

1997 Project Abstract

For the Period Ending June 30, 1999

This project was supported by an appropriation from the Minnesota Future Resources Fund (ML 1997, Ch. 216, Sec. 15, Subd 13b).

TITLE: Watershed Science: Integrated Research & Education Program
Project Manager: Patrick Hamilton
Organization: Science Museum of Minnesota (SMM)
Address: 30 E. 10th St., St. Paul, MN 55101
Legal Citation: ML 1997, Chap. 216, Sec. 15, Subd. 13b
Appropriation Amount:

Statement of Objectives:

Watershed Science in the Field:

SMM's St. Croix Watershed Research Station will initiate a long-term study of the Valley Creek watershed in southern Washington County. SCWRS will: (a) Establish four automated stream monitoring stations and one automated weather station. (b) Develop watershed and groundwater models for the Valley Creek watershed. (c) Use the models to identify the effects of urbanization on land-water interactions. (d) Produce field and analytical methodology that can be applied to other watersheds.

Watershed Science in the Museum:

SMM will develop a Public Geographic Information Systems Map Laboratory for its Our Minnesota hall. A computer-based tutorial about the research being conducted on the Valley Creek watershed will help acquaint museum visitors to the versatility of GIS. In addition, visitors to the Public GIS Map Lab with the help of SMM staff will be able to develop, print out, and take home high-quality watershed/land-use maps tailored to their specific environmental interests. High school students from SMM's Projects Club will work with the SCWRS's scientists to develop interpretations of the Valley Creek research which will be presented to museum visitors in the Our Minnesota hall.

Watershed Science Training:

Staff from Warner Nature Center and scientists from SCWRS will develop a partnership with Stillwater High School that allows the school's teachers and students to participate directly in the study of Valley Creek watershed. The school will follow the progress of SCWRS scientists, and will replicate in a more simplified version the proper research protocol in their study of nearby Browns Creek. Stillwater High School students will produce and maintain a special web site, where they will inform other Minnesota schools about how they set up and maintain their research project.

Overall Project Results

Watershed Science in the Field:

The SCWRS and its partners established stream monitoring and weather stations for Valley Creek. The watershed and groundwater models were developed and then used to model the effects of different urbanization scenarios and land-water interactions. A complete set of field and analytical reports, including Valley Creek GIS and hydrologic data on CD-ROM, have been drafted with final versions to be prepared and distributed by the end of July.

Watershed Science in the Museum:

SMM established the Minnesota Map Lab which has a copy of the entire land-use update for the state of Minnesota. A computer-based tutorial about watersheds throughout Minnesota was developed instead of just focusing on Valley Creek, so that museum visitors could use GIS to explore watersheds of greatest personal interest to themselves. The Lab became a site for graduate student research in GIS, which resulted in the development of many high-quality lake watershed map sets and the production of county land-use maps that then were distributed to county seats throughout Minnesota. High school students involved in SMM's Projects Club made extensive use of the Map Lab in which they prepared maps of the Valley Creek watershed, which they then shared with their counterparts at Stillwater High School.

Watershed Science Training:

WNC staff worked closely with Stillwater High School biology students and teachers in helping them learn how to conduct field inventories and transects of the plants and animals in and along streams. This work required numerous field trips to Browns Creek over the last couple of years in order to establish benchmarks for plant and animal species against which future surveys can be compared. From its initial focus on Stillwater High School and Browns and Valley creeks, the WNC expanded its involvement in Watershed Science to include Marine Elementary School and the recently organized Mill Stream Association. The work at Marine Elementary focused on acquainting students and teachers with the general concept of watersheds and the Mill Stream watershed in particular. Working with the Minnesota Map Lab, the WNC is distributing laminated field books comprised of maps conveying a wide range of information about the watersheds of Mill Stream and Browns Creek. Copies of the books will be delivered to Stillwater High School, Marine Elementary, and the Mill Stream Association in order to help these entities with their ongoing stream monitoring efforts.

Project Results and Dissemination

Watershed Science in the Field:

The final reports will be delivered to LCMR and also to the cities of Afton and Woodbury, the Valley Branch Watershed District, the Minnesota Department of Natural Resources, the Board of Water and Soil Resources, the Washington County Soil and Water Conservation District, and the Belwin Foundation. In addition, the Executive Summary will be mailed to all citizens and agency personnel presently on our mailing list (about 80 individuals). The SCWRS has been successful in finding new sources of funds that will allow it to continue to monitor Valley Creek for the long-term, which was the original intention of this research project. This long-term monitoring of Valley Creek will not only create a good dataset from which to evaluate the ongoing effects of urbanization, but also has the potential to be a significant value to scientists in a wide range of fields, giving the relative scarcity of long-term monitoring programs.

Watershed Science in the Museum:

SMM distributed 6,000 copies of the new Minnesota Lake Use and Cover to teachers and schools throughout the state in the past 10 months. All the maps from the first printing of 7,500 have been distributed. In the new riverfront SMM, the Minnesota Map Lab will devolve into two distinct, but interrelated programs – (1) the Lab as a public program in which museum visitors gain access to digital geographic information about Minnesota, and (2) the Lab as a program within SMM's Adult Learning Center in which it serves as a Minnesota GIS data repository, GIS training facility, and a site for experimentation in GIS research and education. Given the SMM's strong connections with a wide variety of audiences, much attention will continue to be focused on how the museum can serve as a crossroads where innovative map products produced by graduate students and others can be made readily available to citizens with strong interests in using these new tools to study environmental issues.

Watershed Science Training:

As illustrated by the recent grassroots development of Mill Stream Association, interest is growing amongst many living in the St. Croix River Valley to protect their local creeks by establishing small watershed associations. The WNC has used its involvement in Watershed Science during these past two years as an opportunity to develop and test its approaches to watershed education so that it can better assist these growing numbers of local watershed associations. The WNC eventually sees Watershed Science as a way of encouraging and helping these small grassroots organizations to understand land-use issues and their implications with water quality. The WNC, in particular, sees the Minnesota Map Lab as a significant resource for local watershed groups. The WNC will continue working with the Lab on how it might serve as an intermediary between the Lab and local watershed groups interested in using maps to understand better their immediate environmental circumstances.

Date of Report: July 1, 1999

LCMR Final Work Program Update Report

Date of Next Status Report:

Project Completion Date: June 30, 1999

LCMR Work Program 1997

I. PROJECT TITLE: Watershed Science: Integrated Research & Education Program

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Total Biennial Project Budget:

\$LCMR:	500,000
- \$ LCMR Amount Spent:	<u>500,000</u>
= \$ LCMR Balance:	0

A. Legal Citation: ML 1997, Chap. 216, Sec. 15, Subd. 13b

Watershed Science: Integrated Research and Education Program

This appropriation is from the future resources fund to the Science Museum of Minnesota to establish a long-term monitoring program for the Valley Creek watershed, develop a public geographic information system map laboratory, and watershed science education programs.

B. Status of Match Requirement: The Association of Minnesota Counties provided the Science Museum with \$5,000 back in the winter to complement the capital expenditures for the Minnesota Map Lab being supported by LCMR. This gift has made it possible for the museum to obtain a wireless network system, which will allow computers throughout the new museum to access the Minnesota Map Lab's GIS databases independent of the museum's computer network. The museum's education staff, therefore, will be able to offer GIS programming and instructional training to a wide range of audiences anywhere in the new museum and not be limited by direct physical access to the Minnesota Map Lab nor restricted by access to a computer port.

II. PROJECT SUMMARY AND RESULTS:

Objective 1: Watershed Science in the Field:

SMM's St. Croix Watershed Research Station (SCWRS) will initiate a long-term study of the Valley Creek watershed in southern Washington County. SCWRS will (a) Establish four automated stream monitoring stations and one automated weather station. (b) Develop watershed and groundwater models for the Valley Creek watershed. (c) Use the models to identify the effects of urbanization on land-water interactions. (d) Produce field and analytical methodology that can be applied to other watersheds.

Objective 2: Watershed Science in the Museum:

Geographic Information Systems (GIS) are powerful computer research tools that are becoming indispensable to the work of scientists and other professionals. The general public, however, is largely unaware of the existence of large geographic databases, does not have access to the tools for exploring these databases, and has not been introduced to ways in which these databases and tools could help them understand environmental issues. SMM, therefore, will develop a Public GIS Map Laboratory for its Our Minnesota hall. A computer-based tutorial about the research being conducted on the Valley Creek watershed will help acquaint museum visitors to the versatility of GIS. In addition, visitors to the Public GIS Map Lab with the help of SMM staff will be able to develop, print out, and take home high-quality watershed/land-use maps tailored to their specific environmental interests. High school students from SMM's Projects Club will work with the SCWRS's scientists to develop interpretations of the Valley Creek research which will be presented to museum visitors in the Our Minnesota hall.

