting the pre-treatment or the control sample first. After the first sample was collected and analyzed, then the second sample was collected (either the control or the pre-treatment) and analyzed. On discharge, the treatment and control samples were also collected sequentially.

2.3.1.2. Live/Dead and Size Analysis

All live/dead analysis was conducted according to *GSI/SOP/LB/RA/SA/2 - Procedure for Zooplankton Sample Analysis*, and took place within two hours of collecting and concentrating the individual samples. Microzooplankton (e.g., rotifers, copepod nauplii, and dreissenid veligers) and macrozooplankton (e.g., copepods, cladocerans, and insect larvae), all generally greater than or equal to 50 μm in minimum dimension, were analyzed simultaneously by separate taxonomists. Microzooplankton subsamples were analyzed in a Sedgewick-Rafter counting chamber by examination under a compound microscope at a magnification of 40X to 100X. Macrozooplankton were analyzed in a Ward's Counting Wheel at a magnification of 20 to 30X using a dissecting microscope. Due to high densities, quantification of zooplankton in the control intake, pre-treatment intake, and control discharge samples required analysis of sub-samples and extrapolation to number live organisms per cubic meter. For these samples, a subsample was removed for analysis using a Henson-Stempel pipette. The dead organisms (i.e., those organisms that did not move or respond to stimuli) were enumerated, then all organisms in the sample were killed by adding 50 % (v/v) acetic acid solution (for microzooplankton) or Lugol's solution (for macrozooplankton) to the counting chamber/wheel and the total number of organisms was enumerated. The number of live organisms was quantified by subtracting the number of dead organisms from the total number of organisms in the counting chamber/wheel. The treatment discharge samples had lower densities allowing analysis of a greater proportion of the sample (see the "Results" section for the proportion of sample volumes analyzed). Therefore, the treatment discharge samples were split in half using a Folsom Plankton Splitter. Half of the sample was analyzed for macrozooplankton and the other half was examined for microzooplankton. Only live organisms were enumerated using standard movement and response to stimuli techniques.

Statistical analysis for the ≥ 50 μm size class for the four trials was conducted using SigmaStat, version 3.5 (Systat Software, Inc.; Chicago, IL USA). A One Way Analysis of Variance (ANOVA) was used to determine the differences in the mean values among the treatment groups if the data were normally distributed with equal variance. If the data did not meet the assumptions of the One Way ANOVA, the data were transformed using either log (base 10), log normal, or square root transformation and a One Way ANOVA was used to compare the transformed data. If transformation did not produce normally distributed data with equal variance, an appropriate non-parametric test was used. In all cases α=0.050.

Quality assurance measures during these trials included live/dead analysis of four intake (i.e., one pre-treatment and three control samples) and one control discharge sample by two separate taxonomists over the course of the four trials. The average percent similarity of taxonomic identification (live organisms only) and the average relative percent difference of the number of live organisms counted were calculated for all second analyses. In addition, all live organisms identified in the treatment discharge samples were recorded and verified to be live by a second taxonomist, and the minimum visible dimension was measured using an eyepiece micrometer and recorded. Those organisms that were determined to be less than 50 μm in minimum visible dimension were reported separately from the live zooplankton that did meet the size criterion detailed in Annex D-2 of the IMO Convention (IMO, 2004).

2.3.2. Organisms ≥ 10 and < 50 µm in Minimum Dimension

2.3.2.1. Sample Collection

For live analysis of organisms ≥ 10 and < 50 μm in minimum dimension, during intake the following whole water samples were collected:

- One 1 L sample was collected immediately after filling from the pre-treatment sample collection tub (Tub #4, Figure 4), and
- One 1 L sample was collected from the control sample collection tub (Tub #1, Figure 4).

The pre-treatment and control samples served as replicate intake sub-samples for each trial.

During discharge:

- Three 1 L samples were collected from the three treatment sample collection tubs (Tubs #4-#6, Figure 4), and
- One 1 L sample was collected from the control tank via the sample collection tub (Tub #1, Figure 4).

The three, 1 L treatment discharge samples were composited for analysis. Analysis of all samples occurred on-site within 1.5 hours of sample collection, with samples stored in coolers during the interim. Prior to analysis, samples were concentrated through 10 μm mesh plankton netting and stored in a 25 mL sample container. See *GSI/SOP/LB/RA/SC/3 - Procedure for Algae/Small Protozoa Sample Collection*.

2.3.2.2. Sample Analysis

Sample analysis was conducted according to *GSI/SOP/LB/RA/SA/1 - Procedure for Algae/Small Protozoan Sample Analysis.* A 1.5 mL subsample of the concentrated sample was transferred to a 2 mL sample container, with 4 μL of fluorescein diacetate (FDA) viability stain stock solution added. The subsample was then allowed to incubate in the dark for 5 minutes. The 1.5 mL incubated sample was mixed and 1.1 mL was immediately transferred to a Sedgwick-Rafter cell, covered and placed on the stage of a microscope that was set for simultaneous observation using brightfield and epifluorescence. At least two horizontal transects were counted (an area known to reflect greater than 1 mL of original sample water), aiming for at least 100 entities (i.e., unicellular organism, colony or filament) counted. If time permitted, additional transects were counted to increase statistical power. Single cell entities and cells comprising colonial and filamentous entities were characterized as follows: alive = cells showing obvious green fluorescence from cell contents; dead = cells showing no or very little evidence of green fluorescence from cell contents; and ambiguous = cells or entities that cannot be clearly identified as alive or dead (were uncommon). Records were kept of transect lengths and widths so that the total counted area and volume analyzed could be calculated later.

Entities less than 10 μm in all visible dimensions or greater than 50 μm in minimum visible dimension were not counted. Counting and measurement of all other entities followed standard procedures for individuals (length and width), colonies (e.g., number of cells, cell length and width) and filaments (e.g., number of cells, cell length and width or total filament length if cells could not be discerned). The remaining concentrated sample in the 25 mL bottle was archived using a preservative (formalin or Lugol's) for long-term storage.

Statistical analysis for the ≥ 10- and < 50 μm size class for the four trials was conducted using SigmaStat, version 3.5 (Systat Software, Inc.; Chicago, IL USA). A One Way ANOVA was used to determine the differences in the mean values among the treatment groups if the data were normally distributed with equal variance. If the data did not meet the assumptions of the One Way ANOVA, the data were transformed using either log (base 10), log normal, or square root transformation and a One Way ANOVA was used to compare the transformed data. If transformation did not produce normally distributed data with equal variance, an appropriate non-parametric test was used. In all cases α=0.050.

Quality assurance measures included analysis of one intake sample and three discharge samples (i.e., two treatment and one control discharge) by two separate taxonomists using a dual-headed microscope (i.e., both taxonomists analyzed the same sample at the same time) over the four trials of the NaOH BWTS. In addition, subsample analysis was conducted on two treatment discharge samples (over the entire four-trial NaOH BWTS Test) by a single taxonomist (i.e., one taxonomist analyzed two separate aliquots from one sample) to determine within sample precision. The average percent similarity of taxonomic identification and the average relative percent difference of the number of live organisms counted were calculated for all second analyses.

2.3.3. Organisms < 10 μm in Minimum Dimension

Control and treatment samples for these trials were collected and analyzed for heterotrophic bacteria and three specific indicator organisms for waterborne pathogens: total coliform bacteria, *Escherichia coli* and *Enterococcus spp.*

2.3.3.1. Sample Collection

Whole water samples were collected as follows:

- On intake, three 1 L samples were collected immediately after filling the pre-treatment sample collection tub and collection of the ≥ 10 and < 50 μm size class sample (Tub #4, Figure 4).
- On discharge, three 1 L samples were collected immediately after tank discharge from the treatment sample collection tubs (Tubs #4-#6, Figure 4), and three 1 L samples were collected from the control retention tank via Tub #1 (Figure 4) after collection of the ≥ 10 and < 50 μm size class sample.

All samples were collected according to *GSI/SOP/LB/RA/SC/4 – Procedure for Microbial Sample Collection*, and were transported within one hour of collection in an insulated cooler to LSRI and analyzed as individual replicates.

2.3.3.2. Sample Analysis

Viable heterotrophic bacteria were enumerated according to *GSI/SOP/BS/RA/MA/1 – Procedure for Quantifying Heterotrophic Plate Counts (HPCs) using IDEXX's SimPlate® for HPC Method*.

This method utilizes the IDEXX SimPlate® for HPC Method (IDEXX Laboratories, Inc.; Westbrook, Maine), which is based on IDEXX Laboratories' patented multiple enzyme technology.

The most probable number (MPN) per 100 mL of total coliform bacteria, *E. coli* (*GSI/SOP/BS/RA/MA/4 - Procedure for the Detection and Enumeration of Total Coliforms and E. coli Using IDEXX's Colilert®*) and enterococci (*GSI/SOP/BS/RA/MA/3 - Procedure for the Detection and Enumeration of Enterococcus using Enterolert™*) were determined using Quanti-Tray/2000® with Colilert® and Enterolert™, respectively, which are both based on IDEXX's patented Defined Substrate Technology (DST®; IDEXX Laboratories, Inc.; Westbrook, Maine).

Statistical analysis for all four types of bacteria in the <10 μm size class (i.e., total coliform bacteria, *E. coli*, *Enterococcus spp*., and total heterotrophic bacteria) for the four trials was conducted using SigmaStat, version 3.5 (Systat Software, Inc.; Chicago, IL USA). A One Way ANOVA was used to determine the differences in the mean values among the treatment groups if the data were normally distributed with equal variance. If the data did not meet the assumptions of the One Way ANOVA, the data were transformed using either log (base 10), log normal, or square root transformation and a One Way ANOVA was used to compare the transformed data. If transformation did not produce normally distributed data with equal variance, an appropriate non-parametric test was used. In all cases α=0.050.

Quality control samples analyzed for each intake and discharge operation included a media blank and a positive control for *E. coli*/total coliforms and *Enterococcus spp*., and a media blank for heterotrophic bacteria. Quality assurance measures included analysis of at least 10 % of the samples in duplicate from the total number of samples collected over the four trials. The average relative percent difference of all duplicates analyzed during the trials was calculated separately for *E. coli*, *Enterococcus spp*., and heterotrophic bacteria.

2.4. Whole Effluent Toxicity (WET) Testing

GSI's whole effluent toxicity (WET) testing of the NaOH BWTS was conducted using three freshwater species as described in Table 5. The WET tests were conducted on *P. promelas* and *C. dubia* using Trial B treatment discharge, and on *P. promelas*, *C. dubia*, and *S. capricornutum* using Trial D treatment discharge.

The WET of treatment discharge water was determined using standard USEPA procedures (USEPA, 2002) following a three-day retention period in the land-based facility's 200 m^3 treatment retention tank (Figure 4). Sample water (i.e., 19 L), collected from one of the treatment discharge sample collection tubs using a 20 L, high-density, polyethylene container, was immediately transported to LSRI and used upon arrival to set up the WET tests. Following set up of the tests, the remaining sample water was stored at 4 °C in the dark to preserve as much of the initial water quality/chemistry properties as possible, and portions (i.e., 2 to 3 L) of the discharge sample water was warmed to 25 °C each day to serve as renewal water for the bioassay. Filtered Duluth-Superior Harbor water (i.e., filtered through a Whatman 934-AH Glass Microfiber Filter, 1.5 μm particle retention in liquid) served as the control, and treatments consisted of 0 % treatment discharge water (i.e., filtered harbor water control), 100 % treatment discharge water, and a performance control (i.e., *Ceriodaphnia dubia* and *Pimephales promelas* culture water, and algae growth media for *Selenastrum capricornutum*). All tests were conducted in temperature-controlled incubators or water baths, or at ambient room temperature following the SOPs listed in Table 5. Differences in mean percent survival (for *C. dubia* and *P. promelas*), mean dry weight values (for *P. promelas*), mean *S. capricornutum* cell density, and mean number of *C. dubia* young per female between the 0 % and 100 % treatment discharge groups were analyzed for statistical significance at α=0.05 using a One-Way Analysis of Variance and a post hoc statistical comparison.

The WET tests were initiated with healthy, vigorous organisms. To determine the overall health of the test organisms, reference toxicant tests were performed with the cladoceran *Ceriodaphnia dubia* and the minnow *Pimephales promelas* prior to the start of each definitive test or at least once per month. In addition, a performance control was used for all species tested. The performance control consists of the normal culturing conditions for each species, providing the test organisms with the optimal environment for survival, growth, and reproduction. Therefore, the performance control, along with the reference toxicant tests, provides verification of the health of the test organisms. To determine the validity of the WET tests, percent survival of *C. dubia* and *P. promelas*, dry weights of surviving *P. promelas*, mean *S. capricornutum* cell density, and mean number of young per female *C. dubia* in the controls were compared to the test acceptability criteria published in the USEPA's *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (2002). Class I weights were used to verify the accuracy of the laboratory balance according to *GSI/SOP/BS/RA/GL/1 – Procedure for Verification of Laboratory Balances*. Daily or weekly calibration of test meters ensured optimal performance. The *P. promelas* drying process is verified by re-weighing a percentage of the fish after they have been dried for an additional length of time in the oven.

Table 5. Standard Operating Procedures Relative to Whole Effluent Toxicity (WET) Testing.

GSI SOP Code	Test Type	Test Species	Test Endpoint
GSI/SOP/BS/RA/WET/1	Short-Term, Chronic	Cladoceran (*Ceriodaphnia dubia)*	Survival and Reproduction
GSI/SOP/BS/RA/WET/2	Short-Term, Chronic	Fathead Minnow (*Pimephales promelas)*	Survival and Growth (growth measured via dry weight)
GSI/SOP/BS/RA/WET/3	Short-Term, Chronic	Green Alga (*Selenastrum capricornutum)*	Growth (measured via direct density counts)

2.5. Data Management

2.5.1. Data Recording

All biological and chemical data were recorded by hand (using indelible ink) on pre-printed data collection forms and/or in bound, uniquely-identified laboratory notebooks that were specific to the NaOH BWTS test. The data that were recorded on pre-printed data collection forms were secured in uniquely-identified three ring binders, specific to the type of data and to the treatment technology.

Biological and chemical data that were recorded by hand were entered into either a MS Access Database that was designed, developed, and is maintained by the GSI Database Manager (i.e., microbial, phytoplankton, and zooplankton data) or the data were entered into a MS Excel spreadsheet (i.e., water chemistry and WET test data; see *GSI/SOP/G/RA/DM/1 - Procedure for Data Entry, Data Quality Control, and Database Management*).

In-tank water quality data (e.g., temperature, pH, dissolved oxygen, specific conductivity, salinity, turbidity, and total chlorophyll) was measured continuously every fifteen minutes during each retention period and automatically recorded in a text file, which was later translated to a MS Excel spreadsheet. Facility data (e.g., flow rates and pressure measurements) were electronically recorded every five seconds during intake and discharge. This data was exported to MS Excel for subsequent analysis, and is stored by AMI Engineers on a secure network and on GSI SharePoint.

Following completion of the NaOH BWTS trials, a thorough review of all data sheets and laboratory notebooks was undertaken to ensure compliance with the documentation procedures outlined in all relevant GSI SOPs and in the GSI Land-Based Quality Assurance Project Plan (GSI, 2010a). A percentage of data that was recorded by hand and entered into MS Access or MS Excel was verified against the original raw data. This process also included verification of formulas and calculations (i.e., hand-calculation of data). The percentage of verified raw data ranged from 10 % to 100 % of the original raw data, depending on the data type. More detail on the GSI's data validation activities is additionally detailed in Section 7 of the GSI Quality Assurance Project Plan for Land-Based Tests (GSI, 2010a). This section also details the acceptable values, where appropriate, for the following quality objectives: accuracy, precision, completeness, comparability, representativeness, and sensitivity.

2.5.2. Data Processing and Storage

After examination and quality assurance analysis, the data distribution files from the MS Access database were posted to the LSRI's Local Area Network (LAN) in an organized hierarchical folder system. All electronic data files stored on the LSRI's secured LAN can be accessed only by GSI personnel. The GSI Database Manager is the single point of control for access to the LSRI LAN. The LSRI LAN is automatically backed up every 24 hours. A backup of the database was also made regularly to avoid any loss of data following computer/electronic glitches.

Electronic data files, including MS Excel files, are stored on the LSRI LAN as well as GSI's internal SharePoint website, which acts as a secondary data backup/storage mechanism. All original raw data will be stored in a climate-controlled, secure archive room at the LSRI for five years after this report is finalized.

3.0. RESULTS

Four trials (Trials A-D) of the NaOH BWTS's biological effectiveness were completed, with WET tests incorporated into two trials (Trial B and D). During these trials, there were no significant deviations from the above methods.

3.1. Intake and Discharge Challenge Conditions

3.1.1. Operational Conditions

Operational conditions, measured continuously during intake, for all four trials were extremely consistent with each other and between treatment and control tracks of the GSI Land-Based Facility. Flow rate was slightly below 200 m^3/hour and pressure in the facility lines was 30.4 – 31.6 psi (Table 6). On discharge, the flow duration, flow rate, and pressure was very similar between the treatment and control tracks (Table 7).

Table 6. Average Operational Parameters Measured During Ballasting Simulation of the Four Trials of the NaOH Ballast Water Treatment System.

Trial	Flow Duration (min)	Treatment Flow Rate (m^3/h)	Total Volume of Water Treated (m^3)	Control Flow Rate (m^3/h)	Pressure (psi)
A	56.9	198.6	188.3	199.1	30.4
B	56.5	198.9	187.3	198.9	31.0
C	56.5	198.2	186.6	199.3	31.3
D	56.5	198.4	186.8	199.5	31.6

Table 7. Operational Parameters Measured During the Deballasting Simulation for the Four Trials of the NaOH Ballast Water Treatment System.

	Treatment			Control		
Trial	Flow Duration (min)	Flow Rate (m^3/h)	Pressure (psi)	Flow Duration (min)	Flow Rate (m^3/h)	Pressure (psi)
A	53.3	200	30.2	52.6	198	28.9
B	52.3	197	31.2	54.1	195	31.1
C	54.2	196	30.9	54.7	195	31.4
D	54.5	195	31.5	54.0	192	31.4

3.1.2. *Physical, Chemical and Biological Challenge Conditions*

A summary of the physical/chemical conditions of intake water are provided in Table 8. The ambient TSS was characteristically low, ranging from 1.3 mg/L to 2.4 mg/L, and averaging 2.0 mg/L for the four trials. The NPOC was entirely DOC, as the average of both parameters was 13.4 mg/L throughout the four trials. The %T ranged from 24.8 to 29.4 in the first three trials, but in Trial D rose substantially (42.7 %T). The average % T across the four trials was 31.0 %T. The challenge water pH ranged from 7.75 to 7.99 during all four trials.

The average pH of the post-treatment water collected immediately prior to the water entering the treatment retention tank was 12.02, achieving the target pH of 12.00. Samples collected from the treatment retention tank just prior to neutralization had an average pH was 12.04, showing that the pH of the treated water did not change significantly during the holding time. After the neutralization process, samples measured from the treatment tank and in-line from the treatment discharge averaged 8.17 and 8.14, respectively). The neutralized discharge pH met the target value of less than 8.5, and was within the WIDNR permitting levels for discharge to the Duluth-Superior Harbor (i.e., pH 6 to 9).

Table 8. Average (± Std. Dev.) Challenge Water Quality during Four Trials of the NaOH Ballast Water Treatment System.

Parameter	Desired pH Value	Sample	Trial A	Trial B	Trial C	Trial D	Summary (*n*=4)
pH[1]	7-9 (Ambient)	Pre-Treatment Intake	7.76 ± 0.01	7.83 ± 0.04	7.99 ± 0.04	7.75 ± 0.02	**7.83 ± 0.11**
	12.00	Post-Treatment Intake	12.00	12.04	12.04	12.00	**12.02 ± 0.02**
	12.00	In-Tank Before Neutralization	12.06	12.07	11.99	12.02	**12.04 ± 0.04**
	≤ 8.5	In-Tank After Neutralization	8.27	8.21	7.81	8.39	**8.17 ± 0.25**
	7-9	Treatment Discharge	NA	8.22	7.81	8.40	**8.14 ± 0.30**
TSS (mg/L)	N/A	Intake	1.3 ± 0.2	2.0 ± 0.1	2.4 ± 0.1	2.1 ± 0.1	**2.0 ± 0.5**
NPOC (mg/L)	N/A	Intake	13.5 ± 0.5	15.3 ± 0.3	14.4 ± 0.2	10.3 ± 0.2	**13.4 ± 2.2**
DOC (mg/L)	N/A	Intake	13.7 ± 0.3	15.3 ± 0.1	14.3 ± 0.3	10.3 ± 0.2	**13.4 ± 2.2**
POC (mg/L)	N/A	Intake	-0.2 ± 0.7	-0.1 ± 0.2	0.1 ± 0.3	0.0 ± 0.4	**-0.1 ± 0.1**
%T (254 nm)	N/A	Intake	24.8 ± 0.5	26.9 ± 0.1	29.4 ± 0.2	42.7 ± 0.8	**31.0 ± 8.1**

[1]The sample temperature was measured simultaneously with sample pH measurements. The average sample temperature was 20.9 ± 1.8 °C in pre-treatment intake, 23.1 ± 1.9°C in post-treatment intake, 22.6 ± 1.5 °C in the treatment retention tank before and after neutralization, and 21.0 ± 1.0°C in treatment discharge.

The live plankton densities in intake and control discharge samples, for the ≥ 10 μm and < 50 μm size class and for the larger plankton size class (i.e., ≥ 50 μm), are summarized in Table 9. During all four trials, average intake densities of live zooplankton (i.e., those organisms ≥ 50 μm) ranged from 28,331/m^3 (Trial A) to 648,158/m^3 (Trial C), for an average of 291,229/m^3. The zooplankton community was comprised mainly of dreissenid mussel veligers; the rotifers *Keratella, Polyarthra,* and *Synchaeta*; calanoid and cyclopoid copepods; and the cladoceran *Bosmina.* The target intake density of ≥ 100,000/m^3 was achieved during all but the first trial (Trial A). The density of live organisms in the control discharge samples after the two- or three-day holding period ranged from 22,047/m^3 (Trial A) to 725,980/m^3 (Trial C), which was 78 % to 112 % of the starting densities. Control discharge densities in Trials B and C were slightly higher than their corresponding intake densities (1% to 12% respectively), likely due to reproduction of the rotifers (*Keratella spp.* and *Polyarthra spp.*) and the cladoceran *Bosmina*.

The live organism density for the ≥ 10 and < 50 μm organism size class on intake, consisting mainly of phytoplankton, ranged from 67.56 cells/mL (Trial A) to 661.91 cells/mL (Trial D, in which the intake stream was amended with concentrated harbor algae; Table 9). The community of protists comprised, in decreasing relative abundance, chain-forming diatoms (largely *Aulacoseira*), coccoid green algae (largely *Gonium*), filamentous blue-green algae (*Oscillatoria*), miscellaneous microflagellates, and free-living centric diatoms, such as *Cyclotella*. The density of live phytoplankton in the control discharge samples ranged from 16.00 cells/mL (Trial C) to 275.95 cells/mL (Trial D), for an average of 93.43 cells/mL (Table 9). This represented 4 % to 42 % of the intake densities (Table 9). Although organism densities were lower in the control discharge samples, the relative abundance of taxa were similar to that observed in intake samples.

Table 9. Live Plankton Densities in Intake and Control Discharge During the Four NaOH Trials. Note: The Live Intake Densities are an Average of the Control Intake and the Pre-treatment Intake Samples.

Organism Size Category	Sample	Trial A	Trial B	Trial C	Trial D	Average ± Std. Dev. (*n*=4)
≥ 50 *µ*m (#/m^3)	Intake	28,331	384,216	648,158	104,210	**291,229 ± 141,462**
	Control Discharge	22,047	389,885	725,980	102,478	**310,098 ± 159,531**
≥ 10 and < 50 *µ*m (#cells/mL)	Intake	67.56	276.63	417.01	661.91	**355.78 ± 124.77**
	Control Discharge	27.44	54.31	16.00	275.95	**93.43 ± 61.37**

Concentrations of organisms in the < 10 *µ*m size class in the intake and control discharge samples during the four NaOH Trials are provided in Table 10. Overall intake densities within this size class were highest during Trials C and D. Total coliform bacteria ranged from 204 MPN/100 mL in Trial A to 552 MPN/100 mL in Trial D. *E. coli* ranged from 41 MPN/100 mL (Trial A), to 107 MPN/100 mL (Trial C). *Enterococci* ranged from 35 MPN/100 mL (Trial A) to 164 MPN/100 mL (Trial D). Finally, total heterotrophic bacteria ranged from 400 MPN/mL in Trial A to 1240 MPN/mL in Trial B (Table 10). In the control discharge, indicator organisms for waterborne pathogens were more sparse, which is to be expected as the retention tank is not a favorable environment to support growth of these organisms. The total coliform bacteria ranged from 19 MPN/100 mL (Trial B) to 129 MPN/100 mL (Trial D), an overall decline of 78 % relative to intake. The overall average *E. coli* density was 6 MPN/100 mL. *Enterococci* ranged from 4 MPN/100 mL in Trial A to 143 MPN/100 mL in Trial B. Total heterotrophic bacteria ranged from 424 MPN/mL (Trial A) to 1833 MPN/mL (Trial D).

Table 10. Viable Microbial Densities (Average ± Standard Error of the Mean) in Intake and Control Discharge During the Four NaOH Trials.

< 10 μm Size Class Group	Sample	Trial A	Trial B	Trial C	Trial D	Summary (*n*=4)
Total Coliform Bacteria (MPN/100 mL)	Intake	239 ± 53	204 ± 20	536 ± 40	552 ± 46	**383 ± 93**
	Control Discharge	123 ± 32	19 ± 4	51 ± 2	129 ± 7	**81 ± 27**
E. Coli (MPN/100 mL)	Intake	41 ± 2	55 ± 4	107 ± 5	73 ± 5	**69 ± 14**
	Control Discharge	11 ± 2	1 ± 0.5[a]	3 ± 1	9 ± 1	**6 ± 2**
Enterococci (MPN/100 mL)	Intake	35 ± 7	40 ± 14	139 ± 26	164 ± 31	**95 ± 33**
	Control Discharge	4 ± 0.3	143 ± 88	68 ± 8	76 ± 3	**73 ± 28**
Total Heterotrophic Bacteria (MPN/mL)	Intake	400 ± 200	1240 ± 30	1033 ± 491	1117 ± 164	**948 ± 187**
	Control Discharge	424 ± 63	1225 ± 200	900 ± 321	1833 ± 67	**1096 ± 296**

[a] One or more values were below the limit of detection (LOD). Half the value of the LOD was used for calculations. See Appendix 2 for raw data.

3.1.3. In-Tank Water Quality

Control and treatment retention tank water quality data are presented in Table 11. Two values are reported for the treatment tank: the values measured prior to the start of the neutralization period, and the values measured after neutralization and just prior to the start of the discharge operation. Only data from Trials C and D are reported; the YSI Sondes were not calibrated prior to Trial A or Trial B; therefore, the accuracy of the water quality data from these trials cannot be assured.

Temperature and dissolved oxygen were similar in the control and treatment tanks throughout the entire holding period, including after neutralization of the treatment tank. However, several parameters were different as a result of the NaOH injection into the treatment track. As expected, the pH of the treatment tank water was significantly higher than the control tank water. In trials C and D, the average pH of water in the treatment tank prior to neutralization was 11.80 and 11.85, respectively. In contrast, the average pH of water in the control tank was 7.72 for Trial C and 7.45 for Trial D. The pH of water held in the treatment tank following neutralization with CO_2 was 7.57 and 8.18 for the two trials respectively, thereby meeting Wisconsin DNR permit requirements for discharge to the harbor.

In both trials reported in Table 11 (Trials C and D) the specific conductivity in the treatment tank prior to neutralization was on average 14.5 to 17.4 times higher, than in the control tank during the three-day holding period. The neutralization process decreased the specific conductivity by approximately half, but on average the post-neutralization conductivity just prior to treatment discharge was still 6.6 to 7.6 times higher than in the control tank. In addition, the treatment tank salinity (as calculated by the YSI Sonde based on specific conductivity) increased as a result of the NaOH injection. On average, the salinity in the treatment tank prior to neutralization was 15.5 to 20.4 times higher than in the control tank. The neutralization process reduced the salinity by about half from the average salinity measured prior to CO_2 injection but the levels in the treatment tank just prior to discharge were still an average of eight times higher than the levels in the control tank just prior to discharge in both Trial C and D.

The turbidity of water held in the control and treatment tanks during Trial D was similar; however, during Trial C the turbidity reading for the control tank water as substantially higher than all other readings for control and as compared to the treatment tank water (i.e., average 12.7 NTU in the control tank and 1.8 NTU in the treatment tank), possibly indicating a problem with the Sonde probe post calibration. In both trials, the turbidity of the treatment tank did not change after the neutralization process.

Table 11. Control and Treatment Retention Tank Water Quality (Average ± Std. Dev.) During the Three-day Holding Period for Trials C and D of the NaOH BWTS Test.

Parameter	Retention Tank	Sample Period	Trial C	Trial D
Temperature (°C)	Control	Entire Retention	21.95 ± 0.24 (*n*=288)	21.33 ± 0.23 (*n*=283)
	Treatment	Before Neutralization	21.98 ± 0.25 (*n*=277)	21.47 ± 0.23 (*n*=276)
		Prior to Discharge	22.19 (*n*=1)	21.99 (*n*=1)
Specific Conductivity (mS/cm)	Control	Entire Retention	0.224 ± 0.001 (*n*=288)	0.179 ± 0.001 (*n*=283)
	Treatment	Before Neutralization	3.258 ± 0.016 (*n*=277)	3.113 ± 0.021 (*n*=276)
		Prior to Discharge	1.475 (*n*=1)	1.365 (*n*=1)
Salinity (ppt)	Control	Entire Retention	0.11 ± 0.00 (*n*=288)	0.08 ± 0.00 (*n*=283)
	Treatment	Before Neutralization	1.71 ± 0.01 (*n*=277)	1.63 ± 0.01 (*n*=276)
		Prior to Discharge	0.74 (*n*=1)	0.68 (*n*=1)
pH	Control	Entire Retention	7.72 ± 0.06 (*n*=288)	7.45 ± 0.02 (*n*=283)
	Treatment	Before Neutralization	11.80 ± 0.02 (*n*=277)	11.85 ± 0.02 (*n*=276)
		Prior to Discharge	7.57 (*n*=1)	8.18 (*n*=1)
Turbidity (NTU)	Control	Entire Retention	12.7 ± 0.6 (*n*=288)	0.6 ± 0.3 (*n*=283)
	Treatment	Before Neutralization	1.8 ± 0.2 (*n*=277)	0.8 ± 0.5 (*n*=276)
		Prior to Discharge	1.4 (*n*=1)	0.7 (*n*=1)

Parameter	Retention Tank	Sample Period	Trial C	Trial D
Dissolved Oxygen (% Saturation)	Control	Entire Retention	89.2 ± 3.1 (*n*=288)	83.1 ± 0.9 (*n*=283)
	Treatment	Before Neutralization	89.8 ± 2.2 (*n*=277)	83.3 ± 0.9 (*n*=276)
		Prior to Discharge	86.8 (*n*=1)	81.0 (*n*=1)
Dissolved Oxygen (mg/L)	Control	Entire Retention	7.80 ± 0.24 (*n*=288)	7.36 ± 0.10 (*n*=283)
	Treatment	Before Neutralization	7.78 ± 0.16 (*n*=277)	7.29 ± 0.10 (*n*=276)
		Prior to Discharge	7.53 (*n*=1)	7.06 (*n*=1)

3.2. Ballast Water Treatment System Biological Efficacy

Plankton densities and associated sample volumes relevant to live organisms in the ≥ 50 μm and ≥10 μm to < 50 μm size classes in control and treatment discharge samples from Trials A, B, C and D are summarized in Tables 12 to 16. In addition, live densities of four groups of bacteria (i.e., total coliform, *E. coli*, *Enterococcus spp.,* and total heterotrophic) in the <10 μm size class are reported in Tables 17 and 18. Percent reduction of live organism density in the treatment discharge as compared to the control discharge of organisms in the ≥ 50 μm, ≥ 10 and < 50 μm, and < 10 μm size classes is summarized in Table 19.

3.2.1. Organisms ≥ 50 µm in Minimum Dimension

Average live organism densities in treated discharge and total volume of treated discharge water analyzed during Trials A, B, C and D are reported in Table 12. Significant amounts of dead material in the treatment discharge samples limited the sample volume that could be analyzed for live organisms ≥ 50 μm in minimum dimension prior to maximum sample holding time (i.e., two hours). Sample volumes analyzed for live macrozooplankton ranged from 0.6 m^3 to 2.2 m^3 and sample volumes analyzed for live microzooplankton ranged from 0.1 to 0.3 m^3 (Tables 12 and 13). These low volumes resulted in low statistical certainty of density estimates.

Table 12. Live Treatment Discharge Densities and Treatment Discharge Sample Volume Analyzed Within the ≥ 50 μm Size Class During Four Trials of the NaOH Ballast Water Treatment System.

Treatment Discharge Density/ Vol. Analyzed	Trial A	Trial B	Trial C	Trial D	Avg. ± SEM
Density (#/m^3)	0.5	0.0	19	0.0	**4.9 ± 4.8**
Total Vol. Analyzed (m^3)	2.2 MacroZP 0.2 MicroZP	1.3 MacroZP 0.3 MicoZP	0.8 MacroZP 0.1 MicroZP	0.6 MacroZP 0.1 MicroZP	**1.2 ± 0.7 MacroZP** **0.2 ± 0.1 MicroZP**

Overall, the average live organism densities ≥ 50 μm in minimum dimension in treated discharge across all four trials was 4.9 live organisms/m^3 (Table 12). Table 13 provides the relative densities of live organisms across taxa in the treated discharge from the four trials. In Trial A, one live ostracod was observed in the treated discharge sample resulting in a density estimate of 0.5 live organisms per m^3 (Tables 12 and 13). There were no live organisms measuring ≥ 50 μm in minimum dimension observed in trials B or D treatment discharge (Table 12), however, there was one chironomid larvae each (both measuring 40 μm and in minimum dimension) observed in Trial B and Trial D treatment discharge resulting in a density estimate of 0.80 and 1.67 per m^3 respectively (Table 13). Trial C treated discharge had a total of 19.2 live zooplankton per m^3 ≥ 50 μm (Table 12), including chironomid larvae, planaria, copepods, and dreissenid larvae (Table 13).

Table 13. Live Zooplankton Densities Across Taxa in Treatment Discharge from Four Trials of the NaOH Ballast Water Treatment System.

Test Trials:	Trial A	Trial B	Trial C	Trial D
Total Vol. Treatment Discharge Analyzed, m^3:	**2.21 (0.24 MicroZP)**	**1.28 (0.30 MicoZP)**	**0.82 (0.14 MicroZP)**	**0.60 (0.08 MicroZP)**
≥ 50 µm (min. dimension)				
Taxa Group	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**
Copepod: Calenoid/Cyclopoid			2.43	
Chironomid			4.86	
Planaria			4.86	
Ostracod	0.50			
Dreissenid (Zebra Mussel)			7.01	
Equal to or Greater than 50 µm (min. dimension) Total:	**0.50**	**0.00**	**19.16**	**0.00**
< 50 µm (min. dimension)				
Taxa Group	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**	**Avg. Density (per m^3)**
Chironomid		0.80	1.22	1.67
Less than 50 µm (min. dimension) Total:	**0.00**	**0.80**	**1.22**	**1.67**
< 50 µm (min. dimension); Observed but not Quantified				
Taxa Group	**Observations/ Comments**	**Observations/ Comments**	**Observations/ Comments**	**Observations/ Comments**
Eggs/Cysts		A few observed.	Many observed (~85,000/m^3 live).	Many observed.
Phytoplankton		A few observed with chlorophyll.		
Copepod Nauplii			Four live observed under dissecting scope.	

The results of the statistical comparison between live organism density in the treatment discharge and in the control discharge are shown in Table 14. The Kruskal-Wallis One Way ANOVA was used to compare the two groups, as the data were normally distributed but did not have equal variance and transformation of the data (e.g., log base 10, log normal, and square root) did not successfully produce data that met the assumptions of a One Way ANOVA. After four trials of the NaOH BWTS, overall live zooplankton density in the treated discharge was significantly (p = 0.029) lower than that of the control discharge.

Table 14. Result of Statistical Comparison of Live Zooplankton Density in Control Discharge to Treatment Discharge.
The hypothesis tested was that the NaOH BWTS significantly reduces the number of live organisms on discharge in comparison to untreated, control discharge.

Treatment Group	Mean Density (n=4)	Std. Dev.	SEM	t	p	Probability of Trial Resulting in No Difference
Control Discharge	310,098 live/m^3	319,063	159,531	26.000	0.029	1 in 34
Treatment Discharge	5 live/m^3	9	5			

3.2.2. *Organisms ≥ 10 and < 50 μm in Minimum Dimension*

In the ≥ 10 and < 50 μm size class, live organism densities ranged from 0.2 cell/mL (Trial B) to 2.5 cells/mL (Trial D), for an average of 1.0 cell/mL (Table 15). The volume of treatment discharge water analyzed was 5.5 mL to 8.9 mL (Table 15). While few in number, surviving organisms in treated water were taxonomically various including diatoms, green algae, blue-green algae, and protozoans.

Table 15. Live Treatment Discharge Density and Treatment Discharge Sample Volume Analyzed Within the ≥10 μm and < 50 μm Size Class during Four Trials of the NaOH Ballast Water Treatment System.

Treatment Discharge Density/ Vol. Analyzed	Trial A	Trial B	Trial C	Trial D	Avg. ± SEM
#cells/mL	0.3	0.2	1.0	2.5	**1.0 ± 0.5**
Total Vol. Analyzed (mL)	8.9	5.5	8.2	7.1	**7.4 ± 1.5**

The results of the One Way ANOVA are provided in Table 16 below. The data were not normally distributed; therefore, the data were transformed using log (base 10) transformation. Overall, the live phytoplankton density in the treatment discharge was significantly (p = 0.002) lower as compared to the untreated, control discharge.

Table 16. Result of Statistical Comparison of Live Phytoplankton Density in Control Discharge to Treatment Discharge.
The hypothesis tested was that the NaOH BWTS significantly reduces the number of live organisms on discharge in comparison to untreated, control discharge.

Treatment Group	Mean Density (n=4)	Std. Dev.	SEM	t	p	Probability of Trial Resulting in No Difference
Control Discharge	93 cells/mL	123	61	5.200	0.002	1 in 500
Treatment Discharge	1 cell/mL	1	0.5			

3.2.3. Organisms < 10 μm in Minimum Dimension

The density of live organisms in the < 10 μm size class in treatment discharge from the four NaOH BWTS trials are presented in Table 17. The total coliform bacteria concentrations in treated discharge ranged from less than the limit of detection (i.e., <1 MPN/100 mL) in Trials A, B, and D to a maximum of 2 MPN/100 mL in Trial C. For all four trials the *E. coli* density was <1 MPN/100 mL (i.e., the limit of detection) in treatment discharge. The live density of *Enterococci* ranged from 2 MPN/100 mL (Trials A and D) to 42 MPN/100 mL (Trial B) in treatment discharge. Total heterotrophic bacteria densities in treatment discharge ranged from 116 MPN/mL (Trial B) to 363 MPN/mL (Trial A), which is an average of 80 % less heterotrophic bacteria as compared to the control discharge.

Table 17. Live Density (Average ± Standard Error of the Mean) of Regulated Microbes in the Treatment Discharge from the Four Trials of the NaOH Ballast Water Treatment System.

<1 0 μm Size Class Group	Trial A	Trial B	Trial C	Trial D	Summary (*n*=4)
Total Coliform Bacteria (MPN/100 mL)	<1	<1	2 ± 2[a]	<1	**<1**
E. Coli (MPN/100 mL)	<1	<1	<1	<1	**<1**
Enterococci (MPN/100 mL)	2 ± 1[a]	42 ± 42[a]	6 ± 5	2 ± 1	**13 ± 10**
Total Heterotrophic Bacteria (MPN/mL)	363 ± 0	116 ± 6	222 ± 24	174 ± 21	**219 ± 53**

[a] One or more values were below the limit of detection (LOD). Half the value of the LOD was used for calculations. See Appendix 2 for raw data.

The results of the One Way ANOVA are provided in Table 18 below. There was a significant ($p < 0.05$) reduction in live organism density in the treatment discharge as compared to the control discharge for all groups analyzed except *Enterococcus spp.*; with reductions in total coliform bacteria being the most pronounced. The total coliform and *E. coli* data did not meet the assumptions of the One Way ANOVA. The total coliform data were transformed using log (base 10) transformation. Transformation (e.g., log (base 10), natural log, and square root) of the *E. coli* data did not produce normally distributed data with equal variance; therefore, the nonparametric Kruskal-Wallis One Way ANOVA on Ranks was used to compare differences between the treatment and control. The *Enterococcus spp.* data and the total heterotrophic data were analyzed using a One Way ANOVA.

Table 18. Results of Statistical Comparisons of Live Microbe Density in Control Discharge and Treatment Discharge in the <10-μm Size Class.
The hypothesis tested was that the NaOH BWTS significantly reduces the number of live organisms on discharge in comparison to untreated, control discharge.

Type of Bacteria	Treatment Group	Mean Density (*n*=4)	Std. Dev.	SEM	*t*	*p*	Probability of Trial Resulting in No Difference
Total Coliform Bacteria	Control Discharge	80.50 MPN /100 mL	54.19	27.10	7.881	0.0002	1 in 5000
	Treatment Discharge	0.88 MPN /100 mL	0.75	0.38			
E. coli	Control Discharge	6.00 MPN/100 mL	4.76	2.38	26.000	0.029	1 in 34
	Treatment Discharge	0.50 MPN/100 mL	0.00	0.00			
***Enterococcus* spp.**	Control Discharge	72.75	56.85	28.42	1.989	0.094	1 in 11
	Treatment Discharge	13.00	19.43	9.713			
Total Heterotrophic Bacteria	Control Discharge	1095.50	591.55	295.78	2.918	0.027	1 in 37
	Treatment Discharge	218.75	105.48	52.74			

3.2.4. Percent Reduction of Live Organisms in the Treatment Discharge

Percent reduction of live organism density in the treatment discharge as compared to the control discharge for all three regulated size classes was calculated by the following equation:

$$Percent\ Reduction\ in\ Treatment\ Discharge = \left[1 - \left(\frac{Treatment\ Discharge\ Density}{Control\ Discharge\ Density}\right)\right] \times 100\%$$

Table 19 summarizes the percent reduction in live organism density in treatment discharge for all four trials of the NaOH BWTS. The largest percent reduction of live organism density was seen in the ≥ 50 μm (zooplankton) and ≥ 10 μm and < 50 μm (phytoplankton) size classes. There was a reduction of 100 % live zooplankton in the treatment discharge as compared to the control discharge during Trials B and D. Trials A and C saw an approximate reduction of 100 % of the live zooplankton density in the treatment discharge, although 0.5 live/m^3 and 19 live/m^3 were counted in each trial, respectively. Trials B and D were also the most successful for phytoplankton with an approximate treatment discharge reduction of 100 % (5.5 live cells/mL were counted) in Trial B and 99 % reduction in Trial D. There was a reduction of 99 % and 94 % in Trials A and C, respectively, for an overall average of 98 % reduction during all four trials. The NaOH BWTS was less effective for the organisms in the < 10 μm size class. There was a greater than one-log reduction in live coliform bacteria density in treatment discharge as compared to control discharge (i.e., average of 98 % reduction in live density in treatment discharge). The live density of *E. coli*, *Enterococcus spp.*, and heterotrophic bacteria in treatment discharge was reduced less than one log as compared to the control discharge. There was an overall average of 81 % reduction in live *E. coli*, 77 % reduction in live *Enterococcus spp.*, and 68 % reduction in live heterotrophic bacteria.

Table 19. Percent Reduction of Live Organism Density in Treatment Discharge as Compared to Control Discharge. Trial A had a Retention Time of Two Days; Trials B - D had a Retention Time of Three Days.

Organism Size Category	Group	Trial A	Trial B	Trial C	Trial D	Summary (*n*=4)
≥50 µm	Zooplankton	100%[a]	100%	100%[a]	100%	**100% ± 0%**
≥10 µm and <50 µm	Phytoplankton	99%	100%[a]	94%	99%	**99% ± 3%**
<10 µm[b]	Total Coliform Bacteria	100%[a,c]	97%[c]	96%	99%[c]	**98% ± 2%**
	E. coli	95%[c]	50%[c]	83%[c]	94%[c]	**81% ± 21%**
	Enterococci	50%	71%	91%	97%	**77% ± 21%**
	Total Heterotrophic Bacteria	14%	91%	75%	91%	**68% ± 36%**

[a] Live organisms were found during this trial. The percent reduction was rounded up to 100% although complete elimination of live organisms in treatment discharge was not observed.
[b] Percent reduction of live bacteria density in treatment discharge as compared to control discharge is based on the average (*n* = 3 samples) live organism density per trial in treatment and control discharge.
[c] Average (*n* =3) treatment discharge density values were below the limit of detection (LOD), which is 1 MPN/100 mL. Half the value of the LOD, or 0.5 MPN/100 mL was used for percent reduction calculations.

3.3. Whole Effluent Toxicity (WET) Testing

WET tests were conducted on *P. promelas* and *C. dubia* using Trial B treatment discharge, and on *P. promelas*, *C. dubia*, and *S. capricornutum* using Trial D treatment discharge. The performance controls (i.e., culture water for *P. promelas* and *C. dubia*, and algae media for *S. capricornutum*) met test acceptability criteria in all cases, with the exception of the *C. dubia* survival criterion in Trial B. The untreated filtered harbor water controls (0 % treatment discharge water) met the test acceptability criteria for all species tested during both Trials B and D.

The survival of *C. dubia* was only 70 % in the Trial B performance control (i.e., hard reconstituted culture water), and therefore these results were discarded and are not reported here. The WET test conducted on *C. dubia* using Trial D whole effluent showed no lethal effect (Table 20). However, there was a significant ($p<0.05$) reduction in the mean number of young produced per female in the 100 % Effluent group as compared to the 0 % Effluent group (Table 20). In Trial D, each female in the 100 % Effluent produced an average of 20 young as compared to 36 young per female in the 0 % Effluent (Table 20). This result indicates a potential effect of 100 % treatment discharge on cladoceran reproduction.

In the WET test conducted on the algal species *S. capricornutum* using treatment discharge from Trial D, the average cell density at test termination in the 100 % Effluent group (3,896,875 cells/mL) was significantly ($p<0.05$) higher as compared to the 0 % Effluent group (2,875,000 cells/mL), suggesting a possible effect of 100 % Effluent might be enhanced algal growth (Table 21).

Exposure to 100 % BWTS treatment discharge water did not affect *P. promelas* survival or growth in either Trial B or Trial D (Table 22). However, these organisms did display behavioral differences from their counterparts exposed to Control tank discharge. During both Trials B and D, organisms in treated discharge continuously swam in a circular pattern, an effect not observed in the harbor water control.

Table 20. Average (± Standard Error of the Mean) Survival and Reproduction of *C. dubia* Exposed to Whole Effluent Collected from NaOH Treatment Discharge During Trial D. Note: Statistical comparisons were made within one trial only, i.e., no comparisons were made between trials.

Treatment Group	TRIAL D	
	Survival (%)	No. Young per Female
C. dubia Culture Water (Performance Control)	100 ± 0.0	33 ± 3.2
0% Effluent (Untreated Harbor Water)	100 ± 0.0	36 ± 4.0
100% Effluent	90 ± 10.0	20 ± 3.4[a]

Test acceptability criteria: 80 % or greater survival and an average of 15 more young per female in the controls.
[a] The difference in average number of young per female is greater than would be expected by chance; the 100% Effluent group is statistically (p<0.05) less than the 0% Effluent group.

Table 21. Average (± Standard Error of the Mean) Final Density of *S. capricornutum* Exposed to Whole Effluent Collected from NaOH Treatment Discharge During Trial D.

Treatment Group	*S. capricornutum* Density (cells/mL)	CV (%)
Algae Growth Media (Performance Control)	2,240,625 ± 218,146	19.5
0% Effluent (Untreated Harbor Water)	2,875,000 ± 112,384	7.8
100% Effluent	3,896,875 ± 162,850[a]	8.4

Test acceptability criteria: Control flask must exceed 1 * 10^6 cells/mL and not vary more than 20 % among replicates.
[a] The difference in average cell density is greater than would be expected by chance; the 100% Effluent group is statistically (p<0.05) greater than the 0% Effluent group.

Table 22. Average (± Standard Error of the Mean) *P. promelas* Survival and Dry Weight per Surviving Minnow Exposed to Whole Effluent Collected from NaOH Treatment Discharge During Trials B and D.

Treatment Group	TRIAL B		TRIAL D	
	Survival (%)	Dry Weight per Survivor (mg)	Survival (%)	Dry Weight per Survivor (mg)
Laboratory Water (Performance Control)	98 ± 1.7	0.45 ± 0.02	100 ± 0.0	0.54 ± 0.03
0% Effluent (Untreated Harbor Water)	100 ± 0.0	0.47 ± 0.01	100 ± 0.0	0.58 ± 0.02
100% Effluent	95 ± 3.2	0.53 ± 0.02	100 ± 0.0	0.57 ± 0.02

Test acceptability criteria: 80 % or greater survival in the controls; average dry weight per surviving organism in the controls equal to or exceeding 0.25 mg.

4.0. QUALITY MANAGEMENT

GSI uses a wide variety of quality management documents and records to implement its quality management system. These include quality system documentation (i.e., the GSI Quality Management Plan), project-specific documentation (i.e., Quality Assurance Project Plans), and routine procedures documentation (i.e., Standard Operating Procedures).

4.1. Quality Management Plan (QMP)

Detailed information on the structure and organization of GSI's quality system can be found in the GSI Quality Management Plan (GSI, 2010b). Electronic copies of this document are available upon request. The GSI QMP covers all aspects of GSI's commitment to quality including policies and procedures; criteria for and areas of application; roles, responsibilities, and authorities; assessment and response; and quality improvement. It is the framework for planning, implementing, documenting, and assessing the GSI's quality assurance and quality control (QAQC) activities.

4.2. Quality Assurance Project Plan (QAPP)

Additional information and details regarding the activities undertaken by GSI to assure the quality and credibility of its research at the Land-Based RDTE Facility can be found in GSI's Land-Based Quality Assurance Project Plan (GSI, 2010a). This document is available electronically upon request. The QAPP covers all aspects of quality assurance/quality control (QAQC), including data quality indicators, evaluation processes, performance measures and acceptance criteria; instrument certification and calibration; personnel training requirements; documents and records; data management; and QAQC assessments and response actions.

4.3. Standard Operating Procedures (SOPs)

SOPs are used to implement all GSI test activities. This facilitates consistent conformance to technical and quality system requirements and increases data quality. The SOPs include both programmatic and technical processes and procedures such as organism culturing; operation of the GSI Land-Based RDTE facility; sample collection, labeling, analysis and custody; and safety. Appendix 1 provides a list of GSI SOPs relevant to land-based test activities.

5.0. DISCUSSION OF RESULTS

The NaOH BWTS operated effectively during the four trials conducted on the proposed NaOH/CO_2 treatment process. In particular, the BWTS led to highly significant reductions in live organism densities in all taxonomic categories evaluated in treated discharge relative to control discharge. It is not possible to assess performance against a discharge standard using the results from these land-based trials; the testing conditions and quality assurances were not at IMO- or ETV-consistent levels given the research and development objective of the test series.

In these tests, there was a nearly 100 % reduction in live organisms greater than 50 μm in minimum dimension (zooplankton) in the treatment discharge as compared to the control discharge, with zero live organisms found in Trials B and D and very few live organisms found in Trials A and C. The overall percent reduction of live phytoplankton density in the treatment discharge was greater than 97 % as compared to the control discharge density during the four trials of the NaOH BWTS. In terms of microbial organisms, any reductions caused by the treatment system in these tests were less than one log in magnitude. Coliform bacteria and *E. coli* appeared most sensitive to the BWTS of the organisms tested, decreasing these microbial organisms by an average of 98% and 81%, respectively across the four trials. The process had very little effect if any on total heterotrophic bacteria; though densities (i.e. MPN per mL) were on average lower in treated discharge than control discharge. The overall percent reduction was less pronounced for the *Enterococci* and total heterotrophic bacteria, with greater than 77 % and 67 % reduction as compared to the control, respectively.

Treatment effectiveness in this larger size class of organisms (greater than 50 μm in minimum dimension) appeared roughly consistent with IMO D-2 standards. That is, in three trials, the density estimates were well below IMO D-2 standards (0.0/m^3 to 0.5/m^3; Trials A, B, and D). In one trial (Trial C), the estimate was clearly above it (19/m^3), but it was impossible to discern a difference between any of these estimates (above or below) and the 10 live organisms per m^3 benchmark from a statistical standpoint given the small sample volumes analyzed (Miller, *et al*, 2011). With no filter system associated with this treatment process, the detritus in the samples subject to analysis was too great to allow analysis of sufficient sample volumes in the time period required to afford a precise estimate of discharge densities. This problem will likely not go away when the treatment process is subjected to actual certification testing, setting up a situation in which many more trials or many more microscopists are needed to generate adequate statistical certainty.

The relatively high density value for live organisms from the ≥ 50 μm size class in the Trial C treatment discharge is most likely an artifact resulting from the extremely low sample volumes subject to analysis. To illustrate the effect of this sample condition, consider that Dreissenids figure prominently in Trial C treatment discharge, contributing to nearly one-half of the live organism density. However, due to the small amount of sample volume analyzed for microzooplankton (0.14 m^3), the discovery of just one live dreissenid during sample analysis accounted for that density estimate. It is interesting to note that the intake and control discharge density of organisms in the ≥ 50 μm size class was significantly higher in Trial C as compared to the other three trials, ranging from 2 - 23 times higher on intake and 2 - 33 times higher in the control discharge (Table 9), but this difference does not itself account for the disparity. Operational sources of error were likely not the cause. Cross contamination was prevented in Trial C, as well as the other three trials, and samples were analyzed to ensure no live organisms were present in the potable water source used for cleaning, and treatment tubs prior to each discharge operation (see Section 2.1.3.). In addition, a thorough review of the raw data did not reveal any potential contamination from the plankton net or sampling equipment, nor did the procedural audits conducted during the NaOH Trials point out any potential contamination from those sources. The density estimates for organisms in the ≥ 10 and < 50 μm size class in treated discharge were consistently low, but our ability to conclude performance within the IMO D-2 standard is nonetheless limited here by sample size as well (Miller *et al*., 2011).

WET test findings were indicative of chronic toxicity and behavioral effects of 100 % treatment discharge effluent water. Undiluted discharge from the treatment process led to inhibition of cladoceran reproduction, accelerated algal growth, and circular swimming in fish. It should be noted that 100 % effluent is not the condition that aquatic organisms will be subject to in reality at the point of ballast outfall since dilution occurs upon the ballast discharge making contact with the receiving system. Instead it is indicative of a potential for residual toxicity. More WET testing using additional dilution levels should be undertaken in any follow-up land-based tests to corroborate the findings and determine the percent dilution at which toxicity is observed, and at what dilution it no longer is detectable.

In addition, follow-up bench tests at GSI will seek to better elucidate the cause for this effect. The effects may be due to the increased conductivity or residual CO_2 from the neutralization process in the 100 % effluent water as compared to the harbor water control. Bench-scale tests should seek to rule out attributes in the treated water that could contribute to an effect in order to better isolate the causal agent(s).

6.0. CONCLUSIONS

The NaOH (Sodium Hydroxide, Lye) BWTS performed very well operationally and well enough biologically to warrant additional testing at the bench, land and ship-based scales. The system successfully treated ballast water without interruption, and successfully neutralized treated ballast water to achieve WIDNR permitting levels for harbor discharge (i.e., pH 6-9). The BWTS also significantly reduced live organism densities in treated discharge relative to control discharge in all size classes of organisms. Finally, in these tests, the BWTS performance met discharge target values that were approximately consistent with the IMO Convention's Annex D-2 discharge standards, though precision in this estimate was not possible given the research and development testing parameters. This testing revealed that the water discharged after two- or three-day retention periods was not entirely environmentally benign (i.e., with no residual toxicity at the 100 percent effluent dilution), though the level of residual toxicity in 100 % effluent evident from these tests may not be of regulatory concern.

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APPENDIX 1.

List of GSI SOPs Relevant to the Land-Based Evaluation of the NaOH Ballast Water Treatment System.

SOP CODE	SOP TITLE	CATEGORY	SUBCATEGORY
GSI/SOP/G/A/RK/1	Procedure for Record Keeping	Administration	Record Keeping
GSI/SOP/G/RA/DM/1	Procedure for Data Entry, Data Quality Control and Database Management	Research Activities	Data Management
GSI/SOP/G/RA/SC/2	Procedure for Labeling Samples Collected at the GSI Land-Based RDTE Facility	Research Activities	Sample Custody
GSI/SOP/BS/RA/GL/1	Procedure for Verification of Laboratory Balances	Research Activities	General Laboratory
GSI/SOP/BS/RA/WET/1	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to *Ceriodaphnia dubia*	Research Activities	Residual Toxicity
GSI/SOP/BS/RA/WET/2	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to the Fathead Minnow (*Pimephales promelas*)	Research Activities	Residual Toxicity
GSI/SOP/BS/RA/WET/3	Procedure for Assessing Chronic Residual Toxicity of a Ballast Treatment System to the Green Alga (*Selenastrum capricornutum*)	Research Activities	Residual Toxicity
GSI/SOP/BS/RA/MA/1	Procedure For Quantifying Heterotrophic Plate Counts (HPCs) Using IDEXX's SimPlate® for HPC Method	Research Activities	Microbial Analysis
GSI/SOP/BS/RA/MA/3	Procedure for the Detection and Enumeration of *Enterococcus* Using Enterolert™	Research Activities	Microbial Analysis
GSI/SOP/BS/RA/MA/4	Procedure for the Detection and Enumeration of Total Coliforms and *E. coli* Using IDEXX's Colilert®	Research Activities	Microbial Analysis
GSI/SOP/BS/RA/MP/1	General Microbiology Preparation Procedures	Research Activities	Microbial Procedures
GSI/SOP/BS/RA/C/3	Procedures for Measuring Organic Carbon in Aqueous Samples	Research Activities	Chemistry
GSI/SOP/BS/RA/C/4	Procedure for Determining Percent Transmittance (%T) of Light in Water at 254 nm	Research Activities	Chemistry

SOP CODE	SOP TITLE	CATEGORY	SUBCATEGORY
GSI/SOP/BS/RA/C/8	Procedure for Analyzing Total Suspended Solids (TSS)	Research Activities	Chemistry
GSI/SOP/BS/RA/C/9	Procedure for pH Meter Calibration and pH Measurement	Research Activities	Chemistry
GSI/SOP/LB/G/O/1	Procedure for Operating the GSI Land-Based RDTE Facility	General	Operation
GSI/SOP/LB/G/O/2	Procedure for Sampling and Analyzing Treated Water in the Retention Tanks Prior to Discharge	General	Operation
GSI/SOP/LB/G/O/3	Procedure for Cleaning and Verifying Cleanliness of the Retention Tanks and Piping at the GSI Land-Based RDTE Facility	General	Operation
GSI/SOP/LB/G/O/4	Procedure for Cleaning Sampling Equipment at the GSI Land-Based RDTE Facility	General	Operation
GSI/SOP/LB/G/O/5	Procedure for Injecting Organisms and Solids into the GSI Land-Based RDTE Facility	General	Operation
GSI/SOP/LB/G/O/7	Procedure for Maintaining Solids Suspension in the GSI Land-Based RDTE Facility's Retention Tanks	General	Operation
GSI/SOP/LB/G/C/4	Procedure for Calibration, Deployment, and Storage of YSI Multiparameter Water Quality Sondes	General	Calibration
GSI/SOP/LB/G/S/1	Procedure for Ensuring Worker Health and Safety at the GSI Land-Based RDTE Facility	General	Safety
GSI/SOP/LB/RA/SC/1	Procedure for Collecting Biological Sample Water via In-Line Sample Ports	Research Activities	Sample Collection
GSI/SOP/LB/RA/SC/3	Procedure for Algae/Small Protozoa Sample Collection	Research Activities	Sample Collection
GSI/SOP/LB/RA/SC/4	Procedure for Microbial Sample Collection	Research Activities	Sample Collection
GSI/SOP/LB/RA/SC/6	Procedure for Zooplankton Sample Collection	Research Activities	Sample Collection
GSI/SOP/LB/RA/SA/1	Procedure for Algae/Small Protozoan Sample Analysis	Research Activities	Sample Analysis
GSI/SOP/LB/RA/SA/2	Procedure for Zooplankton Sample Analysis	Research Activities	Sample Analysis

APPENDIX 2.

Trimmed, Raw Microbial Analysis Data from Testing of Lye (NaOH) Ballast Water Treatment System

Trial	Sample Location	Sample Tub	Rep.	Total Coliform Bacteria	*E. coli*	*Enterococcus spp.*	Heterotrophic Bacteria
				MPN/100 mL	MPN/100 mL	MPN/100 mL	MPN/1 mL
A	PRE-TREATMENT INTAKE	4	1	179	42	21	200
			2	192	36	45	200
			3	345	44	40	800
	CONTROL DISCHARGE	1	1	186	12	4	514
			2	79	8	5	454
			3	105	12	4	303
	TREATMENT DISCHARGE	4	1	<1	<1	1	363
		5		<1	<1	4	363
		6		1	<1	1	363
B	PRE-TREATMENT INTAKE	4	1	210	50	35	1210
			2	166	52	19	1210
			3	236	62	67	1301
	CONTROL DISCHARGE	1	1	17	2	313	1150
			2	14	<1	101	923
			3	26	<1	16	1603
	TREATMENT DISCHARGE	4	1	<1	<1	<1	104
		5		<1	<1	126	124
		6		<1	<1	<1	120
C	PRE-TREATMENT INTAKE	4	1	548	113	173	1000
			2	461	111	155	1900
			3	598	96	88	200
	CONTROL DISCHARGE	1	1	55	4	84	800
			2	48	2	65	400
			3	51	3	56	1500
	TREATMENT DISCHARGE	4	1	6	<1	1	266
		5		<1	<1	15	183
		6		<1	<1	1	216
D	PRE-TREATMENT INTAKE	4	1	614	67	186	800
			2	461	69	204	1200
			3	579	82	103	1350
	CONTROL DISCHARGE	1	1	118	6	80	1900
			2	142	11	71	1700
			3	127	10	78	1900
	TREATMENT DISCHARGE	4	1	<1	<1	1	216
		5		<1	<1	2	155
		6		<1	<1	4	151

2009 Project Abstract
For the Period Ending June 30, 2012

PROJECT TITLE:	**Emergency Delivery System Development for Disinfecting Ballast Water**
PROJECT MANAGER:	Scott Smith
AFFILIATION:	USGS Western Fisheries Research Center
MAILING ADDRESS:	6505 NE 65th St.
CITY/STATE/ZIP:	Seattle, WA 98115
PHONE:	206-427-8374
E-MAIL:	sssmith@usgs.gov
WEBSITE: [If applicable]	\
FUNDING SOURCE:	Environment and Natural Resources Trust Fund
LEGAL CITATION:	M.L. 2009, Chap. 143, Sec. 2, Subd. 6(b)

APPROPRIATION AMOUNT: $590,000

Overall Project Outcome and Results

This project was part of Phase III of an overall effort to produce an Emergency Response Guide to Handling Ballast Water to Control Non-Indigenous Species. Phase I ($25,000) was funded by National Oceanic and Atmospheric Administration and resulted in a study plan entitled "Mixing Biocides into Ships' Ballast Water: Efficiency of Novel Methods." Phase II ($185,000) was funded by the Great Lakes Fisheries Trust and studied in-line injection, bulk dye dosing, perforated hose dosing, and passive mixing methods, such as ship's motion.

Similar to Phase II, this effort (Phase III) prepared ballast tank mixing and sampling equipment, field work on a working ship to trial promising ballast mixing methods, and analysis/report. The active methods being studied in Phase III are venturi eductors and air lifts. The outcome will be the incorporation of these methods (if determined to be effective and practical) into a best practices guide for treating the ballast water of ships either:

- Arriving in port with high risk ballast water,
- Leaving a port that contains ballast known to be high risk for the destination port, or
- Grounded and laden with high risk, untreated ballast water.

Use and Dissemination

Preliminary information from Result 1 and Result 2 activities were shared at the May 18, 2010 Great Lakes Ballast Water Collaborative meeting in Montreal, QC and at the June 1, 2010 Lake Superior Binational Program - Invasive Species Workshop in Duluth, MN.

The final project results consisting of two reports entitled "Emergency Response Guidance for Handling Ballast Water to Control Aquatic Invasive Species" and "Mixing Biocides into Ship's Ballast Water—Great Lakes Bulk Carrier Field Trials" are posted on the National Park Service web site at http://www.nps.gov/isro/naturescience/handling-ballast-water-to-control-non-indigenous-species.htm

Trust Fund 2009 Work Program

Date of Report: 7 December 2012
Date of Next Progress Report: FINAL
Date of Work Program Approval: 1 June 2010
Project Completion Date: 30 June 2011

I. PROJECT TITLE:	Emergency Delivery System Development for Disinfecting Ballast Water
Project Manager:	Scott Smith
Affiliation:	USGS Western Fisheries Research Center
Mailing Address:	6505 NE 65th St.,
City / State / Zip:	Seattle, WA 98115
Telephone Number:	206-427-8374
E-mail Address:	sssmith@usgs.gov
Fax Number:	206-526-6654
Web Site Address:	N/A

Location:
Project work, both previously completed efforts and the current effort, has taken place on board the ship, *M/V Indiana Harbor*, as it has transited through the Great Lakes.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**125,000**
	Minus Amount Spent:	**$**	**125,000**
	Equal Balance:	**$**	**0**

Legal Citation: M.L. 2009, Chap. 143, Sec. 2, Subd. 6b

Appropriation Language: (b) Emergency Delivery System Development for Disinfecting Ballast Water. $125,000 is from the trust fund to the commissioner of the Pollution Control Agency for an agreement with the United States Geological Survey to test the viability of treating ballast water through access ports or air vents as a means to prevent the spread of invasive species.

II. PROJECT SUMMARY AND RESULTS:

This project is **Phase III** of an overall effort to produce an Emergency Response Guide to Handling Ballast Water to Control Non-Indigenous Species. Phase I ($25,000) was funded by NOAA and resulted in a study plan entitled "Mixing Biocides into Ships' Ballast Water: Efficiency of Novel Methods." Phase II ($185,000) was funded by the Great Lakes Fisheries Trust and studied in-line injection, bulk dye dosing, perforated hose dosing and passive mixing methods, such as ship's motion.

Similar to Phase II, this effort (**Phase III)** prepared ballast tank mixing and sampling equipment, field work on a working ship to trial promising ballast mixing methods, and analysis/report. The active methods being studied in Phase III are venturi eductors and air lifts. The outcome will be the incorporation of these methods (if determined to be effective and practical) into a best practices guide for treating the ballast water of ships either:

- Arriving in port with high risk ballast water,
- Leaving a port that contains ballast known to be high risk for the destination port, or
- Grounded and laden with high risk, untreated ballast water.

III. PROGRESS SUMMARY

Project completed

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Logistics and Equipment Preparation

Description: Shipboard field trials require significant preparations because: (a) There is no opportunity to "go to back to the shop" to get broken or forgotten supplies. (b) Ship's commercial rates typically ranging between $40,000 and $80,000 per day. This requires equipment to be ready to go and integrated with operations such that it does not delay the ship. Equipment preparation specifically includes:

- Logistics Preparation:
    - Team Coordination: Sampling Team, Dosing Team, Ship Personnel, Ship Office Personnel
    - Finalize Test Protocol
    - Develop, Print, Bind Field Logs
    - Obtain Ballast Water Discharge Permit(s).
    - Team Travel and Accommodation Arrangements
    - Purchasing and administrative preparations
- Equipment Preparation:
    - Sampling and Measurement
        - Dye Sampling Equipment Rental and Set-up
        - Pressure Transducer Suite Set-up
        - Ship Dynamics Measurement Suite Set-up
    - Mixing Equipment
        - Dye Stock and Dosing Equipment Set-up
        - Air Lift Equipment Set-up
        - Eductor Equipment Set-up
    - Consumables Procurement
    - Shipment and Handling of Equipment to Ship Location

Summary Budget Information for Result 1: **Trust Fund Budget: $ 39,829**
Amount Spent: $ 39,829
Balance: $ 0

Deliverable	**Completion Date**	**Budget**
1. Summary-Personnel	15 May 2010	$4,770
2. Summary- Contracts	15 May 2010	$17,475
3. Summary-USGS-Leetown Science Center	15 May 2010	$2,065
4. Summary-Supplies	15 May 2010	$15,519

Result Completion Date: 15 *May 2010.*

Result Status as of 1 June 2010: **RESULT 1 COMPLETED.**

Result Status as of 1 December 2010: **RESULT 1 COMPLETED.**

Result Status as of 1 June 2011: Project Completed

Final Report Summary:

Logistics and equipment preparations performed and complete, ready for ship trials.

The three groups: eductor team, air lift team, and sampling team, responsible for set-up and execution of the on ship testing completed preparations for the on ship trials in a timely fashion. Planning took place during weekly teleconferences where each of the three teams gave status updates. Communication with the ship's owner was ongoing during the planning process and their comments/concerns were answered and communicated to the teams. The majority of the required equipment was purchased or rented in advance and was loaded onto the ship approximately 1 week before the testing teams arrived in Duluth, MN.

The remainder of the equipment and consumables were delivered to the ship with the crew. The ships grocery supplier was utilized to help with transferring equipment to the ship during cargo loading at Two Harbors, MN. The teams arrived and boarded the vessel with all equipment on time 15 May 2010.

Result 2: Field Deployment

Description: Field deployment is the effort required to execute the actual work on board the ship. There are significant set-up and break-down efforts on board the ship such that the testing methods are ready for execution when the ship actually takes on the ballast water.

Summary Budget Information for Result 2: **Trust Fund Budget: $ 64,519**
Amount Spent: $ 64,519
Balance: $ 0

Deliverable	Completion Date	Budget
1. Summary-Personnel	23 May 2010	$10,075
2. Summary- Contracts	23 May 2010	$35,018
3. Summary-USGS-Leetown Science Center	23 May 2010	$15,800
4. Summary-Travel	23 May 2010	$3,626

Result Completion Date: 23 May 2010

Result Status as of 1 June 2010: RESULT 2 COMPLETED.

Result Status as of 1 December 2010: RESULT 2 COMPLETED.

Result Status as of 1 June 2011: Project Completed

Final Report Summary:

Field deployment, including demobilization efforts, performed and complete.

The teams boarded the ship 15 May 2010 and disembarked 23 May 2010. Equipment was installed in the ballast tanks, the conveyor tunnel and on deck between 15 May and 17 May with all setups tested before closing of manhole accesses. The ship took on ballast in Gary Harbor Indiana the night of 17 May and testing commenced the morning of 18 May as the ship left port. Testing continued almost nonstop until the ship arrived in Superior, Wisconsin on 20 May. Discharge monitoring and harbor dilution studies were conducted while the ship was loading cargo the night of 20 May. The ship made an additional stop in Superior, WI to offload equipment requiring a crane to lift after cargo operations were completed. The test teams entered the empty ballast tanks after the ship exited Duluth Harbor the morning of 21 May to remove all equipment. Equipment was all removed, cleaned, and stowed on deck by the afternoon of 23 May. All remaining testing personnel disembarked ship at the Sault St. Marie Locks the afternoon of 23 May. The remaining equipment on board the ship will be offloaded the next time they make a Superior, WI port call.

Result 3: Data Analysis/Report

Description: Project completed

Summary Budget Information for Result 3: **Trust Fund Budget: $ 20,651**
Amount Spent: $ 20, 651
Balance: $ 0

Deliverable	Completion Date	Budget
1. Summary-Personnel	15 Sept 2010	$3,154

Result Completion Date: 30 June 2011.

Result Status as of 30 June 2011: Project completed

Final Report Summary:

V. TOTAL TRUST FUND PROJECT BUDGET: $125,000

Personnel: $ 17,999
Contracts: $ 69,990
USGS-Leetown Science Center: $17,865
Equipment/Tools/Supplies: $ 15,519
Travel: $ 3,626

TOTAL TRUST FUND PROJECT BUDGET: $125,000

Explanation of Capital Expenditures Greater Than $3,500: NONE

VI. PROJECT STRATEGY:

A. Project Partners:

1. USGS Western Fisheries Research Center (WFRC). As the primary contract for the grant, the Center will receive no indirect costs for implementing this research. The WFRC has agree to cost-share the indirect costs of this project by paying for these expenses out of other bugdgets. The indirect costs absorbed by the WFRC amount to $42,000.
2. USGS Leetown Science Center. The center will receive $17,865 to cover efforts to develop the air lift methods, staff time, and travel to the ship for field trials.
3. A marine engineering firm. The marine engineering firm selected by the WFRC through a compeditive process will perform as a contractor and receive $69,990. This will cover overall logistical coordination of the testing efforts, including dye dosing and sampling preparation, execution, and reporting upon completion of the effort.
4. National Park Service, Isle Royal. NPS will not receive any funding. However, NPS will be obtaining critical discharge permits, as well as supply needed on-site support efforts in the Great Lakes. Additionally, NPS will serve as the “customer” by both providing feedback real time as field efforts are progressing, and be a receipient of the results of the study.

B. Project Impact and Long-term Strategy:

Ballast water is the primary pathway for aquatic invasive species (AIS) introduction and spread to the Great Lakes and Lake Superior. At least one new invasive species is found in the Great Lakes each year. Many ballast water treatment technologies are currently undergoing research, development and various regulatory approvals. International, national and state laws are being established to mandate the use of ballast treatment; however it will be many years before effective ballast treatment devices are available or required for all vessels. Lake Superior will remain at risk for new AIS for many years unless simple cost effective emergency treatment is developed, especially for high risk vessels. High risk vessels include those that frequent Great Lakes ports with known infestations or active outbreaks of AIS. For example, viral hemorrhagic septicemia (VHS) has not been found in Lake Superior, but ships that take up ballast water in areas where there is an outbreak of VHS and then discharge untreated ballast water into Lake Superior may pose a high risk. Development of methods to treat ballast water in high risk vessels would substantially reduce the risk of spreading VHS and other AIS to Lake Superior.

This study would build on existing efforts to reduce risks of introducing and spreading AIS through ballast water. An ongoing investigation at the Great Ships Initiative is bench testing the efficacy of active substances such as chlorine to treat ballast water. At the same time, other researchers are developing methods to identify high risk ports in the Great Lakes. This study will field test several emergency treatment methods in the absence of installed metering systems, including powered mixing devices and administering a biocide directly through the access ports. The methods must include protocols to ensure an environmentally sound discharge. The methods should also be practical for deployment on any vessel, economical, and cause minimal delays in the vessels' schedule.

C. Other Funds Proposed to be spent during the Project Period:

This project is Phase III of a planned IV to achieve final project results. At the end of each successive phase, we are advancing the best practices for emergency ballast water treatment. As such, each phase is valuable in isolation – and each phase builds upon the results of the last.

Efforts which have been completed or are in progress to complement this $125,000 grant for Phase III:

- Phase I – Study Planning. Funding Agency NOAA - $25,000. Completed.
- Phase II – Passive Mixing Field Trials. Funding Agency Great Lakes Fisheries Trust - $185,000. In progress, 80% complete.
- Phase III – This proposal.
- Phase IV – Finalizing Novell Methods. Funding Agency USGS – TBD. Proposal under development.

- Significant in-kind financial contributions have been made by the NPS, and the USGS-WFRC through proposal preparation efforts and during phases I, II and III.

D. Spending History: See “C” above.

VII. DISSEMINATION:

The focus of the effort is to provide practical guidance for handling high risk ballast water to emergency responders. The outcome will be the incorporation of these methods (if determined to be effective and practical) into a best practices guide for treating the ballast water of ships either:

- Arriving in port with high risk ballast water,
- Leaving a port that contains ballast known to be high risk for the destination port, or
- Grounded and laden with high risk, untreated ballast water.

Progress

– Preliminary information from Result 1 and Result 2 activities were shared at the May 18, 2010 Great Lakes Ballast Water Collaborative meeting in Montreal, QC and at the June 1, 2010 Lake Superior Binational Program - Invasive Species Workshop in Duluth, MN.

- The final project results consisting of two reports entitled “Emergency Response Guidance for Handling Ballast Water to Control Aquatic Invasive Species” and “Mixing Biocides into Ship’s Ballast Water—Great Lakes Bulk Carrier Field Trials” are posted on the National Park Service web site at http://www.nps.gov/isro/naturescience/handling-ballast-water-to-control-non-indigenous-species.htm

VIII. REPORTING REQUIREMENTS: Project completed

IX. RESEARCH PROJECTS: N/A

Attachment A: Budget Detail for 2009 Projects - **Summary and a Budget page for each partner (if applicable)**

Project Title: *Emergency Delivery System Development for Disinfecting Ballast Water*

Project Manager Name: *Scott Smith.*

Trust Fund Appropriation: $125,000

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

2009 Trust Fund Budget	Result 1 Budget:	Amount Spent (date)	Balance (date)	Result 2 Budget:	Amount Spent (date)	Balance (date)	Result 3 Budget:	Amount Spent (date)	Balance (date)	TOTAL BUDGET	TOTAL BALANCE
	Logistics and Equipment Preparation			*Field Deployment*			*Data Analysis/Report*				
BUDGET ITEM											
PERSONNEL: wages and benefits	9,575			13,706			9,969		0	33,250	0
Noah Adams ($62.21 per hour - Loaded rate) 40 hrs Logistics, 88 hrs Field Deployment, 80 hrs Data Analysis (Estimated $12,940)											
Gary Rutz ($34.41 per hour - Loaded Rate) 40 hrs Logistics, 88 hrs Field Deployment, 40 hrs Data Analysis (Estimated $5,781)											
Marshal Hoy ($23.12 per hour -Loaded Rate) @ 80 hrs field deployment, 80 hrs data analysis. (Estimated $3,670)											
Scott Smith ($63.50 per hour - Loaded Rate) 28 hrs Logistics, 6.8 hrs field deployment, 28 hrs data analysis) (Estimated $3,999)											
Carolyn Brill, Administrative Officer (.013 FTE $750) Logistics, (.013 FTE $750) Field Deployment (Estimated $1,500)											
Staci Clark, Budget Analyst (.026 FTE $1250) Logistics, (.026 FTE $1250) Field Deployment (Estimated $2,500)											
Libby Pierce, Purchasing Agent (.015 FTE $500) Logistics, (.015 FTE $500) Field Deployment (Estimated $1,000)											
Roy Dodson, Shop Manager (.024 $1000) Logistics (Estimated $1,000)											
Melonie Skinner, DOI Fiscal Analyst, (.1 FTE $430) Logistics, (.1 FTE $430) Field Deployment (Estimated $860)											
Contracts											
Professional/technical sevices from a marine engineering firm will be selected by the WFRC through a bid process	22,955			29,803			17,242		0	70,000	0
Other contracts *(with whom?, for what?) list out: personnel, equipment, etc.*											
Other direct operating costs *(for what? – be specific)*	225			3,991						4,216	0
Equipment Shipping costs to & from test site (Estimated $225)											
Diesel Air Compressor (rental, del, return) (Estimated $2,891)											

Attachment A: Budget Detail for 2009 Projects - Summary and a Budget page for each partner (if applicable)

Project Title: *Emergency Delivery System Development for Disinfecting Ballast Water*

Project Manager Name: *Scott Smith.*

Trust Fund Appropriation: $125,000

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**Result 2 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**Result 3 Budget:**	**Amount Spent** *(date)*	**Balance** *(date)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Logistics and Equipment Preparation			***Field Deployment***			***Data Analysis/Report***				
High Pressure Air Line Hose (rent,del, return) (Estimated $1,100)											
Non-capital Equipment / Tools *(what equipment? Give a general description and cost)*	7,074									7,074	0
Airline manifolds (2) (Estimated $1,370)											
Air Flow Meters (6) (Estimated $1,700)											
Control Valves (8) (Estimated $300)											
Pressure gages (6) (Estimated $180)											
Airlift eductor piping (Estimated $2,100)											
Suction Line tubing (Estimated $1,174)											
Support brackets (Estimated $250)											
Supplies *(list specific categories)*				5,040					0	5,040	0
Rental of Water inductors (Estimated $1,000)											
Purchase of 1.5 inch hose, connectors, and mounting hardware for hose (Estimated $1,445)											
Purchase of mounting hardware for inductors (Estimated $1,580)											
Data collection/storage devices and data storage (Estimated $265)											
Diesel Fuel for air compresor (Estimated $750)											
Travel expenses in Minnesota (hotel, perdiem, parking, taxie)				500					0	500	0
Travel outside Minnesota *(where?, for what purpose?)*				4,920					0	4,920	0
Travel for Dr. Watten from duty station (W.VA) to Superior WI (Estimated $1,100)											
Travel from Cook to Deluth for Noah (airfair, parking, taxie) (Estimated $1,230)											
Travel from Seattle to Deluth for Marshal (airfair, parking, taxie) (Estimated $1,260)											
Travel from Cook to Deluth for Gary (airfair, parking, taxie) (Estimated $1,330)											
Other *(Describe the activity and cost) be specific*											
COLUMN TOTAL	**$39,829**	**$0**	**$39,829**	**$57,960**	**$0**	**$57,960**	**$27,211**	**$0**	**$0**	**$125,000**	**$0**

Emergency Response Guidance for Handling Ballast Water to Control Aquatic Invasive Species

Prepared for
Isle Royale National Park
Houghton, Michigan

File No. 09078.01
17 January 2012
Rev. B

THE GLOSTEN ASSOCIATES
Consulting Engineers Serving the Marine Community

Emergency Response Guidance for Handling Ballast Water to Control Aquatic Invasive Species

Prepared for
Isle Royale National Park
Houghton, Michigan

File No. 09078.01
17 January 2012
Rev. B

SIGNED ORIGINAL ON FILE

PREPARED: ______________________ ________

Kevin J. Reynolds, PE
Project Manager

CHECKED: ______________________ ________

Jon K. Markestad, PE
Senior Marine Engineer

APPROVED: ______________________ ________

David W. Larsen, PE
Principal-in-Charge

Contents

References

1 *Stemming the tide: Controlling introductions of nonindigenous species by ships' ballast water*, NRC (National Research Council), Marine Board Committee on Ships' Ballast Operations, Wash. DC: National Academy Press, 1996.

2 *Evaluation of Chemicals for Potential Treatment of Ballast Water*, US Coast Guard Research and Development Center, October 2004.

