

M.L 2018 Project Abstract

For the Period Ending June 30, 2019

PROJECT TITLE: County Geologic Atlases-Part A

PROJECT MANAGER: Barbara Lusardi

AFFILIATION: Minnesota Geological Survey, University of Minnesota

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03a

APPROPRIATION AMOUNT: \$1,240,000

AMOUNT SPENT: \$1,240,000

AMOUNT REMAINING: \$0

Sound bite of Project Outcomes and Results

We have completed 1 county, started 4 new counties, and continued work in 11 counties. Based on the time spent, this is equivalent to “completing” about 4 atlases with one year’s worth of funding. Atlas maps and data provide foundational information that supports water management activities to the benefit of drinking water and aquatic habitat.

Overall Project Outcome and Results

A Geologic Atlas provides the geologic framework of our state. It describes the materials and features at the land surface and extends all the way down to the bedrock surface. An atlas provides information useful for resource management and land-use planning. Each Atlas typically requires more than 7,000 person-hours of work. Some of that work is in the field: drilling test borings, examining, sampling, and describing outcrops. Much of the work follows after: interpreting field measurements, recognizing and formally naming geologic units described in well records, and making maps. The result is a detailed account of the distribution and properties of the rock and sediment that lie below the land surface. These materials, and their ability to store or transmit water, determine where we can find water, and how we can protect and make wise use of that water. This includes our lakes and rivers as well as groundwater.

As part of this 2018 award, we completed Kandiyohi County, started work in Cook, Yellow Medicine, Polk and Chippewa counties, and continued working in 11 other counties. We’ve described hundreds of outcrops, taken thousands of hand samples, and drilled nearly 30 continuous cores allowing us to sample rocks and sediment up to 325 ft deep.

We completed the equivalent of about 4 atlases with the ML 2018 funds, which were exhausted in one year of spending. This represents a higher number of atlases completed than our average of 5 atlases a year with all (CWF, DNR, and ENRTF) funds combined.

Continuing under the M.L 2019 award, atlases for Rock and Nobles counties will be complete within the next 3 months. Aitkin, St. Louis, Lake, and Steele counties should be finished within the next 12-18 months. The County Geologic Atlas program began in 1981 and continues with support of the Environment and Natural Resources Trust Fund as well as the Clean Water Fund, the Department of Natural Resources, and the U.S. Geological Survey. To date we have completed atlases for 43 counties, 23 are underway; and 21 have yet to be started. All of our mapping products and data are available in print or digital format.

Project Results Use and Dissemination

Every atlas is produced in portable document format (PDF), as geographic information system files (GIS), and in printed form. The digital files are available as a DVD, and are also available from the University of Minnesota Digital Conservancy, and via link from the [MGS web page](#). Each project culminates with a meeting held in the project area to present the results to the county staff, and any other interested parties. At these meetings the products are described, access to the products is explained, and examples of applications of the products to common resource management situations are demonstrated.

The products of subprojects in St. Louis and Lake counties are being released in digital form immediately following technical review. When all the subproject areas are complete county-wide compilations will be created and distributed digitally and in print. The printed copies are shared with the county, who in turn can distribute them to libraries, schools, townships, and other agencies. They are also distributed by the MGS map sales office. Products are also made available to earth science teachers and other educators for classroom exercises. Atlas products are also displayed and explained at educational events for SWCD staff and onsite sewage treatment system contractors.

Kandiyohi County Geologic Atlas is [available online](#) through the University of Minnesota Libraries Digital Conservancy. Interim products that will become the St. Louis and Lake County Atlases are also [available online](#). Completed atlas products have been posted to the MGS website and linked to the University's Digital Conservancy as noted above. PDF products as well as all of the related GIS data are available on these pages.

In addition, the MGS hosts an [Open Data Portal](#) on which many of our county geologic atlases are presented as "Story Maps" that allow for direct access of the data without any special software or interface.



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2018 ENRTF Work Plan Final Report

Today's Date: July 24, 2020

Final Report

Date of Work Plan Approval: 06/05/2018

Project Completion Date: June 30, 2020

PROJECT TITLE: County Geologic Atlases - Part A

Project Manager: Barbara Lusardi

Organization: Minnesota Geological Survey, University of Minnesota

College/Department/Division: College of Science and Engineering

Mailing Address: 2609 Territorial Road

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Web Address: www.cse.umn.edu/mgs

Location: statewide

Total Project Budget: \$1,240,000

Amount Spent: \$1,240,000

Balance: \$0

Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03a

Appropriation Language: \$1,240,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota, Minnesota Geological Survey, to continue producing county geologic atlases for the purpose of informed management of surface water and groundwater resources. This appropriation is to complete part A, which focuses on the properties and distribution of earth materials to define aquifer boundaries and the connection of aquifers to the land surface and surface water resources. This appropriation is available until June 30, 2022, by which time the project must be completed and final products delivered.