Objective 3: Watershed Science Training:

Staff from SMM's Warner Nature Center and scientists from SCWRS will develop a partnership with Stillwater High School that allows the school's teachers and students to participate directly in the study of Valley Creek watershed. The school will follow the progress of SCWRS scientists, and will replicate in a more simplified version the proper research protocol in their study of nearby Browns Creek. Stillwater High School students will produce and maintain a special web site, where they will inform other Minnesota schools about how they set up and maintain their research project.

III. PROGRESS SUMMARY:

Watershed Science in the Field

Progress as of January 23, 1998

Much of Result 1 (Monitor Station Network) has been accomplished. Four sites have been selected for monitoring by the St. Croix Watershed Research Station (SCWRS), and permits for site installation obtained from the Minnesota DNR and the City of Afton. Two sites are on the main perennial branches of Valley Creek on property owned by the Belwin Foundation; the other two sites are on ephemeral branches of the creek that collect runoff from the western and southern parts of the watershed. A fifth site has been chosen near the stream mouth in collaboration with the Metropolitan Council, which plans to install a long-term monitoring station there, to be owned by the Valley Branch Watershed District and operated by the SCWRS. Equipment for the four SCWRS stations has been obtained and physically installed at the four sites, although the sites are not yet electronically operational. An automated weather station owned by St. Thomas University already existed at the Belwin Outdoor Education Center, but was not being actively used. With permission from St. Thomas, we have agreed to update and operate the station, at considerable cost savings to us. Telephone connections have been installed to the weather station; we plan to install connections to the two stream monitoring stations with perennial flow sometime this next spring or summer.

Result 2 (Sampling and Analysis) was begun in August, as soon as the manually-operated field equipment was purchased. Because the automated stations are not yet operational, we have manually measured flow and collected water samples about weekly from August through October, and about bi-weekly thereafter during the winter months.

Result 3 (Data Base Management) has proceeded as necessary to organize the accumulating data.

Result 4 (Watershed Modeling) is well under way. Under subcontract to the SMM, Dr. David Pitt and Diane Whited of the University of Minnesota Department of Landscape Architecture have assembled many of the necessary geographic information system (GIS) data sets, and have initiated a watershed model, in collaboration with Dr. Bruce Wilson in the Department of Agricultural Engineering.

Problems

The permitting process required by the City of Afton and the DNR was more time-consuming than anticipated and delayed making the stations fully operational; this delay is not serious, because stream flow and water chemistry are rather steady during the winter months and can be adequately sampled by hand. During the initial sampling and analysis, we identified two additional pieces of equipment that will be needed for long-term maintenance of our monitoring program.

A fluorometer will be used in making dye-trace streamflow estimates, the most accurate and rapid method of measuring stream flows over short stream reaches, particularly during short-lived flood events that we expect at our ephemeral runoff sites. An autoclave will be used to process large batches of samples prior to analysis for dissolved nutrients (phosphorus and nitrogen). Without these items, the accuracy and efficiency of our monitoring program will be reduced. Because of cost savings in the purchase of other equipment and in site installation, these two additional items are affordable within the allotted budget.

Watershed Science in the Field

Progress as of August 22, 1998

Most of Result 1 (Monitor Station Network) has now been completed. Most of the purchased field equipment is now installed and operational. This includes primarily two stream monitoring stations on the two main perennial branches of Valley Creek and the weather station at Belwin Outdoor Education Center. Each stream monitoring station measures water temperature, specific conductance, and stage (height) every minute and stores the average hourly. The automatic samplers were installed just a week ago and are programmed to sample the stream weekly at a minimum and during storm events where stage rises by more than a centimeter. Two other shelters have been established on intermittent branches, but instrumentation has not yet been installed.

As part of its Watershed Outlet Monitoring Program (WOMP), the Metropolitan Council is installing a fifth monitoring station near the mouth of Valley Creek, to be operated by the SCWRS as part of its monitoring network. This station will be equipped with electric power and a telephone connection for year-round sampling and remote access. The weather station is also accessible remotely by a telephone connection and measures rainfall, air temperature, relative humidity, incident solar radiation, wind speed, and wind direction.

Results 2 (Sampling and Analysis) and 3 (Data Base Management) are continuing. The main channel was walked on 12 May by project personnel to observe stream conditions firsthand. Since last August, about 45 samples have been collected at three sites on Valley Creek by hand on a weekly to bi-weekly basis, prior to the recent installation of the automatic samplers. These samplers will not decrease our field time as they will still need to be visited weekly to pick up the collected samples. However, the samplers will greatly improve sampling precision by collecting water during storm events, which have been missed up to this point. A fluorometer and autoclave were purchased as planned and are used weekly in sample analysis. A water-quality data base has been constructed as an MS Excel spreadsheet. The data are graphically summarized every six months for distribution.

Result 4 (Watershed Modeling) is on schedule. All base data layers for the GIS (geographic information system) have been compiled for the surficial modeling component of the project. These layers include land use, hydrography, topography, soils, and infrastructure. Additional data layers will be created for the simulation of urban development. Two models (WEPP and SWAT) have been selected for closer scrutiny. Currently, the SWAT model is interfaced with ArcView. The SWAT/ArcView model is being tested and evaluated using local climatological data and existing land use conditions. Calibration of the model has begun. A WEPP/GIS interface is presently under development at the University of Minnesota.

Result 5 (Groundwater Modeling) has not yet begun in earnest. However, Dr. Otto Strack has made his modeling program MLAEM available free of charge for use on this project, and Almendinger attended week-long training in use of this model. John Seaberg and Andrew Streitz of the Minnesota PCA have met with project personnel and have devoted time in setting up components of their metro-area groundwater model on SCWRS computers.

Result 6 (Reporting) has resulted in six-month summary reports that have been targeted to a lay audience and sent to interested citizens and agency personnel. The mailing list currently has over 80 addresses. The purpose of the reports is to inform and educate the local citizens about their watershed, to present basic data about the watershed, and to keep agencies abreast of our activities.

Problems

Automatic samplers were installed later than planned; consequently storm events that occurred early in the summer were not sampled. The weather station was made operational just prior to the exceptional wind storm that struck Woodbury and Afton earlier this summer, but a short in the battery system caused all data from that weekend to be lost. Laboratory equipment for analyzing nutrients (phosphorus and nitrogen) in water samples is still not fully operational at desired levels of detection. The manufacturer has agreed that their prescribed method is faulty and is working on developing necessary modifications.

Related projects and activities

Extended water sampling in both Valley Creek and Browns Creek watersheds has begun with funding from the Metropolitan Council's TCWQI program. This grant was leveraged by using the present LCMR grant to provide matching funds. As noted above, the Metropolitan Council is also installing a stream-monitoring station near the mouth of Valley Creek; delays caused by land-owner concerns reportedly have been resolved. The SCWRS will be contracted to operate this station, and SCWRS personnel attended training sponsored by the Met Council and Minnesota Dept. of Agriculture to establish uniform monitoring methods among local agencies.

Bell LIVE! is a live "electronic field trip" broadcast to grade-school and junior-high students across the nation and sponsored by the Bell Museum of Natural History. Valley Creek has been chosen for the October 22 broadcast, and SCWRS personnel will participate by providing expertise in physical hydrology.

Watershed Science in the Field

Progress as of January 22, 1999

- **Result 1: Monitor Station Network**

The installation of the monitoring station network is complete, and all present activities consist of routine maintenance and seasonal operations. Activities this reporting period include surveying the sites to establish local benchmarks; installation of a solar panel on the weather station; removal of woody debris affecting operation of one of the stations; and equipment adjustments in preparation for the upcoming snowmelt period. In addition to our stations, the Metropolitan Council has completed installation of a year-round sampling shelter near the mouth of Valley Creek as part of the Watershed Outlet Monitoring Program (WOMP). The St. Croix Watershed Research Station (SCWRS) will be contracted to operate this station for the Council. In total, we now have five stream-monitoring stations and one weather station in the Valley Creek watershed.

- **Result 2: Sampling and Analysis**

About 70 samples have now been collected from each of three sites on Valley Creek. The two intermittent sites have yet to have any flow, which we anticipate may occur during the spring snowmelt. Most of these samples are grab samples collected manually. The automatic samplers did collect stream-water samples during a few autumn storms, but these small storms caused only minor increases in stream flow and consequently triggered only a few samples (one to three per event). Chemical analysis of water samples is well underway. Analytical problems that caused a backlog of samples awaiting nutrient analysis have been resolved, through joint effort of the SCWRS and the instrument manufacturer's research laboratory.

- **Result 3: Data Base Management**

All data are presently being recorded in Microsoft Excel spreadsheets. Data for public release are extracted after being proofed for accuracy and consistency. Such data management will be a continuing effort.

- **Result 4: Watershed Modeling**

Colleagues at the University of Minnesota have nearly finished work on the development of GIS coverages for the Valley Creek watershed. Beyond coverages of the physical landscape, which were completed last year, new coverages were developed that integrated the physical features of the landscape to help predict areas sensitive to urban development. Such coverages will be of interest to Woodbury and Afton planning commissions.