3 *Ballast Water Treatment Technology*, Lloyd's Register, September 2008.

4 *Guidelines For Risk Assessment Under Regulation A-4 of the BWM Convention (G7),* Resolution MEPC.162(56), International Maritime Organization, 13 July 2007.

5 *Chinese Submersible Barge "LUCKY ANGEL" Arrives in Bellingham – Cooperative ballast water treatment and hull fouling investigation case,* Washington Department of Fish & Wildlife, 7 January 2009.

6 Jeffery R. Cordell, et al., "Factors influencing densities of non-indigenous species in the ballast water of ships arriving at ports in Puget Sound, Washington, United States," Aquatic Conservation Marine and Freshwater Ecosystems (2009) Vol 19, Iss. 3 pp 322-343, 27 October 2008.

7 *Ballast Water Treatment During Emergency Response Operations Planning Issues*, Region 4 Regional Response Team for Area Contingency Plan Development, US National Response Team, 9 May 2002.

8 Mearns, A.; Benggio, B.; Waite, T.; "Ballast Water Treatment During Emergency Response: The Case of The M/T Igloo Moon," Division of Hazardous Matter Response, NOAA, Seattle, Washington, 1999.

9 Reynolds, K.; "Ship's Ballast Discharge Dispersion, Benchmark Dye Tracer Test," The Glosten Associates, 14 January 2005.

10 Reynolds, K.; "Mixing Chemicals into Ship's Ballast Water - Efficiency of Novel Mixing Methods," The Glosten Associates, 26 November 2008.

11 Reynolds, K.; "Mixing Chemicals into Ship's Ballast Water – Results of Great Lakes Bulk Carrier Field Trials," The Glosten Associates, 2012.

Section 1 Introduction

This field guide is intended as an aid to incident responders responsible for handling ships with high-risk ballast water that may be laden with potentially harmful non-indigenous species and pathogens collectively referred to as aquatic invasive species (AIS). The methods presented were developed in coordination with the US Geological Survey (USGS) and trialed aboard a Great Lakes bulk carrier (Reference 11). High risk carriers may wish to utilize these novel intervention methods at sea before arrival, upon arrival in port, or at an incident location, such as a grounding site. The decision process outlined in this guide can assist responders in balancing practical field considerations with sound environmental practice in emergency situations; for example, upon prediction of bad weather threatening to break a ship's hull. The response guide flow chart in Figure 1 maps the relevant section of this guide for each key inquiry during a response.

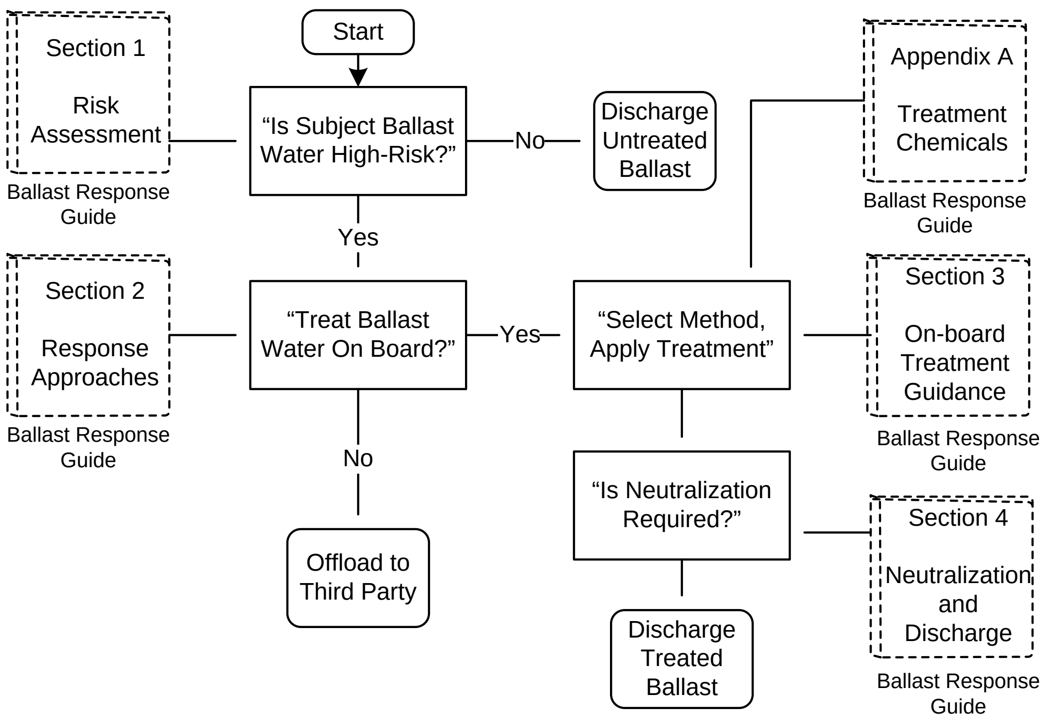

Figure 1 - Response Guide Flow Chart

Emergency responses described in this guide may be needed to treat suspect ballast water onboard in the following situations:

- Ship Casualty: This scenario involves a salvage situation where a vessel runs aground and cannot be freed without decreasing the ground reaction. Salvage cases may be time critical, making the discharge of ballast water a favored early response technique. The risk of discharging suspect ballast water in an environmentally sensitive area may be mitigated by directing the salvor to introduce, and possibly later neutralize, a chemical disinfecting agent into the casualty's ballast tanks. In this case, the deployment of the appropriate mixing technology could be critical to the success of the operation.

- Regulatory Intervention to High Risk Vessel Arrivals: Environmental monitoring for the distribution of AIS has led to the identification of high risk areas. Port State Control measures can be exercised to identify those vessels considered high risk arrivals. Suspect vessels that fail to demonstrate functioning ballast water treatment systems or evidence of volumetric open ocean exchange can then be mandated to undergo emergency interventions similar to that discussed for ship casualties.

A relevant example of casualty risk was demonstrated by the November 1996 *M/T Igloo Moon* grounding (Reference 8). Ballast water from the stricken tanker had to be offloaded in order to move the ship off the reef. Emergency treatment of ballast water was deemed necessary due to the origins of the ballast water and the vessel's proximity to the sensitive environment of Biscayne Bay National Park, and concerns were raised over the potential risk of introducing AIS via the ballast water that could harm the reef's natural biota. Twelve days after the grounding, 1.1 million gallons of the ship's ballast water was treated with calcium hypochlorite. The treated ballast water was then discharged overboard, after which assisting vessels safely towed the ship off the reef without incident or spillage.

The methods used in the *Igloo Moon* emergency response were better than inaction for reducing the risk of a new AIS introduction. The situation clarified the need for further research to develop scientifically-verified methods to dose ballast tanks with a biocide proven to be effective and that could be neutralized to a safe level for discharge.

Photo 1 - Tanker *Igloo Moon* carrying suspect ballast water shown aground on a sensitive coral reef. The adjacent ship is receiving cargo from the casualty vessel.

This guide broadly outlines considerations for determining whether treatment is appropriate, and on-board approaches to treating ballast water trialed aboard an operating Great Lakes bulk carrier. Actual treatment could be 1) conducted voluntarily under the responsibility of the vessel Master or Owner, 2) initiated by emergency response personnel when they have the authority, or 3) required through legal mandates by the agency with authority over the waters where discharge is to take place.

The Great Lake field trials were held aboard a single vessel and used dye to simulate and assess the methods of introduction of a biocide and in-tank mixing needs. With respect to mixing, the dye constituted a worst-case scenario, as it does not naturally diffuse through a water body as is common with some other chemicals. While the trials were conducted in freshwater, the methods discussed should work effectively in salt water and thus, the guide is suitable for general salt and fresh water use. The trials were conducted in two, 1 million gallon ballast tanks of a similar cathedral design filled with 800 thousand gallons of ballast water. While the volume of water tested was close to a worst case scenario, the application of these methods may be of limited practicality for other tank designs. With continued input from the ballast water and salvage community, subsequent revisions could address broader application needs. Currently, this guide intends to provide a framework for ship personnel and interested parties involved in either a casualty or regulatory intervention situation, and gives practical examples based on the trials conducted.

Section 2 Risk Assessment

Is there a significant threat of invasive species from release of this ballast water?

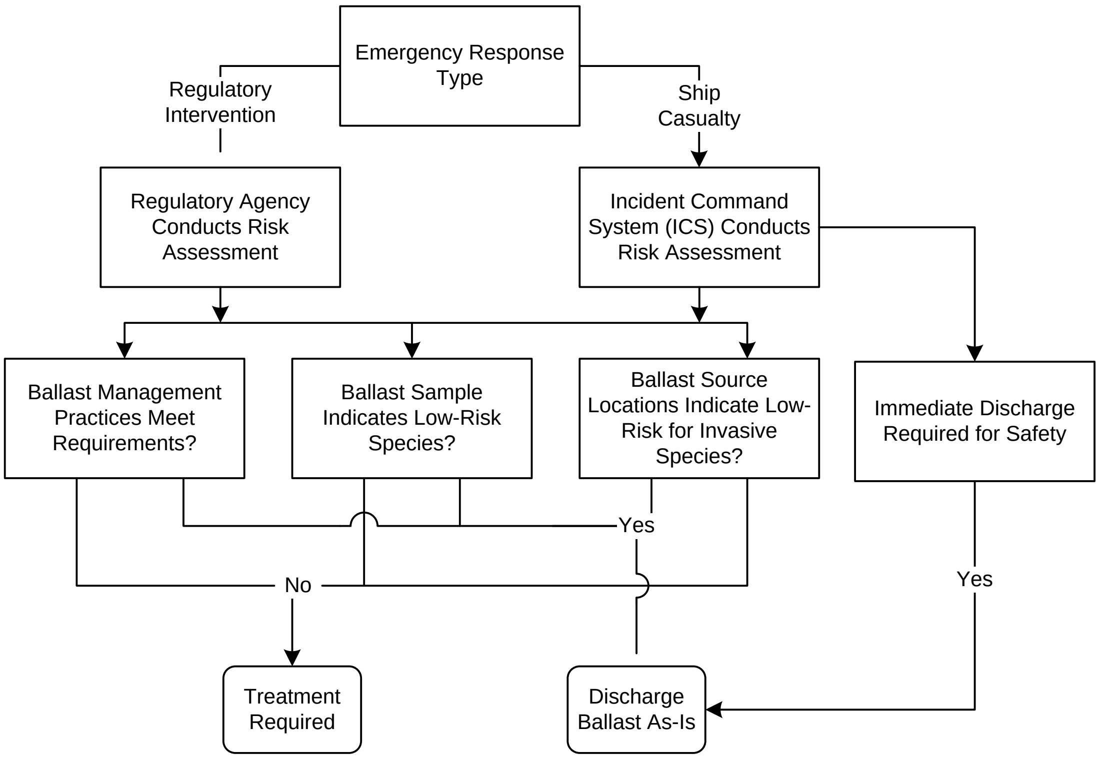

Figure 2 - Risk Assessment Flow Chart

This section outlines a process for determining whether a marine vessel's ballast water presents a significant threat of introducing AIS to the local ecosystem. Current practice calls for the response team to determine if required ballast management practices have been followed. If they have not been, the conservative practice is to consider the ballast water high risk. Other methods may determine risk based on sampling of the ballast tanks and/or analysis of the source water's geographic location. These assessments can be difficult to conduct on an emergency basis, and are therefore identified as "developing" in Figure 2.

Due to considerations for the safety of the ship and personnel, there may be cases where neither assessments nor emergency treatment can be performed before ballast water must be discharged for safety reasons.

2.1 Risk Assessment Responsibility

As commercial shipping regulations in the United States are enforced by a combination of federal and local agencies, risk assessment responsibility for:

- **Regulatory Intervention** generally lies with the intervening entity.
- **Casualty Response** depends on the scope and nature of the casualty, with large incidents requiring implementation of a Unified Command (UC) as described below.

2.1.1 Regulatory Intervention

On the federal level, the U.S. Coast Guard (USCG) has traditionally regulated marine vessel environmental compliance. The U.S. Environmental Protection Agency (EPA) has recently begun regulation of ship effluent discharges into U.S. waters. EPA response teams provide off-ship support when an incident threatens general populations or the environment.

On a local level, some U.S. states have developed and enforce their own ballast water discharge requirements to minimize the spread of non-indigenous species and/or to ensure that discharges are non-toxic. For example, Washington State Department of Fish and Wildlife regulates ballast water in accordance with state law. This agency coordinates with Washington State Department of Ecology to ensure that discharges meet state toxicity requirements.

2.1.2 Casualty Response

On the federal level, the USCG has traditionally regulated marine vessel safety. This mandate and tradition has positioned the USCG with the required infrastructure and experience to respond to ship incidents large and small. State and local level responders may include port authorities, emergency responders, and law enforcement, among others.

2.1.3 Level of Response

Risk assessment responsibility generally lies with the lowest level of command which has the capacity to handle the incident. Responsibility moves to higher levels of command depending on the location, circumstances, and scale of the incident or intervention. A low level incident might be a ship which did not exchange its ballast water and is waiting to discharge cargo. This incident might be assessed by a local USCG or state regulatory agency inspection team. A high level incident might be a grounded ship threatening to break-up and spill oil in an ecologically sensitive area. This incident might have several competing priorities, such as a high risk ballast water versus a possible oil spill, and therefore falls under the responsibility of UC as part of the Incident Command System (ICS).

The UC consists of the federal on-scene coordinator, the state on-scene coordinator, and the responsible party; i.e., vessel owner. The ICS organizes resources into operations, planning, logistics, and finance sections. The ICS planning section includes an Environmental Unit, which would likely assist the health and safety officers in performing the risk assessment.

In National Parks, the Natural Resources Trustee will be part of the UC. The National Park Service (NPS) Park Rangers generally have authority to respond to accidents in a park's jurisdiction. Additionally, NPS has specific mandates which prohibit the release of AIS:

- Preservation of natural, cultural and archeological resources, 36 CFR 2.1(a)(2). This section prohibits "Introducing wildlife, fish or plants, including their reproductive bodies, into a park area ecosystem."
- Park System Resources Protection Act, 16 U.S.C Section 19jj-2(b)(1) directs the Secretary to "undertake all necessary actions to prevent or minimize the destruction, loss of, or injury to park system resources, or to minimize the imminent risk of such destruction, loss, or injury."
- NPS Management Policies, Chapter 4.4.1.1, *Plant and Animal Population Management Principles*. "Prevent the introduction of exotic species into units of the

national park system, and remove, when possible, or otherwise contain individuals or populations of these species that have already become established in parks."

2.2 Assessment and Response Expertise

Once a situation is identified as requiring an emergency response, the appropriate responding agency or team will:

1) Assess the risk of AIS introduction.
2) Determine an appropriate response including compliance with applicable regulations.
3) Execute the response as outlined in Sections 2 and 3.

The expertise required to make these decisions will include roles for a chemical engineer, toxicologist, and a biologist familiar with ballast water treatment. Potential resources include the USCG, EPA, state/local water quality representatives, and the Aquatic Nuisance Species Task Force. This expertise may be critical to carry out many of the tasks listed in this guide, most notably:

- Conducting the compliance survey outlined below.
- Determining what chemical can be applied to inactivate high risk ballast water. This includes required chemical concentration and residence (soak) time required.
- Determining if neutralization of treatment chemical is required prior to discharge and, if so, the proper means.

All applicable regulatory requirements and approvals must be completed prior to executing a response. The expertise in determining compliance with regulations will generally be found within the regulatory agency itself.

The methods outlined in this guide rely on the addition of biocides to ballast tanks. Generally, biocide application is regulated by the EPA under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The EPA may allow use of a biocide for an unregistered use during a crisis. There are specific exemptions which support AIS rapid response and control efforts, specifically FIFRA Section 18 - Emergency Exemptions at:

http://www.epa.gov/owow/invasive_species/invasives_management/fifra18.html#when

and FIFRA Section 24(c) - Special Local Need Registrations at:

http://www.epa.gov/owow/invasive_species/invasives_management/fifra24.html#when

The EPA may be contacted for consultation directly at 703-308-8179, or 703-305-5447 and ask for the Section 18 Emergency Exemption Team Leader.

Use of a biocide may also require approval from appropriate water quality regulatory authorities at the state level. Applicable regulations may be waived during an emergency. In the Great Lakes region, a list of pollution control agencies is provided at:

http://www.great-lakes.net/links/envt/orgs_pollution.html#p2

The United States has established the Aquatic Nuisance Species Task Force, "an intergovernmental organization dedicated to preventing and controlling aquatic nuisance species, and implementing the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990." Although not typically focused on field response efforts, this task force is a source of expertise related to AIS. Contact information for various experts in each state through their web-site:

http://anstaskforce.gov/experts/search.php

2.3 Do Ballast Management Practices Meet Requirements?

Current best practice is to assess risk by determining compliance with regulations. Generally, **vessels in compliance with the requirements are not considered to have high risk ballast water** on board. The invasive species experts should be able to advise on the ballast management practices required by regulatory agencies for vessels operating in specific jurisdictions. Generally, this involves either **ballast water exchange** or **treatment**. These measures are considered, by regulation, as the minimum requirements to protect local waters. In the case of marine protected areas, sanctuaries, and National Parks, however, the release of invasive or exotic organisms is prohibited. Consequently, these cases may require analysis during emergency response.

2.3.1 Compliance Survey – Ballast Water Exchange

The International Maritime Organization (IMO) identifies three acceptable methods of ballast water exchange: 1) sequential, where ballast tanks are emptied and then refilled; 2) flow-through, where ballast tanks are overfilled by a prescribed amount; and 3) dilution, where a ballast tank is filled on top while it is being discharged from the bottom. These exchange events are generally required to be conducted in deep oceanic waters, and are expected to have a volumetric exchange efficiency of 95%.

Verification of ballast water exchange practice requires a review of the ship's ballast water management log. Various survey methods have been developed to assess the accuracy of these logs, and compliance with regulatory requirements.

Salinity Verification

The USCG fields a detachment at the Snell Lock on the Saint Lawrence Seaway in Massena, New York. A primary function of this detachment is to ensure that vessels entering the Great Lakes have conducted a mid-ocean exchange. This survey is conducted by taking a water sample from the ship's ballast tank and testing salinity. This can be achieved by a conductivity meter or light refractometer. An efficient oceanic water exchange requires salinity readings to be over 30 parts per thousand. Readings below 30 parts per thousand are considered non-compliant for fresh waters such as the Great Lakes.

Dakota Technologies BEAM

Dakota Technologies (http://www.dakotatechnologies.com/) developed and is currently testing a product called BEAM. BEAM (Ballast Exchange Assurance Meter) is a portable, handheld fluorimeter designed to generate a response relative to the amount of colored dissolved organic matter (CDOM) in ballast water. The CDOM related response is determined by exciting the sample with near-UV light and measuring the resulting fluorescence to Raman scatter ratio. This handheld device is designed to determine if ballast water is from near-coastal locations (out of compliance) or from oceanic locations (in compliance) for ship's from outside the EEZ.

Newcastle Method

Australian authorities developed a method which compared the electrical loads in engine room logs, with the ballast management logs maintained on the bridge. This method was trialed on almost 200 ships in Newcastle in 1998. During the listed ballast exchange event in mid-ocean locations, authorities would look for a corresponding increase in electrical loads indicating that the ballast water pumps were running. Additionally, authorities would review pumping capacities and tank volumes, to determine if the timeframe in which exchanges took place satisfied requirements. Similar techniques are currently used in Washington State. Effective execution of such a survey requires specific training and experience.

2.3.2 Compliance Survey – Ballast Water Treatment

Ballast water treatment is being phased in on international, national, and local levels to replace the less effective ballast water exchange methods. In general, this phase-in has already begun with various trial and testing programs. The potential technologies range broadly from filtration and ultraviolet radiation to the use of active chemicals such as chlorine. Systems either treat the ballast water upon uptake, while in the tank, upon discharge, or in combination.

With ballast water treatment systems generally under development, there is little in the way of compliance history. In general, inspections should follow the guidance provided in the IMO Ballast Water Management Convention as follows:

- Identify Type Approval Certificate for treatment device.
- Inspect Maintenance Logs to ensure unit is in proper repair.
- Operational test of treatment system to ensure unit is functional.
- Inspect Ballast Management Logs to ensure subject ballast water has been treated.

2.4 Using Ballast Samples to Determine Risk

In some cases, it may be possible to conduct sampling to prove that the ballast water is high risk. However, it is very difficult to use samples to prove that ballast water is low risk, because sampling may not be possible in the remote locations which are most likely to hold high concentrations of high risk organisms and the number of samples needed would be significant.

However, in some cases sampling can be used successfully. For example, a risk assessment was performed by the Washington State Department of Fish and Wildlife, in conjunction with University of Washington science teams, on a bulk carrier in the Columbia River in 2009. Ballast water samples were taken on-site and evaluated. A high concentration of coastal organisms was found, resulting in the ship leaving port to conduct ballast water exchange 50 miles off-shore. The results are shown in Table 1. This method can take days to get qualified personnel and equipment on hand.

Table 1 - Ikan Acapulco Ballast Sample Analysis (University of Washington, 2009)

	Before Exchange (1/22/09)	**After Exchange (1/26/09)**
Tank	**Density m^{-3} coastal + non-indigenous**	**Density m^{-3} coastal + non-indigenous**
Forepeak	**32,541**	**3**
#1 SWB-S	**25,239**	**8**

2.5 Using Ballast Source Locations to Determine Risk

The metrics for using ballast source locations to determine risk are not widely documented, and therefore not generally suitable for emergency response situations. When used, it should consider a comparison between the ballast water source location and planned discharge location ecosystems. This comparison should include any known AIS threats and similarities of ecosystems. Additional factors include the duration of the voyage, volume of the ballast water to be discharged, and the ballast water/sediment management practices which have been conducted.

The Marine Environment Protection Committee (MEPC) of the IMO has produced "Guidelines for Risk Assessment Under Regulation A-4 of the BWM convention (G7)." Although developed to guide IMO members in exempting certain "low-risk" vessels from ballast management practices, the same principles may be applied to emergency response risk assessment. The IMO guidelines provide metrics for the following approaches:

- Environmental Matching Risk Assessment
- Species' Biogeographical Risk Assessment

2.6 Emergency Management of High-Risk Ballast Water

Once a vessel has been identified as carrying high-risk ballast water, emergency management measures may be used. The primary options are to:

- Off-load the ballast water to a third party, or
- Treat the ballast water onboard prior to discharging in local waters.

The next section, Response Approaches, discusses challenges identified during the field trials, with a description of each approach taken to selection of the appropriate option.

Section 3 Response Approaches

Should high risk ballast water be treated onboard, or off-loaded to a third party?

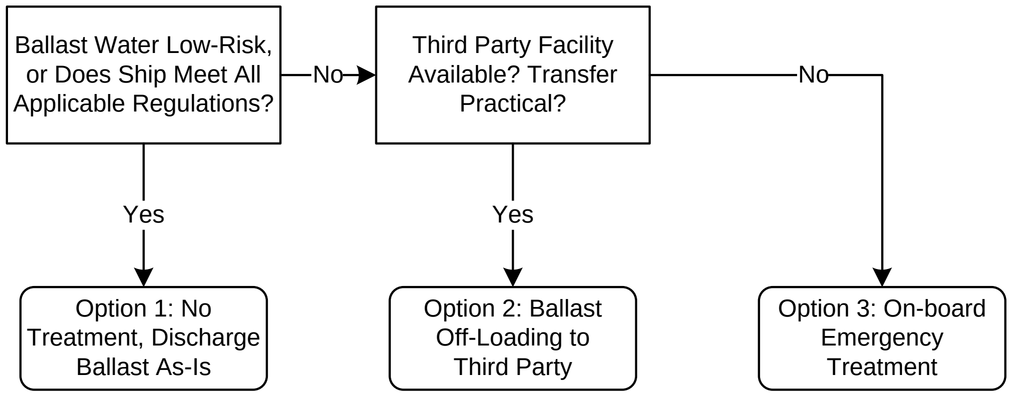

Figure 3 - Response Approach Flow Chart

3.1 Option 1: No Treatment

The previous section, Risk Assessment, outlines the field trial approaches used to determine the risk of a marine vessel's ballast water introducing an invasive species or harmful pathogens to the local ecosystem. A "low risk" conclusion of this risk assessment should allow discharge of the ballast water as-is, without further management.

A "high risk" conclusion may require further management, as outlined in the following options.

3.2 Option 2: Ballast Off-Loading to a Third Party

It is typical in salvage cases to discharge harmful liquids, such as fuel oil, to waiting tank barges to prevent pollution. The salvor may determine that such off-loading is preferred over on-board emergency ballast water treatment. If the situation allows, off-loading of ballast water to a third party in the same manner is an attractive alternative as it fits within the existing methods and tools of salvage teams. A primary consideration is the timing necessary to acquire third party resources. Off-loading ballast presents the following opportunities:

- Transfer to Holding Tank(s): The salvage team uses the vessel's pumps, or salvage team pumps to remove the ballast water to adequate holding tanks off vessel. Typically this is achieved by transferring the water to a tank barge, but could also be transferred to another ship or a shore facility. The third party will then need to consult with local authorities on how to treat the transferred high risk ballast water.
- Transfer to Treatment Facility: A third party ballast treatment system, possibly mounted in a container, is located either at a shore facility or on a deck barge (possibly on the ship's deck). Ballast water is pumped to the device, which then treats the water in **compliance with local efficacy requirements**, before it is discharged into local waters in **compliance with local toxicity discharge standards**. Such an operation

was conducted using the Hyde Guardian ballast treatment system on the lift barge "Lucky Angel" in Puget Sound, Washington (see Photo 2). The third party may require some tank holding capacity to handle waste streams that result from the treatment process, such as from back-flushing filters.

Off-loading the ballast water to a third party, to a holding tank or to a treatment plant, presents significant practical challenges. The challenges will vary significantly between various vessel classes, and individual vessel installations. Generally, ballast piping is of large diameter and located deep within the vessel, as close to the bottom plating as possible. While such installations limit energy consumption and power requirements during normal operations, it results in installed piping systems that are not capable or outfitted to send ballast water to the main deck for ease of third party access.

It should also be understood that, in many salvage situations, the subject vessel may not be under its own power. These cases require the salvage team to either provide power to the desired equipment, or to bring independently powered equipment. Some opportunities for third-party access are outlined here:

- Vessels with lower ballast water capacities and flow rates may have interconnected ballast and fire-main piping. This is common with salt water bulk carriers, container ships, roll-on/roll-off carriers, and many specialty vessels. In these cases, it is recommended that the vessel's fire pump(s) be used to off-load the high-risk ballast through the main deck located fire-main International Shore Connection.
- Typical ballast water discharges are either through an overboard pipe or through a sea-chest. It may be possible to secure a containment arrangement around such a discharge, secured to the outside of the vessel's hull. Although some leakage is likely, a third party may then be able to pump out the containment while the vessel discharges its ballast water in a traditional manner.
- Salvage teams typically carry submersible pumps that are independently powered and capable of high flow rates. Such operations require vertical access to the ballast tank(s), such as a hatch or manhole cover, or for a new opening of adequate size to be cut into the tank top. This may only be applicable for upper wing tanks. These pumps are then operated from the weather deck and lowered into the subject tank. The water is then pumped "over the top," the vessel's main deck, and to the third party.

Photo 2 - Hyde Guardian System As Used for Emergency Treatment of Ship Lift Barge "Lucky Angel" in Puget Sound (Hyde Marine, 2009)

3.3 Option 3: Onboard Emergency Treatment

If the high-risk ballast water cannot be transferred to a third party, onboard emergency treatment should be considered. For the passive treatment options described in this document, the required equipment will typically exist aboard the ship, with only the treatment chemicals requiring sourcing. The active mixing methods described herein, however, require additional equipment that must be brought aboard the ship for treatment or even pre-installed while not in ballast. The response team, in consultation with local, state, and federal agencies, will need to consider the following issues:

- Stability of vessel, and amount/location of untreated ballast water
- Current and forecast weather
- Sea conditions
- Hazards imposed to on-site responders
- Health Hazards imposed to the local community
- Areas of special environmental concern (coral reef, state park, etc.)

Additionally, some treatment chemicals may be neutralized prior to discharge by addition of a second chemical or through degradation over time. Unneutralized treatment water could be hazardous to aquatic organisms and may violate pollution regulations. A risk analysis should consider the potential harm of an unneutralized discharge versus the potential harm of an introduced species. Pollution regulations may be waived during an emergency, but this issue would need to be assessed.

After gaining an idea of the risks as itemized above, a decision can be made as to whether onboard emergency treatment can proceed. In general, emergency treatment considers mixing a liquid chemical into a full ballast tank. The next section, Onboard Treatment Guidance, was developed based on 2009 and 2010 trials aboard a 1,000 foot, 16 million gallon ballast capacity, Great Lakes bulk carrier. The suggested methods were field verified in one or more tanks of approximately 1 million gallons on this working ship. The first of the methods outlined in the following section use simple equipment readily available in a ship's locker, while the later methods outline active mixing methods which require some specialized equipment.

Section 4 Onboard Treatment Guidance

What onboard mixing method is practical given the physical constraints of the ship, and equipment on-hand?

4.1 Determine Chemical Quantity

If onboard treatment is advised, chemicals may be used to treat ballast water and prevent the introduction of AIS. The type of chemical must be chosen carefully to avoid harming humans, the ship, or the environment. The experts, particularly the chemical engineer, (see Section 1 – Risk Assessment) can provide valuable resources in selecting, handling, applying, and monitoring the treatment chemical. The following worksheet provides a worked example.

Table 2 - Worksheet to Determine Chemical Volume

Invasive Species Expert Inputs	User Input	*Example*
1. Designate Ballast Treatment Chemical		*Sodium Hypochlorite*
Target Concentration (TC) (parts per million)		*3.00*
Chemical Solution Concentration (CSC) (%)		*12%*
Specific Gravity of CSC (SGC)		*1.165*
Ballast Quantity to be Treated (BQT) (gallons)		*1,000,000*
Specific Gravity of BQT (SGB)		*1.025*
2. Determine Chemical Solution Amount (gallons)		
=(TC*BQT*SGB) / (CSC*SGC*1,000,000)		*22.00*
3. Designate Residence (Soak) Time (hours)		12
4. Is Neutralization Required Before Discharge?		TBD

Photo 3 - Measuring Dye for Ballast Water Treatment

Note: Appropriate Personal Protective Equipment (PPE) should be used when handling hazardous chemicals. Materials in photo are non-toxic.

4.2 Chemical Introduction and Mixing Methodology

To select a method for introducing and mixing a chemical treatment agent into ballast tanks, the applicability of each method needs to be evaluated. This guidance will cover four different passive methods and four different active methods of chemical introduction and mixing, as well as when the methods can be used.

Table 3, *Mixing Method Selection*, provides a framework to determine the most effective mixing method that can be practically deployed. Methods are ranked based on the combination of effectiveness and ease of installation from the ship's deck, as experienced during the shipboard trials. Testing for these methods occurred on one vessel in tanks of nearly identical design and size. Differences in effectiveness could occur under different situations, however, so this discussion should be considered guidance rather than a simple set of instructions. In particular, some chemicals will naturally diffuse through a water body until it reaches equilibrium. Different chemicals achieve equilibrium at different rates.

Table 3 - Mixing Method Selection

Mixing Method	Time to Reach 90% Mixing (hrs)	Setup Difficulty	Relative Ranking	Reasoning
Nozzle Active Mixing	1.5	Moderate	1	Rapid mixing and moderate installation/operation effort.
Air Lift Point Diffuser Mixing	1.25	Moderate	2	Rapid mixing only using air. Installation more challenging than nozzle.
In Line Dosing	4	Moderate	3	Rapid mixing. Requires transfer of all ballast water, so not always practical for emergency use
Air Lift Grid Diffuser Mixing	1.25	Hard	4	Rapid mixing. Not practical to install in full ballast tank, so not always practical for emergency use
Bulk-on-Bottom Dosing		Easy	5	Easy application, mixing times could be improved by applying chemical close to ballast intake
Moderate Seas	24			
Mild Seas	48			
Perforated Hose Dosing	16	Easy	6	Moderate mixing rate. Simple application. Could be improved by introducing chemical in multiple locations
Vent Dosing		Easy	7	Slow mixing relying on ships motions for majority of mixing. Mixing would be very slow for stationary ship
Moderate Seas	24			
Mild Seas	36			
Internal Transfer Dosing	36	Moderate	8	Slow mixing for effort required. Increase transfer rate to reduce mixing time, or add nozzle for rapid mixing.

4.2.1 Method 1: Nozzle Active Mixing

Application: Full or Partially Full Ballast Tank

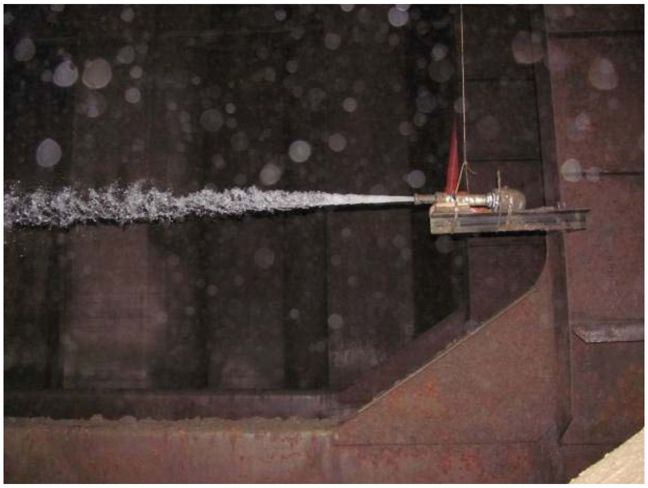

Photo 4 - Parallel Nozzle Setup

Photo 5 - 45° nozzle setup (lower nozzle part of parallel setup)

As many nozzles as practical are lowered into tank through manholes or hatches and proper location is dependant on tank geometry. Nozzles should be installed such that the water jet creates movement in the whole tank.

No. of Nozzles	Orientation	Test Results
2	Center in tank, each facing 45° off the outboard wall.	< 2 hours
3	Distribute across tank, each facing parallel towards the centerline.	< 1.5 hours

Chemical is metered into the water flow, and mixes into the ballast water by a combination of turbulent water movement and chemical diffusion.

1. Obtain source water supply. Ships firemain or deck washdown can be utilized if ~350 gpm and ~50psi at the outlet is available and the addition of water to the tank is acceptable. Alternatively, lower a submersible pump into the ballast tank to make a closed loop system. Plan on 100-150 gpm per nozzle to size pumps.
2. Lower nozzle on rigid pipe until ~3' above bottom structure. Secure support pipe at deck to maintain water source jets in proper direction. Note that the rigid pipe must be capable of supporting the thrust imparted by the nozzles.
3. Add required quantity of chemical to treat tank into drum, and dilute with water.
4. Set up chemical injection. Use small, high head metering pump. Connect in line with water source.
5. Start water source to establish in tank circulation, this can take 10-20 minutes.

6. Inject chemical into water source over a period of 10-20 minutes. Flush chemical drum with as much water as practical, pumping into water source.
7. Continue to run water through nozzles for 2 hours after start of chemical injection to complete mixing.

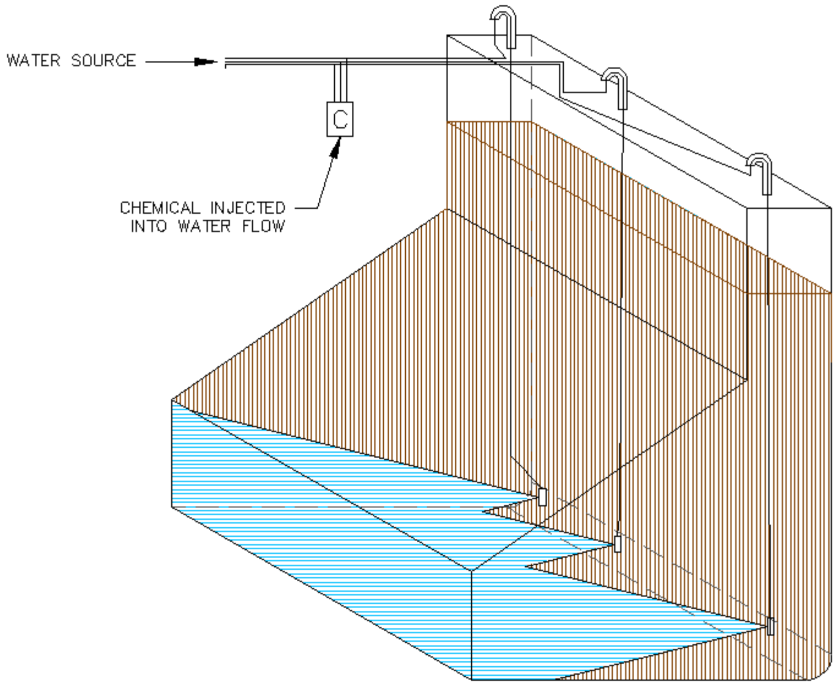

Figure 4 - Three Parallel Nozzle Arrangement

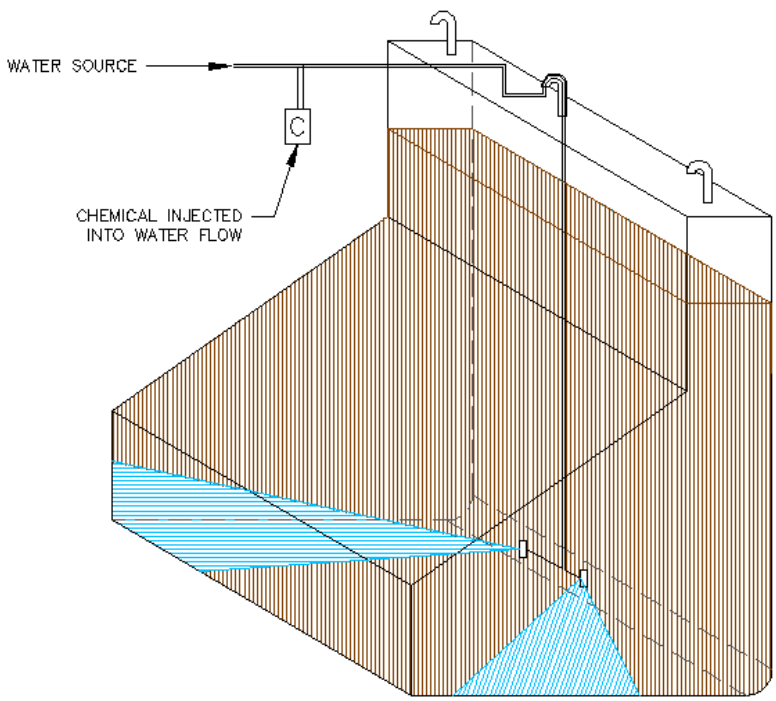

Figure 5 - Two 45 Degree Nozzle Arrangement

4.2.2 Method 2: Air Lift Point Diffuser Active Mixing

Application: Full or Partially Full Ballast Tank

Photo 6 - Point diffuser in tank

Point diffusers are dropped into the tank along outboard sideshell, centered between deep frames, spaced equally through vents or manholes. The chemical is introduced to the tank just above each point diffuser using a pump and tubing. The chemical is expected to mix into the ballast water by a combination of turbulent water movement and chemical diffusion. During tests, this method mixed a partially full ballast tank in just under 1-1/4 hours.

1. Connect suction side of small pump to a drum, and connect the discharge side to a manifold with enough ports to supply chemical to each diffuser. Connect tubing between manifold and each point diffuser tying tubing to air supply hose. Terminate tubing 1' above diffuser. Start small pump and adjust flow to equalize all branches.
2. Lower point diffusers into tank using air supply hose until ~4' above the bottom. Insure there is enough weight attached to keep them submerged.
3. Start air supply to establish in tank circulation, this can take 10-20 minutes.
4. Add required quantity of chemical to treat tank into drum, and dilute with water.
5. Inject ballast tank with chemical over a period of 5-10 minutes. Rinse drum with water and continue to inject into tank until drum is clean.
6. Continue to run air through point diffusers for 2 hours after start of chemical injection to insure complete mixing.

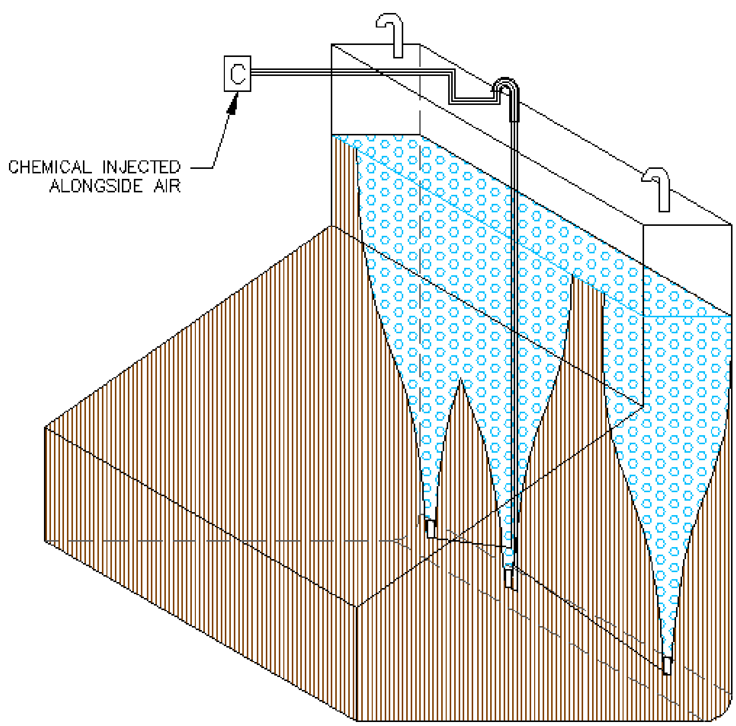

Figure 6 - Three point diffuser diagram

4.2.3 Method 3: In-Line Dosing

Application: Empty Ballast Tank (During Uptake or Transfer)

Photo 7 - Inline dosing setup

"In-line dosing" injects the chemical directly into the ballast main while the ballast is being gravitated or pumped into the ballast tank. The mixing takes place both in the piping, as well as in the tank.

1. Determine how much chemical is needed to treat target ballast tank.
2. Connect small pump and hose between the drum and the ballast pump (preferably on pump suction side).
3. Fill drum with water. Start chemical dosing pump. Continue filling drum with water such that it stays partially full.
4. Start ballasting. Add chemical to drum in proportion to amount of ballast water loaded. If ballast tank is 25% full, then 25% of chemical should have been used. Continue filling drum with water such that it stays partially full.
5. Finish adding chemical early. Make sure 100% of chemical has been added to drum before finished ballasting, such that drum can be flushed and emptied into ballast line.

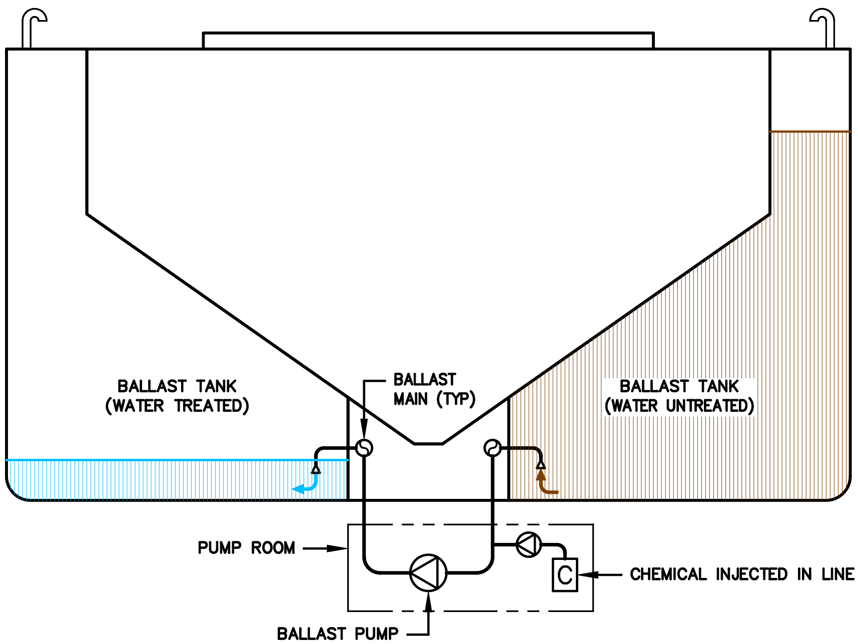

Figure 7 - Inline dosing diagram

4.2.4 Method 4: Air Lift Grid Diffuser Active Mixing

Application: Empty Ballast Tank (perminant/semiperminant installation)

Grid diffusers are installed into tank along outboard sideshell, centered between deep frames. The chemical is introduced to the tank just above each diffuser grid using a pump and tubing. The chemical is expected to mix into the ballast water by a combination of turbulent water movement and chemical diffusion. During tests, this method mixed a partially full ballast tank in just under 1 hour.

Photo 8 - Grid diffuser in tank

1. Connect suction side of small pump to a drum, and connect the discharge side to a manifold with enough ports to supply chemical to each diffuser. Connect tubing between manifold and each diffuser tying tubing to air supply hose. Terminate tubing at the midpoint of diffuser. Start small pump and adjust flow to equalize all branches.
2. Install diffuser grids in tank ~4' above the bottom. Insure there is enough weight attached to keep them submerged or tie grids to structure.
3. Fill tank with water.
4. Start air supply to establish in tank circulation, this can take 10-20 minutes.
5. Add required quantity of chemical to treat tank into drum, and dilute with water.
6. Inject ballast tank with chemical over a period of 5-10 minutes. Rinse drum with water and continue to inject into tank until drum is clean.
7. Continue to run air through grid diffusers for 2 hours after start of chemical injection to insure complete mixing.

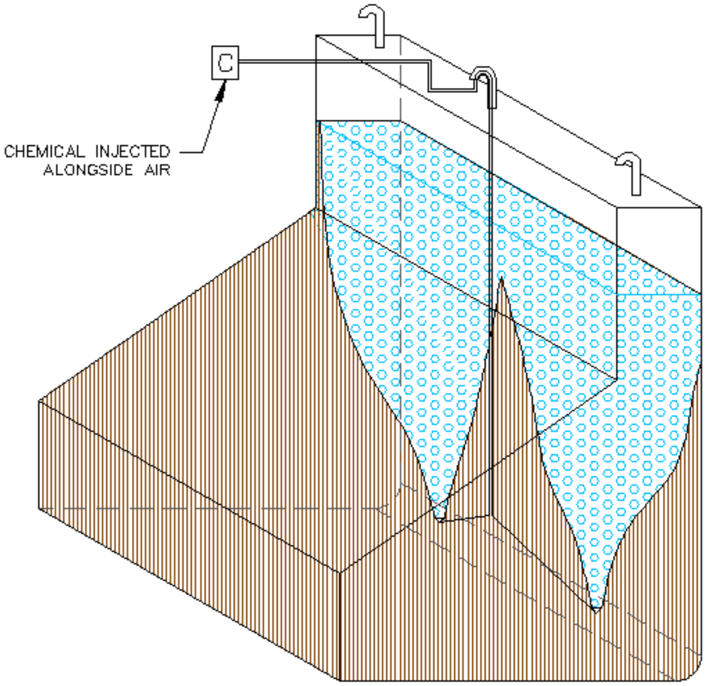

Figure 8 - Grid diffuser diagram

4.2.5 Method 5: Bulk-On-Bottom Dosing

Application: Empty Ballast Tank (During Uptake or Transfer)

"Bulk-on-bottom dosing" pumps chemical into the tank before it is filled by means of a manhole, vent, sounding tube, or other access. The tank is then filled with ballast, which mixes with the chemical as the tank is filled.

Photo 9 - Dosing setup on deck

1. Add required quantity of chemical to treat tank into drum, and dilute with water.
2. Target pumping chemical as close as possible to where the ballast water fill is located to promote mixing.
3. Pump chemical mixture into empty ballast tank. Flush out drum with as much water as possible, "chasing" chemical placed in ballast tank with as much water as reasonable (~250 gallons or more).
4. Start ballast transfer operations as soon as possible, at as high of a rate as possible. There is concern that sediment may absorb chemicals given enough time.

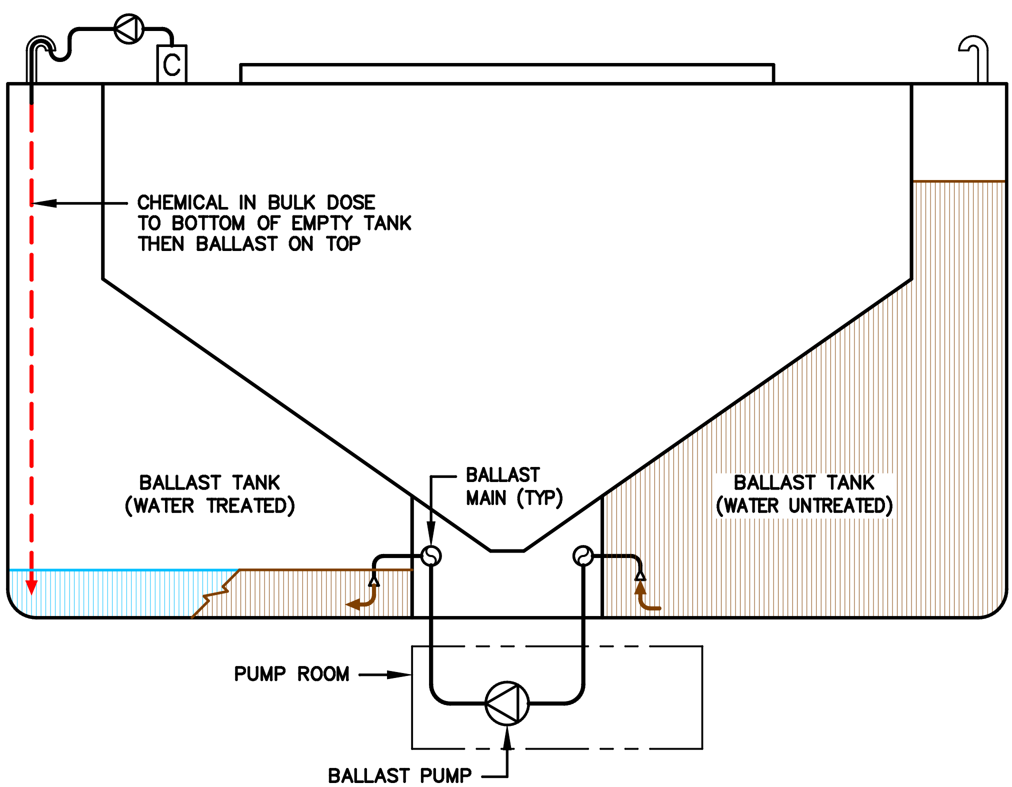

Figure 9 - Bulk on bottom dosing diagram

4.2.6 Method 6: Perforated Hose Dosing

Application: Full or Partially Full Ballast Tank

"Perforated hose dosing" *sprays* the chemical into the water column in the ballast tank. This can be done at one tank location (manhole, vent, or other tank top access), or if available, at several tank locations.

1. Set-up perforated hose (see equipment section) of a length to suit water level in the ballast tank.
2. Add required quantity of chemcial to treat tank into drum and dilute with water.
3. "Spray" the chemical into the ballast tank by running the small pump at maximum pressure. Flush as much water after the chemical as practical (at least 20 minutes).

Photo 10 - Perforated hose setup on deck during dye study

Note: Appropriate PPE should be used when handling hazardous chemicals.

4. If more than one tank location is available, divide the chemical accordingly, and repeat steps 2 – 4 in each additional location.

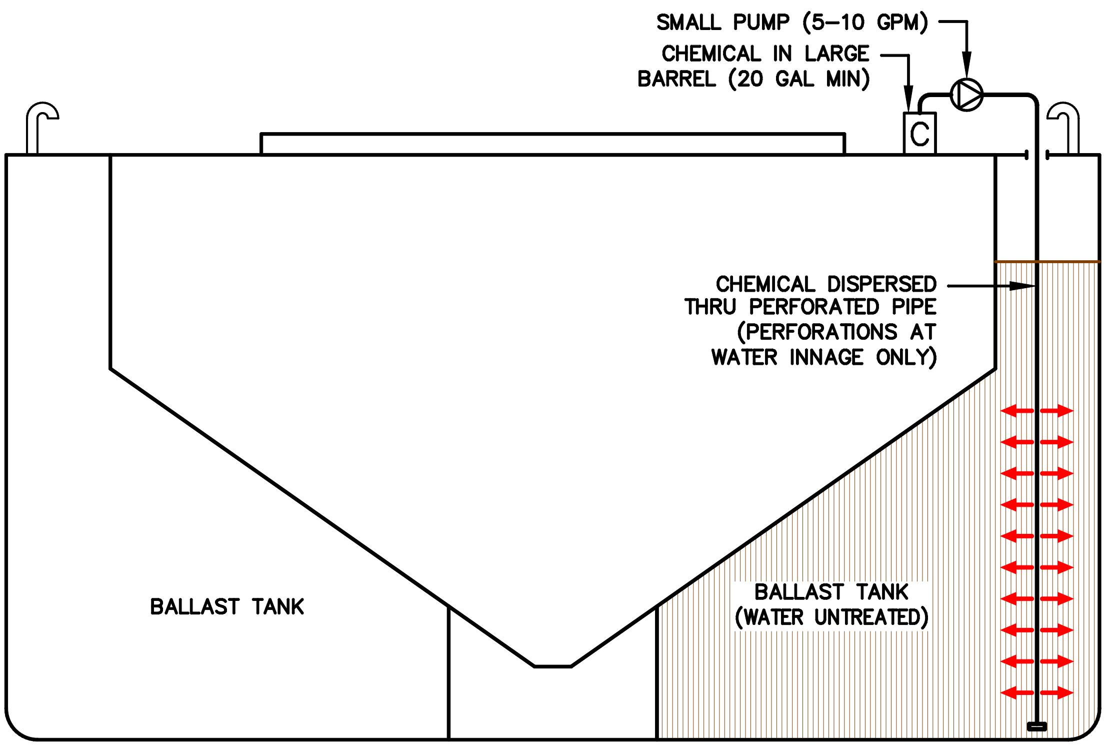

Figure 10 - Perforated hose diagram

4.2.7 Method 7: Vent/Sounding Tube Dosing

Application: Full or Partially Full Ballast Tank

"Vent/sounding tube dosing" pumps chemical through any available tank opening into a full ballast tank. The chemical is expected to mix into the ballast water by a combination of chemical diffusion, and of any motion undergone by the ship. Although this method was used during the *Igloo Moon* response, and is currently required by jurisdictions such as Argentina for resonding to cholera outbreaks, it is considered the least effective mixing method reviewed here.

1. Add required quantity of chemical to treat tank into drum, and dilute with water.
2. Inject partially full ballast tank with chemical, flushing out drum with as much water as practical (~250 gallons or more), "chasing" chemical placed in ballast tank with as much water as possible.
3. If more than one tank location is available, divide the chemical accordingly, and repeat steps 2 – 4 in each additional location.

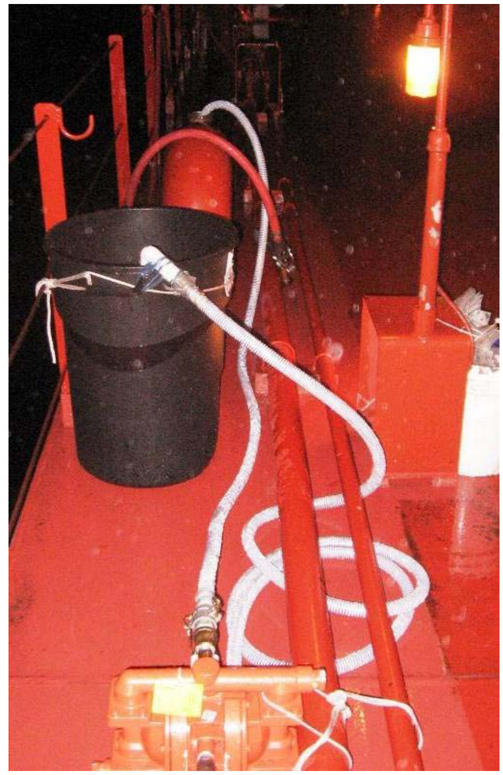

Photo 11 - Vent Dosing setup on deck

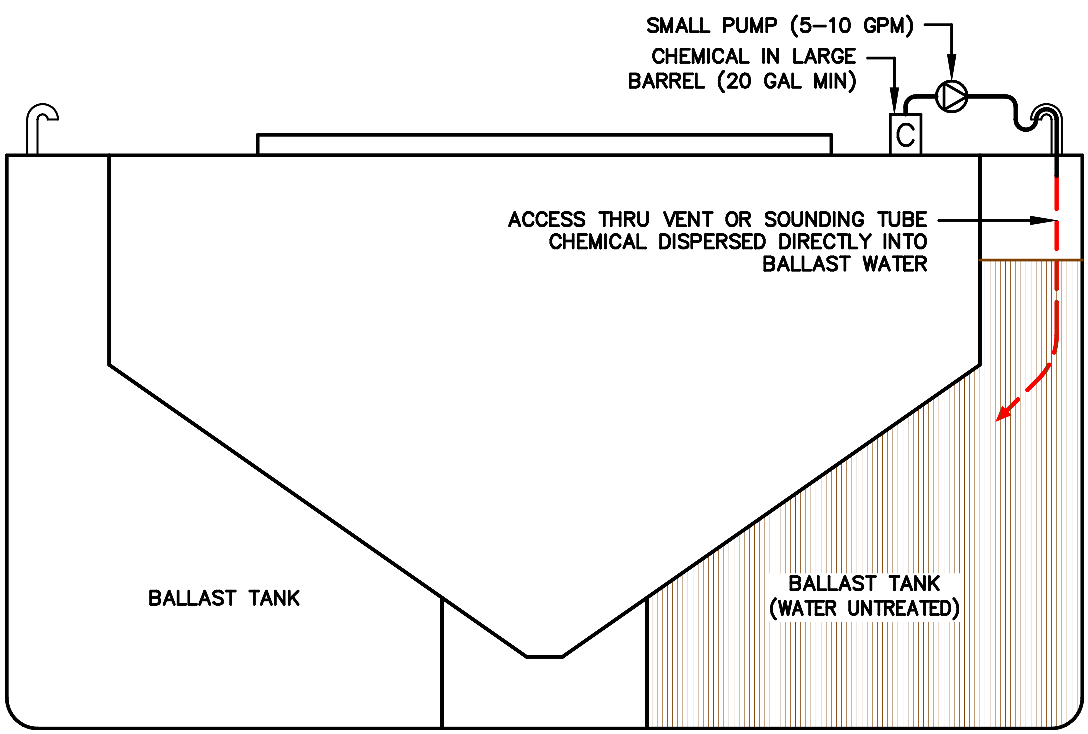

Figure 11 - Vent/sounding tube dosing diagram

4.2.8 Method 8: Internal Transfer Dosing and Mixing

Application: Full or Partially Full Ballast Tank

"Internal transfer dosing" circulates the ballast water internally within a single tank, while metering in chemical during this circulation process.

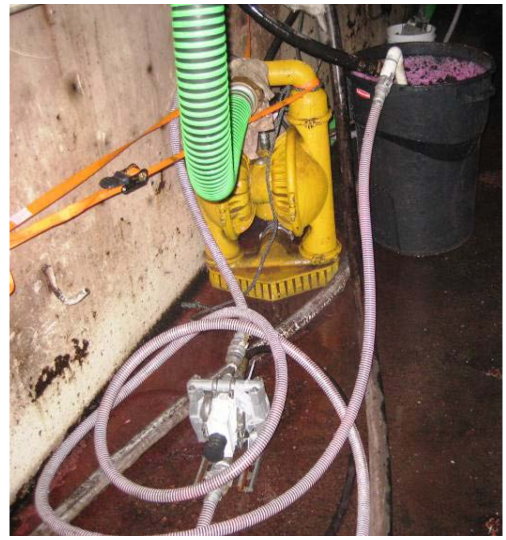

Photo 12 - Internal transfer setup in hold

1. Internal Transfer Equipment Set-up. See Equipment List section.
2. Start the large circulation pump. This will be run during dosing, and for as long afterwards as needed to achieve mixing (perhaps several days).
3. Set-up small dosing pump and hoses, connecting to the suction manifold. Add required quantity of chemcial to treat tank into drum, and dilute with water.
4. Inject the chemical into the circulation loop over a period of no less than two hours. Flush chemical drum with as much water as practical, pumping into the circulation loop.
5. Continue running circulation loop until mixing is achieved.

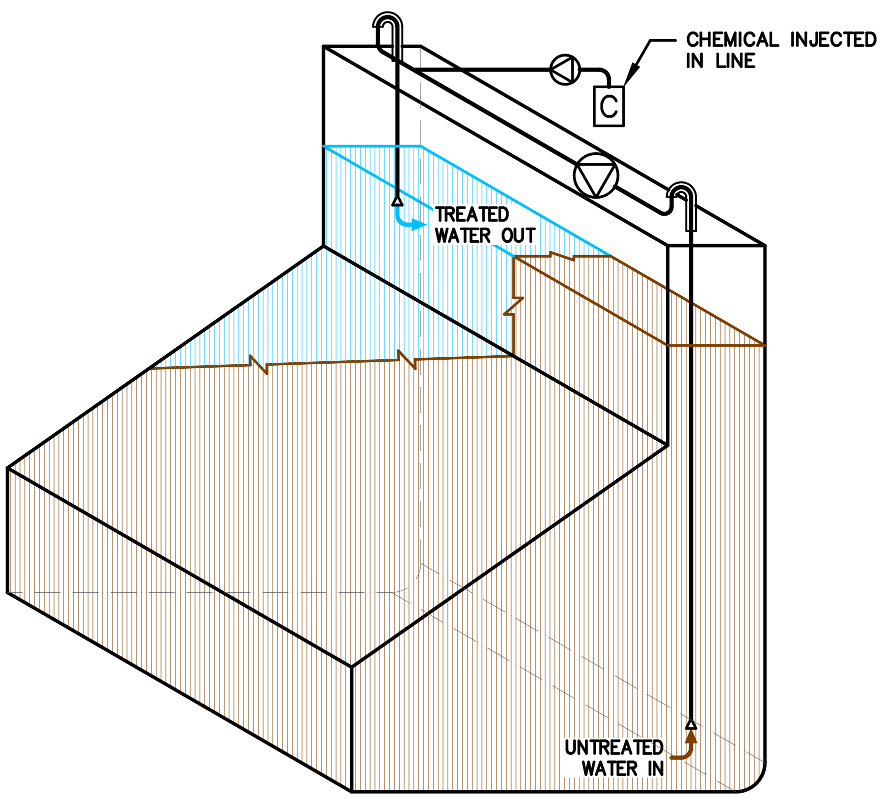

Figure 12 - Internal transfer mixing diagram

4.3 Equipment Requirements

The methods developed for this guide assume that the response team only has access to typical ship's equipment. In general, this includes a small pump(s), hoses, fittings, and drums. The ability to apply advanced equipment will improve the effectiveness of the response.

4.3.1 Basic Equipment

- Pump (1): Small pump with capacity between 5 and 20 gallons per minute. Must have check valve on discharge side, and adequate head to overcome ballast main pressure.
- Drum (1): 20 to 50 gallon capacity, to add chemical diluted with water.
- Hose (2): ~ 3/4" to 1" diameter, with length and fittings to suit. Rated to the greater of the ballast main pressure or small pump head.
- Generator: Diesel powered generator sized to power the basic equipment and any advanced equipment required (only required if ship is without power).

Photo 13 - Typical drum and small pump with hoses connected

4.3.2 Method Specific Equipment

- Nozzle Equipment (2 or 3 nozzles): This supports the "Nozzle Active Mixing" Method 1.
  - Hose (2 or 3): Two inch (2") diameter for individual nozzles, rigid hose, with length and fittings to suit. The length should reach from the water supply on the main deck to each of the nozzle locations. The hoses should be run in parallel with each other.
  - Nozzle (2 or 3): one and one-half inch (1-1/2") NST base solid stream nozzle with three quarter inch (3/4") or seven-eighths inch (7/8") outlet. It is expected

that ~150 gallons of water a minute at 50 pounds per square inch is required at each nozzle outlet. If relying on the ships firemain to provide water a reasonable estimate of water supply is a maximum of 325 gallons per minute on a large ship.

- Flow meter (2 or 3): Used to measure the flow to each of the nozzles.
- Valves (2 or 3): Sized to suit hose. Used to balance the flow between each of the nozzles.
- Fittings to allow injection of chemical into each hose.
- Use of Basic Equipment described in this section.

Photo 14 - Nozzle mounted to ship's structure in tank in parallel nozzle arrangement

Photo 15 - Nozzle equipment on deck: hoses, valves, meters, chemical injection equipment

- Air Lift Equipment: This supports the “Air Lift Point Diffuser Active Mixing” Method 2.
    - Air compressor(s): Air compressor(s), diesel powered, to provide 150 scfm per point diffuser.
    - Pressure reducing station: To reduce air pressure to ~15psi at the tank bottom.
    - Mist eliminator or air dryer (if needed): To prevent icing during pressure reduction.
    - Hoses: One and one-half inch (1-1/2") diameter for each point diffuser, 30psi minimal rating, with length and fittings to suit. The length should reach from the air supply on the main deck to each of the diffuser locations. The hoses should be run in parallel with each other.
    - Point Diffusers: Largest diameter PVC pipe (schedule 40) that will fit through manhole or cut off vent pipe, roughly three feet (~3') long, capped and plumbed with fittings to attach to air hose, one eighth inch (1/8") holes drilled on three inch (3") centers over whole surface of pipe.
    - Valves: Sized to suit air hose. Used to balance the flow between the point diffusers.
    - Hose: Small diameter hose to suit chemical pump with length to match each air hose. Used to inject chemical at each diffuser location. Fittings to split and balance flow between all lines.
    - Use of Basic Equipment described in this section.

Photo 16 - Point diffusers, 10" diameter pipes 36" long with ~100 1/8" holes

- Air Lift Equipment: This supports the “Air Lift Grid Diffuser Active Mixing” Method 4.
    - Air compressor(s): Air compressor(s), diesel powered, to provide 250 scfm to each grid diffuser.

- Pressure reducing station: To reduce air pressure to ~15psi at the tank bottom.
- Mist eliminator or air dryer (if needed): To prevent icing during pressure reduction.
- Hose: Two inch (2") diameter to each grid diffuser, 30psi minimal rating, with length and fittings to suit. The length should reach from the air supply on the main deck to each of the diffuser locations. The hoses should be run in parallel with each other.
- Grid of Diffusers: Grid of course bubble puck diffusers, spaced in a twelve inch (12") grid, diffuser array sized to fit between deep web frames. Fittings to make air tight connections to pucks and air hose.
- Mounting system to hold diffuser grid in place.
- Valves: Sized to suit air hose. Used to balance the flow between each of the diffuser grids.
- Hose: Small diameter hose to suit chemical pump with length to match each air hose. Used to inject chemical at each diffuser location. Fittings to split and balance flow between all lines.
- Use of Basic Equipment described in this section.

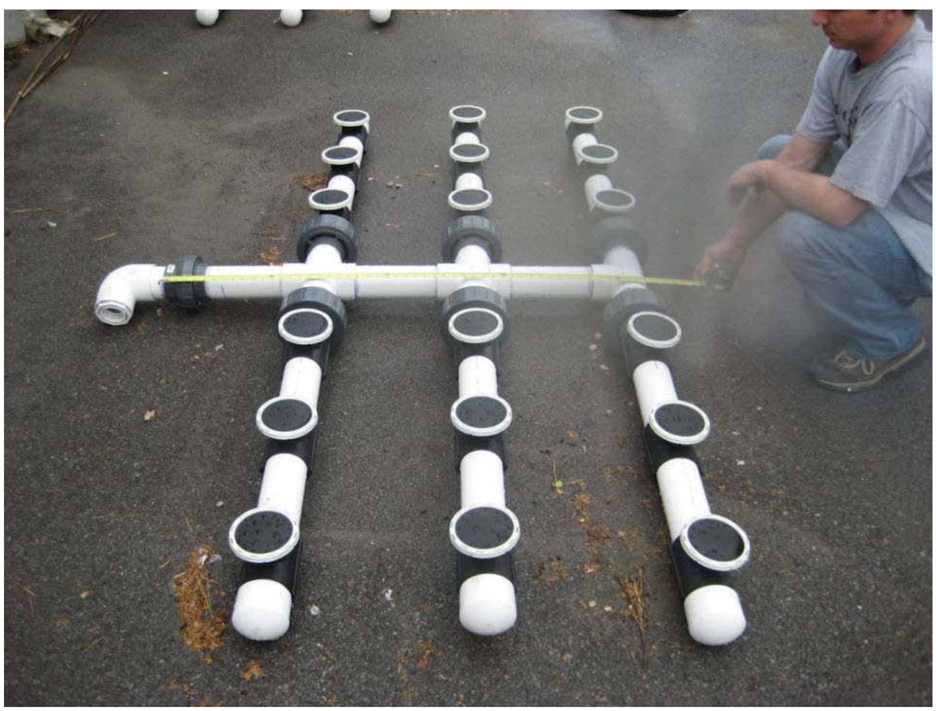

Photo 17 – Diffuser grid of 18 coarse bubble puck diffusers

Photo 18 – Air supply equipment on deck for point diffuser and grid diffuser trials

- Perforated Hose (1): This supports the "Perforated Hose" Method 6.
  - ~ 3/4" to 1" diameter hose, with length and fittings to suit. The length of the hose should be cut to match the vertical depth of the ballast water in the subject tank. The hose should be drilled with twenty 1/8" diameter holes, evenly distributed on all sides of the hose for the length which will be submerged in the ballast water. The end of the hose should be plugged. The end of the hose should be weighted so that it hangs vertically (about 5 pounds).

Photo 19 - Testing the spray pattern of the perforated hose

- Internal Transfer Equipment: This supports the “Internal Transfer” Method 8.
    - Transfer Pump (1): Maximum volume throughput, suitable for continuous use for 24 to 72 hours. The pump may be driven by any suitable means, including diesel engine, electrical motor, hydraulic pump, or pneumatic if freezing can be avoided.
    - Hose (2): Hose diameter to suit pumping capacity, rigid hose, with length and fittings to suit. The suction length should reach from the bottom of the deepest portion of the ballast tank to the transfer pump. The discharge length should reach from the transfer pump to the top of the opposite end of the ballast tank.
    - Chemical Injection Manifold (1): The manifold consists of a tee fitting connected to the inlet side of the pump. A valve and reducer is connected to the branch side of the tee for injection of the chemical.

Photo 20 - Rigging transfer pump and hose on main deck

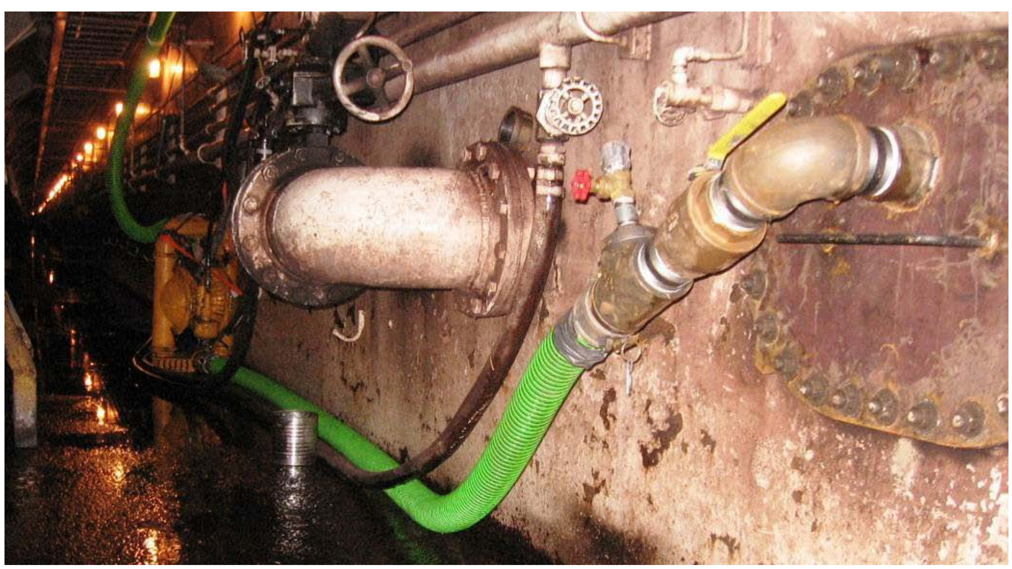

Photo 21 - Chemical injection manifold tee fitting shown, transfer pump in background

Section 5 Neutralization and Discharge

Will the chemicals used to kill the AIS and pathogens in the ballast water harm the local waters? Is neutralization required before discharge?

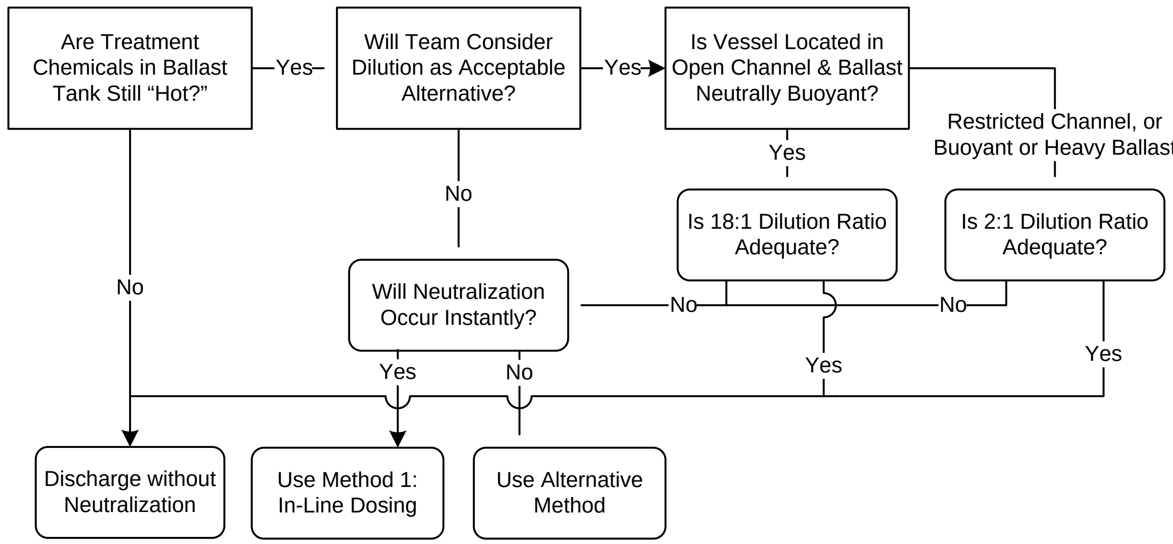

Figure 13 - Neutralization Flow Chart

Typically, a ballast tank will be dosed with a high enough concentration of chemical so that the tank remains "hot" even after adequate time has elapsed to kill the harmful organisms and pathogens. This approach gives a cushion in case the dose is not perfectly mixed, and also to prevent re-growth from the few remaining viable organisms and pathogens. Thus, only one dose of chemicals is needed. The response team, at this point, needs to determine if a neutralization step is required. The Neutralization Flow Chart provides guidance in making this assessment.

5.1 Chemical Analysis

The response team must analyze the chemical used to kill the harmful organisms and pathogens prior to discharging it into local waters. The key factors to determine are the:

- Concentration of chemical in the subject ballast tank(s).
- Concentration of chemical acceptable for local waters.

If the concentration in the subject ballast tank(s) is less than the acceptable discharge concentration, then no neutralization is required.

5.2 Dilution

The response team should determine if the use of a dilution zone is acceptable for local waters. The approach accepts that the water immediately in way of the discharge pipe will have the same concentration of chemical as the ballast tank during the discharge. It is also understood that the concentration decreases at increasing distances from the point of discharge. The factors that impact how quickly this dilution takes place include:

- Ballast Volume - Large volumes may overwhelm restricted channels.
- Ballast Flow Rate - The higher the flow rate, the greater the ability to overwhelm restricted channels.
- Ballast Velocity - Higher velocities can encourage mixing with local waters, which increases dilution ratios.
- Ballast Density - Density is mostly impacted by salinity and temperature; this has a significant impact on dilution ratios.
    - Neutrally buoyant ballast water (same density as the local waters) will effectively mix and result in high dilution ratios.
    - Buoyant ballast water (less dense than local waters) will tend to float on the surface and result in low dilution ratios.
    - Heavy ballast water (more dense than local waters) will tend to sink, particularly in shallow channels, and result in low dilution ratios.
- Channel Bathymetry - The shape of the channel, depth and width of the local body of water, has significant impact on dilution ratios.
    - An open bathymetry, deep and unrestricted waters, allows mixing with local waters and can result in high dilution ratios.
    - A closed bathymetry, shallow and restricted waters, may cause the ballast water to be kept close to the point of discharge, concentrating the discharge and resulting in low dilution ratios.
- Current and Tide - Currents and tides have a significant impact on dilution ratios.
    - An active current, tide, or significant weather can serve to move discharged ballast water away from the discharge point, which results in higher dilution ratios.
    - A lack of current, slack tide or calm weather can serve to concentrate the ballast water at the discharge point, which results in lower dilution ratios.

Field studies with ballast water have shown dilution ratios within 50' of the discharge point to range from 2:1 in non-ideal conditions, to 18:1 in ideal conditions (Reference 9). The response team will need to consider the specific conditions of the planned discharge and determine a reasonable factor.

5.3 Neutralization

Certain chemicals can be neutralized almost instantly when exposed to a second chemical. Instant neutralization allows Method 3, *In-Line Dosing*, to be effectively used by directly pumping the neutralization chemical into the ballast main during ballast discharge. This method avoids the complications of mixing additional chemicals as a batch process in the ballast tank.

One installed ballast treatment prototype uses such an in-line process to neutralize ballast water treated with sodium hypochlorite (NaOCl). Sodium bisulfite ($NaHSO_3$) is injected in-line during ballast discharge, and has been found to mix completely and neutralize the hypochlorite within just a few pipe lengths.

Chemicals which require significant contact time (more than one minute) in order to neutralize the treatment chemical will need to be neutralized as a batch process. In other words, the chemical will need to be added to the full tank for the required period of contact time prior to discharge. The full ballast tank mixing methods (Methods 1, 2, 6, 7, and 8), as outlined in Section 4, can be considered for this effort.

Section 6 Acknowledgements

We thank Dr. Barnaby Watten, Noah Adams, Matt Sholtis, Gary Rutz and Travis Tucker of USGS for their identification, engineering, and testing of the active mixing techniques evaluated in Phase III trials, as well as the development and implementation of appropriate methods for characterizing ship dynamics in Phase II and III.

In addition, we thank Scott Smith of the USGS Western Fisheries Research Center for his efforts in partnership development, industry outreach, and consultation of program development.

Development of this report was possible because of broad support from multiple sources.

- **National Park Service**. Phyllis Green of Isle Royale National Park identified the need for the Guide, formed the project team, and provided broad coordination of multiple stakeholders. Jeffrey Henquinet reviewed and edited the second version of this report.
- **National Parks of Lake Superior Foundation**. NPLSF provided efficient management of the Phase I and II project grants.
- **U.S. Geological Survey**. USGS is providing efficient management of the Phase III project grant.
- **Legislative-Citizen Commission on Minnesota Resources through the Environment and Natural Resources Trust Fund:** LCCMR provided financial support from the ENRTF for the Phase III grant.
- **Great Lakes Fisheries Trust**. GLFT provided financial support for the Phase II grant.
- **National Oceanic and Atmospheric Administration**. NOAA provided financial support for Phase I grant.
- **American Steamship Company**. Noel Bassett, Pierre Pelletreau, and Kenny Gliwa provided access to the *M/V Indiana Harbor*. Additionally, ASC installed extensive sampling equipment inside the vessel's ballast water tanks.
- ***M/V Indiana Harbor***. Captain Yowell and his crew provided significant support to all phases of our testing efforts. The support of the conveyor men and engineers was critical to project success.
- **Phase II Field Team**. Dr. Barnaby Watten, Noah Adams, and Gary Rutz of the U.S. Geological Survey; and Kevin Reynolds, Jon Markestad and Dan Clopton of The Glosten Associates conducted 8 days and nights of field trials.
- **Phase III Field Team**. Dr. Barnaby Watten, Gary Rutz, Matt Sholtis, and Travis Tucker of the U.S. Geological Survey; and Jon Markestad and Robin Madsen of The Glosten Associates conducted 11 days and nights of field trials.
- **Phase II Discharge Team**. Jay Austin and his team from Minnesota Technical University, Jay Glase of National Park Service, and the NPLSF volunteers Dave Miller and Chris Gale performed discharge sampling from the vessel and two small crafts during the Phase II ballast discharge.

- **Phase II Discharge Team**. Jay Austin and his team from Minnesota Technical University and the NPLSF volunteer Dave Miller performed discharge sampling from the vessel and a small craft during the Phase III ballast discharge.
- **Review and comment on the first draft came from broad sources including**: U.S. EPA – Great Lakes, U.S. EPA – Region 5, U.S. Coast Guard Cleveland, NOAA, American Salvage Association, California State Lands Commission, and University of Wisconsin-Superior.

Section 7 Guide Revisions

This Guide is a working document, and subject to revision as the community continues to gain experience in responding to high risk ballast water. The authors will continue to work to update this guide as additional information becomes available. The following items have been identified as critical to the utility of this guide:

- The non-indigenous species experts (chemical engineering, marine engineers, toxicologist, biologist) should be identified prior to an emergency response, including a means to access these individuals at all times.
- A means of determining compliance with applicable ballast management regulations should be clearly established to enable first responders to conduct this effort easily and immediately.
- Each jurisdiction is encouraged to develop area contingency plans or a net benefit analysis. Such an effort should consider acceptable chemicals, concentrations, soak times, and neutralization steps.
- Logistics for gaining third party barge mounted treatment systems must be established with expected lead times prior to an emergency response to be an effective option.
- Sampling and source risk assessment processes need to be further developed.
- This guide should be expanded to include areas outside of the United States.

Please provide field reports and case histories relevant to this topic, such that these lessons learned can be shared with the larger community. The National Park Service will maintain an updated online copy of drafts as part of its National Spill Response Management. A copy will be available as part of Area Contingency Plans for waters within NPS jurisdictions. After concurrence is gained by multiple agencies, NPS will transfer management of the document and updates to an appropriate clearinghouse. During this review process, please send comments and case studies to:

Dave L. Anderson
NPS National Spill Response Coordinator
D_L_Anderson@nps.gov
Phone: 970-225-3539

Phyllis A. Green
Superintendent, Isle Royale National Park
Phyllis_Green@nps.gov
Phone: 906-487-7140

Appendix A Treatment Chemical Overview

This appendix is based on the U.S. Coast Guard "Evaluation of Biocides for Potential Treatment of Ballast Water," Reference 3. This evaluation report contains valuable guidance and data, which is summarized in Table A.1, below.