I. PROJECT STATEMENT: Geologic atlases provide maps and databases essential for improved management of ground and surface water resources. This is foundational data that supports water management activities to the benefit of drinking water and aquatic habitat. Geologic Atlases are specifically identified as essential data in the Statewide Conservation Plan, and in the efforts of the Environmental Quality Board, DNR Waters, and the Water Resources Center at the University of Minnesota to design a sustainable water management process. Geologic Atlases define aquifer boundaries and the connection of aquifers to the land surface and to surface water resources to enable a comprehensive water management effort. The program goal of atlas coverage statewide has benefited from long-term support of LCCMR to accelerate the work.

A complete geologic atlas consists of Part A constructed by the Minnesota Geological Survey (MGS) and focused on geology and the County Well Index, and Part B constructed by the DNR Division of Waters (funded separately) and focused on hydrology. Local participation is a primary factor in determining which counties are chosen for this work, while ground water sensitivity, water demand, and the size of the population served are also considerations. The counties are required to provide funds or in-kind service, typically by establishing accurate locations for water wells. The construction records of water wells are a fundamental data source that describe subsurface conditions, and also tell us where the population is obtaining water.

Atlases enhance natural resource management and regulation, and facilitate wise use of water resources. They support water management activities for sustainable water use and protection and improvement of water quality such as: permitting, land use planning, wellhead protection, remediation, nutrient management, monitoring, modeling, and well construction. Atlas information is used by citizens, local government, counties, and state agencies (SWCDs, MDH, DNR, MPCA, Ag). The atlases document existing conditions so that changes in the water system can be recognized and evaluated. A User's Guide to geologic atlases supports and educates users of all backgrounds.

This project continues an effort to provide county geologic atlases statewide. The first atlas was initiated in 1979. Funding from ENRTF in the early 1990s and from 2007 to the present has greatly accelerated production (see attached map). At this time 55 of the 87 counties (63%) have a completed Part A atlas or a project underway (40 complete including 4 revised and 15 underway including 2 revisions). Total funding of about \$16,500,000 (aggregate from all sources) would achieve statewide coverage. We are currently capable of creating atlases at a rate of about 5 per year.

This project originally requested \$4,121,625 to accomplish the equivalent of 10 county atlases. The award is 30% of the request, and the project will now accomplish the equivalent of 3 atlases. The term equivalent is used because these funds will finish some atlases already underway, and some that are started will not be complete at the end of the grant.

II. OVERALL PROJECT STATUS UPDATES:

First Update December 21, 2018

Please note the change in project manager from Dale Setterholm to Barbara Lusardi was approved by Becca Nash in an e-mail message dated December 5, 2018. We have only recently transitioned from the 2017 grant. Under the 2018 grant, work continues on pre-existing projects in St. Louis, Lake, Kandiyohi, Aitkin, Rock, Nobles, Steele, Pennington, Lac Qui Parle, Otter Tail, Lincoln and Pipestone counties, and new projects have been initiated in Yellow Medicine and Cook counties. Work is progressing in Olmsted, Dodge, and Dakota counties on non-ENRTF funding. We expect to finish work in Kandiyohi, Dodge and Olmsted counties in the period ahead. In St. Louis and Lake counties we have open-filed completed subproject products so that they can be used immediately. The bedrock map for St. Louis County is being compiled and completed this year with federal cost-sharing. The bedrock map for Lake County will likely follow in the year after (under a new federal grant.) Glacial mapping in these counties is about two-thirds complete. A rotary sonic drilling program has been completed in

the southwestern portion of the St. Louis and Lake project area, and in Aitkin and Steele counties. Due to the timing of the transition from the 2017 grant, a large portion of this year's drilling contract and drilling supplies were applied to this 2018 grant. Thus, we have already exceeded the estimated budget in the equipment/tools/supplies category (an amendment requesting reallocation will come at a later date). Drilling generally marks the culmination of field operations and a shift from geology at the land surface to subsurface elements. This marks about two-thirds completion of an atlas. Work on the subsurface elements is nearly complete in Kandiyohi County, is underway in Rock and Nobles counties, and is just getting started in Steele and Aitkin counties. Field work will continue next spring in Pennington, Otter Tail, Lac Qui Parle, Lincoln and Pipestone counties. In the new project areas—Yellow Medicine and Cook counties—the focus is on the water well database and surficial geology.

Amendment Request of 1/16/19:

Due to the timing of the transition from the 2017 grant, a large portion of this year's drilling contract and drilling supplies were applied to this 2018 grant. Thus, we have already exceeded the estimated budget in the equipment/tools/supplies category. We would like to amend the plan transferring \$5,319 from Professional/Technical/Service contracts to Equipment/Tools/Supplies to cover the overage. This will leave a small balance in the Equipment/Tools/Supplies category to cover expenses through the beginning of the field season. The Professional/Technical/Service Contracts category is money we use for drilling. We will not incur additional drilling costs until late in the year, at which time we will assess our budget needs based on the projects that are ready to start drilling, and what additional funding sources become available in the next fiscal year.