Progress on watershed models for the Valley Creek area has continued. Physical data for the landscape have been entered into the model. Calibration of the model to the existing hydrologic data should be complete by March. The final modeling task will be to input different development scenarios to estimate the effects of urbanization on the hydrology of Valley Creek.

- Result 5: Groundwater Modeling

This task is significantly behind schedule. Staff at the Minnesota Pollution Control Agency (MPCA) have been most helpful in supplying the computer model and data. However, they are still calibrating the "northeast province" of the metro area groundwater model, wherein lies Washington County. Other data-analysis tasks have taken time away from the groundwater modeling effort. We still intend to develop the groundwater model, but expect results to be less complete than originally hoped for. Nonetheless, our initial model will be part of a continuing effort to develop a groundwater model for Washington County, which is the desire of several agencies, most notably MPCA, Washington County, and the Minnesota Department of Health (MDH). We expect that MDH will release a request for proposal soon for a Washington County groundwater model, which will allow continued development of our present modeling effort.

- Result 6: Reporting

A second semi-annual report, targeted at a lay audience, was sent to about 80 interested citizens and agency personnel in August 1998. A third report is planned to be released later this month.

Considerable effort was directed at summarizing the available hydrologic and GIS data for Valley Creek this past autumn. This information was passed on to the Valley Creek Subwatershed Technical Advisory Committee to be an integral part of a report to be presented to the planning commissions for the cities of Afton and Woodbury. Although this report was not originally planned as a product of our project, we felt our input was important because we had the needed data, and because the report will potentially have a direct impact on land-use decisions in the watershed.

One presentation of our work was delivered at the Annual Soil and Water Conservation meeting in San Diego, CA, in July, and two presentations were given at the 1998 St. Croix River Research Rendezvous in Marine on St. Croix. A fourth presentation is planned for an EPA-sponsored conference in late summer of 1999.

- General activities and related projects

A Technical Advisory Committee for Watershed Science in the Field was assembled comprising experts in each of the following fields: watershed monitoring, aquatic chemistry, groundwater modeling, watershed modeling, and land-use planning. This team of experts met with our research group at the SCWRS on 17 August 1998 for a day-long critique of our project. This committee generally agreed that our efforts were in the right directions and provided many useful suggestions for improvement.

Bell Live! is an hour-long, live, television "electronic field trip" broadcast nationwide to over 40,000 school children. The program is produced by the Bell Museum of Natural History, which chose Valley Creek as the site for this year's broadcast. Jim Almendinger served as the water-quality specialist for the program, which aired 22 October.

Problems

- The groundwater model is behind schedule (see Result 5 above).
- The University of Minnesota has not yet invoiced the Science Museum for most of its work, even though that work is progressing on schedule. Consequently, the budget numbers below for Result 4 represent estimates of invoices that we expect to see from the University sometime within the next six months.

Watershed Science in the Field

Progress as of June 30, 1999

Result 1: Monitor Station Network

Installation of the monitor station network was complete as of the last reporting period. All activities this reporting period consisted of routine maintenance, which included refining data logger programs, battery replacements, sample pick-up, and flow measurements. Maintaining the monitor station network will continue beyond the end of this project with funding from subsequent grants. See general activities and related projects section below.

Result 2: Sampling and Analysis

All planned work is complete to date. About 300 samples were collected during the course of the project from the three stations on the perennial reaches of Valley Creek. An additional 24 samples were collected from the two stations on the two main intermittent tributaries to Valley Creek, which flowed only one day during the project, on 17 March 1999 due to snowmelt. Sample analysis is up to date. Sampling and analysis will be summarized through 1998 for the purposes of this project. Sampling will continue on a regular basis beyond the end of this project with funding from subsequent grants.

Result 3: Data Base Management

All planned work is complete to date. Data are presently being recorded in Microsoft Excel spreadsheets and are current through early 1999. Data through 1998 for public release have been extracted after being proofed for accuracy and consistency. These data will be included on a CD-ROM as part of the final report for this project. Data management is continuing beyond the end of this project with funding from subsequent grants.

Result 4: Watershed Modeling

All planned work is complete to date. Colleagues at the University of Minnesota have completed geographic information system (GIS) analysis of the Valley Creek watershed. These data will constitute the primary data set on a CD-ROM as part of the final report for this project. Such spatial data provided input into two computer models of the Valley Creek area. One model, called SWAT (Soil and Water Assessment Tool), has been used for such simulations before and may be useful for comparison with other studies. However, the other model, called WEPP (Water and Erosion Prediction Program), is theoretically better able to simulate some physical processes. Models were calibrated to known flows in Valley Creek, and then potential scenarios of urbanization were input into the models to infer the impact on the hydrology of Valley Creek.

Result 5: Groundwater Modeling

All planned work is complete. The modeling effort was accelerated by cooperation with Emmons and Olivier Resources (EOR), the Minnesota Pollution Control Agency (MPCA), and the City of Afton. The City of Afton provided extra funding to help map groundwater levels in the area, which provided the main data for model calibration. The MPCA provided regional templates of the groundwater model, into which components specific to the Valley Creek area could be added. EOR had produced a groundwater flow model for the South Washington Watershed District, adjacent to the Valley Branch Watershed District, and this model in turn provided a starting place for the Valley Creek model.

Result 6: Reporting

This project will produce six final reports, all falling under the general title of Monitoring and Modeling Valley Creek Watershed:

1. Executive Summary
2. Hydrologic Data Collection Methods
3. Hydrologic Data Summary, 1997-98
4. GIS Atlas
5. Groundwater Interactions and Modeling
6. Modeled Effects of Urbanization on Watershed Hydrology

In addition, GIS and hydrologic data will be included on a CD-ROM. Report writing is well underway; drafts have been prepared for each report. We expect final versions to be delivered by the end of July. We plan delivery to not only LCMR, but also to the cities of Afton and Woodbury, the Valley Branch Watershed District, the Minnesota Department of Natural Resources, the Board of Water and Soil Resources, the Washington County Soil and Water Conservation District, and the Belwin Foundation. In addition, the Executive Summary will be mailed to all citizens and agency personnel presently on our mailing list (about 80 individuals).

General activities and related projects

- (1) A challenge grant from the Board of Water and Soil Resources (BWSR) was obtained to fund continued monitoring and analysis of Valley Creek through June 30, 2001. The total award was for \$64,000 (\$32,000 from BWSR, matched by contributions from the Valley Branch Watershed District (VBWD), the Science Museum of Minnesota, and the University of Minnesota). Matching funds from the Science Museum of Minnesota will come from an endowment set up by a Museum board member for continued research in the Valley Creek area. These funds will be available on a continuing basis, thereby providing leverage for future grant proposals and demonstrating the commitment of the Science Museum and the St. Croix Watershed Research Station (SCWRS) for long-term data collection at Valley Creek.
- (2) The Metropolitan Council is dedicated to maintaining operation of their monitoring station at the mouth of Valley Creek, and the SCWRS has been contracted to operate this station, with local matching funds provided by the VBWD.
- (3) Emmons and Olivier Resources (EOR) has been awarded a contract from the Minnesota Department of Health to model groundwater flow in all of Washington County. The starting point for this model will be the regional template provided by the MPCA and the local models that EOR has produced for southern Washington County, including the Valley Creek area. This county-wide effort will strengthen the understanding of the regional hydrogeologic setting for Valley Creek, thereby improving the local model of the creek. In addition, such a county model and details learned at Valley Creek will provide important experience in interpreting groundwater interactions in other trout streams along the St. Croix River, notably Browns Creek near Stillwater. These projects demonstrate the benefits of multi-agency collaborations and use of a uniform regional groundwater flow model that can be built upon and improved by a series of related modeling efforts.

Problems

- None, except that final reports will not be completed by the 30 June 1999 deadline. We expect report completions by the end of July 1999.

Watershed Science in the Museum

Public GIS Map Lab

Progress as of January 23, 1998

Development of the Public GIS Map Lab has been waiting for the completion of the new statewide land use update. The update apparently is now finished, so Pat Hamilton is setting up meetings with Les Maki (Minnesota Department of Natural Resources) and George Orning (Center for Urban and Regional Affairs, U. of M.), and museum staff to begin the development of the Map Lab.

Public GIS Map Lab

Progress as of August 22, 1998

Pat Hamilton and Joel Halvorson (education technology fellow at the Science Museum) met with Les Maki and Tim Loesch of the DNR back in the winter. The results of these meetings were that Joel Halvorson and Scott Haire (manager of the Project Club) participated in four day-long GIS training sessions that the DNR provides to the staff of its regional offices. In addition, the DNR has offered to make virtually its entire GIS database available to the Public GIS Map Lab.

In May, Joel submitted a proposal to the Minnesota Department of Children, Families, and Learning to leverage the resources of the Minnesota Map Lab for the benefit of 9 school sites across the state. This proposal was not funded, but generated considerable interest with the DNR education committee. Joel has since met with this committee, and they are eager to leverage the lab to the benefit of their education outreach. In June, space was made available in the Our Minnesota Hall for the Public GIS Map Lab (now known as the Minnesota Map Lab). Equipment was ordered and set up. Joel Halvorson and Scott Haire are taking the lead in setting up the lab and developing it into a good museum visitor experience.