Table A.1. – Ballast Treatment Chemicals. Group A = Kills Broad Spectrum of Organisms, Group B = Kills Narrow Spectrum of Organisms (USCG, 2004)

Biocide	Effective against Broad Range of Organisms?*	pH Inhibition	Adsorp-tion	Toxic byproducts	Recalci-trance	Shipboard Application Difficult	Cost Prohibitive	Safety Concerns	Regulatory Concerns
Group A Biocides									
Chlorine	Yes	Yes	Yes	Yes	Some	Yes	Somewhat	Yes	Yes
Chlorine dioxide	Yes	No	No	Yes†	Some	Somewhat	Yes	Yes	Some
Hydrogen peroxide	Yes	Yes	Un-known	Yes†	No	Somewhat	Somewhat	Yes	Some
Glutaraldehyde	Yes	Yes	No	No	No	No	Somewhat	No	No
Peraclean®	Yes	Unknown	Yes	Unknown	Unknown	No	No	Yes	Some
Cationic surfactants	Yes	Unknown	No	Unknown	Some	Unknown	Somewhat	Yes	Some
SeaKleen®	Yes	Unknown	No	No	No	No	No	No	No
Phenol	Yes	Unknown	Yes	No	No	Somewhat	Somewhat	Yes	Yes
Group B Biocides									
Copper	Yes	Some	Yes	No	Some	Somewhat	No	Yes	Yes
Bromine	No	Yes	Yes	Yes	Unknown	Yes	No	Yes	No
Iodine	No	Unknown	Un-known	Yes	Unknown	Somewhat	Somewhat	Yes	No
Sodium chlorite	No	Unknown	Un-known	Yes	Some	Somewhat	No	Yes	Yes
Chloramines	No	No	Some	Yes	Some	Somewhat	No	Yes	Unknown
Ozone	No	No	Yes	Yes†	No	Yes	Yes	Yes	Yes
Formaldehyde	No	Some	Un-known	No	No	Somewhat	Somewhat	Yes	Yes
Ethylene oxide	No	No	No	Yes†	No	Yes	Unknown	Yes	Yes
Dowicil® 75	No	No	Yes	Yes	No	Unknown	Unknown	Yes	Some

* If the biocide was found to be effective against six or more of the nine target organisms, a "yes" was entered. If it was effective against fewer than six, a "no" was entered.
† Toxic byproducts may form depending on existing environmental conditions

Chemicals should maximize mortality while minimizing environmental impact. Consequently, the effective use of chemicals in ballast water treatment requires a balance between the amount of time required to achieve inactivation of organisms, with the time needed for those chemicals and residuals to degrade or be treated to environmentally-acceptable levels.

Chemical effectiveness (and time needed for effective dosing) varies as a function of pH, ballast water temperature, organic content, sediment load, and mixing methodology. The ability to sample the ballast water prior to treatment assists the water quality regulatory authority in evaluating which chemical should be used, the time for treatment, and the need for neutralization after treatment.

Many regulations apply to the application of chemicals, which is why it is important to contact the Water Quality Regulatory Authority for authorization before using them. Some (but not all) of these regulations include the:

- United States Federal Water Pollution Control Act (Clean Water Act) of 1972, as amended.

- Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972.
- Endangered Species Act (ESA) of 1973.
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947.
- The Occupational Safety and Health Act (OSHA) of 1970.

Concerns about chemical use specific to shipboard operation include corrosion, safety (personnel and ship safety), and vessel design limitations that impact the availability of space onboard for chemical storage.

A.1 Neutralizing Treated Ballast Water—Toxicity Concerns

Mixing is not only important for introducing a chemical into the ballast water, it is also a factor in neutralizing treated ballast water. It is important that discharged treated ballast water not be toxic to the environment. Previous work by the project team indicated that dilution ratios formed by a plunging ballast water discharge stream exceeded 1:18, and may only reach 2:1 in cases of high volume discharges in restricted channels (Reference 9).

In cases where overboard dilution by the receiving body of water is not acceptable, a means of neutralizing the chemical before discharge is required. The mixing methods suggested in this guidance are also applicable to neutralizing or reversing the toxicity of 'treated' ballast water before it is discharged to the surrounding environment.

A.2 How Mixing Efficiency Affects Efficacy

In all emergency applications, ballast tank geometry, tank capacity, and liquid levels (e.g., the volume of ballast water contained in each tank) will present responders with challenges to dosing and mixing. Baffled tank geometry is complex by design to help maintain vessel stability by inhibiting the uncontrolled movement of water within the tank. As ship sizes have increased to leverage economies of scale, ballast tank capacities have increased proportionally. Consequently, concentrations of AIS may differ from one part of the tank to another, and mixing may result in an uneven concentration of chemical depending on tank geometry and current patterns within the tank. Disproportional concentrations of AIS and chemical decrease the efficacy of any chemical used. Onboard dye testing helps clarify which mixing methods are most effective under a variety of conditions.

A.3 Sediment Control

Sediment control is an important issue in chemical mixing efficacy, as sediment can directly interfere with the chemical treatment being applied. It also can become encrusted on cross members, beams and other physical structures within ballast tanks, providing a medium for trapping cysts, eggs, and other forms of aquatic life, which can subsequently be released in ballast water discharges. Best practices for managing this sediment will improve any chemical treatment and reduce the risk of introducing AIS.

Mixing Biocides into Ship's Ballast Water—Great Lakes Bulk Carrier Field Trials

Prepared for
Isle Royale National Park
Houghton, Michigan

File No. 09078.01
17 January 2012
Rev. B

THE GLOSTEN ASSOCIATES
Consulting Engineers Serving the Marine Community

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SIGNED ORIGINAL
ON FILE

PREPARED: ______________________ ________

Kevin J. Reynolds, PE
Project Manager

CHECKED: ______________________ ________

Jon K. Markestad, PE
Senior Marine Engineer

APPROVED: ______________________ ________

David W. Larsen, PE
Principal-in-Charge

THE GLOSTEN ASSOCIATES
Consulting Engineers Serving the Marine Community

1201 Western Avenue, Suite 200, Seattle, Washington 98101-2921 | **TEL** 206.624.7850 | **FAX** 206.682.9117 | **www.**glosten.com

Contents

Revision History

Section	Rev	Description	Date	Approved
All	-	Initial Release	16 July 2010	-
All	A	Rev. — was stamped and signed by Kevin J. Reynolds, P.E., Washington Registration No. 36584, on 16 July 2010. The stamp and signature above applies only to the content of the current revision.	4 November 2010	JKM
All		Revision to include findings of Phase III mixing trials of active mixing methods.		
7.4	B	Revised relative ranking system.	17 January 2012	KJR
All		Update to reflect USGS and NPS comments.		

Executive Summary

Marine vessels of all types move not only people and goods, but also move ballast water in order to maintain stability and trim, control hull stresses, and assure propeller immersion. Ballast water is often taken up by a ship in a port in one geographic location and discharged into the harbor of a port in a different geographic location. Ballast water may be considered *high risk* if it suspected or known to contain harmful aquatic organisms and/or pathogens. When such high risk ballast water is transferred from one port to another, it could result in a non-native species invasion or result in fish mortality from the release of harmful pathogens.

Ballast water management efforts to minimize such transfers include mandatory ballast water exchange for transoceanic and some inter-coastal voyages and, more recently, the development of water treatment capabilities on the vessels themselves; however, many gaps remain in this management approach. Of those vessels currently required to manage ballast water, equipment failures or human error could result in the arrival of high risk ballast water. In addition, a vessel that has not managed its ballast water could go aground; this creates an incident where potentially high risk ballast water may be pumped off the vessel for purposes of refloating.

Vessels operating on the U.S. Great Lakes, inland waterways systems, and on some near coastal voyages are not currently required to manage their ballast water discharges. There is concern that transfer of organisms and pathogens between the lakes could be harmful. In particular, recent pathogen outbreaks have occurred in some parts of the Great Lakes, but not others. Methods to treat ballast water from affected locations are particularly desired by management at Isle Royal National Park in the State of Michigan.

To address the need to have strategies that can be implemented to manage high risk ballast water, the National Park Service (NPS) has developed an *Emergency Response Guide for Handling Ballast Water to Control Non-Indigenous Species* (hereafter referred to as Guide). The Guide assumes that there are suitable biocides that can inactivate the harmful organisms and pathogens. The Guide outlines several methods for mixing such biocides into the ballast tanks of marine vessels. This report outlines the field work performed in the development of suitable methods to address a fundamental challenge for an emergency responder; e.g., how to mix biocides into large, complex ballast tanks that are already full of water.

The field trials were conducted on the Great Lakes bulk carrier, *M/V Indiana Harbor,* to determine the relative effectiveness of five passive and four active methods of mixing chemicals into a vessel's ballast water. The trialed passive methods were selected for their promise to be used in handling vessels with high-risk ballast water by using materials readily available on board the vessel. The active methods were selected for their promise to rapidly mix (in under 2 hours mixing time) a full ballast tank using readily obtainable equipment; this equipment may not be available on the vessel, however.

Passive method trials were conducted in April of 2009, and active method trials were conducted in May of 2010. Vessel trials offer significant challenges including:

- Vessel motions, which can eventually become a more dominant mechanism for mixing than the mixing methods being tested.

- Coordination with vessel operations, which can limit the number of replicate tests needed to produce robust results.
- Limitations in extrapolating the results from tests conducted on a single ballast tank configuration.

These trials measured environmental factors, gained control measurements by repeating one of the passive methods during each trial period, gained multiple replicates for each of the active methods, and tested a large volume ballast tank of challenging geometry. The results of these trials were used in ranking the relative effectiveness of the proposed mixing methods provided in the Guide.

The trials also resulted in ancillary data that support the following insights:

- Moderate motions while the vessel is underway may be effective at mixing chemicals in a full or partially full ballast tank, even if the chemical is simply added to the tank through the vent on the deck.
- Ballast water, if relatively dense and in adequate quantity, when discharged into a restricted channel will sink to the bottom of that channel at dilution ratios as low as 2:1.
- Calculations made using Computational Fluid Dynamics (CFD) software, and scale models were confirmed during the full scale trials.
- It is possible to practically mix large, complex ballast tanks that are already full in less than 1.5 hours by using active mixing methods.

Future planned efforts include tests of mixing methods using chemical biocide and subsequent neutralization, if required. It is expected that the mixing methodology developed in the initial tests will be further refined to ensure biologic efficacy and optimize the practicality of deploying the necessary equipment.

Section 1 Background

An effective response to high risk ballast water has become increasingly important, as commercial vessels are a primary vector in the transfer of unwanted aquatic non-indigenous species (NIS) throughout the world. Over 40,000 commercial vessels currently carry cargo between the world's ports, taking on ballast water in one aquatic ecosystem and discharging it, in an industrial quantity, in another quite different ecosystem. When non-native aquatic life is released into an ecosystem, it may out-compete native species. Problems directly resulting from invasive species include the collapse of entire commercial fisheries, the displacement of native seabed communities, and the red tide contamination absorbed by filter-feeding shellfish.

Vessels with high risk ballast water will require novel intervention methods that can be applied at sea before arrival, upon arrival in port, or at the incident location of a grounding. An example of this casualty risk was demonstrated when the *M/T Igloo Moon* was grounded and required salvage operations in 1996. Emergency treatment of ballast water was necessary, as ballast water from the stricken tanker had to be offloaded in order to move the vessel off the reef. Because of the origins of the ballast water and the vessel's proximity to the sensitive environment of Biscayne Bay National Park, concerns were raised over the potential risk of introducing non-indigenous biota via the ballast water that could harm the reef's natural biota. Twelve days after the stranding, the 1.1 million gallons of water in the ballast tanks were treated with liquid calcium hypochlorite. The chemical was poured through the tank vents on deck into the full ballast tanks. After sufficient exposure time elapsed, the treated ballast water was discharged overboard and the grounded freighter was towed off the reef without incident (see Reference 13).

The methods used in this emergency treatment response were not sufficiently vetted but were deemed better than doing nothing in terms of reducing the risk of a new introduction. The situation also made it clear that further research was needed to develop scientifically verified methods to dose ballast tanks with a biocide that was proven to be effective and could be neutralized to a safe level for discharge.

Photo 1 - Tanker Igloo Moon is shown carrying suspect ballast water shown aground on a sensitive coral reef. The adjacent vessel is receiving cargo from the casualty vessel. (NOAA photo)

1.1 Objectives

The field trials were conducted to support the development of the *Emergency Response Guide for Handling Ballast Water to Control Non-Indigenous Species* (hereafter referred to as Guide: Reference 22). These trials were specifically targeted at determining the relative effectiveness of methods of mixing treatment chemicals into ballast tank water. Passive mixing methods were chosen that could be deployed using materials readily available on board the vessel and active methods were chosen that could be deployed using readily available materials that could be brought aboard the vessel. Emergency response is needed to treat ballast water onboard in the following situations:

- <u>Vessel Casualty:</u> This scenario involves a salvage situation where a vessel runs aground and cannot be freed without decreasing the ground reaction. Success in many salvage cases is time critical, making the discharge of ballast water a favored early response technique. The risk of discharging suspect ballast water in an environmentally sensitive area may be mitigated by directing the salvor to introduce (and neutralize if needed) a chemical disinfecting agent into the casualty's ballast tanks. In this case, the deployment of the appropriate mixing technology would be critical to the success of the operation.
- <u>Regulatory Intervention to High Risk Vessel Arrivals</u>: Environmental monitoring efforts are under development by U.S. Fish and Wildlife to prevent the distribution of aquatic non-indigenous species (NIS). This has led to the identification of high risk aquatic nuisance species (ANS) areas. Port State Control measures can be exercised to identify those vessels that are considered high-risk arrivals. Further, vessels that fail to demonstrate functioning ballast water treatment systems or evidence of volumetric open ocean exchange can be mandated to undergo emergency interventions similar to that discussed for vessel casualties.

To develop such emergency response methods, NPS and U.S. Geological Survey (USGS) assembled a team consisting of scientists with experience in shore based mixing technology and marine engineers experienced in marine vessel design, construction, and operations. That team developed a four phase program that included two sets of field trials.

- *Phase I—Program Planning*. Efforts focused on planning, literature search, and provided a report: *Mixing Biocides into Vessels' Ballast Water, Efficiency of Novel Mixing Methods*. This phase is complete.
- *Phase II—Passive Method Field Trials*. Five passive mixing methods were tested and provided the data in the first release of this report. This phase is complete.
- *Phase III—Active Method Field Trials.* Four active mixing methods and one passive method (as a control) were tested and provided the data for the current revision of this report. This phase is complete.
- *Phase IV—Active Substance Trials.* Test the most promising active mixing method in combination with an active biological control chemical, as well as a neutralization chemical if required. This phase is ongoing.

The Guide will be revised as each phase of the program is completed. This report provides the methods and results through *Phase III—Active Method Field Trials*.

1.2 Phase II—Passive Mixing Methods Trials

The Phase II trials were conducted between 12 and 24 April 2009 on the American Steamship Company bulk carrier the *M/V Indiana Harbor*. The charts below show the progression of the trip from Indiana Harbor in Indiana to Duluth, Minnesota. During this trip, the passive methods for mixing a chemical into ballast water were tested. The six person team boarded the vessel in Duluth and installed dosing and sampling equipment in route to Indiana Harbor while the vessel was transporting bulk cargo. Once the vessel unloaded its cargo in Indiana Harbor and completed taking on ballast, the test team began dosing the tanks with dye and measuring the concentration of dye as it dispersed throughout each tank. The team completed all trials before arriving back in Duluth. During discharge of ballast water in Duluth, a discharge study in Duluth Harbor was conducted by a third party.

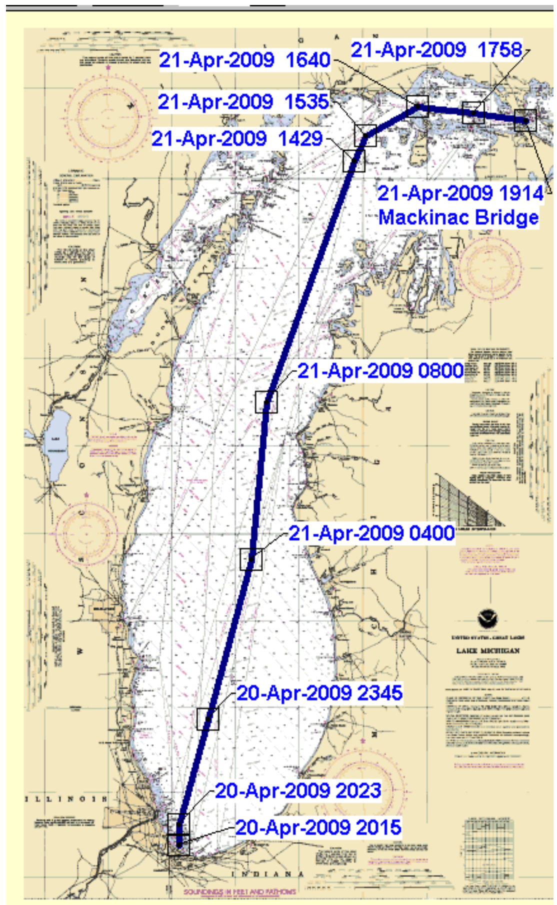

Figure 1 - Phase II Trials Route (Lake Michigan Leg)

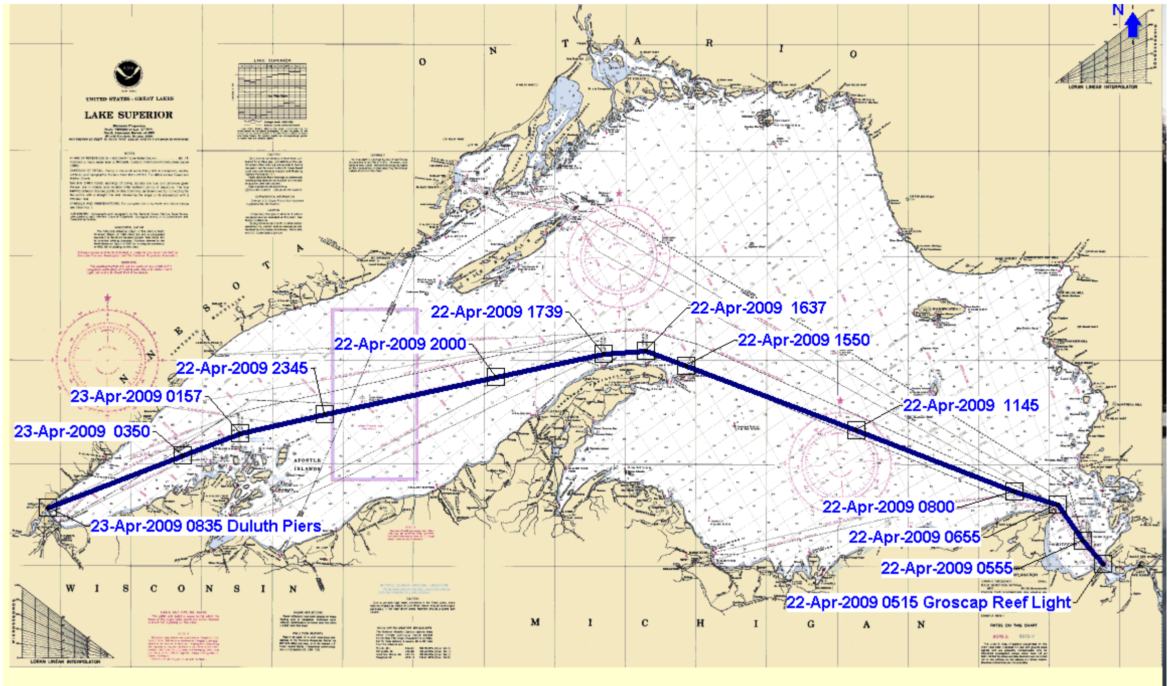

Figure 2 - Phase II Trials Route (Lake Superior Leg)

1.3 Phase III—Active Mixing Methods Trials

The Phase III trials were conducted between 15 and 23 May 2010 on the American Steamship Company bulk carrier the *M/V Indiana Harbor*. The figures below show the progression of the trip from Gary Harbor in Indiana to Duluth, Minnesota. During this trip, the active methods for mixing a chemical into ballast water were tested. The six person team boarded the vessel in Duluth and installed dosing, mixing, and sampling equipment in route to Gary Harbor while the vessel was transporting bulk cargo. Once the vessel unloaded its cargo in Gary Harbor and completed taking on ballast, the test team began a series of mixing trials. The team ran a total of 16 mixing trials in route back to Duluth. Two trials were control tests of passive mixing trials repeated from the previous trial, and the other 14 trials involved active mixing methods. Similar to the Phase II trials, the team assisted with a discharge study in Duluth Harbor conducted by a third party.

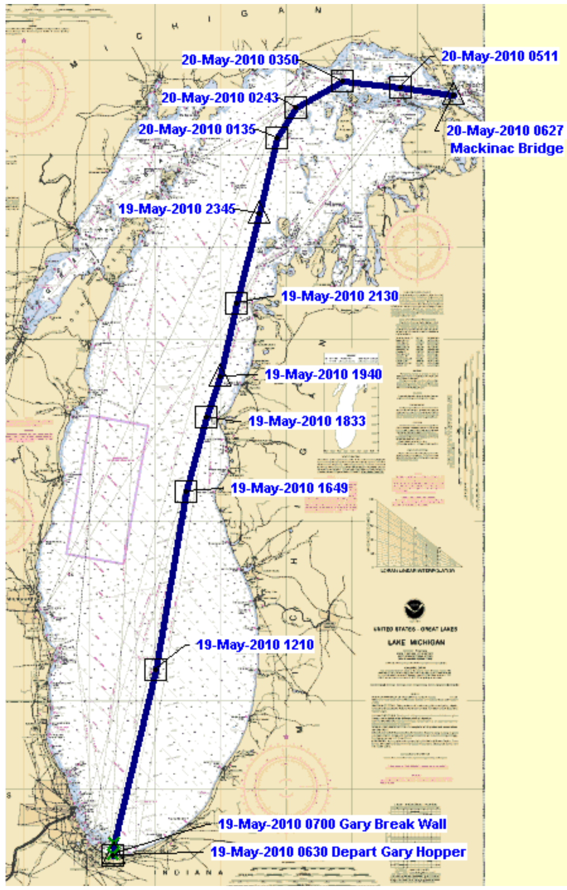

Figure 3 - Phase III Trials Route (Lake Michigan Leg)

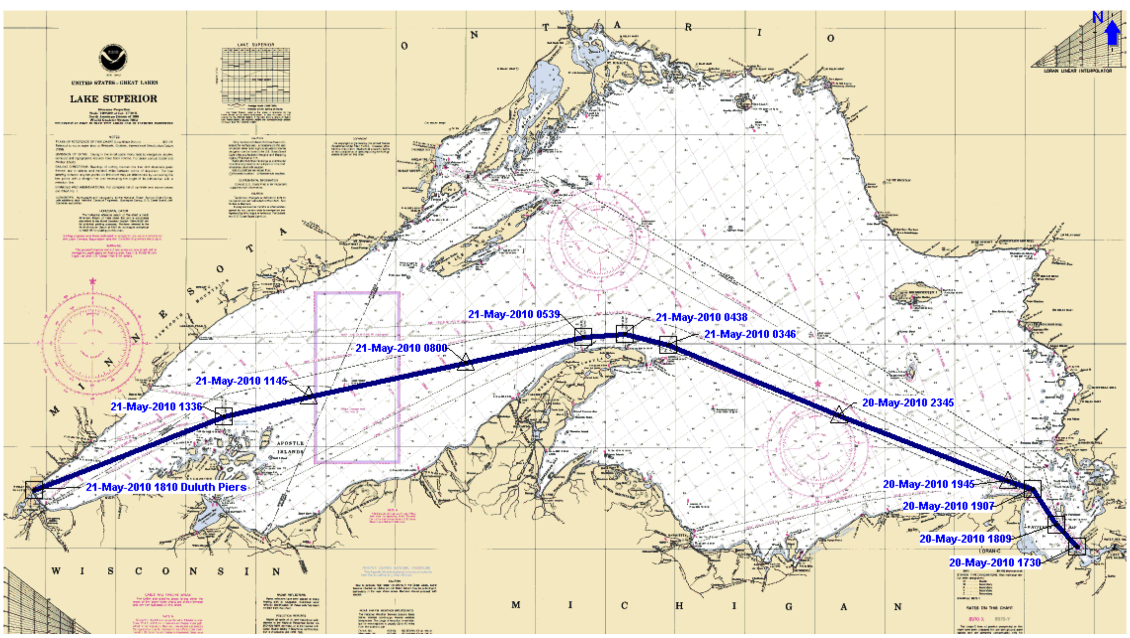

Figure 4 - Phase III Trials Route (Lake Superior Leg)

Section 2 Study Approach—Feasibility

2.1 Hypothesis

The study asserts that, if an emergency situation occurs and ballast water needs treatment before discharge, novel mixing methods may be effective in dosing and mixing a biocide into full ballast water tanks.

2.2 Taking a Stepwise Approach - Feasibility

A series of steps were defined by the project team to guide the progressing of the studies towards development of novel mixing solutions and deliver a final emergency response guide. This study took the first of these steps, which was determining the feasibility of basic mixing methods by performing field tests on a Great Lakes bulk carrier. The results of this effort are reported here, and have been incorporated into the first draft of an emergency response guide for handling high risk ballast water (Reference 21).

The feasibility phase was supported by computational fluid dynamics work and scale modeling that looks at the development of novel methods. Further phases will build on the early lessons learned during the tests using the basic mixing methods and scale modeling efforts and field verification of the methods will continue. At the end of each phase, the *Emergency Response Guide for Handling Ballast Water to Control Non-Indigenous Species* will be updated.

The following table outlines both the methods trialed during these tests, as well as the methods which are being explored in the scale model work, with potential field trials planned depending on their success.

Table 1 -Mixing Methods Summary

Mixing Method Class	Test Description	Mixing Energy	Dye Method/Particulars	Status
Passive Mixing	Ship's Underway Motion:			
	Variation A: Bulk Dye Dose on Top	Ship's Motion	Bulk Load Applied at: Tank Manhole or Vent	Done-Phase I
	Variation B: Bulk Dye Dose through Sounding Tube		Bulk Load Applied at: Tank Sounding Tube	Defer
	Variation C: Perforated Hose Dosing		Bulk Load Applied by means of perforated tube hung vertically.	Done-Phase I
	Filling Empty Tank: Bulk-On-Bottom Dosing	Hydraulic Energy of Loaded Ballast Water	Bulk Load Applied at Tank Manhole or Tank Vent	Done-Phase I
Active Mixing	In-Line Dosing	Turbulent Flow of Ballast Water in Pipe	Metering Pump Injection in Ballast Main	Done-Phase I
	Internal Transfer Dosing	Circulating Ballast Water	Set-up Circulation Loop Internal to Ballast Tank, Meter Dye into Loop	Done-Phase I
	Axial Flow Propeller	Mechanical Device Inserted thru Tank Manhole	Metering Pump Injection behind Propeller Blade	Defer
	Eductor Mixing In Tank			
	Variation A: Dye Pumped into Eductor Line	Eductor Device Inserted thru Tank Manhole	Metering Pump Injection into Eductors Located Below Each Tank Vent With Flow Directed Athwartship.	Done- Phase II
			Metering Pump Injection into Eductors Located at longitudinal Center of Tank with two flows each directed 45° Off Athwartship	Done- Phase II
	Variation B: Dye Proportioned by		Venturi Effect Using a Metering Valve to Proportion Dye into	Defer
	Variation C: Dye Bulk Dosing		Bulk Load Dropped thru Tank Manholes	Defer
	Nozzle Mixing in tank			
	Dye Pumped into Eductor Line	Nozzle Devise Inserted through Tank Manhole	Metering Pump Injection into Nozzels Located Below Each Tank Vent With Flow Directed Athwartship.	Done- Phase II
			Metering Pump Injection into Nozzles Located at longitudinal Center of Tank with two flows each directed 45° Off Athwartship	Done- Phase II
Air Lift Mixing	Air Lift Pumping, Mixing by Compressed Air			
	Variation A: Dye Bulk Dosing	Compressed Air Lift Device Inserted thru Tank Manhole	Bulk Load Dropped thru Tank Manholes	Defer
	Variation B: Dye Pumped into Air Lift Tube		Metering Pump Injection into Air Lift Tube. Sparging Tables Located at 1/3 and 2/3 Longitudinal distance	Done- Phase II
			Metering Pump Injection into Air Lift Tube. Sparging Stones Located Under Each Vent.	Done- Phase II
	Variation C: Dye Pumped into Lateral Intake Line		Metering Pump Injection into Lateral Intake Line	Defer
	Air Lift Pumping, Mixing by Chemical Agitation			
	Variation A: Liquid Carbon Dioxide	Rapid Release of Gas into Full Tank	Metering Pump Injection into Air Lift Tube	Defer
	Variation B: Liquid Nitrogen		Metering Pump Injection into Air Lift Tube	Defer
	Variation C: Dry Ice		Bulk Load Dropped thru Tank Manholes or Air Lift Tube	Defer

Section 3 Test Platform (*M/V Indiana Harbor)*

The American Steamship Company provided access to one of their newer ships operating on the Great Lakes. Cooperation from the company was instrumental in outfitting the ship for field testing, as well as providing advice to the project team on many shipboard practicalities for implementation of the research. The ship will continue to be used during all four phases of the project to allow for results comparison. The ballast tanks on the vessel are large and complex, thereby providing a unique opportunity to test mixing methods under challenging circumstances. Because the tanks include both deep and double-bottom areas, the mixing methods that performed well at mixing an entire tank should be considered for further evaluation under a variety of tank configurations.

Photo 2 Great Lakes Bulk Carrier *Walter J. McCarthy Jr*. This ship is identical to the *Indiana Harbor* used in Trials. (A portion of the deck of the *Indiana Harbor* is shown in the right of the photo.)

3.1 Particulars

Vessel Name: *M/V Indiana Harbor*

Owner: American Steamship Company

Built: Bay Shipbuilding, 1979

Particulars:

- Great Lakes Bulk Carrier, U.S. Flag
- Iron ore pellets and western coal transport
- 1,000'-0" length overall
- 105'-0" beam, 56'-0" depth, 34'-3/4" midsummer draft (MS)
- 80,900 gross tons deadweight capacity at MS draft
- 10,000 tons/hour cargo unloading capacity
- 14,000 shaft horsepower, twin screw

Ballast Particulars:	• Four (4) main pumps at 10,000 gallon per minute (gpm) each, with 30-inch header and 14-inch branch lines • Two (2) stripping pumps at 1,000 gpm each, with 10 inch header and branch lines • Fourteen (14) deep ballast tanks with small double bottom portion, typical capacity of 1,259,000 gallons (4,808 long tons) each, **~67,000 long tons total ballast capacity** • Two (2) double bottom ballast tanks, one (1) forepeak and one (1) aftpeak ballast tank
Test Locations:	Great Lakes
Ballast Uptake:	Indiana Harbor, Indiana
Ballast Discharge:	Superior, Wisconsin; Mid-west Energy Terminal
Dye Generic Name:	Rhodamine WT (Aqueous Acid Red Colorant Solution)
Trade Name:	Keyacid Rhodamine WT Liquid, 70301027 Tracer Dye
Concentration:	• 20% solution, single 5 gallon container for transport • 0.26% solution, when introduced into ballast tanks
Vessel Discharge:	• 120 ug/L (parts per billion), entrained in ballast stream, end-of-pipe value, average concentration • 5,905 metric tons per hour, maximum discharge rate • 28,665 metric tons, maximum discharge volume

3.2 Description of Ballast Water Tanks and Piping System

The particulars of the *Indiana Harbor* ballast water tank capacities, and ballast water pumping capacities are detailed above. This section provides a description of the ballast water tank structure and the ballast water piping system. These tanks and this system support the taking up and discharging of ballast water.

There are fourteen cargo holds that extend from just forward of the ship's house to just aft of the ship's forepeak tank. The hold of the ship is a large capacity hopper that is widest at the weather deck, and then narrows in a funnel shape into a series of sluice gates located at the bottom of the hold. Below the hold is a conveyor belt system for discharging the cargo. This conveyor system is located in the conveyor tunnel that runs the length of the ship's midline. The double bottom portions of the ballast tanks are located below the tunnel. To either side of the tunnel are the open portions of the ballast tanks, and above is the cargo hold (Figure 5 and Figure 6). The cargo, typically taconite pellets or coal, drops through remotely controlled sluice gates onto the conveyor belt for discharge to shore. Shore based loading arms fill the cargo holds by dropping the bulk material through weather deck hatches.

Photo 3 ***M/V Indiana Harbor*, discharging cargo through loop conveyor system**

Each of these cargo holds is cradled by ballast water tanks, one on the port side and one on the starboard side. Taking on ballast water during cargo loading serves several purposes: to maintain ship stability by keeping adequate weight low in the ship's hull; to minimize longitudinal stresses on the structural components of the ship's hull by keeping an even weight distribution; to adjust trim for operational purposes such as keeping adequate submersion of the ship's propeller. There are four additional ballast water tanks located forward and aft of the cargo holds which serve similar purposes, especially for controlling the trim of the ship. While the cargo is being discharged from a cargo hold, lake water is taken up into the ballast water tanks. While cargo is being loaded into a cargo hold, lake water is discharged from the adjacent ballast water tanks into the harbor.

Each ballast water tank is outfitted with one sounding tube pipe (about one and one half inch in diameter), which extends from the weather deck of the ship to the bottom of the ballast water tank. These sounding tubes are used to gage the water levels of the tanks. Each of the ballast tanks also has three vent pipes. Each vent (about ten inch in diameter) extends from the weather deck of the ship to the top of the ballast water tank. The vents allow air, and ballast water, if overfilled, to escape while the ballast tank is being filled. The vents are open to the weather deck at all times, thereby maintaining atmospheric pressure in the ballast tanks.

Like the ship's hull, the ballast tanks are constructed of carbon steel. Because the tanks are only filled with fresh water, they are not coated. Ships that operate in saltwater often have ballast tanks that are coated to prevent rusting. Water tight, welded steel plates separate the ballast water tanks from each other, the cargo holds, the conveyor tunnel, and the outside or side shell of the ship. All structural supports for these plates are located in the ballast water tanks. This includes deep frames every thirty-six feet along the length of the tanks, as well as smaller stiffening structures located every two feet between the frames. In addition, there are stanchions located as needed to provide vertical structural support. To enhance drainage from the tanks when water is discharged, support structures and structural steel webbing inside the tank have limber holes (often referred to as “rat holes”).

The *Indiana Harbor* is outfitted with separate port and starboard side ballast water main lines for filling the tanks, as well as cross-over lines between each mainline. The crossover lines, which are normally closed, can be used to move ballast water from one side of the ship to the other. Each ballast tank has two points on the main line where water can be moved in or out of the tank. The first is a larger suction and fill line that terminates at about the longitudinal center of the ballast tank, about twelve inches above the floor. The second is a smaller suction point for stripping water out of the tank that terminates at the aft end of the ballast tank, closer to the floor. Each point is controlled by remotely operated valves located in the conveyor tunnel. The tanks are almost always filled and emptied in port/starboard pairs, so as to prevent a list on the ship.

Each main line used to move water into the tanks is connected to a sea chest. A sea chest is essentially a large steel box welded to the bottom skin of the ship in the main machinery space, located at the aft end of the ship. These boxes are outfitted with a steel grate that prevents large items, typically one-inch or larger, from entering the ballast water main lines. Further, these boxes are outfitted with vents that extend to the weather deck to prevent them from becoming air bound.

To fill the ballast tanks, water is allowed to freely enter the sea chest. Because the ships are frequently in shallow water, sometimes even sitting on the lake bed, a large amount of sediment can also enter the sea chest and subsequently enter the ballast tanks. The ship’s propellers can also stir up sediment during docking operations and external environmental effects such as river run off can increase the amount to sediment in the water. Once water, and sediment, enters the sea chest it is moved to the ballast tanks using either gravitation forces or with pumps, whichever is most effective.

To empty the ballast tanks, water enters the ballast main line through the same opening that was used to deliver the water to the tank. If possible, gravitational forces are used to discharge the water through the same sea chest used during uptake. When gravity alone is not enough, pumps are then used to complete the majority of the tank. If needed, each tank can be further emptied by using the smaller stripping line in each tank. A separate pump is connected to the stripping line, but the discharge from the stripping line still goes through the same sea chest as the water does from the main line. The sediment that enters the ballast tanks during uptake tends to settle in the tanks, within the complex structure on the bottom. When the tanks are discharged, much of this sediment is left behind. Through successive empty and fill cycles, the sediment continues to build up, with accumulations particularly significant behind larger structures. We observed relatively large deposits, as much at two-feet deep, of clay-like sediment in the ballast tanks during the tests.

3.3 Description of Ballast Water Tank Sampling

The efficiency of the various mixing methods was estimated by means of monitoring the concentration of the dye in the ballast water at various points in time of the mixing processes. Given the large size and complex arrangement of the ballast tanks, three different methods were used to gather water samples from the ballast tanks. The following sections describe the methods used and locations where the samples were taken.

- Discrete samples. This method involved using tubing fixed to a specific location in the tank and running to a remote sampling apparatus in the conveyor tunnel. See photos 5, 6, and 7.
- Vertical profiles. This method involved lowering a sampling device through the vent at the top of the tank and collecting samples vertically from the top of the tanks to the bottom.
- Discharge "end-of-pipe" sampling. This method involved taking samples of a small slip-stream of the ballast water as it was passing through the main line in the engine room.

The ship itself has a total of fourteen (14) deep ballast water tanks. Three pairs, for a total of six (6) of these tanks, were set-up for sampling. This provided a total of 152 sample points within the tanks. The discharge sampling provided an additional two (2) locations.

- Two of the six tanks used in the tests (Tank #3 port and #3 starboard) were equipped with fifteen (15) discrete sampling points inside each tank and three (3) vertical profile sampling points in each tank.
- The remaining four of the six tanks used in the tests (Tank #4 port, #4 starboard, #5 port, and #5 starboard) were equipped with eight (8) discrete sampling points in each tank and three (3) vertical profile samples points in each tank.

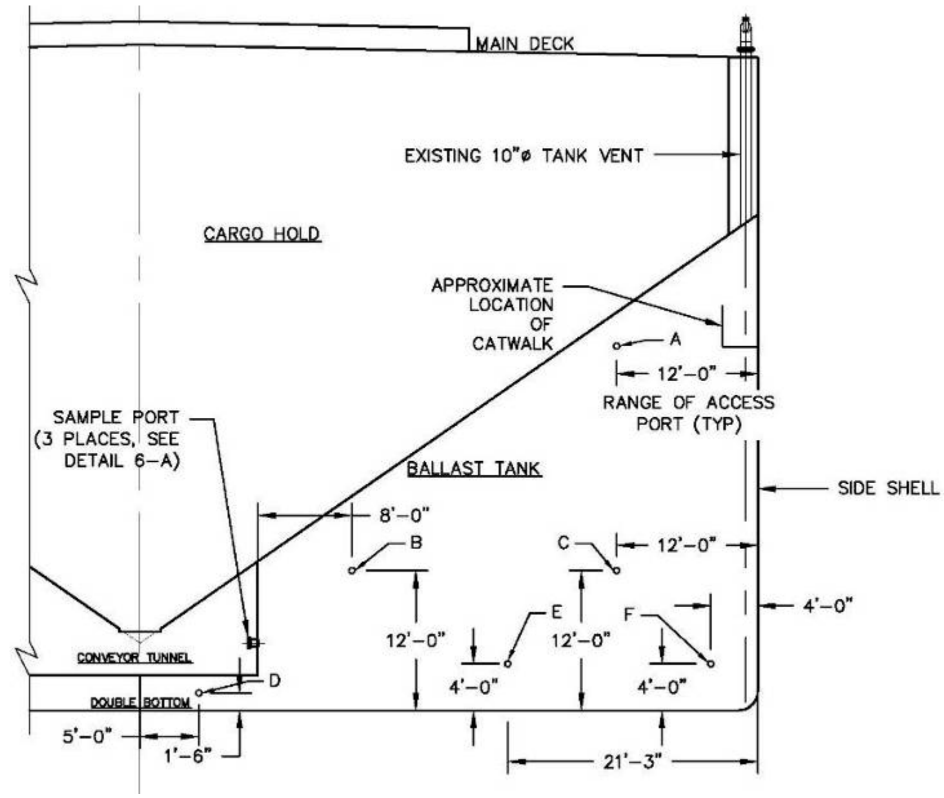

Figure 5 Section view of ballast tank vertical profile and discrete sample locations

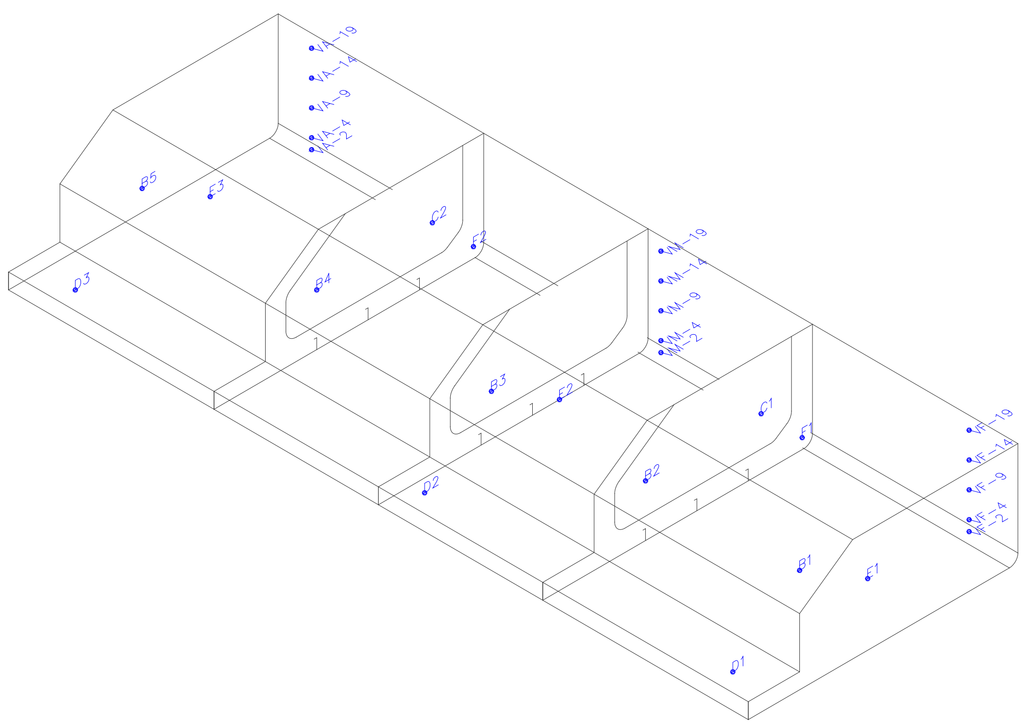

Figure 6 Isometric view of ballast tank vertical profile and discrete sampling locations (one of six tanks shown)

3.3.1 Tank Vertical Profiles: Samples VF, VM, and VA

The vertical forward (show as "VF" in Figure 6), vertical middle (VM), and vertical aft (VA) sampling locations were accessed from the ballast tank weather deck vents. The number following each of the sample port locations denotes the associated water depth. For example, VM-2 is the reading recorded from the middle tank profile at two-feet of water depth.

At these locations, the ballast water was tested by lowering a probe through the tank vents and measuring the water properties at various heights throughout the water column. This above deck testing was conducted on each tank through the tank vents wherever it was possible to lower the probe through vent. Some vents were obstructed by sounding tubes or dye dosing equipment. Sampling took place periodically.

Photo 4 Tank Vertical Profiles - team members on vessel's main deck lowering sonde through fitting on tank vent and reading handheld data logger

3.3.2 Tank Discrete Points: Samples B, C, D, and E

Sample locations labeled B, C, D, and E (as shown in Figure 6) indicate a specific sectional location, or height from the floor and transverse distance from the side shell. The numbers denote sequence of longitudinal location, with number 1 being most forward. For example, D-1 is the forward-most sample point located in the ballast tank double bottom portion.

The sample tubing used in each of the six ballast tanks was three-quarter inch clear PVC. Within each tank, each tube was individually run from its selected position (Photo 5) to a single steel plate bolted to the bulkhead between the tank and the conveyor tunnel (Photo 6). Each plate was located near the longitudinal center of each tank. Each plate was fitted with steel pipe nipples that extended through the plate, and a bronze isolation valve on the conveyor tunnel side (Photo 7). Inside the tanks, each tube was secured over its associated steel nipple. The length of the tubing varied from approximately twenty-feet for the D-2 and B-3 sample locations, to as much as 140 feet for the B-1, B-5, E-1, and E-5 locations.

Before testing began, each hose was inspected and back flushed with fresh water to ensure that there were no blockages or loose connections in any of the hoses. During testing operations, ballast water gravity flowed through each in-tank tube to a single sample manifold mounted outside each tank in the conveyor tunnel.

Measurements were taken periodically from one location at a time. The valve associated with the desired sample location was opened, and sample water of at least three times the volume of the tubing run was flushed to waste. A reading of the sampled water was then taken, and the valve for that sample location shut. The process was then repeated for the next desired location.

During the active methods (Phase III) trials, an additional sampling method was added. This was continuous sampling from two of the sample ports, D-2 and E-1. Port D-2 was chosen as it was in the double bottom portion of the tank and could record how the chemical moves through this restricted area. Port E-1 was located at the end of the tank in the larger open area of the tank. In these two cases, the tubes were not connected to the manifold, but rather directed into their own sampling apparatus.

Photo 5 Discrete Sample Location—Open end of tubing secured at specific location within one of the six ballast tanks (one of sixty-two (62) locations)

Photo 6 Discrete Tubing Internal Terminations—Steel plate located in ballast tank bulkhead where all discrete tubes for that tank are terminated (view from inside ballast tank)

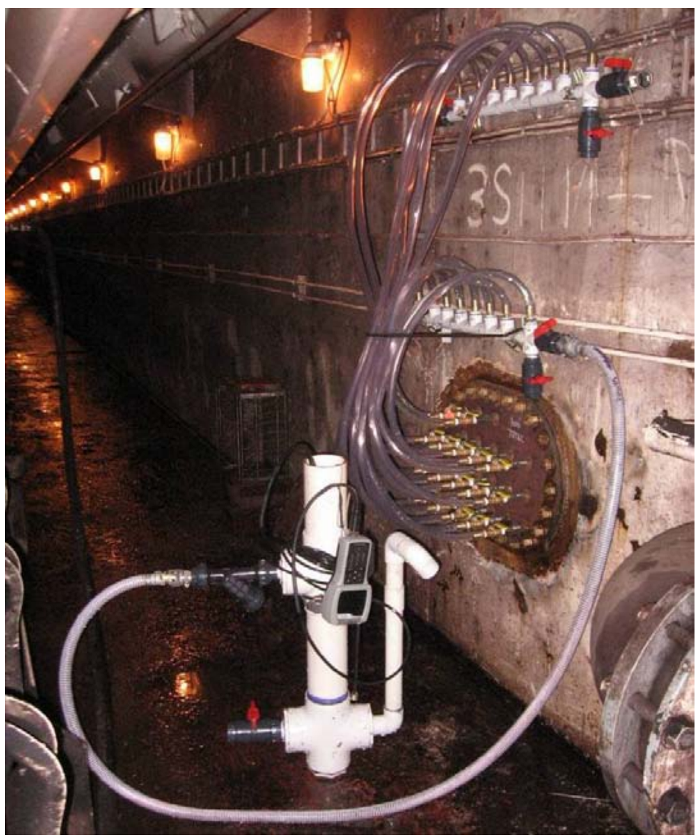

Photo 7 Discrete Sampling Apparatus and Arrangement—Valve and manifold arrangement allow direction of one discrete sample location to flow into the apparatus (view from conveyor tunnel, outside of ballast tank)

3.3.3 Discharge End-of-Pipe Monitoring: Samples Port and Starboard

Whereas the vertical profiles and discrete point sampling took place during the mixing process, a third set of readings was obtained after the mixing process. In fact, this sampling took place days following the sampling. These end-of-pipe samples were taken to detect potential dead zones, where little mixing may have occurred, that the vertical profiles and discrete point sampling failed to detect.

One (1) port side and one (1) starboard side monitoring apparatus was set-up in the respective port and starboard ballast water mains. Each was positioned physically in the engine room space, and the sample taken immediately after the respective main ballast pump but before the respective sea chest where the ballast water was being discharged overboard.

This slip-stream arrangement diverted a small portion of the discharged ballast water into the apparatus. While the discharge pumps operated at approximately 10,000 gallons per minute, the apparatus flow rate was estimated at 10 gallons per minute, or 0.1% of the total ballast water.

Photo 8 Discharge Monitoring Apparatus—Single hose supplies sample apparatus as ballast water is being pumped overboard (view from engine room)

Photo 9 Making Discharge Sampling Connection

3.3.4 Sampling System Apparatus and Instruments

The sampling apparatus was purpose built to permit reliable monitoring of the many discrete sampling locations, with a few sets of instruments. Given sixty-eight discrete locations, it was not fiscally feasible for the project to have sixty-eight sets of instruments. The objectives of the sampling device included:

- Means for quick and easy change from one discrete point to a second.
- De-bubbling of the sample to prevent false readings of the instrument.
- Submersion of the instrument maintained (e.g., kept "wet") to prevent out-of-range readings that would delay rapid sampling.

The sample water flowed from the tubing (either directly from the ballast tank, or through a manifold) through a 50 micron sediment strainer and into the side of a four-inch diameter PVC sonde chamber. The sample water was drained down the vertical length of the chamber into a tee-fitting, then up through a discharge tube, and then dumped to waste. The discharge tube functioned like a weir, keeping the sonde chamber water level above the sample inlet to minimize air entrainment. Further, the sonde chamber was open at the top to allow any entrained air to escape. The sonde itself sat inside the sonde chamber (figure 7).

A second bottom connection was used to periodically flush sediment from the bottom of the main chamber. The discharge tube served a second function, as it allowed a location for grab samples to be taken.

- In the case of periodic sampling, the ballast water flowed into a manifold. By opening and closing manifold valves, ballast water from the selected discrete point was routed to the apparatus.
- In the case of continuous sampling, the ballast water flowed directly from the discrete sampling tube into the apparatus, by-passing the manifold.

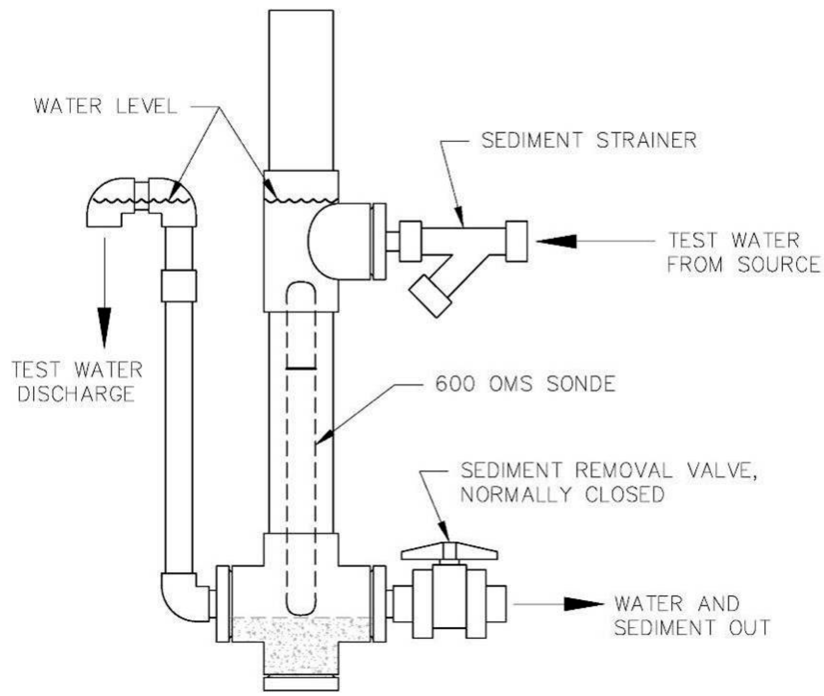

Figure 7 Sampling Apparatus Arrangement

Water quality measurements were performed with the YSI Optical Monitoring System (OMS) 600 system, which was outfitted to measure conductivity, temperature, and Rhodamine concentration. For continuous monitoring, readings were automatically recorded at set intervals in the data logger. For discrete monitoring, readings were manually entered into the display and recorded on log sheets.

Photo 10 Sampling Instrumentation—YSI 650 Multiparameter Display System, YSI 600 Optical Monitoring System Sonde, and YSI 6130 Rhodamine Sensor

Table 2 YSI 600 OMS Specifications—only conductivity, temperature, and Rhodamine recorded during trials (table by YSI International)

	Range	Resolution	Accuracy
ROX™ Optical Dissolved Oxygen• % Saturation	0 to 500%	0.1%	0 to 200%: ±1% of reading or 1% air saturation, whichever is greater; 200 to 500%: ±15% of reading
ROX™ Optical Dissolved Oxygen• mg/L	0 to 50 mg/L	0.01 mg/L	0 to 20 mg/L: ± 0.1 mg/L or 1% of reading, whichever is greater; 20 to 50 mg/L: ±15% of reading
Conductivity••	0 to 100 mS/cm	0.001 to 0.1 mS/cm (range dependent)	±0.5% of reading + 0.001 mS/cm
Salinity	0 to 70 ppt	0.01 ppt	±1% of reading or 0.1 ppt, whichever is greater
Temperature	-5 to +50°C	0.01°C	±0.15°C
Depth Medium Shallow Vented Level	0 to 200 ft, 61 m 0 to 30 ft, 9.1 m 0 to 30 ft, 9.1 m	0.001 ft, 0.001 m 0.001 ft, 0.001 m 0.001 ft, 0.001 m	±0.4 ft, ±0.12 m ±0.06 ft, ±0.02 m ±0.01 ft, 0.003 m
Turbidity• 6136 Sensor*	0 to 1,000 NTU	0.1 NTU	±2% of reading or 0.3 NTU, whichever is greater**
Rhodamine• ETV	0-200 µg/L	0.1 µg/L	±5% reading or 1 µg/L, whichever is greater

• Maximum depth rating for all optical probes is 200 feet, 61 m.
•• Report outputs of specific conductance (conductivity corrected to 25° C), resistivity, and total dissolved solids are also provided. These values are automatically calculated from conductivity according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (ed 1989).

**In YSI AMCO-AEPA Polymer Standards.

3.3.5 Sampling Regime

3.3.5.1 Phase II Trials

During the Phase II Trials, samples were taken at approximately 1, 2, 4, 8, 16, 24, 36, 48, and 60 hours after each mixing method was applied. This included both the vertical profiles and the tank discrete points. Discharge end-of-pipe continuous sampling was performed during deballasting of the six test tanks.

A grab sample routine was established for the tank discrete points in the case of an instrument failure, or in the event that Rhodamine concentrations exceeded the capacity of the instrumentation. Several samples were taken as precautionary measures but, as no failures occurred, the samples were not analyzed. In addition, samples were also taken from each B, C, D, and E location after reaching the 60-hour mark for that particular tank. These samples were taken in case that post-processing indicated an inconsistency in the instrument readings. As post-processing indicated consistent trends, such as dye concentrations moving towards equilibrium, these grab samples were not analyzed.

3.3.5.2 Phase III Sampling

The Phase III nozzle and air lift mixing methods (Tanks 3P, 3S, 4P, and 4S) were expected to mix the ballast tanks more rapidly than the methods employed during Phase II. Therefore, tank discrete samples were taken at approximately ten-minute intervals. Vertical profiles were not taken. For the two control tanks that repeated the vent dosing passive mixing method (5P and 5S), the Phase II sampling procedure for tank discrete monitoring was employed except, again, vertical profiles were not taken.

As with Phase II, discharge end-of-pipe continuous sampling was performed during deballasting of the six test tanks, and grab samples were taken which were analyzed by the University of Minnesota, Duluth.

Section 4 Mixing Trials Objectives and Methods

4.1 Objectives

The objectives of the mixing trials included:

- Establishing a rough estimate of the off time required for various methods to mix a ballast tank.
- Establishing a relative ranking between the methods based on: time for mixing, difficulty of set-up, and suitability for full or empty ballast tanks.

4.1.1 Dye Concentration Deviation and "Fully Mixed"

The trials were set-up to measure the relative differences in dye concentration over time.

The use of a biocide demands that all portions of a tank are exposed to a minimum concentration. Therefore, mixing efficiency for ballast water biocide application is of concern with regard to the deviation between the target dose and the lowest concentration. For example, if biological efficacy requires a minimum dose of 10 parts per million, a dose of 11 parts per million should be applied to account for an expected deviation of 10%.

The trials were set-up to be able to determine when dye concentrations reached a deviation of less than 25% and 10%. This less than 10% deviation, for the purposes of the trials, was considered to be fully mixed. The selection of a 10% deviation for a fully mixed tank was selected as similar to the accuracy of biocide concentrations and measurement instruments. Field teams need to consider multiple uncertainties when applying the biocides, including their ability to fully mix it into a ballast tank, the actual ballast tank water volume; the actual concentrations of biocide concentrates, and biocide application challenges.

4.1.2 Practical Timeframes

The timing of dye concentration measurements was adjusted to suit the expected times of the various methods to mix into the ballast water tanks. For Phase II trials, the expected timeframe for mixing the tanks was more than one day. Therefore, measurements were never more than once an hour and, in the later stages of mixing, intervals were more than four hours. For Phase III trials, the expected timeframe was less than two hours and, therefore, measurements were conducted at ten minute intervals.

The measured timeframes were well within practical timeframes for applying biocides on marine vessels. In an actual incident, an emergency response team would likely be needed to treat multiple tanks, and one or more treatment kits would be moved between these multiple tanks. From an application perspective, this would require set-up, mixing time, and then breakdown. Many marine operations take place in four-hour shifts; at the end of the period, either the team is then changed out or a rest period takes place. Thus, practical field application methods would fall into the following categories:

- Less than two hours, where multiple ballast tanks could be dosed within a single shift.
- Between two and four hours, where one ballast tank could be dosed per shift.
- Greater than eight hours, where dosing a ballast tank would take more than one shift and need multiple application crew.

4.2 Mixing Trials Overview

4.2.1 Phase II—Passive Mixing Methods Trials

The Phase II trials tested five methods for mixing biocides into full and empty ballast water tanks. The methods were selected as they could be practically executed using equipment commonly available on board most marine vessels. As such, these methods could assist a vessel operator attempting to handle their own high-risk ballast water in an emergency.

In each test, a tracer dye was used in place of the biocide. As the mixing methods were predicted to take several days to reach 95% efficiency, only one test per each of the six (6) tanks was planned and executed. Of the five (5) methods, only the vent dosing was replicated. The other methods were performed only once, which allowed for a relative comparison between the methods, but lacked a means to judge the repeatability of that specific method.

Table 3 - Passive Mixing Methods Overview

TANK	MIXING METHOD	DESCRIPTION	APPLICATION BENEFIT
5P	**Bulk-on-Bottom Dosing**	Dye was pumped into an empty ballast water tank. The mixing energy was provided by the force of the ballast water filling the ballast tank.	Can be used in cases where slack tankage exists on the casualty vessel and re-distribution of ballast water may decrease ground reaction at the impingement point. Ballast water entering the tank can mix the dye upon entry.
5S	**In-Line Dosing**	Dye was pumped into the ballast piping while the ballast water is being filled. The mixing energy was provided by the turbulence in the main ballast piping, and the force of the ballast water itself entering and filling the ballast tank.	Can be used in cases where slack tankage exists on the casualty and re-distribution of ballast water may decrease ground reaction at the impingement point. Dye can mix into the ballast water before entering the tank.
3P	**Internal Transfer Dosing**	Dye was pumped into the circulating water loop of a full ballast water tank. The loop removed ballast water from one tank location, and pumped it into another tank location. The mixing energy was provided by the transfer pump, moving the ballast water.	Can be used in cases where tanks are already filled and there are sufficient tank fittings and equipment to set up the circulation loop. Dye is injected into the circulation loop after flow is established through the portable pump. The circulation loop promotes fluid motion inside the tank to promote mixing, even without the presence of natural vessel motion.
3S	**Perforated Hose Dosing**	Dye was pumped into a 3/4" perforated hose that hung vertically through the water column of a full ballast tank. Energy was imparted by the force of the dye pump.	Can be used in cases where tanks are already filled and there are vents or manholes that allow vertical access from tank top to tank bottom. Equipment is readily available on most vessels and setup for this procedure is easy. Natural motion of the vessel continues mixing the dye after injection is complete.
4P & 4S	**Vent Dosing**	Dye was pumped onto the top of a full ballast water tank through a tank vent opening. Energy is imparted by the freefall of the dye.	Can be used in cases where tanks are already filled and there are vents or manholes that allow access into the tank top. Equipment is readily available and there is almost no equipment setup required.

The 4P and 4S tanks tested only one mixing method, in order to promote repeatability in results. This mixing technique is currently the most widely used method for applying biocide to ballast tanks with high risk ballast water, so it was critical to get accurate results from this tank pair. For these trials, ballast water was first pumped into the 5P and 5S tank pair, then into the 3P and 3S tank pair, and then, finally, into the 4P and 4S tank pair.

4.2.2 Phase III—Active Mixing Methods Trials

Phase III repeated the vent dosing method from the Phase II trials, and introduced six new methods for mixing biocides into ballast water tanks. The first two new methods were variations on air lifts that released compressed gas at the bottom of the ballast tank to impart mixing. The next four methods were variations of water jet mixing, two of which used educators and two of which used nozzles. A total of sixteen (16) tests were conducted in the Phase III shipboard trials.

Table 4 Methods and Tests Overview for Phase III Trials

TANK	MIXING METHOD	DESCRIPTION	# of Trials	BENEFIT
3P	**Air-Lift: Two Diffuser tables with large footprint**	Two widely spaced air-lift diffuser tables established a ~6' square bubble column, resulting in circulation of ballast water within tank. Dye was injected into each of the bubble columns.	3	Very rapid mixing potential. Requires in tank assembly so cannot be used on existing full tank. Requires specialty hardware to construct diffuser grid that may be harder to source.
4P	**Air-Lift: Three Point Diffusers**	Three widely spaced air-lift point diffusers, each establishing a bubble column, resulted in circulation of ballast water within tank. Dye was injected into each of the bubble columns.	3	Can be used in cases where tanks are already filled and there are vents or manholes that allow vertical access from tank top to tank bottom. Cylindrical diffusers can be lowered into tank through manholes or removable vent piping. Diffusers can be made from materials available at most industrial supply houses.
3S	**Eductor: Three Longitudinally Spaced Units**	Three widely spaced water powered eductors each established circulation of ballast water within the tank. Dye was injected into each of the eductors.	1	Can be used in cases where tanks are already filled and there are vents or manholes that allow vertical access from tank top to tank bottom. Eductors can be lowered into full tank from manholes or removable vent pipes. Water to power the eductors can be provided by the vessel's washdown or firemain system.
3S	**Eductor: Two Units at Longitudinal Midpoint of Tank**	Two water powered eductors were located at a single centered location in the ballast tank. Each eductor established circulation of ballast water within the tank. Dye was injected into each of the eductors.	2	Can be used in cases where tanks are already filled and there are vents or manholes that allow vertical access from tank top to tank bottom. Eductors can be lowered into full tank from manhole or removable vent pipes. Water to power the eductors can be provided by the vessel's washdown or firemain system.

TANK	MIXING METHOD	DESCRIPTION	# of Trials	BENEFIT
4S	**Nozzle: Three Units Longitudinally Spaced**	Three widely spaced water powered nozzles each established circulation of ballast water within tank. Dye was injected into each of the eductors.	3	Can be used in cases where tanks are already filled and there are vents or manholes that allow vertical access from tank top to tank bottom. Nozzles can be lowered into full tank from manholes or removable vent pipes. Water to power the nozzles can be provided by the vessel's washdown or firemain system.
4S	**Nozzle: Two Units at Longitudinal Midpoint of Tank**	Two water powered nozzles were located at a single centered location in the ballast tank. Each eductor established circulation of ballast water within the tank. Dye was injected into each of the nozzles.	2	Can be used in cases where tanks are already filled and there are vents or manholes that allow vertical access from tank top to tank bottom. Nozzles can be lowered into full tank from manhole or removable vent pipes. Water to power the Nozzles can be provided by the vessel's washdown or firemain system.
5P & 5S	**Vent Dosing**	Dye was pumped into the vent of a filled ballast tank and allowed to mix using natural ship motion.	2 (1 per tank)	Control test repeated from Phase 2 testing. Can be used in cases where tanks are already filled and there are vents or manholes that allow access into the tank top. Equipment is readily available and there is almost no equipment setup required.

4.3 Tracer Dye Selection and Application

4.3.1 Dye Selection

A tracer dye, *Rhodamine WT*, was selected to evaluate the efficiency of the various mixing methods. The dye met multiple selection criteria for the testing effort, as:

- It was commercially available and widely used field instrumentation and dye batches.
- Regulatory agencies were generally familiar with dye, which decreased the time and effort to gain required permits.
- It was fit for purpose, with a documented history of use in previous shipboard, wastewater, and geological trials.
- It had suitable chemical properties for conservative test results, it:
  - Was a similar density to the tested ballast water at dilute concentrations,
  - Had a low molecular diffusion rate, which assured that mixing results were primarily a function of physical mixing actions and not chemical reactions.
- As an inert compound, it was safe for handling with standard personal protection equipment.

The trials were conducted in accordance with permits from Wisconsin, Michigan, and Minnesota. Although allowable discharge concentrations were generally higher, applications and methods targeted an end-of-pipe discharge concentration of 120 ug/L.

4.3.2 Setting Data Confidence Requirements

Dye application and measurement methods were developed to provide general guidance to first responders in estimating both: the time required for applying the method, and the expected deviation between target biocide concentration and actual concentrations in the ballast water tank after the application of that method. For the purposes of this report and in broad terms, the *mixing efficiency* is considered to be the time required for a particular method to achieve a target deviation. These trials set the target deviation at 25% and 10%, as that level of accuracy was in line with a first responder's ability to estimate ballast tank volumes, measure biocide bulk quantities, and time the application of various mixing methods.

Further, it is important to understand that the trials could only provide the first responder with the relative mixing efficiency of the various trialed methods. This is because marine vessel ballast tanks vary significantly in configuration and volume. As such, the required mixing times and measured dosing deviations experienced with the trial tank configurations could not be directly applied to different tank configurations. The tank configurations used in the trial were moderately complex, and included a short double bottom portion and deep frames that hindered mixing. Marine vessel tank configurations include deep tanks that could be more easily mixed, as well as more complex "L-shaped" tanks that have more extensive baffling and a more extended double bottom portion that could be more difficult to mix. The volume of ballast water in the trial tanks was generally 880,000 gallons. This was generally on the high end of ballast tank volumes. It may be reasonable to assume that achieving mixing in smaller capacity tanks would require less mixing.

In practice, a first responder will be able to use the mixing efficiency indicated in the trials as one of the criteria in selecting a method. Other criteria might include availability of equipment, physical limitations of the tanks to be treated, and time available to perform the mixing. The first responder will also be able to use the time to complete mixing of the selected method as a rough indicator for planning purposes. It should also be noted that most biocides will diffuse through the water at a much faster rate the test dye which may reduce the need for complete mixing efficiency.

At this time, there are no guidelines for how conservative a first responder might be in actually applying the trialed methods in actual practice. However, based on consultation with a marine salvage engineer, it is understood that first responders generally work with rough estimates and tend to be conservative. For example, if trials indicated that mixing methods required 105 minutes, a first responder might be conservative and plan to apply the method for 120 minutes. For an additional example, if trials indicated that a mixing method achieved a deviation between the high and low concentration of 10%, a first responder might be conservative and apply a dose 20% higher than required. A first responder is also likely to obtain and measure samples to confirm that the required targets had in fact been reached. Confidence that adequate mixing has actually been achieved will require the responder to take measurements during and/or following employment of the selected method.

Understanding the end use of the report findings decreased the trial methods focus on accuracy and bias, and increased its focus on repeatability and representativeness; e.g., it was more important to measure how readings converged than it was to know their absolute value.

4.3.3 Accuracy and Percent Deviation

Accuracy of the field measurements are a combination of the ability to dose the ballast tanks to target dye chemical concentration and then to measure those concentrations. However, the accuracy of the overall testing efforts can be improved by employing methods that rely on comparative measures rather than absolute concentrations.

The first challenge was to dose the tanks to a known dye concentration. The dye batch, sold as a 20% concentration, was provided by the manufacturer as only accurate within +/- 5%. To measure the dye for the dosing we used a 2,000 mL graduated cylinder with 10 mL graduations. For a measurement of 1,740 mL, the accuracy was +/- 6%. To determine the ballast tank volume, we used the ship's tank level indicating system. Based on experience and conversations with the ship's crew, we estimated the accuracy to be at least +/-5%. Combined, our ability to dose the ballast tanks to an absolute dye concentration was +/- 16%.

The second challenge was to determine the accuracy of measurements. First, we developed a standard (discussed below) for calibrating the instrument. We used an electronic scale rated for 120 to 0.01 grams, accurate within +/-0.02 grams. Based on measuring ~24 grams, our accuracy was +/- 0.1%. We then accounted for the nameplate accuracy of our dye concentration sonde, details above, which is +/-5%. Combined, we rounded to +/- 5%.

The third challenge was our ability to take repeated readings in various locations throughout the ballast water tank in space and time. As our focus was to compare the dye concentration differences between the various locations, ideally all readings would have been taken at the same time. One way to accomplish this (although we did not implement this option) would have been to deploy multiple instruments in each tested tank. In this way, the readings would have had occurred at the same time, and the time variable would be mostly eliminated from our accuracy considerations. However, even with time removed from the equation of accuracy, we also needed to consider dose accuracy of +/-16% and measurement accuracy of +/-5% for a combined +/-21% accuracy. Given that we were focusing on reducing the difference in dye concentrations to less than 10%, this level of accuracy was problematic.

The approach we took to address this challenge was to use the same instrument for all readings. (Note – we did use two supplementary meters during phase 3 trials.) We then combined the consideration that we were using one meter, with the consideration that we were looking for differences in concentration, to determine that we could almost disregard considerations of absolute value measurements; "almost," only because we still needed to stay within the limits of the meter, and because the meter accuracy was dependent on the total deflection.

Our focus, therefore, was the ability of the instrument to repeatedly provide the same reading when reading the same dye concentration. There were multiple challenges for accurately repeating such readings. We took various steps to account for those challenges.

To limit the impact of bubbles on the lens, the unit was cleaned before starting a reading series. The impact of temperature was limited because the meter self-corrects for temperature, and the ballast tank temperatures were fairly consistent.

The meters tended to drift over time. For example, following a five hour testing period on 23 April 2009, the three meters had all drifted from a 100 ug/L calibration to 100.5, 97.6, and 101.7 ug/L. This implied a drift of at least 2.4% in one case. However, it should be noted that the target concentration that was being measured was 120 ug/L and all of those measurements were being taken during a short (perhaps ten minutes) interval. As such, the drift becomes insignificant (2.4% over five hours is perhaps 0.1% over 10 minutes) when comparing readings taken.

This however, still did not account for the space and time differences. Three sets of vertical column readings were taken through the vents of tank 3 port on 22 April 2009 after the tank was "fully mixed." Each of the fifteen readings was taken from a different physical location, and at a slightly different time over a roughly ten minute period. These readings were: 124.2, 124.5, 123.7, 124.3, 124.5, 123.4, 123.4, 123.2, 124.5, 123.5, 122.2, 122.0, 122.0, 122.0, and 122.0 (all in ug/L). The standard deviation was 1.0 ug/L or less than 1%.

In conclusion, our focus on comparing sequential readings utilizing the same instrumentation provided accuracy in the range of +/-1%.

4.3.4 Dye Standards and Instrument Calibration

Each instrument used underwent a two-point calibration process in accordance with the instrument manufacturer's instructions. The zero used non-dyed lake water from the same source as the ballast tanks, and the span standard was the product of the non-dyed lake water and the actual dye batch that was used to dose the tanks. The span standard was developed by means of weighing a quantity of the 20% dye concentrate, and then undergoing three-serial dilutions based on volume to produce a 120 ug/L standard. Instruments were zeroed and spanned before the trials.

Following each trial, the instruments were checked against the zero and span to determine instrument drift. During Phase III trials, instruments checked against the standard indicated drift ranging from 117 ug/L to 127 ug/L, against the 120 ug/L standard.

4.3.5 Dose Measurement

The longer mixing times required for Phase II methods only allowed one test per available ballast water tank. Consequently, the dosing concentration targeted 120 ug/L as it is: (a) below permit requirements, and (b) within the instrumentation range of 0–200 ug/L. The shorter mixing times required for Phase III methods allowed planning for three tests per ballast water tank. As such, the dosing concentrations were stepped in three phases: 35 ug/L; 70 ug/L; and then, finally, 140 ug/L. In both trial sets, the ballast water tanks were filled with approximately 3,330 metric tons of ballast water. *Rhodamine WT* at 20% concentration and a specific gravity of 1.13 was used for both trials.

For each Phase II test, approximately 1,750 mL was measured on a volumetric basis, using a graduated cylinder to suit the 120 ug/L target concentration. The graduated cylinder contents were poured into a transfer container with a sealed cap. The graduated cylinder was then rinsed three times with lake water, with the wash added to the transfer container.

For Phase III trials, approximately 2,000 mL of dye concentrate was measured for each tank using a graduated cylinder to suit a final target concentration of 140 ug/L. As three tests were planned for each tank, this 2,000 mL of dye concentrate was proportioned between three transfer containers, each dedicated for a separate test. The graduated cylinder was then rinsed three times with source water, with the wash roughly proportioned between the transfer containers.

4.4 Equipment

The methods trialed in Phase II assumed that the response team only had access to typical vessel's equipment. In general, this consisted of small pump(s), hoses, fittings, and drums.

The methods trialed in Phase III assumed that certain equipment would be brought on board the vessel by the response team. This equipment was mostly available at industrial supply stores and rental companies, but may be harder to obtain on short notice.

4.4.1 Basic Equipment

Basic equipment used in the trials included the following.

- Pump (1): Execution required use of a small pump with capacity between 5 and 20 gallons per minute, a check valve on discharge side, and adequate head to overcome ballast main pressure. The trials actually used a Wilden P1 air-operated diaphragm pump rated at 15.5 gallons per minute and a maximum pressure of 125 psi.
- Drum (1): Execution required a 20 to 50 gallon capacity, to add chemical diluted with water. The trials used plastic trash barrels at 40 gallon capacities.
- Hose (2): Execution required hoses of 3/4 to 1 inch in diameter, with length and fittings to suit. These were rated to the greater of the ballast main pressure or small pump head. One hose was fitted to the suction side of the pump, and the second hose to the discharge side of the pump. Actual trials used a 1–inch, spiral wound PVC hose, rated for discharge and suction use.

Photo 11 Phase II Trial Small Pump, Hoses, and Dosing Drum

4.4.2 Method-Specific Equipment

Method-specific equipment used in the trials included the following.

- Perforated Hose Equipment: This equipment supported the "Perforated Hose" Method conducted in Phase II trials.

- Hose (1): A 3/4-inch diameter hose, approximately forty feet in length, was used in the trials. The hose was a "red rubber" utility hose typically used in shipboard compressed air service. The hose was drilled with 1/8" diameter holes, spaced evenly 6" to 12" apart along the 20 foot submerged length of the hose, on all sides of the hose. The end of the hose was plugged. The end of the hose was weighted so that it would hang vertically (about 5 pounds of weight).

Photo 12 Testing the spray pattern of the perforated hose prior to in-tank test

- Internal Transfer Equipment: This equipment supported the "Internal Transfer" Method conducted in Phase II trials.
  - Hose (2): Several three-inch hoses were used for suction and discharge service to the diaphragm pump.
  - Transfer Pump (1): A Wilden M8 three-inch diaphragm pump was used, which was rated to a maximum of 165 gallons per minute.
  - Chemical Injection Manifold (1): The manifold used consisted of a tee fitting connected to the inlet side of the pump. A valve and reducer were connected to the branch side of the tee for injection of the chemical.

Photo 13 Internal transfer method, showing suction hose from ballast tank leading to diaphragm pump

- Eductor Equipment (2 or 3 eductors): This equipment supported the "Eductor Mixing" Methods conducted in Phase III trials.
    - Hose: Trials used 3-inch diameter rigid hoses. The length reached from the water supply on the main deck to each of the three eductor locations. The hoses were run in parallel with each other.
    - Eductor: Eductors had orifices sized to suit a water supply flow from the ship's firemain, with a flow rate estimated at 325 gallons per minute.
    - Flow meter: These were used to measure the flow to each of the three eductors.
    - Valves: These were used to balance the flow between each of the eductors.
    - Fittings: These were used to allow injection of dye into each hose.

Photo 14 Eductor mounted to vessel structure in ballast tank

- Nozzle Equipment: This equipment supported the "Nozzle Mixing" Method conducted in Phase III trials.
    - Hoses: Trial used two-inch diameter rigid hoses, each for individual nozzles. The length reached from the water supply on the main deck to each of the nozzle locations. The hoses were run in parallel with each other.
    - Nozzles: Three (3) nozzles were used, each were one and one-half inch (1-1/2") NST base solid stream nozzle with three quarter inch (3/4") or seven-eighths inch (7/8") outlet. Each assumed a supply of ~150 gallons of water a minute at 50 pounds per square inch at each nozzle inlet.
    - Flow meters: These were used to measure the flow to each of the nozzles.
    - Valves: These were used to balance the flow between each of the nozzles.
    - Fittings: These were used to allow injection of chemical into each hose.

Photo 15 Nozzle mounted to vessel structure inside ballast tank

- Air Lift Equipment: This equipment supported the "Air Lift (Point Diffuser)" Methods conducted in Phase III trials.
  - Air compressor(s): Used a diesel powered air compressor(s) that provided 150 scfm per point diffuser.
  - Pressure reducing station: Used to reduce air pressure to ~15psi at the tank bottom.
  - Hoses: Used one and one-half inch (1-1/2") diameter hose for each point diffuser, rated 30psi minimal, with length and fittings to suit. The length reached from the air supply on the main deck to each of the diffuser locations. The hoses were run in parallel with each other.
  - Point Diffusers: Used largest diameter PVC pipe (Schedule 40) that fit through manhole or cut off vent pipe, roughly three feet (~3') long, capped and plumbed with fittings to attach to air hose, with one eighth inch (1/8") holes drilled on three inch (3") centers over whole surface of pipe.
  - Valves: Sized to suit air hose and used to balance the flow between the point diffusers.
  - Hose: Used a small diameter hose to suit chemical pump with length to match each air hose to inject chemical at each diffuser location. Fittings split and balanced flow between all lines.

Photo 16 Point diffusers, 10" diameter pipes, 36" long, with ~100 holes each 1/8" diameter

- Air Lift Equipment: This equipment supported the “Air Lift (Grid Diffuser)” Methods conducted in Phase III trials.
  - Air compressor(s): Used a diesel powered air compressor(s) that provided 250 scfm to each grid diffuser.
  - Pressure reducing station: Used to reduce air pressure to ~15psi at the tank bottom.
  - Mist eliminator or air dryer to prevent icing during pressure reduction.
  - Hose: Ran two-inch (2") diameter hose to each grid diffuser, rated 30psi minimal, with length and fittings to suit. The length reached from the air supply on the main deck to each of the diffuser locations. The hoses ran in parallel with each other.
  - Grid of Diffusers: Used a grid of course bubble puck diffusers, spaced in a twelve inch (12") grid, diffuser array sized to fit between deep web frames. Fittings made air tight connections to pucks and air hose.
  - Mounting system held diffuser grid in place.
  - Valves: Valves were sized to suit air hose, and used to balance the flow between each of the diffuser grids.
  - Hose: Used a small diameter hose to suit chemical pump with length to match each air hose to inject chemical at each diffuser location. Fittings split and balanced flow between all lines.

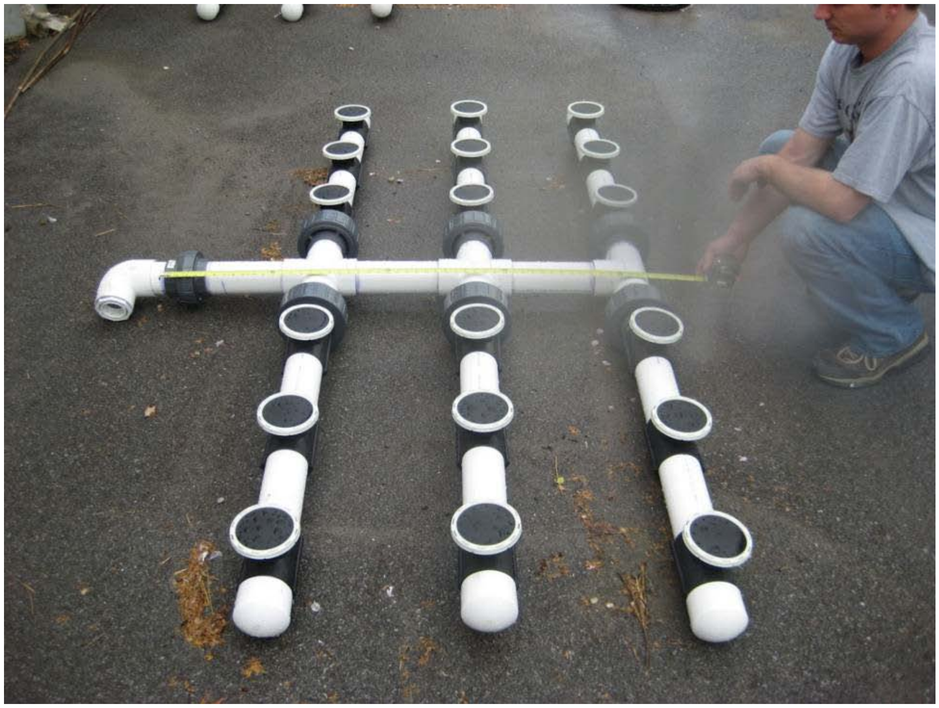

Photo 17 Grid diffuser, 18 course bubble puck diffusers

Photo 18 Air supply on deck for point and grid diffuser trials

4.5 Method 1: In-Line Dosing

This method was used to simulate treatment of the water as it was delivered to an empty ballast tank (Tank 5S) during the uptake of ~880,000 gallons of ballast water.