Amendment Approved by LCCMR 2/1/2019

Second Update June 30, 2019: The Kandiyohi County Geologic Atlas is complete. At this time bedrock and surficial mapping in Lake and St. Louis counties is about 75% complete. Good progress has been made on associated databases. Federal cost-sharing has been applied to this work each year. Effort on Olmsted and Dodge counties have been shifted to another funding source, and both should be complete by the end of the summer. In Aitkin County, the bedrock map is nearly ready for review; the bedrock topography is about 75% complete. The Aitkin surficial map is nearly complete, and work on the cross sections and sand models is underway. For the Rock and Nobles CGAs the bedrock maps are about 85% complete and the bedrock topography is nearly ready for review. The surficial geology for both counties is complete, and the work on the cross sections and sand models is underway. Similarly, in Steele County all bedrock and surficial maps are near completion and work on the cross sections and sand models is underway. The work in Pennington, Lac Qui Parle, Lincoln and Pipestone, and Ottertail counties is still in the early stages with mostly field work underway to support maps. We will conduct rotary sonic drilling in all of these counties (underlined) starting this fall. New atlases have started in Yellow Medicine, Cook, Chippewa, Polk, and Red Lake counties. Red Lake County is being funded by Clean Water funds.

Amendment Request of 6/30/19:

Apparently my increased estimate for Equipment/Tools/Supplies was not quite enough to cover the expenses necessary at the beginning of the field season. In addition, we have initiated work in several new counties, which also require supplies to get started. I do not anticipate that this award will last beyond the calendar year, and based on the schedule of our current atlas projects it is unlikely that we will expend much, if any, in the way of printing costs. So, I would like to propose that we transfer the majority of those funds to other categories, including Personnel, Professional/Tech/Service Contracts (Drilling), and Equipment/Tools/Supplies, which will continue to incur expenses.

Amendment Approved by LCCMR 7/15/2019

Third Update December 26, 2019: Dodge County is at the printers. Olmsted County is in final production and should be ready to print within the next 3 months. Both Dodge and Olmsted counties are funded in part by Clean Water Funds. Rock and Nobles counties are in editing and should be ready for printing within the next 6 months or so. Work continues on St. Louis, Lake, Steele and Aitkin counties. All field work is complete. We are currently processing and interpreting data as well as drawing maps and cross sections. Elements of these atlases require at least another year of effort before they will be ready for editing and production. Rotary sonic drilling in Pennington, Lac Qui Parle, Otter Tail, and Dakota counties started this fall and will be complete early next year. Drilling is funded in part by the Department of Natural Resources and Clean Water Funds. Geochemistry of till samples is now a regular part of our analysis. We have submitted nearly 400 samples from cores taken last Spring. These data will help us better understand how subsurface aquifers are distributed and potentially interconnected. Invoices for this work, as well as for 16 OSL samples have not yet been received. Work in Lincoln, Pipestone, Yellow Medicine, Cook, Chippewa, Polk, and Red Lake counties is in various stages of completion. Lincoln and Pipestone are further along while other counties have just finished their first field season. New counties that have just signed on for an atlas include Douglas, Grant, Faribault, Waseca, and Lake of the Woods. Well locating is underway in these counties. Field work won't start until later next year.

Amendment Request of 12/26/19 (modified 3/4/2020):

As anticipated, the bulk of this award will be spent by the time of this report. Because we have already initiated contracts for professional services (drilling and geochemical analyses) under this award, we have already started to transition our other spending (equipment/tools/supplies and travel) to another award. We will also not be in a position to print any atlases before this award is spent. Therefore, we would like permission to reallocate the remaining funds in each of those categories to cover remaining personnel and drilling costs.

Remaining funds in the following categories to be reallocated to Personnel (\$49,000) and Professional/Technical/Services (\$3,501):

- Professional/Technical/Service contracts (printing) \$20,000
- Equipment/Tools/Supplies \$14,489
- Travel \$18,012

TOTAL: \$52,502 (see Budget spreadsheet for revised budget activities).

In addition, it has recently come to my attention that LCCMR funds should not be used for out of state travel expenses. This has never been a problem for us before, but with our current work in northwestern Minnesota, we have been negotiating the use of the core library in Grand Forks, North Dakota to store and log our cores. This is a tremendous cost and safety benefit as it reduces the need for our staff drive back and forth between distant field sites and our offices in St. Paul. The core can be dropped off generally within an hour of the drill site instead of driving 6 hours (one way) to bring it here. The core library, part of the North Dakota Geological Survey, has graciously allowed for us to log the cores at their facility as well. This provides a wonderful avenue for collaboration between our state surveys. Unknowingly, our staff members stayed on the North Dakota side of the border during this field excursion. We therefore request that \$833 in Minnesota travel expenses be reallocated to cover the expenses incurred out of state.