Joel Halvorson has been meeting with George Orning of the Center for Urban and Regional Affairs at the University of Minnesota. Consequently, several of George's students have been using the lab to publicly perform GIS work on several lake watersheds in northern Minnesota. One of the lab's goals is to encourage GIS students/professionals and interested parties from the community, to do their work in the lab, share knowledge, and use the lab as a community resource. As an example, in September the museum is hosting a meeting of board of the Minnesota Lakes Association. Joel has also been working with local ESRI representatives. ESRI has provided software, data, and technical assistance at no charge. ESRI will also assist in helping the Minnesota Map Lab develop educational uses of the DNR state-wide data. In fact, one of ESRI's technical staff, Angie Lee, has enrolled to be an SMM volunteer. She and Joel will also be sharing this project with other Museum professionals at the annual Association of Science and Technology Centers (ASTC) conference in Edmonton in October.

Problems

Earlier in the summer when the equipment for the lab was being specified by Joel Halvorson, Hewlett-Packard offered to provide the museum the free use of one of its new 80 gigabyte optical storage devices. Consequently, the Hewlett-Packard computer that was ordered was configured in anticipation of it operating in association with an HP optical storage device. Hewlett-Packard later informed the museum that such a storage device was not available. An optical storage device or more conventional disk storage system is necessary so that the Minnesota Map Lab can hold all of the DNR's GIS data. The museum is continuing to pursue an optical storage device with Hewlett-Packard. If this device proves not to be available, then the museum will seek out a more conventional data storage system. This will also be a great asset to the DNR. As they receive request for state land use data, they will be able to direct people to the map lab, where they will be able to make copies of data sets to either a floppy, zip, jaz, or CD ROM.

Watershed Science in the Museum
Progress as of January 22, 1999

The Minnesota Map lab is currently residing in the Our Minnesota Gallery. The lab is comprised of the following equipment:

Hardware

- 1 - HP Kayak Workstation
- 81GB of hard disk storage
- 1- CD-ROM drive
- 1- Writeable CD-ROM drive
- 1 – internal Jaz drive
- 1 - internal Zip drive
- 1 - 19" monitor
- 1 - Rear projection system for projecting on a large screen
- 1- HP 2500CP color plotter
- 1- HP Color Laser Printer
- T1 Internet Access

Software

- ESRI Arcview and all extension products
- ESRI ArcInfo
- Microsoft Office Suite
- Netscape
- Various other software tools

Data

- State-wide coverage for:
DRGs Scale 1:24,000, 1:100,000, and 1:250,000
DOQs
County libraries with complete centmis and centsbp for each county
DNR Arview tools and metadata
- All MNRRA "non-sensitive" GIS data
- All ESRI GIS data CD's
- Assorted other unrelated GIS data sets.

During the summer 1998, the museum purchased the hardware and prepared the space for the Map Lab. Plans were developed to work with the DNR to purchase a large volume "GIS data server" for storage of the new state-wide land-use data. Working with Tim Loesch, DNR GIS Specialist, the museum purchased an 74GB storage drive. As part of our agreement with the DNR, the data server was configured by Tim to contain all non-sensitive statewide data, approximately 60GB. The DNR, while configuring the data server, used the opportunity to further organize, index, and coordinate their spatial data sets for similar distribution to their regional offices. This work, completed in January 99, left the museum with limited statewide data until this month.

With the arrival of the statewide data, attention recently has turned to training museum volunteers to serve as operators of the Minnesota Map Lab. An employee of ESRI is volunteering her time to develop simple menus that will facilitate the searching of the databases by museum volunteers so that they can readily call up topographic maps, aerial photographs, and land use information for locations of particular interest to museum visitors.

During the late summer and fall, focus was placed on developing partnerships with groups in the community that had GIS projects appropriate for the museum. The goal was to invite groups to use the Map Lab for their own work, and to share their work with the visiting public. An invitation to use the Minnesota Map Lab space was also extended to College/University departments with GIS programs. As a rule, groups using this space have also signed-up as museum volunteers.

Currently, the museum is working with CURA (Center for Urban and Regional Affairs) to house working projects in the Map Lab. As an example, Graduate students from CURA's LCMR-funded Sustainable Lakes Project have been using the lab to create the various coverage maps for five pilot lake watershed associations to use as tools for developing long-range lake management plans. By doing their work in the Map Lab, visitors are exposed to the "inside" of a working GIS project. In addition, CURA has used the Map Lab space to hold meetings of the Minnesota Lakes Association and their various partners. Currently, one of the CURA graduate students has designed her Master's project to generalize the activities of the Sustainable Lakes Project, so that visitors to the lab can generate the same coverage maps for any watershed in Minnesota and apply the same "assessment practices" that are being applied by the pilot sites. Other projects currently using the Lab include the CURA Neighborhood GIS Project, the CURA and AMC State Land Use Update, and a University of Minnesota Forestry Project

Students involved in the museum's Youth Science Center also have been using the lab to help build their working knowledge of GIS. To date, these students have been building coverage maps of the Valley Creek Watershed, and are acting as a "service bureau" to the Stillwater High School Students, producing the maps they can use as part of their field studies. In the future, these students will be developing other maps for use in the museum.

We are currently putting together a Minnesota Map Lab advisory committee comprised of GIS professionals and others from the community. This group will meet and further define the ways in which the museum can best support the use of spatial data. With the move to the new museum happening later this year, we are currently at the point where we need to make some decisions for how best to incorporate the lab into the new museum. Our four main goals are:

- Goal 1) Establish the Minnesota Map Lab.
- Goal 2) Make the visible Minnesota Map Lab a valuable experience for the museum's visitors.
- Goal 3) Secure the long-term health, viability, and relevance of the Minnesota Map Lab as a valued component of the new Science Museum.
- Goal 4) Establish the Minnesota Map Lab as a valued component in the State of Minnesota's efforts to increase GIS literacy amongst teachers, students, government employees, and other professionals.

Within the new museum, we will have a wonderful opportunity to further develop the Minnesota Map Lab into meaningful visitor experiences, public programs, and training classes. As an example, the museum's Computer Education Center will be moving from its off-site location into the new museum. This resource could significantly enhance the potential for the museum to offer GIS training sessions.

We have also discovered that the museum as an educational institution is an appropriate location for encouraging public discourse on the use of GIS. However, like any component of the museum, our ability to support a "vertical knowledge base" around the use of spatial data is largely dependent on our community partnerships. For this reason, we hope to establish a university-style GIS institute at the museum that through the involvement of graduate and undergraduate students carries out the research, development, analysis, and implementation of projects that at their core use spatial information to serve the citizens of Minnesota. With such an Institute, projects like the Sustainable Lakes Project, would be ongoing, and would be reflected through visitor activities, public programs, and training classes.

Watershed Science in the Museum *Progress as of June 30, 1999*

From January through June 1999, the Minnesota Map lab served a variety of audiences. Graduate students from the University of Minnesota used the Lab to produce maps for the Sustainable Lakes project at the Center for Urban and Regional Affairs. Graduate students also used the new statewide land use database to generate county-level land use maps that were then distributed to county seats throughout the state. One graduate student, in particular, used the Lab to conduct her research in how the algorithms developed for selected watersheds in the Sustainable Lakes project could be applied to watersheds throughout the state. This graduate work is expected to be completed in July, at which time the Minnesota Map Lab will have a new educational resource to experiment with making accessible to its audiences.

The museum continued to distribute the new statewide land use map to schools visiting the museum and to schools reached through the museum's Museum on the Move program. The Minnesota Map Lab was also the site for research activities performed by undergraduate students, neighborhood groups, and local high school students. In addition, the Lab was used to pilot a focused field trip in which teachers along with their school groups were introduced to the concepts of maps and GIS. This focused field trip activity will be further refined once the new museum and the Mississippi River Gallery open.

All these varied activities have allowed the museum to prepare and position the Lab so that it will continue to be an integral part of the new museum. As part of the preparation for this move, a Map Lab advisory board was established to help oversee and direct the further development of GIS education at the museum. Twenty-one people representing the following institutions attended the initial meeting in March: Center for Urban and Regional Affairs - University of Minnesota, ESRI, Forest Resources - University of Minnesota, Geography Department - Macalester College, Geography Department - University of Minnesota, Metropolitan Council, Minnesota Board of Water and Soil Resources, Minnesota Department of Natural Resources, Minnesota Historical Society, Mississippi National River and Recreation Area, St. Croix National Scenic Riverway, U.S. Geological Survey, Water Resources Center - Minnesota State University at Mankato.

With help from our advisors, the Minnesota Map Lab is evolving into two distinct, but interrelated program initiatives. The first is the Lab as a public program in which museum visitors gain access and exposure to digital geographic information about the state of Minnesota that is of personal interest to them. The second is the Lab as an aspect of the Adult Learning Center in which the museum serves as a Minnesota GIS data repository, GIS training facility, and a site for experimentation in GIS research and education.