The in-line dosing method injected the dye directly into the ballast main while the ballast was being gravitated or pumped into the ballast tank. The mixing took place both in the piping, as well as in the tank. For these trials, the testing team:

1. Determined how much day was needed to treat the target ballast tank.
2. Connected the small pump and hose between the drum and the ballast pump (preferably on pump suction side).
3. Filled the drum with water, started the dye dosing pump, and continued filling the drum with water such that it stayed partially full.
4. Started ballasting, added dye to drum in proportion to amount of ballast water loaded. Continued filling drum with water such that it stayed partially full.
5. Finished adding dye before all the ballast water was in the tank to ensure 100% of dye had been added to the drum before finishing ballasting. This allowed the drum to be flushed and emptied into the ballast line as filling of the tanks was being completed.

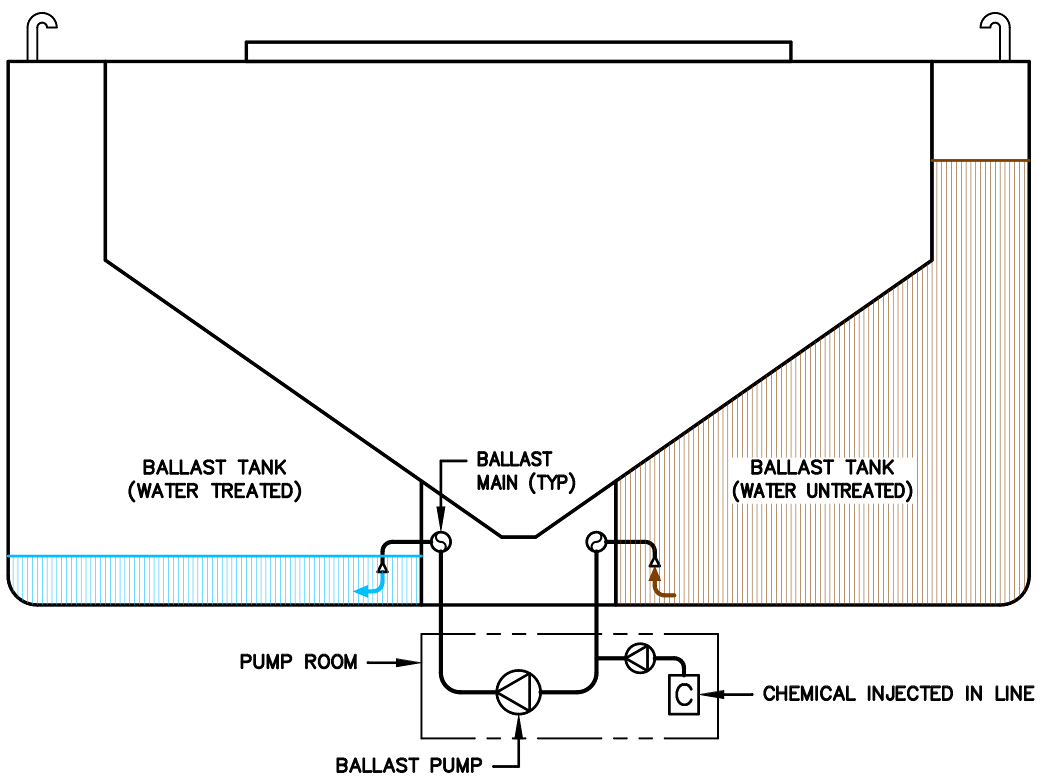

Figure 8 Overview of inline dosing method

4.6 Method 2: Bulk-on-Bottom Dosing

This method was used on an empty ballast tank (Tank 5P) immediately prior to loading ~880,000 gallons of ballast water.

The bulk-on-bottom dosing method consisted of pumped dye into the tank before it was filled by means of a manhole, vent, sounding tube, or other access. The tank was then filled with ballast, which mixed with the dye as the tank was filled. For these trials, the testing team:

1. Added the required quantity of dye to the drum and diluted it with water.
2. Connected the suction side of a small pump to the drum, and passed the discharge to the ballast tank opening.
3. Pumped the dye mixture into the empty ballast tank. The drum was then flushed out with as much water as possible, and the wash water was flushed in the ballast tank with as much water as reasonable (~250 gallons or more).
4. Ballast transfer operations were started as soon as possible, at as high of a rate as possible, to avoid sediment absorption of the dye over time.

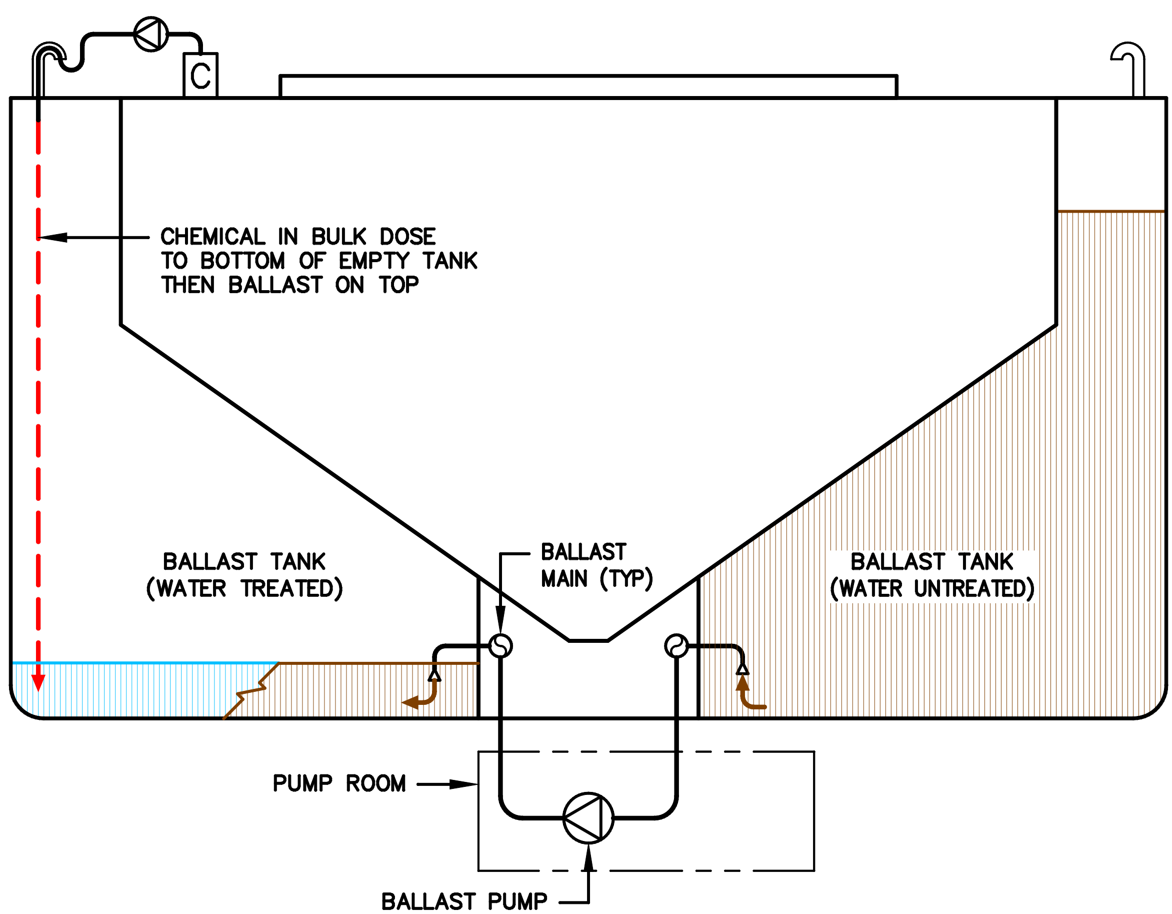

Figure 9 Overview of bulk-on-bottom dosing method.

4.7 Method 3: Perforated Hose Dosing

This method was used with a full tank (Tank 3S), containing ~880,000 gallons of ballast water.

The perforated hose dosing method consisted of spraying the dye into the water column in the ballast tank.

For these trials, the testing team:

1. Set up a perforated hose (see equipment section) of a length to suit the water level in the ballast tank.
2. Added the required quantity of dye to the drum and diluted it with water.
3. Connected the suction side of a small pump to the drum, and passed the discharge to the ballast tank opening. They then connected the discharge to the perforated hose.
4. The dye was sprayed into the ballast tank by running the small pump at maximum pressure. The tank holding the day was then flushed with water for 20 minutes while the wash water continued to flow into the tank through the perforated hose.

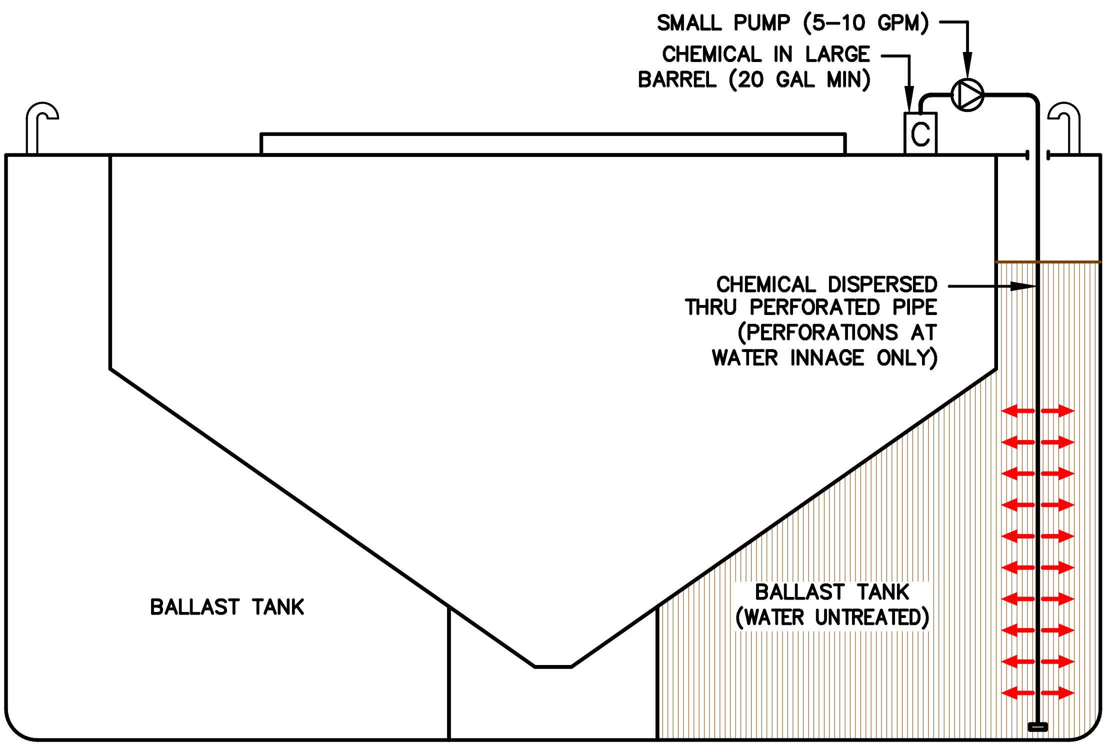

Figure 10 Overview of perforated hose dosing method

4.8 Method 4: Internal Transfer Dosing

This method was used to circulate water within a ballast tank (Tank 3P) previously filled with ~880,000 gallons of ballast water.

The internal transfer dosing circulated the ballast water internally within a single tank. The dye was metered into the circulation loop during this process. For this trial, the testing team:

1. Set up the Internal Transfer Equipment (see Equipment List section).
2. Started the large circulation pump. This was run during dosing, and for as long afterwards as needed to achieve mixing (several days).
3. Set up small dosing pump and hoses, connecting to the suction manifold. They then added the required quantity of dye into a drum and diluted it with water.
4. Injected the dye into the circulation loop over a period of no less than two hours. The drum was washed with water for 20 minutes and the wash water was injected into the circulation loop.
5. Continued running the circulation loop until mixing was achieved.

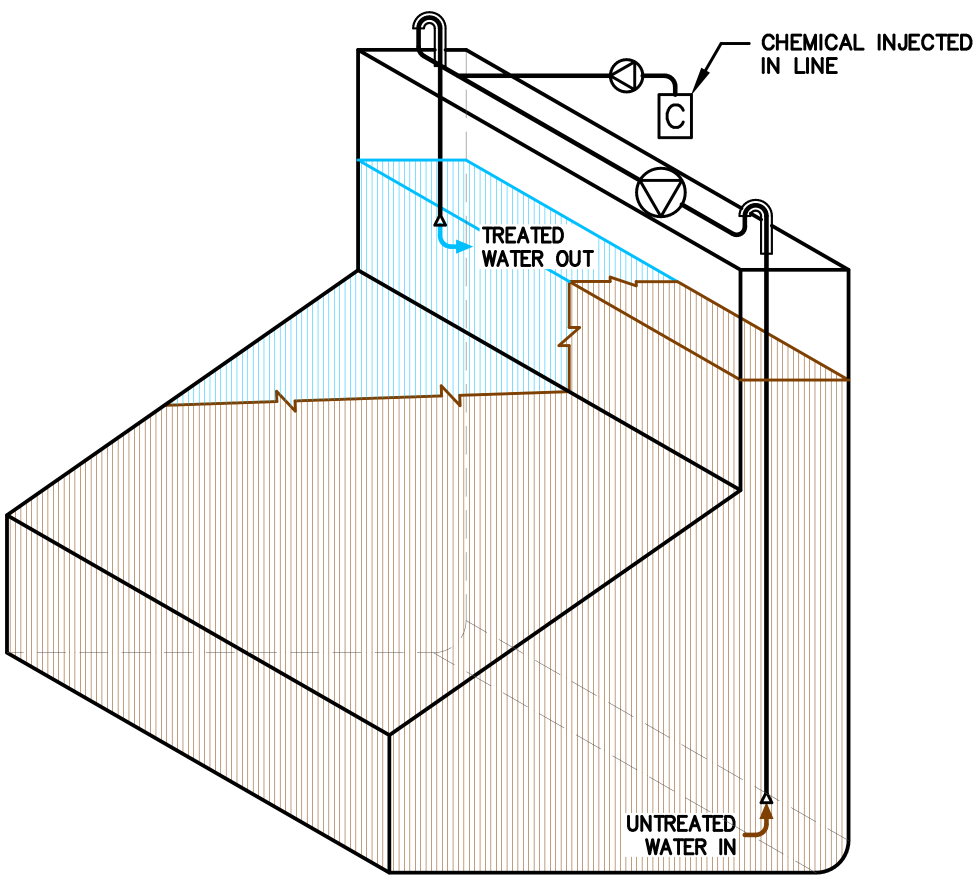

Figure 11 Overview of recirculation dosing method—note that trials actually located suction hose and pump adjacent to the bottom of the tank and pumped "up" to the tank top vent

4.9 Method 5: Vent Dosing

This method was used in ballast tanks previously filled with ~880,000 gallons of ballast water each (Tanks 4P and 4S for Phase II trials, and Tanks 5P and 5S for Phase III trials as a control test).

The vent/sounding tube dosing method consisted of pumping dye through any available tank opening into the full ballast tank. The dye was expected to mix into the ballast water by a combination of diffusion and any motion which the vessel may undergo. For these trials, the testing team:

1. Added the dye to treat the tank into a drum and diluted with water.
2. Connected a suction side of small pump to the drum, and passed the discharge to the ballast tank opening.
3. Injected the partially full ballast tank with the dye and flushed out the drum with as much water as practical (~250 gallons or more). The wash water was then placed into the ballast tank with as much water as possible.

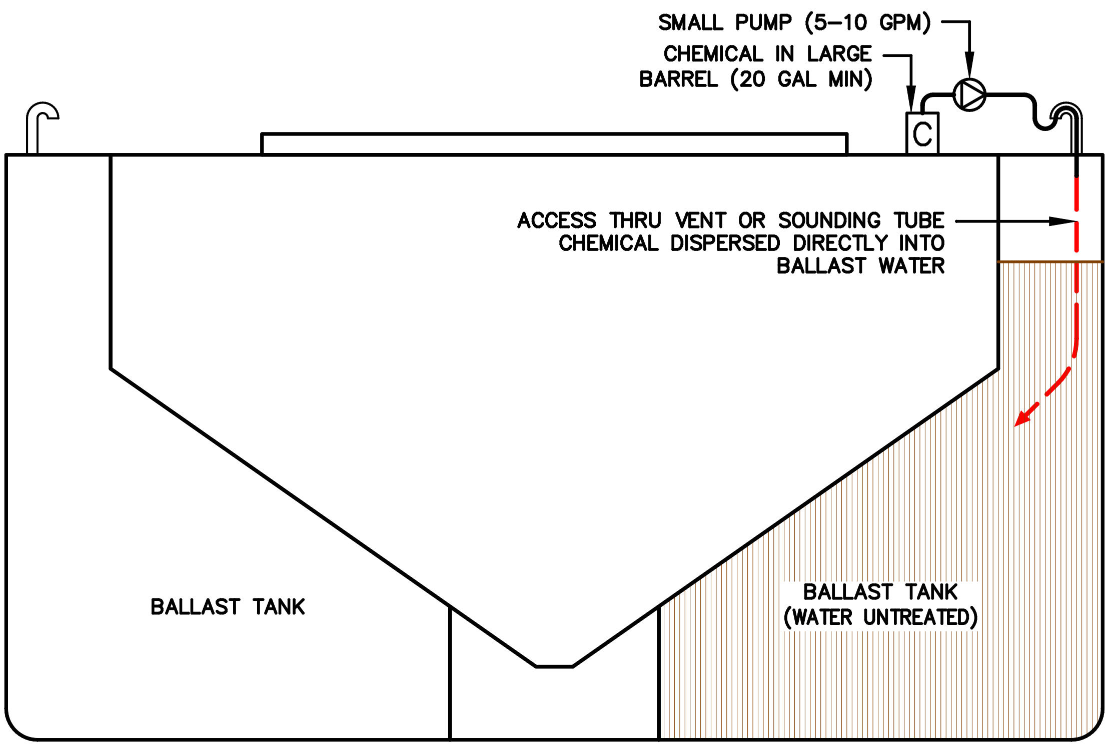

Figure 12 Overview of vent dosing method

4.10 Method 6: Nozzle or Eductor Active Mixing

This method was used in both a full and partially full ballast tank (Tanks 3S and 4S).

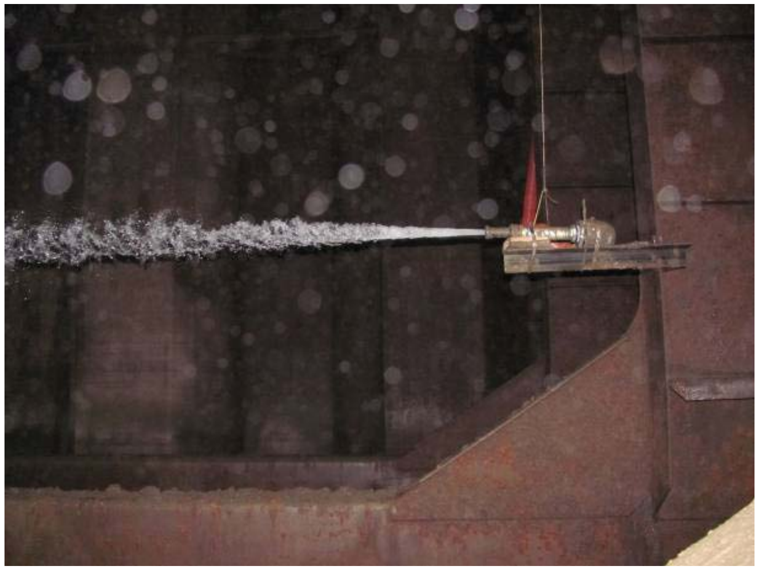

Photo 19 Parallel nozzle set-up located inside ballast tank

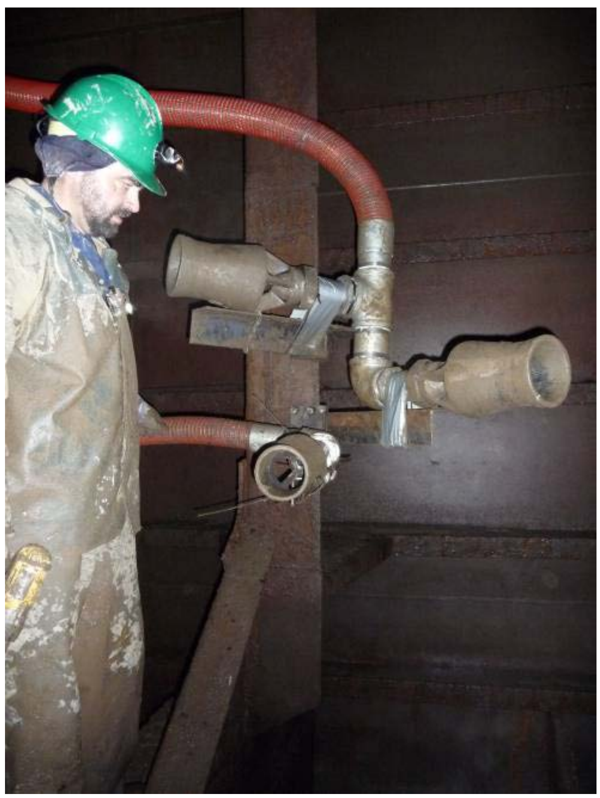

Photo 20 Top two nozzles are set-up at 45 degree spread for the single location nozzle trials- the lower nozzle is one of three set up for the parallel nozzle trials

For these trials, the testing team placed nozzles and eductors inside of the empty tanks. One configuration consisted of one set of two nozzles in a single location, pointing 45 degrees away from each other. A second configuration consisted of a set of three nozzles/eductors in three separate locations in the tank, each in parallel to each other.

The tanks were then filled with ~880,000 gallons of ballast water.

The dye was metered into the nozzle motive water flow from a fire main, and mixed into the ballast water by the turbulent water movement induced by the nozzles. The testing team then:

1. Obtained a source water supply; the vessel's firemain was utilized at ~350 gpm at ~50psi.
2. Nozzles and eductors were fixed on rigid pipes ~3' above bottom structure.
3. The required quantity of dye to treat the tank was added to the drum and then diluted with the source water.
4. Set up the dye injection. The small, high head metering pump was connected in line with the water source.
5. Opened the fire main and established tank circulation.
6. Injected tracer dye into water source over a period of 10-20 minutes. The dye drum was then flushed with water and the wash water was delivered to the tanks through the nozzles or eductors.
7. Ran water through nozzles or eductors for about 2 hours after the start of dye injection to complete mixing.

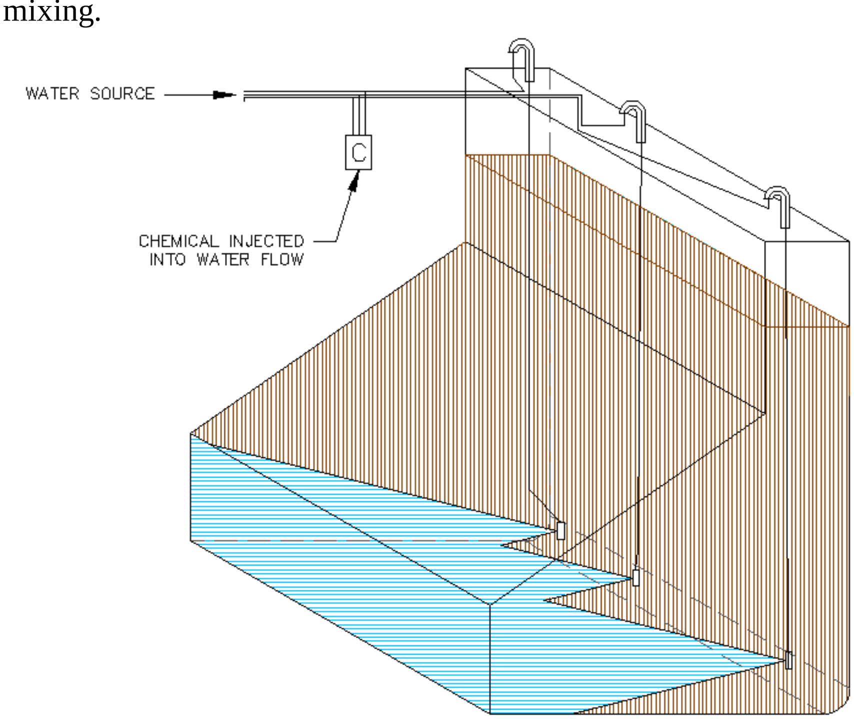

Figure 13   Overview of three nozzle arrangement

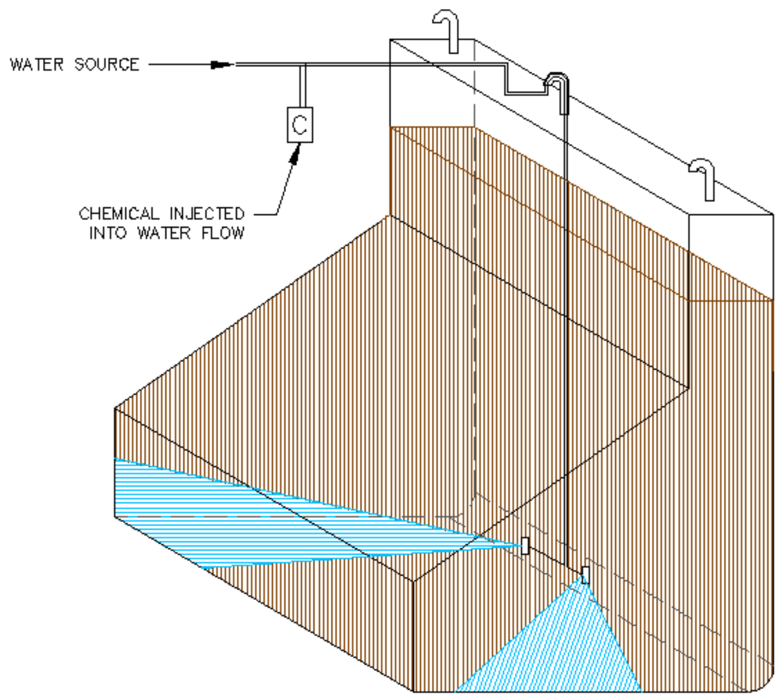

Figure 14 Overview of two nozzle, 45 degree arrangement

4.11 Method 7: Air Lift Mixing Point Diffuser

This method was used in a ballast water tank (Tank 4P) previously filled with ~880,000 gallons.

Three point diffusers were located in the ballast tank along outboard sideshell, centered between deep frames, and spaced equally between the tank vents. The dye was introduced to the tank just above each point diffuser using a pump and tubing. The dye was mixed into the ballast water by turbulent water movement.

Figure 15 Point diffuser located in ballast tank

For these trials, the testing team:

1. Set up diffuser(s), by placing diffuser rigs that created micro-bubbles into the ballast tank and connected the air supply to the diffusers.
2. Set up dye dosing by adding the dye to the drum and diluting it with water. A small pump was used to move the dye to the diffusers in the tanks. The tubing was terminated 1' above each diffuser. The dosing pump was started, and balancing valves used to adjust flow to equalize delivery of dye to the three locations in the tank.
3. Located point diffusers in the tank using an air supply hose until ~4' above the bottom. They then ensured there was enough weight attached to keep them submerged.
4. Started an air supply of approximately 450 scfm at 20 feet of head to establish in tank circulation.
5. Injected the ballast tank with dye over a period of 5-10 minutes. They then flushed the dye drum with water, and pumped the wash water into the tank through the diffuser.
6. Continued to run air through the diffusers for 2 hours after the start of dye injection to complete mixing.

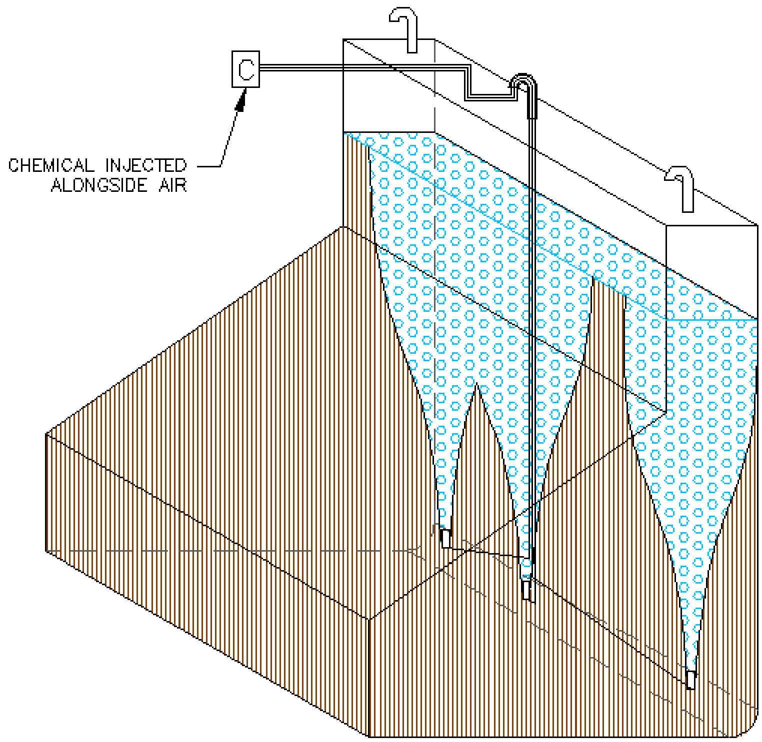

Figure 16 Overview of point diffuser method.

Section 5 Vessel Dynamics Data Collection

5.1 Objective

The efficacy of passive and active mixing methods was influenced by forces generated by normal vessel operations. These forces include accelerations associated with vibration and movement about the vessels major axis, e.g. roll, pitch, and yaw. During initial mixing tests, the instruments/methods described below were used as indicators of these forces.

5.2 Accelerometers

A GP1-L programmable accelerometer (Sensr brand) and its associated software were used to measure and summarize accelerations in the *x*, *y* and *z* axis of the vessel during a prescribed sampling period. The *x*-axis was taken as the longitudinal axis of the vessel. Measurements were in units of G (gravity). Two accelerometers were used. One was placed on deck near the aft vent of Ballast Tank 3P adjacent to the port side of Hatch No. 11. The second unit was located under the hopper tank in the conveyer tunnel near the aft end of Ballast Tank 3P. Both instruments were attached directly to structural steel using the magnetic mounting assembly provided by the Sensr group (R001-199-V2). Power requirements of each sensor were provided by two AA batteries. Data logging was initiated at T=0 (0600 h vessel time, EST) of the prescribed sampling schedule established for the morning of April 20, 2009. The data was logged for a planned period of 70 h, which provided coverage through the early morning period of April 23.

Photo 21 GPL1 Accelerometer

5.3 Inclinometers

Two types of inclinometers were used to measure pitch, roll, and yaw during the 70 h test period described in Method 1. Measurements were in units of degrees from the horizontal established in reference to gravity. A Microstrain Model 3DM inclinometer was placed on deck near the aft vent of Ballast Tank 3P adjacent to the port side of Hatch No. 11, and located just above (within cm) the previously described accelerometer. The inclinometer was mounted on 2x4 wood framing to minimize the influence of structural steel on magnetic heading readings (yaw) provided by the instrument. A second inclinometer (Jasco) was positioned on the starboard side of the vessels in the wood shop located in the bow of the vessel (3 m from centerline, 1.5 m from the floor). Commercial software and dedicated laptop computers (Panasonic Model CF-18) were used to log and summarize instrument readings. Power requirements for both instrument types were 110V AC, as provided by existing vessel service receptacles.

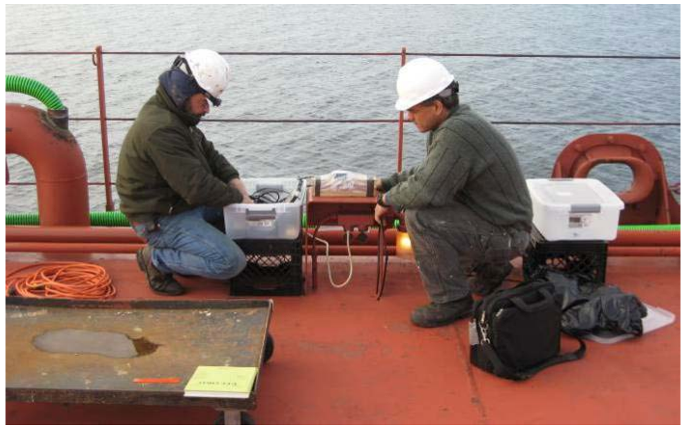

Photo 22 3DM inclinometer mounted at tank vent

5.4 Vessel Log

For the vessel's log, weather condition, sea condition, and vessel position were used to document operating conditions during the prescribed test period. Specific variables included wave height, wind direction and speed, barometric pressure, air, cloud cover, precipitation, vessel speed and direction, latitude, longitude, vessel operations and load condition. All variables were measured by the vessel's crew, as summarized in the vessel's official log. Log entries were photographed following completion of the dye dispersion analyses scheduled at their time of arrival in Duluth, Minnesota.

5.5 Video of Ballast Surface Water

Turbulence and wave action within ballast tank 3P were qualitatively evaluated using a Fisheye® type underwater video camera. The video camera was mounted on a 10 foot section of PVC pipe, which was threaded to accept two additional 10 foot sections of pipe so as to provide a planned extension to a position 30 feet below deck. The camera and an associated submersible light (UK C4, Underwater Kinetics®) were lowered to the headspace/water interface at the midpoint tank vent previously outfitted with a 10-inch flange. A video survey panned the view directly below the vent at four points during the trial: (1) while leaving Indiana Harbor, (2) at a Mid-Lake Michigan point, (3) at a pre- Sault Locks point, (4) at a mid-Lake Superior point, and (5) while entering Duluth harbor. Video images were digitized using commercial hardware package (Diamond® One touch Video Capture VC500), then recorded using a dedicated laptop computer (Panasonic Model CF-18).

5.6 Surface Re-Aeration Coefficient

Vessel motion and vibration was expected to enhance the movement of gases into and out of the solution as quantitatively measured by the overall mass transfer coefficient kLa. The kLa was determined for spring water held in an open rectangular container positioned adjacent to the inclinometer monitoring bow roll, pitch, and yaw, as described in Method 2, above. The kLa was established during the light seas case on our return run through Lake Michigan, as well as the moderate seas case encountered during the return run to Duluth across Lake Superior. Further, kLa was established in three replicate trials conducted as controls under conditions of no movement (stationary) in the onboard laboratory.

The container (plastic cooler) supporting vessel onboard trials measured 12.0 inches in height, 22.0 inches in length, and 11.0 inches in width. The container was positioned so that its long axis was perpendicular to the longitudinal axis of the vessel. The container used in the control runs measured 12.0 inches in height, 19.7 inches in length, and 14.0 inches in width. The containers in both cases were charged with about 4.25 inches of spring water, and supersaturated with oxygen to a level representing about 200% of the local saturation concentration. Supersaturation was achieved through application of a submerged sparger receiving compressed oxygen.

A Hach Model HQ10 Portable LDO Dissolved Oxygen Meter, with air calibration following manufacturers recommended procedures, was used to log test water DO (mg/L), temperature (C), time, and local barometric pressure (mm Hg). Clean water saturation concentrations (C*) of DO were calculated based on Henry's Law, for each time-specific data set, to establish the prevailing dissolved oxygen deficit (C*-DO). The C* values were calculated using temperature-specific Bunsen solubility coefficients and calculated water vapor pressures following the models of Weiss (1970) and Weiss and Price (1980), respectively, as summarized by Colt (1984).

The resulting data showing DO degassing versus time, and the deficit over the course of each test period, was then used to calculate kLa, O2 at 20C following the linear regression method as described by Brown and Baillod (1982). Data was truncated so that regression analysis was performed over the range of about 20% and 80% of the initial deficit established at the start of each run. The resulting kLa is expressed in units of 1/hr. All kLa values were standardized to 20C using the APHA (1985) correlation.

As expected, kLa (20C) values established in the laboratory, with no movement, were relatively low and averaged 0.035 Hr^-1 (CV=15.3%), whereas the single values established with light and moderate seas were 0.130 and 0.447 Hr^-1, respectively. The latter value represents a 12.7 fold increase over the control kLa mean.

This test was simple to carry out, appeared to be sensitive to vessel motion over the range tested, and should, therefore, be carried forward into planned future mixing trials on the *Indiana Harbor* so as to establish a record of relative energy inputs. Additionally, kLa values established, for a specific reactor type and gas species, are useful in predicting gas absorption and desorption rates given temperature, ^{o}C, and the initial dissolved gas deficits; i.e., from Brown and Baillod (1982), the concentration of DO at any time t can be calculated from the expression:

DO = C* - [(C* - DO,start) e^(-kLa * t)]

The relative kLa value can be established for a selected gas species pair (e.g., oxygen and carbon dioxide) given tabulated values for molecular diameter as described by Einstein's Law of Diffusion (Tsivoglou et al., 1965).

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Photo 23 Surface reaeration test equipment

5.7 Submerged Pressure Transducers

Wave action within the tanks will cause fluctuations in measured pressure within a vertical water column. These pressure variations were measured by means of remote pressure transducers (RBR Global Model RBR-1050). By subtracting out the atmospheric baseline measurement and converting the recorded values in decibars to feet of water, the tank level may be monitored directly above the pressure transducer.

The minimum recording rate for the RBR-1050 transducers used in this experiment was one second. This rate is too slow for accurate mapping of the wave profile within the tank, but it is adequate to determine the maximum wave height at any given time over the course of this experiment. A total of three pressure transducers were used in the 3P tank. All three pressure transducers were located 4 feet above baseline, and 12 feet inboard of the side shell. Longitudinally, the forward transducer was in line with the A2/C2 sample hose inlets, the middle pressure transducer is in line with the middle tank vent, and the aft pressure transducer is in line with the A1/C1 sample hose inlets.

Each pressure transducer was powered by the two CR 123 camera batteries housed within the unit. The units are configured using RBR Data Logger Software version 6.13. This same software was also used for configuring the start and stop time for data collection, as well as the sampling interval. The manufacturer of this software is RBR Global (www.rbr-global.com).

Photo 24 Pressure transducers following retrieval from full ballast water tanks

Section 6 Data Summary

6.1 Data Summary Overview

Data from the trials were collected using the instruments detailed in the previous sections. It was understood that some of the data would be used to support recommendations for the emergency response guide development. This analysis is reviewed in the conclusions.

The remainder of the data was collected for future analysis. These data are available for others for review, and for the development of additional conclusions. Such future work might include the determination of the impact of a vessel's motion on the mixing of chemicals in the ballast tank, or the superimposition of chemical molecular diffusion rates of promising biocides onto the mixing effects of the *Rhodamine WT*. The available electronic files include the:

- Sonde data for in-tank testing above deck, below deck, continuous discharge sampling, and environmental testing onboard and around the vessel
- Accelerometers
- Inclinometers
- Pressure transducers
- Video of tank 3P ballast water surface
- Surface reaeration
- Vessel’s log

6.2 Data Formats and Files

The data were originally collected in several file types and formats. Some of the files have been entered into more typical programs, such as Excel, for ease of analysis. Other data were hand written and transposed into Excel. The data available are summarized in the following table.

Table 5 Dye Study Data File Summary

Equipment	Trial Phase	Test / Location	Data Type	File Name(s)
Sondes	2	In-Tank (Above deck)	Excel	Vesselboard Sonde Data.xls 09019 Analysis Rev1.xls
	2	In-Tank (Below deck)	Excel	Vesselboard Sonde Data.xls 09019 Analysis Rev1.xls
	2	Discharge (Engine room continuous)	Excel	Vesselboard Sonde Data.xls
	2	Discharge (Onboard environmental)	Excel	Vesselboard Sonde Data.xls
	2	Discharge (Environmental around vessel)	PDF	Discharge Log Notes.pdf
	3	Tank 3P (Grid Diffusers)	Excel	Tank 3P trials-normalized.xlsx
	3	Tank 4P (Point Diffusers)	Excel	Tank 4P trials-normalized.xlsx
	3	Tank 3S (Eductors)	Excel	Tank 3S trials-normalized.xlsx
	3	Tank 4S (Nozzles)	Excel	Tank 4S trials-normalized.xlsx
	3	Tank 5P/S (Control Vent Dose)	Excel	Tank 5PS trials.xlsx
	3	Discharge (Engine room continuous)	Excel	DISCRG-P.xlsx DISCRG-S.xlsx
Ballast Samples	2	In-Tank (Below deck) Discharge (Engine room)	Excel	April_2009_bottle_samples.xls
	3	In-Tank (Grab Sample analysis)	Excel	May 2010 bottle Samples.xls
Accelerometers	2	Tunnel Location	Data	Indiana Harbor to Duluth April 20,09 3P Tunnel Site.snr
	2	Deck Location	Data	Indiana Harbor to Duluth April 20,09 Inclinometer site.snr
	3	Bow Station	Data	bow station-51910.snr
	3	Port side Deck Location	Data	Port by #3 ballast vent 39-519.snr
Inclinometers	2	Wood Shop Location	Log	dye_study_4_20_fwd.log
	2	Deck Location	Comma-Separated Values	DYE_STUDY_4_20.csv DYE_STUDY_4_21.csv
	3	Deck Location	Comma-Separated Values	3P.3dm.05.19.2010.csv 3P.3dm.05.20.2010.csv 3P.3dm.05.21.2010.csv
	3	Wood Shop Location	Log	bowjaco.05.19.2010.log bowjaco.05.20.2010.log bowjaco.05.21.2010.log

Equipment	Trial Phase	Test / Location	Data Type	File Name(s)
Pressure Transducers	2	Tank 3P Forward	Data	013551_3P Tank_5-28-09.dat
	2	Tank 3P Middle	Data	013550_3P Tank_4-22-09.dat
	2	Tank 3P Aft	Data Excel	013552_3P Tank_4-22-09.dat 013552.xlsx
	3	Tank 5P Aft	Data	013550 During trial.dat
	3	Tank 5P Middle	Data	013551 During Trial.dat
	3	Tank 5P Forward	Data	013552 During Trial.dat
Ballast Water Surface Video	2	Tank 3P	Video	P4220127.AVI
Surface Reaeration	2	Wood Shop Location		
	2	Tunnel Location		
	3	Woodshop Location		
Vessel's Log	2	Vessel	Excel	20Apr-24AprLog.xls
	3	Vessel	Photos	Vessels Log.pdf

6.3 Vessel Route

6.3.1 Phase II—Passive Mixing Methods

All dye was introduced to the ballast tanks within 3 hours of departing Indiana Harbor, Indiana. Conditions were calm, and vessel motions were minimal through Lake Michigan until departure for the Sault Ste. Marie locks and entrance to Lake Superior. The light vessel motions during the initial 33 hours resulted in minimal vessel motion and induced mixing. After departing the Sault Ste. Marie locks, conditions gradually deteriorated to a moderate sea state for the northwesterly portion of the trip in Lake Superior. These increased vessel motions, which resulted in greater vessel motion, induced mixing. Data collection was stopped roughly 12 hours before arriving in Duluth, to allow time for demobilization of all of the testing equipment. This condition corresponds to the majority of the southwesterly portion of the trip on Lake Superior.

6.3.2 Phase III—Active Mixing Methods

For this phase, dye was introduced to the tanks at multiple times throughout the trip except in control tanks. The control tanks (5P & 5S) were both dosed with dye soon after leaving Gary Harbor. The vessel's route was almost identical to the Phase II trial route. Weather was calm in both lakes and in the Sault Locks. Data collection was stopped in the control tanks, roughly 8 hours before arrival in Duluth.

6.4 Environmental Data

6.4.1 Overview

6.4.1.1 Phase II—Passive Mixing Methods

The environmental data were collected for future analysis. This will provide an opportunity to gain a better understanding of the impact of environmental conditions on tank mixing, and perhaps even vessel motions. In general, the sea conditions were the roughest in Lake Superior, and both Lake Michigan and Lake Superior were rougher than the transit of the Sault Ste. Marie waterway. This observation was supported by both the in-tank wave height measurements and the Surface Reaeration Coefficient calculations.

6.4.1.2 Phase III—Active Mixing Methods

Environmental data were collected for future analysis. In general, the sea conditions were calm throughout the trip. There was no discernable difference between any of the three major geographical areas. This observation was supported by the in-tank wave measurements.

6.4.2 Pressure Transducers

6.4.2.1 Phase II—Passive Mixing Methods

The in-tank wave heights were calculated using the aft of the three pressure transducer loggers that were installed in ballast tank 3P. The wave heights reported were the maximum and minimum deviations from the average depth of the ballast tank over the time the vessel was in each of the waterways. The reason for the small deviation in average depth of the tank was not fully understood. It may be that the vessel's heel varied some due to wind or fuel use. As the transducer was kept in one location near the outboard shell, a small heel angle change could have caused water depth to change.

Further analysis on the in-tank wave heights could be conducted to show the relative time at specific wave heights, which would give a better indication of the mixing potential of vessel motions.

Table 6 In Tank Wave Heights

Lake Michigan		Sault St Marie		Lake supperior	
13.8	=Average depth of tank (ft)	13.7	=Average depth of tank (ft)	14	=Average depth of tank (ft)
4.2	=Max wave height (in)	1.3	=Max wave height (in)	5.1	=Max wave height (in)
-3.2	=Min wave height (in)	-1.3	=Min wave height (in)	-6.4	=Min wave height (in)
7.4	=Wave Magnitude (in)	2.6	=Wave Magnitude (in)	11.5	=Wave Magnitude (in)

A data plot from one of the three pressure transducers can be seen below. Shown is a period of moderate pressure fluctuations, then a relatively calm period followed by a more active period. These three periods correspond to periods in Lake Michigan, while transiting the Sault Locks and Lake Superior, respectively.

The additional transducer pressure readings are available for future analysis. Such analysis might compare the pressure readings between the three locations, as well as look for consistency between the readings. Further, there may be an ability to track a wave transit from one end of the tank to another.

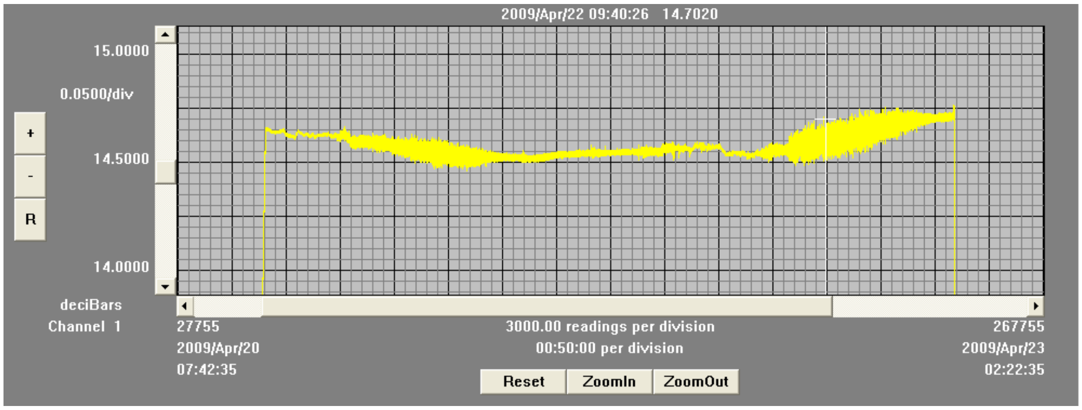

Figure 17 Phase II trial pressure transducer readings

6.4.2.2 Phase III—Active Mixing Methods

A plot of one of the three pressure transducers can be seen below. From the plot, it can be seen that throughout the entire trip the wave motions were minimal.

The average wave heights were not calculated for Phase III trials as it was clear that vessel motions were minimal.

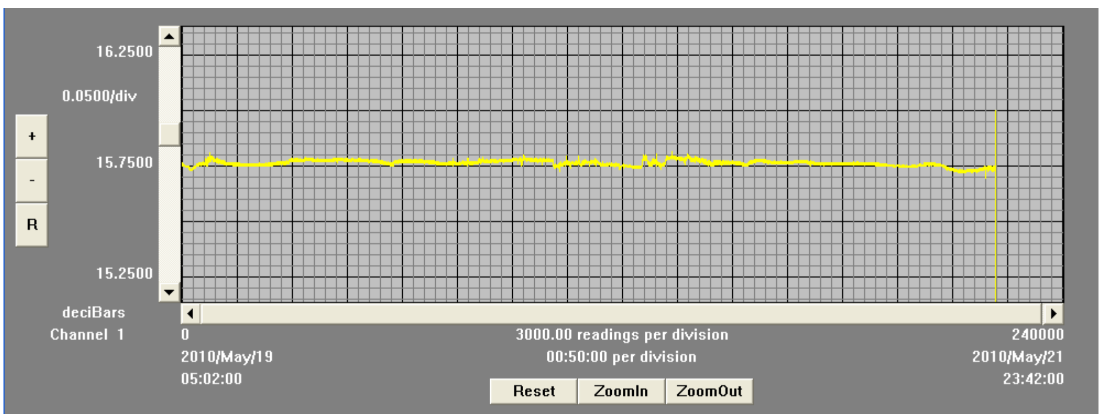

Figure 18 Phase III trial pressure transducer readings

6.4.3 Surface Re-Aeration Coefficient

6.4.3.1 Phase II—Passive Mixing Methods

The following figures provide a rough approximation of the energy imparted to the ballast tanks from the vessel's motion and vibration, based on relative changes in the measured mass transfer coefficient kLa. Measurements were taken for the light seas cases through Lake Michigan, moderate seas case through Lake Superior, and were controlled, subsequently, in a laboratory.

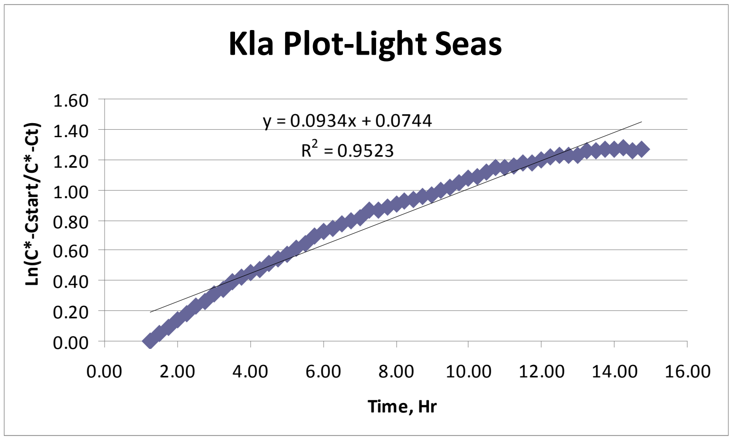

Figure 19 kLa plot series for Lake Michigan portion of transit during Phase II trials

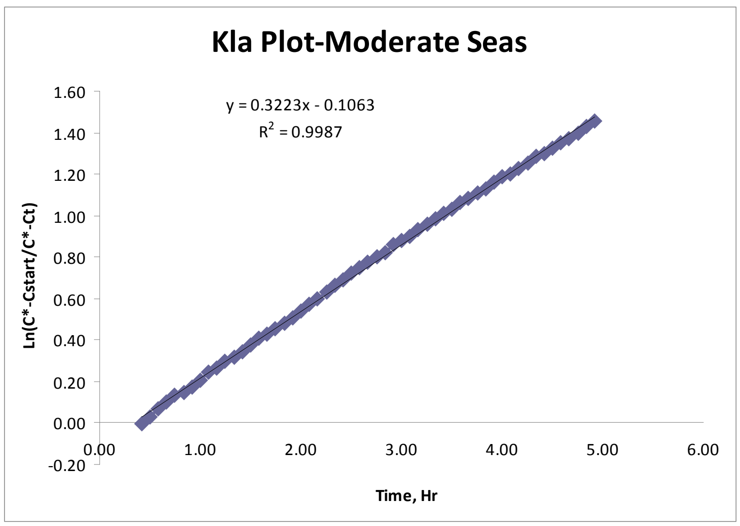

Figure 20 kLa plot series for Lake Superior portion of transit during Phase II trials

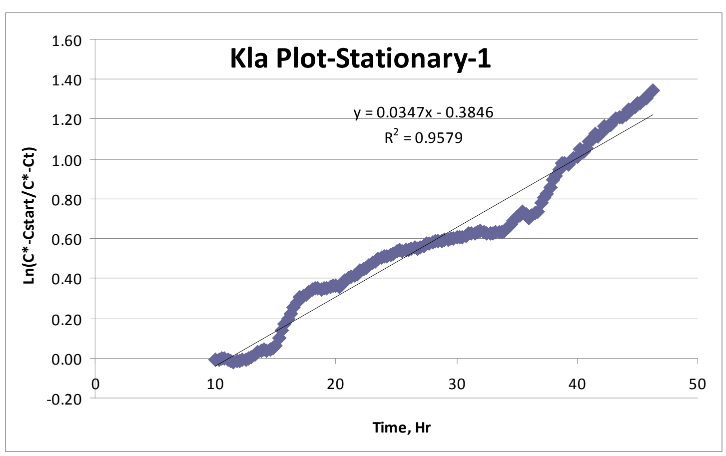

Figure 21 Control Test Showing Stationary kLa

6.4.3.2 Phase III—Active Mixing Methods

Surface reaeration experiments were attempted during the Phase III trials, but due to unforeseen complications, no data is available.

6.5 In-Tank Mixing Data

6.5.1 Phase II—Passive Mixing Methods

In-tank mixing data is reported, herein, to provide an overview of the general trends of the various trialed mixing methods. The data is presented as actual tracer dye concentrations as measured. It should be noted that the vessel's motion played a significant role in the mixing of the dye in the ballast tanks, particularly in the later hours of the trials. A further discussion is provided in the conclusions.

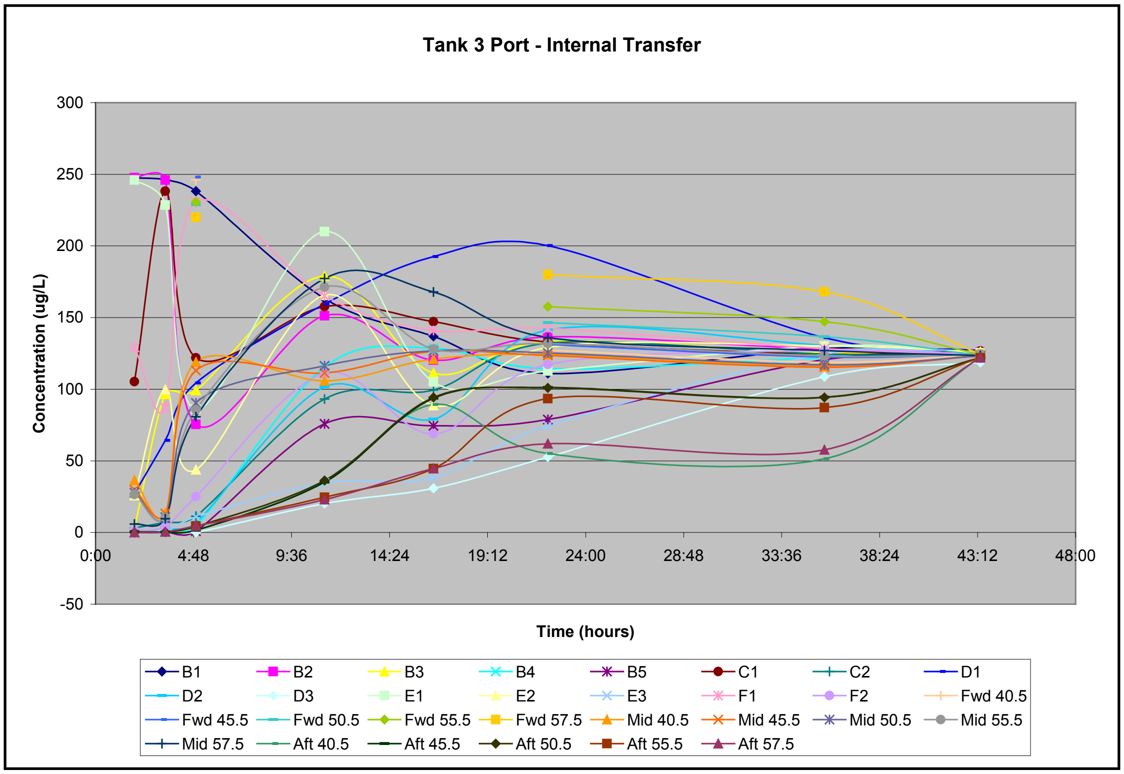

Figure 22 Convergence of Dye Concentrations to being "Well Mixed" during Mixing Trial Time Series Plot of Dye Concentration during Mixing Trial

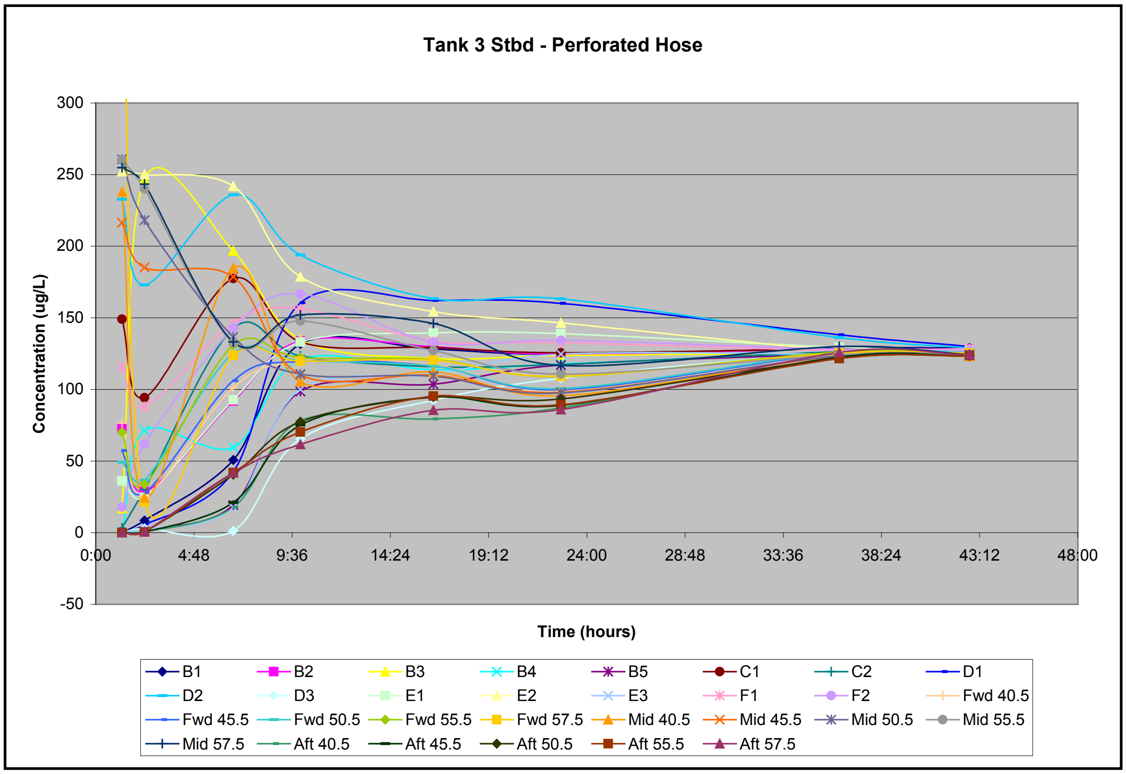

Figure 23 Time Series Plot of Dye Concentration during Mixing Trial

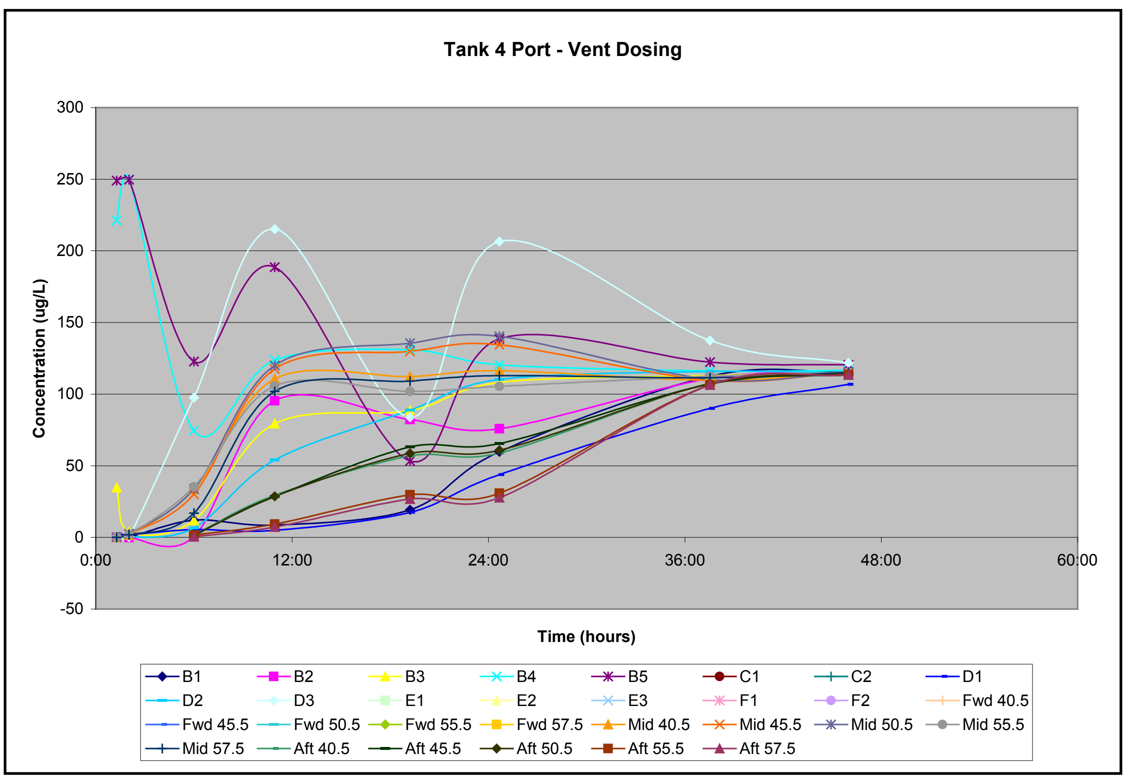

Figure 24 Time Series Plot of Dye Concentration during Mixing Trial

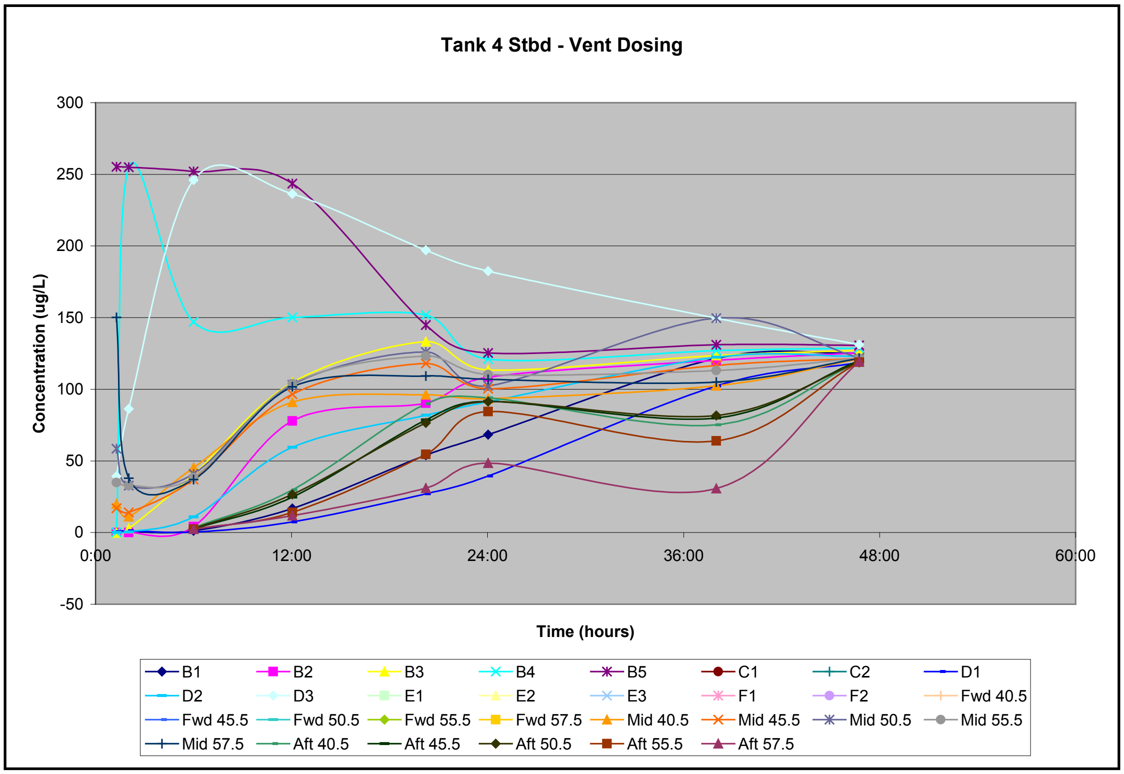

Figure 25 Time Series Plot of Dye Concentration during Mixing Trial

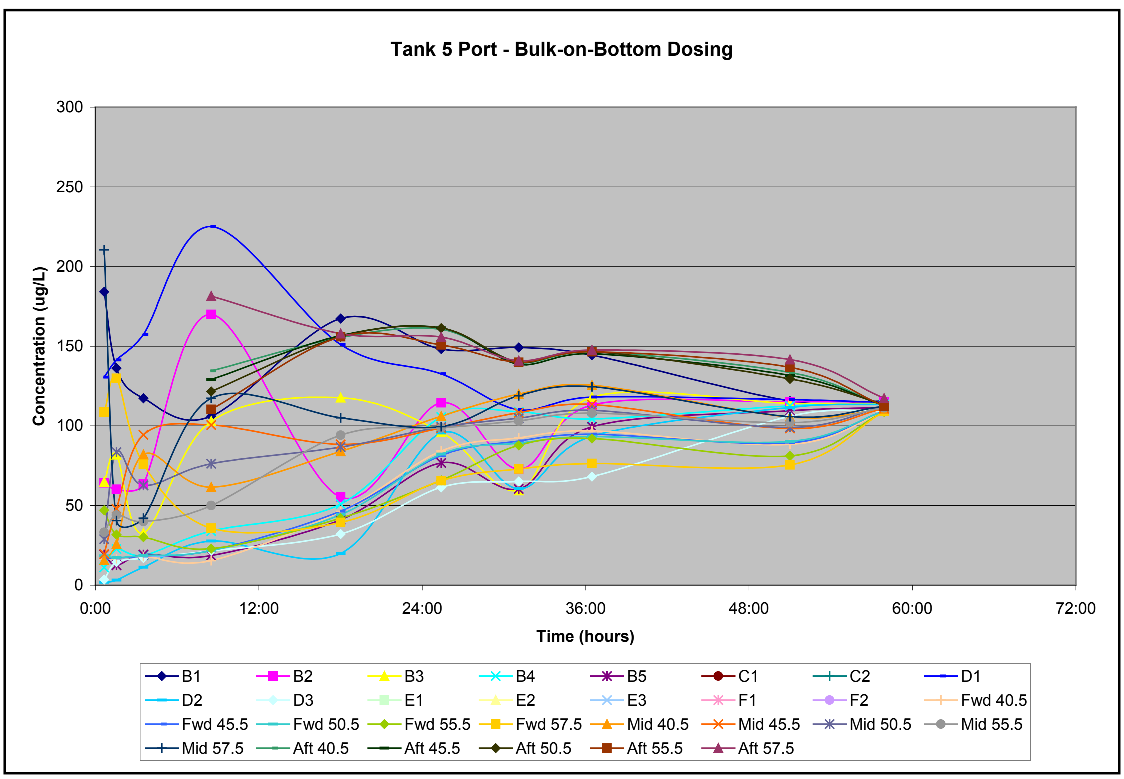

Figure 26 Time Series Plot of Dye Concentration during Mixing Trial

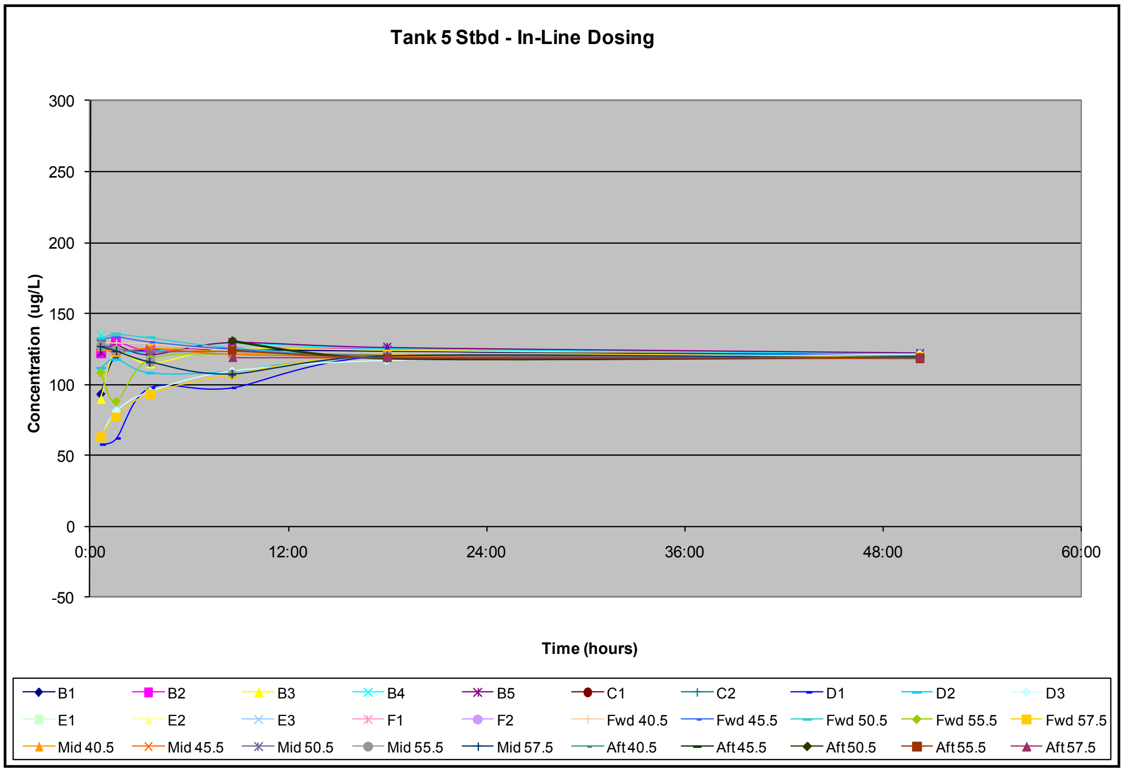

Figure 27 Time Series Plot of Dye Concentration during Mixing Trial

6.5.2 Phase III—Active Mixing Methods

In-tank mixing data are reported, herein, to provide an overview of the general trends of the various trialed mixing methods. The first two data sets are for the 5 Port and 5 Starboard "control tanks" that repeated the vent dosing methods performed during the Phase II trials. These plots report actual tracer dye concentrations.

The subsequent plots for the faster mixing trials in tanks 3 Port, 3 Starboard, 4 Port, and 4 Starboard tanks. In order to perform multiple trials per tank, each tank was dosed in three steps. The plots "normalize" the concentrations to allow a comparison between the various steps. The normalization is based on a scale of 1, where the initial tank concentration is 0 and the fully mixed target concentration is 1.