The public program aspects of the Minnesota Map Lab in the new museum will be incorporated into the Mississippi River Gallery. Visitors to the gallery will be able to visually explore GIS data sets as part of a "Find Your Watershed Activity." This activity, being developed with the assistance of a GIS graduate student from the University of Minnesota and a museum volunteer from ESRI, is a user friendly, mouse-driven discovery of any watershed in the state. Building off of the maps developed through the Sustainable Lakes project, the DNR, and the Science Museum, visitors will be able to visually browse many different layers of information, in the context of learning more about their local watershed. This activity will allow the museum to standardize the GIS experience for the average visitor, yet personalize the information. This same system is also being used as the basis for preparing GIS workshops the museum will offer to teachers this fall.

The museum also is entering into a working relationship with the University of Minnesota's Remote Sensing Labs, in which the Minnesota Map Lab dovetails with the education outreach of two of the University's recently awarded NASA projects – TerraSIP (Spatial Information Partnership for Land Managers) and RESAC (Regional Earth Science Applications Center). By working with the U. of M.'s Remote Sensing Labs, the Minnesota Map Lab will gain access to a wealth of satellite imaging data, which will provide new opportunities for educational collaborations. In particular, the Minnesota Map Lab and the Remote Sensing Labs will be working this summer on how to work together to pursue mutual exhibit activity, teacher training, and classroom instructional resources.

In addition to the above program activities, the Minnesota Map lab continued to play a vital role producing various mapping tools for the museum. Recently the Lab:

- designed and produced a series of laminated field maps for Warner Nature Center of its immediate watershed area for use in its Watershed Science Training activities.
- designed and produced a series of detailed laminated field maps of the Mississippi River for the River Eye boat volunteers for their use on the river and with visitors to the Our Minnesota exhibit hall.
- designed and produced an 8' x 12' aerial photo wall map of the Mississippi River in the Twin Cities area for the Mississippi River Gallery.
- designed and produced numerous thematic maps for use in various exhibit displays, especially maps about drinking water sources and the wastewater collection system for the Twin Cities Metropolitan Area for display in the Mississippi River Gallery.

The Minnesota Map Lab has been an exciting project for the museum. The ideas we are pursuing have evolved over this past year and in consultation with our community advisors. We look forward to leveraging the knowledge, skills, and insights gained from this LCMR-funded phase into a long-term commitment by the museum in making GIS resources more widely accessible and meaningful to the museum's large and varied audiences.

Projects Club

Progress as of January 23, 1998

During July and August 1997, the Projects Club student team leaders and volunteers worked with the St. Croix Watershed Research Station staff and two biology teachers from Stillwater High School to collect and identify stream macroinvertebrates in Valley Creek. The students worked with the Stillwater teachers to develop methods of collecting and worked in the Stillwater biology classroom to identify stream macroinvertebrates.

In the fall the Projects Club and Stillwater High School's after-school Science Club students collected, identified, and preserved stream macroinvertebrates specimens from Browns Creek. The students also conducted water quality testing on Browns Creek that will be a part of a long-term study of the creek performed by the Stillwater High School. In addition, Projects Club collected and identified stream macroinvertebrates from Spring Creek, located at the Science Museum of Minnesota's St. Croix Watershed Research Station.

The Projects Club students presented their Watershed Science work-in-progress in Museum Square on October 11 as part of the Girls in the Center/Spanish Heritage Week and for the St. Paul Chamber of Commerce on October 9 in the museum's exhibit shop. In December the Projects Club's Watershed Science Team began developing a portable stream table and activities that they will exhibit at the museum and as a part of their outreach work to communities.

Projects Club

Progress as of August 22, 1998

In the Winter of 1998, the Projects Club Watershed Science team developed activities about water chemistry and watering testing. They also made invertebrate 'flash cards' to help people identify stream invertebrates and teach people how to determine stream health by the invertebrates that are found in that environment.

In the spring, Projects Club Watershed Science team leaders and volunteers taught and presented living stream macroinvertebrates, and water testing activities at the Science Museum of Minnesota on:

- March 7th for the Youth Opportunity Fair
- April 17th for the Anderson Foundation
- April 18th for the Hispanic Pre-College Program, Family Day Event
- April 30th for the Common Bond Community Science Fair
- May 2nd for Girls in the Center event

They also did outreach in the spring at Humbolt Jr. High School on April 15th, where they presented living stream macroinvertebrates and taught a 'build - a - bug' activity that teaches students about insect anatomy.

In June, the Projects Club Watershed Science students started working on a game that deals with invertebrates that live in streams, and web pages that will be linked to the Science Museum of Minnesota's web site to present their activities, explain the procedures to collect stream invertebrates, talk about their experiences, and share information about what they have learned.

Projects Club

Progress as of January 22, 1999

During summer 1998, the Projects Club student team leaders and volunteers worked with the St. Croix Watershed Research Station staff to collect and identify stream invertebrates in Spring Creek. The students also collected stream invertebrates at streams in St. Paul and developed methods of collecting, identifying and rating stream health.

From this experience and research of stream invertebrates, the Projects Club students developed an activity that teaches people about stream monitoring and stream health. Visitors collect invertebrates from a simulated stream and count the number of sensitive and insensitive invertebrates to determine if the stream is healthy or polluted. The Projects Club students presented their activity at a special event held at the Science Museum of Minnesota during the Youth ALIVE Microbiology Conference on August 5, 1998. Projects Club students also finished the Youth Science Center "Watershed Science" web pages that present their activities, explain the procedures to collect stream invertebrates, talk about their experiences, and share information about what they have learned.

In the fall, the students designed and developed a portable stream table prototype. The stream table is designed to teach people about stream hydrology. Students are now working on a portable stream table that will teach people about invertebrates that live in fresh water stream. In November and December, the students worked with a teacher from the Museum's Learning Technology Center to design computerized games on watershed science that the students will create for display in the Our Minnesota Hall. Students are developing several games and activities that deal with the identification and collection of stream invertebrates, stream hydrology, and watersheds.

Also in November and December, Projects Club students began work in the Minnesota Map Lab. They initiated the development of GIS activities for museum visitors, and they produced several maps of the Valley Creek Watershed to aid Stillwater High School teachers and students in their studies of Valley Creek and its watershed.

Projects Club

Progress as of June 30, 1999

Watershed Science Team: From January through June 1999, this team of 13 students met twice a week to plan and present activities for public events and to design and build an exhibit, computer programs, and table-top activities on the topics of watersheds, stream health, and aquatic invertebrate sampling in streams:

1. Rain Table (exhibit): The Watershed Science team met with a Science Museum exhibit developer to design and create an exhibit that simulates how different landscapes disperse precipitation to create distinct watersheds. Two other staff from Science Museum's Paleontology Hall, helped team members to create four different landscapes for the "Rain Table" exhibit. They made clay landscapes that were painted with latex to make a rubber mold and then, the molds were used to make a plastic cast. The landscapes were then painted accordingly. The exhibit will be in the Our Minnesota hall this summer and then will be moved to the new museum this fall, where it will be on display in the Youth Science Center.
2. Healthy Stream Games (computer games): A teacher in the Science Museum's Learning Technology Center continued to work with the students to use the Microworlds software. Team members then finalized the development and finished the programming for the games. The games were designed to help visitors understand about stream health, stream indicators and land use issues that impact the structure and life in a stream.
3. The bug game (table top board game): The students designed and developed the bug sampling game (activity they taught to visitors) into an exhibit component. Students made clay models of the insects and invertebrates used in the bug game, the clay models will be cast in the same method used for the Rain Table exhibit. Students have also designed and developed a table top activity that will be used to simulate a river.

Activity Presentation

The students presented watershed activities at the Science Museum for the Hispanic Pre College Program's Family Day on April 17 and for Girls at the Center, a museum event in coordination with the Girls Scouts of America on April 3, 1999.

GIS Mapping Lab Team: From January through June 1999, the GIS team of five students met twice a week in the Minnesota Map Lab to learn how to use the mapping hardware and software, to develop their own GIS web page, to plan and present mapping activities to museum visitors. In particular, the GIS team members produced maps of the Valley Creek and Browns Creek watersheds for use by Stillwater High School students conducting field studies along these waterways. These maps also were put up on the Projects Club's Watershed Science web pages. Students worked with museum staff to learn the software necessary to manipulate DOQ and DRG datasets and to work with the "Where's Your Watershed" activity. The GIS team leaders in the Minnesota Map Lab also helped museum visitors identify sites of personal interest to them in the Minnesota GIS datasets and then printed out maps that these visitors then could take home.

Activity Presentations

On April 1, the GIS Mapping Lab team leaders planned and hosted a day long mapping workshop at the Science Museum for Capitol View Apartments and Scheffer Recreation Center's after-school programs. 40 children attended. Both organizations are from the Frogtown Neighborhood of Saint Paul and are a part of the Frogtown's Leap forward for Children Initiative. They also presenting maps and activities at Jackson Elementary School's "Geography Fair" on March 25 and Hispanic PreCollege Project's "Children's Day" at Humboldt Jr. High School on April 29.