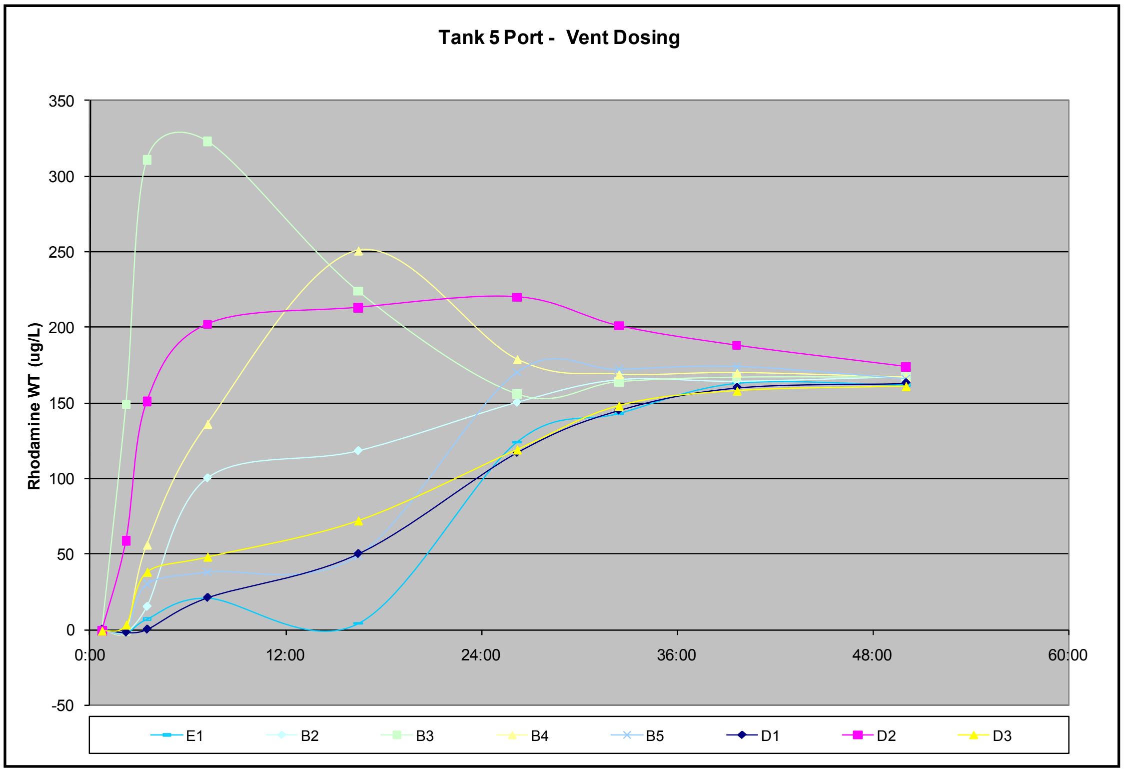

Figure 28 Time Series Plot of Dye Concentration during Mixing Trial

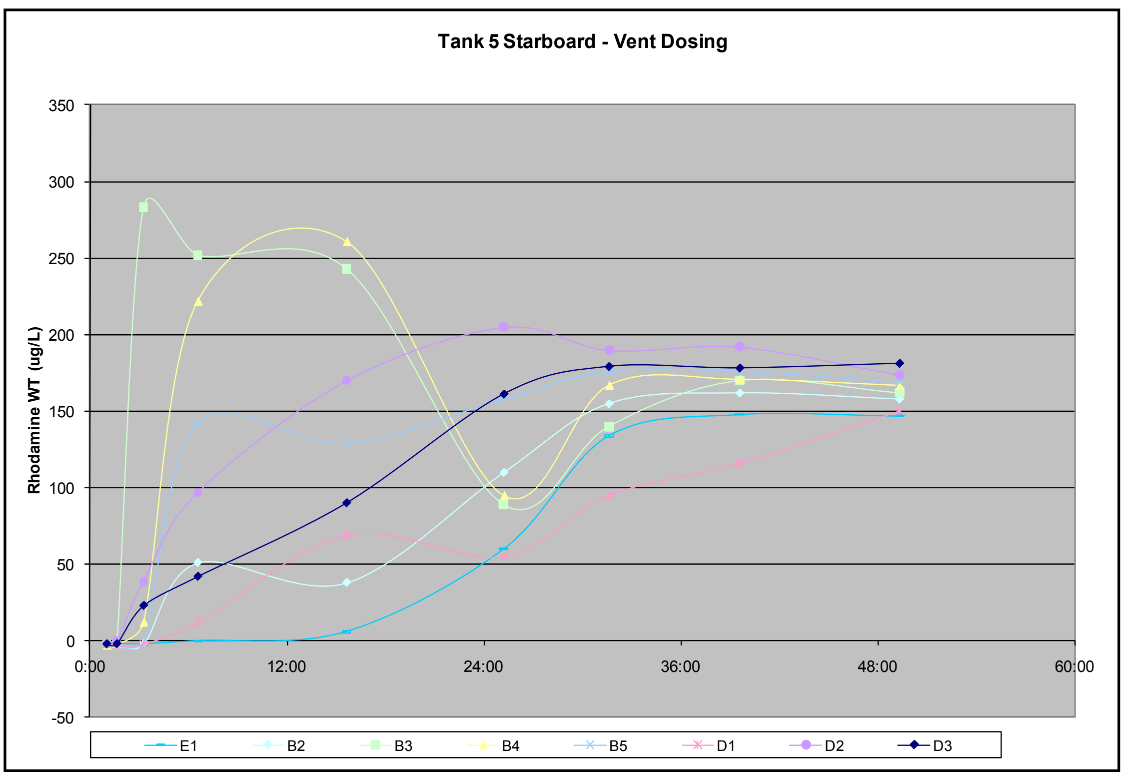

Figure 29 Time Series Plot of Dye Concentration during Mixing Trial

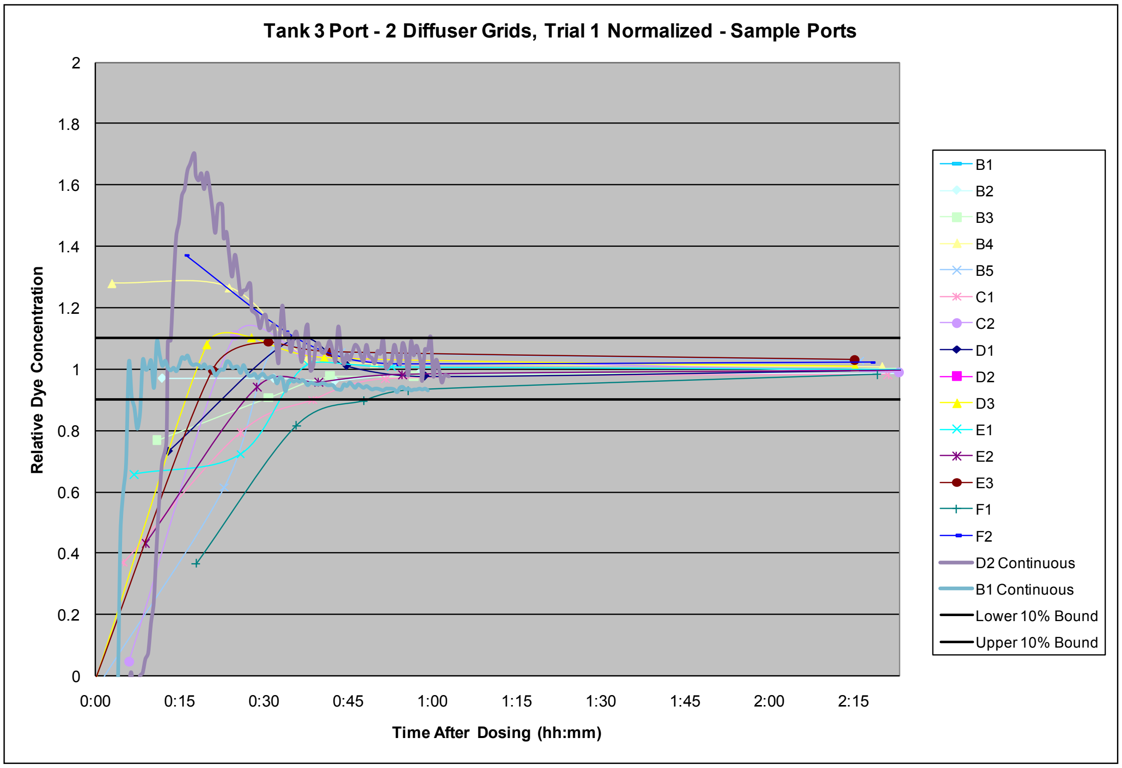

Figure 30 Normalized Time Series Plot of Relative Dye Concentration during Mixing Trial

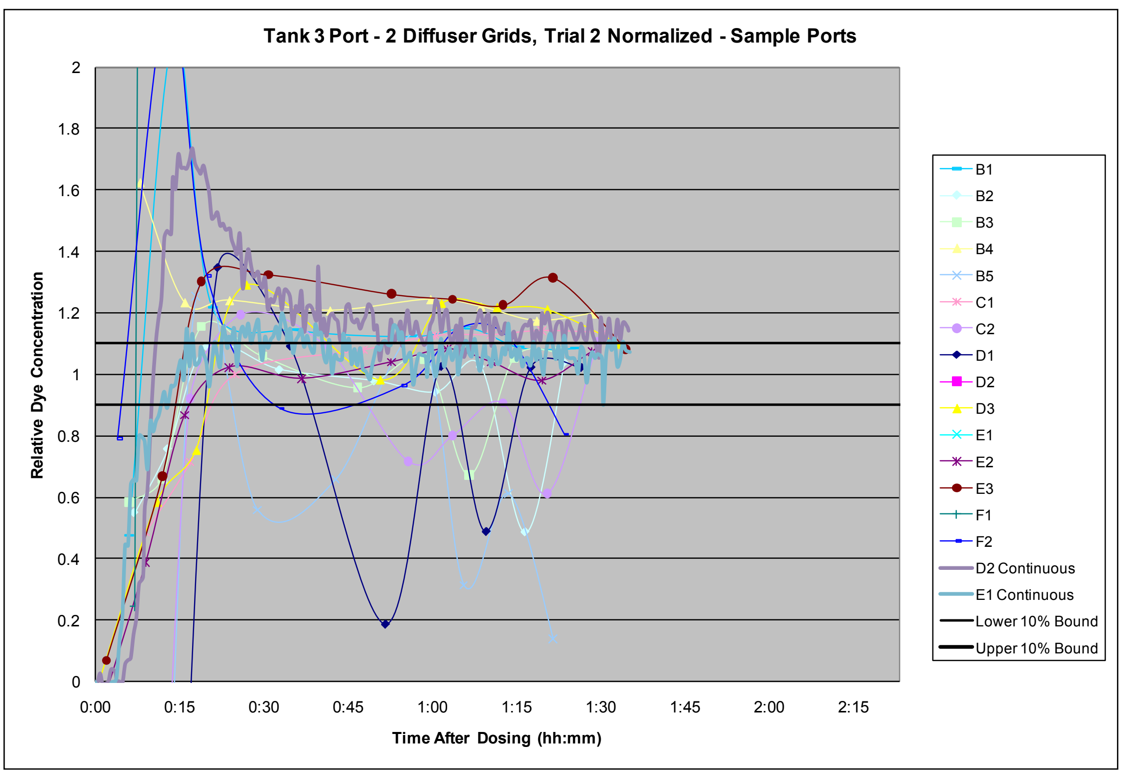

Figure 31 Time Series Plot of Relative Dye Concentration during Mixing Trial

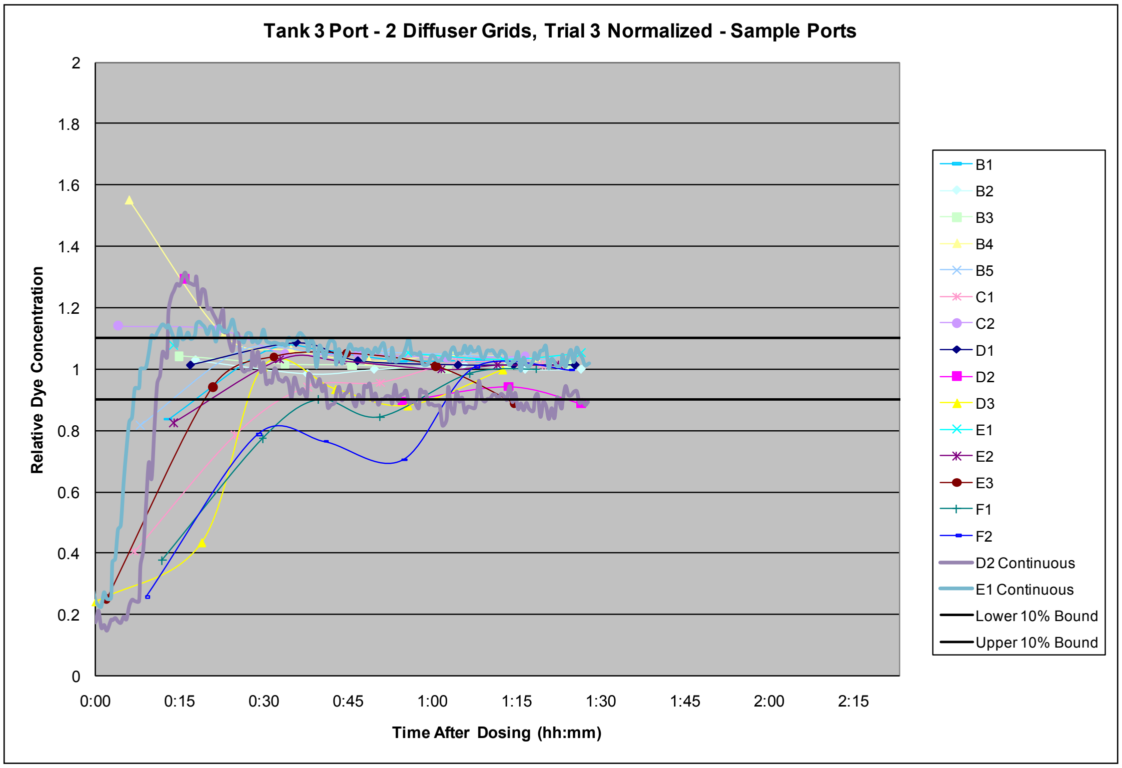

Figure 32 Time Series Plot of Relative Dye Concentration during Mixing Trial

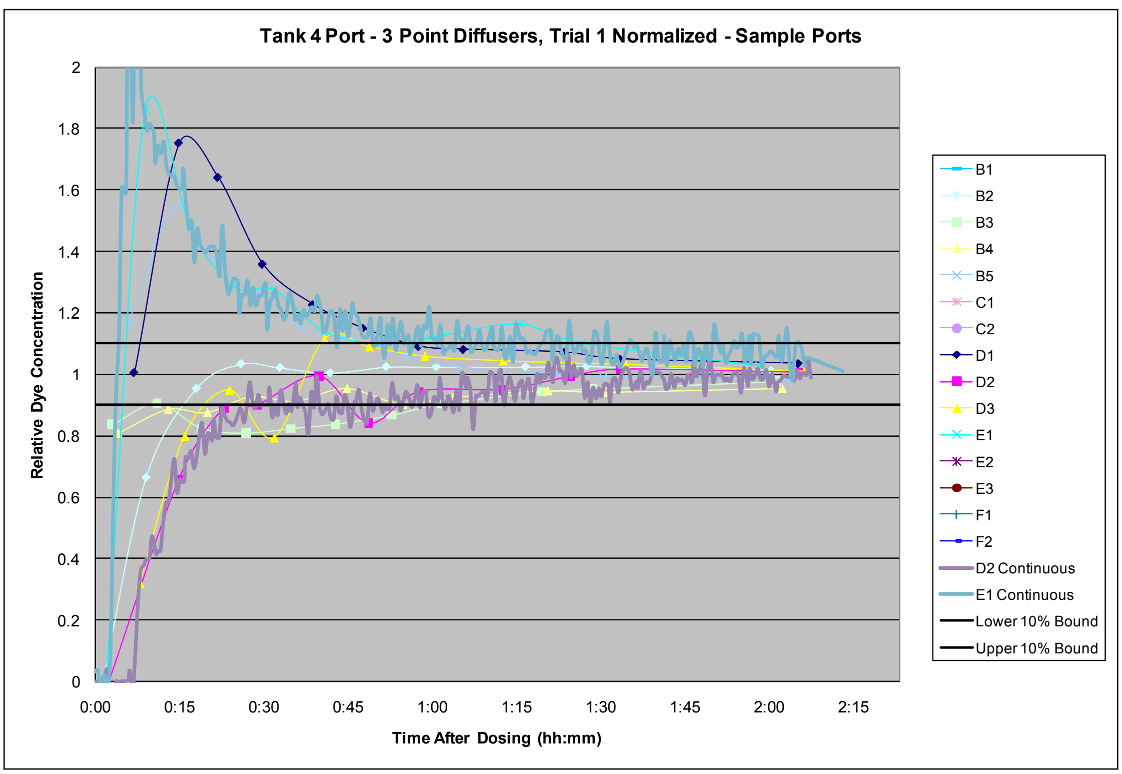

Figure 33 Time Series Plot of Relative Dye Concentration during Mixing Trial

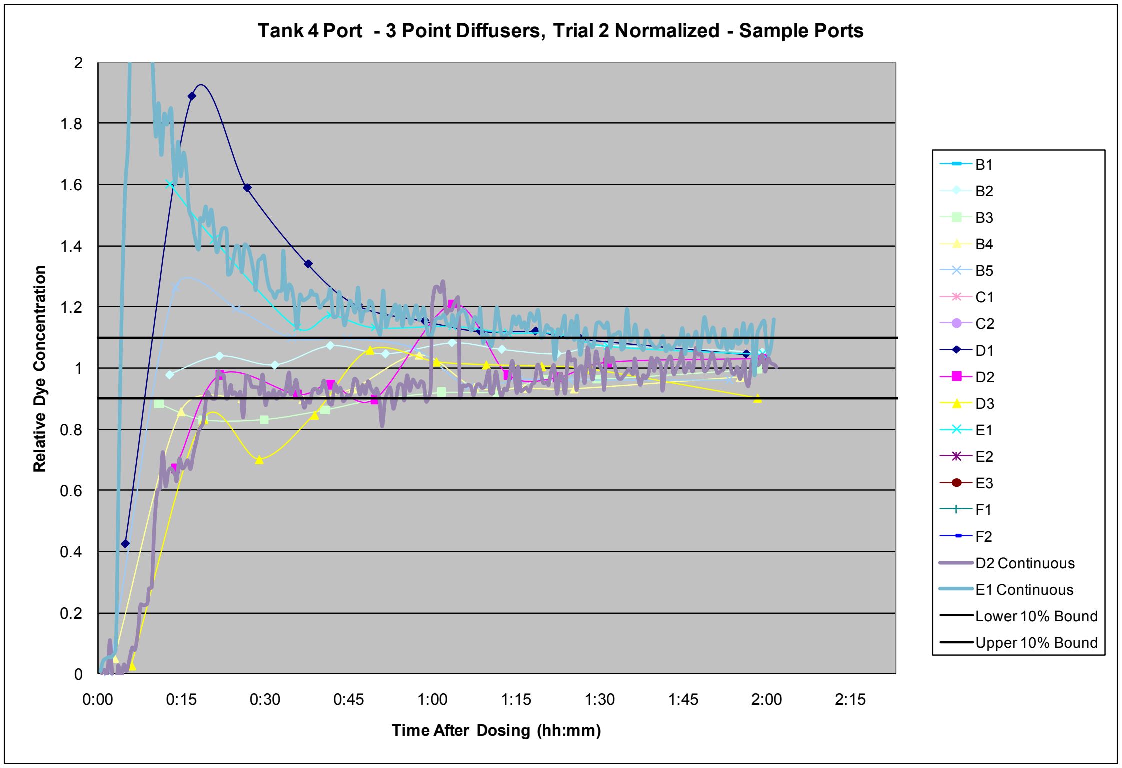

Figure 34 Time Series Plot of Relative Dye Concentration during Mixing Trial

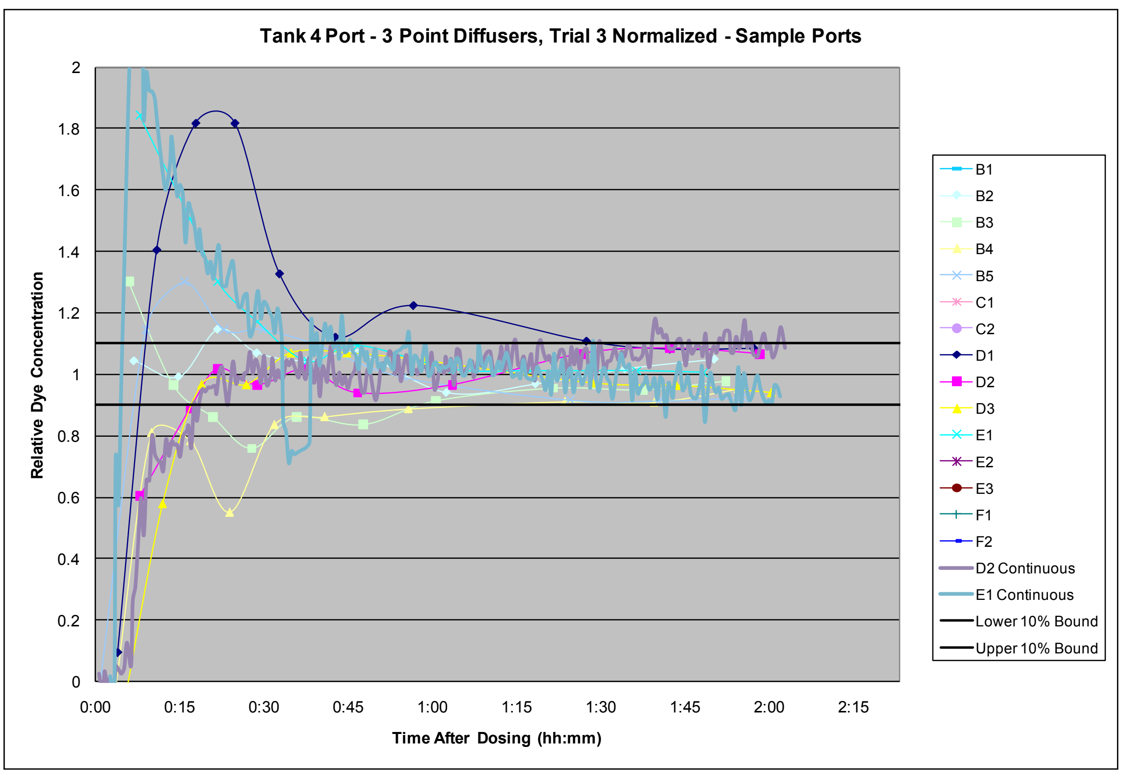

Figure 35 Time Series Plot of Relative Dye Concentration during Mixing Trial

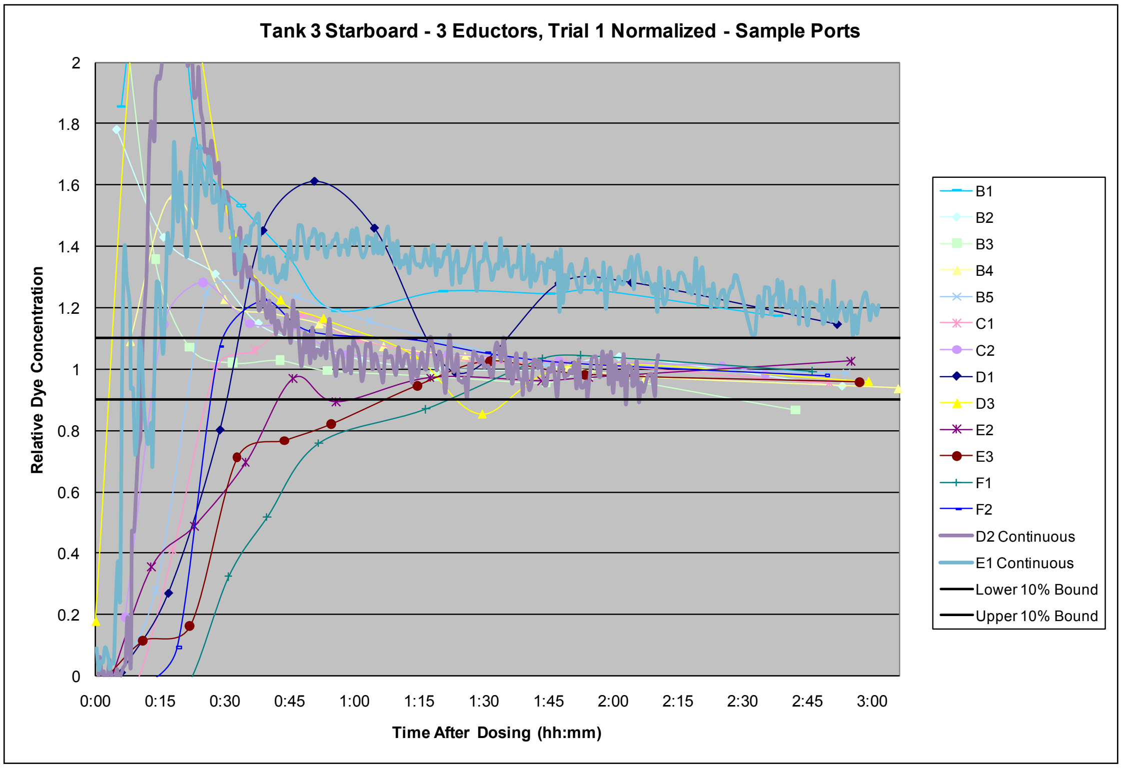

Figure 36 Time Series Plot of Relative Dye Concentration during Mixing Trial

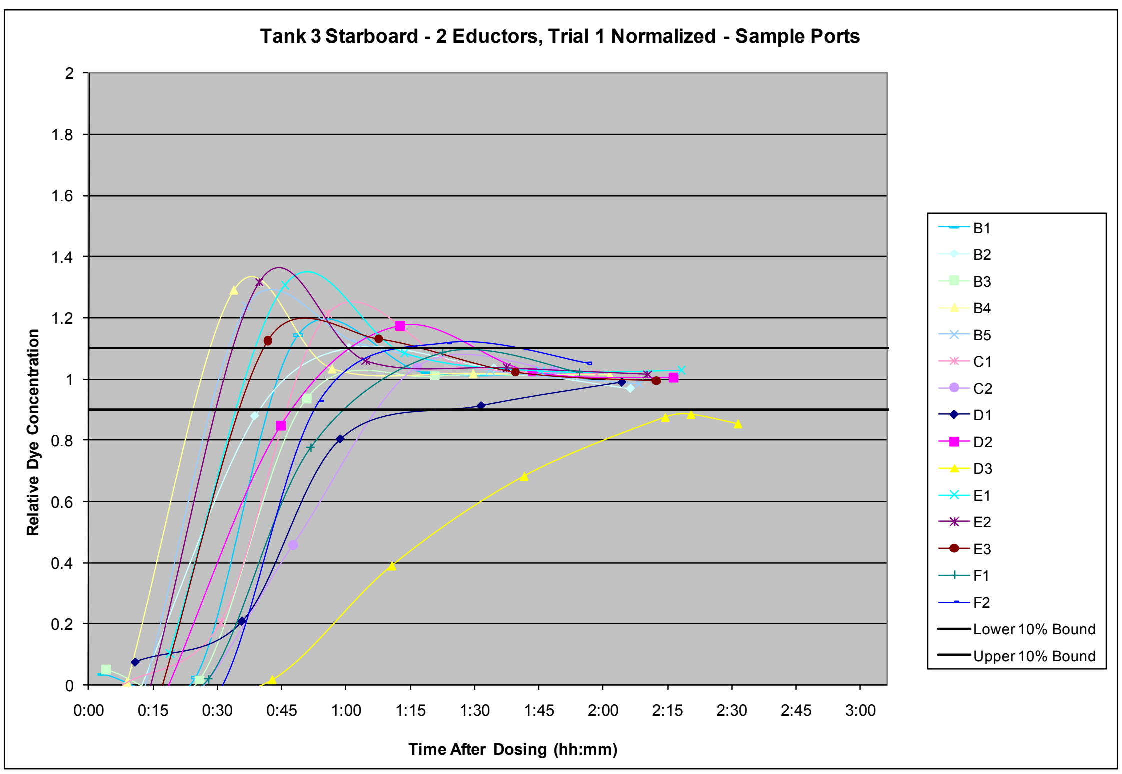

Figure 37 Time Series Plot of Relative Dye Concentration during Mixing Trial

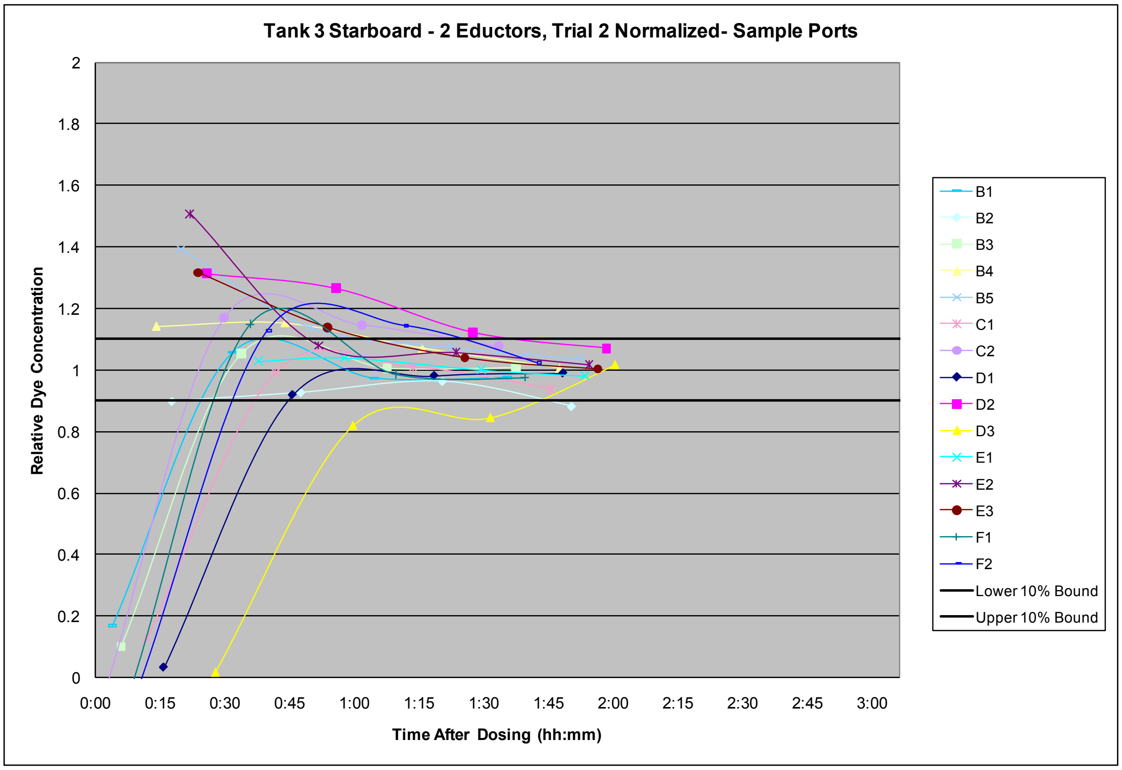

Figure 38 Time Series Plot of Relative Dye Concentration during Mixing Trial

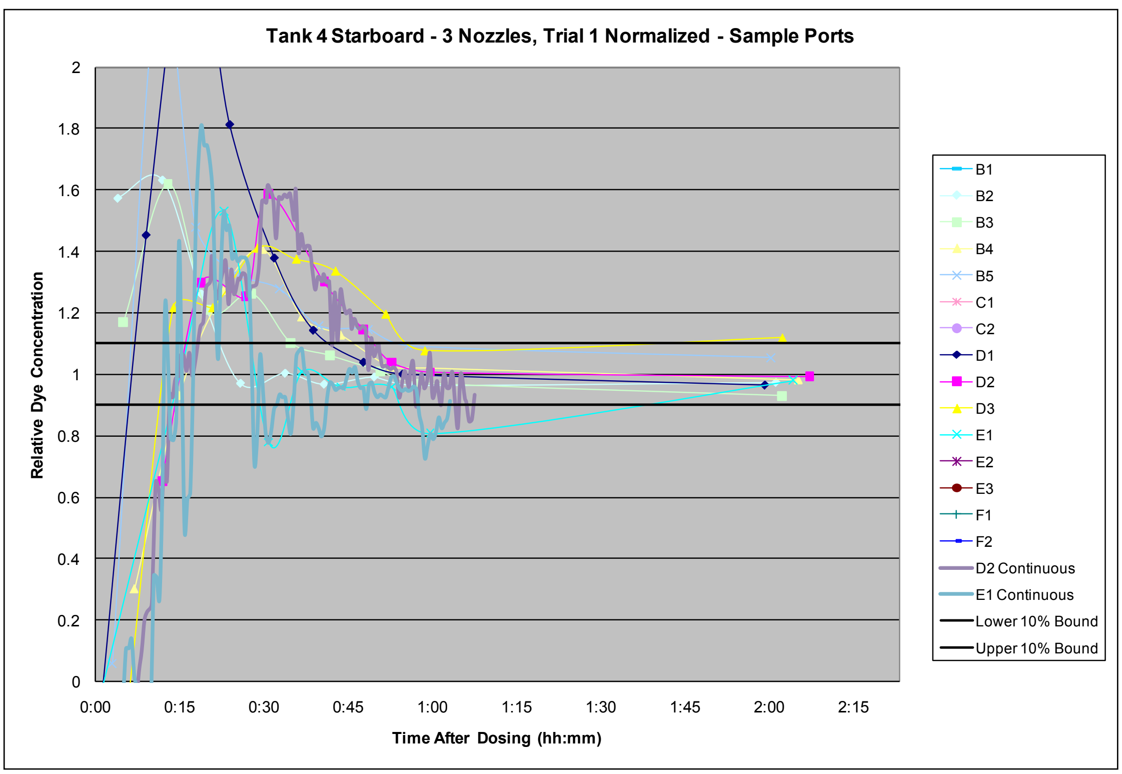

Figure 39 Time Series Plot of Relative Dye Concentration during Mixing Trial

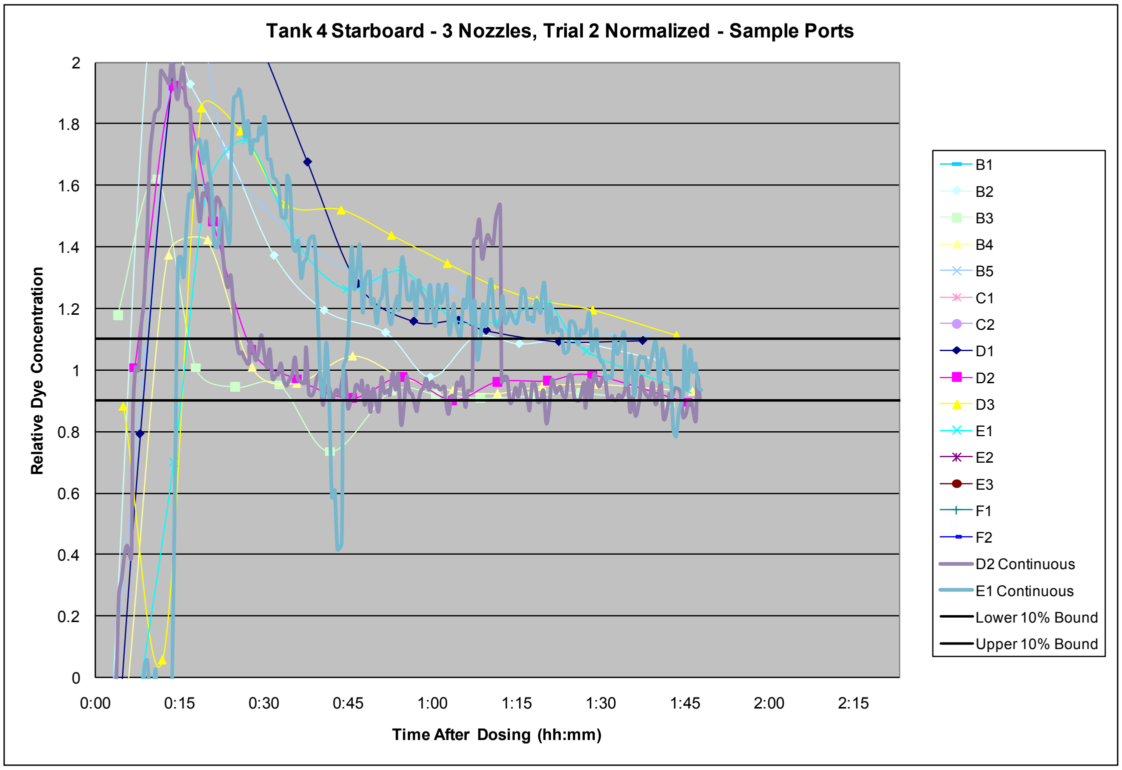

Figure 40 Time Series Plot of Relative Dye Concentration during Mixing Trial

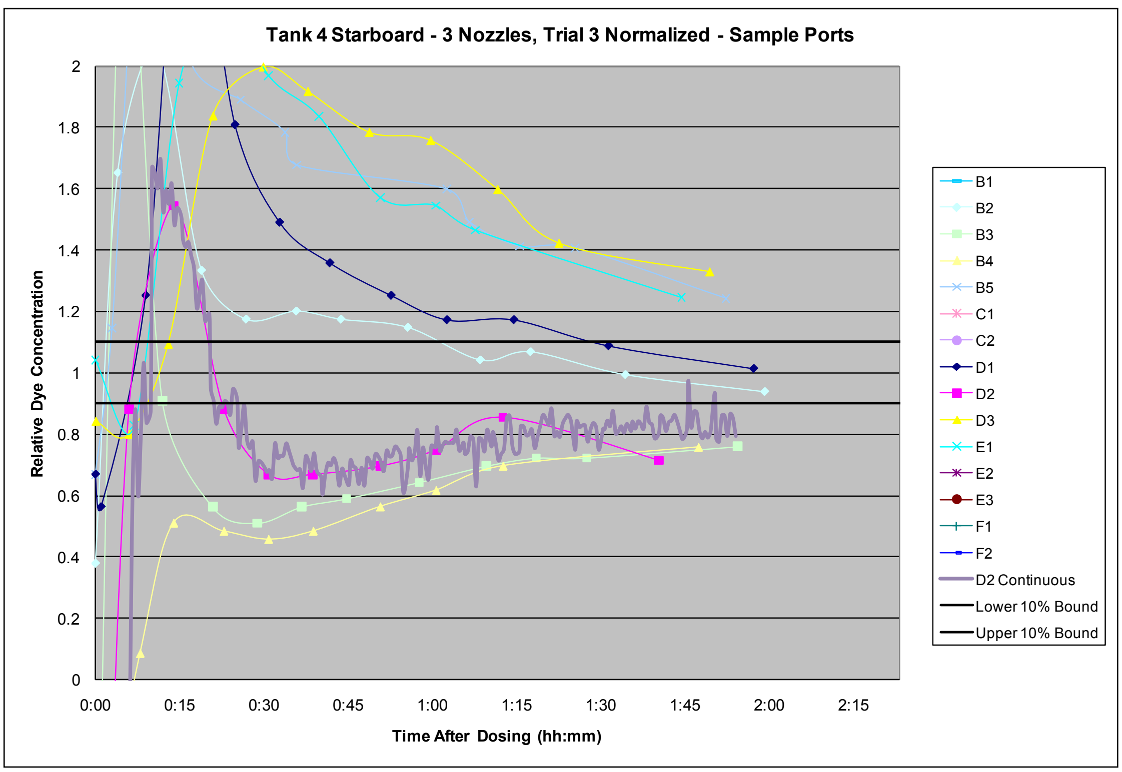

Figure 41 Time Series Plot of Relative Dye Concentration during Mixing Trial

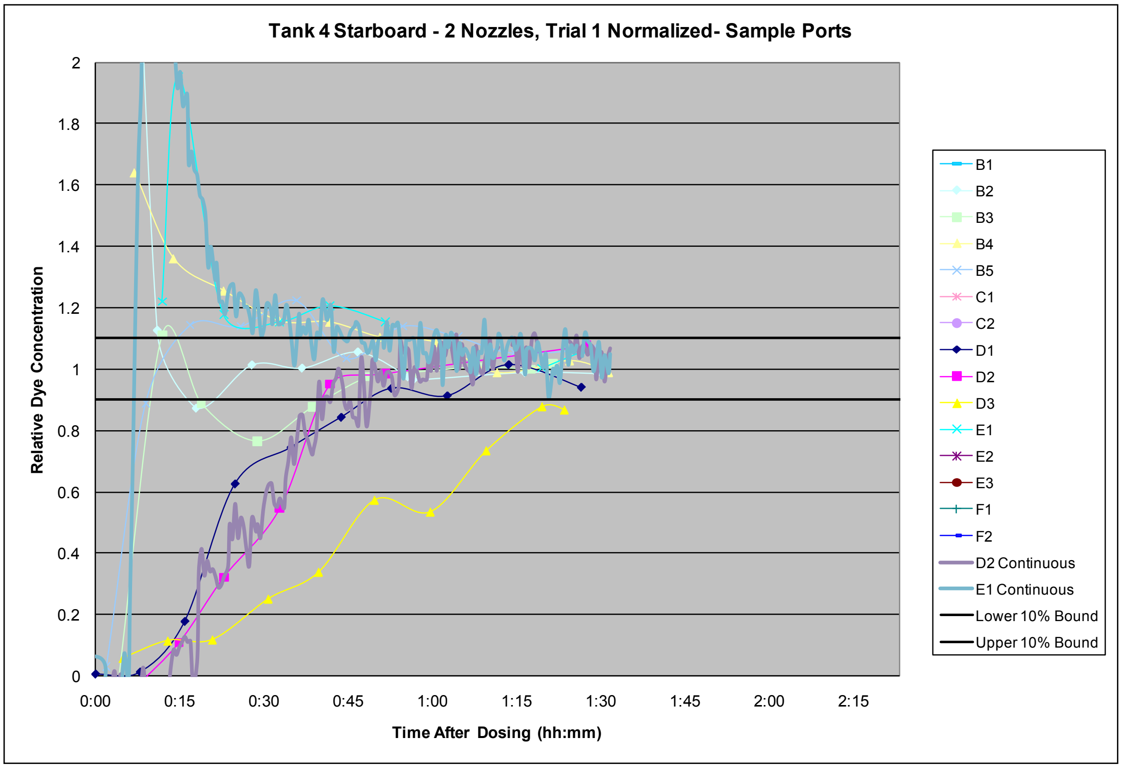

Figure 42 Normalized Plot of Dye Mixing Progress during Trials

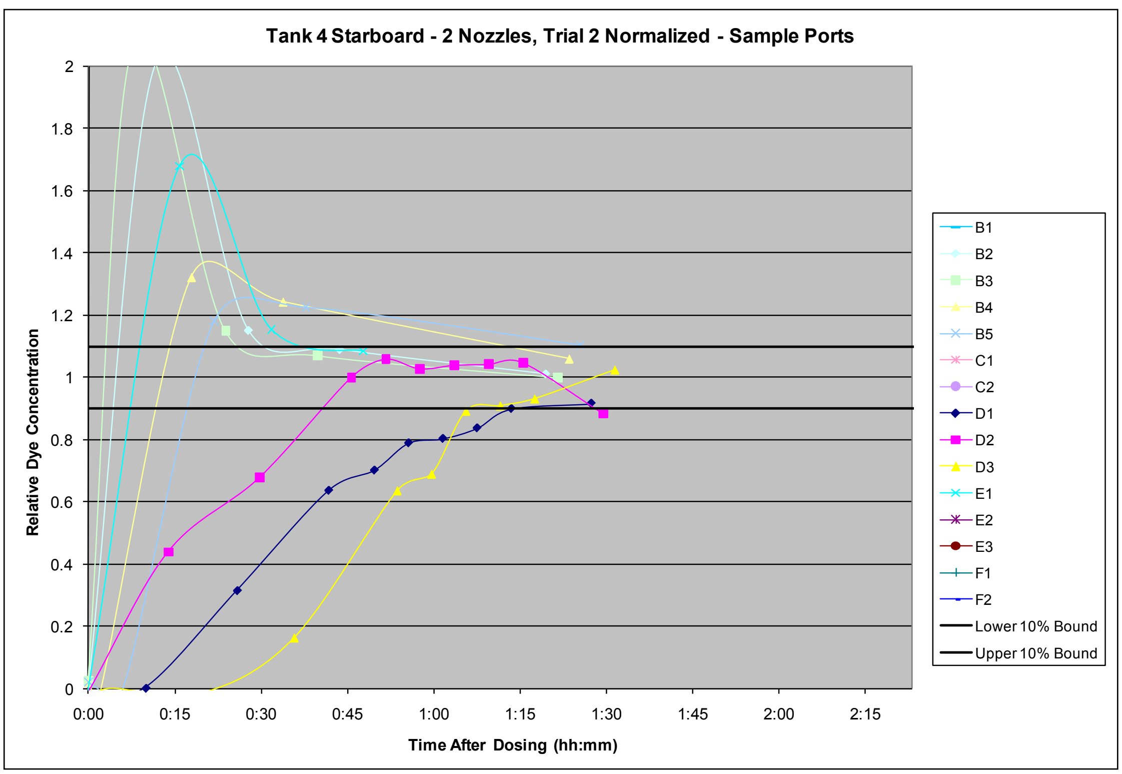

Figure 43 Normalized Plot of Dye Mixing Progress during Trials

Section 7 Conclusions

7.1 Support of Emergency Response Guide

In addition to determining the effectiveness of novel mixing methods for dosing and mixing a biocide into ballast water tanks, these trials were conducted to support the development of an emergency response guide. The guide will provide instructions to first responders on how to implement the mixing methods trialed here. Additionally, this guide provides a recommendation on the relative efficiency of each method. In this way, the first responder will work to target the most effective method first and, should conditions make application of the first choice too challenging, then move on to the next method.

7.2 Environmental Effects

7.2.1 Phase II - Passive Mixing Methods

Moderate vessel motions appear to be effective at mixing chemicals into ballast tanks given adequate time. This is evidenced in the plots of dye concentration versus time. After the 33 hour mark, when the vessel entered the moderate seas of Lake Superior, the dye concentration values converged quickly. The accelerated mixing was attributable to the increase in vessel motion induced mixing.

The increased surface re-aeration kLa values during this period of moderate seas support this conclusion.

7.2.2 Phase III - Active Mixing Methods

Light vessels motions do not appear to be effective at mixing chemicals into ballast tanks. Again, data were not analyzed in detail for the Phase III trials. Weather was calm and the in tank pressure fluctuations were minimal. The control tank mixing plots show even mixing rates throughout the trip. It can be concluded that the reduced final mixing in the control tanks, compared to the Phase II trials, can be attributed to the reduced vessel motions.

Due to the short duration of the active mixing methods trials and the mild weather conditions, it can be concluded that weather did not have an effect on the advanced mixing trials.

7.3 Relative Efficiency Calculation

The relative efficiency of each method was calculated by comparing the average absolute deviation of each trialed method, and then weighting it for known field factors that may have had significant impact on the results.

7.3.1 Average Absolute Deviation

The average absolute deviation or, simply, average deviation of a data set, is the average of the absolute deviations of data points from their mean.

The focus of biocide application is to ensure adequate contact or "soak" time of organisms at a certain concentration. This soak time cannot start until there is some confidence that the required concentration is evenly distributed throughout the ballast tank. If one corner of the ballast tank remains un-exposed to the biocide (offer referred to as being "cold") at less than toxic concentrations for targeted organisms, viable high-risk organisms may be discharged even after treatment. The sampling tubing installed in the tanks was arranged to measure these far corners, and to look for deviations in the mixing pattern.

7.3.1.1 Phase II—Passive Mixing Methods

For the passive mixing trials, deviation from the target concentration of 120 ug/L was used as the metric for successful mixing. For example, a deviation of 25ug/L for the perforated hose method at 12 hours can be translated to 79% mixed (25/120= 79%). We could then expect tank doses to range between 145 ug/L and 94.8 ug/L, when targeting 120 ug/L.

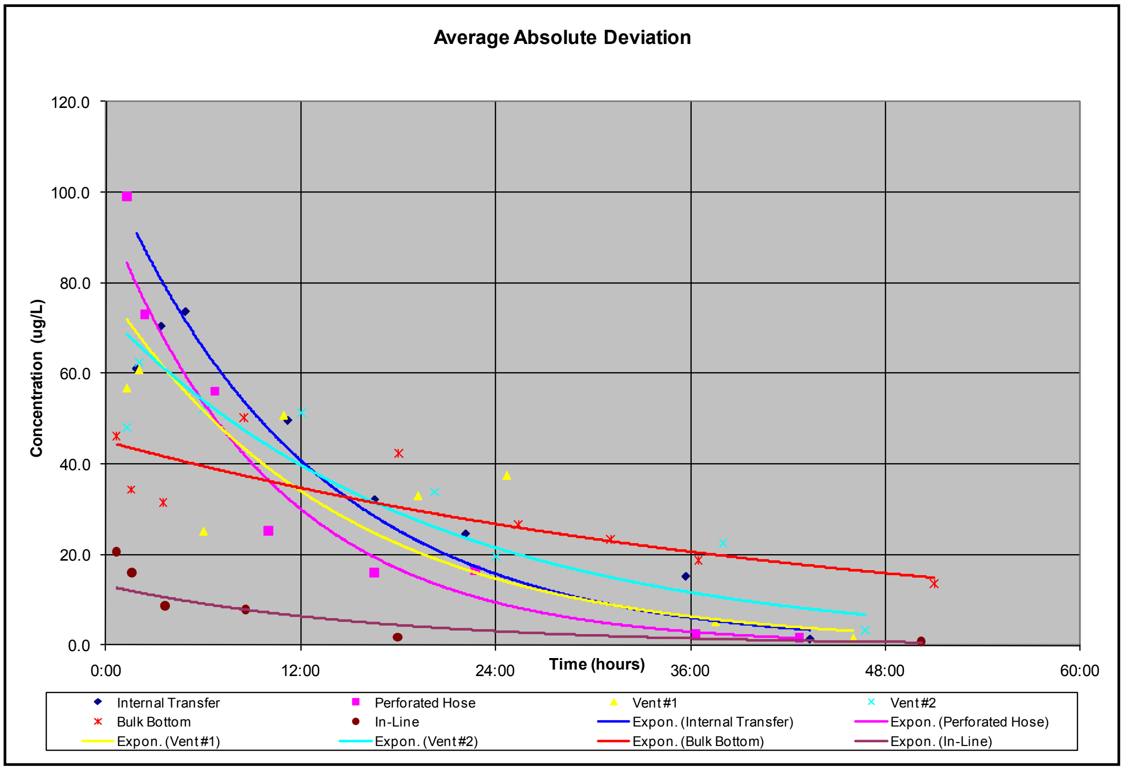

Figure 44 Phase II trials - Deviation measurements of dye concentrations

The above figure was developed as:

- Recorded concentration vs. time since application data on dye concentrations for each tank/mixing method.
- Calculated average absolute deviation for each dataset was based on adjusted data.
- Exponential trend lines were provided for each data series.

Phase III—Active Mixing Methods

The average absolute deviation for each of the active mixing trials was calculated, and is shown in the figure below. For the active mixing trials, a target concentration of 30ug/L was used as a metric for successful mixing. A deviation of 3ug/L represented a 10% deviation, or a tank that is 90% mixed.

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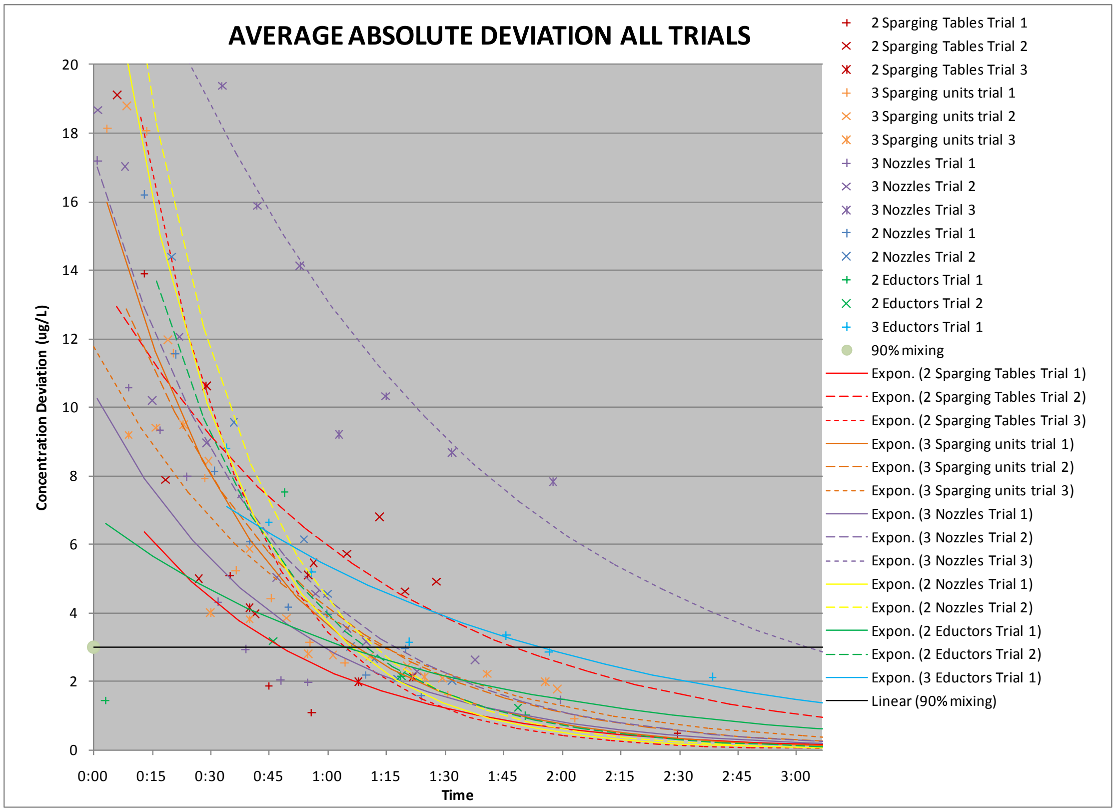

Figure 45 Phase III trials-deviation measurements of dye concentrations

The above figure was developed as follows:

- Recorded dye concentration vs. time since application of dye for each tank/mixing method/trial.
- Calculated average absolute deviation for each timeframe dataset and plot vs. the average time the dataset was taken.
- Exponential trend lines were provided for each data series.
- To determine when a method reached 90% mixing, a line was placed at 10% of the target concentration, or 3 ug/L.

A trial that takes less time to converge on a 90% mixing line was assumed to be a faster mixing method.

7.4 Relative Rankings and Discussion

Relative rankings of the various mixing methods are shown in Table 7. These rankings are used as a basis for the emergency response guide. Furthermore the time data provides rough guidance regarding the time required for the chemical dosing concentration average deviation to be less than 10% and less than 25%. This would mean that a tank requiring 10 parts per million of a chemical would need to be treated to 11 ppm and 12.5 ppm, respectively, to compensate for mixing efficiency.

Methods are relatively ranked best to worst as they performed during the various trials. It is reasonable to assume that additional trials and improvements of techniques might change these results. "Vessel in Place" assumes a grounded or stationary vessel. "Vessel in Motion" assumes typical vessel motions in a seaway, which over time acts as an effective means of mixing chemical within a tank regardless of the chemical application method. These rankings consider the data that resulted from the deviation calculations, as well as lessons learned during the trials.

Passive and active mixing methods are considered in the same table. Active methods are much faster than the passive methods but require equipment and more advanced installation and operation procedures. The decision to use active methods must be based on the equipment readily available, the required timeframe for treatment, and the skill of the technicians that will install and operate the equipment.

Table 7 Mixing Method Relative Rankings

Mixing Method	Time to Reach 90% Mixing (hrs)	Setup Difficulty	Relative Ranking	Reasoning
Nozzle Active Mixing	1.5	Moderate	1	Rapid mixing and moderate installation/operation effort.
Air Lift Point Diffuser Mixing	1.25	Moderate	2	Rapid mixing only using air. Installation more challenging than nozzle.
In Line Dosing	4	Moderate	3	Rapid mixing. Requires transfer of all ballast water, so not always practical for emergency use
Air Lift Grid Diffuser Mixing	1.25	Hard	4	Rapid mixing. Not practical to install in full ballast tank, so not always practical for emergency use
Bulk-on-Bottom Dosing		Easy	5	Easy application, mixing times could be improved by applying chemical close to ballast intake
Moderate Seas	24			
Mild Seas	48			
Perforated Hose Dosing	16	Easy	6	Moderate mixing rate. Simple application. Could be improved by introducing chemical in multiple locations
Vent Dosing		Easy	7	Slow mixing relying on ships motions for majority of mixing. Mixing would be very slow for stationary ship
Moderate Seas	24			
Mild Seas	36			
Internal Transfer Dosing	36	Moderate	8	Slow mixing for effort required. Increase transfer rate to reduce mixing time, or add nozzle for rapid mixing.

7.4.1 Nozzle Active Mixing

7.4.1.1 Two Nozzle Mixing (Figure 42 and Figure 43)

The two nozzle mixing setup requires access to only one location with clear access from the deck to the bottom of the tank. The nozzles in the trials were installed in an empty tank and clamped onto the vessels structural framing in a V-pattern, pointing roughly 45 degrees forward and aft of athwart vessel. The installation method could be modified by attaching the nozzles onto a riser pipe, allowing them to be lowered from the deck with water hose attached. The chemical could be introduced into the water stream on deck, and diluted in route to the nozzle. The relatively large volume of water required to power each nozzle, ~150gpm each, may prove to be a challenge. For the trials, water was provided by the firemain and added to the tank, increasing the ballast load. In many circumstances, this would not be acceptable. In order to avoid adding water, a submersible pump could be lowered into one of the deck openings to provide the water flow and pressure required to operate the system.

The two trials of this system both showed rapid mixing of the ballast tanks as summarized in Figure 45. Each of the trials resulted in the tank reaching <25% deviation within 35 minutes in the middle of the tank, with only the double bottom area taking 1 hour. The tank reached <10% deviation within 1-1/2 hours. The double bottom portion of the tank was the slowest to mix. The energy imparted to the water in the middle of the tank by the nozzles had a hard time inducing flow into the double bottom area.

Nozzle mixing using 2 nozzles for the example tank configuration resulted in:

- Average Deviation <25% within 1 hour
- Average Deviation <10% within 1-1/2 hours

This method could be easy to set up if there was a way to install the submersible pump to recirculate the water.

7.4.1.2 Three Nozzle Mixing (Figure 39, Figure 40, and Figure 41)

The three nozzle mixing setup requires access to three locations along the longest bulkhead in the tank, with clear access from the deck to the bottom of the tank. The nozzles in the trials were installed in an empty tank and clamped onto the vessels structural framing with each nozzle pointing athwart vessel. The installation method could be modified by attaching the nozzles onto riser pipes, allowing them to be lowered from the deck with water hose attached. The chemical could be introduced into the water stream on deck, and diluted in route to the nozzles. The relatively large volume of water required to power each nozzle, ~100gpm each, may prove to be a challenge. For the trials, water was provided by the firemain and added to the tank, increasing the ballast load. In many circumstances, this would not be acceptable. In order to avoid adding water, a submersible pump could be lowered into one of the deck opening to provide the water flow and pressure required to operate the system.

The first trial of this arrangement worked quite well, with the tank reaching <25% deviation within 50 minutes, and <10% deviation within 1-1/2 hours. The second and third trials had complications during the trials. The second trial had problems maintaining the proper water flow, and the dye injection pump failed and required assistance before all the dye was introduced. The time to < 25% deviation was 1-1/4 hours, and <10% deviation was seen at 1-3/4 hours. The third trial started out in a non-homogonous state, as the concentration of dye in the tank had to be reduced before the trial began. Water was pumped out of the tank, and back in again, to dilute the existing dye. The fresh water that was introduced did not mix well before the trial began. As a result, the concentration plot looks nothing like the others and, after 2 hours of mixing, the tank was just getting to <25% deviation. From these trials, it is hard to say how long mixing would take on a consistent basis, but with proper setup and well functioning equipment, mixing could be rapid.

Nozzle mixing using three nozzles for the example tank configuration resulted in:

- Average Deviation <25% within 1-1/4 hours
- Average Deviation <10% within 1-1/2 hours

This method could be relatively easily set up if there were a way to install the submersible pump to recirculate the water, but the requirement of three locations could be problematic.

7.4.2 Air Lift Point Diffuser Mixing (Figure 33, Figure 34, and Figure 35)

The three point diffusers used in the trial were installed in the tank before filling with water. The method of installation could easily be modified to allow installation on any vessel that has ~12" diameter direct vertical access to the bottom of the tank roughly every 50 feet. The sparging heads could be weighed sufficiently to ensure they stayed at the proper depth, and then were lowered through the deck with the air and chemical supply hoses attached.

The three trials showed quite consistent results, with most portions of the tank evenly converging in an asymptotic manor. The double bottom portions of the tank showed slightly more concentration volatility, as the water movement was greatly restricted by structure.

Air lift mixing using three point diffusers for the example tank configuration resulted in:

- Average Deviation <25% within 45 minutes
- Average Deviation <10% within 1-1/4 hours

This method would be relatively easy to install, and operated provided that enough air volume could be provided, but the requirement of three locations could be problematic.

7.4.3 In-Line Dosing (Figure 27)

In-line dosing meters the chemical into the ballast main while the tank is being filled. Mixing takes place in the pipe, through the pump, and as the ballast enters the tank. This method can be as efficient as the metering method employed. In the case of these trials, rudimentary methods were employed to simulate rough field conditions with less than perfect equipment. Rather than carefully metering in the chemical with a special pump, the dye was pumped into the main in four “shots” at the beginning, two in the middle, and one at the end of the one hour ballasting operation. While not *worst case*, typical response personnel should be able to meet this level of efficiency.

The raw data initially showed concentrations as low as 57 ug/L in the far reaches of the double bottom area, which was significantly below the targeted 120 ug/L. However, within four hours, these areas had reached at least 95 ug/L; this at a time when the vessel was still at the dock (no vessel motions). By 12 hours, the deviation was less than 10%.

In-line dosing for the example tank configuration resulted in:

- Average Deviation <25% immediately
- Average Deviation <10% within four hours

Carefully metering in the treatment chemical will improve efficiency.

7.4.4 Air Lift Grid Diffuser Mixing (Figure 30, Figure 31, and Figure 32)

The two air diffuser table mixing setup requires equipment to be mounted inside the tank. The arrangement and size of the equipment would preclude it from being lowered into place from a deck opening. Due to this requirement, it is not a preferred method in an emergency response, or for installation by personnel on an unknown vessel. However, this system would be a fairly robust system if installed in a ballast water treatment barge where treating in tank, rather than on uptake and discharge, could be preferred to ensure neutralization of all NIS before discharge.

The three trials show varying results. The first and third trials both converged to less than 10% deviation within 1 hour 15 minutes. The second trial had complications with the dye injection system and, therefore, took longer to mix.

Air lift mixing using two air diffuser grids for the example tank configuration resulted in:

- Average Deviation <25% within 45 minutes
- Average Deviation <10% within 1-1/4 hours

7.4.5 Bulk-on-Bottom Dosing (Figure 26)

Bulk-on-bottom dosing applies a bulk amount of treatment chemical in the bottom of an empty tank. The tank is then ballasted, with the filling ballast water providing the mixing energy. In the case of this trial, the bulk chemical was added about 75 feet away, with significant structural isolation from where the ballast water would enter the tank. This significantly impeded the mixing of the ballast water initially. Furthermore, the chemical did not mix as well as other methods once the vessel was underway. This may be as the chemical was mostly in the bottom of the tank, while sloshing energy in the tank is up near the tank surface.

The raw data initially showed concentrations as low as 2 ug/L in the far reaches of the double bottom area, which was significantly below the targeted 120 ug/L. Even the open portions of the tank had concentrations as low as 11 ug/L, especially in areas distant from the chemical application point. It was not until 24 hours after application, including the 12 hours underway, that dye concentrations began to balance with these areas to reach at least 61 ug/L.

Bulk-on-bottom dosing for the example tank configuration resulted in:

- Average Deviation <25% within twenty-four hours
- Average Deviation <10% depending on vessels motions

It is noteworthy that initial dye concentrations where the chemical was added were moderately mixed. For example, the aft vertical profile (through the same vent where chemical was added prior to filling), after eight hours and no vessel's motions, had concentrations at a minimum of 110 ug/L. Additionally, the middle and aft portions of the open portion of the tank were a minimum of 103 ug/L. This indicates that, had the chemical been applied near to the ballast intake location, efficient mixing of most of the tank may have been achieved.

7.4.6 Perforated Hose Dosing (Figure 23)

Perforated hose dosing applies a bulk amount of chemical through the vertical water column of a full tank. The chemical is "blasted" out of little holes in a hose that extends to the bottom of the tank. In these trials, the chemical was "chased" with water, but compressed air might be even more effective. It is worth note that this method could have been applied in three separate vertical locations in the tank, but was only applied to a single location.

The results of this method were promising. Within seven hours of application, all locations in the middle and forward portions of the tank (even those 75 feet away) had a concentration of at least 42 ug/L, with all but two greater than 90 ug/L. Within 16 hours, the tank was generally well mixed, with all but two of the aft readings over 94 ug/L.

Perforate hose dosing for the example tank configuration resulted in:

- Average Deviation <25% within fourteen hours
- Average Deviation <10% within sixteen hours

It is apparent that the method immediately distributed the chemical evenly in the vertical column. This allowed it to be rapidly dispersed by vessels motion, even in the relative light seas of Lake Michigan. It could be assumed that, had the method been applied not in just one vent, but rather all three, mixing would have been more rapid. Additional "chasing" of the chemical, perhaps with compressed air, would also be expected to increase mixing efficiency.

7.4.7 Vent Dosing (Phase II Trials – Figure 24 and Figure 25) (Phase III Trials – Figure 28 and Figure 29)

Vent dosing simply adds the chemical to the top of a full or partially full ballast tank through the vent. In the case of the trials, the tanks were only partially full. The mixing is then a result of any momentum from the action of adding the chemical, any energy impacted from vessel motions, and any molecular diffusion.

As this is the method used on the *Igloo Moon* high risk ballast water response, and by *Argentina* when treating vessel's ballast water for pathogens, this method was trialed twice to gain at least one set of replicates.

The results of this method indicated that mixing is dependent on vessel motions, and would not be a preferred method for a vessel at rest. The chemical slowly migrated from the application point and, within two hours, only two of seventeen sample locations gaining a meaningful reading. After eleven hours of vessel motions, chemical readings in the upper portions of the tank were increasing. It was not until after twenty-four hours that the chemical reached the lower and forward portions of the tank, and deviations were less than 25%.

Vent dosing for the example tank configuration resulted in:

- Average Deviation <25% after twenty-four hours
- Average Deviation <10% after thirty-six hours

The replicates of this method showed the same trends, with the chemical migrating more quickly in the upper reaches of the tank, and more slowly to lower portions of the tank. The variability was on the range of ten percent. It would appear that the more locations that one could apply the chemical, the more quickly it might be well mixed.

7.4.8 Internal Transfer (Figure 22)

Internal transfer dosing circulates ballast water from one area in the tank to another. The chemical is metered into this circulation loop. The results from this effort indicated that the circulation loop generally short circuits most of the tank volume, as the water repeatedly takes the path of least resistance.

The relatively low flow rate of this circuit, about 175 gpm in a tank of 180,000 gallons, was likely a factor in this lack of mixing. After one tank volume of mixing (or 18 hours), this method had reached 25% deviation, but still left the aft portion of the tank (double bottom and deep tank reaches) essentially short circuited with four readings below 40 ug/L.

Vent dosing for the example tank configuration resulted in:

- Average Deviation <25% after eighteen hours
- Average Deviation <10% after thirty-six hours

A higher flow rate for the tank size may result in better mixing results. Another improvement approach may be to move the location of the circuit to several locations. However, it appears that this method is a great deal of effort for little gain in mixing efficiency.

Section 8 Acknowledgements

We thank Dr. Barnaby Watten, Noah Adams, Matt Sholtis, Gary Rutz and Travis Tucker of USGS for their identification, engineering, and testing of the active mixing techniques evaluated in Phase III trials, as well as the development and implementation of appropriate methods for characterizing ship dynamics in Phase II and III.

In addition, we thank Scott Smith of the USGS Western Fisheries Research Center for his efforts in partnership development, industry outreach, and consultation of program development.

Development of this report was possible because of broad support from multiple sources.

- **National Park Service**. Phyllis Green of Isle Royale National Park identified the need for the Guide, formed the project team, and provided broad coordination of multiple stakeholders.
- **National Parks of Lake Superior Foundation**. NPLSF provided efficient management of the Phase I and II project grants.
- **U.S. Geological Survey**. USGS is providing efficient management of the Phase III project grant.
- **Legislative-Citizen Commission on Minnesota Resources through the Environment and Natural Resources Trust Fund:** LCCMR provided financial support from the ENRTF for the Phase III grant.
- **Great Lakes Fisheries Trust**. GLFT provided financial support for the Phase II grant.
- **National Oceanic and Atmospheric Administration**. NOAA provided financial support for Phase I grant.
- **American Steamship Company**. Noel Bassett, Pierre Pelletreau, and Kenny Gliwa provided access to the *M/V Indiana Harbor*. Additionally, ASC installed extensive sampling equipment inside the vessel's ballast water tanks.
- ***M/V Indiana Harbor***. Captain Yowell and his crew provided significant support to all phases of our testing efforts. The support of the conveyor men and engineers was critical to project success.
- **Phase II Field Team**. Dr. Barnaby Watten, Noah Adams, and Gary Rutz of the U.S. Geological Survey; and Kevin Reynolds, Jon Markestad and Dan Clopton of The Glosten Associates conducted 8 days and nights of field trials.
- **Phase III Field Team**. Dr. Barnaby Watten, Gary Rutz, Matt Sholtis, and Travis Tucker of the U.S. Geological Survey; and Jon Markestad and Robin Madsen of The Glosten Associates conducted 11 days and nights of field trials.
- **Phase II Discharge Team**. Jay Austin and his team from Minnesota Technical University, Jay Glase of National Park Service, and the NPLSF volunteers Dave Miller and Chris Gale performed discharge sampling from the vessel and two small crafts during the Phase II ballast discharge.

- **Phase II Discharge Team**. Jay Austin and his team from Minnesota Technical University and the NPLSF volunteer Dave Miller performed discharge sampling from the vessel and a small craft during the Phase III ballast discharge.
- **Review and comment on the first draft came from broad sources including**: U.S. EPA – Great Lakes, U.S. EPA – Region 5, U.S. Coast Guard Cleveland, NOAA, American Salvage Association, California State Lands Commission, and University of Wisconsin-Superior.

Section 9 References

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Section 10 Testing Schedule

The following timeline shows the schedule by which the ballast dye study was conducted during the *Phase III - Active Mixing Method* trials. Team members included:

- Barnaby Watten, Principal Investigator—USGS
- Jon Markestad, Project Marine Engineer—Glosten
- Robin Madsen, Project Naval Architect—Glosten
- Travis Tucker, Associate Investigator —USGS
- Gary Rutz, Associate Investigator —USGS
- Matt Shultis, Associate Investigator—USGS

Date	Ship Location	Tasks
Prior to 9 May	Frasier Shipyard	The dye team delivered two compressors, an air hose, and additional gear to the Frasier Shipyard.
9 May	Superior Fuel Dock	While vessel was at the fuel dock, the shipyard transferred equipment and loaded it aboard. Compressors were lashed down on the Main Deck port side between Ballast Tanks 3 and 4. Hose and equipment was stowed and secured on Main Deck.
12 May	Superior Fuel Dock	The dye team arrived in Duluth and checked into the hotel
13 May	Superior Fuel Dock	The dye team met for breakfast to discuss mobilization plans, and then met with Jay Austin regarding the Dilution Study. Additional equipment was procured and picked up in Superior (All)
14 May	Vessel Underway	The vessel prepared for the dye team arrival by adding one extra cot in each owner's stateroom, for total of three bunks per room. The dye team met with Alouez Marine to plan the Two Harbors' equipment transfer to the vessel. Additional Equipment was then procured and picked up in Superior (All).
15 May	Two Harbors	The vessel received additional equipment (est. three pallets) in Two Harbors as delivered by Alouez Marine. Six dye study team members boarded the vessel. The dye team remained available to discuss plans with the Captain as needed, moved personal equipment to staterooms, and met for a safety and orientation meeting. The team then confirmed that the shipped gear was onboard the ship, and moved it into the conveyor tunnel. The sampling team then began setting up sampling manifolds in the conveyor tunnel.
16 May	Two Harbors (departed)	Ship crew and dye team met for a safety and logistics review. Ship crew then provided an electric impact wrench for the dye team to remove bolted access, one pair of ballast tanks at a time. Ship crew certified 3P and 3S safe for entry, assisted with washdown hose connections on deck and in tunnel, and assisted with fueling the air compressors on the Main Deck.

Date	Ship Location	Tasks
16 May (continued)		The Air Lift Mixing Team • Set up deck mixing equipment • Set up 3P in-tank dosing equipment and test The Eductor Team • Set up deck mixing equipment • Set up 3S in-tank mixing equipment and test The Sample Team • Set up deck dosing equipment • Set up tank sample equipment • Inspected sample tube installations 3P, 3S • Made rhodamine standards The dye team then calibrated instruments and set up the environmental measurement equipment.
17 May	Underway	Ship's crew certified 4P, 4S, 5P, 5S as safe for entry (one pair at a time) and assisted with washdown hose connections (as needed). The dye team continued setting up project The Air Lift Mixing Team • Set up 4P in-tank mixing equipment and test The Eductor Mixing Team • Set up 4S in tank mixing equipment and test The Sample Team • Completed set-up tank sample equipment • Inspected sample tube installations 4P, 4S 5P, 5S • Installed pressure transducers in 5P Completed all calibration of instruments Complete set-up environmental measurement equipment
18 May	Gary, Indiana (arrived)	Ship crew communicated ballast activities with test team After ballasting complete for 5P and 5S, the dye team dosed from top with full dye quantity. They then performed sampling measurements on Ballast Tanks 5P and 5S from the Tunnel and Main Deck. Environment measurements were begun.
	Gary, Indiana (departed)	Ship crew communicated ballast activities with test team The test team dosed and sampled 3P, 3S, 4P, 4S, one tank at a time, with either an air lift trial or eductor trial (estimated 2-3 hours per tank)
19 May	Underway	Ship crew communicated ballast activities with test team The test team discharged partial ballast as needed from 3S and 4S (estimated at 20,000 gal per tank per hour of eductor mixing and communicated ballast amount to crew).

Date	Ship Location	Tasks
		The team performed sampling measurements from the Tunnel and Main Deck and took environmental measurements. The test team dosed and sampled one tank at a time (estimated 2-3 hours per tank). Dosing/sampling trials with modifications were repeated as necessary.
20 May	Underway	Ship crew communicated ballast activities with test team The team discharged partial ballast as needed from 3S and 4S (estimated at 20,000 gal per tank per hour of eductor mixing, and communicated ballast amount to crew. The team performed sampling measurements from the Tunnel and Main Deck and took environmental measurements. The test team dosed and sampled one tank at a time (estimated 2-3 hours per tank). Dosing/sampling trials with modifications were repeated as necessary. Upon completion of testing, the test team demobilized all sampling and mixing equipment in tunnel and on deck.
21 May	Superior Fuel Dock (arrived)	Ship crew communicated ballast activities with test team The team performed final sampling measurements from the Tunnel and Main Deck and took final environmental measurements. They then set up the pump discharge sampling arrangement and coordinated off-vessel sampling during discharge.
	Superior Cargo Dock	The test team conducted sampling during ballast discharge. The dispersion study was conducted while discharging from dyed ballast tanks.
22 May	Underway	Ship's crew provided assistance with stowage of sampling equipment. The testing team: • Demobilized all mixing equipment in 3P, 3S, 4P, 4S (one pair at a time). • Retrieved pressure transducers from 5P. • Demobilized all sampling equipment in tunnel and on deck. • Stored sampling equipment. • Palletized all equipment for removal by crew at next Superior port call.
23 May	Soo Locks (arrived)	The ship's crew provided assistance with team disembarkation. The test team secured all equipment on board, sign-off vessel and departed.

2009 Project Abstract

For the period ending June 30, 2012

PROJECT TITLE: Improving Emerging Fish Disease Surveillance in Minnesota
PROJECT MANAGER: Katharine Pelican, DVM, PhD
AFFILIATION: College of Veterinary Medicine, University of Minnesota
MAILING ADDRESS: 136B Andrew Boss Laboratory, 1354 Eckles Ave
CITY/STATE/ZIP: St. Paul, MN 55108
PHONE: 612-625-8561
E-MAIL: pelicank@umn.edu
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp.143, Sec.2, Subd. 6c. ML 2011, 1st Special Session, Chap. 2, Article 3, Sec. 2, Subd. 18.

APPROPRIATION AMOUNT: $80,000

Overall Project Outcome and Results

Heterosporosis is an emerging disease of importance to Minnesota fish populations. The disease is caused by the previously undescribed microsporidian parasite, *Heterosporis* sp., which effectively destroys the skeletal muscle of susceptible fish hosts. The resulting damage from advanced infection renders the fillet unfit for human consumption and likely results in indirect mortality due to increased predation and reduced fitness. With no treatment of the disease in wild fish populations, management is limited to preventing the spread to naïve fish populations. The goal of this study was to improve diagnostic testing capabilities and perform a survey to prevent the further spread of this important fish disease. To that end, a highly sensitive and specific quantitative PCR (qPCR) assay was developed to detect sub-clinical Heterosporosis disease in fish. This assay vastly improved our capacity to detect the pathogen and was used to survey 50 waterbodies in Minnesota. From this survey and three additional MDNR submitted samples, six new waterbodies were identified as Heterosporis-positive, including: North Long Lake, (Crow Wing County), Mary Lake (Douglas County), a private pond in both Douglas and Pope Counties, Wabana Lake (Itasca County), and Black Hoof Lake (Crow Wing County). Positive fish species from this study included: walleye, yellow perch, cisco, northern pike, and for the first time spottail shiners. Further evaluation to characterize the parasite identified very low genetic variability in the species *H. sutherlandae*, collected from inland waters of Minnesota. However, there was a unique Heterosporis species (*H. superiorae*) in Lake Superior. This suggests a distant evolutionary divergence between the parasite species, but a rapid distribution once introduced into inland waters. These findings highlight the importance of continued surveillance and research to improve our understanding and control this important pathogen in Minnesota.

Project Results Use and Dissemination

The results from this project have been important for the management of the emerging fish disease, Heterosporosis, in Minnesota. This was achieved, in part, by increasing laboratory capacity and diagnostic confidence. The Minnesota Veterinary Diagnostic Laboratory now offers this highly sensitive and specific qPCR assay for surveillance testing and research. In addition, the ability to make science based management decisions at the MDNR has been greatly improved following the survey performed in this study. Understanding the distribution of Heterosporis is essential to controlling the spread.

The results from this project will be widely disseminated online, in press, and presented to a variety of stakeholders. A summary report will be made available on the University of Minnesota Extension's aquaculture website for review by aquaculture producers, veterinarians, MDNR, LCCMR, and other groups. A more detailed published paper will be prepared for submission to the Journal of Parasitology and presented at the American Fisheries Society – Fish Health Section Annual Meeting to update the scientific community on these important findings.

Environment and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report: September 14, 2012
Date of Next Progress Report: Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2012

I. PROJECT TITLE: Improving Emerging Fish Disease Surveillance in Minnesota

Project Manager: Katharine Pelican, DVM, PhD
Affiliation: College of Veterinary Medicine, University of Minnesota
Mailing Address: 385 Animal Science/Vet Medicine, 1365 Gortner Ave.
City / State / Zip: St. Paul, MN 55108
Telephone Number: 612-625-8561
E-mail Address: pelicank@umn.edu
FAX Number: (612) 624-4906
Web Site Address:

Location: The majority of the project will take place on the University of Minnesota, St. Paul campus, in the Veterinary Diagnostic Laboratory and aquaculture facility. Fish collected for surveillance testing have already been acquired and banked from throughout the state during 2008 through a relationship with the Minnesota Department of Natural Resources (see map).

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**80,000**
	Minus Amount Spent:	**$**	**80,000**
	Equal Balance:	**$**	**0**

Legal Citation: M.L. 2009, Chp.143, Sec.2, Subd. 6c. ML 2011, 1st Special Session, Chap. 2, Article 3, Sec. 2, Subd. 18.

Appropriation Language:
$80,000 is from the trust fund to the Board of Regents of the University of Minnesota to assess mechanisms and control of the transmission of Heterosporosis, an emerging fish disease in Minnesota, to assist in future management decisions and research. Carry forward (a) The availability of the appropriation for the following projects is extended to June 30, 2012: 6) Laws 2009, chapter 143, section 2, subdivision 6, paragraph (c), Improving Emerging Fish Disease Surveillance in Minnesota.

II. and III. FINAL PROJECT SUMMARY

Heterosporosis is an emerging disease of importance to Minnesota fish populations. The disease is caused by the previously undescribed microsporidian parasite, *Heterosporis* sp., which effectively destroys the skeletal muscle of susceptible fish hosts. The resulting damage from advanced infection renders the fillet unfit for human consumption and likely results in indirect mortality due to increased predation and reduced fitness. With no treatment of the disease in wild fish populations, management is limited to preventing the spread to naïve fish populations. The goal of this study was to improve diagnostic testing capabilities and perform a survey to prevent the further spread of this important fish disease. To that end, a highly sensitive and specific quantitative PCR (qPCR) assay was developed to detect sub-clinical Heterosporosis disease in fish. This assay vastly improved our capacity to detect the pathogen and was used to survey 50 waterbodies in Minnesota. From this survey and three additional MDNR submitted samples, six new waterbodies were identified as Heterosporis-positive, including: North Long Lake, (Crow Wing County), Mary Lake (Douglas County), a private pond in both Douglas and Pope Counties, Wabana Lake (Itasca County), and Black Hoof Lake (Crow Wing County). Positive fish species from this study included: walleye, yellow perch, cisco, northern pike, and for the first time spottail shiners. Further evaluation to characterize the parasite identified very low genetic variability in the species *H. sutherlandae*, collected from inland waters of Minnesota. However, there was a unique Heterosporis species (*H. superiorae*) in Lake Superior. This suggests a distant evolutionary divergence between the parasite species, but a rapid distribution once introduced into inland waters. These findings highlight the importance of continued surveillance and research to improve our understanding and control this important pathogen in Minnesota.

Despite the advancements made in this study, many questions remain. To date, no population level affects have been attributed to Heterosporis. However, the potential indirect parasite induced mortality or added stress in an ever increasingly compromised ecosystem is concerning. Further research into the effects of this parasite on the host and population level is warranted to make science-based management decisions. In addition, this study did not investigate the risk this parasite poses to other animals, including humans. While microsporidian diseases are becoming more frequently reported around the world, the two species described here have never been reported outside a fish host. Although the zoonotic potential is low, it is recommended by the MDNR to thoroughly cook all fish prior to consumption. A more thorough public health evaluation should be performed.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Validation of a quantitative PCR assay to detect *Heterosporis* sp. in fish.

Description: We will validate a quantitative PCR assay that satisfies four areas 1) Sensitive – the assay will have a sensitivity comparable to other qPCR assays, about 10 copies per reaction. 2) Specific – the assay will be specific for Heterosporis DNA and not detect related species. 3) Accurate – the assay will be have a PCR efficiency between 90 – 110% and correlation of the standard curve greater than 0.9. 4) Precise – the assay will be provide the similar results with samples tested over three days, and by two different laboratories. The Minnesota Department of Natural Resources will provide positive and negative control samples. The validation will be completed July 2009 – March 2010.

Deliverables	Completion Date	Budget
A. *Validation of a quantitative PCR assay to detect* Heterosporis *sp. in fish.*	March 2010	$11,000

Summary Budget Information for Result 1: Trust Fund Budget: $ 11,000
Amount Spent: $ 11,000
Balance: $ 0

Final Report Summary

A. *Validation of a quantitative PCR assay to detect Heterosporis sp. in fish.*

A quantitative PCR (qPCR) assay was developed and validated for the detection of Heterosporis sp. in fish. The assay was modified several times throughout the study to optimize the sensitivity, specificity, and turnaround speed based on results collected as part of Studies 2 – 4. This new assay vastly improves the sensitivity and specificity as compared to previous diagnostic tests. Detection has been improved to identify five spores per sample, long before clinical lesions are observed. The assay did not cross react with related microsporidian species, but did detect all samples in this study. It is possible that testing wild fish with a plethora of undescribed parasites, closely related species may cross-react or be missed by these methods. It is important to note that while qPCR offers many advantages, traditional diagnostic method (visual inspection) and case history should be considered during result interpretation.

The use of this diagnostic test is a major advancement in the management of this emerging fish disease. This assay will be available at the University of Minnesota Veterinary Diagnostic Laboratory for research and surveillance testing. In addition, details of this assay will be published in a peer-reviewed journal and presented at the American Fisheries Society – Fish Health Section (AFS-FHS) annual meeting for use by other laboratories.

Result 2: Determination of optimal sampling methods and tissue selection for *Heterosporis* sp. in fish.

Description: To determine optimal sampling methodology, yellow perch (Infected; n = 20) will be experimentally infected with Heterosporis spores per os and compared to un-infected fish (Control; n = 20). Two months following exposure to *Heterosporis* spores, fish will be humanely euthanized, and matched tissue (muscle (three sections: dorsal, central, and caudal) kidney, spleen, liver, blood) collected and tested from Infected and

Control fish. Tissues from each fish will be homogenized separately and three replicate PCR tests will be performed on each homogenized sample. The tissue that results in the most specific and sensitive identification of infected fish over control fish will be identified. Optimization of sampling methods will be completed January 2010 – January 2011 .

To prevent the risk of contaminating the public water supply and wild fish while maintaing the infected fish, a safe biosecure facility must be developed. An aquatic system of 6 50-gal aquaria will be constructed in the Veterinary Diagnostic Laboratory. The system will operate as either a static of recirculating system, depending on the presence of pathogens. An ultra violet filter and individual aerators will be used to maintain water quality. All potentially infected water and fish will be disinfected in the VDL tissue digester. The tanks will be subsequently be disinfected with a 10% bleach solution to prevent contamination of future studies. This laboratory will be a first at the University of Minnesota and provide the necessary space for future fish disease investigations. Laboratory development will be completed June 2009 – June 2010.

Deliverables	**Completion Date**	**Budget**
A. *Development of a fish disease research facility.*	June 2010	$17,500
B. *Infect fathead minnows with* Heterosporis *spores.*	August 2010	$3,000
C. *Determination of optimal sampling methods and tissue selection for Heterosporis sp. in fish.*	Jan 2011	$5,000

Summary Budget Information for Result 2: Trust Fund Budget: $25,500
Amount Spent: $25,500
Balance: $0

Final Report Summary

A. *Development of a fish disease research facility*

The new Fish Disease Research Area (FDRA) within the Aquaculture/ Fisheries Laboratory was completed. A system of 24 20-gallon tanks were set up within a confined space, including separate water supply and flow through system, biosecurity procedures and supplies, and barriers to prevent contact with other disease-free research projects in the Laboratory. No infected water or fish came in contact with the Aquaculture/Fisheries Laboratory's recirculating system or the city sewer system. The FDRA allowed the holding of fish infected with *Heterosporis* sp., with minimal risk to other research projects or natural fisheries.

B. *Infect fathead minnows with Heterosporis spores*

Fathead minnows were exposed to fresh *Heterosporis* spores by a bath treatment in February 2011. The parasite was confirmed by qPCR in the intestinal tract two weeks post exposure and in muscle tissue one month post exposure. It was not until four months post exposure that clinical signs (visually apparent necrosis of skeletal muscle) was first observed. This is consistent with our hypothesis that low level and early infections would frequently be missed by traditional diagnostic methods and demonstrates the value of the qPCR assay for detection of this pathogen in fish populations.

The infection trial did take longer than expected to achieve clinical signs of disease. Compared to previous research suggesting a two month time period, our trial took twice as long to achieve clinical signs. Conditions such as environment, host species, dose rate and method were all consistent between treatments. It is possible that the *Heterosporis* spores used for this treatment were less virulent, less productive, had fewer viable spores, or otherwise different. Future research is needed to identify the variation between this *Heterosporis* isolate and others that may exist in the region.

Fathead minnows were monitored for 16 months post-exposure to Heterosporis. Mortality was high in both control and infected fish (>90%), however, infected fish consistently had clinical lesions (muscle wasting) of Heterosporosis at time of death. The surviving infected fish had no clinical signs of disease and should be examined for characteristics of resistance in future studies.

C. *Determination of optimal sampling methods and tissue selection for Heterosporis sp. in fish*

We have successfully identified Heterosporis DNA in many organs of infected fish, supporting the hypothesis that immature stages of the parasite exist in the blood prior to maturation in muscle tissue. This has been significant finding for the detection of this, and related parasites, in a wide variety of sample types. To facilitate future research into the development of this disease, improved diagnostics, and critical control points for intervention, these findings will be published in a peer-reviewed manuscript and presented at the AFS-FHS Annual Meeting.

Result 3: Minnesota-wide survey for Heterosporosis.

Description: The heterosporosis quantitative PCR test developed, validated, and optimized in studies 1 and 2 will be used to test fish samples submitted to the state veterinary diagnostic laboratory for viral hemorrhagic septicemia. These samples will include banked tissue from years 2007 - 2008 as well as all samples submitted during the study year. Samples will be pooled by year, lake, and species to provide an initial determination of the location, timing, and species involved across the state. For example, if Gull Lake was sampled in 2007 and 2008, samples will be pooled for each species for each year and tested. Due to the possibility of false-positive results, all positive samples from previously negative lakes or species will undergo DNA sequencing to confirm. Testing of the banked samples will be completed February 2011 – May 2011.

The results of the studies will be presented at the annual American Fisheries Society – Fish Health Section meeting. In addition, a report will be provided to the DNR for management purposes.

Deliverables	**Completion Date**	**Budget**
A. *Minnesota-wide survey for Heterosporosis.*	May 2012	$15,651
B. *Present research at scientific conference and provide a report to the Minnesota DNR*	June 2012	$1,700

Summary Budget Information for Result 3: **Trust Fund Budget: $17,351**
Amount Spent: $17,351
Balance: $0

Final Report Summary

A. *Minnesota-wide survey for Heterosporosis*

A total of 592 samples, representing approximately 3,000 fish from 50 waterbodies in Minnesota were examined for Heterosporis spp. by qPCR (Attachment 1). 10% (5/50) of the waterbodies were identified as positive, including our reference lake (Leech Lake, Cass County, MN). The other positive waterbodies identified include, North Long Lake, (Crow Wing County), Mary Lake (Douglas County), and a private pond in both Douglas and Pope Counties. Precise locations of the private ponds are not provided for privacy. Positive fish included spottail shiners, yellow perch, walleye, and northern pike. As a result of this survey, we have shown Heterosporosis is more widespread than previously known. This survey has informed fish health mangers on the distribution of Heterosporosis in Minnesota (Attachment 2a-b).

In addition, during the course of this study, three angler caught fish were submitted to the Veterinary Diagnostic Laboratory by the MDNR with clinical lesions of Heterosporosis (Attachment 3). The disease was confirmed with the methods previously described. The fish included a walleye from Wabana Lake (Itasca County), a northern pike from Black Hoof Lake (Crow Wing County), and a cisco from Lake Superior.

This is the first report of Heterosporosis in North Long, Mary, Wabana, Black Hoof lakes, and private ponds in Minnesota. Furthermore, this is the first report of the disease in spottail shiners, a popular baitfish species.

To date, no population level affects attributed to Heterosporis have been reported by the MDNR. However, additional research is needed to investigate the potential effects of this disease to better inform science-based management decisions. Continued surveillance in recommended to monitor the spread of

Heterosporis in Minnesota, as well as the long-term dynamics and persistence in infected waterbodies.

B. *Present research at scientific conference and provide a report to the Minnesota DNR*

A final report summarizing the results of this survey will be provided to the MN DNR. In addition, the results from this project will be presented at the AFS-FHS annual meeting.

Result 4: Morphologic and genetic analysis of Heterosporis sp.

Description: Current management strategies are based on the assumption that Heterosporosis is an emerging disease. While this is likely the case given the known history of this and related pathogens, anecdotal evidence now suggests this parasite may have been locally isolated as far back as the 1970s, 30 years prior to the first reported case. It is therefore possible that the parasite has mutated, gaining virulence in the last 10 years to cause the recent emergence. This is supported by preliminary data from Result 2B and the particularly patchy distribution (diagnosed based on clinical signs) in the Great Lakes region, despite frequent movements of fish and boats from infected waterbodies over the last four decades. It is also possible that infected fish populations have become more susceptible to the disease, suggesting an environmental or other fish health concern.

It is therefore important to better understand the variations among Heterosporis isolates in Minnesota to better manage the disease. To do this, we will collect Heterosporis-infected fish from different host species (yellow perch, walleye, northern pike, and cisco) and a variety of locations (three lakes in MN, two lakes in WI, and Lake Erie). Each isolate will be analyzed by electron microscopy and genetic sequencing. An ultra structural veterinary pathologist (Dr. Anibal Armien, Minnesota Veterinary Diagnostic Laboratory) will assist with the EM analysis. Small variations in spore morphology or infection mechanisms could be observed by this technique. In addition, complete sequencing of the 16s rRNA genome will be performed by a molecular biologist (Sunil Kumars, MVDL). Genetic variations, or lack thereof, will be helpful to determine the evolution of the parasite in the region.

We hypothesize that low variation would suggest a recent introduction and the distribution may be based on increased susceptibility of fish populations to the disease. On the other hand, high variability would suggest a more evolved parasite with higher virulence and a greater concern for management. This data will also, for the first time, provide the necessary information to classify this parasite to the species level.