Team Leaders are now starting to work with volunteers from the Our Minnesota Hall's River Eye boat to develop maps about the Mississippi River and its watershed. Beginning on June 28, GIS team members start going out on the Mississippi River in the River Eye boat in order to gather information for their maps. They will then present these maps and other information they collect to museum visitors in the Our Minnesota Hall and at special events through out the summer.

Watershed Science Training

Progress as of January 23, 1998

In August 1997, WNC staff, Stillwater teachers, St. Croix Watershed Research Station staff, and the DNR Metro Trout Stream coordinator began planning a Watershed Science workshop to help train people who will be involved in monitoring Browns Creek in Stillwater. The workshop was held on September 15 and focused on instructing participants on how to collect and identify aquatic invertebrates. The participant list was expanded to include members of organizations interested in establishing monitoring programs on St. Croix Valley streams other than Browns Creek. The 23 participants included Stillwater High School students and teachers, Belwin Nature Center staff, Science Museum staff, members of the Mills Stream Association (in Marine-on-St. Croix), and National Park Service staff.

WNC staff and Stillwater High School teachers in the fall began working with students on collecting and inventorying aquatic invertebrate samples from Browns Creek. WNC staff met with Stillwater High School teachers in December to begin planning for spring field trips in which Stillwater students will continue to inventory Browns Creeks aquatic invertebrates and then expand the inventorying to include riparian vegetation and bird populations. WNC staff and Stillwater teachers and students also have met with the DNR Metro Trout Stream coordinator in order to strategize efforts in monitoring metro trout stream invertebrate populations.

WNC staff have expanded Watershed Science Training efforts to include the community of Marine-on-St. Croix. WNC staff delivered three outreach watershed science programs to students at Marine Elementary School during the fall, including helping the school to plan and implement a schedule of invertebrate sampling. WNC staff also are working with the recently formed Mill Stream Association to help it organize its efforts to protect this stream.

Progress as of August 22, 1998

On April 3, Warner Nature Center hosted a DNR Stream Monitoring Workshop. Emphasis was concentrated on collecting techniques and identification of aquatic invertebrates. There were 24 attendees, primarily teachers, students and DNR personnel.

Warner staff, Tom Anderson and Lynette Anderson, visited Stillwater High School to assist in the identification of aquatic invertebrate samples taken from Brown's Creek. Several nature center dissecting scopes were loaned to the high school during the spring months to allow more students experience in keying out insects.

On May 3, Lynette Anderson represented Warner Nature Center and Watershed Science by participating in "Mill Stream Days" in Marine on St. Croix. The intent of the festival was to inform the community of local efforts to inventory and protect the Mill Stream (a trout stream that runs through the city limits).

The following equipment was purchased by the nature center to assist in the project: kick nets, water sampling equipment, a scope camera, a high-resolution dissecting scope for identification purposes, a 27 inch monitor for classroom use (to project the Scope Cam image), field microscopes, and a collection of books and curricula that relate to water quality and watersheds.

Progress as of January 22, 1999

In September 1998, Tom Anderson visited Stillwater High School to assist high school biology staff and DNR biologists in the identification of aquatic invertebrate samples taken from Browns Creek. Tom Anderson and Jim Hall of Warner Nature Center met with Stillwater High School biology teachers, Andy Weaver and Jeff Ranta in late December 1998. A schedule for the upcoming spring 1999 Browns Creek field season was discussed and finalized. Besides the further inventorying of Browns Creek aquatic invertebrates, field work also will include the investigation of Browns Creek's riparian flora and fauna. This will include:

- the banding of resident and migratory birds.
- identifying the breeding territories of riparian bird species by noting consistent vocalizations.
- inventorying the local populations of reptiles and amphibians through observations, live-trapping, and vocalizations.
- collecting and keying representative vegetation.
- acquiring additional microscopes and sampling nets.

It was agreed that a major goal will be to have a variety of high school students following defined protocols to generate consistently gathered data for comparison with future data collecting. Discussion was held on the development of a Stillwater High School web page and public presentations that would display all water chemistry data and inventory results gathered from the Browns Creek project.

In December 1998, Warner Nature Center staff met with Marine-on-St. Croix resident and key member of the Mill Stream Association, Jim Shaver. The Warner Nature Center and the Mill Creek Association are interested in how the Watershed Science Training can be broadened to include Mill Creek. In January 1999, Warner naturalist, Lynette Anderson, met with Marine Elementary teacher, Nancy Wisniewski and Jim Shaver to discuss the partnership and to begin curriculum planning for the fifth and sixth grade students. The curriculum will revolve around the Mill Stream watershed, the community of Marine (including the history of the watershed), water quality, and issues that impact the natural community. A survey of watershed issues will be developed by the students, and the students then will survey a sampling of Marine residents.

There will be an open house at the Warner Nature Center in April 1999 in which Marine elementary students will share data, research, data, writings, and artwork that interpret the watershed. The youth will play a key role in teaching the community about watershed science.

Watershed science will be a strong component in the June introduction of the Warner Summer Camp programs. These classes will be offered primarily to residents of the St. Croix watershed, particularly to the youth of Marine, Stillwater, and Scandia.

Watershed Science Training

Progress as of June 30, 1999

Marine Elementary School

From January through June 1999, WNC directed its Watershed Science Training at Marine Elementary on the fifth and sixth grade students and teachers. WNC staff focused on acquainting students and teachers with the concept of watersheds in general and then focused specifically on the Mill Stream watershed so as to encourage the students to become community educators on watershed issues. In order to do so, WNC staff guided the students in the creation of models of the St. Croix River watershed so that the impacts of various land uses could be modeled. The students then made repeated trips to Mill Stream to learn how to sample for aquatic invertebrates and how to use other kinds of observations in order to gauge the health of a stream. Students also visited the St. Croix Watershed Research Station where they talked with Jim Almendinger about his Valley Creek watershed research. In May, WNC staff helped the 5th and 6th grade students prepare a Mill Stream watershed fact sheet that the students then delivered door-to-door in Marine-on-St. Croix. Finally, WNC staffed a booth at the 2nd annual Mill Stream Association Fair on May 2.

Stillwater High School

From January through June 1999, WNC staff assisted the Stillwater High School biology students in learning the methodology for collecting aquatic invertebrates from Browns Creek and then taxonomically keying them out. As spring advanced and the vegetation grew, WNC staff helped the Stillwater students to learn how to set up and sample vegetation along a transect from the water's edge to the top of the bluff. WNC staff also provided and set up mist nets in the Browns Creek valley so that the Stillwater students could capture, record, band, and release song birds. Although the Watershed Science project is concluded, WNC staff will continue their involvement with Stillwater High School. In particular, Stillwater High School teacher Andrew Weaver has prepared a watershed curriculum for use by WNC targeted to grades 3-8. Also, WNC staff will be assisting Stillwater High School students in the development of a watershed booth for the 1999 Midwest Environmental Education Conference taking place in August in Stillwater.

IV. OUTLINE OF PROJECT RESULTS:

Objective 1: Watershed Science in the Field:

Budget for Objective 1: \$339,600 Balance: \$0

Result 1: Monitoring Station Network

Budget for Result 1: \$102,000 Balance: \$(6,700)

Explanation: More time than expected was spent to obtain permits for site installation and to maintain the stations.

1a) Site selection: Sites will be identified for the four automated stream monitoring stations and one automated weather station in the Valley Creek watershed.

Budget: \$2,000 Balance: \$(2,400)

1b) Equipment design/ordering: Specifications will be finalized for the stream stage recorder, data logger, automated water sampler, and automated meteorological equipment and the equipment will be ordered.

Budget: \$72,000 Balance: \$(2,100)

1c) Equipment installation: Flumes will be installed, if possible, at sites on small tributaries with low flow. The stream stage recorders, data loggers, automated water samplers, and automated meteorological equipment will be installed in the field.

Budget: \$28,000 Balance: \$(2,200)

Result 2: Sampling and Analysis

Budget for Result 2: \$70,000 Balance: \$(6,200)

Explanation: Analytical problems caused by the need to troubleshoot new instrumentation increased expected cost per analysis significantly. Supplies costs were also greater than expected for in-laboratory water analysis. However, time required for streamflow measurements was overestimated, compensating for part of the analytical cost overruns.

2a) Stream flow measurement: Streamflow will be measured about monthly at each monitoring station to develop a stage-discharge relation. Stage will be recorded at hourly or shorter intervals, once stations are operational

Budget: \$28,000 Balance: \$7,000

2b) Water sample collection: During the installation phase, water will be automatically sampled once each day and combined into three-day composites, once stations are operational. The composite samples will be picked up weekly. Later, automatic sampling frequency will be altered to obtain representative samples during short-lived runoff events, after initial data clarifies the stream-flow characteristics unique to each site.