Deliverables	Completion Date	Budget
A. Morphological analysis of Heterosporis sp.	June 2012	$10,000
B. Genetic analysis of Heterosporis sp.	June 2012	$16,149

Summary Budget Information for Result 4: **Trust Fund Budget: $26,149**
Amount Spent: $26,149
Balance: $0

Final Report Summary

A. *Morphological analysis of Heterosporis sp.*

Infected and non-infected tissue samples were collected and processed for negative contrast and scanning electron microscopy. Heterosporis was found mostly in macrophages with few microorganisms within muscular cells (Attachment 4). Mature spores were ultra-structurally characterized by the presence of a thick capsule, anchoring disk, endo- and exospores, polar filament, anterior and posterior polarplast, nucleus, posterior vacuole and ribosomes. Large numbers of the microorganism were in different stages of development, including merogony and sporogony, as well as in different stages of degradation. The size of mature spores were ovoid and uniform in shape at 6.16µm x 2.36µm (sd: 0.71µm x 0.39µm).

The mechanism by which the parasite is transported to the muscle from the gut is currently unknown, however this data showing the parasite at various stages of development within macrophages is very interesting. We hypothesize that the macrophages consume the invading parasite within the guy and are transported via the blood stream until suitable skeletal muscle cells are found. This area deserves additional research and has applications to treatment of not only fish, but human-infecting, microsporidian diseases.

B. *Genetic analysis of Heterosporis sp.*

Three fish (Attachment 3) confirmed positive for Heterosporis were thoroughly examined to describe the parasite and determine genetic relatedness. Samples were collected from walleye, yellow perch, and cisco, from Lake Wabana, Leech Lake, and Lake Superior, respectively. Phylogenetic analysis was performed on the partial 16s rRNA sequence for each sample. Two new species of Heterosporis were clearly distinguished: *H. sutherlandae* (included the walleye and yellow perch) and *H. superiorae* (included the cisco) (Attachment 5). *H. sutherlandae* sequences were 99.1 – 100% similar within the group and 96.8% similar Asian and European Heterosporis species. *H. superiorae* only has 90% similarity with other Heterosporis species infecting fish. All Heterosporis spp. have only 48.0 – 50.0% similarity with known microsporidians of humans.

The previously undescribed *Heterosporis* sp. sample from north central Wisconsin was also analyzed to determine regional relatedness and spread. An archived sample from Catfish Lake (Villas County, WI) was provided by the US Fish and Wildlife Service. This sample was conformed to be *H. sutherlandae*, with 99.3% similarity to the samples from Northern Minnesota.

Given the low genetic variability between *H. sutherlandae* samples we examined, we hypothesize that this species is a fairly recent introduction. Interestingly, *H. sutherlandae* is more closely related to *H. anguillarum* (found in Japanese eels) than *H. superiorae*. Further research is needed to determine the evolutionary rate and complete gene sequence of these parasites to estimate introduction date and source.

Taking into account the morphologic and genetic data, we conclude that there are two distinct species of Heterosporis in Minnesota and described for the first time as a result of this study.

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $19,601. Funds will be used for one month of salary and fringe for the Project Manager ($8,801). In addition, funding is needed to support a student assistant for fish care (2 hours/day x 365 days) and sample management (3.5 hours/week) throughout the year (900 hrs x $12/hr; $10,800).
Equipment/Tools/Supplies: $31,354. Funds will be used to develop an aquatic research laboratory at the University of Minnesota Veterinary Diagnostic Laboratory for emerging fish disease research. For general bio-secure precautions ($5,000), several items will be purchased, including equipment for hand washing, foot dipping and clothing changes to maintain quarantine between diseased and clean fish populations. Funds will also be used for system design and management ($26,650), including six 50-gal tanks, shelving and support structures, ultraviolet filtration systems to prevent disease movement between tanks, individual tank aeration, water quality maintenance supplies, and fish handling tools, including the purchase of required nets and cleaning supplies.
Travel: $2,500. Funds will be used to cover travel (airline tickets and per diem) to one conference for PhD student, Nicholas Phelps to present results and discuss findings with other fish health professionals at the American Fisheries Society – Fish Health Section annual meeting, location to be determined. In addition, travel expenses are needed to cover local travel costs (vehicle and fuel) to and from the DNR to maintain the active collaboration. Funds are also needed for Nicholas Phelps to travel to field collection sites to advise on appropriate sample collection and storage techniques for submitted tissues.
Other: $26,454. Other funds will be used for laboratory supplies, sample collection and storage supplies. Laboratory supplies and costs include PCR primers and probe, reagents, pipette tips, gloves, instrument maintenance, computer software, DNA

extraction kit, microcentrifuge tubes, and PCR plates. Sample collection and storage supplies include sample boxes, sample vials, alcohol, coolers, and ice packs.

TOTAL TRUST FUND PROJECT BUDGET: $80,000

Explanation of Capital Expenditures Greater Than $3,500: To prevent the movement of experimental pathogens from the laboratory to the environment, existing space must be renovated to meet the unique bio-safety requirements of an aquatic health research laboratory at the Veterinary Diagnostic Laboratory. The laboratory and equipment set up will be a permanent addition to the research infrastructure at the University and used to do equivalent fish disease research in the future. The Principal Investigator will work with the Co-PIs of the project to ensure that this facility is accessible and useful for future fish disease research efforts at the University of Minnesota.

VI. PROJECT STRATEGY:

A. Project Partners: Nicholas Phelps, Veterinary Diagnostic Laboratory, University of Minnesota. Dr. Peter Sorenson, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota. Ling Shen, Ecological Resources, Minnesota Department of Natural Resources. Project partners will not directly receive any funds from the appropriation.

B. Project Impact and Long-term Strategy: *Heteropsoris* sp. is an emerging parasite infecting many economically important and popular game fishes in Minnesota. The current diagnostic methods are not robust enough to succesfully control for this disease. The qPCR assay developed in this study will be used to opportunistically survey the State for *Heterosporis*, which for the first time, will provide managers with the necessary information to better control the spread of this disease between lakes. This will also decrease the time needed to perform diagnostic inspecions and reduce future laboratory costs for the State. Furthermore, this study is the first part of a larger PhD project by co-investigator Nicholas Phelps. These results will inform his research on *Heterosporis* classification, transmission, treatment, and host suseptibility.

C. Other Funds Proposed to be Spent during the Project Period: $0

D. Spending HIstory: $0

VII. DISSEMINATION: Findings from this research will be provided to fisheries managers at the Minnesota Department of Natural Resources to inform fish disease control strategies in the state. In addition, findings will be communicated to the scientific community with at a research conference and a peer-reviewed publication as well as other stakeholders with a report available on the University of Minnesota Extension Aquaculture website.

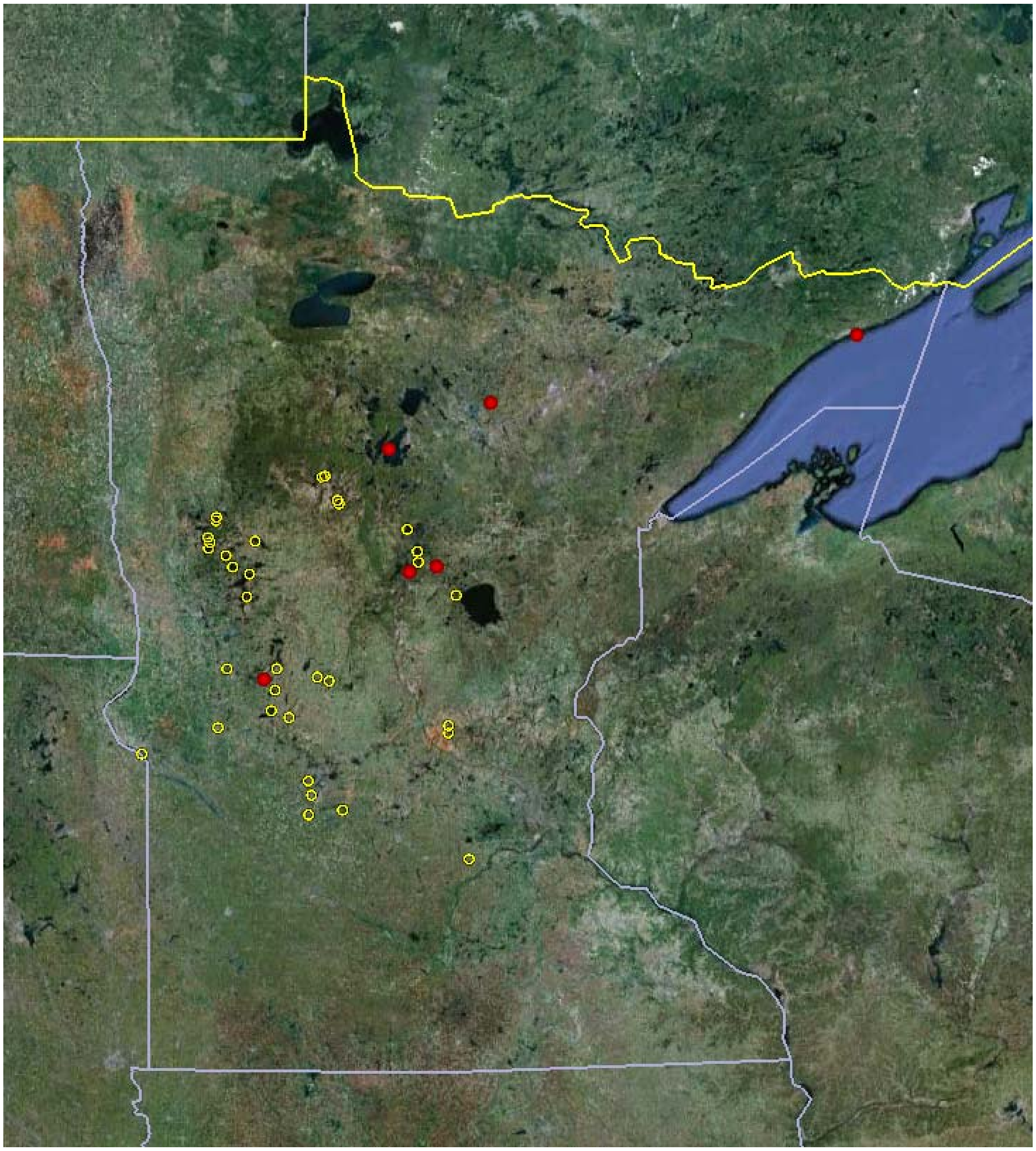
VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than December 30, 2009. A final work program report and

associated products will be submitted by June 30, 2012 as requested by the LCCMR.

IX. RESEARCH PROJECTS: n/a

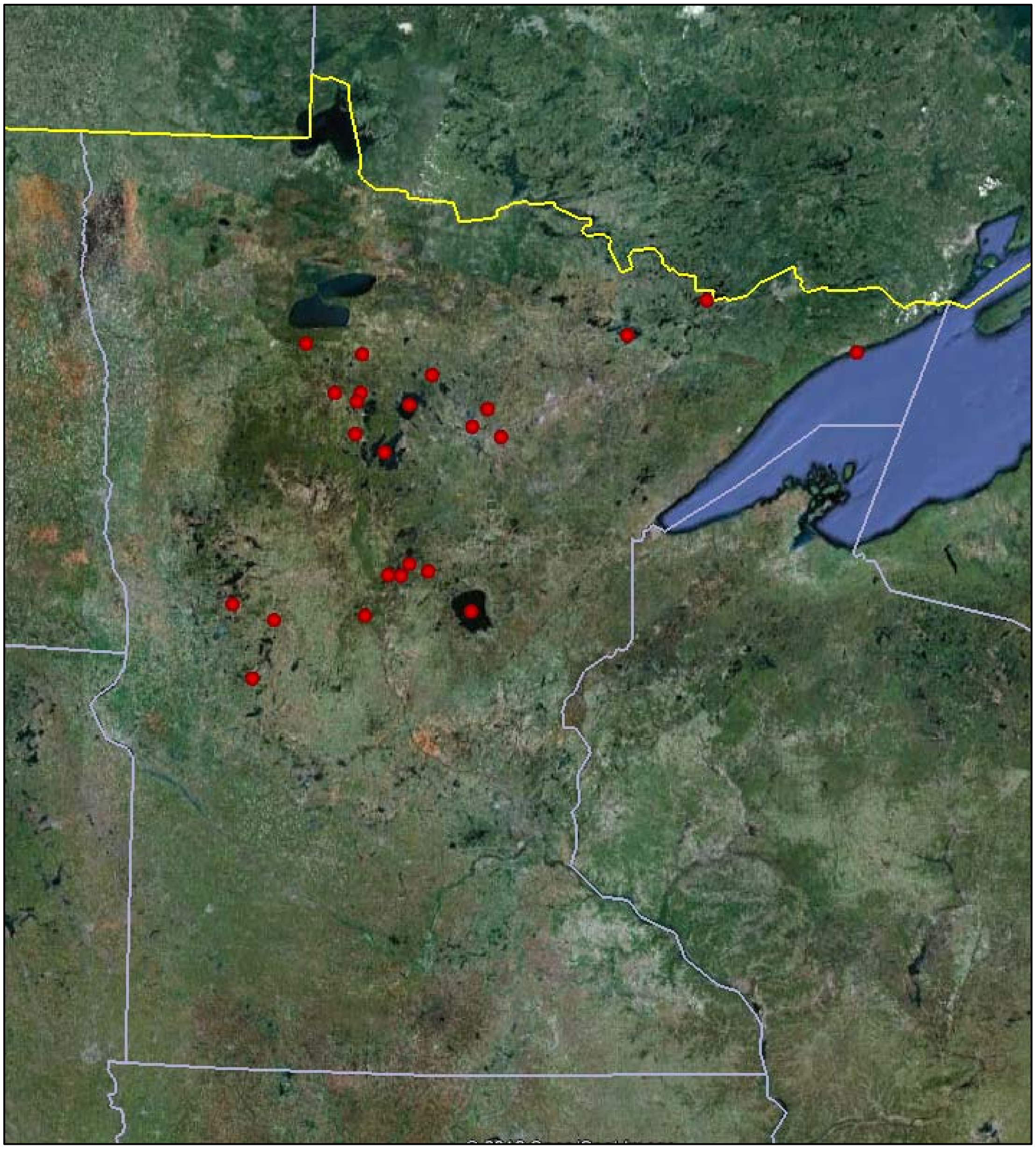
Attachment 1

2010 – 2011 Heterosporosis survey locations (50 sites) and angler submissions (3 sites). Red dots indicate positive waterbodies. Open yellow circles indicate negative waterbodies. Private ponds in Douglas and Pope Counties not listed for privacy.



Attachment 2a

Heterosporosis positive waterbodies in Minnesota from 1990-2011. Private ponds in Douglas and Pope Counties not listed for privacy. Data provided from this study and the MDNR. As of 2011, Heterosporosis has been confirmed in 26 waterbodies in Minnesota.



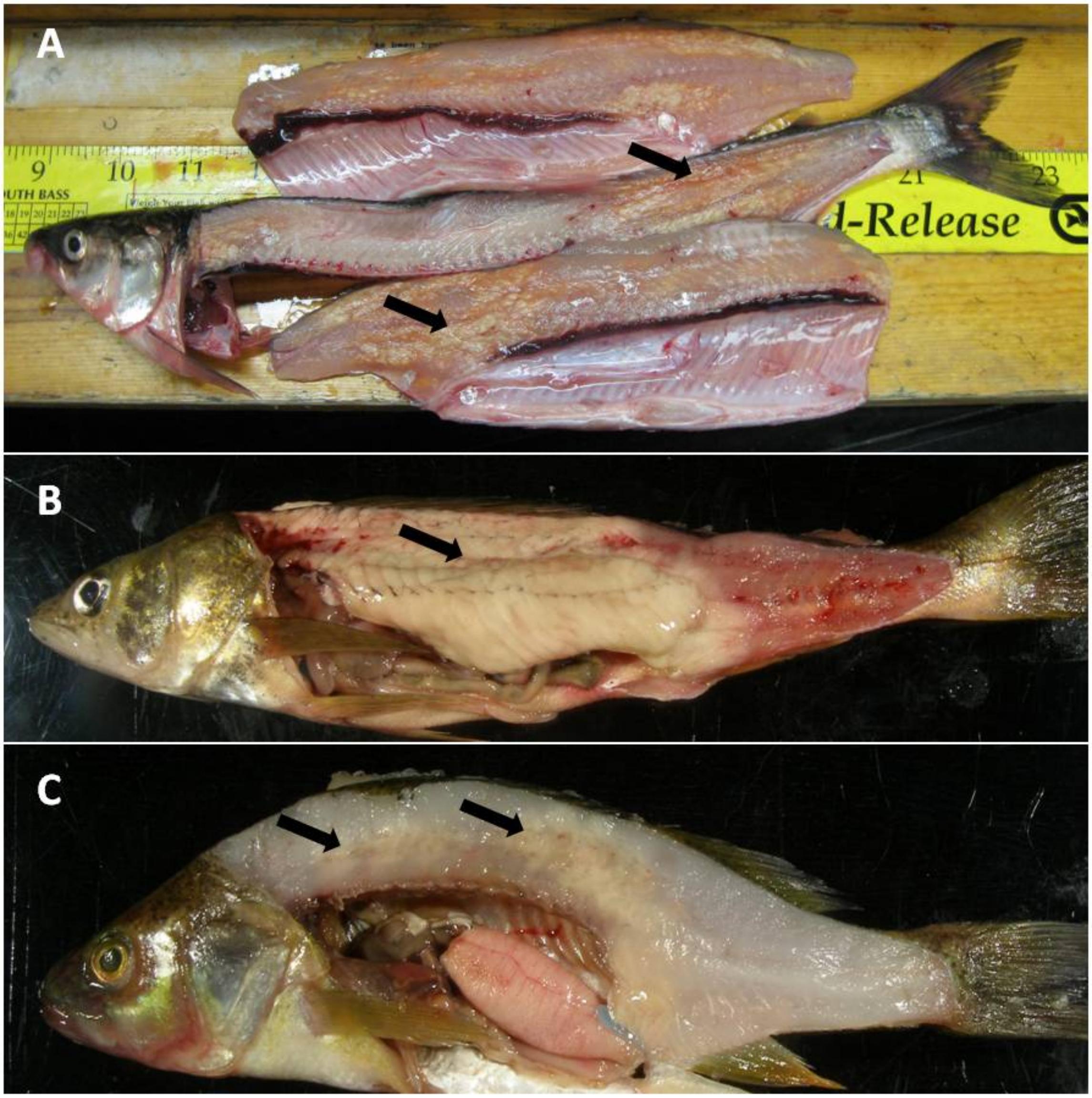
Attachment 2b

Heterosporosis positive waterbodies in Minnesota from 1990-2011. Data provided from this study and MDNR.

Lake	County	First Identified
Leech Lake	Cass	1990
Sand Lake	Itasca	1999
Bass Lake	Itasca	1999
Horsehead Lake	Ottertail	1999
Steamboat Lake	Cass	1999
Mille Lacs Lake	Mille Lacs	2000
Lake Vermilion	St. Louis	2000
Bear Lake	Itasca	2000
Lake Andrusia	Beltrami	2000
Clitherall Lake	Ottertail	2000
Gull Lake	Cass	2002
Lake Alexander	Morrison	2003
Lake Winnibigoshish	Cass	2003
Basswood Lake	Lake	2004
Lake Bemidji	Beltrami	2004
Blackduck Lake	Beltrami	2006
Trout Lake	Itasca	2007
Balm Lake	Beltrami	2008
Big Lake	Beltrami	2008
Lake Superior	Cook	2008
Black Hoof Lake	Crow Wing	2010
Wabana Lake	Itasca	2010
Mary Lake	Douglas	2011
Private pond	Douglas	2011
Private pond	Pope	2011
North Long Lake	Crow Wing	2011

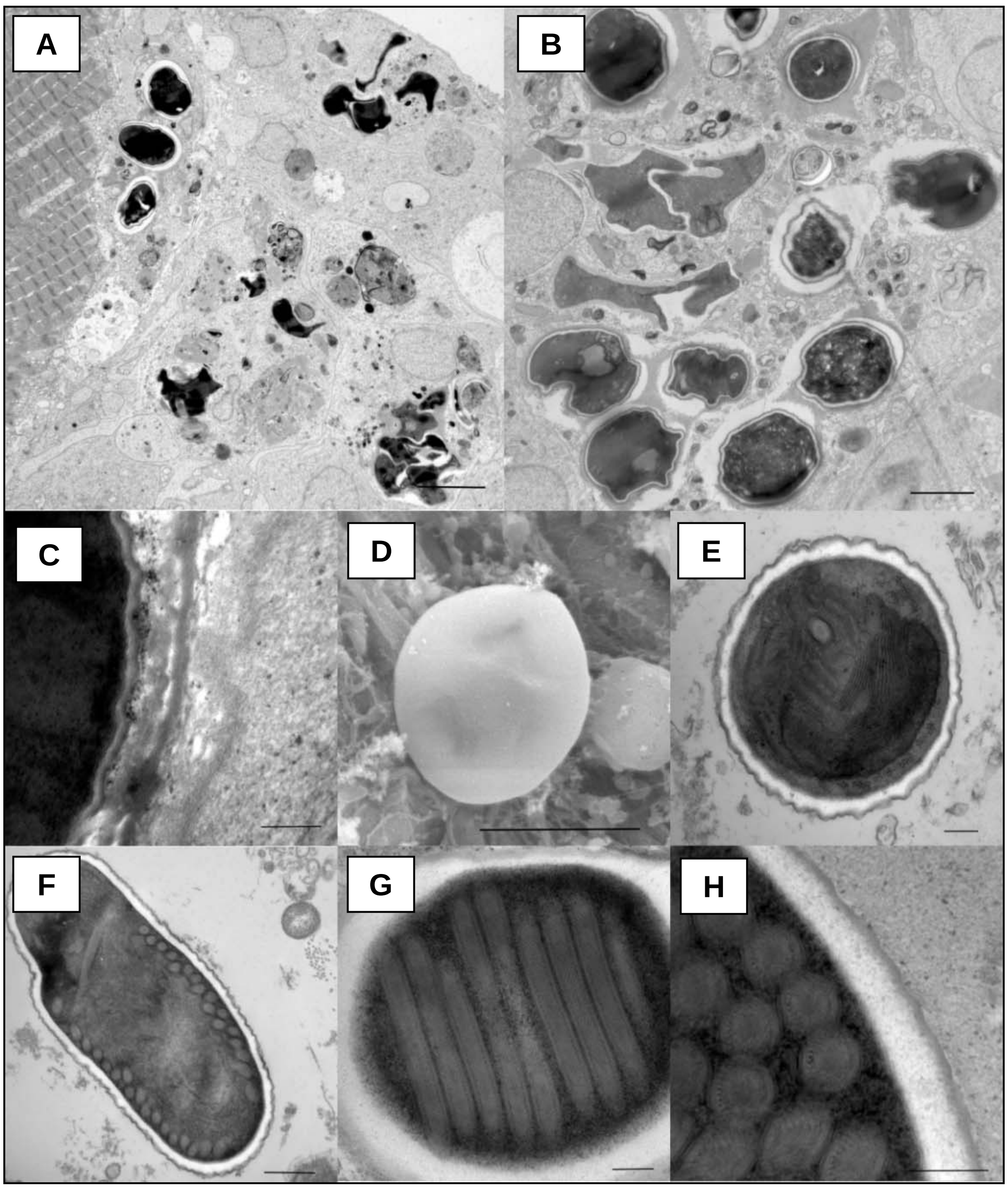
Attachment 3

Heterosporis-infected A) Cisco (Lake Superior, Cook County), B) Walleye (Wabana Lake, Itasca County), and C) Yellow Perch (Leech Lake, Cass County). Widespread muscle destruction (arrows) due to A) *H. superiorae* and B-C) *H. sutherlandae.*



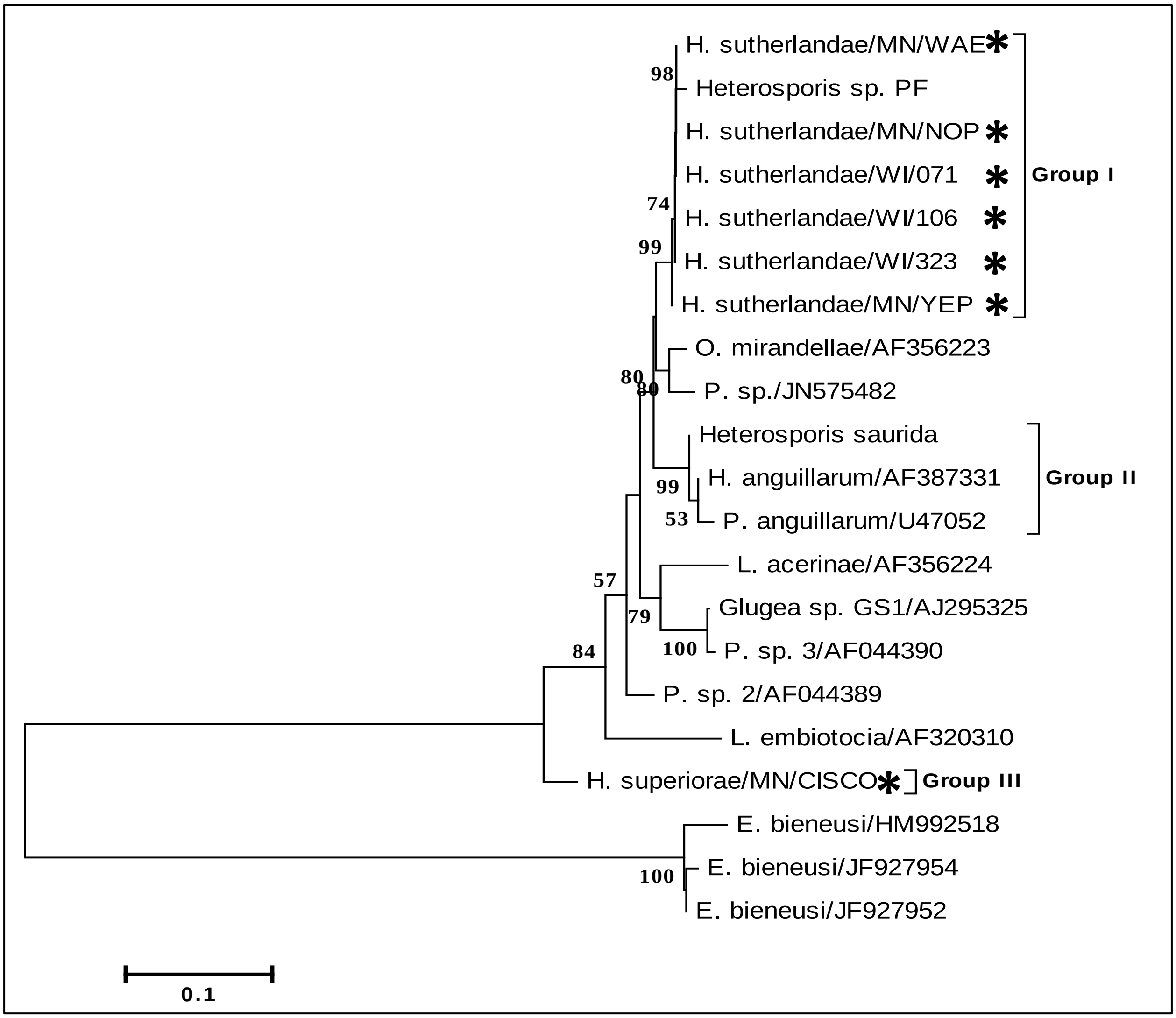
Attachment 4

Heterosporis sutherlandae from yellow perch. A-B) Granulomatous inflammation and necrosis of skeletal muscle (sm). Multiple mature spores (s) and SPVs (sv) inside phagolysosomes of macrophages (m) at various stages of digestion. C) Wall of SPV. D) Mature spore by SEM. E) Cross section of mature spore with anterior polarplast (ap), anchoring disk (ad), endospore (ed), exospores (ex), and polar tubual (pt). F) Longitudinally sectioned spore with polar tubual (pt). G) Cross section of polar tubual. H) Longitudinal section of polar tubual.



Attachment 5

Phylogenetic tree of partial 16s gene sequence, with samples reported in this study indicated by *. Group I sequences are 99.1 – 100% similar within the group and 96.8% similar with the Group II. *H. sutherlandae* sequences have 99.3% similarity with *H.* sp. Groups I and II are only 90% similar to Group III. All Groups have only 48.0 – 50.0% similarity with known microsporidians of humans.



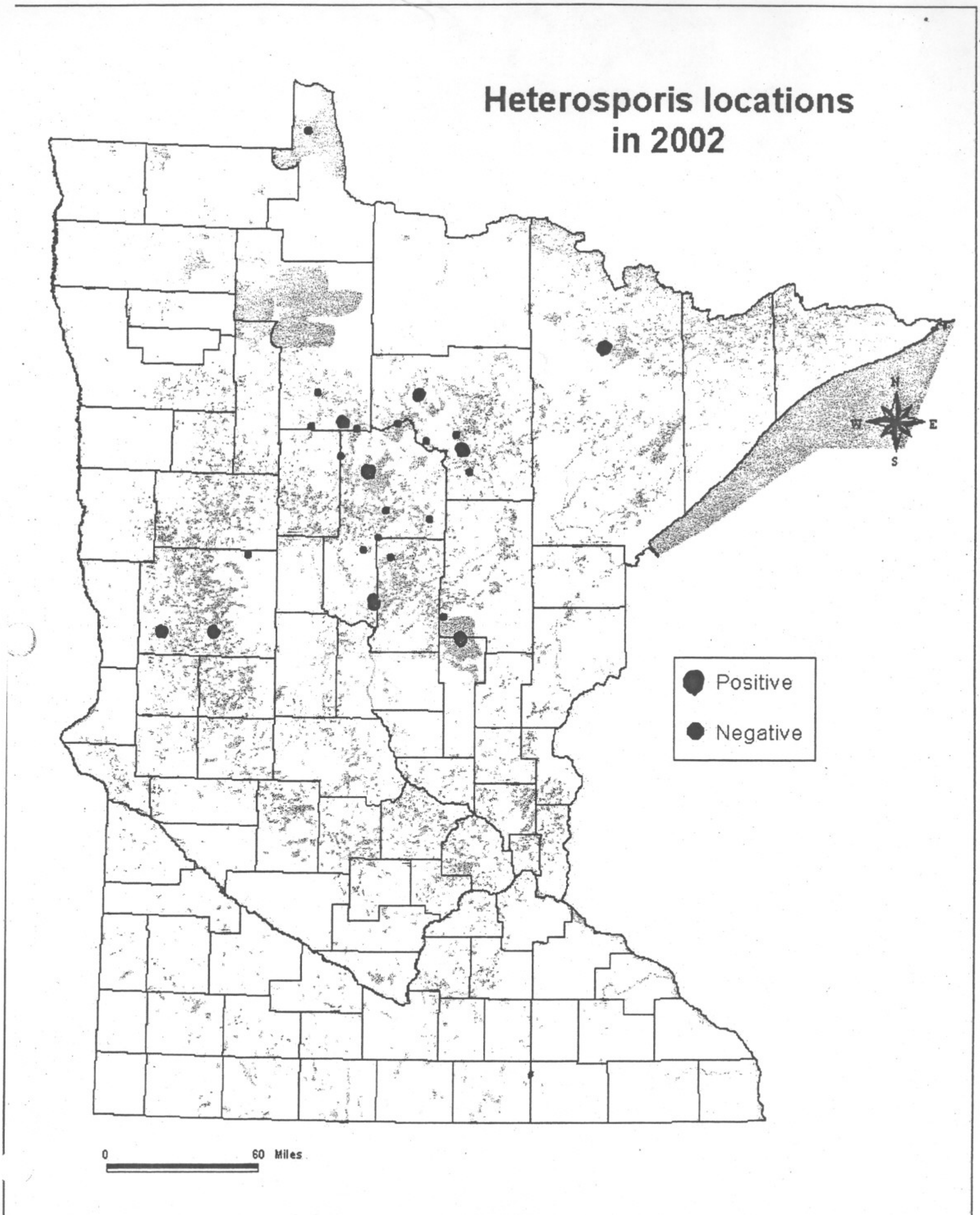
Attachment A: Final Budget Detail for 2009 Project

Project Title: Improving emerging fish disease surveillance in Minnesota

Project Manager Name: Katharine Pelican, DVM, PhD

Trust Fund Appropriation: $ 80,000

2009 Trust Fund Budget	Result 1 Budget:	Amount Spent (30June12)	Balance (30June12)	Result 2 Budget:	Amount Spent (30June12)	Balance (30June12)	Result 3 Budget:	Amount Spent (30June12)	Balance (30June12)	Result 4 Budget:	Amount Spent (30June12)	Balance (30June12)	TOTAL BUDGET	TOTAL BALANCE
	Validation of a quantitative PCR assay to detect Heterosporis sp. in fish			Determination of optimal sampling methods and tissue selection for Heterosporis sp. in fish			Minnesota-wide survey for Heterosporosis			Morphological and genetic analysis of Heterosporis				
BUDGET ITEM														
PERSONNEL: wages and benefits	Katherine Pelican, 8%: $2200	2,200	0	Katherine Pelican, 8%: $4400	4,400	0	Katherine Pelican, 8%: $2201	2,201	0	0	0	0	8,801	0
PERSONNEL: wages and benefits	Student Assistant: $2700	2,700	0	Student Assistant: $5400	5,400	0	Student Assistant: $2700	2,700	0	Student Assistant: $3,000	3,000	0	13,800	0
Non-capital Equipment / Tools	0	0	0	6 50-gal aquaculture tanks with UV filter and aeration, misc construction supplies to support tanks: ~~$20,000~~ $7,500. Laboratory tools (scalpels, forceps, scissors) for infective tissue handling and feeding: $250. Dissecting scope for visual inspection: $500.	8,250	0	0	0	0	0	0	0	8,250	0
Printing	0	0	0	0	0	0	Publication for DNR summarizing results: $200	200	0	0	0	0	200	0
Supplies	PCR reagents (primers, probe, master mix), centrifuge tubes, PCR plates, gloves, disinfectant: $6100	6,100	0	Supplies for biosecurity (foot bath, disinfectant, gloves, rubber boots, lab coats), nets, and buckets: $5716. Fish food: $200. PCR reagents and supplies: $689.	6,605	0	PCR reagents and supplies: ~~$23649~~ $9,800	9,800	0	Electron microscopy and sequencing procedures: $23,149	23,149	0	45,654	0
Travel expenses in Minnesota	0	0	0	Travel to collect fish: $250	250	0	Travel to field sites to assist in sample collection, if needed: $750	750	0	0	0	0	1,000	0
Travel outside Minnesota	0	0	0	0	0	0	Travel to AFS-FHS Annual Conference to present findings: $1700	1,700	0	0	0	0	1,700	0
Other	0	0	0	Positive (fathead minnows) and negative (goldfish) fish: $595	595	0	0	0	0	0	0	0	595	0
COLUMN TOTAL	**$11,000**	**$11,000**	**$0**	**$25,500**	**$25,500**	**$0**	**$17,351**	**$17,351**	**$0**	**$26,149**	**$26,149**	**$0**	**$80,000**	**$0**


Heterosporis locations in 2002
N
W
E
S
Positive
Negative
0
60 Miles
Minnesota Department of Natural Resources

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Projecting Environmental Trajectories for Energy-Water-Habitat Planning
PROJECT MANAGER: Peter Reich
AFFILIATION: University of Minnesota
MAILING ADDRESS: 200f Green Hall
CITY/STATE/ZIP: St. Paul, MN 55018
PHONE: (612) 624-4270
E-MAIL: preich@umn.edu
WEBSITE: http://www.forestry.umn.edu/people/facstaff/reich/
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2009, Chp. 143, Sec. 2, Subd. 7b

APPROPRIATION AMOUNT: $ 180,000

Overall Project Outcome and Results

Just as weather flows across the surface of the earth, so does climate—only much more slowly. Understanding the flow of climate is of particular importance in Minnesota because Minnesota encloses the junction of the three great ecosystems of North America—western prairie, northern needle-leaf forests, and eastern broad-leaf forests. Conditions here are particularly sensitive to local changes, and therefore can also be indicators for the nation as a whole.

We applied new methods for understanding this flow of climate, in terms of direction and speed, to actual historical Minnesota weather data. Utilizing established data on both average temperature and total precipitation, we found the lines along which precipitation and temperature do not change and where those lines intersect across Minnesota's landscape. Tracking the advancement of an intersection over time, artifacts of historic importance on climate are identifiable, such as the beginning and end of the dust bowl era. For the present and future, the data show climate in recent years moving northward at a few miles per year.

Results have two major implications, first, as a new confirmation of rate of climate shifts from projections based on global circulation models, and second, as a fine-scale mapping of climate migration in Minnesota. In addition to the average migration, we found differences between longitudinal and lateral migration and differences within Minnesota’s ecoregions.

This report outlines the significance of climate migration on habitat for trees, tree pests and diseases, and insects in Minnesota. The project has spawned future research to apply the implications of climate flow, such as how it relates to degree days and other agricultural parameters for the bioenergy industry.

A public product of this project is the Climate Tracker, found on the project website, http://www.cbs.umn.edu/climatetracker. Climate Tracker allows citizens to follow the flow of climate at any point in Minnesota over the past century—where it has been and where it is going.

Project Results Use and Dissemination

This was a two-year project. Its first year involved data assembly, algorithm validation, analysis, and preparation of preliminary maps and tables. In its second year, results were correlated with ecological, hydrological, physical, and social aspects. Included in the second year are a final report, public presentations, and web dissemination, which can be found at http://www.cbs.umn.edu/climatetracker. This website is designed to be user-friendly, useful, and interesting to both scientists and the general public. The interactive Climate Tracker application was developed as a novel way to dynamically view a century of data at a glance, while the brief video introduction presents information in a broader context and allows visitors to the website to meet some of the project researchers.

Future publications in scientific journals are expected to result from this project. Impacts of shifting climate on crops important to Minnesota's economy are being explored through collaborations with the Department of Agronomy and Plant Genetics at the University of Minnesota. A collaboration with the University of Minnesota's Department of Forest Resources is considering the interaction of climate and tree growth, tree ranges, and tree pests. A methods paper is underway documenting the methodology used in this project and comparing the resulting climate velocities with those found using Global Circulation Models.

Environment and Natural Resources Trust Fund 2009 Work Program
Final Report

Date of Report: October 31, 2011
Final Report
Date of Work Program Approval: June 16, 2009
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Projecting Environmental Trajectories for Energy-Water-Habitat Planning

Project Manager: Peter Reich
Affiliation: University of Minnesota
Mailing Address: 200f Green Hall
City / State / Zip: Saint Paul, MN 55018
Telephone Number: (612) 624-4270
E-mail Address: preich@umn.edu
FAX Number: (612) 624-4270
Web Site Address: http://www.forestry.umn.edu/people/facstaff/reich/

Location: Saint Paul

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$**	**180,000**
Minus Amount Spent:		**$**	**174,039**
Equal Balance:		**$**	**5,961***

* See budget notes at end of section IV.

Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 7b

Appropriation Language:
$180,000 is from the trust fund to the Board of Regents of the University of Minnesota to combine detailed climatic records of Minnesota with present and past ecosystem boundaries to forecast future fine-scale flow of climate across the state impacting human activities and natural resources.

Amendment Approved [5/2/2011]:
II. and III. FINAL PROJECT SUMMARY:

Just as weather flows across the surface of the earth, so does climate—only much more slowly. Understanding the flow of climate is of particular importance in Minnesota because Minnesota encloses the junction of the three great ecosystems of North America—western prairie, northern needle-leaf forests, and eastern broad-leaf forests. Conditions here are particularly sensitive to local changes, and therefore can also be indicators for the nation as a whole.

We applied new methods for understanding this flow of climate, in terms of direction and speed, to actual historical Minnesota weather data. Utilizing established data on both average temperature and total precipitation, we found the lines along which precipitation and temperature do not change and where those lines intersect across Minnesota's landscape. Tracking the advancement of an intersection over time, artifacts of historic importance on climate are identifiable, such as the beginning and end of the dust bowl era. For the present and future, the data show climate in recent years moving northward at a few miles per year.

Results have two major implications, first, as a new confirmation of rate of climate shifts from projections based on global circulation models, and second, as a fine-scale mapping of climate migration in Minnesota. In addition to the average migration, we found differences between longitudinal versus lateral migration and within Minnesota's ecoregions.

This report discusses the significance of climate migration on habitats for species of trees, tree pests and diseases, and insects in Minnesota. The project has spawned future research to look at the implications of climate flow on the burgeoning bioenergy industry, as it relates to growing degree days and other agricultural parameters. Results obtained as part of this project are outlined here and are being developed in detail for peer-reviewed publication.

A public product of this project is an engaging Climate Tracker tool, found on the project website, http://www.cbs.umn.edu/climatetracker. Climate Tracker allows citizens to follow the flow of climate at any point in Minnesota over the past century.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Data and software assembly, computer runs.

Description:

We used the millions of observations that are combined in established databases of century-long climatological records, available across Minnesota and the bordering regions. From this vast collection we constructed mathematical representations that abstracted the prevailing conditions, interpolating to any point on the ground and at any time within the range of the data. We then used the mathematical representations to determine how regional conditions across Minnesota changed on a fine grid during the 20th century, and then made best estimates of how they are expected to change in the foreseeable future. We paid special attention to areas that could be sensitive to change, such as the historical prairie-forest border.

Amendment Approved 5/2/2011:
Summary Budget Information for Result 1: Trust Fund Budget: $ 86,054
Amount Spent: $ 86,054
Balance: $ 0

Deliverable	Completion Date	Budget
1. ***Data assembly, unification, database construction***	***11/30/2009***	$43,000
2. ***Software adaptation and automation of pilot programs***	***1/30/2010***	$27,000
3. ***Computer runs and production of working maps and tables***	***6/30/2010***	$16,054

Result Completion Date: 06/30/2010

Final Report Summary:

Assembly of daily data

The U.S. Historical Climatology Network (USHCN) is a group of 1219 stations, 33 in Minnesota, spread across the 48 contiguous states drawn from the U.S. Cooperative Observer Network. The USHCN was developed as a collaboration between NOAA's National Climatic Data Center (NCDC) and the Department of Energy's Carbon Dioxide Information Analysis Center (CDIAC). The stations produce an accurate and modern data set of daily values for maximum and minimum temperatures, precipitation, snowfall, and snow depth. Monthly values are available for maximum, minimum, and average temperature and total monthly precipitation.

The project was designed at the outset using USHCN daily data, and arrays were created and formatted to organize the voluminous data for rapid retrieval. Careful data auditing showed, however, a tradeoff between minimum number of data-days and number of months that met minimum requirements (Figure 1). In addition, the daily data contained no adjustments for biases resulting from historical changes in instrumentation and observing practices. Ongoing work at NCDC is now developing adjustments for daily maximum and minimum temperatures (Menne et al., 2011), and we look forward to a daily derived product in the future.

The USHCN Version 2 serial monthly data release used in this study is the most recent update to the USHCN datasets. Version 2 data were produced using a new set of quality control and homogeneity assessment algorithms. Two papers (Menne and Williams, 2009 and Menne et al., 2009) provide an overall description of the adjustment methods as well as an assessment of the Version 2 maximum and minimum temperature trends. The USHCN V2 website provides a brief summary of the processing steps at http://cdiac.ornl.gov/epubs/ndp/ushcn/monthly_doc.html.

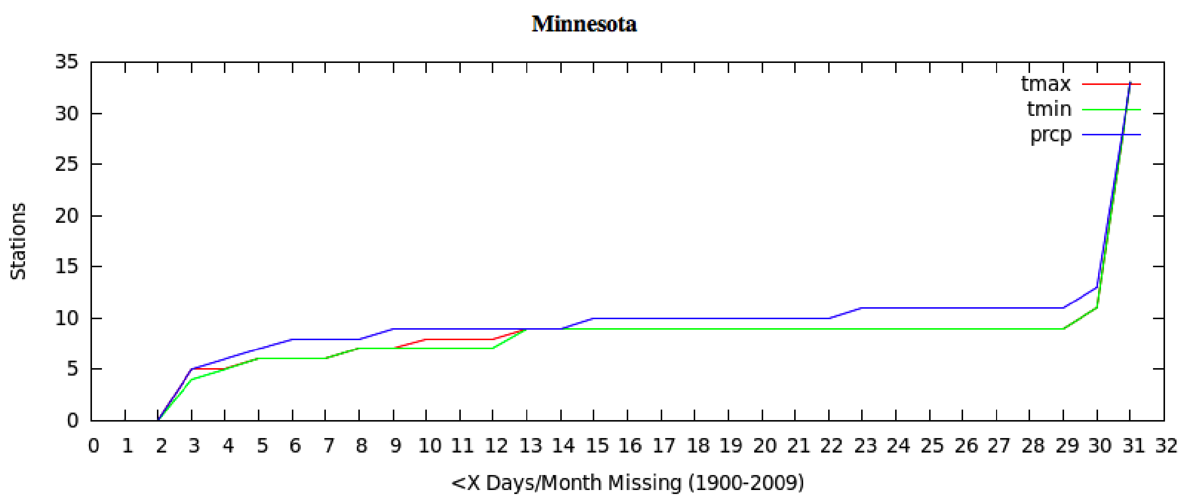


Figure 1. Daily data presented a tradeoff between minimum number of data days required for analysis and number of months that meet that requirement.

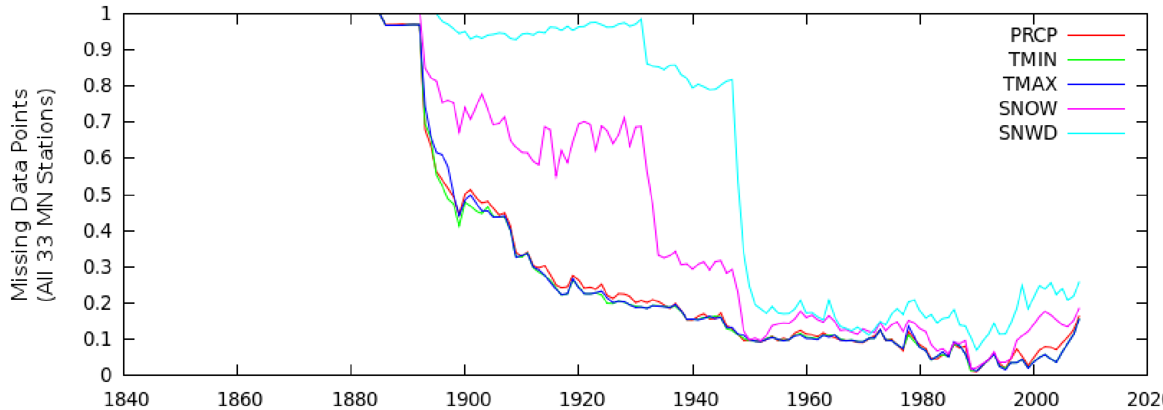


Figure 2. The amount of missing data as a function of time. Excessive missing data early in the record made fitting the daily data difficult. Monthly data did not have this problem.

Assembly and automation of monthly data

After acquiring data on total precipitation, maximum, minimum, and average temperature for all of Minnesota's USHCN weather stations, they were audited and formatted for processing. The numerical surface-fitting algorithms of the pilot programs were automated to run without manual assistance. In addition, the data preparation algorithms were coded in a standard format that can be publicly distributed and they were adapted to the expanded conditions of the present project.

Production of working maps and tables

Trial computer runs and prototype maps were constructed for testing the data and the programs. Software memory allocation and other technical methods used in the pilot program were streamlined to forms that are universally accessible. This is to facilitate distribution of the program and allow others to adapt the programs to new situations. Scaling of latitude and longitude and the generation of geographic Lambert Conical Orthographic projections were incorporated into the climate tracking component of the software.

Feedback to climate agencies

An incidental benefit of this project was feedback we were able to provide to the climate agencies and other groups who collect and maintain the climate data. Such feedback will reduce problems for other researchers and may considered part of the project's documentation and legacy. Feedback is detailed below.

An inconsistency between the USHCNv2 Monthly Data's documentation and file names was identified. The inconsistency prevented reliable matching between USHCN climate stations and their data; the USHCN welcomed this feedback and corrected this problem.

The USHCNv2 Monthly Data's documentation concerning the calculation of annual means was found to be ambiguous; it was unclear whether annual means were calculated as a separate product or as the mean of a given year's monthly means. The USHCN has resolved this ambiguity in their documentation.

A less important problem was the location information for the USHCN stations. The USHCN releases GPS coordinates for the stations in decimal degrees to three digits of accuracy and does not document the geodesic reference of the coordinates. Minnesota's climate station near the town of Ada, for instance, is located at 47.299N, 96.516W. At this level of accuracy, it is possible to locate the station to within 250-350 feet. Our results are robust against such small inaccuracies in siting, but this lack of precision could confound algorithms designed to automatically unbias station data. We provided this information to the USHCN for their consideration.

Canada's Climate Services' National Climate Data and Information Archive provides Canadian Daily Climate Data (CDCD) in a compressed binary format along with a DOS program to extract the data. This program is not well-suited to mass analysis of climate data, requiring the individual extraction of each station's data. Upon request, Climate Services provided the format of the binary files. The file they provided had been written in 1993 and contained multiple errors and omissions which had gone uncorrected. The CDCD data is divided into climate regions, though no map of these is available in any public archive. Upon request, Climate Services provided a low-quality map and later a high-quality map to address this. An updated set of documentation including this map and resolving the errors and omissions in the original documentation has been produced. This was provided to Climate Services and they will add it to their formal documentation. The information will also be made publicly available on this project's website.

Environment Canada, provides a set of monthly climate data for approximately 200 temperature stations and 400 precipitation stations. The documentation for that dataset, the Adjusted and Homogenized Canadian Climate Data (AHCCD), does not specify the units for the data, which is broken up into many different files. In the case of precipitation data, this prevents automated processing of the data. In the case of temperature data, there is ambiguity that introduces uncertainty in processing. A request for clarification was made in late July 2011, and changes are expected to the AHCCD documentation as a result.

The OpenLayers project, which we use in this project to display results interactively, is developing a JavaScript framework for dynamic display of GIS data on websites. Version 2.11, Release Candidate 1 (2.11RC1) was used extensively in developing the analysis tools for the later stages of this project, along with the project's website. To reduce visual clutter, the climate stations are grouped by proximity when they are displayed on the map; however, it is sometimes necessary to break these groups apart. OpenLayers did not provide a way of doing this, so a module was developed as part of this project. It is being evaluated by the OpenLayers group for inclusion in Version 2.12 of their product.

Result 2: Analysis, documentation, and publication.

Description:
Beginning concomitantly with Result 1, but emphasized after and following from the previous result, we used the working maps and tables to provide information relevant to, and as feasible evaluated, (1) delineation of areas having future potential for renewable bioenergy production, (2) ranges of locally threatened or endangered species, (3) the movement and velocity of climate near particularly vulnerable ecoregions, such as the prairie-forest border in Minnesota, (4) areas of increased dangers of fire and climate-related movement of pests and diseases of trees, both native and exotic, (5) artifacts of major historical shifts in climate in Minnesota.

Amendment Approved: 5/2/2011:

Summary Budget Information for Result 2:	**Trust Fund Budget**	**$ 93,946**
	Amount Spent:	**$ 87,985**
	Balance	**$ 5,961***

* See budget notes at end of section IV.

Deliverable	Completion Date	Budget
1. ***Correlation with ecological, physical, and local conditions***	***11/30/2010***	$42,000
2. ***Web-based time-lapse video files of results across Minnesota***	***1/30/2011***	$11,000
3. ***Analysis and reporting***	***6/30/2011***	$40,946

Result Completion Date: 06/30/2011

Final Report Summary:

Stages of analysis

(1) Daily data were collected by the United States Historical Climate Network (USHCN) and processed into smoothed monthly data. This step was performed by the USHCN. However, when we were pursuing the use of daily data, we were required to perform such a step, so it is relevant here.

(2) The monthly data was extracted from the USHCN files in which it was packaged.

(3) A subset of stations, regions, and/or months was selected and 30-year averages, stabilities, growth rates, and other relevant properties were calculated.

(4) Mathematical climatic surfaces were fit to these results.

(5) A set of geographic relevant points on the intersection of the climate surfaces were chosen, mapped to the surfaces, then tracked over time.

(6) Properties of the movement of the points (velocity of a point's entire track, velocity of a portion of its track, indicators of goodness-of-fit) were calculated.

(7) The surfaces and/or tracked points were overlaid on maps of the geopolitical terrain they traversed.

Each of the above steps was distinct in its requirements and different tools were therefore developed for each, using a programming language suitable for each step. Details on the programs, languages, and alternatives for each step are documented below, as a record and as an aid for those who would adapt these methods to other regions of the world.

(1) Generation of monthly data. USHCN daily data, initially hoped to provide valuable insights into discrete, extreme weather events proved untenable to work with for reasons stated earlier in this report. Programs and code for this step were developed by other parties in conjunction with the USHCN. Information on the USHCN generation of monthly data is available on the USHCNv2 Monthly Data website.

(2) Unpacking of monthly data. Throughout the project, the code for this process was written in the programming language C or C++. C compiles to computer code which, appropriately written, is extremely fast and efficient. It also allows excellent management of computer memory. Both of these properties were important, given that the USHCN daily data consumes 1.6GB and that intermediate processing steps require an additional 2-3GB of main memory (RAM). While we ultimately did not employ the daily data, we do not rule out its use in future projects we or others conduct. C is a widely-used and well-understood language. Therefore, when we began work with the monthly data, code was again developed in C. Code to unpack Canada's daily climate data was also developed. This code base is accessible from other programs via function calls and represents a unified module for accessing the climate data of the majority of North America's land mass. The source code is available on this project's website.

(3) Calculation of averages. The code developed for this step was small, specific to the processing needs of this project, and therefore has a lower probability of reuse. Nonetheless, it is also available on the website.

(4), (5) Fitting of Surfaces/Tracking of Points. Commonalities in these two steps allowed the same language for both and many functions could be shared. The prototype code was developing using William Waite's Stage2 general purpose macro processor to produce Mathematica analysis scripts, the results of which were again passed through Stage2 to develop output suitable for mapping. This required some manual intervention and human judgment. The actual code for surface fitting and intersections was prototyped in Matlab and programmed in Python for speed and generality. The Stage2 pre- and post-processing steps were folded in Step 3 (calculation of averages) and the manual steps were automated to remove the need for human intervention.

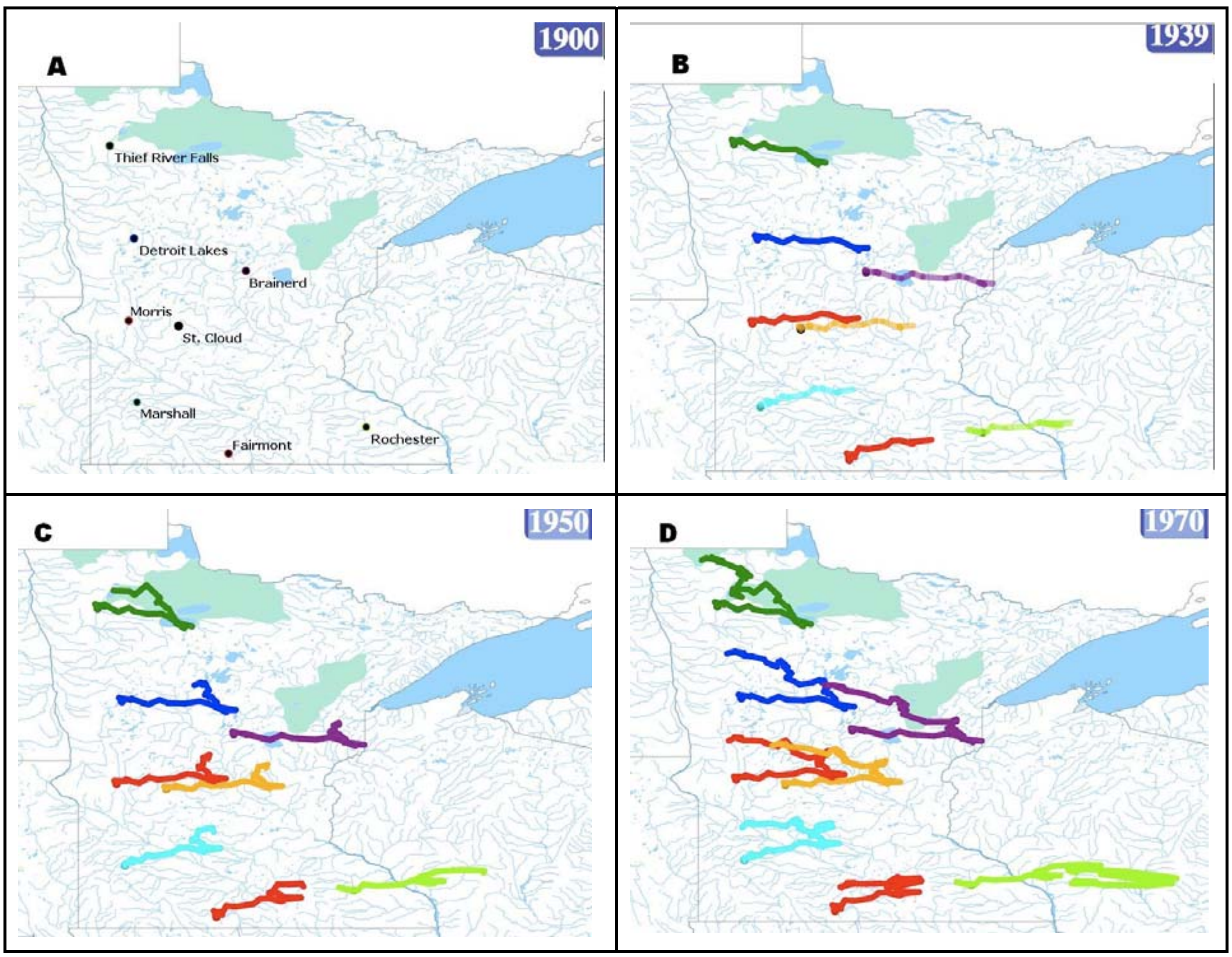
(6) Calculation of track properties. The track was represented by a series of GPS locations, one per year. Great circle distances between each sequential pair of points in the track were calculated in Javascript (see below) to reduce communication times. From these, the overall velocity and directional components of velocities of any subset of the track were calculated.

(7) Map overlay. Finally, we instituted procedures to make the map overlay step as intuitive, useful, accessible, and powerful as feasible, and available by web access. For those wishing to adapt our work to other applications, the technical details are as follows: A client-side

AJAX/Javascript/OpenLayers web application was developed to run with a Unix/Apache/PHP/SQL server stack. On the client-side, the web interface uses the open-source OpenLayers framework to display geopolitical maps of the areas of interest. We supplied the USHCN station information and the locations of all the stations. Specific instances of these were selected and climate surfaces fit (see above) to the selected stations using BASH scripts to run steps 2-4. The researcher may then select any point on the map, thereby initiating another AJAX request to launch a BASH script which runs step 5.The server returns the GPS points of the track. Step 6 is then performed on the client side using Javascript and the OpenLayers framework. Finally, the tracks were displayed using the Openlayers framework and made interactive through Javascript controls on the page. The resulting graphical interface allowed researchers full access to the analysis products of this project while being simple enough for anyone to use.

Artifacts of a moving climate

Parameters were expanded to explore other relevant aspects of a moving climate within participants' areas of expertise, such as forestry, forest pests, agriculture, wildlife, and biomass energy production, especially along ecosystem intersections. Participants targeted perceptible artifacts of climate change trends in related fields, such as the historical velocity of climate movement.



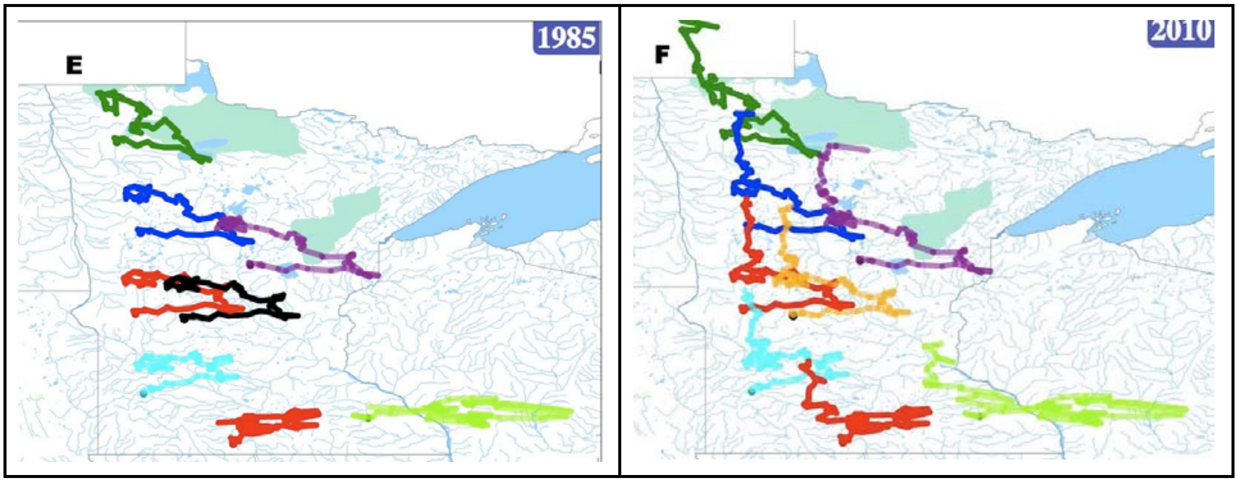


Figure 3A-F. Climate tracks for eight Minnesota cities.

A) Continuous, reliable weather station data, including monthly precipitation and temperature averages, began in Minnesota shortly after 1900 and is now curated by the USHCN. In this figure 30-year climate averages are tracked, originating from eight Minnesota cities representing some of the diverse environments throughout the state. A lateral movement is a change in precipitation (i.e. an eastern movement indicates dry, prairie rainfall patterns moving into a forest environment), and a north or southward movement indicates climatic temperature changes, where northward movement is warming and southward is cooling.

B) For four decades, from 1900 to 1939, the climate in all eight cities marched to the east at an average rate of 4-5 miles per year. The five southern cities had a small northward component. For example, Fairmont was moving northward at 1.30 miles per year during this period. The three northern cities had a southward component to their trajectories or tracks, averaging between 0.5 and 1.21 miles per year. Interestingly, the eastern extent of all eight climate tracks was reached in synchrony in 1939. In 1940, the tracks double back on themselves, indicating higher precipitation. The Dust Bowl in Minnesota lasted from 1933 through 1940 (Albertson and Weaver, 1944), then ended abruptly when precipitation resumed. These eight climate tracks clearly mirror the progress and sudden end to the climatic dust bowl conditions.

C.) The next decade, from 1940-1950, the climate of southern Minnesota tended to “hover” close to the eastern extent of its track, but in northern Minnesota the climate had already begun its retreat westward. In fact, by 1950 the Thief River Falls climate track had already achieved the entire western movement that it would regain immediately following dust bowl conditions. This suggests that northern Minnesota experienced climatic relief from the Dust Bowl earlier and more steadily than southern Minnesota.

D.) Two decades later, by 1970, the westward-retreating climate in southern Minnesota had caught up with the western movement of northern Minnesota. In terms of precipitation, most climate tracks ended near their original pre-1930s location. However, the temperature component had shifted somewhat northward. From 1900-1970, the northward velocity for all cities was between 0.5 and 1 miles per year.

E) A second period of climatic “hovering” with relative stability was 1970 to 1985. This is visible on the eight cities’ tracks by the tight “knots” where the climate had little net movement in any direction. An isolated, short-term burst from northwest to northeastward around 1988 corresponds to a damaging drought suffered in Minnesota and across the Midwest that year.

F.) In 2010, the climate tracks were heading almost due north. The east and west components were negligible, except for the tracks originating in Thief River Falls moving 1.3 miles per year eastward, and Brainerd, which abruptly added a 3.18 miles per year eastward component in 2009. The reason for this is not yet clear.

Notes: 1.) These tracks can be recreated on the website by loading all 33 Minnesota stations along with stations near MN borders, for a total of approximately 66 stations. See www.cbs.umn.edu/climatetracker for detailed instructions. 2.) The track originating in Rochester (light green) is included to illustrate results of choosing an area near the edge of the selected stations. To create a good fit, choose stations that are evenly distributed around the area of interest, including stations in neighboring states and Canada.

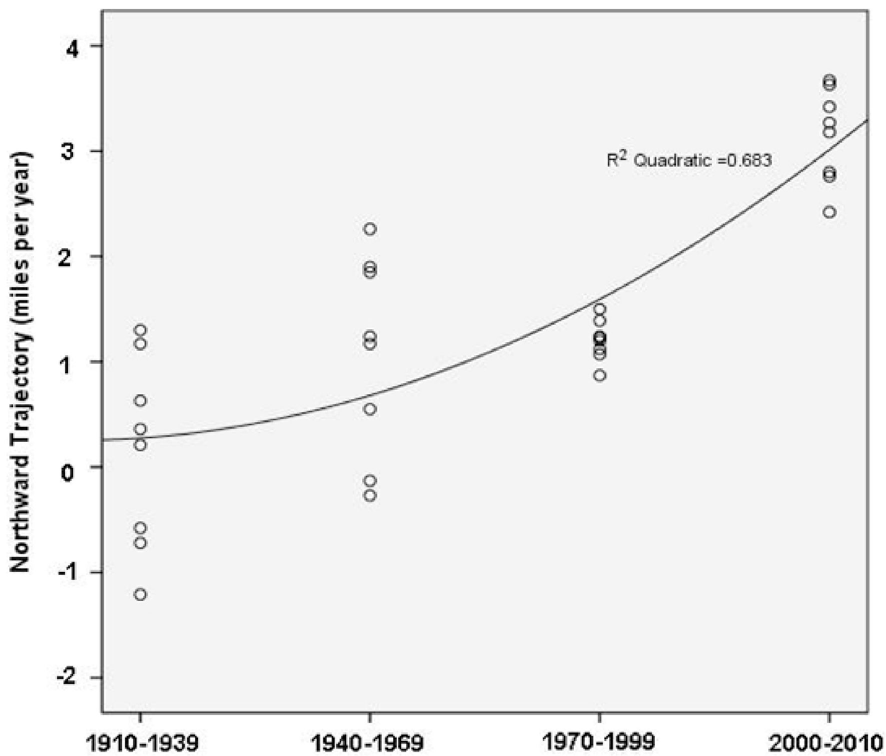


Figure 4a. Northward components of climate trajectory for eight MN cities are plotted for the time ranges indicated. The cities, mapped in Figure 3A, decrease in range of trajectories, and increase in overall speed over time.

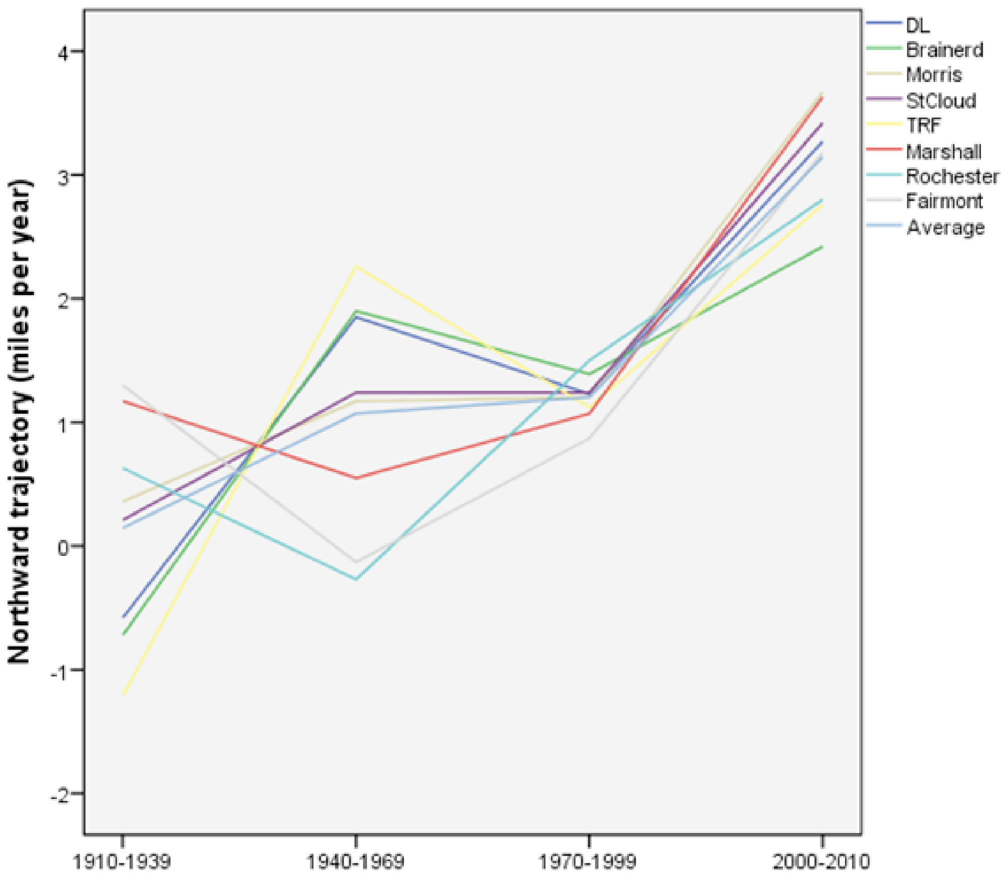


Figure 4b. Northward components of climate trajectory for eight MN cities are plotted for the time ranges indicated. Tracks that were initially moving southward (Thief River Falls, Brainerd, and Detroit Lakes) were decidedly moving northward by the 2000-2010 period.

Loarie et al. (2009) calculated climate velocity---the rate at which a given climate would move across the landscape annually during the present century---under a business-as-usual greenhouse gas emission scenario (IPCC A1B). Although the global mean velocity was projected to be 0.26 miles per year (0.42 km/yr), faster velocities of 0.6-4.0 miles per year were projected in flat areas of continental interiors such as Minnesota. Galatowitsch et al. (2009) estimated climate migration rates of 3.0-3.9 miles per year from SSW to NNE for each of eight ecoregions of Minnesota between 1970-1999 (midpoint, 1985) and 2060-2069 (midpoint, 2065). These indirect estimates for velocity of climate migration through the middle to late 21st century are in accord with the observed rates of northward climate migration in recent years from this project, of approximately 3 miles per year. Thus, this project provides independent confirmation of conclusions based on more abstract global circulation models.

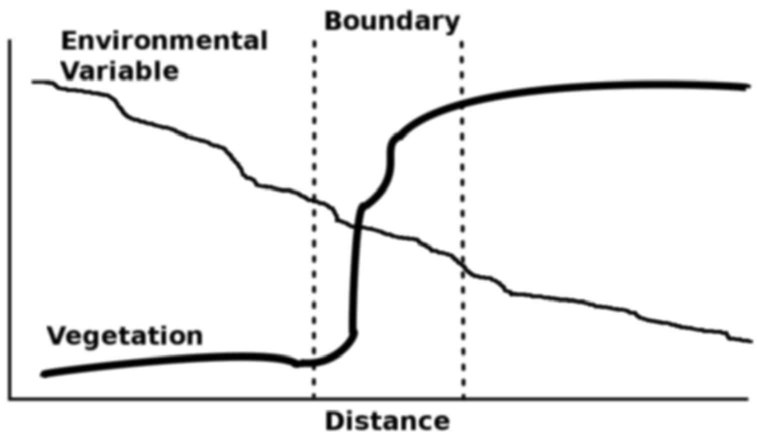


Figure 5: The general form of observations of biome boundaries. Environmental variables, such as precipitation and temperature, vary smoothly over distance, but vegetation, such as percent tree cover, shows a much sharper transition

Other authors (e.g. Danz, 2011; Fagan et al., 2003) have observed sharp changes in vegetation across smooth transitions in climate variables. An example of such observations is depicted in Figure 5. If we combine this observable fact about the world with the mathematics of the Climate Tracker, an interesting result emerges. The slope of a climate surface along a climate track is given in units such as “degrees per meter per year” or “inches of rainfall per meter per year.” Since climate track segments are each a year long, each segment is associated with a value in “degrees per meter” or “inches of rainfall per meter.” Multiplying the reciprocal of this figure (“meters per degree”, “meters per inches of rainfall”) by the derivative of the vegetation function (“% vegetation per meter”) gives an output in “% vegetation per degree” or “% vegetation per inch of rainfall.”

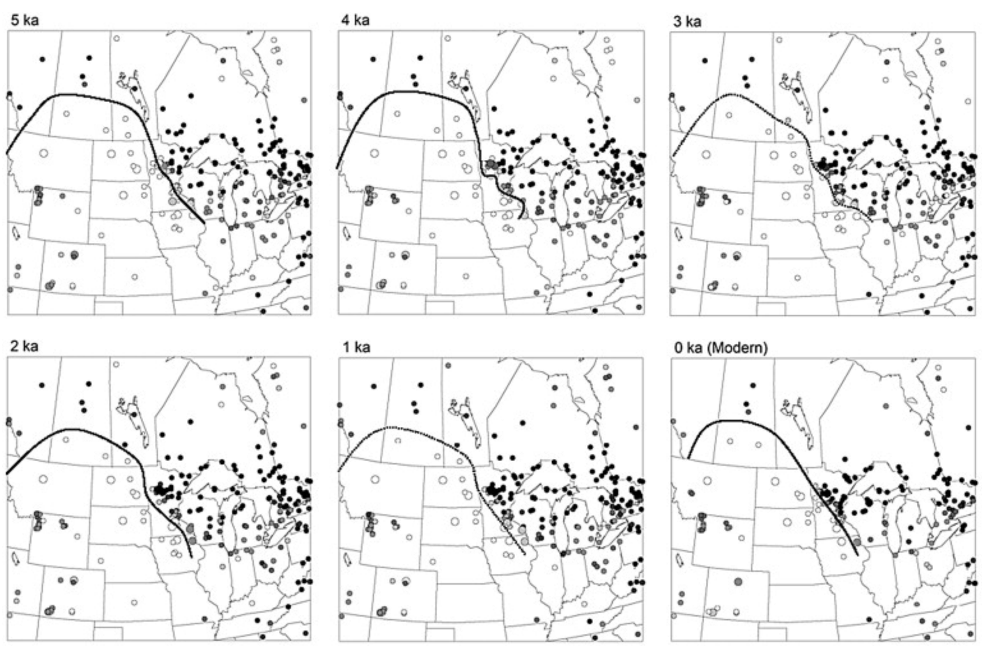


Figure 6. Williams et al. (2009) used fossilized pollen to determine the position of the prairie forest border for the last 11,000 years. This excerpt of their figure shows the boundary’s mobility over time.

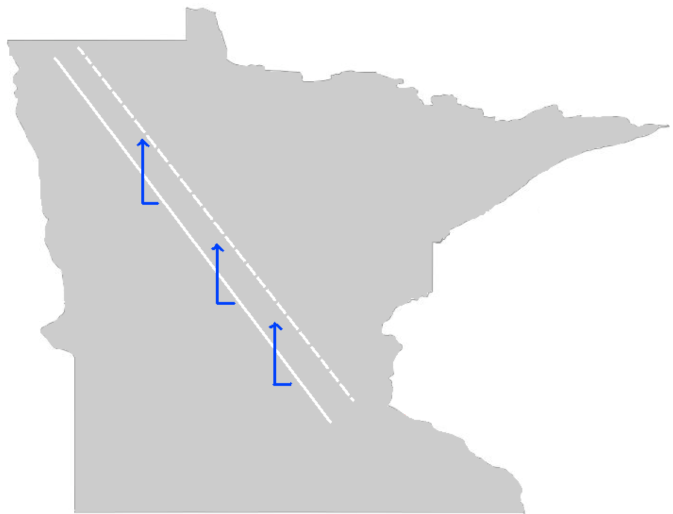


Figure 7. A schematic illustrating how a slight westward climate movement followed by northern movement can actually move the initial prairie forest border (solid line) eastward (dotted line).

Qualitatively, vegetation changes across space are steepest at boundaries, so the effects of fluctuations in climate will manifest themselves strongest and foremost there. In the past, boundaries occurred predominantly at the edges of ecosystems, but, since the effects are general, strong climate forcing should occur at any boundary. As Minnesota's landscape has become fragmented in the past century, this forcing applies to much of the state. On a large scale, the present trend in Minnesota is to push the prairie-forest boundary slightly to the west as the state's climate tracks move west, and to push its southern boundary strongly to the north in accordance with the trends in the climate tracks. However, because the prairie-forest border slants northwest to southeast, the net effect is that the border is moving to the east (Fig. 7).

Implications for state and national parks and other protected places

Minnesota's climate is moving northward at approximately several miles per year. Many individual species, especially plants, migrate much more slowly. However, invasive pests move faster. A worst case scenario for a species is that climate will shift its habitat faster than it can keep up while simultaneously introducing large numbers of predators. Sandel et al. (2011) state that "low-velocity areas are essential refuges for Earth's many small-ranged species." We consider possible outcomes for selected species below, but, for now, take a more general view.

Changing climatic parameters alone are rarely responsible for a species's extinction; rather, it is the impact of these changes on a species's environment.

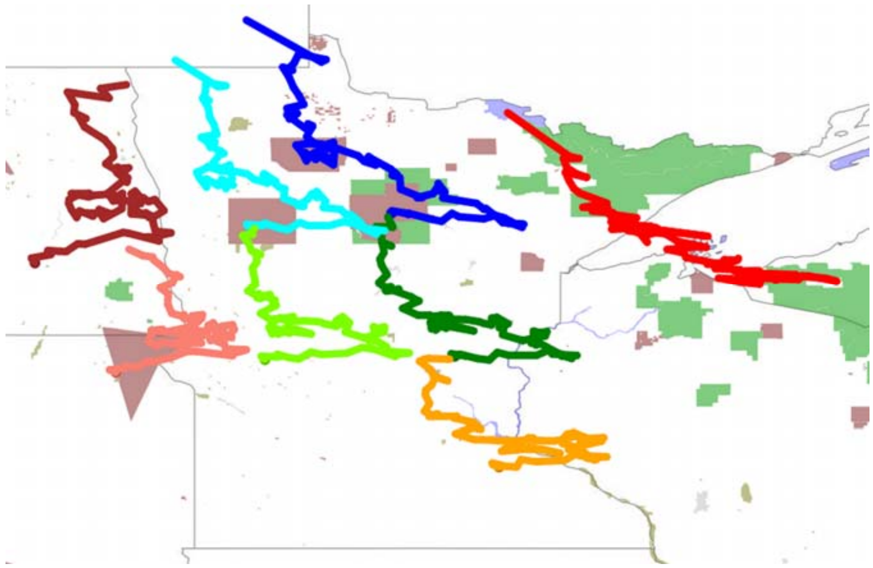


Figure 8. Climate tracks overlaid on federal lands in Minnesota and surrounding states

Overlaying climate tracks on federal lands in Minnesota and its surrounding states shows that residence times for a particular climate point within any given parcel of protected land are brief. None of the presently protected lands in effected areas of Minnesota would have been sufficiently large to contain the precipitation variation of the Dust Bowl. Fortunately, this fluctuation was not long lived. No single parcel of protected land has proven large enough to contain recent variations.

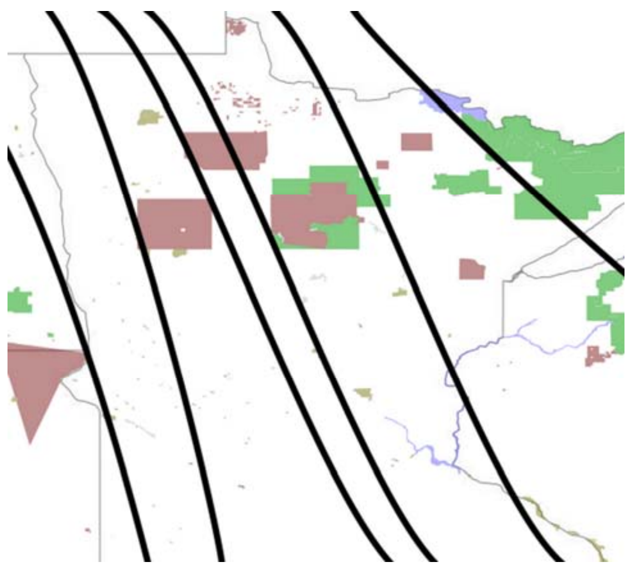


Figure 9. Generalized past and future climate paths in Minnesota

However, the serendipitous alignment of some protected lands, such as Paul Bunyan State Forest, Itasca State Park, the Red Lake region, and protected areas in Canada by the Northwest Angle form a “conservation parkway” along which climate pressures may push ecosystems. The Superior National Forest, Boundary Waters Canoe area, and Quetico Provincial Park form another such parkway. Other protected lands, such as the Dakota Tallgrass Prairie do not lie in such parkways and do not have other safe refuges to relocate to.

While individual species with low tolerance for climate change may conceivable be identified and transported to or replanted in new locations, this introduces them to new and subtly different environments with unknown ramifications. Ensuring clear paths for ecosystem movement helps maintain existing interspecial relations and may provide the most cost-effective method for preserving large numbers of species in the face of change.

Existing protected lands under state and federal schemes have served as a foundation for previous conservation efforts, yet they were not designed to conserve against all possible pressures. While our protected areas are fixed in space, the climates which give rise to the forests, grasslands, and species being protected are mobile.

Idle agricultural lands, patch forests, and marginal wetlands can all play roles as intermediate locations for ecosystems transitioning from one protected area to another. In other locations, they may be the only locations to which an ecosystem can move.

Species disperse at different rates and some may require special attention, others are of special interest. These are discussed below.

Implications for species movement

Climate velocities of several miles per year are considerably faster than rates of tree migration during the deglaciation of North America, which ranged from 0.06-0.25 miles per year for a variety of tree species (Davis 1981). Although some species that are capable of more rapid migration, such as aspen, were not mapped by Davis (1981), many species common to Minnesota today, such as jack, red and white pine, spruce, fir, oak, hickory and maple were analyzed by Davis (1981) and fall within the range above, and are unlikely to be able to migrate fast enough on their own to keep up with their optimum climate.

On the other hand, pests and diseases of trees, both native and exotic, can spread at least as fast as the climate. Dutch elm disease, chestnut blight, butternut canker, emerald ash borer, balsam woolly adelgid and hemlock woolly adelgid, for example, have moved much longer distances, having covered 300-1000 miles or more in one to several decades. Rates of spread of 12-20 miles per year occur for exotic fungal diseases such as Dutch elm disease and chestnut blight (Evans and Finkral 2010). Athough rates of spread for insect pests of trees are somewhat slower (5-8 miles per year for adelgids and emerald ash borer), many insects actually move substantially faster than that due to long-distance jumps caused by human movement of infested wood or nursery stock (Evans and Gregoire 2007, Liebhold and Tobin 2008).