Budget: \$22,000 Balance: \$(3,200)

2c) Water sample analysis: The three-day composite samples will be analyzed at the SCWRS for total phosphorus, soluble reactive phosphate, total nitrogen, dissolved nitrate, dissolved organic carbon, and total suspended matter. Monthly composite samples will be analyzed at the University of Minnesota for major ions, selected metals, and stable isotopes.

Budget: \$20,000

Balance: \$(10,000)

Result 3: Data Base Management

Budget for Result 3: \$13,800

Balance: \$(19,000)

Explanation: The time required for data-base management was grossly underestimated. This category included creation of working data bases for data entry and calculation, extracted data bases of proofed data for public release, and miscellaneous data manipulations and extractions as requested by cooperating agencies. Statistical analyses for interim reports added to the time burden.

3a) Weather data: The automated weather station will collect data on air temperature, humidity, wind speed and direction, incident solar radiation, and rainfall. Snowfall will be obtained from the nearest national weather station.

Budget: \$4,000

Balance: \$(2,000)

3b) Stream flow data: Stream stage data, collected at hourly or smaller intervals, will be converted to streamflow data via the stage-discharge relation for each monitoring site.

Budget: \$4,900

Balance: \$(6,400)

3c) Water quality data: Data on nutrients, suspended solids, major ions, carbon, and stable isotopes will be compiled and summarized quarterly.

Budget: \$4,900

Balance: \$(10,600)

Result 4: Watershed Modeling

Budget for Result 4: \$82,800

Balance: \$0

Explanation: This result was executed as a fixed-price contract with the University of Minnesota, and so its balance comes to exactly zero. The apportioned amounts below were estimated according to the terms of the contract.

4a) GIS data set assembly: Spatial data sets of land use, surficial geology, bedrock geology, surface slopes, soil type, hydrography, and watershed boundaries will be obtained from various sources.

Budget: \$22,000

Balance: \$400

4b) Model calibration: The watershed will be modeled with a distributed-parameter, nonpoint-source-pollution simulation program modified for urbanizing landscapes. Modeling will be done under the direction of Dr. David Pitt, Department of Landscape Architecture, University of Minnesota.

Budget: \$37,800

Balance: \$300

4c) Model scenario generation: Model runs with hypothetical land-use distributions will demonstrate potential effects of urban runoff under different scenarios of residential development.

Budget: \$23,000 Balance: \$(700)

Result 5: Groundwater Modeling

Budget for Result 5: \$62,000 Balance: \$39,900

Explanation: This category was underspent to make up for deficits in other categories. Use of a regional model template developed by the MPCA and of a local model of an area adjacent to Valley Creek greatly accelerated the modeling process.

5a) GIS data set assembly: Existing data from the County Well Index, the US Geological Survey (USGS) Ground Water Site Index data base, and selected USGS summary reports will be accessed.

Budget: \$20,000 Balance: \$15,600

5b) Model calibration: The regional template for the Valley Creek groundwater model will be obtained from the metropolitan area groundwater model, currently being constructed by the Minnesota Pollution Control Agency, with MLAEM, a multiple-layer model using the analytical-element method.

Budget: \$36,000 Balance: \$20,400

5c) Flow-path & travel time analysis: Flow-path analysis will delineate the groundwater recharge area for Valley Creek, and travel-time analysis will indicate potential lag times between land-use changes and their effect on Valley Creek.

Budget: \$6,000 Balance: \$3,900

Result 6: Reporting

Budget for Result 6: \$9,000 Balance: \$(8,000)

Explanation: Even though interim data summary reports are included in categories above (data-base management and GIS development), the time required for assembling final project reports was underestimated. This is mostly because of the decision to expand the final product to be a package of six related reports, rather than just the methods report and fact sheet as originally planned.

6a) Methods Handbook: The project scientist will prepare a handbook outlining the methods used in the Valley Creek study. This handbook will be provided free of charge to any interested parties.

Budget: \$5,000 Balance: \$(500)

6b) Effects of urbanization fact sheet: The project scientist will prepare a fact sheet or series of short papers summarizing the data and incipient model results as related to the effects of urbanization on Valley Creek. The fact sheet will be distributed free of charge to all interested parties, especially those interested in and/or living in the Valley Creek watershed.

Budget: \$4,000 Balance: \$(7,500)

TIMELINE & COMPLETION DATES	WATERSHED SCIENCE IN THE FIELD FISCAL YEAR 1997-98												WATERSHED SCIENCE IN THE FIELD FISCAL YEAR 1998-99											
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Monitoring Station Network																								
Site selection	X	X	X																					
Equipment design/ordering	X	X	X	X	X	X	X	X	X	X	X	X												
Equipment installation			X	X	X						X	X	X	X	X	X								
Sampling and Analysis																								
Stream flow measurement			X	X	X			X	X	X	X	X	X	X	X	X					X	X	X	X
Water sample collection			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Water sample analysis				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Data Base Management																								
Weather data				X			X			X			X			X			X			X		
Stream flow data				X			X			X			X			X			X			X		
Water quality data				X			X			X			X			X			X			X		
Watershed Modeling																								
GIS data set assembly	X	X	X	X	X	X	X	X																
Model calibration									X	X	X	X	X	X	X	X								
Model scenario generation																	X	X	X	X	X			
Groundwater Modeling																								
GIS data set assembly									X	X	X	X												
Model calibration													X	X	X	X								
Flow-path & travel time anal.																	X	X	X	X	X			

TIMELINE & COMPLETION DATES, CONT.	WATERSHED SCIENCE IN THE FIELD FISCAL YEAR 1997-98												WATERSHED SCIENCE IN THE FIELD FISCAL YEAR 1998-99											
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Reporting																								
Methods Handbook						X	X	X										X	X	X		X	X	X
Effects of urbanization fact sheet																		X	X	X		X	X	X

Objective 2: Watershed Science in the Museum:

Budget for Objective 2: \$130,400 Balance: \$(6,700)

Result 1: Public GIS Map Lab

Budget for Result 1: \$98,400 Balance: \$(6,400)

1a) Goals & outcomes identified: A set of goals and outcomes will be developed for the Public GIS Map Lab.

Budget: \$3,000 Balance: \$0

1b) Front-end evaluation: Museum visitors will be interviewed in order to determine what aspects of a Public GIS Map Lab would be of greatest interest and appeal.

Budget: \$1,500 Balance: \$1,300

A formal evaluation

1c) Component list developed: The equipment and software needs of the Public GIS Map Lab will be researched, identified, and itemized.

Budget: \$2,700 Balance: \$0

1d) Computer hardware & software purchased:

Budget: \$30,000 Balance: \$(2,800)

1E) Prototyping & formative evaluation of Public Map Lab: A preliminary version of the Public GIS Map Lab will be set up in the Our Minnesota hall and tested with museum visitors.

Budget: \$51,200 Balance: \$(13,000)

1F) Fabrication:

Budget: \$10,000 Balance: \$8,100

Result 2: Projects Club

Budget for Result 2: \$32,000 Balance: \$(300)

2a) Valley Creek field work: Projects Club members will spend summer 1997 learning how SCWRS will set up the Valley Creek research project.

Budget: \$3,000 Balance: \$0

2b) Stillwater High School coordination: During the 1997 school year, Projects Club members will work with Stillwater High School students and teachers involved in the Browns Creek project to learn how that project might be part of the Valley Creek research story that will be interpreted in the Our Minnesota exhibit hall.

Budget: \$7,000

Balance: \$0

2c) Valley Creek field work: Project Club members will spend summer 1998 learning how the Valley Creek research project has progressed.

Budget: \$4,000

Balance: \$0

2d) Interpretation project planning: Projects Club members will establish their goals, objectives, and interpretive techniques for how they will explain the Valley Creek research and the Browns Creek research in the Our Minnesota hall.

Budget: \$10,000

Balance: \$0

2e) Interpretation project development: Projects Club members will design and fabricate their Valley Creek/Browns Creek interpretive project and install it for public viewing in the Our Minnesota hall.

Budget: \$8,000

Balance: \$(300)

TIMELINE & COMPLETION DATES	WATERSHED SCIENCE IN THE MUSEUM FISCAL YEAR 1997-98												WATERSHED SCIENCE IN THE MUSEUM FISCAL YEAR 1998-99											
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Public GIS Map Lab																								
Goals & outcomes identified	X	X																						
Front-end evaluation	X	X																						
Component list developed			X																					
Computer hardware, software, & supplies				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Prototyping & formative evaluation of Public Map Lab				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fabrication																						X	X	X
Final version of Public Map Lab opens to the public																								X

TIMELINE & COMPLETION DATES, CONT.	WATERSHED SCIENCE IN THE MUSEUM FISCAL YEAR 1997-98												WATERSHED SCIENCE IN THE MUSEUM FISCAL YEAR 1998-99											
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Projects Club																								
Valley Creek field work	X	X	X																					
Stillwater H.S. coordination			X	X	X	X	X	X	X	X	X	X												
Valley Creek field work													X	X	X									
Interpretation project planning																X	X	X	X					
Interpretation project development																				X	X	X	X	
Interpretation project opens to the public																								X

Objective 3: Watershed Science Training:

Budget for Objective 3: \$30,000

Balance: \$6,700

3a) Meetings to set up the Browns Creek project: Staff of SMM's Warner Nature Center, members of SMM's Projects Club, and Stillwater High School faculty will meet to develop an outline for the study and interpretation of Browns Creek during the next two years. Warner Nature Center, Projects Club, and Stillwater High School faculty also will meet with Dr. Mary Vogel to see how their efforts can complement the work of the LCMR project, "Preventing Stormwater Runoff Problems Through Watershed Land Design."