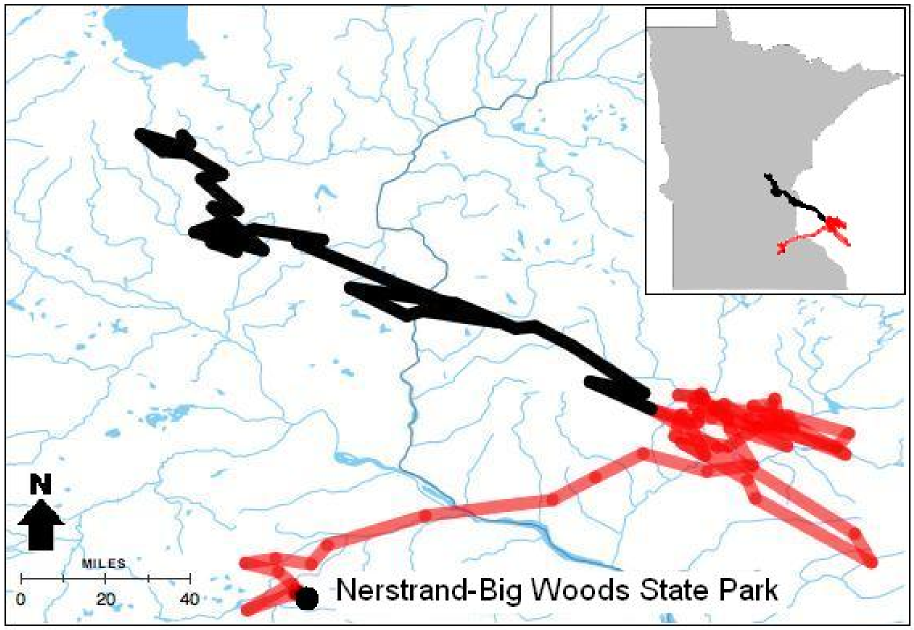


Figure 10. The climate track for Nerstrand-Big Woods State Park is shown from 1900-2010, with the years 1980-2010 indicated in black. This state park contains some of the only remaining native wildflower, Minnesota dwarf trout lily.

Dwarf trout lily

The Minnesota dwarf trout Lily (*Erythronium propullans*) is a federally endangered wildflower found nowhere else on earth other than maple-basswood forests in three counties in southeastern Minnesota (Rice, Goodhue, and Steele Counties; Sather 1990). The Minnesota dwarf trout lily may face the same problem as other rare native species with small isolated populations: namely that in a rapidly changing climate, it could be impossible for the species to migrate across a fragmented landscape at a rate necessary to keep up with its preferred climate. Climate Tracker shows that the climate of Nerstrand Bigwoods State Park, one of the locations where Minnesota dwarf trout lily grows, is moving north at an average of 2.70 miles per year between 1980 and 2010 (Fig. 10). This is faster than most native wildflowers can migrate (Cain et al., 1998), making the Minnesota dwarf trout lily a potential flagship species for how climate change will impact a large number of other rare native plants growing in fragmented habitats.

Canada Lynx

The Canada lynx is a large cat that is dependent on northern forests, including conifer forests, and young mixed birch, aspen and conifer forests and shrublands. In addition, deep snow cover for several months each year is necessary to support its principal prey species, snowshoe hare (McCann and Moen 2011). Northeastern Minnesota contains one of five critical habitat units in the 48 states for Canada lynx, which is federally listed as threatened in the contiguous U.S. (http://www.fws.gov/mountain-prairie/species/mammals/lynx/). The historic range of the Minnesota lynx includes the northern tier of counties, therefore the species could move out of the state within several decades if the climate continues migrating north for the last 30 years, as Climate Tracker has demonstrated.

Western Prairie fringed orchid

Western prairie fringed orchid (*Platanthera praeclara*) is a federally threatened plant that grows in medium to wet prairies and meadows (http://www.fws.gov/midwest/ endangered/plants/prairief.html). The species is threatened because of conversion of most prairies to farmland throughout its range. This is one species that may benefit from an eastward movement of the prairie-forest border in Minnesota, as Climate Tracker shows occurred during the mid 1900s, and may occur in the future. This is because large areas of public wildland that are unlikely to be converted to agriculture, and which may convert from forest to grassland with a changing climate, exist just to the east of its current range in northwestern Minnesota.

Mesophication of oak forests (SE, E and central MN)

A phenomenon known to foresters as 'Mesophication' has occurred from the 1950s through the 1990s in Minnesota and elsewhere across the lake states and northeastern U.S., during which the maples have steadily invaded oak forests. Oaks (e.g. northern red oak and white oak in Minnesota) grow best on well drained sandy soils, but may invade silty (i.e. mesic) soils during periods of dry climate, whereas maples (e.g. sugar maple and red maple) grow best on silty soils but may invade oak forests on sandier soils during periods of wet climate. Although consumption of oak seedlings by deer have helped maple, as has a lack of fire, a wetter summer climate likely underlies this maple expansion (McEwan et al., 2011), and this is shown by the westward expansion of climate in Minnesota in Climate Tracker during the mid 1900s (Fig. 3D).

Forest to grassland transitions

The northward and eastward track of climate in Minnesota in recent years, if it continues as expected, will present standing forests with environments typical of prairies. Forests can survive in such environments, but events such as wildfire or insect invasions can induce damage from which forests will have difficulty regenerating. Therefore, some places in Minnesota that are presently wooded can be expected to give way to more open grasslands.

A transition from forest to grassland ecology has multiple implications for the people of Minnesota, and for tourists visiting Minnesota, both positive and negative. For example, forest-based economies can adapt economically by harvesting grasslands rather than woodlands for bioenergy. Ongoing research sponsored by the Environment and Natural Resources Trust Fund and other sources has indicated harvesting to be an alternative that can encourage wildlife diversity and a sustainable ecosystem (Jungers et al., 2010). This research, on established prairie in the north-west, west-central and south-west regions of Minnesota, is also examining the economic, nutrient, and yield potentials for perennial grass biofuels, and the present project thus has relevance to that.

Prairie-forest border

In Minnesota, the prairie-forest border extends from the northwest along a curved path toward the southeast. Along the way is the triple point, where conditions conducive to northern needle-leaf trees give way to broad-leaf trees. This border has been characteristic of

Minnesota for thousands of years. But what is happening to it now, and what may happen in the foreseeable future?

The climate track over recent decades has a northward component and a slight lateral component. The westward component represents the wetter climate of eastern Minnesota moving slowly west, and the northward component represents warmer climate of southern Minnesota moving slowly north.

The slight lateral component is more pronounced in southern Minnesota and barely perceptible in the north (see Fig. 3). This means that the climatic conditions of the prairie-forest border are moving north and at the same time rotating to the east. In other words, the prairie-forest border is shifting to become more north-south than it has been. If these trends continue, northern parts of Minnesota will be more susceptible to changes than the south. This is notable since the north is favored for weekend retreats by Minnesota residents and out of state tourists alike. Fortunately, the northeast triangle, with its canoe-country lakes and forest, will be the latest to be affected, affording the most time for amelioration of global conditions that might be influencing environmental trajectories.

Overall location of the boundary between the original grasslands and forests in Minnesota was determined by climate, especially the balance between rainfall and evaporation and use of water by the vegetation—when this balance is positive (more rain than evaporation), forest is favored, and when it is negative, grassland is favored. Other factors such as sandiness of the soil, nearness to water bodies and topography fine tune the location of the prairie-forest border, creating the small twists and turns that occur at the township level (Danz et al., 2011). Climate Tracker shows that the climate favoring prairies moved east during the early 1900s, but then receded west during the mid 1900s (Fig. 3).

Implications for agriculture

The Climate Tracker suggests possible trends, so there is much future potential for collaborations with agriculture. Long term agricultural records of crops and yields by the USDA in many case are far more complete and accurate than records of non-commercial natural ecosystems. Therefore, agricultural archives form a good basis for comparisons with Climate Tracker models.

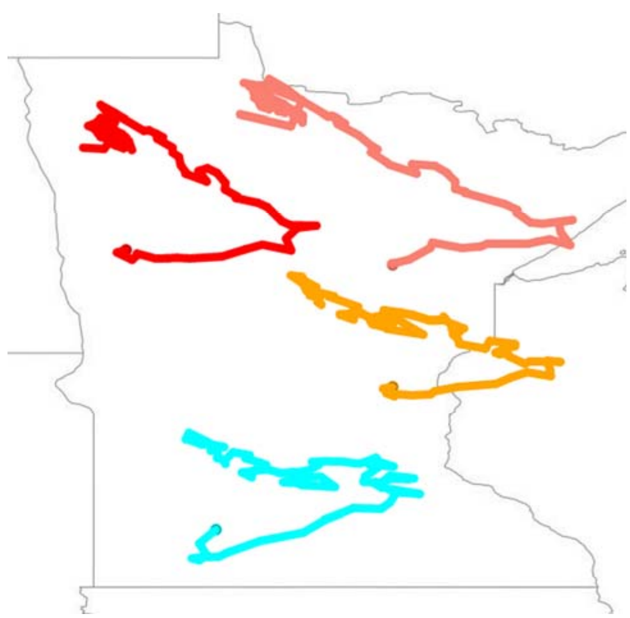


Figure 11. Growing-degree day tracks in Minnesota, with precipitation as the second climate variable

Growing-degree days are a widely used metric of an area's potential agricultural productivity. Days with an average temperature below 50°F are said to have no growing-degrees. At 51°F, one growing-degree is accumulated; at 52°F, two growing-degrees are accumulated. At 86°F this trend stops and no more growing-degrees are gained for higher temperatures. Put another way, there is a temperature below which a given plant will not grow appreciably, and a temperature above which it will not grow any faster.

Substituting growing-degree days for temperature in the Climate Tracker yields an interesting result. Though temperatures in the state continue to rise, and climate tracks continue to move northward, growing-degree tracks in the north part of the state stalled in 1966 and have hovered since then. The south part of the state has seen continued movement, but larger as a result of changes in precipitation. Though the northern part of the state continues to warm, and to do so more quickly than the south of the state, the effects of fluctuating climate will be felt most strongly in the state's southwest.

Implications for bioenergy

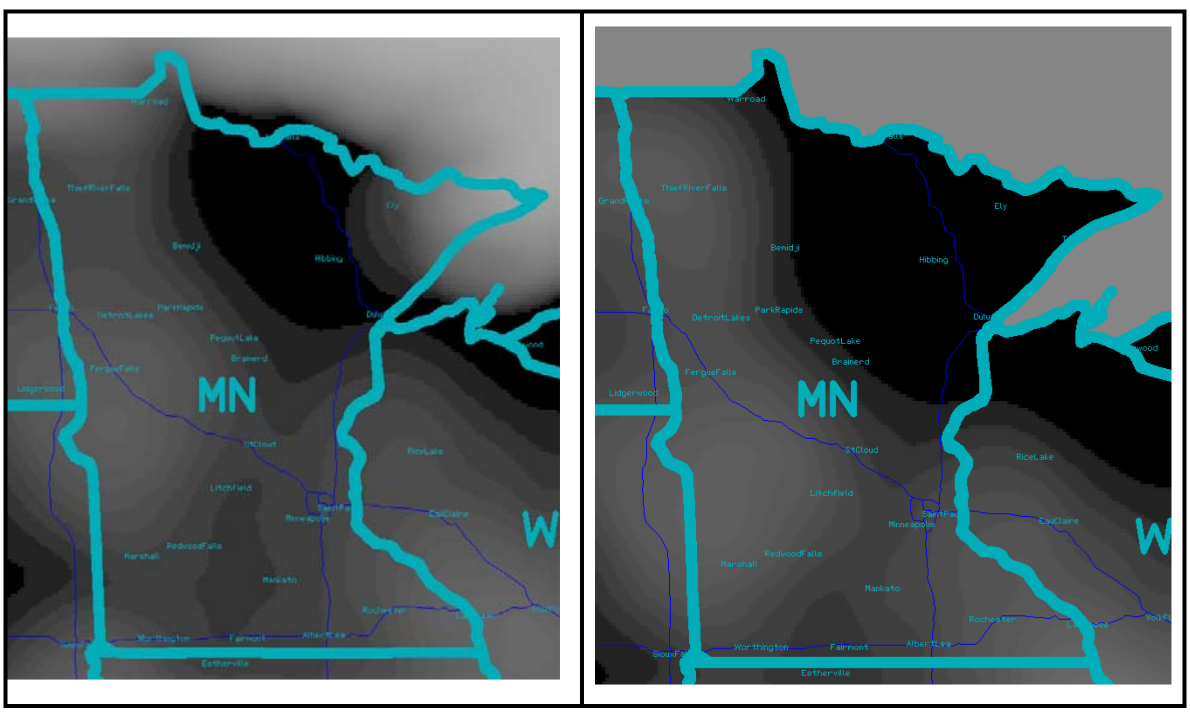


Figure 12. Grassland bioenergy potential now (left) and if growing conditions shift 60 miles northward (right). The broad bioenergy hotspot presently south of Fergus Falls remains within Minnesota, but the one presently near Thief River Falls moves largely out of the state. An area in the south-central that is not ideal for grassland bioenergy expands and moves north. The hotspot appearing in the Arrowhead Region is partly an artifact of the processing, to be refined as the paper describing these results is completed. Results are obtained, for each point of the landscape, from USDA databases, by (1) calculating the number of acres of former cropland in the neighborhood of each point that could be applied to grassland bioenergy, (2) multiplying by the yield per acre of production grasslands nearby (left) and 60 miles to the south (right, representing climate velocity of 3 miles per year for 20 years), (3) summing available energy production within a 50-mile radius of each point.

Implications for infrastructure

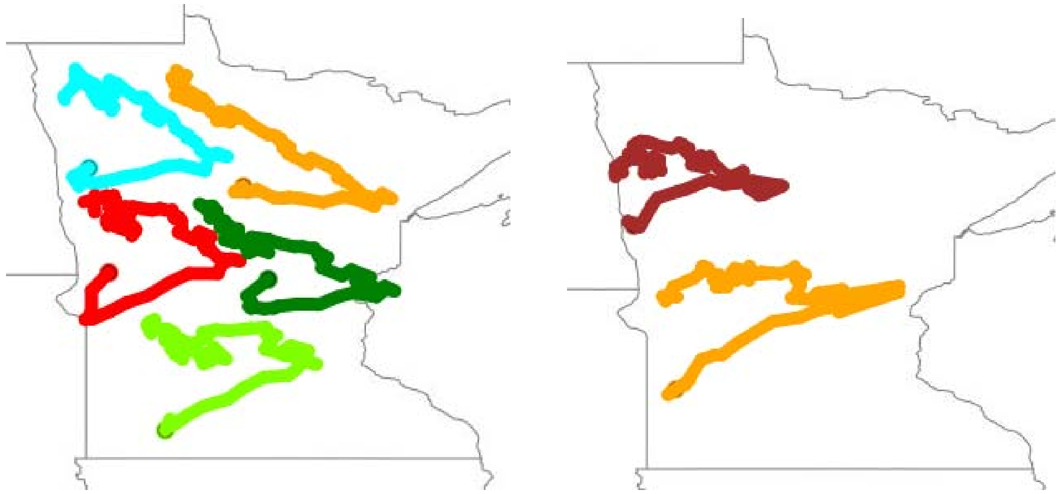


Figure 13. Climate tracks for cooling-degree days are depicted on the left while climate tracks for heating-degree days are depicted on the right.

While a full analysis of the impacts of climate on infrastructure was not part of the scope of this project, we include a partial analysis here. If only yearly average temperatures are considered, the Dust Bowl cannot be said to have had a large effect on the state's temperatures. Cooling- and heating-degree days tells another story.

Cooling-degree days are the difference between the average daily temperature and 65°F, neglecting those days cooler than 65°F. They accumulate over a year. Similarly, heating-degree days are the difference between 65°F and the average daily temperature, neglecting those days warmer than 65°F. Put another way, cooling-degree days can be thought of often and how strongly one's air-conditioning must be turned on, whereas heating-degree days represent how often and how strongly one's home heating must be turned on.

During the Dust Bowl, the need of both heating and cooling increased, which indicates years having both more days which are warm and more days which are cooler, or, overall, more days which are farther from being 65°F. As the Dust Bowl's eastward excursion ended in 1940, heating-degree days leveled off throughout most of the state. Heating infrastructure needs, then, have remained largely constant for the past seventy years.

Cooling-degree days are different, where cooling needs have remained essentially unchanged in southern Minnesota for the past seventy years, while northern Minnesota, and especially northeastern Minnesota, has an increased need for cooling.

Despite these trends, the *impact* of heating- and cooling-degree day fluctuations over time is not as easily assessed. Changing building codes, better forms of insulation, the introduction of central air, and double-paned windows have all played a part in determining the social and economic impacts of these changes. While projecting future infrastructure needs is outside the scope of this project, it is an example of how Climate Tracker may be useful outside of the biosciences.

Reporting to the public and scientific community

A project website presents the final products of the project to the public (see Appendix A). All data sources are listed and explained. All of the code and tools developed for the project are being made available for public download and analysis. Project contributors and biographies are listed. Funding sources are credited for their contributions. As publications resulting from the project become available, they will be added to the site and explained in accessible terms. The project's methodology is explained pictorially on the website, with examples drawn from actual Minnesota data. Appendix B contains this information, intended as an easy-to-understand explanation of the methods used in this project.

The site also includes access to the application developed during the project to facilitate extraction of climate data. Website visitors are able to select regions they find relevant and ask, for any point, where its climate conditions have been and are going. It provides citizen access to the data, devices, and developments of this project, making the information available to all.

In addition to the website, the project has been described in presentations by investigators and participating students, including:

- Clarence Lehman, University of Minnesota Open House. Environmental issues booth, 25,000 people in attendance. October 4, 2009.
- Clarence Lehman, Fertile, MN. October 22, 2009.
- Clarence Lehman, Glacier Lake State Park, MN. October 29, 2009.
- Clarence Lehman, Talcot Lake Wildlife Management Area, MN. November 19, 2009.
- Esther Widiasih, The Comparison of Different Projections for Environmental Trajectories Global Circulation Models vs. Surface Fitting Models. Mathematics of Climate Change Seminar. May 5, 2010.
- Clarence Lehman, keynote presentation at Tallgrass Prairie for Biofuel Conference, Guelph University, Ridgetown, Canada. May 25, 2010.
- Clarence Lehman, CIG Wildlife and Biofuels Demo. October 19, 2010.
- Richard Barnes, University of Minnesota Student Sustainability Symposium. October 28, 2011.

Anticipated publications

This project has uncovered new principles that deserve publication in the general literature of environmental science. Future papers are anticipated to cover (1) the methods developed to obtain the results described in this report, for those who want to extend these results to other areas of the globe. (2) Comparison of rates and directions of change between the new methods applied here and the projections from existing, more complex global circulation models. (3) Comparison of trajectories and speeds among climate, Minnesota's flora, and disruptive elements such as insect pests, pathogens, and fire. (4) Similarities and contrasts with conclusions from the USDA Forest Service Climate Change Tree Atlas. (5) Projections of agricultural concerns, including prospects for locations of 90 versus 100-day corn.

Budget notes

The project was completed under budget, since one anticipated item was not necessary and two were funded from other sources. In particular: (1) Special papers and inks for preparing maps and other results were not needed, since web development resources have advanced enough over three years that maps can be produced interactively for specific purposes, for $861.00 saved. (2) For in-state travel, dissemination to the public was able to be funded through a federal USDA Conservation Innovation Grant, as described above, and travel to understand the weather data was able to be accomplished by electronic communication, for $1600.00 saved. (3) Some funds that we expected to apply to a project video to make the results more accessible to citizens had to be done concurrently with the preparation of this report, hence after the project funding period. That video, available on the project website, was funded by the University of Minnesota, for $3500.00 saved. A total of $5961.00 is being returned to the state.

Concluding remarks

Projecting the climate tracks shows Minnesota's future as it *might be*, not as it *shall be*. Some changes are happening now and other short-term changes are probably unavoidable. But if the recent rate of the climate track continues at a few miles per year northward, it will take most of a century for all of Minnesota to have the climate of a prairie state, unconducive to northern forests. A century is only a single human lifetime, but it is a vast span in the course of modern civilization. There is still time to implement known methods of environmental improvement (e.g. Pacala and Socolow, 2004), enough of which will help restore equitable conditions of the past, and there is nearly a century of future innovations that could arise. We hope that studies such as ours will help clarify the environmental changes that may occur, and encourage new environmental efforts by showing that we may still have enough time to halt some of the possibly detrimental effects.

Project goal summary

In a multi-year, multi-faceted project like this, the basic goals and research questions can be lost in the discussion. To summarize the status of the project objectives, here are the proposed, completed, discontinued, and exceeded aspects, followed by future outgrowths of the project.

<u>1. What we proposed to do, per the deliverables:</u>

- Assemble data in suitable format; construct a database
- Adaptation and automation of pilot programs
- Develop computer runs and production of working maps and tables
- Correlation with ecological, physical, and local conditions
- Develop web-based time-lapse video files of results across MN
- Analysis and reporting, including:
  - Delineation of areas having future potential for renewable bioenergy production,
  - Ranges of locally threatened or endangered species,
  - The movement and velocity of climate near particularly vulnerable ecoregions, such as the prairie-forest border in Minnesota,
  - Areas of increased dangers of fire and climate-related movement of pests and diseases of trees, both native and exotic,
  - Artifacts of major historical shifts in climate in Minnesota.

<u>2. What, of that, we did:</u>

- Assemble data in suitable format; construct a database

  *Completed as of final report; see "*Assembly of daily data."

- Adaptation and automation of pilot programs

*Completed as of final report; see “*Production of working maps and tables.*”*

▪ Develop computer runs and production of working maps and tables
Please see number 3, below, as work went beyond what was proposed.

▪ Correlation with ecological, physical, and local conditions:
*Correlation with local conditions was enhanced once Climate Tracker matured to allow backwards tracking. Now, it's possible to easily see what area was experiencing a set of known climate conditions one to one hundred years ago. Correlation with ecological conditions is addressed in sections “*Implications for species movements,” “Implications for bioenergy,” *and* “Implications for agriculture*.” Correlation with physical conditions is most obvious during the Dust Bowl years, and in less dramatic fashions, the droughts Minnesota suffered in 1977 and 1988.*

▪ Delineation of areas having future potential for renewable bioenergy production,
An example of delineation of bioenergy potential production areas is shown in Figure 12. This is based on analysis of USDA productivity and land availability. The methods used to create that figure are being expanded to other bioenergy and other agricultural aspects, such as corn and other commodity crops. Please see point 5, below for discussion of the future pursuits on this topic.

▪ Ranges of locally threatened or endangered species,
*The impact of climate velocity on Minnesota native and invasive species is discussed generally, along with several examples of specific species of interest in Minnesota; please see “*Implications for species movement.*”*

▪ The movement and velocity of climate near particularly vulnerable ecoregions, such as the prairie-forest border in Minnesota,
The final report addresses the vulnerability of the prairie-forest border. This addendum expands on this discussion by addressing the general mathematics of borders, which have implications for landscape fragmentation, and by discussing how climate tracks interact with protected lands; please see “Implications for state and national parks and other protected places”

▪ Artifacts of major historical shifts in climate in Minnesota.
The Dust Bowl years of 1933-1940 are the clearest artifacts of historical and historic climate identified by the Climate Tracker. Please see maps in Figure 3 - or use Climate Tracker to create new maps - which breaks down portions of the climate tracks for eight Minnesotan cities. In the discussion, shifts in climate are pointed out as they are encountered. Additionally, the Dust Bowl is depicted within the context of growing-degree days, an agriculturally-relevant metric of productivity.

▪ Develop web-based time-lapse video files of results across MN
Please see number 3, as work went beyond what was proposed.

<u>3. What we did beyond what we proposed</u>

▪ Develop computer runs and production of working maps and tables, and
▪ Develop web-based time-lapse video files of results across MN
The Climate Tracker application was initially intended to be a tool built for the sole use of the researchers on this project. However, the results were visually enlightening, so special effort was invested in making the Climate Tracker appropriate for public

evaluation and use. The result is an accessible website, which includes project background information, an approachable description of the methods employed, and instructions on how to use the application. Since climate change is a much-discussed topic, efforts were made to remain transparent and open about who conducted the project. To this end, a short video was sponsored, produced, and distributed at the College of Biological Sciences to introduce two of the U of M contributors. A short professional background of all contributors on the project can be found on the website as well.

Improving on the idea of pre-selecting and pre-recording time-lapse videos, Climate Tracker users can select locations and time frames of interest, then watch an animation of the moving climate. This has much greater interactive utility than a video.

An expanded feature of Climate Tracker is warming and cooling degree days. By changing an internal algorithm, Climate Tracker is able to track their movements, which have implications outside of the biosciences. With further future funding, this feature and others could be integrated with the current climate tracks.

4. What we did not do of what was proposed

As discussed under "Assembly of daily data," the proposed idea of using daily weather data was infeasible, due to unexpectedly missing data and related problems of continuity and completeness. We successfully bypassed the problems by substituting monthly data, but at the cost of resolution in the projections and at the cost of time for other aspects of the project in Result 2.

▪ Areas of increased dangers of fire and climate-related movement of pests and diseases of trees, both native and exotic

We did not address fire and pests, and will not be pursuing this further for the current report. Some analyses, such as emerald ash borer temperature tolerance, require data with more resolution, such as daily data. As previously discussed, we look forward to pursuing such topics using the methods we have developed, as daily data improves.

5. What we are doing in the future as outgrowth of this project

▪ Delineation of areas having future potential for renewable bioenergy production

Regular developments have been made to the Climate Tracker website to increase utility and approachability. Recently, a choice of background map was added so the user could correlate climate trajectories with roads, rivers and lakes, or federal lands. Seasonal climate tracks showing the different behaviors of summer and winter temperature and precipitation over time may be added in the future. Another contribution is a means of depicting tracks based on growing-degree days.

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V. Total Trust Fund Project Budget:

Personnel: $174,039 represents the sum total of salary and benefits to project investigators including: C Lehman who provided software expertise to carry out the computer computations, data processing, and geographic mapping, and worked with the technical and student assistants; E. Widiasih, S. Williams, R. Barnes, students involved in implementing the underlying mathematics for the climate projections, performing simulation, developing the website, map and report preparation; P Reich who managed the project, interacted with all participants in developing goals, interpreting data, and writing reports; L Frelich who contributed to the evaluation of plant community responses to climate velocity projections.

Contracts: $ none

Equipment/Tools/Supplies: $ none
No supplies, such as specialized inks and papers for mapping, were necessary. Mapped results are published online, which facilitates better animations, updates, and interactivity, along with broader availability to Minnesotans. To support development of the website, maps, and animations, an amendment on 5/2/2011 allowed Result 1 equipment allowances to be transferred into Result 2 personnel costs.

Acquisition, including easements: $ none

Travel: $ none
No visits to climatological stations were necessary for data retrieval or interpretation. Reviews with local climatologists, ecologists, and other experts were easily facilitated via phone and email, leaving anticipated travel funds unneeded. Several in-state presentations were given on this and complementary climate change projects, with travel expenses covered by other funding sources, including a USDA Conservation Innovation Grant that was targeted for public presentation of environmental issues.

Other: $ none

TOTAL TRUST FUND PROJECT BUDGET: $ 180,000

Explanation of Capital Expenditures Greater Than $3,500: No capital expenditure greater than $3,500 was necessary.

VI. PROJECT STRATEGY:

A. Project Partners:

Peter Reich was project manager. In addition: (1) ***Clarence Lehman*** (Ecology) provided software expertise to carry out the computer processing, and worked with graduate assistants. (2) ***Richard McGehee*** (Mathematics) provided mathematical expertise, and also worked with graduate assistants.(3) ***Lee Frelich*** (Forest Ecology) lent his expertise on the plant communities of Minnesota and how they are responding to present-day change in their conditions. (4) ***Mark Seeley*** (Climatology) applied his expertise with long-term climatic trends in the region. (5) ***Donald Wyse*** (Agronomy) contributed his expertise on agricultural systems. (6) We also employed undergraduate and graduate assistants.

B. Project Impact and Long-term Strategy:

This project had a broad scope, covering all four areas in the LCCMR 2009 Phase-2 Funding Priorities by providing tools and information important for planning the future of land, habitat, water, invasive species, and renewable bioenergy. In particular, the project provided tools and information on or relevant to the following issues, among others: (1) locations of lands suitable for future grassland, woodland, and potentially wetland bioenergy, (2) locations of lands suitable for food crops in the future, (3) conditions that affect invasive species, (4) future spatial boundaries of our state's ecosystems, (5) validation of other climate models, and (6) other various conditions involving human, animal, and ecosystem health.

The project addressed the above topics and assessed their scope, but focused in more detail on that subset of topics determined to be most relevant and feasible during the first phase of the effort. For all topics we assessed and described projected climatic features relevant to each specific issue, while evaluating qualitatively and wherever feasible quantitatively how projected climate features will influence the specific issues in focus. The project also aimed to increase awareness of the effects of global environmental change and thereby encourage actions that could ultimately help prevent or reverse some of its effects.

Our goal was to provide tools and information for planners to adapt to environmental changes before they actually occur, including adaptive management of the next-generation bioenergy industry. For example, long-term variability in temperature and rainfall might favor certain mixed species over single species, and potentially favor grassland biofuels over woodland ones. The techniques apply to the entire state of Minnesota, but they can also be able to be adapted by all other contiguous states of the union to later form a nation-wide assessment and expansion of the topics considered here locally.

C. Other Funds Proposed to be Spent during the Project Period:

No other funds allocated.

D. Spending History:

Please see Attachment A for spending history. An amendment to spending was granted May 5, 2011, allowing up to $8915 to be transferred from Result 1 to Result 2 salaries. This allowed additional focus to be placed on analysis, modeling, and reporting findings to a broader community.

VII. DISSEMINATION:

This was a two-year project. Its first year involved data assembly, algorithm validation, analysis, and preparation of preliminary maps and tables. In its second year, results were correlated with ecological, hydrological, physical, and social aspects. Included in the second year are a final report, public presentations, and web dissemination, which can be found at http://www.cbs.umn.edu/climatetracker. This website is designed to be user-friendly, useful, and interesting to both scientists and the general public. The interactive Climate Tracker application was developed as a novel way to dynamically view a century of data, while the brief video introduction presents information in a broader context and allows visitors to the website to meet some of the project researchers.

Future publications in scientific journals are expected to result from this project, as described in section IV.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than 12/15/2009, 2/15/2010, 7/30/2010, 12/15/2010, and 2/15/2011. A final work program report and associated products will be submitted between June 30 and August 1, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS:

Attachment A: Final Budget Detail for 2009 Project

Project Title: *Projecting Environmental Trajectories for Energy-Water-Habitat Planning*

Project Manager Name: *Peter Reich*

Trust Fund Appropriation: $ 180,000

2009 Trust Fund Budget	Result 1 Budget:	Amount Spent (6/30/2011)	Balance (6/30/2011)	Result 2 Budget:	Amount Spent (6/30/2011)	Balance (6/30/2011)	TOTAL BUDGET	TOTAL BALANCE
	Data, software, computer runs			*Analysis, documentation, publication*				
BUDGET ITEM								
PERSONNEL: Academic wages and benefits (**R1:** Reich, 4% FTE; Lehman, 40% FTE; Frelich, 4% FTE; graduate research analyst, 80% FTE; technical specialists, 8.3% FTE; **R2**: Reich, 4% FTE; Lehman, 27% FTE; Frelich, 12% FTE; graduate research analyst, 80% FTE; technical specialists, 17% FTE;) ***Ammendment approved 5/2/2011: $3,946 transferred from Result 1 to Result 2*	86,054	86,054	0	91,485	87,985	3,500	177,539	3,500
Supplies *(specialized inks and papers for mapping)*	0	0	0	861	0	861	861	861
Travel expenses in Minnesota *(Reviews with local climatologists, agronomists, ecologists, plus any necessary visits to climatological stations, plus in-state presentations at public events and scientific symposia.)*	0	0	0	1,600	0	1,600	1,600	1,600
COLUMN TOTAL	**$86,054**	**$86,054**	**$0**	**$93,946**	**$87,985**	**$5,961**	**$180,000**	5,961

Appendix A – Introduction to the website

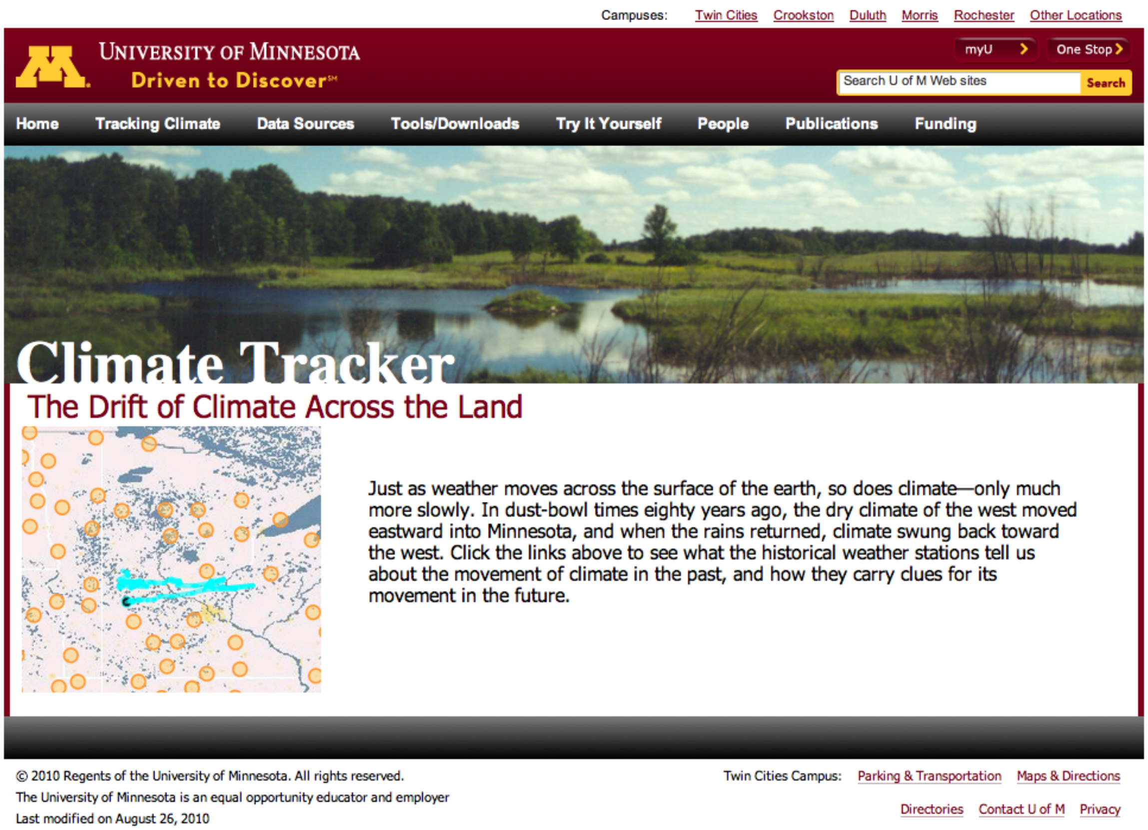


Figure A1. The Climate Tracker website is an account of the project background, methods, and results. A brief video introduction features researchers describing the project in a broader context.

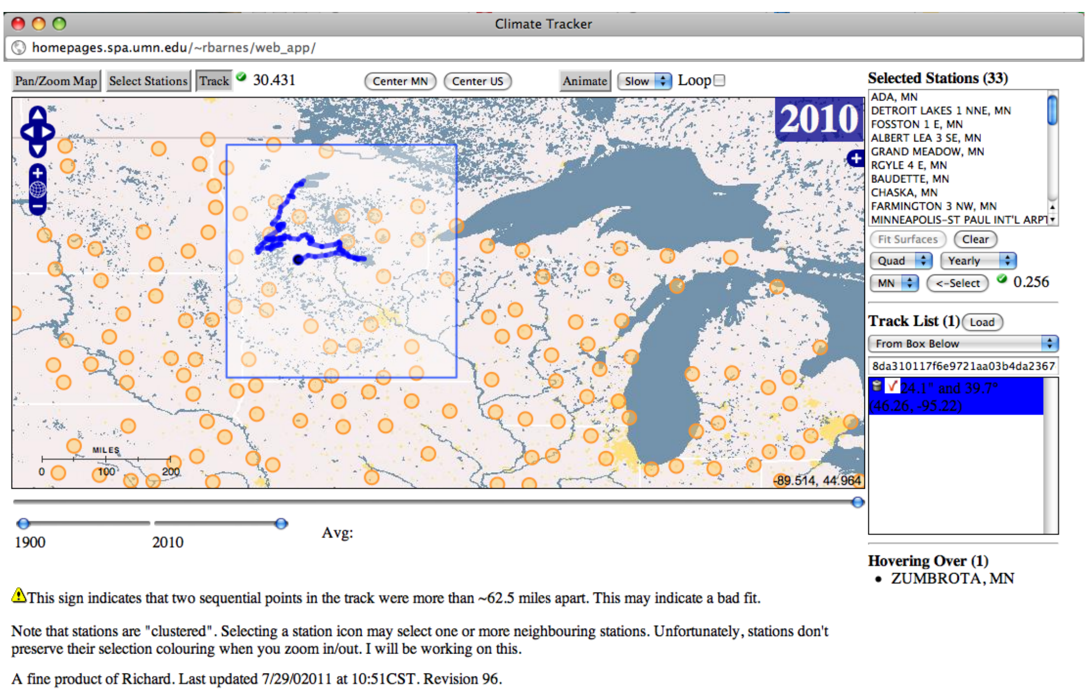


Figure A2. The interactive Climate Tracker lets visitors to the website select regions they find relevant and ask, for any point, where its climate has been and the direction it is going. It provides a way to see a century of climate data in motion at a glance.

Appendix B - Sketch of the principles employed

The full details of processing are esoteric, but the basic principals are not. Here is a distillation of the process we intend to be suitable for a broad audience.

A Meeting of Ecosystems

Part of the allure of Minnesota and the Upper Midwest—its appeal to visitors and residents alike—lies in its diversity—in all the different kinds of plants and animals that make the area their home.

Think for a moment of the whole of North America. The continent has many different ecosystems—tundra in the far north, ancient old-growth in the Pacific Northwest, real deserts in the Southwest—but there are three really large ecosystems: the northern forests of needle-leaved softwoods, the eastern forests of broadleaf hardwoods, and the central prairie grasslands—once amber waves of grain rolling westward to the Rockies.

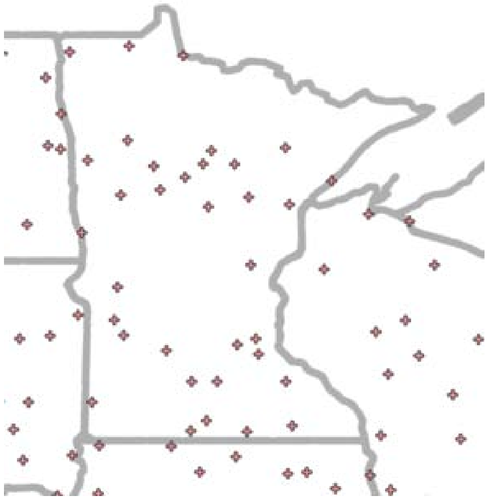
These three great ecosystems all join at a triple meeting point—what ecologists call a triple ecotone—in central Minnesota.

The interior of an ecosystem—for example at Red Lake, Ontario—will not soon see things changing beneath it. The places most sensitive to climate change are those at the boundaries of ecosystems. Minnesota is at the boundary of three, and that makes this area triply sensitive. So what is the fate of this triple meeting point? Where has it been and where will it go?

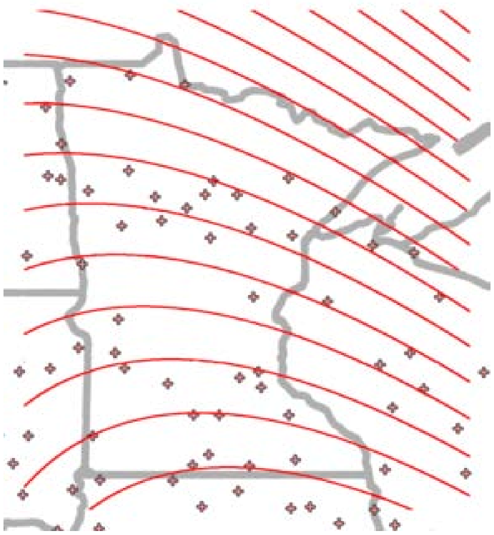
Pinpointing the Meeting Spot

The location of the triple ecotone is determined by several things, but a large part is climate. By identifying the climatic characteristics of a given place—its 30-year average precipitation and temperature—and by mathematically filling in smoothly between the member stations of the U.S. Historical Climate Network (USHCN), it is possible to track the climate over time by computer and see where a particular climatic spot is moving.

Pictorial Explanation



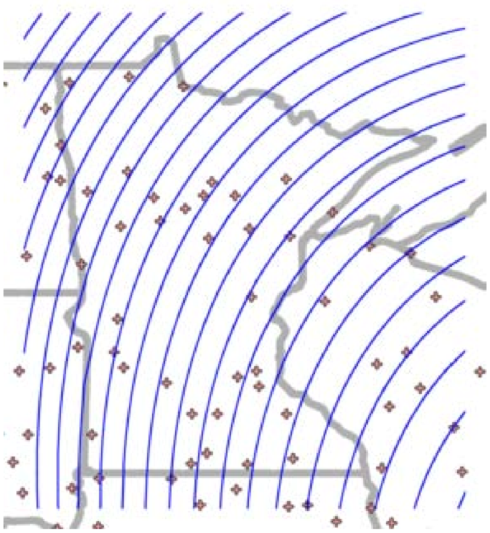
The process begins by looking at data from all the weather stations. There are about 1200 of these in the U.S. and 33 in Minnesota. Some stations' records date back as far as 1850, but the majority of the data are for 1900 onwards. Data are kept in the form of monthly averages and totals.



Each station keeps track of its average temperature every month. From these, we find yearly averages.

For a given year, we average the previous 30 years together; the result is the temperature of the station's climate for that year.

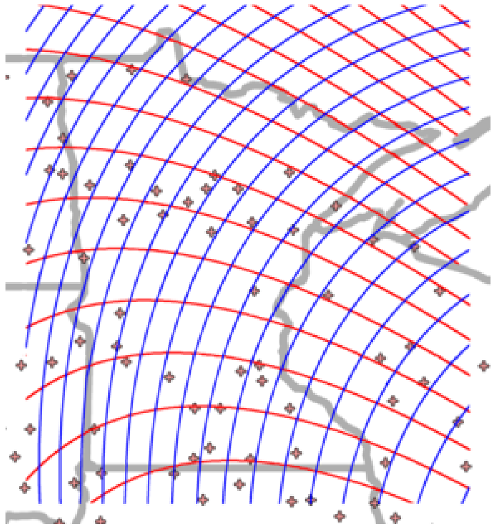
Using these known values, we can mathematically calculate the temperature of any other point on the map. If you were to draw curves between the points that have the same temperatures, it might look like this.



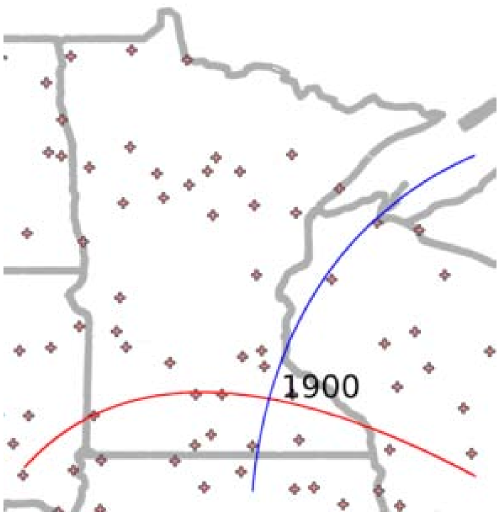
Each station also keeps track of its total precipitation for each month. From these, we find yearly totals.

For a given year, we average the previous 30 years together; the result is the precipitation of the station's climate for that year.

Using these known values, we can mathematically calculate the precipitation of any other point on the map. If you were to draw curves between the points that have the same precipitation, it might look like this.

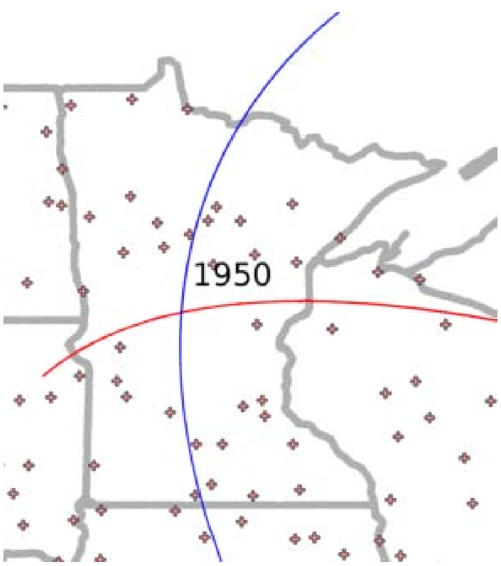


Now, we can overlay the precipitation and temperature curves on top of each other and find their intersections. Each intersection defines a climatic point—a specific combination of temperature and rainfall more or less hospitable to any given ecosystem.

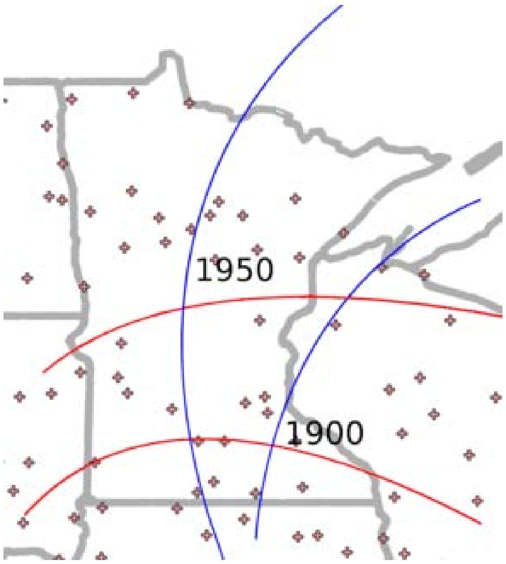


Now, let's make a few of the temperature and precipitation lines disappear.

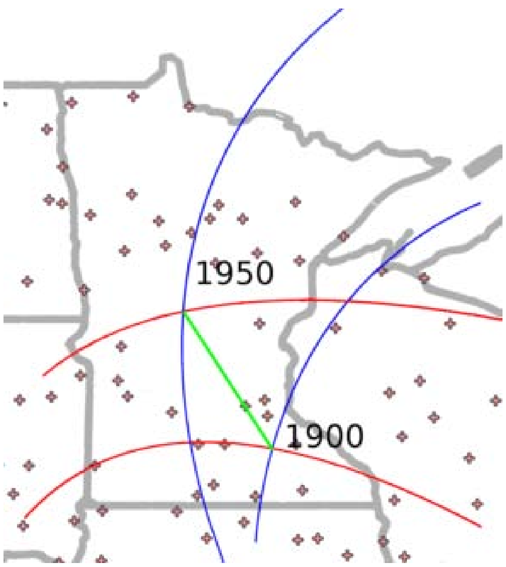
The intersection of the remaining lines is a climatic point. It shows where a particular combination of temperature and precipitation (let's say 52°F and 7" of rain) is in the year 1900.



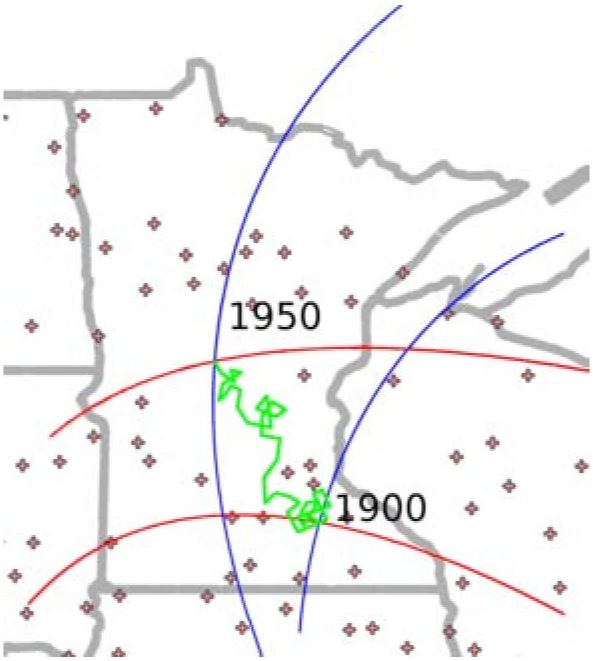
We can figure out where that same climatic point is in 1950.
(This isn't real data, it's just an example.)



Now, if we know where the climate was in both 1900 and 1950, we can begin to track its movement…



…by connecting the dots—in this case, climatic points.



Of course, connecting the dots between 1900 and 1950 doesn't say very much about where the climate has gone, so we connect each year's dot with the dot of the following year.

Remember, this isn't real data: it's an example.

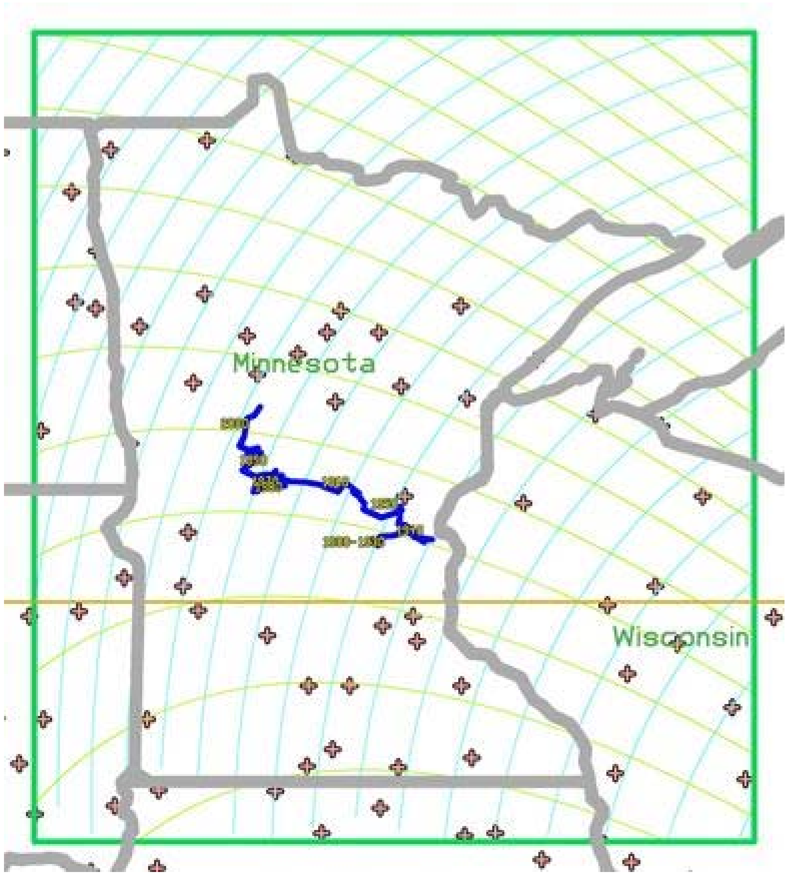
The new path connects every year and doesn't look as nice, but tells a more interesting story.

From 1900–1920, we see that the climate hovered in the same place. No two years' weather is the same, so the climate was always moving, but not very far: it was moving in circles.

From 1920–1930, the climate moved north and west. Some years it moved a lot, other years a little. During some years, it even reversed direction, but the general trend was north and west.

After a little more hovering and moving the climate arrived at its 1950 location.

This means that the climate of 1900 has moved to a new location by 1950, displacing whatever climate was there before.



Now, let's look at some real data; this is the story of one of Minnesota's climate points.

Our data for the point, located in south-east Minnesota, begins in 1900. Thirty years later, we have enough data to calculate the point's climate. At this time, in 1930, the Dust Bowl was just beginning and the point moved steadily eastward as a result of this change in climate. By the time the Dust Bowl ended, the point had touched the Wisconsin border, north of Taylors Falls. Had it stayed there, Minnesota would eventually have had only prairies, not forests.

But in just a single year it abruptly turned 180 degrees, retracing part of its path and beginning thirty-year northwestward journey toward the Dakota border, south of Fargo. Had it continued moving in this direction, Minnesota would eventually have had only forests and no prairies. But, instead, it stalled out and hovered in the middle of the state, southwest of Brainard.

In the last twenty years it has again abruptly changed direction, turning 90 degrees north and heading in the direction of the pine stands of Itasca.

2009 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE:	Energy Efficient Cities
PROJECT MANAGER:	Carl Nelson
AFFILIATION:	Center for Energy and Environment
MAILING ADDRESS:	212 Third Ave N
CITY/STATE/ZIP:	Minneapolis, MN 55401
PHONE:	612-335-5871
E-MAIL:	cnelson@mncee.org
WEBSITE:	www.mncee.org
FUNDING SOURCE:	Environment and Natural Resources Trust Fund
LEGAL CITATION:	ML 2009, Chap. 143, Sec. 2, Subd.7c

APPROPRIATION AMOUNT: $2,000,000

Overall Project Outcome and Results

The Energy Efficient Cities project was developed to demonstrate innovative residential energy efficiency program delivery to reduce energy use and environmental impact in at least 6,000 homes through a community-wide partnership approach. With strong and crucial support from local gas and electric utilities, city-specific programs were developed in a total of 8 cities: Apple Valley, Austin, Duluth, Minneapolis, Owatonna, Park Rapids, Rochester, and St. Paul. While each city developed a customized approach, each program was designed to provide a "one-stop shop" comprehensive whole-house approach that makes taking energy efficiency actions as easy as possible for the homeowner, while maximizing participation and energy savings opportunities. This comprehensive approach involved the following components shared by each program:

- Community-based marketing strategies to recruit participants to workshops and for training participants to take low-cost energy actions;
- Home energy visits that include installation of low-cost materials and identify other energy-saving opportunities;
- Energy usage feedback reports to encourage individual energy-saving actions;
- Follow-up assistance, including providing cost-share, for completion of major efficiency upgrades including insulation, air sealing and major mechanicals replacement; and
- Training and quality control for insulation and air sealing contractors.

The project exceeded its original goals for participation, with 8,243 people attending workshops, 6,922 of those households completing a home energy visit, and 1,474 homes completing major energy efficiency upgrades. Over 36 contractors were trained in high performance installation techniques for insulation and air sealing jobs. The upgrades completed under this program generated $4.8 million in work for Minnesota's insulation and heating contractors. The total energy savings from measures installed in these homes will result in an estimated $13.8 million dollars in energy savings for the homeowners over the life of the measures. The programs will be continued in at least 5 of the participating cities.

Project Results Use and Dissemination

Dissemination of information to homeowners was an integral part of the program. Our outreach activities for the program reached tens of thousands of Minnesotans, resulting in over 7,500 households attending a workshop that was produced by the project. The workshops educated people on basic energy conservation concepts and strategies, such as how a home loses energy, low-cost or no-cost methods for reducing energy, and what the process is for doing major energy efficiency upgrades in your home. The "Home Energy Resource Minnesota" website was also designed for education and outreach on energy efficiency issues. In addition, each city program had an on-line presence for dissemination of information about the program.

In addition to outreach targeted to homeowners as part of program activities, efforts were made to communicate to utilities, cities and other potential program sponsors of energy efficiency programs the Energy Efficient Cities program results, and increase uptake of similar residential programs. A presentation was given in August 2010 at the American Council for an Energy-Efficient Economy's (ACEEE) Summer Study on Buildings in Pacific Grove, California. Based on interest at that conference, another webinar presentation on the program was given as part of a series sponsored by the U.S. Department of Energy and attended by over 500 participants. A second webinar presentation was conducted for a national network of local government officials organized by the Institute for Sustainable Communities. A presentation was also conducted for the Clean Energy Teams (CERTs) conference in February 2011. Both Minneapolis's and St. Paul's programs were featured in a national study of retrofit programs by Lawrence Berkeley National Lab entitled "Driving Demand for Home Energy Improvements." As a result of the initial program success, programs in Minneapolis, Duluth, Owatonna, Rochester and Austin will continue beyond the grant period, funded by utilities and other sources.

Finally, a report was completed to document the project and communicate lessons learned to utilities and other potential program sponsors. The report will be disseminated to Minnesota utilities, and presentations will be scheduled with interested parties. A presentation has been scheduled for October in Owatonna for the Midwest chapter of the Association of Energy Service Professionals.

Environment and Natural Resources Trust Fund
2009 Work Program Final Report

Date of Report: August 31, 2011
Final Report
Date of Work Program Approval: June 24, 2009
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Energy Efficient Cities

Project Manager:	Carl Nelson
Affiliation:	Center for Energy and Environment
Mailing Address:	212 3rd Avenue North, Suite 560
City / State / Zip:	Minneapolis, MN 55401
Telephone Number:	612-335-5871
E-mail Address:	cnelson@mncee.org
FAX Number:	612-335-5888
Web Site Address:	www.mncee.org

Location: Minneapolis, St. Paul, Apple Valley, Owatonna, Austin, Rochester, Duluth, Park Rapids.

Total Trust Fund Project Budget:	**Trust Fund Appropriation**	**$ 2,000,000**
	Minus Amount Spent:	**$ 1,745,651**
	Equals Balance:	**$ 254,349**

Legal Citation: ML 2009, Chap. 143, Sec. 2, Subd.7c

Appropriation Language:
$2,000,000 is from the trust fund to the commissioner of commerce for an agreement with the Center for Energy and Environment for demonstration of innovative residential energy efficiency delivery and financing strategies, training, installation, evaluation, and recommendations for a utility residential energy conservation program.

II. and III. FINAL PROJECT SUMMARY:

The Energy Efficient Cities project was developed to demonstrate innovative residential energy efficiency program delivery to reduce energy use and environmental impact in at least 6,000 homes through a community-wide partnership approach. With strong and crucial support from local gas and electric utilities, city-specific programs were developed in a total of 8 cities: Apple Valley, Austin, Duluth, Minneapolis, Owatonna, Park Rapids, Rochester, and St. Paul. While each city developed a customized approach, each program was designed to provide a "one-stop shop" comprehensive whole-house approach that makes taking energy efficiency actions as easy as possible for the homeowner, while maximizing participation and energy savings opportunities. This comprehensive approach involved the following components shared by each program:

- Community-based marketing strategies to recruit participants to workshops and for training participants to take low-cost energy actions;
- Home energy visits that include installation of low-cost materials and identify other energy-saving opportunities;
- Energy usage feedback reports to encourage individual energy-saving actions;
- Follow-up assistance, including providing cost-share, for completion of major efficiency upgrades including insulation, air sealing and major mechanicals replacement; and
- Training and quality control for insulation and air sealing contractors.

The project exceeded its original goals for participation, with 8,243 people attending workshops, 6,922 of those households completing a home energy visit, and 1,474 homes completing major energy efficiency upgrades. Over 36 contractors were trained in high performance installation techniques for insulation and air sealing jobs. The upgrades completed under this program generated $4.8 million in work for Minnesota's insulation and heating contractors. The total energy savings from measures installed in these homes will result in an estimated $13.8 million dollars in energy savings for the homeowners over the life of the measures. The programs will be continued in at least 5 of the participating cities.

IV. OUTLINE OF PROJECT RESULTS*:*

<u>Result 1: Design and develop 8 or more city-specific residential energy-efficiency programs.</u>

Description:

City-specific residential energy-efficiency programs will be designed in the following cities: Minneapolis, St. Paul, Apple Valley, Rochester, Owatonna, Rochester, Duluth and Park Rapids. Other cities may be added later as resources allow. The programs will be designed to be comprehensive, emphasize ease of use for participants, and be oriented towards achieving cost-effective energy savings. Program design will be informed by successful past programs (such as Operation Insulation) as well as emerging research and new technology opportunities.

These programs will be designed in consultation with local cities and utilities. It is expected that utilities will provide significant cost-share in implementing these programs, in order to help them achieve their state-required energy conservation goals. Although the program would be tailored to each city, we expect that the program design would have the following components:

1) Recruitment of participants through workshops or other events
Homeowners would be recruited for the program through community energy workshops, or other community-based recruitment techniques to encourage efficiency actions as "keeping up with the neighbors" and a healthy sense of competition for improving energy efficiency. These recruitment techniques would involve significant partnerships with local community organizations. A variety of studies have shown that through the use of this "foot-in-the-door" technique individuals who agree to small requests are much more likely to agree to larger requests later. Combined with a public commitment by residents and long-term feedback, this will set the foundation for lasting and effective behavior change, as well as increasing the likelihood of households making larger investments in efficiency retrofits that are a later part of the program. At the workshop, some low-cost energy-efficiency measures would be distributed, while others would be distributed at an in-home visit.

2) In-home visit
Based on an analysis of energy usage, participants would be pre-screened using a "triage" approach and sorted into large energy users and small energy users; more time would be concentrated on households with high energy usage. With this information, an in-home visit would be scheduled with an energy specialist, where the low-cost measures would be installed and/or verified and additional homeowner education provided. This education would include no-cost recommendations such as lowering the hot water heater setback temperature if appropriate. If the home is a medium or high energy user, building diagnostics would be performed.

Low-cost gas saving measures could include: setback thermostats (if needed), pipe insulation, gasket seals, recessed light inserts, attic door weather-stripping, door sweeps and other weather-stripping items, faucet aerators, low-flow showerheads and window insulation film. Low-cost electric-saving measures could include: CFLs (assortment of types), LED holiday lights (if participants traded in for old incandescent type) and outlet strips.

If the home energy visit determined that either air sealing or insulation was required, the energy technician would write out the specifications for the necessary work, and provide the homeowner with an estimate of the work to be done by a third-party contractor. The program would work with qualified contractors to develop a standardized bidding system to ensure the bids would be as low-cost as possible to the homeowner, while ensuring they provided sufficient revenue to the contractors to keep them in the program. It is anticipated that participating contractors would be able to offer competitive pricing, as they would not need to invest in marketing their companies for work received through this program. Homes with medium or high energy usage may be provided with a blower door test that would be used as diagnostics for air sealing and insulation work.

3) Contractor work
Contractor work recommended by the in-home visit is expected to include air sealing, insulation and major mechanical (furnace, air conditioner, hot water heater) upgrades. Quality-control protocols would also be established for the program. After work was completed by the contractor, an energy technician would verify the work was completed according to specifications through infrared camera or other means. Contractors would be required to do call-backs for work not meeting quality standards. After a certain number of jobs are completed for a given contractor, not every job would be inspected, but random audits would still be performed.

4) On-going home energy feedback and action messages to encourage energy savings through behavior change
Research has demonstrated homeowners can reduce their energy bills if they are provided context for their energy use (how does it compare with their peers), given sustained feedback on how to reduce their energy use, and provided a clear benchmark for their progress in achieving energy savings. Further, this type of feedback can help create and reinforce social norms that energy efficiency is “the right thing to do.” Simple behavioral changes resulting from this type of feedback program can result in up to a 10 percent reduction in energy use, at zero cost to the homeowner, depending on the intensity of the feedback program. This project will develop such a feedback program by collecting energy data for those in the program, tracking their improvements over time, and developing a platform for processing and delivering feedback to users over time.

5) Cost-share incentives and other resources for implementing
In order to encourage participants to implement contractor work, information on financing and incentives would be provided to homeowners.

The extent to which all of these components as described above are integrated into an individual city’s program will depend on interest and the extent to which it can be merged with utility objectives. It is anticipated that local utilities will want to tailor the in-home visit to their needs and specific programs. For example, Dakota Electric (in Apple Valley) has an air conditioner tune-up program for residents that could be promoted through the LCCMR program. In addition to CEE staff time, Neighborhood Energy Connection (NEC) would also dedicate staff time to assist with developing these programs, particularly with St. Paul.

Summary Budget Information for Result 1: **Trust Fund Budget: $ 64,100**
Amount Spent: $ 63,869
Balance: $ 231

Deliverable	Completion Date	Budget
1. Design residential energy-efficiency programs for 8 cities	3/30/2010	$64,100

Result Completion Date: 3/30/10

Final Report Summary:

City-specific programs were designed for Minneapolis, St. Paul, Apple Valley, Austin, Owatonna, Park Rapids, Rochester and Duluth. Each city had a unique program design as well as city-specific names and branding. Below is a city-by-city description of the program design.

<u>Minneapolis</u>

Recruitment

Minneapolis has strong neighborhood organizations that the City has financially supported over many years, many of which have the capacity and desire to help with local marketing efforts. Thus partnering with neighborhood groups was a prominent feature of the Minneapolis program design. Neighborhoods were selected for initial participation the program through a Request for Proposals (RFP) process. Selection of the neighborhoods was based on the leveraging opportunities that the neighborhoods offer to provide for helping market and recruit program participants within their neighborhood. Primarily, this leveraging was expected to be the people-power they can offer. Training was provided by CEE for neighborhood volunteers, who then go door-to-door to recruit participants for a workshop. Other marketing efforts, including promoting in neighborhood newsletters, support the door-to-door approach. The program was planned to be offered only in the selected neighborhoods, with opportunity for new neighborhoods to join the program during the project period. This was designed to allow the program to get a high saturation rate through concentrated marketing in a given neighborhood. Low-cost materials were given out at the workshop for those that sign up for the in-home visit. The name for the Energy Efficiency Cities program in Minneapolis is “Community Energy Services”.

In-home visit

Labor costs for the in-home visit were funded with leveraged non-Trust Fund dollars by the local gas utility (CenterPoint Energy) and electric utility (Xcel Energy). For Xcel’s contribution, Xcel funded the in-home visit as part of their new “Home Energy Squad” direct install program, also to be run by CEE in Minneapolis. The in-home visit includes direct install of materials, identification and encouragement of no-cost actions, as well as an assessment of major upgrade opportunities. A $20 or $30 co-pay by participants helps pay for additional low-cost materials.

Contractor work

Minneapolis ensured high quality contractor work by requiring all air sealing and insulation contractors that are referred work through the in-home visit to sign a participation agreement with CEE. Contractors that sign this participation agreement were put on a participating contractor list given to homeowners in the program who need air sealing and/or insulation work (although the homeowner is ultimately free to select whomever they want – they are not bound by the list). The participation agreement requires contractors to: 1) have basic training in air sealing & insulation; 2) meet industry standards as set by CEE and outlined in a standards document; 3) agree to warranty their work for at least one year; 4) carry basic insurance; 5) report results of work to CEE; 6) agree to have their work checked periodically by CEE to ensure they are meeting standards. Contractors who do not abide by these rules will be taken off the participating contractor list.

On-going home energy feedback and action messages
CEE has worked with CenterPoint and Xcel on a system to periodically get the energy usage data of participating homeowners. With this data, CEE has developed two reports that will be used to provide feedback and facilitate action messages to participating homeowners. The “Home Energy Snapshot” was given to homeowners during the home visit, and compares their weather-normalized energy usage to other Minnesotans. It also calculates a target energy usage that the homeowner can strive to achieve. The “Home Energy Progress Report” was sent out as often as utility data was available, but not more often than every two months, to program participants after completion of the home visit. This will provide the homeowner with updates on how they are doing in achieving their targeted energy usage.

Providing of cost-share incentives and other financing resources
CEE offered loan financing to all program participants through the Minnesota Housing Finance Agency and other energy loan programs. In addition, CEE processed Energy Saver rebates for program participants. Energy Saver rebates was a stimulus-funded program through Minnesota Housing that offered a 35% rebate on qualified energy upgrades for participants that took out a Minnesota Housing loan. In addition, CenterPoint Energy started a new rebate program for insulation and air sealing in March 2010. The CenterPoint rebates provide homeowners with a 50% rebate of the total air sealing and insulation cost, up to $400 (later reduced to $350).

<u>St. Paul</u>

Recruitment
Recruitment in St. Paul was be done by the Green Institute, and later Eureka Recycling, as the Metro CERTs coordinator, in coordination with Xcel Energy, Neighborhood Energy Connection (NEC) and other partners. Efforts initially focused on neighborhoods located adjacent to the planned Central Corridor Light Rail Transit project. This was done in conjunction with the “Energy Innovation Corridor”, a partnership effort of utilities, non-profits, local governments and businesses along the Central Corridor working to develop innovative energy projects in parallel with the light rail development. The Green Institute worked to organize and recruit homeowners for workshops in conjunction with St. Paul’s District Council neighborhood organizations. The Green Institute had homeowners sign a utility data release so that they could receive feedback reports. Low-cost materials were given out at the workshop for those that signed up for the in-home visit. The St. Paul program was called “Neighborhood Energy Services” or the workshop component, and the “Home Energy Squad” for the home visit portion.

In-home visit
Xcel Energy, as the gas and electric utility in St. Paul, is funding NEC to conduct the home visits as part of their "Home Energy Squad" program. The Home Energy Squad program does not include a blower door test or other detailed diagnostic work. Thus Trust Fund dollars were provided to NEC to enhance the Home Energy Squad visits to do this diagnostic work, which is a necessary precursor to getting homeowners to do major efficiency upgrades. A $30 co-pay by homeowners helped pay for additional low-cost materials installation.

Contractor work
NEC provided participating homeowners with a list of qualified contractors.

On-going home energy feedback and action messages
CEE provided the Home Energy Snapshot and Progress Updates as in Minneapolis (see above).

Providing of cost-share incentives and other financing resources
NEC offered loan financing and Energy Saver rebates to all program participants needing upgrades through the Minnesota Housing and other energy loan programs. Xcel Energy has existing rebates for air sealing and insulation, as well as for furnace and hot water heater replacement. These rebates were promoted through the program.

<u>Apple Valley</u>

Recruitment
Recruitment of participants to workshops was led by CEE with the City and other partners. The City of Apple Valley, with support from the Great Plains Institute, designed a city-wide energy-efficiency campaign called "be Apple Valley" ("be" stands for "better energy"). The program was marketed to Apple Valley residents under the "be Apple Valley" Campaign. As in the other cities, low-cost materials were given out at the workshops.

In-home visit
CenterPoint Energy (gas utility) and Dakota Electric (electric utility) jointly funded the home-visit, which was delivered by CEE. The home visit was identical to the one in Minneapolis.

Contractor work
Contractor work will be coordinated as in Minneapolis (see above).

On-going home energy feedback and action messages
Feedback will be provided as in Minneapolis (see above).

Providing of cost-share incentives and other financing resources
Financing resources were provided to Apple Valley residents as in Minneapolis (see above). In addition, Apple Valley has dedicated $50,000 in EECBG stimulus funding for a residential loan program that CEE administered as part of the program.

<u>Owatonna and Austin</u>
(These cities are combined, since Owatonna and Austin have coordinated closely on all aspects of the program development and implementation.)

Recruitment
CEE coordinated recruitment on a city-wide basis, in conjunction with the Cities and local partners. The program was branded under the utilities' existing "Conserve and Save" residential program. Low-cost materials were given out at the workshops to those that sign up for the in-home visit.

In-home visit
Greg Ernst and Associates provided the in-home visit, called the "Conserve and Save House Call" and funded by Owatonna Public Utilities and Austin Utilities, with a $25 co-pay provided by the homeowner (it was $50 for those that don't attend the workshop). Greg Ernst was previously the audit provider for both utilities, and since the utilities funded the in-home visit portion of the program, Greg Ernst continued to be used for this program. The visit included direct install of low-cost materials, recommendations on no-cost actions, and recommendations for major upgrades. A blower door test was conducted as part of the visit.

Contractor work
At the Conserve and Save House Call, the auditor provided the homeowner with a list of participating contractors. Contractors signed a participation agreement with CEE, similar to the one in Minneapolis (see above). Quality-control visits were conducted after the visit.

On-going home energy feedback and action messages
Austin and Owatonna contracted with O-POWER to provide city-wide home energy feedback reports with action messages. These reports went out to every city resident. Thus CEE did not provide additional reports. CEE and the cities coordinated with O-POWER to market the program through the homeowner reports.

Providing of cost-share incentives and other financing resources
CEE worked with local financing providers to provide homeowners with financing opportunities for both loan and Energy Saver rebates. Austin and Owatonna started a new air sealing and insulation rebate program in 2010, in conjunction with their Conserve and Save House Call.

Rochester

Recruitment
CEE led recruitment efforts in Rochester, in partnership with the city and utilities. The program partnered with "R-Neighbors," a city-funded neighborhood resource group, to promote the program to Rochester neighborhoods. Because utilities were working on setting up new audit and insulation rebate programs in conjunction with the workshops, the program did not start until the spring of 2010. The program was named the "Neighborhood Energy Challenge."

In-home visit
Greg Ernst and Associates conducted the in-home visit, with funding from the gas utility, Minnesota Energy Resources Corporation (MERC) and the electric utility, Rochester Public Utilities. The in-home visit included direct install of low-cost measures, identification and encouragement of no-cost actions, and recommendations for major upgrades.

Contractor work
Greg Ernst provided a list of participating contractors to the homeowner during the in-home visit. Contractor work will be coordinated by CEE (see Minneapolis and Austin/Owatonna description above).

On-going home energy feedback and action messages
MERC is also funding O-Power to conduct a large feedback program in Rochester, nearly identical to the Austin and Owatonna program. Thus CEE did not produce additional reports.

Providing of cost-share incentives and other financing resources
CEE provided homeowners with financing options and support. MERC started a new air sealing and insulation rebate program in 2010, which was promoted by CEE and Greg Ernst.

Duluth

Recruitment
Duluth has a coalition of utilities, non-profits, and local government agencies called Duluth Energy Efficiency Initiative (DEEP) that worked to develop a comprehensive residential program. Common Ground, a Duluth non-profit, led recruitment efforts in Duluth. They were selected in the summer of 2009 to operate the financing program for which the City of Duluth received $1.5 million in stimulus funding. This contract was not completed until late in 2010. Further, DEEP worked on an agreement with the electric (MN Power) and natural gas (Comfort Systems) utilities that was not completed until late 2010. Thus Duluth got a late start to their program. Although workshops were held and people signed up for home visits, the home visits were not available until late 2010. Common Ground coordinated a "Green Canvass" (staffed by Americorp workers) to do recruitment for the workshops. The Green Canvass went door-to-door to sign people up for the workshops.

In-home visit
The in-home visit was co-funded by Minnesota Power (the electric utility) and Comfort Systems (the municipally-owned gas utility), and run by contractors selected by the two utilities. It included direct install of low-cost materials as well as recommendations for major upgrades. The Duluth process includes screening for homes that have high energy usage, and targeting those homes for more in-depth home performance visits.

Contractor work
Common Ground planned insulation contractor trainings in order to ensure high quality contractor work.

On-going home energy feedback and action messages
The DEEP group, with leadership from Minnesota Power, developed a Home Energy Yardstick report that provides homeowners with a context for their energy bill. This is provided to homeowners at or before they have the in-home visit.

Providing of cost-share incentives and other financing resources
Financing coordination for homeowners is provided by Common Ground. Comfort Systems (the gas utility) does not currently have a rebate program for air sealing and insulation.

<u>Park Rapids</u>

Recruitment
The recruitment effort and program in Park Rapids was an extension of the "Green Park Rapids" Initiative, which is a broad partnership effort to improve the energy efficiency of Park Rapids housing and commercial buildings. Initially the HRA (Housing Redevelopment Authority) of Park Rapids was contracted to do recruitment with support from CEE. After several workshops, the HRA and other Green Park Rapids partners decided to focus their residential efforts on a grant they received through stimulus funding to provide large rebates for electrical appliances. Thus after spring of 2010, Park Rapids dropped out of the Energy Efficient Cities program.

In-home visit
The in-home visits were jointly funded by MERC (gas utility) and Minnesota Power (electric utility). Greg Ernst and Associates conducted the visits, which were only available to residents who have attended the workshops. They included direct install of low-cost materials, identification and encouragement of no-cost actions, and recommendations for major upgrades. A blower door test will be included. Homeowners paid a $40 co-pay.

Contractor work
Greg Ernst provided homeowners with a list of local contractors.

On-going home energy feedback and action messages
A Home Energy Yardstick report, identical to that used in Duluth, was planned to be used for Park Rapids, and given out to participants at the home visit. However, as Park Rapids dropped out of the program, this was not completed.

Providing of cost-share incentives and other financing resources
CEE offered participating homeowners financing support.

<u>Result 2: Coordinate, track and provide feedback on household energy usage.</u>

Description:

Program participants will be provided information and feedback on their home energy consumption in order to encourage them to take actions to reduce their energy usage.

Specifically, we would prepare home energy reports on a bi-monthly basis (or other interval depending on how often we receive the data from utility companies) containing the following information:

- Homeowner's energy usage in a standardized index, which we call the "flame index" for natural gas (Btus per square foot per heating degree day) and the "spark index" for electric (kilowatt-hours per square foot)
- Energy usage of similar homes in the neighborhood or state
- Benchmark energy use of an efficient home
- Customized energy actions giving recommendations for how the homeowner can reduce energy usage through individual actions
- Feedback on electricity and natural gas usage

For cities that are already planning on regular delivery of feedback messages through their local utility (Owatonna, Austin and perhaps others), we will not provide separate mailings, but coordinate our efforts with theirs.

A website will be created for this project using interactive media approaches to reach a wide audience, effectively communicate an energy efficiency message and turn this information into action and energy savings. Interactive media approaches will include such tools such as instructional videos and step by step do-it-yourself instructions to allow residents to assess their needs and determine and implement energy savings actions. Users will be able to input their energy use data to track the savings that they have achieved and get direct feedback on their usage with tips for improvement. Since the project will be delivered over the Internet, it will reach and serve a statewide audience. The site will be a comprehensive one-stop informational resource on home energy efficiency and resources (such as stimulus dollars) to achieve energy efficiency. Resource links to utility residential audit and rebate programs as well as financing options and a supported online community to promote Minnesota home energy efficiency will be included. The website will allow users the ability to interact with others and experts in order to get feedback and advice and provide reviews and ratings on products, tips and actions. The website will be produced by the Builders Association of Minnesota (BAM), anticipated to be as an enhancement to their existing successful website, home-smart.org. The other major costs are mailing costs and CEE staff time.

As CEE will maintain a database of people enrolled in the program, and their actions, this will be provided as requested to LCCMR in summary form (with personal information removed) as we report on our results.

Summary Budget Information for Result 2: Trust Fund Budget: $ 136,200,
Amount Spent: $ 118,320
Balance: $ 17,880

Deliverable	**Completion Date**	**Budget**
1. Enter data, track, produce and send feedback assessments to 6,000 participants	6/30/2011	$86,200
2. Develop educational information, instructional videos and other web resources	12/31/2009	$60,259

Result Completion Date: 6/30/11

Final Report Summary:

Three cities (Austin, Owatonna and Rochester) provided feedback reports paid for by the electric and/or gas utility in their city. One city (Duluth) developed their own feedback report (the "Home Energy Yardstick") in conjunction with local utilities. CEE produced the reports and acquired the necessary data for Apple Valley, Minneapolis and St. Paul. Development of the feedback report was completed within the first quarter of the program. However, the more challenging aspect was acquiring the necessary data (i.e., energy usage data from utilities) in an appropriate format in order to produce the report. It was necessary to develop agreements with utilities, and obtain the necessary legal approval, in order to obtain access to utility data on behalf of program participants. At first, utilities were only able to provide data in a scanned format that could not be imported directly into a database, so CEE had to hand-enter all of the data. By the final two quarters of the project, CEE acquired the data in an electronic format that could be uploaded into the database that produced the reports. Ultimately, reports were produced for all the program participants, with the exception of Park Rapids, where we did not have access to the utility data.

Development of the website with the Builders Association of Minnesota was completed, and is available at: www.homeenergyresourcemn.org. One of the primary features is the "Home Energy Explorer" which is an interactive tool to look at energy saving opportunities room-by-room. There are also comprehensive resources on incentives and financing opportunities as well. This offers a resource to homeowners state-wide, whether they are in a participating city or not.

It should also be noted that nearly every city developed their own website for their city-specific program, for example, St. Paul's is: www.cleanenergyresourceteams.org/regions/metro/NES; Duluth's is: www.duluthenergy.org; Minneapolis's is www.mnces.org; and Rochester's is accessed from: www.rpu.org/your_home/.

The project also conducted marketing to promote both the main website resource (homeenergyresourcemn.org) and the city-specific program websites. The city-specific website URLs are included on most of the marketing material produced for the programs. The Builders Association of Minnesota sent out an email to 14,000 contractors in Minnesota promoting Minnesota's residential stimulus rebates, and providing links to those programs, which are listed on the website.

Result 3: Train insulation and air sealing contractors.

Description:

Currently there are only a handful of qualified insulation and air sealing contractors in Minnesota. In order to ramp up residential energy efficiency work, new contractors will need to be trained. Contractor training will be provided by highly experienced contractors (Conservations Services Group, Shelter Supply and others) in coordination with local technical schools. These consultants will develop curriculum that incorporates comprehensive best practices for insulation and air sealing, and can be used as the basis for further training. We will recruit contractors to attend the training, anticipated to be existing remodeling contractors looking for expanded business opportunities.

We will coordinate our efforts closely with the Office of Energy Security, and anticipate that there may be stimulus dollars that would also be available for this training. If this turns out to be the case, we would request an amendment to reallocate a portion of the budget for training to other activities.

Amendment Request (approved 2/3/2011):
In addition, CEE will work with the Builders Association of Minnesota (BAM) to develop a curriculum and conduct trainings for training existing contractors in the remodeling industry to become involved in helping their customers to do insulation work. BAM would consult with industry leaders in the remodeling industry prior to developing the curriculum. Effectively engaging the remodeling industry in building energy efficiency work could significantly leverage the groundwork laid by the Energy Efficient Cities project, while creating new job opportunities for Minnesota's remodeling industry. Expanding the original scope of work to include this deliverable is able to be done at no budget impact to the project. This is because the project was able to leverage efforts from the Project ReEnergize program that was funded after this workplan was written. Project ReEnergize, implemented by the Builders Association of Minnesota with federal stimulus dollars, developed a curriculum for insulation contractors that CEE was able to use for this project (CEE provided input

on this curriculum). The curriculum development represented a large portion of the original budget. In addition, Project ReEnergize conducted the training for many of the contractors in the Energy Efficient Cities project, so that CEE did not need to train as many contractors as otherwise would have been the case.

Summary Budget Information for Result 3:	**Trust Fund Budget:**	**$60,000**
	Amount Spent:	**$ 47,056**
	Balance:	**$ 12,944**

Deliverable	**Completion Date**	**Budget**
1. Train 10 contractors	12/1/2009	$5000
2. Train an additional 15 contractors	10/1/2010	$5000
3. Develop curriculum and conduct at least 7 trainings for existing remodeling contractors	6/30/2011	$50,000

Result Completion Date: 6/30/2011

Final Report Summary:
The Builders Association of Minnesota (BAM), under subcontract to CEE, conducted a training for the Owatonna and Austin programs in December 2009, which was attended by 19 local contractors. An identical training was held in Rochester in the fall of 2010 that was attended by 17 insulation contractors and 5 auditors. The training curriculum was identical to the BAM trainings for their Project Re-Energize program, and was conducted by Mike Wilson of Shelter Supply (recently acquired by Dakota Resource Group). The morning curriculum covered air sealing, including an extensive hands-on segment where contractors had to demonstrate their knowledge of air sealing techniques on props. The afternoon covered blower-door assisted air sealing, including a hands-on demonstration of how to conduct a blower door test. The training was required for air sealing and insulation contractors participating in Austin and Owatonna's program.

BAM also conducted a series of trainings for remodelers across the state focusing on training existing remodeling contractors becoming involved in helping their customers to do insulation work. A series of focus groups with existing remodelers were conducted to help define what the training needs were for curriculum development. A curriculum was then developed, focusing on the benefits of ice-dam prevention from air sealing. Over 250 contractors across the state attended 12 trainings organized by BAM.

Result 4: Implementation of energy efficiency programs.

Description:

Although program design will vary by city, we will work to achieve the following overall results in implementing the residential energy efficiency programs in each of the eight cities.

Generate at least 6,000 participants in workshops and other community events
We expect to organize between 50 and 100 workshops during the project period, depending on the turnout per workshop. That will be an average of one workshop every week to two weeks throughout the project period once we start organizing them. Community-based marketing efforts will be used to recruit people to workshops. Generally we will try to work with schools and other community centers for hosting the workshops. One important strategy is working with local neighborhood and community organizations and volunteers to organize the workshops. A volunteer training program will be developed for the volunteers working on the workshops.

Tactics used to increase awareness of the program and get people to attend the workshops will vary according to the community, but are expected include the following:

- Utilization of block leaders and other community leaders to recruit their neighbors
- Presentations at community events
- Door-to-door knocking
- Postcard mailings
- Door hangers
- Neighborhood and community newsletters

Volunteers will also be utilized in the production of the workshop as well, including providing food, signing people in, and setting up the room.

In Minneapolis, St. Paul and Apple Valley, CEE will work with Metro CERTs (coordinated by The Green Institute) for recruiting participants for workshops. CERTs and CEE will split primary responsibility for organizing these workshops; for example, CERTs might organize turn-out for all the workshops in St. Paul, and assist with turn-out in other cities. For some of the Greater Minnesota cities, one or more contractor will be hired to assist with the workshop production.

The Great Plains Institute (GPI) will work exclusively with program design and implementation in Apple Valley. Apple Valley is one of four communities in the upper Midwest participating in a pilot to develop strategies for community-wide energy efficiency initiatives. In order to leverage this opportunity to maximum advantage for this project, GPI will help develop and integrate these efforts (which focus on all sectors of energy use, including business and institutional) with this LCCMR project, which focuses just on the residential sector. Activities include facilitating a community-wide planning process, stakeholder recruitment and facilitation, and development and implementation of a community energy efficiency plan. LCCMR-funded activities will focus on the residential component of this community-wide plan. It is anticipated that these efforts will help deepen community engagement on energy-efficiency issues in general, and result in a more concentrated turn-out of Apple Valley residents to workshop events.

<u>Assist 6,000 participants in the direct installation of low-cost measures through in-home visits</u>

At the workshop, participants receive free energy-efficiency materials to install in their home, such as CFLs, set-back thermostats, LED night lights, power strips and pipe wrap. CEE has learned from past experience that providing education and free materials does not automatically insure that the materials will be used and energy savings will be achieved. Providing a home visit to the participants in their home is a critical component to a successful workshop centered program. This follow-up home visit (funded with matching utility funding) allows the homeowner to ask specific questions about their home, identifies insulation and other needs, provides additional hands on education on how to use the materials and gives the energy technician the opportunity to reenergize the homeowner's interest in energy conservation. Low cost insulation and air sealing work would be referred to a specially trained contractor. Participants in need of high efficiency furnaces would be referred for financing. The in-home visits would be coordinated with, or incorporated into, existing and planned utility programs. For example, Xcel Energy and CenterPoint Energy both plan on implementing an in-home visit program called "Quick-Fix" starting in January, 2010.

In St. Paul, NEC would implement the in-home visits, utilizing their existing energy auditor staff. In Minneapolis and Apple Valley, CEE would implement the in-home visits. In other cities, local contractors, with utility cost-share funding, would implement the in-home visits.

<u>Ensure 1,600 homes receive insulation, air sealing and other major energy improvements</u>

If major weatherization work is needed, the homeowners will receive a blower door test, analysis and bid with a referral to a qualified insulation contractor. This diagnostic work would be provided by NEC in St. Paul, CEE in Minneapolis and Apple Valley, and existing auditor contractors in other cities. We estimate contractor work would be recommended in about half of the homes that receive in-home visits, and of these, 1,600 would act on the recommendations to conduct major insulation, air sealing, or furnace or hot water heater installations.

In addition to the initial cities, if budget and resources allow, CEE may also extend the program into other cities.

Summary Budget Information for Result 4: **Trust Fund Budget: $ 1,253,700**
Amount Spent: $ 1,058,247
Balance: $ 195,453

Deliverable	**Completion Date**	**Budget**
1. Recruit, educate and enroll at least 6,000 participants in workshops and other community events	6/30/2011	$ 563,850
2. Conduct 6,000 in-home visits including installation of low cost measures	6/30/2011	$ 689,850
3. Ensure that 1600 homes receive insulation, air sealing and other major energy improvements	6/30/2011	(included in #2 above)

Result Completion Date: 6/30/11

Final Report Summary:

The following table shows results from the program activities that were outlined above. These results are further discussed below.

Energy Efficient Cities Results Through June 2011				
City	**Workshop Attendees**	**Home Visits Completed**	**Households Completing Upgrades**	**Number of Upgrades Completed**
Apple Valley	796	780	147	151
Austin	224	184	64	83
Duluth	789	177	15	15
Minneapolis	4,139	3,886	948	1,063
Owatonna	204	180	43	47
Park Rapids	14	6	0	0
Rochester	302	216	78	110
St. Paul	1,775	1,493	179	221
Total	**8,243**	**6,922**	**1,474**	**1,690**

<u>Goal: Generate at least 6,000 participants in workshops and other community events</u>

The Energy-Efficient Cities exceeded the goal for total workshop participants by over 2,000 participants. In total 8,243 people attended the workshops (some households had more than one person in attendance, but typically only one member of the household would sign in at the workshop). The number and size of the workshops varied, with generally more workshops being done in the larger cities, and less, but larger, workshops being done in the smaller cities. The larger cities, like St. Paul, Minneapolis and Rochester, generally marketed the workshops by neighborhood, while the smaller cities marketed them across the city. The workshops completed included:

- 91 workshops in Minneapolis
- 51 workshops in St. Paul
- 10 workshops in Apple Valley
- 4 workshops in Owatonna
- 4 workshops in Austin
- 9 workshops in Rochester
- 31 workshops in Duluth
- 3 workshops in Park Rapids

In addition, Duluth piloted an “on-line workshop,” which several hundred additional participants utilized.

<u>Goal: Assist 6,000 participants in the direct installation of low-cost measures through in-home visits</u>

All of the programs resulted in installation of low-cost items as part of the home visit, as well as diagnostic work, such as a blower door test, to make recommendations for major efficiency upgrades. In total, 6,922 home visits were completed, exceeding the goal by nearly 1,000 home visits.

In most cases, there was a very high percentage of people attending the workshops that took the next step of completing the home visit (for some cities, over 95% of workshop attendees completed a home visit). The case of Duluth requires special explanation, as Duluth had many more people attend the workshop than followed through with completing the home visit. This was largely because the home visit portion of the program was not available in Duluth until late 2010, due to contractual negotiations with the utilities and DEEP on finalizing the administrative details of the home visits. Consequently, the home visits were not available at the time of the workshops, and all but 5 home visits were completed in the first months of 2011. As the Duluth program is now ongoing, it is expected that many of the workshop participants will in the future receive a home visit. Also, some workshop participants in other cities (including Minneapolis and St. Paul) were scheduled to have a home visit, but the home visit was not completed until after the end of the project period (6/30/2011).

<u>Goal: Ensure 1,600 homes receive insulation, air sealing and other major energy improvements</u>

As of the end of the project period, 1,474 homes participating in Energy Efficient Cities completed upgrades to their homes; about 15% of these homes completed more than one upgrade (e.g., insulation work and furnace replacement), resulting in a total of 1,690 upgrades in these homes. These upgrades were facilitated by follow-up work and assistance to participating homeowners who had upgrade recommendations, including phone calls, letters and email. These upgrades generated $4.8 million in work for insulation and heating contractors. In total, measures installed by the programs (including low-cost measures) resulted in an estimated $13.8 million of energy bill savings over the lifetime of the installed measures.

Although the project fell 126 homes short of its goal of 1,600 homes, it is expected that in time additional upgrades will be completed beyond the end of the project period by homes that participated in Energy Efficient Cities. This is because there is a lag period between when the home visit is completed and when the homeowner completes the upgrade which is typically 2-6 months, but can be 12 months or more. Thus, it can be expected that a year after the end of the project period, more homes will have completed upgrades, coming closer to or exceeding the original goal of 1,600 homes.

In order to assure the quality of the work completed, CEE developed quality assurance protocols for contractors to follow. The basis of these protocols is air sealing and insulation installation standards. The starting point for these standards is based on CEE's experience in overseeing air sealing and insulation over 8,000 homes through the Metropolitan Airport Commission's Sound Insulation Program. The standards set expectations for what insulation contractors will be expected to accomplish in their scopes of work for individual houses. Based on building science principles, the standards provide a framework to ensure that the work is done right the first time, avoiding issues like ice dams, missed opportunities for energy savings, and moisture problems. CEE has also developed a protocol for testing the homes post-retrofit to ensure good indoor air quality (i.e., adequate ventilation and no combustion safety issues from tightening up the home). Participating contractors are required to conduct these tests. These standards were provided to all cities in the program, and were adopted by a majority of the Energy Efficient Cities programs (Minneapolis, Apple Valley, Rochester, Austin, Owatonna and Rochester).

In November 2010, Minneapolis was selected as one of ten communities, and the only city in the Upper Midwest, for piloting the U.S. Department of Energy's Home Energy Score tool. CEE ran the pilot for 154 homes participating in the Energy Efficient Cities program (called Community Energy Services in Minneapolis). The Home Energy Score rates a home based on its existing energy usage, and indicates how the rating could be improved through retrofitting the home. CEE entered this pilot in order to test other methods of persuading homeowners to complete upgrades. A separate report (funded through the Department of Energy) will be completed for this pilot in the fall of 2011.

The project was able to accomplish Result 4 with nearly $200,000 less expenditures than originally planned. In fact, a majority of the budgeted money that was not spend for the Energy Efficient Cities project was from Result 4. This was largely due to the fact that additional cost-share was provided through utility programs and other sources. Minneapolis, St. Paul and Duluth received stimulus funding from the state for outreach activities. CEE also received additional stimulus funding through a City of Minneapolis Energy Efficiency and Conservation Block Grant (EECBG) in July

2010. No LCCMR funding was spent on homes recruited through this funding. In addition, less funding was needed for insulation diagnostics, as most of this was provided through utility funding.

Result 5: Provide cost-share for installing energy-efficiency measures.

Description:

Trust Fund dollars would be used to provide cost-share for homeowners to act on the in-home visit recommendations requiring contractor work (result 4). This contractor work will include air sealing, insulation and major mechanical replacement.

In conjunction with loans provided by other sources such as the Minnesota Housing Finance Agency, these cost-share incentives would be tailored to each city to cover project costs. We would also work with local utilities to complement and enhance existing rebate programs. In general, we would strive to have LCCMR cost-share, combined with other incentives, pay for 30-50 percent of the costs to the homeowner for air sealing (total cost of around $800) and 20-25 percent of the cost of insulation (total cost of around $4,000). In total, this would require funding of about $900,000 in cost-share. We assume half would be provided by utilities and stimulus dollars, and half by this program.

Specifically, stimulus funding to the MHFA is expected to be able to supplement cost-share incentives to homeowners provided by this LCCMR project. The stimulus funding will include loans, and may include cost-share incentives as well, although this has not yet been determined. As more details about this program are made available, CEE will work with LCCMR staff to further refine our budget for cost-share.

Summary Budget Information for Result 5: **Trust Fund Budget: $475,000**
Amount Spent: $ 450,934
Balance: $ 24,066

Deliverable	**Completion Date**	**Budget**
1. Provide cost-share for installing energy-efficiency measures in 1,600 households	6/30/2011	$475,000

Result Completion Date: 6/30/11

Amendment request (approved 6/17/11):
An amendment is being requested to shift $25,000 from Result 2 to Result 5, in order to provide more participants the opportunity to receive cost-share. We have had a greater demand for these funds than we anticipated, and the request is to meet that demand. Note that the level of cost-share per participant will not be

increased, and that other non-LCCMR utility-funded rebates will still provide a portion of this cost-share, as described above.

Final Report Summary:

CEE developed the program guidelines, and started implementation, for providing cost-share for major upgrades completed as part of the Energy Efficiency Cities program in May 2010. It was decided that offering the same package to each city would be most fair, and the cleanest to administer. Cost-share was available to homeowners who had gone through the program (completed the home visit), and have received recommendations for major upgrades. These customers were eligible for Trust Fund dollars to pay a portion of their upgrade costs in the following amounts:

- $250 for installing a natural gas forced air furnace with 95% or greater efficiency
- $250 for installing a boiler with 85% or greater efficiency
- 50% of the total project cost, up to $400, for air sealing, or air sealing and insulation, or wall insulation.

The total amounts ($250 for furnace/boiler and $400 for insulation/air sealing) were set to roughly equal utility rebates (although the rebate levels are slightly different in each city), so that Trust Fund cost-share would be about equally matched with utility rebates. Although the cost-share was available anytime after May 2010, the vast majority of applications for cost-share were received in the final four months of the project. Participants were responsive to marketing that conveyed a sense of urgency of an impending deadline, after which the money would not be available. In the final weeks of the project, based on the volume of request being received, CEE requested a transfer of $25,000 from Result 2 (these funds were not needed for Result 2 as they were dedicated to postage for the feedback reports, when most were actually send via email). In the end, however, although the entire original budget was spent, less than $1,000 was spent of the $25,000 transferred from Result 2. In total, 1,162 homeowners received cost-share from Trust Fund dollars (some of these homes did both insulation and heating system upgrades).

Result 6: Conduct project evaluation and make recommendations for ongoing utility programs.

Description:

A major objective of this proposal is to transform the delivery of residential energy efficiency programs, so that they can be massively scaled up to reach significantly more (an order of magnitude more) homes than will be served by this project. Thus we would evaluate the success of the program in achieving cost-effective energy efficiency services, and recommend enhancements and improvements for ongoing utility programs.

Summary Budget Information for Result 6:	**Trust Fund Budget:**	**$11,000**
	Amount Spent:	**$ 7,225**
	Balance:	**$ 3,775**

Deliverable	**Completion Date**	**Budget**
1. Evaluation of program including number of participants, measures installed, cost and savings, and recommendations for future programs	6/30/2011	$11,000

Result Completion Date: 6/30/11

Final Report Summary:

A separate report was produced for this result.

Figure 1: Anticipated program delivery workflow and relationship to project results

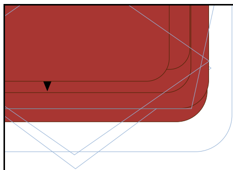


Figure 2: Anticipated project timeline

Figure 3: Summary of participation / funding commitments of partners

	Minneapolis	St. Paul	Apple Valley	Austin, Owatonna, Rochester	Duluth	Other Cities
Participation / Tracking	LCCMR	LCCMR	LCCMR	LCCMR	LCCMR	LCCMR
Data Analysis and Feedback	LCCMR	CenterPoint, LCCMR	LCCMR	Triad (utilities of Austin, Owatonna & Rochester), LCCMR	LCCMR	LCCMR
Home visit/ Materials	CenterPoint Energy, LCCMR	Xcel Energy, LCCMR	CenterPoint Energy, Dakota Electric, LCCMR	Triad, LCCMR	Minnesota Power, Comfort Systems, stimulus	local utilities, LCCMR
Cost-share for insulation / air sealing / mechanical upgrades	Xcel, stimulus, LCCMR	CenterPoint, stimulus, LCCMR	CenterPoint, stimulus, LCCMR	Triad, stimulus, LCCMR	MN Power, Comfort Systems, stimulus	Local utility, LCCMR, stimulus

V. TOTAL TRUST FUND PROJECT BUDGET:

Personnel: $ 681,000

CEE has about 60 staff, of which about 1/6th will be assigned for some portion of time to this project. In implementing the majority of project activities for the LCCMR project, these staff will utilize expertise in project management, program design, recruitment and organizing of workshops, data input and tracking, field experience with home visits and technical analysis.

Contracts: $ 500,000

$100,000 to CERTs for assistance recruiting and organizing workshops
$85,000 to other Greater Minnesota contractors for assistance recruiting and organizing workshops
$150,000 to NEC and others for insulation diagnostics, post-Installation inspection and home visits
$25,000 to Great Plains Institute for assistance with Apple Valley implementation
$30,000 to NEC for program design in implementation assistance
$50,000 to BAM for website development
$60,000 to Conservation Services Group, Shelter Supply, and other contractors for developing and producing air sealing and insulation contractor trainings

Other direct project costs: $ 80,000

$50,000 for workshop production costs including promotion and direct costs of producing the workshops (food, venue rental, etc.)
~~$30,000~~ $5,000 for production and delivery of the feedback forms

Travel (within Minnesota): $ 39,000

Estimated based on an average of about two visits/month to each participating city.

Low-cost energy-efficiency materials: $ 250,000

Low-cost energy-efficiency materials for 6,000 homeowners will include items such as compact florescent light bulbs, weather stripping, outlet gasket seals, recessed lighting inserts, low-flow showerheads, facet aerators, hot water pipe insulation, outlet strips, and programmable thermostats.

Cost-share for energy-efficiency: $475,000

Cost-share to be provided for homeowners who pay for contractor work for air sealing, insulation and major mechanical replacement.

TOTAL TRUST FUND PROJECT BUDGET: $ 2,000,000

Explanation of Capital Expenditures Greater Than $3,500: None.

VI. PROJECT STRATEGY:

A. Project Partners:

Cities: Saint Paul, Minneapolis, Apple Valley, Rochester, Owatonna, Austin, Duluth, Park Rapids

Utilities: Rochester Public Utilities, Owatonna Public Utilities, Austin Public Utilities, Minnesota Energy Resources (Rochester's gas utility), Comfort Systems (Duluth gas utility), Xcel Energy, Great River Energy, Dakota Electric, Minnesota Power

State agencies: Minnesota Office of Energy Security, Minnesota Pollution Control Agency

Contractors:

Builders Association of Minnesota (BAM)

BAM has extensive knowledge of building energy efficiency, and has developed the successful home-smart.org website.

Neighborhood Energy Connection (NEC)

The NEC is a St. Paul-based non-profit with extensive experience in residential energy efficiency. They will assist with developing the program design, and will implement in St. Paul.

Clean Energy Resource Teams (CERTs)

In the Metro CERTs, efforts for this project will be coordinated by Diana McKeown through The Green Institute.

Great Plains Institute (GPI)

The Great Plains Institute is a 501(c)(3) nonprofit organization that brings together key public and private leaders from across the northern plains to accelerate the transition to a renewable and low-carbon energy system by mid-century. GPI's core competency is facilitation and collaboration with a diverse group of creative, intelligent individuals to achieve consensus on policy and technology recommendations for businesses and government.

Conservation Services Group (CSG), Shelter Supply and other contractors

CSG and Shelter Supply have decades of experience in training energy efficiency contractors, in Minnesota as well as other states.

Common Ground Construction

Common Ground is the implementing organization of the Duluth Energy-Efficiency Program (DEEP), and conducted

B. Project Impact and Long-term Strategy:

Estimated direct impacts include the following:

- served 6,933 households
- reduce energy costs $1,000,000/year in those homes
- reduce CO_2 26,000,000 lbs.
- create 30 new full-time jobs

In addition, it is our intent to transform how residential energy services are delivered, so that after we complete this project, these benefits would continue and increase by approximately an order of magnitude. After initial funding by LCCMR, we would anticipate that these programs will be funded by utilities in the long term. Duluth, Minneapolis, Rochester, Austin and Owatonna have made commitments to keep funding their programs.

This pilot project will demonstrate strategies that can be incorporated into utility residential Conservation Improvement (CIP) programs for the next decade. In order to meet the legislatively mandated 1.5 percent per year savings goal within the residential sector, over the next decade hundreds of thousands of homes will need to enter in a program such as we will be implementing. Thus we would anticipate that this LCCMR project could catalyze the implementation of much larger utility programs that would enroll 50,000 or more homes per year over a 10 year span, creating hundreds of jobs and significantly reducing CO2 emissions in the residential sector.

C. Other Funds Proposed to be Spent during the Project Period:

The following lists estimated funding leveraged by this project:

CEE in-kind	$330,000
Other utilities:	$2,000,000
Stimulus funding (Duluth):	$1,500,000
Stimulus loan financing:	$1,600,000
TOTAL:	$5,430,000

D. Spending History:

CEE has spent over $100,000 of its own funding planning for this project prior to June 30, 2009. Activities conducted with this funding include:

- Conducting program pilot in fall of 2008 in select neighborhoods in Minneapolis and Oakdale;
- Providing in-home visits and free materials for the pilot;
- Discussions and planning with project partners;
- Developing a training curriculum and conducting a “train the trainer” session so training can be conducted during the project period.

VII. DISSEMINATION:

Our program will involve significant outreach efforts inherent in the program design, including a website developed for the project. Outreach efforts will include presentations at workshops and working through community partners to turn out people to the workshops. Program results will be captured through the final report which will be sent to key stakeholders. In August 2010 CEE presented the program at a conference of the American Council for an Energy Efficient Economy (ACEEE). In December 2010 CEE presented the program at a webinar sponsored by the U.S. Department of Energy.

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted on the following dates: January 31, 2010; July 31, 2010; and January 31, 2011.

A final work program report and associated products will be submitted by August 31, 2011.

IX. RESEARCH PROJECTS:

None.

Attachment A: Final Budget Detail for 2009 Project

Project Title: ***Energy Efficient Cities***

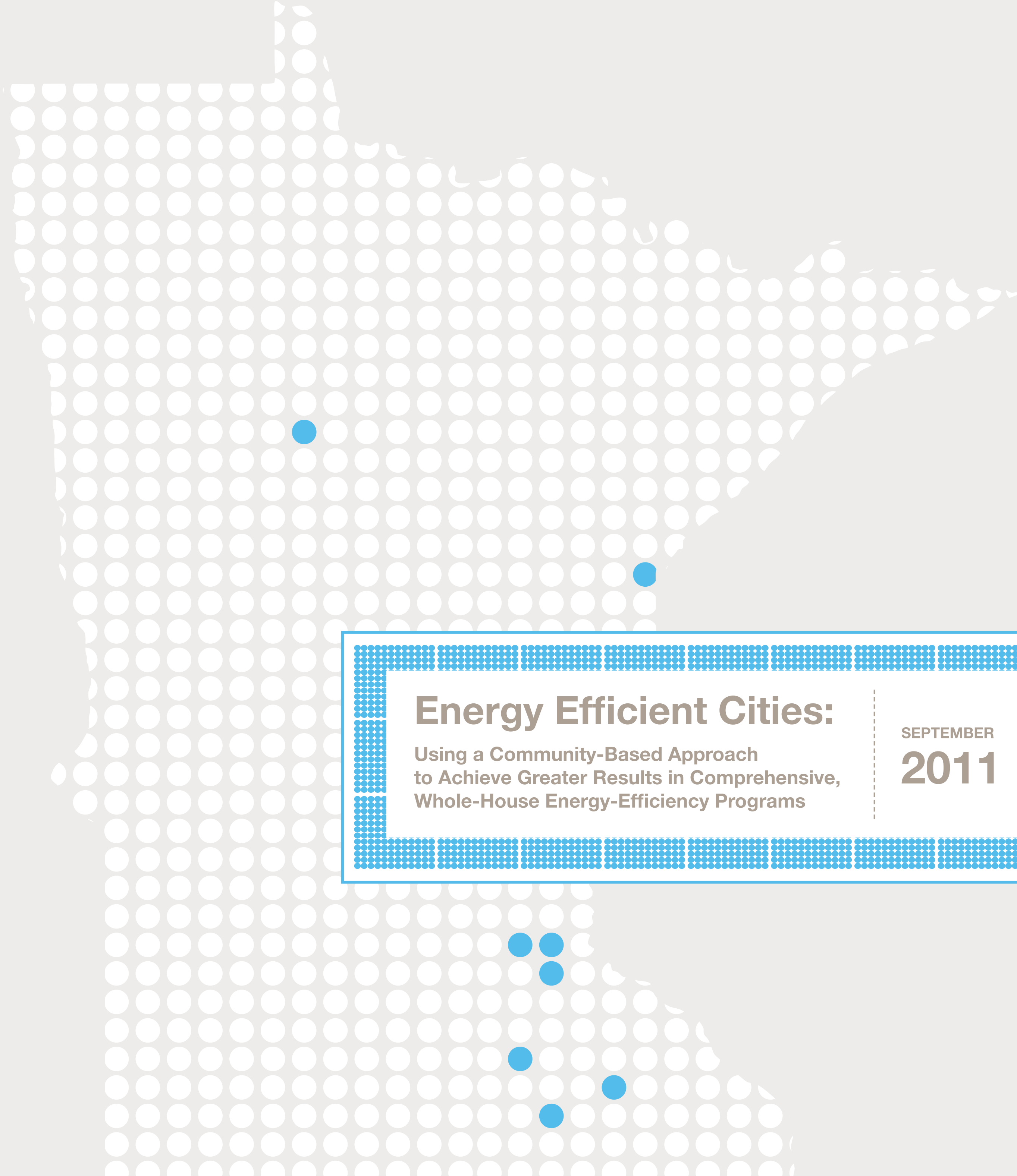
Project Manager Name: Carl Nelson

Progress Report: July 15, 2011

Reporting budget results as of: *6/30/11*

Trust Fund Appropriation: $ *2,000,000*

2009 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent: (6/30/11)**	**Balance: (6/30/11)**	**Revised Result 2 Budget:**	**Amount Spent: (6/30/11)**	**Balance: (6/30/11)**	**Result 3 Budget:**	**Amount Spent: (6/30/11)**	**Balance: (6/30/11)**	**Result 4 Budget:**	**Amount Spent: (6/30/11)**	**Balance: (6/30/11)**	**Revised Result 5 Budget:**	**Amount Spent: (6/30/11)**	**Balance: (6/30/11)**	**Result 6 Budget:**	**Amount Spent: (6/30/11)**	**Balance: (6/30/11)**	**TOTAL BUDGET**	**TOTAL BALANCE**
	RESULT 1: *Design and develop 8 city-specific programs*			*RESULT 2: Coordinate, track and provide feedback on energy use*			***RESULT 3:*** *Train insulation and air sealing contractors*			***RESULT 4:*** *Implement energy efficiency programs*						***RESULT 6:*** *Recommendations for ongoing utility programs.*				
PERSONNEL: wages and benefits																				
Project Manager (Carl Nelson - 60% FTE)	22,000	11,669			2,399					77,100	55,262					11,000	7,225			
Participation Coordinator (Erica Graber-Mitchell - 60% FTE)		1,556								87,500	27,785									
Community Organizers (100% FTE)		3,960								99,900	73,382									
Logistics Coordinator (Judy Thommes - 30% FTE)										54,300	56,638									
Project Assistant (John Kracum - 100% FTE)				62,600	31,431					15,700	7,618									
Project Assistant (Beth Bennett - 90% FTE)					254					75,300	29,082									
In-home Visit Coordinator & other field staff (Bob Mello - 20% FTE)		28,105								31,900	155,159									
Administrative support (10% FTE)					29,714					8,100	37,305									
Workshop Coordinator (Neely Crane-Smith - 70% FTE)					1,629					73,700	18,168									
Project Engineer & technical support (Lester Shen - 25% FTE)	37,100	13,623		18,600	3,872					6,200	69,134									
SUBTOTAL PERSONNEL:	***59,100***	***58,912***	***188***	***81,200***	***69,299***	***11,901***				***529,700***	***529,534***	***166***				***11,000***	***7,225***	***3,775***	**681,000**	***16,030***
CONTRACTS																				
Organizing Assistance - CERTs										100,000	81,133	*18,867*							100,000	*18,867*
Insulation diagnostics, post installation inspection, home visits (NEC & other contractors)										150,000	88,637	*61,363*							150,000	*61,363*
Organizing Assistance - Additional local contractors										85,000	74,250	*10,750*							85,000	*10,750*
Apple Valley assistance (Great Plains Institute)										25,000	20,504	*4,496*							25,000	*4,496*
Program design & implementation assistance (NEC)	5,000	4,957	*43*							25,000	25,000	*0*							30,000	*43*
Insulation and air sealing contractor training (Conservation Services Group, Shelter Supply, Builders Association of MN and others)							60,000	47,056	*12,944*										60,000	*12,944*
Website development (Builders Association of MN)				50,000	49,000	*1,000*													50,000	*1,000*
SUBTOTAL CONTRACTS:	***5,000***	***4,957***	***43***	***50,000***	***49,000***	***1,000***	***60,000***	***47,056***	***12,944***	***385,000***	***289,524***	***95,476***							**500,000**	***109,463***
TRAVEL IN MINNESOTA										**39,000**	**5,041**	***33,959***							**39,000**	***33,959***
OTHER DIRECT PROJECT COSTS																				
Workshop production costs (materials & promotion)										50,000	35,649	*14,351*							50,000	*14,351*
Production and delivery of feedback materials				5,000	21	*4,979*													5,000	*4,979*
SUBTOTAL OTHER DIRECT COSTS:				***5,000***	***21***	***4,979***				***50,000***	***35,649***	***14,351***							**55,000**	***19,330***
SUPPLIES (low-cost energy-efficiency materials for homeowners)										**250,000**	**198,499**	***51,501***							**250,000**	***51,501***
COST-SHARE FOR EFFICIENCY INVESTMENTS													**475,000**	**450,934**	***24,066***				**475,000**	***24,066***
COLUMN TOTAL	**$64,100**	**$63,869**	**$231**	**$136,200**	**$118,320**	**$17,880**	**$60,000**	**$47,056**	**$12,944**	**$1,253,700**	**$1,058,247**	**$195,453**	**$475,000**	**$450,934**	**$24,066**	**$11,000**	**$7,225**	**$3,775**	**$2,000,000**	**$254,349**



Energy Efficient Cities:

Using a Community-Based Approach to Achieve Greater Results in Comprehensive, Whole-House Energy-Efficiency Programs

SEPTEMBER
2011

Center for Energy and Environment

REPORT AUTHOR

Carl Nelson
Program and Policy Manager
Center for Energy and Environment
212 3rd Ave. N., Ste. 560
Minneapolis, MN 55401
cnelson@mncee.org

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR). The Trust Fund is a permanent fund constitutionally established by the citizens of Minnesota to assist in the protection, conservation, preservation, and enhancement of the state's air, water, land, fish, wildlife, and other natural resources. Currently 40% of net Minnesota State Lottery proceeds are dedicated to building the Trust Fund and ensuring future benefits for Minnesota's environment and natural resources.

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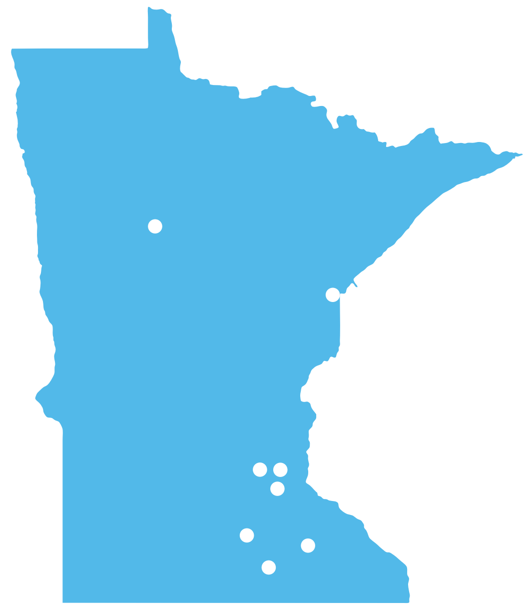
The project exceeded its original goals for participation, with 6,922 households completing a home energy visit and 1,474 of those households completing major energy upgrades, which generated $4.8 million in contractor work and saved homeowners $13.8 million on their energy bills.

Introduction to Energy Efficient Cities

The Energy Efficient Cities project was developed to demonstrate the delivery of innovative residential energy-efficiency programs to reduce energy use and environmental impact in at least 6,000 homes through a community-wide partnership approach, with initial seed funding from Minnesota's Environment and Natural Resources Trust Fund. **With strong and crucial support from local gas and electric utilities, city-specific programs were developed in eight cities: Apple Valley, Austin, Duluth, Minneapolis, Owatonna, Park Rapids, Rochester, and St. Paul.** While each city developed a customized approach, all of the programs were designed to provide a "one-stop shop" whole-house approach that would make it as easy as possible for homeowners to take energy-efficiency actions, while maximizing participation and energy savings. This comprehensive approach involved the following components in every program:



- ***Community-based marketing strategies*** to recruit participants to workshops, for training participants to take low-cost energy actions and to serve as an entry into the program;
- ***Home energy visits*** that include installation of low-cost materials, identify other energy-saving opportunities, and provide a customized energy action plan;
- ***Energy usage feedback reports*** to encourage individual energy-saving actions;
- ***Follow-up assistance***, including providing cost-share for completion of major efficiency upgrades including insulation, air sealing and major mechanicals replacement; and
- ***Training and quality assurance*** for insulation and air sealing contractors.

The project exceeded its original goals for participation, with 8,243 people attending workshops, 6,922 of those households completing a home energy visit, and 1,474 homes completing major energy-efficiency upgrades. Quality-assurance protocols were developed to provide confidence to the homeowner that their upgrade was being done right, as well as to ensure promised energy savings would be realized. Thirty-six contractors were trained in high-performance installation techniques for insulation and air sealing jobs. The upgrades completed under this program generated $4.8 million in work for Minnesota's insulation and heating contractors. The estimated total energy savings from measures installed in these homes is $13.8 million for the homeowners over the life of the measures. The programs will be continued in at least five of the participating cities.

This report provides a summary of the project, as well as lessons learned for implementing similar programs.

Why Was Energy Efficient Cities Started?

Minnesota has a long-standing commitment to improving the energy efficiency of its homes and businesses. In 2007, the legislature reinforced this commitment by requiring both natural gas and electric utilities to increase their efforts to help their customers save energy, sufficient to reduce energy use 1.5% per year from what it otherwise would have been. While utilities have a long history of successfully implementing programs to help customers save energy, the residential sector has been a particularly hard sector to serve, especially for natural gas savings. Achieving significant natural gas savings in the residential sector requires deeper efforts like insulation and heating system upgrades (so-called "whole-house" programs[1]). Major upgrades, such as insulation and air sealing, typically require some kind of home visit to assist with the diagnosis of the problems and design of the upgrades. However, traditional audit programs (the predominate program offering in Minnesota), which simply provide information to help guide consumer action, often do not achieve results on their own. It has long been recognized that providing information is, in itself, insufficient for motivating participant action. New approaches are needed to unleash the potential for energy efficiency in homes.

Traditional audit programs, which simply provide information to help guide consumer action, often do not achieve results on their own.

The Center for Energy and Environment (CEE) set out to design an approach that could address energy efficiency in the residential sector, and jump-start these efforts throughout the state. CEE was awarded a grant from the Minnesota Environment and Natural Resources Trust Fund in 2009 to pilot residential energy-efficiency programs in eight cities throughout Minnesota.

Participating Cities and Partners

Eight cities from across Minnesota participated in the Energy Efficient Cities project: Apple Valley, Austin, Duluth, Minneapolis, Owatonna, Park Rapids, Rochester and St. Paul. Park Rapids participated in the program for only a few months before the city decided to focus instead on another energy-efficiency initiative it had received stimulus funding for. Each city had a broad range of partners that helped make the program possible, summarized below. Utilities from each of the cities were strong supporters and critical to the programs' success, typically funding the home energy visit portion of the program. Cities and community and neighborhood groups were essential to helping garner participation. Program implementers were also different for each city. CEE implemented the programs in Minneapolis and Apple Valley in their entirety; implemented everything except the home energy visit in Austin, Owatonna and Rochester; and conducted the workshops in Park Rapids. In St. Paul, the Metro Clean Energy Resource

Teams (CERTs) did most of the recruitment and workshops, while the Neighborhood Energy Connection conducted the home visits and follow-up work as well as a portion of the recruitment and workshops. Duluth had a large coalition of organizations that resulted in the formation of the Duluth Energy Efficiency Program, which was implemented by Common Ground, a local nonprofit.

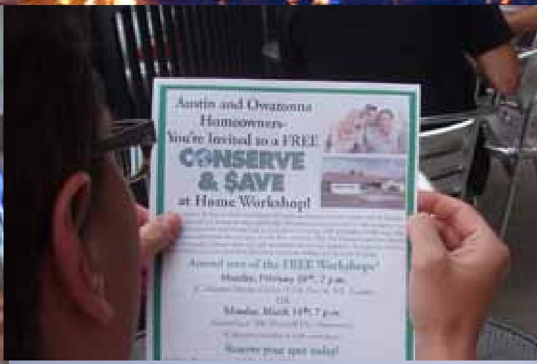
Figure 1: Summary of Energy Efficient Cities Program Partners

City *Program Name*	**Utilities**	**Program Implementers**	**Other Partners**
Apple Valley *be. (better energy) Apple Valley*	Dakota Electric Association *(electric)* CenterPoint Energy *(gas)*	CEE *(everything)*	City of Apple Valley Metro CERTs Great Plains Institute Great River Energy
Austin *Conserve & Save House Call*	Austin Utilities *(electric and gas)*	CEE *(recruitment, workshops, follow-up, quality control)* Greg Ernst and Associates *(home energy visit)*	Owatonna Public Utilities
Duluth *Duluth Energy Efficiency Program (DEEP)*	Minnesota Power *(electric)* Comfort Systems *(gas)*	Common Ground *(everything)*	City of Duluth
Minneapolis *Community Energy Services & Home Energy Squad*	Xcel Energy *(electric)* CenterPoint Energy *(gas)*	CEE *(everything)*	City of Minneapolis Over 50 neighborhood groups
Owatonna *Conserve & Save House Call*	Owatonna Public Utilities *(electric and gas)*	CEE *(recruitment, workshops, follow-up, quality control)* Greg Ernst and Associates *(home energy visit)*	Austin Utlities
Park Rapids *Green Park Rapids*	Minnesota Power *(electric)* MInnesota Energy Resources *(gas)*	HRA of Park Rapids *(recruitment)* CEE *(workshops)* Greg Ernst and Associates *(home energy visit)*	City of Park Rapids Green Park Rapids coalition
Rochester *Neighborhood Energy Challenge*	Rochester Public Utlities *(electric)* MInnesota Energy Resources *(gas)*	CEE *(recruitment, workshops, follow-up, quality control)* Greg Ernst and Associates *(home energy visit)*	City of Rochester R-Neighbors
St. Paul *Neighborhood Energy Service & Home Energy Squad*	Xcel Energy *(electric and gas)*	Neighborhood Energy Connection *(home energy visits, some recruitment, some workshops, follow-up)* Metro CERTs *(recruitment and workshops)*	City of St. Paul District Councils

Challenges for Residential Energy-Efficiency Programs

The benefits of investing in energy-efficiency measures, such as adequate attic and wall insulation, are well documented and can result in a positive economic return for the homeowner. Yet research indicates that homeowners consistently under-invest in energy-saving opportunities. Before starting the project, CEE identified the following challenges that would need to be addressed in developing a successful residential approach.[2]

- *Information barriers*. It might seem surprising that so few consumers take the sensible step of investing in all conservation opportunities with a payback of 10 years or less, but they can't take advantage of those opportunities if they don't know about them. Giving homeowners information about conservation opportunities is essential, but care must be taken in how that information is presented. Research shows that presenting too many choices can actually increase the likelihood that someone won't choose at all.
- *Individual consumer behavior plays a large role in household energy consumption.* It is well established that consumption in identical homes, even those designed to be energy-efficient, can easily differ by a factor of two or more depending on the behavior of the inhabitants. Recent utility studies have established that addressing energy-related behaviors can result in significant reductions in energy consumption.
- *Logistical barriers and short homeowner attention span*. Even if homeowners know what action to take, they may not take that action unless it is made very convenient for them. Research has shown that homeowners are willing to spend only a limited amount of time dealing with their home's energy issues. Programs must reduce confusion, provide easy steps to action, and deal with logistical barriers such as finding qualified contractors.
- *Factors other than economics are primary in consumer decision-making.* Even if a measure can be demonstrated to be a good economic investment, other factors determine homeowner priorities. A kitchen remodel is undeniably a more exciting project to most homeowners than installing insulation. Programs should include persuasion based on non-economic factors, such as creating peer pressure to do the right thing.
- *Financial barriers.* Homeowners often do not have access to capital to make needed improvements. It should be noted that in CEE's experience with financing more than $100 million in energy improvements, the importance of this issue is often overstated, but is nonetheless important for program designers to address.
- *High transaction costs relative to energy savings*. Compared to the commercial or industrial sector, the magnitude of the available energy savings per customer is relatively small. Thus, residential programs that involve a home visit must achieve high efficiencies in program delivery to minimize transaction costs. Minimizing the number of visits to the home (and maximizing the energy savings per visit) is necessary to achieve program cost-effectiveness. To maximize energy savings per customer, each visit must focus on all fuel types present, as well as multiple modes of savings, including direct installation, major retrofits and behavioral changes.



"Really happy with the program and happy it was in Apple Valley. That's not something that you really expect in a suburb. I was really proud I could participate in it. I wanted to do my part to help you guys out with any other research with hopes that we can expand the program to other areas and cities."

-Energy Efficient Cities Program Participant

Components of the Energy Efficient Cities Program

Informed by the challenges of serving the residential sector as outlined above, Energy Efficient Cities aimed to create a “one-stop shop” comprehensive approach to make taking energy-efficiency actions as easy as possible for the homeowner, while maximizing participation and energy-savings opportunities. CEE developed five basic program components, discussed below. The intent of this program design was for each of the components to build upon the others to create an integrated whole, creating a “conveyor belt to energy savings.”

Community-based marketing strategies including workshops

The Energy Efficient Cities program implementers worked closely with communities on outreach and marketing, for several reasons. First, the programs were able to leverage the interest by cities and community and neighborhood groups in helping their residents save money and energy in their homes. Many cities and neighborhood groups are actively seeking ways to engage their residents in these issues, and the programs provided an outlet for that interest.

Equally important, community-based strategies can provide an additional motivation for homeowners to take action, from taking the first step by enrolling in the program to investing in major upgrades. Insights from behavioral psychologists have shown that people are more strongly influenced by social norms than by economic drivers such as saving money (even though people may say, and believe, that they care more about saving money than they do about what their neighbors think). Showing that a behavior such as insulating your home is a social norm creates a powerful motivator for people to adopt that behavior. Community-based strategies can be important in establishing energy efficiency as a social norm, helping to increase program participation and the number of actions by program participants. This can be particularly true if community leaders are publicly involved with the program.

Energy Efficient Cities used community workshops to reinforce the social norm that energy efficiency is the right thing to do as well as to create a feeling of involvement by the whole community, helping to push individual participants to action. All of the Energy Efficient Cities programs used community workshops as a recruitment technique. It was found that when homeowners could schedule a home energy visit right at the workshop, more homeowners took that next step. This method also has the benefit of having homeowners make a public commitment to energy efficiency in front of their neighbors. Behavioral psychologists have found that public commitments are an effective strategy in driving people to take further actions, in this case making it more likely that homeowners would make investments in major energy-efficiency upgrades down the road.

The workshops also served to prepare the homeowner for the home visit, including setting expectations that doing major upgrades is an important part of a home's energy efficiency. The workshop content was informative, but also engaging for homeowners.

Partnering with neighborhood and other community groups, where such organizations existed, was a successful approach for many cities. Minneapolis has more than 80 neighborhood groups, more than two-thirds of which actively worked with CEE on promoting the program. This varied from helping market the program through community newsletters and email lists to recruiting volunteers for door-knocking efforts.

Many of the other cities also employed volunteer door-knockers to sign people up for the workshops. Minneapolis and St. Paul held volunteer trainings for door-knockers, and hosted door-knocking volunteer events. In Duluth, a "green canvass" talked to more than 2,000 households in their door-knocking efforts.

Home energy visits

The home energy visits provided an opportunity for the homeowner to get personalized assistance and recommendations from energy-efficiency experts. Most cities referred to the home energy visits as "energy audits." This term, however, conjures images of the IRS and tax accounting for many people, making it sound like an unpleasant chore. For this reason, the Energy Efficient Cities project and programs in Minneapolis and Apple Valley used the term "home energy visit."

Procedurally, the home energy visit involved diagnostics to determine the need for insulation and air sealing, typically a blower door test. The heating systems were checked to see if they needed to be upgraded, as well as for safety. To maximize energy savings potential, low-cost materials were installed during the home visit. The exact product mix varied by city, but included compact fluorescent light bulbs, low-flow showerheads, low-flow faucet aerators, programmable thermostats, hot water heater insulation blankets and pipe wrap, refrigerator thermometers and weather-stripping. At the end of the visit, homeowners were presented with any recommendations for major upgrades like insulation, air sealing and heating system replacement. As mentioned above, research has shown that presenting too many options tends to overwhelm people, resulting in no option being selected at all. Because of this, an effort was made in most cities to focus the recommendations on the top two or three most important ones.

> **The home visit was great! It was great to learn about all the specific improvements that were being made and how to implement some changes myself. The staff was great about answering questions and involving me in the process.**

-Energy Efficient Cities Program Participant

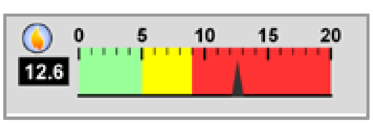
Energy use feedback reports

One barrier to people taking energy-efficiency actions is a lack of context for their energy bills. They generally don't know if their energy use is relatively high or low compared to other homes. Providing feedback on homeowners' energy bills can be a step toward their taking actions to reduce their energy use. Many studies have shown that well-designed "feedback reports" can result in people taking small actions to save energy, such as turning down their thermostats in the winter, and make it more likely that they will take larger actions, like buying a new furnace. Feedback reports were an integral part of Energy Efficient Cities. The reports require the participation of gas and electric utilities to acquire the necessary data, and typically require the homeowner to sign a waiver to release the data to a third party like CEE, who then provides it to the homeowner. The data acquisition process was not easy, and was fairly resource-intensive.

Different cities had different approaches to these reports. Duluth used a tool designed by the U.S. Environmental Protection Agency called the "Home Energy Yardstick," which combined natural gas and electric energy use to give a single score. Minneapolis, St. Paul and Apple Valley used a separate score for electric use (the "Spark Index") and natural gas usage (the "Flame Index"). Austin, Owatonna and Rochester, separately from Energy Efficient Cities, contracted with a large national provider of feedback reports (O-POWER). Those cities also worked with O-POWER to help market the program through their feedback reports.

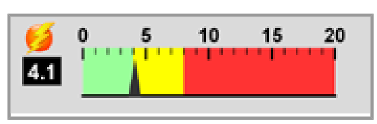
Having a score that provided context for homeowners helped to engage them in conversations about their energy use. Most homeowners found the reports extremely useful. The feedback reports were also very useful in encouraging further actions after the home visit. Homeowners are frequently not ready (financially or otherwise) to immediately do the upgrade work, and it may take many months before they engage a contractor to do the work. The feedback reports provided a reminder to the homeowner of their intention to complete that work.

YOUR HOME'S FLAME INDEX
(Btu/sq.ft. - HDD/year)



A good value for the Flame Index is 5 or less.

YOUR HOME'S SPARK INDEX
(KWh/year/sq.ft.)



A good value for the Spark Index is 4 or less.

Having a score that provided context for homeowners helped to engage them in conversations about their energy use.

Follow-up assistance to support implementation of recommendations

After the home visit, homeowners received assistance in following through on the home visit recommendations. This included answering questions about how to select a contractor and what should be included in the scope of the work, assistance with various government and utility incentives, and help with financing if it was needed. With the variety of programs available (including, in Minneapolis, neighborhood-specific financing programs), it can be hard for homeowners to keep track of what they may qualify for, and how they should proceed to maintain eligibility. For example, Duluth homeowners could be eligible for a city-run 4.9% loan program, Minnesota Housing Finance Agency loans available through at least four local lenders, several income-eligible loan programs, rebates from the gas and electric utilities, and a rebate through the DEEP program. A specific rebate was also available from Energy Efficient Cities for all cities, for up to $400 for insulation and up to $250 for heating systems. Often just a simple call to check in with the homeowner helped to keep projects moving along.

In addition to assistance by phone, program implementers created websites and sent emails and letters to homeowners to remind them of rebate offers and any upcoming deadlines for these rebates. As mentioned above, an energy usage feedback report sent out a couple times after the home visit can also serve to trigger action by the homeowner to implement recommendations.

> **"We greatly appreciated the follow-up call after the visit because that is where we were beginning to have more questions."**
>
> *-Energy Efficient Cities Program Participant*

Training and quality assurance for contractors

Energy Efficient Cities incorporated contractor training and quality assurance into the program design for two purposes. The first reason was to ensure that the maximum potential energy savings would be realized. Energy savings from insulation in particular is highly dependent upon the quality of the installation. Secondly, program implementers believed that providing homeowners with an assurance that contractor work would be done well and solve their energy problems would make it easier for them to make the decision to invest in upgrades.

Air leaks are a primary cause of ice dam issues.

Generally, there are few issues with installations of heating systems. However, the quality of work done by insulation contractors for existing homes is highly variable. Many contractors are not trained in proper techniques, particularly in sealing air leaks prior to installing insulation. And yet properly sealing air leaks is one of the most critical aspects of insulation work. Air leaks can result in an equal or greater heat loss than through insufficient insulation. Failing to properly seal air leaks can also result in moisture, mold and wood decay issues. This is caused by moisture in the warm, moist air condensing on cool attic spaces in the winter months. In addition, air leaks are a primary cause of ice dam issues, created when warm air reaches the roof deck and melts the snow on the roof. Adding more insulation without sealing air leaks can magnify these moisture issues.

Besides installation issues, contractors must be aware of and ready to deal with indoor air quality issues that may result from their work. Tightening up a home in some situations can result in the potential for combustion gases to leak into the home from combustion appliances (like most older natural gas water heaters) that are not power-vented. Tighter homes may also need mechanical ventilation for supplemental fresh air, and contractors should be ready to help homeowners address this need.

Because the difference between a well-done installation and a badly done installation is not visible to the homeowner, there is little market incentive for a contractor to do the job well, particularly when shortcuts can result in the work being done less expensively. Thus many homeowners experience a wide variation in bids from contractors, because one contractor may be doing more detailed work, while another may be taking shortcuts such as not fully sealing all attic bypasses. Even if homeowners are aware that improper insulation work can cause indoor air quality problems, they may not know the right questions to ask to make sure a contractor will properly deal with this issue. All of these issues create confusion for homeowners, which makes it less likely that they will go forward with doing the work.

To solve this dilemma, Energy Efficient Cities created a quality-assurance process, which was adopted in its entirety by a majority of the programs. The basis of the quality-assurance process is insulation and air sealing standards and a quality-control process to ensure the standards were followed. The standards were developed by CEE, largely based on CEE's experience overseeing the insulation and/or air sealing of more than 8,000 homes through the Metropolitan Airport Commission's Sound Insulation Program.

The quality-assurance process is under continuous improvement. The current process is different than originally chosen, as initial testing of contractor work showed more quality issues that was deemed acceptable. Additional training and more one-on-one contact between contractors and CEE's experienced staff were added to improve results. The current process involves the following steps:

1. Contractor completes required trainings and/or certifications (including on indoor air quality issues like ventilation and combustion safety), becomes familiar with the insulation and air sealing techniques and standards, and confirms they have required equipment, including a blower door and proper insulation equipment. Contractor also confirms they can properly fill out post-installation report that includes indoor air quality testing as part of program requirements;

2. Contractor is placed on a list of participating contractors that is provided to program participants;

3. Contractor is entered into the program on a probationary basis. Program quality control staff perform on-site "proctoring," or confirmation that the contractor is meeting the standards;

4. Contractor notifies the program administrator as they finish jobs for homeowners, and quality control staff conduct audits on at least 10% of the completed jobs. If deficiencies are found during the quality control audits, contractor corrects deficiencies. Contractors that consistently fail quality control audits are dropped from the program.

Training for contractors involved in Energy Efficient Cities was held to support the quality-assurance process (step 1 above), focusing on air sealing techniques. Toward the end of the project period, the national Building Performance Institute (BPI) developed a certification for insulation installers. A majority of the Energy Efficient Cities programs will be requiring this certification for participating contractors in the future (Duluth already requires contractors to hold another BPI certification for building envelope professionals).

Results

The Energy Efficient Cities project ran for two years, from July 2009 through June 2011. Since the program design and partner relationships had to be created before implementing the individual city programs, most programs didn't start until late 2009 or early 2010, meaning that the results presented here were accomplished in an average of about 18 months.

In total, 8,243 participants attended workshops, resulting in 6,922 home visits. Of the households that had a home visit, 1,474 (21%) completed a major energy-efficiency upgrade, and about 15% of those completed more than one upgrade (resulting in a total of 1,690 upgrades). The breakdown of these results by city is shown below. Of the total major upgrades, 1,348 (80%) were insulation and air sealing jobs, while 342 (20%) were heating system (furnace and boiler) upgrades. These upgrades generated $4.8 million in work for insulation and heating contractors.[3]

Figure 2: Energy Efficient Cities Project Results

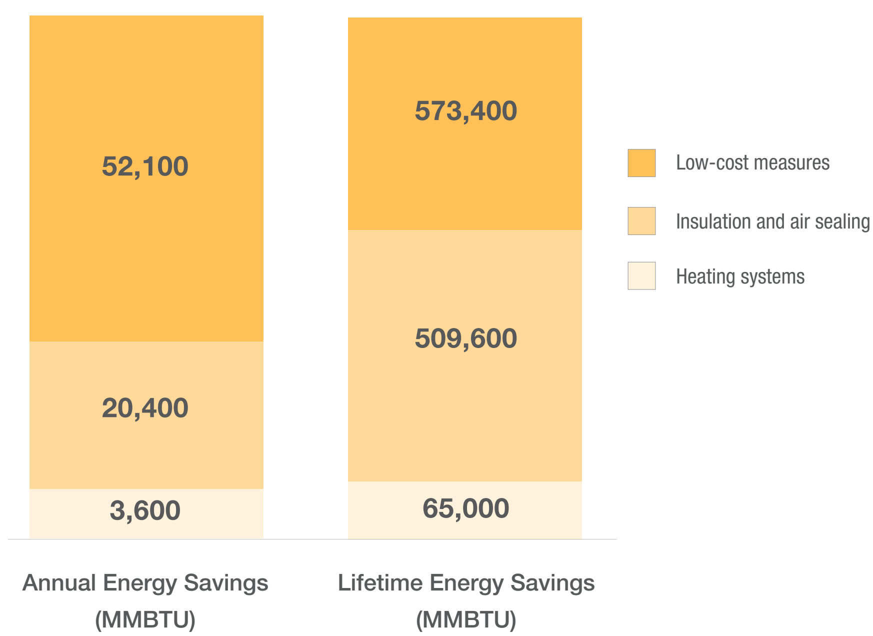
City	Workshop attendees	Home Visits Completed	Households Completing Upgrades	Number of Upgrades Completed
Apple Valley	796	780	147	151
Austin	224	184	64	83
Duluth	789	177	15	15
Minneapolis	4,139	3,886	948	1,063
Owatonna	204	180	43	47
Park Rapids	14	6	0	0
Rochester	302	216	78	110
St. Paul	1,775	1,493	179	221
TOTAL	**8,243**	**6,922**	**1,474**	**1,690**

A comprehensive assessment of energy savings from each program was not available at the time this report was written. Our estimates are based on savings claimed in calendar year 2010 by utilities from the three cities with the largest participation (Minneapolis, St. Paul and Apple Valley), and extrapolated to the remaining program participants.[4] This calculation resulted in the following estimates of energy savings[5] for the 6,922 households participating in the programs:

- 76,120 million BTUs of annual energy savings
- 1,148,000 million BTUs of total savings over the lifetime of the installed measures (35 million kWh of electric savings and 10.2 million therms of gas savings)
- $13.8 million in energy bill savings over the lifetime of the installed measures

The graph below provides a breakdown of energy savings for low-cost and major upgrades, and compares the immediate impact of annual energy savings compared to the long-term impact over the lifetime of the installed measures. As seen below, low-cost measures can provide large energy savings because they can be installed in every house. However, even though insulation and air sealing were installed in less than one-fifth of participating homes, these measures provide a much larger portion of total lifetime energy savings because insulation lasts longer than low-cost measures. And for the homes that installed insulation and air sealing, 80% of lifetime energy savings was attributable to insulation and air sealing. Heating system upgrades resulted in a smaller portion of energy savings, mainly because only 5% of participants installed heating systems. Thus the percentage of homes that actually follow through with insulation upgrades is critically important to the long-term energy savings the program will achieve.

Figure 3: Low-Cost and Major Upgrades: Annual vs. Lifetime Energy Savings



The above savings estimates do not include savings attributable to the program from behavioral changes that participants may make to decrease their energy usage. Although these savings were encouraged by the programs, they are hard to measure without large (more than 10,000 sample size) populations and utility bill information for each participant as well as a control group. Past studies have shown from zero to 12% savings per household from behavioral programs.[6] However, in order to sustain those savings year after year, research suggests that a continued effort (sending feedback reports for at least several years) is necessary.

Insights for Future Program Development

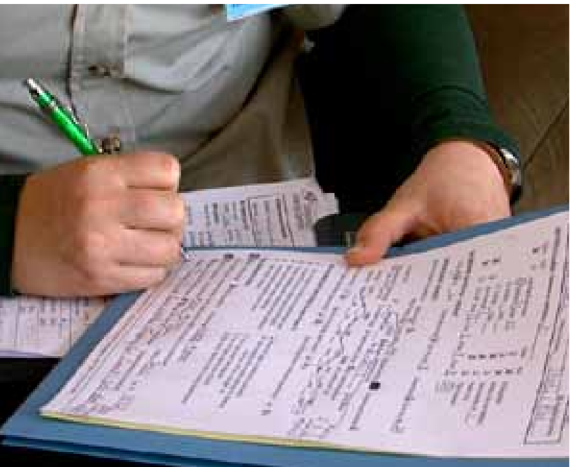
Overall, the Energy Efficient Cities project demonstrated that comprehensive energy-efficiency programs can achieve high participation and energy savings. The experience of many energy-efficiency program administrators is that it can take several years for a successful program design to mature and reach its full potential for cost-effective energy savings. Toward that end, the following reflections and insights are offered for the future development of current Energy Efficient Cities programs and those with similar aspirations.

Community-based marketing combined with traditional marketing can be an effective approach

Engaging local partners, such as cities and community groups, can be an effective method to market a residential energy-efficiency program. In order for it to be a fruitful partnership, the program must have something meaningful to offer all parties that will make it worth their time and effort. For the Energy Efficient Cities program, this was the case. In addition to being popular with participants (based on survey results), the programs helped to improve the local housing stock through home improvement investments and created local jobs for contractors. By being associated with an effective service to their residents, local partners could benefit from the goodwill created by the programs. All of these factors were effective motivators for city and community groups to become involved in the programs.

In addition, community members were willing to volunteer time for program recruitment. While this requires strong volunteer management to use their time effectively (which can be staff-intensive), having neighbors involved in the recruitment can reach people in ways that traditional marketing cannot. It can also increase the effectiveness of other more traditional marketing channels, such as direct mail.

Workshops were found to be a highly effective way to jumpstart participation in residential programs, as well as improve program results. However, it is recognized that those willing to take time away from evening and weekend activities to attend a workshop represent only a segment of the population. To reach deeper participation, future efforts will need to evolve to a program model that goes beyond workshops as a main recruitment method.



> I was totally pleased with the whole experience from start to finish. It makes me want to do something with our older appliances in our house, or anything we can do to save energy which will save us money and the environment. It was a good starting point, and now we'll look for other ways to save energy.
>
> *-Energy Efficient Cities Program Participant*

Combining low-cost measures with insulation measures can increase savings beyond that achieved by separate strategies

All of the programs involved the installation of some low-cost measures in the homes. While homeowners could in theory install some of these materials themselves more cost-effectively, the program significantly increased the penetration of efficient technologies beyond what homeowners would have done on their own. Time and again homeowners said they had done all they could, and yet additional opportunities to install low-cost measures were found. As shown by the savings numbers above, these direct install measures can result in high energy savings on their own. However, combining these direct install measures with an effective pathway for the homeowner to install major upgrades (in particular, insulation and air sealing) increases the overall cost-effectiveness of the program, eliminates the need for multiple visits to the home, and maximizes all opportunities for energy efficiency through a comprehensive approach.

Combining direct install measures with an effective pathway for the homeowner to install major upgrades increases the overall cost-effectiveness of the program.

Further cost reductions in program delivery are possible

While each of the Energy Efficient Cities programs was slightly different, it is estimated that the total cost of this pilot program was between $500 and $700 per participant that completed a home energy visit, including utility funding and rebates, other grant funding, and Environment and Natural Resources Trust Fund dollars. This results in a cost of energy saved of about 3.2 cents/kWh for electricity and 33 cents/therm for natural gas. This is money well spent, as it is less than the cost of procuring new sources of electricity and natural gas. However, a good portion of this cost was start-up costs to get the programs up and running, and the rebates offered were generous (sometimes paying for more than half the cost of the upgrades). These rebates were helpful in motivating people to complete the upgrades, but as the programs become more mature and recognized for the quality they can deliver, the same completion rate should be achievable with smaller rebates.

Quality control and contractor training is important to achieving savings and homeowner confidence

In initial quality-assurance visits, CEE found that even some experienced insulation contractors were not properly completing jobs, particularly air sealing. Insufficient air sealing, as discussed above, not only results in less energy savings, but can create other problems for the homeowner. Incorporating quality assurance into the program design not only forestalls these problems, but serves as a major selling point for the program.

Feedback reports can require significant resources when done on a small scale

Homeowners generally found it very useful to see their home's energy usage compared to some benchmark, as was presented in various forms by the feedback reports of individual city programs. However, producing reports on a relatively small scale (that is, less than 10,000 per year) can be very resource-intensive per participant. The most useful report was the feedback report with utility bill data used at the time of the home energy visit, as this provided a focus for the discussion of energy usage between homeowners and program staff. However, while it is useful to have follow-up reports after the home energy visit, it may not be cost-effective to do this on a small scale for future programs. A better possibility might be to integrate information and messaging from the home energy visit with a larger-scale feedback program if it is being run by a utility already (such as the programs being run by feedback report company O-POWER in more than half of the Energy Efficient Cities territories). For example, homeowners who had a home energy visit could get a special version of a feedback report that would emphasize recommendations made during the home energy visit.

Motivating homeowners to complete upgrades is critical

Because such a high portion of lifetime energy savings come from the major upgrades, it is critical for a program to achieve a high "conversion rate" of participants that complete the recommended upgrades. Energy Efficient Cities programs were generally very successful at this, convincing 21% of participating homeowners to complete upgrades. The most successful programs achieved conversion rates above or well above this average: 24% (Minneapolis and Owatonna), 35% (Austin) and 36% (Rochester). The program design of Energy Efficient Cities lends itself to maximizing the number of households that complete upgrades. This includes an orientation toward homeowner engagement and persuasion from the very beginning of the program, an easy pathway for homeowners to find reliable contractors, and a process for following up with homeowners after the home energy visit. This hand-holding approach is necessary to keep homeowners engaged in the process.

CEE also experimented with using an asset-based energy label to help further persuade homeowners to complete upgrades. This type of label objectively rates the energy performance of a home's building envelope and major energy-using systems independent of building occupant behavior. It is similar to the yellow "EnergyGuide" labels on appliances that tell you how much energy your new appliance will use compared to other appliances for a typical household. CEE was one of 10 participants in piloting the U.S. Department of Energy's "Home Energy Score" label in 154 Minneapolis and Apple Valley homes. An energy label can provide a clear visualization of a home's energy-efficiency deficiencies and a pathway to correcting those deficiencies, which can be useful in the effort to move the homeowner to action. CEE is currently developing a simplified energy asset label that may be useful for future programs.

[1] Nationally, many of these "whole-house" programs have been marketed under the name "Home Performance with ENERGY STAR," which is a joint effort of the U.S. Department of Energy and Environmental Protection Agency. These agencies establish criteria for what constitutes Home Performance with ENERGY STAR (HPwES) and are thus allowed to use their brand; the Energy Efficient Cities program design could qualify under existing criteria to be a HPwES program. The HPwES program is currently under review for revisions by the U.S. Department of Energy. As each of the Energy Efficient Cities established a local "brand," the HPwES designation was not deemed necessary, but could be added in the future if it was deemed that it could add value to the individual programs.

[2] Sources for these barriers include CEE's own staff's experience with implementing residential programs, as well as the following sources, among others:

Darby, Sarah, 2006, *The Effectiveness of Feedback on Energy Consumption: A review of the literature on metering, billing and direct displays,* University of Oxford, Environmental Change Institute.

Dougherty, Anne, et al., "Ethnographic Inquiry in Energy: Exploring Meaning-Making and Sociality in Language Use, Program Participation, and Behavioral Choice," Proceedings, ACEEE 2010 Summer Study on Energy Efficiency in Buildings, American Council of an Energy-Efficient Economy (ACEEE), Pacific Grove, California, August 15-20, 2010.

E Source Letter, 2010, *MNCEE inquiry on effectiveness of residential audits regarding major upgrades.* Boulder, CO: E Source, March 25.

Karg, Richard, 1987, "The Soft Audit: A Human Approach to Energy Conservation," *Energy Auditor and Retrofitter,* July/August.

PA Consulting Group, 2010, *Cape Light Compact: Residential Smart Energy Monitoring Pilot Final Report,* Madison, WI: Cape Light Compact, March 31.

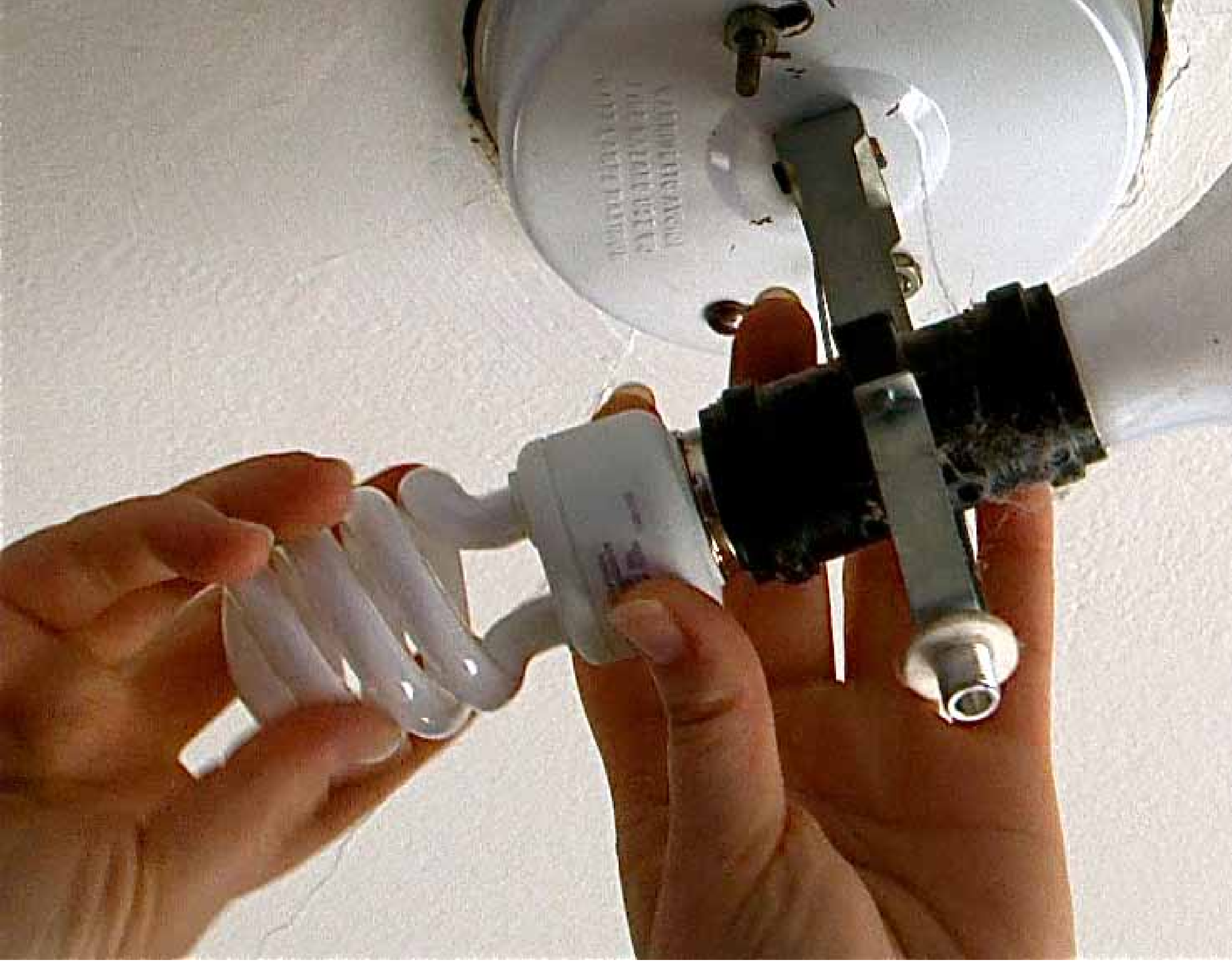
Schwartz, Barry, 2004, *The Paradox of Choice: Why More is Less,* New York: Harper Perennial.

[3] CEE tracked actual contractor costs where the data was available, which was for about 89% of the total reported upgrades (mostly from the paid invoices after the work was completed); the cost of the remainder of the upgrades was assumed to average the same amount as the known costs. About 1% of the upgrades were self-installed by homeowners; these do-it-yourself jobs were not included in the total contractor work estimate.

[4] It should be noted that the programs in these three cities had fairly aggressive installation of low-cost measures; for example, the average number of CFLs installed in Minneapolis was about 13 per household.

[5] Savings from low-cost measures were calculated for an average participant based on claimed savings as filed by CenterPoint Energy and Xcel Energy in their CIP Status Reports for 2010, and then extrapolated to all 6,922 participants. Savings from insulation and air sealing per participant were based on Xcel Energy's average claimed savings of 15.1 dekatherms per house as filed in their 2010 CIP Status Report (note: Xcel's value was used instead of CenterPoint Energy's deemed savings calculation, because Xcel's calculation is more representative of the actual existing R-values in homes in the programs, while CenterPoint Energy's calculations assume existing R-values of R-30, which was rarely the case in the homes treated in the programs). Furnace and boiler savings were calculated based on an average of Xcel Energy's and CenterPoint Energy's claimed savings in their 2010 Status Reports.

[6] See, for example: Ehrhardt-Martinez, Karen, et al., 2010, *Advanced Metering Initiatives and Residential Feedback Programs: A Meta-Review for Household Electricity-Saving Opportunities,* American Council for an Energy-Efficient Economy, Washington, D.C.



> Overall I found the experience very educational, informative, and helpful. I'm very glad I did it. The home visit was great, even the advice was great! I really had a positive experience overall.

-Energy Efficient Cities Program Participant

212 3rd Ave North #560
Minneapolis, MN 55401
(612) 335-5858
www.mncee.com

Center for Energy and Environment

2009 Project Abstract
For the Period Ending June 30, 2012

PROJECT TITLE: Contract Management
PROJECT MANAGER: Kristel Lynch
AFFILIATION: MN DNR
MAILING ADDRESS: 500 Lafayette Road
CITY/STATE/ZIP: St. Paul, MN 55155-4010
PHONE: 651-259-5533
E-MAIL: kristel.lynch@state.mn.us
WEBSITE: http://www.dnr.state.mn.us/index.html
FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML2009, Chapter 143, Section 2, Subd.8(a) Contract Management

APPROPRIATION AMOUNT: $158,000

Overall Project Outcome and Results

This appropriation was used to provide continued contract management services to pass-through recipients of Environment and Natural Resources Trust Fund dollars. The DNR provided this fiduciary service to ensure funds were expended in compliance with session law, state statute, grants policies, and approved work plans. Contract management ensured oversight of reimbursement for project deliverables and met the requirements of the Department of Administration's Grants Management procedures.

Ensuring timely access to the funds through streamlined grant agreements and prompt processing of reimbursement requests was an overarching goal of DNR's contract management. Services provided under this appropriation included the following:

- Contract Management Services
  - Prepare grant agreements and amendments.
  - Encumber/unencumber funds.
  - Execute Use of Funds agreements.
  - Communicate with LCCMR staff and pass-through grant recipients, informally and formally.
  - Continue to work on process improvements that improve efficiency and ease for grantee while ensuring fiscal integrity.
  - Contract management documentation, including file management.

- Training and Communications
  - Train recipients on state grant requirements, including reporting procedures, proper documentation of expenses, and the Department of Administration's grants management policies, to ensure grantees follow state law and grants management policies set forth by the state's grant agreement.
  - Work with recipients to ensure grantees understand the state's reimbursement procedures and requirements.
  - Provide ongoing technical assistance/guidance to recipients.

- Reimbursement Services
  - Review reimbursement requests to ensure claimed reimbursements include sufficient documentation and comply with state and session laws, LCCMR approved Work Plan and grants policies.
  - Arrange for prompt payment once grantee has submitted a completed reimbursement request and expenses have been deemed eligible for reimbursement.
  - Detailed accounting by pass-through appropriation for each recipient.

- Fiscal and Close-out Services
    - Financial reconciliation/reporting.
    - Contract management reporting (fund balance/expenditures).
    - Examine records of recipients.
    - Work with recipients to successfully close-out grants.

Project Results Use and Dissemination

This project's grants specialists are in frequent contact with pass-through grant recipients. The grants manager and DNR's liaison communicate with LCCMR staff. In addition, grant agreement requirements are communicated through manuals, emails, and letters.

Environment and Natural Resources Trust Fund (ENRTF) 2009 Work Program Final Report

Date of Status Update: 6/30/2012
Final Report
Date of Work Plan Approval: 9/27/2011
Project Completion Date: 6/30/2012 **Is this an amendment request?** NO

Project Title: Contract Administration

Project Manager: Kristel Lynch
Affiliation: MN DNR
Address: 500 Lafayette Rd, Box 10
City: St Paul **State:** MN **Zipcode:** 55155

Telephone Number: 651-259-5533
Email Address: kristel.lynch@state.mn.us
Web Address: http://www.dnr.state.mn.us

Location:

Counties Impacted: Statewide

Ecological Section Impacted: Lake Agassiz Aspen Parklands (223N), Minnesota and Northeast Iowa Morainal (222M), North Central Glaciated Plains (251B), Northern Minnesota and Ontario Peatlands (212M), Northern Minnesota Drift and lake Plains (212N), Northern Superior Uplands (212L), Paleozoic Plateau (222L), Red River Valley (251A), Southern Superior Uplands (212J), Western Superior Uplands (212K)

Total ENRTF Project Budget:		
	ENRTF Appropriation $:	**158,000**
	Amount Spent $:	**158,**000
	Balance $:	0

Legal Citation: Laws 2009, chapter 143, section 2, subdivision 8, paragraph (a), Contract Management

Appropriation Language:
$158,000 is from the trust fund to the commissioner of natural resources for contract management for duties assigned in Laws 2007, chapter 30, section 2, and Laws 2008, chapter 367, section 2, and for additional duties as assigned in this section.

Amended by M.L. 2011, First Special Session, Chapter 2, Article 3, Section 2, Subd, 18(a)(7) Carryforward
The availability of the appropriation for the following projects is extended to June 30, 2012:

…
(7) Laws 2009, chapter 143, section 2, subdivision 8, paragraph (a), Contract Management,

I. PROJECT TITLE: Contract Management

II. and III. FINAL PROJECT SUMMARY

This appropriation was used to provide continued contract management services to pass-through recipients of Environment and Natural Resources Trust Fund dollars. The DNR provided this fiduciary service to ensure funds were expended in compliance with session law, state statute, grants policies, and approved work plans. Contract management ensured oversight of reimbursement for project deliverables and met the requirements of the Department of Administration's Grants Management procedures.

Ensuring timely access to the funds through streamlined grant agreements and prompt processing of reimbursement requests was an overarching goal of DNR's contract management. Services provided under this appropriation included the following:

- Contract Management Services
    - Prepare grant agreements and amendments.
    - Encumber/unencumber funds.
    - Execute Use of Funds agreements.
    - Communicate with LCCMR staff and pass-through grant recipients, informally and formally.
    - Continue to work on process improvements that improve efficiency and ease for grantee while ensuring fiscal integrity.
    - Contract management documentation, including file management.

- Training and Communications
    - Train recipients on state grant requirements, including reporting procedures, proper documentation of expenses, and the Department of Administration's grants management policies, to ensure grantees follow state law and grants management policies set forth by the state's grant agreement.
    - Work with recipients to ensure grantees understand the state's reimbursement procedures and requirements.
    - Provide ongoing technical assistance/guidance to recipients.

- Reimbursement Services
    - Review reimbursement requests to ensure claimed reimbursements include sufficient documentation and comply with state and session laws, LCCMR approved Work Plan and grants policies.
    - Arrange for prompt payment once grantee has submitted a completed reimbursement request and expenses have been deemed eligible for reimbursement.
    - Detailed accounting by pass-through appropriation for each recipient.

- Fiscal and Close-out Services
    - Financial reconciliation/reporting.
    - Contract management reporting (fund balance/expenditures).
    - Examine records of recipients.
    - Work with recipients to successfully close-out grants.

IV. OUTLINE OF PROJECT RESULTS

ACTIVITY 1: Manage the Environment and Natural Resources Trust Fund Pass-through Program
Description:
Activity 1: Administer agreements for pass-through grant recipients. The DNR provided contract management services to pass-through grant recipients. This appropriation funds contract management services billed using a professional services rate of $60/hr. The professional services hourly rate

includes salary and fringe for grants management staff, supervisory time, travel costs, supplies, agency directs, and related costs necessary to carry out the pass-through management functions. Multiple staff with a variety of grants, financial or responsibilities provide contract management services to ENRTF pass-through recipients.

Contract management costs will be billed using a professional services rate of $60/hr up to the level that this appropriation supports. The professional services hourly rate includes salary and fringe for grants management staff, supervisory time, travel costs, supplies, agency directs, and related costs necessary to carry out the pass-through management functions.

Summary Budget Information for Activity 1:

ENRTF Budget:	**$ 158,000**
Amount Spent:	**$ 158,000**
Balance:	**$ 0**

Activity Completion Date:

Outcome	Completion Date	Budget
1. Administer Environment and Natural Resources Trust Fund Pass-through Program. Activities include: grant agreements and amendments, grants training, technical support, reporting, auditing, payment reimbursement review and processing, and grant close-out. Reporting for both the carry-forward and new funding will be reported jointly.	June 30, 2012	$158,000*

*Amount spent is not tracked by result; services are billed at an hourly rate of $60.

Final Report Summary June 2012: In order to streamline the agreement process, a contract template was designed and implemented for new pass-through grantees. In addition to the new contract template, staff revised the 2010 reimbursement manual and the DNR land acquisition procedures. The development of a training module for the reimbursement manual has begun along with an external grants unit website for pass-through recipients.

The Grants Unit is now fully staffed. Grant specialists were assigned pass-through recipients, providing the grantee one point of contact for their agreement. The DNR continues to work through project closeout and processing reimbursement requests on existing agreements.

V. TOTAL TRUST FUND PROJECT BUDGET

A. ENRTF Budget:

Budget Category	$ Amount	Explanation
Other: (Professional Services)	$ 158,000	DNR provides contract management services at a rate of $60/hr. Staff working on ENRTF contract management document time worked by project codes built into the timesheets. Because DNR provides contract management services for other funds, project coding for ENRTF contract management is unique. Services unrelated to this appropriation are not charged to this project code.
TOTAL ENRTF BUDGET:	**$ 158,000**	

Explanation of Use of Classified Staff: This appropriation funds contract management services. This service may or may not be provided by staff in classified positions. Multiple staff with a variety of grants, financial or responsibilities provide contract management services to ENRTF pass-through recipients. These funds are for professional services and are not used to fund a position.

Explanation of Capital Expenditures Greater Than $3,500: N/A

Number of Full-time Equivalent (FTE) funded with this ENRTF appropriation: N/A

Number of Full-time Equivalent (FTE) estimated to be funded through contracts with this ENRTF appropriation: N/A

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
State			
	$	$ 0	
TOTAL OTHER FUNDS:	**$**	**$ 0**	

The DNR will continue to review the professional services rate to ensure there is no under/over-recovery of funds for Contract Management Services.

VI. PROJECT STRATEGY

A. Project Partners: Grantees, LCCMR staff, Office of Grants Management Staff, DNR staff, other agency and legislative staff.

B. Project Impact and Long-term Strategy: Centralized administration of Trust Fund pass-through appropriations to the commissioner of natural resources results in more efficient and consistant management of these grants and better communication among the recipients, LCCMR staff and DNR contract administrators and financial management staff.

C. Spending History:

Funding Source	M.L. 2005 or FY 2006-07	M.L. 2007 or FY 2008	M.L. 2008 or FY 2009	M.L. 2009 or FY 2010	M.L. 2010 or FY 2011
Environment and Natural Resources Trust Fund	$150,000 Sec. 11, Subd. 3b	$40,000 Subd. 3b		$158,000 Subd. 8a	

VII. DISSEMINATION

This project's grants specialists are in frequent contact with pass-through grant recipients. The grants manager and DNR's liaison communicate with LCCMR staff. In addition, grant agreement requirements are communicated through manuals, emails, and letters.

VIII. REPORTING REQUIREMENTS

A final report and associated products will be submitted between June 30 and August 15, 2012 as requested by the LCCMR.

IX. RESEARCH PROJECTS

N/A

Attachment A: Final Budget Detail for 2009 Project					
Project Title: Contract Management					
Legal Citation: M.L. 2009, Chp. 143, Sec. 2, Subd. 8(a)					
M.L. 2011, 1st Special Session, Chp. 2, Art. 3, Sec. 2, Subd 18(a)(7) authorization to carry-forward $31,241 from M.L. 2009					
Project Manager: Kristel Lynch, Grants Manager					
Project Length and Completion Date: June 30, 2012					
Date of Final Report: June 30, 2012					
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	*Contract Management Services*				
Other : DNR provides ENTRF pass-through appropriation administration as a professional service; services are billed at rate of $60/hr up to the level this appropriation supports	158,000	158,000	0	158,000	0
COLUMN TOTAL	$158,000	$158,000	$0	$158,000	$0