Budget: \$500

Balance: \$0

3b) Recruitment of high school students: Warner Nature Staff and Stillwater High School faculty will identify a core group of students interested in the Browns Creek project.

Budget: \$500

Balance: \$0

3c) Site visits to Valley Creek: Warner Nature Center staff will take students involved in the Browns Creek project on site visits to Valley Creek. They explore the watershed and learn from the SCWRS project scientist how the Valley Creek research project was set up and how the work is progressing.

Budget: \$1,200

Balance: \$0

3d) Browns Creek monitoring program established: The research objectives will be identified, data collection site will be selected, monitoring protocols will be established, and equipment will be purchased.

Budget: \$8,000

Balance: \$0

3e) Browns Creek data collection and research:

Budget: \$17,800

Balance:\$5,200

3f) Web site: Stillwater High School students will create and maintain a web site that explains how they set up and maintain the Browns Creek research project. This web site will be linked to the Science Museum's web site.

Budget: \$ in-kind contribution by Stillwater High School

3g) Research results: The Stillwater High School students involved in the Browns Creek project will present results of their research to various audiences. In particular, presentation will be made to the science staff of the SCWRS and Stillwater students will be invited to use the Our Minnesota hall as a setting in which to inform museum visitors about their work on Browns Creek.

Budget: \$2,000

Balance:\$1,500

TIMELINE & COMPLETION DATES	WATERSHED SCIENCE TRAINING												WATERSHED SCIENCE TRAINING											
	FISCAL YEAR 1997-98												FISCAL YEAR 1998-99											
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Organizational meetings	X	X																						
Recruitment of high school students			X																					
Site visits to Valley Creek				X						X						X						X		
Browns Creek monitoring program established				X	X																			
Browns Creek data collection						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Stillwater HS students create & maintain web site																X	X	X	X	X	X	X	X	X
Stillwater HS students present results of their research																						X	X	X

V. DISSEMINATION

Objective 1: Watershed Science in the Field:

Professional audiences: The results of the research will appear in papers that will be published in scientific journals. The network of monitoring stations and the accompanying data base, furthermore, likely will attract other researchers to study in the Valley Creek watershed, which in turn should generate additional scientific articles.

Interested parties: The project scientist will prepare a handbook outlining the methods used in the Valley Creek study. This handbook will be provided free of charge to anyone interested, particularly watershed management organizations and local government officials who likely have a strong interest in watershed issues. The project scientist also will prepare a fact sheet or series of short papers summarizing the data and incipient model results as related to the effects of urbanization on Valley Creek. The fact sheet will be distributed free of charge to all interested parties, especially those interested in and/or living in the Valley Creek watershed.

Museum visitors: SMM's Projects Club will develop interpretive materials about the Valley Creek research project for display in the Our Minnesota Hall. These educational materials will be available to the 400,000 people who visit the hall annually. After relocation to the new museum's Mississippi River Gallery, these resources will be available to about 1,000,000 museum visitors annually.

Objective 2: Watershed Science in the Museum:

The Public GIS Map Lab will be available to Our Minnesota's 400,000 annual visitors when the final version of the lab is completed in June 1999. After relocation to the new museum's Mississippi River Gallery, the Map Lab will be available to about 1,000,000 museum visitors annually.

Objective 3: Watershed Science Training:

The Browns Creek web site created by Stillwater High School will be linked to the Science Museum's web site. This web site will be available to a projected 480,000 Minnesota teachers, students, and citizens expected to have Internet access by the time the web site is created.

The Stillwater High School students involved in the Browns Creek project will present results of their research to various audiences. In particular, presentations will be made to the science staff of the SCWRS and Stillwater students will be invited to use the Our Minnesota hall as a setting in which to inform museum visitors about their work on Browns Creek.

VI. CONTEXT

A. Significance:

Research: Suburbanization of the watershed is the single greatest threat to the water quality of the St. Croix River and many other Minnesota waterways. Such development already has profoundly affected lakes in the Twin Cities metropolitan area. Much less is known about the effects of suburbanization on stream ecosystems. Baseline data on pre-development conditions are practically nonexistent, and data on present stream flow and water quality characteristics are difficult to obtain because of the dynamic nature of small watersheds. Valley Creek, a relatively pristine stream in the southeastern part of the metropolitan area, offers an excellent experimental watershed for evaluating long-term water-quality impacts of suburbanization. Urban planning will benefit from information on how present development affects, and how further development may change the stream flow and water quality.

Education: Through the Public GIS Map Lab, museum visitors will be introduced to the wide range of on-line geographic data available about Minnesota. They will be shown ways in which this data can be used to provide insights into environmental questions. High school students participating in the museum's Projects Club and Stillwater High School students working on the Browns Creek project will have direct access to research scientists who will help them understand how watershed research is conducted. They, in turn, will share their insights with other audiences, especially visitors to SMM.

B. Time: All project objectives will be completed by June 30, 1999. Operation and maintenance of the exhibits after June 30, 1999 will be assumed by SMM. The long-term monitoring of Valley Creek watershed will be assumed by the SCWRS.

C. Budget Context:

	July 1995-June 1997	July 1997-June 1999	July 1999-June 2001
1. LCMR	336,000	500,000	
2. Other State			
3. Non-State	1,112,230	1,664,000	540,000
4. Other			
Total	1,448,230	2,164,000	540,000

Budget:

Personnel	\$357,141
Equipment	82,900

The St. Croix Watershed Research Station is committed to maintaining the stream monitoring stations and one automated weather station for another eight years after June 30, 1999. The Science Museum is committed to making the Public GIS Map a long-term element of its future Mississippi River Gallery, which will open to the public with the new Science Museum of Minnesota in late 1999. The museum's expectation, therefore, is that the Valley Creek research equipment and Public GIS Map Lab equipment purchased through the appropriation for Watershed Science will continue to be by their respective programs through its useful life. If any changes in the use of the equipment occur, the Science Museum will pay back to the appropriate fund or account number an amount equal to either the cash sale price the museum receives from its sales or a residual value to be negotiated with the director of the LCMR if the museum chooses not to sell it.

Watershed Science in the Field

<u>Item</u>	<u>Unit Cost</u>	<u># Needed</u>	<u>Total</u>
CR-10 dataloggers	\$1,200	4	\$4,800
Storage modules	400	6	2,400
Modems	400	5	2,000
Sealed CR-10 shelter	300	4	1,200
Cables	100	5	500
Shelter houses	1,000	4	4,000
Flumes	2,000	2	4,000
Laptop computer	3,000	1	3,000
ISCO sampler	3,000	4	12,000
Tubing, cables, misc.	200	5	1,000
Climate station	5,000	1	5,000
Flow meter kit	5,000	1	5,000
HydroLab	8,000	1	8,000
<i>Equipment total for Watershed Science in the Field</i>			\$52,900

Watershed Science in the Museum

GIS computer hardware and software	30,000	
Acquisition		0
Development		0
Other		59,959
supplies		
Watershed Science in the Field	22,224	
Watershed Science Training	9,600	
contracts	12,355	
mileage	5,940	
analyses	9,840	
Total		\$500,000

VII. COOPERATION:	<u>% time spent on project</u>	<u>\$ Cost</u>
Patrick Hamilton, project manager	20%	20,028
Dr. James Almendinger, lead scientist	100%	84,456
Shawn Schottler, assistant scientist	65%	44,239
GIS specialist (contract)		48,552
Mark Dahlager, Public GIS exhibit developer	15%	10,000
Public GIS visitor assistants	multiple personnel	20,158
Scott Haire, Projects Club manager	60%	32,000
Bill Stirrat, evaluator	10%	5,592
Jeff Ranta, Biology Dept., Stillwater High School	10%	in-kind
Andrew Weaver, Biology Dept. Stillwater High School	10%	in-kind
Tom Anderson, Warner Nature Center	2%	2,452
Warner Nature Center naturalists	multiple personnel	17,380
Total		284,857

VIII. LOCATION: See map included.

IX. REPORTING REQUIREMENTS: Periodic workprogram reports will be submitted no later than January 23, 1998, August 21, 1998, and January 22, 1999. A final workprogram report and associated products will be submitted by June 30, 1999, or by the completion date as set in the appropriation.

X. RESEARCH PROJECTS: See addendum.