Amendment Approved by LCCMR 03/09/2020

Fourth Update June 23, 2020

Both Dodge and Olmsted counties are printed and complete. Rock and Nobles counties are in editing and should be ready for printing within the next 3 months or so. Work continues on St. Louis, Lake, Steele and Aitkin counties. All field work is complete. We continue to process and interpret data as well as draw maps and cross sections. Elements of these atlases require at least another year of effort before they will be ready for editing and production. Rotary sonic drilling in Pennington, Lac Qui Parle, Otter Tail, and Dakota counties is complete and analysis of the cores is underway (description, sampling, analyses for texture and grain counts). Geochemistry of till samples is now a regular part of our analysis. Once the samples from these cores have been

interpreted, we will select samples for geochemical analyses. Work in Lincoln, Pipestone, Yellow Medicine, Cook, Chippewa, Polk, and Red Lake counties is in various stages of completion. We hope to do rotary sonic drilling in several counties this fall. Depending on the available budget these counties may include: Lincoln, Pipestone, Yellow Medicine, Chippewa, Polk and Red Lake. New counties that are just getting underway include Douglas, Grant, Faribault, Waseca, and Lake of the Woods. Well locating is underway in these counties. Field work is slowing getting started as much as COVID travel and distancing guidelines permit.

Amendment Request of 06/23/2020

There are always a few remaining charges that come through the system as the award is spent down. In this case, one of the rental trucks that was used for rotary sonic drilling in the fall was mistakenly reserved under this older budget number instead of the new award. Because the drilling extended well into the new year, we did not get the invoice until after the last amendment was approved. In order to offset the additional travel expense as well as the small overage from drilling, we would like permission to reallocate funds from the geochemistry category. All new geochemistry studies will be charged to the 2019 award.

- Remaining funds in Professional/Technical/Service contracts (geochemistry) \$14,900 to be reallocated to Professional/Technical/Services (\$447) and Travel-MN (\$14,453)

TOTAL: \$14,900 (see Budget spreadsheet for revised budget activities).

Amendment Approved by LCCMR 7/9/2020

Sound bite of Project Outcomes and Results

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A Geologic Atlas provides the geologic framework of our state. It describes the materials and features at the land surface and extends all the way down to the bedrock surface. An atlas provides information useful for resource management and land-use planning. Each Atlas typically requires more than 7,000 person-hours of work. Some of that work is in the field: drilling test borings, examining, sampling, and describing outcrops. Much of the work follows after: interpreting field measurements, recognizing and formally naming geologic units described in well records, and making maps. The result is a detailed account of the distribution and properties of the rock and sediment that lie below the land surface. These materials, and their ability to store or transmit water, determine where we can find water, and how we can protect and make wise use of that water. This includes our lakes and rivers as well as groundwater.

As part of this 2018 award, we completed Kandiyohi County, started work in Cook, Yellow Medicine, Polk and Chippewa counties, and continued working in 11 other counties. We’ve described hundreds of outcrops, taken thousands of hand samples, and drilled nearly 30 continuous cores allowing us to sample rocks and sediment up to 325 ft deep.

We completed the equivalent of about 4 atlases with the ML 2018 funds, which were exhausted in one year of spending. This represents a higher number of atlases completed than our average of 5 atlases a year with all (CWF, DNR, and ENRTF) funds combined.

Continuing under the M.L 2019 award, atlases for Rock and Nobles counties will be complete within the next 3 months. Aitkin, St. Louis, Lake, and Steele counties should be finished within the next 12-18 months. The County Geologic Atlas program began in 1981 and continues with support of the Environment and Natural Resources Trust Fund as well as the Clean Water Fund, the Department of Natural Resources, and the U.S.

Geological Survey. To date we have completed atlases for 43 counties, 23 are underway; and 21 have yet to be started. All of our mapping products and data are available in print or digital format.

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Initiate about 1 new county geologic atlas; continue existing projects- equivalent of about 3 atlases total.

Description: Current atlas projects in St. Louis, Lake, Steele, Aitkin, Rock, Nobles, Kandiyohi, Pennington, Lac Qui Parle, Lincoln, Pipestone, and Otter Tail counties are those most likely to need funding from this grant to sustain progress. If DNR funding is withdrawn Olmsted and Dodge atlases will also need support.

Atlases begin with compilation of a database of subsurface information including well records. The local project partner establishes accurate digital locations for these wells. Concurrently, geologists visit the project area to describe and sample landforms, and exposures of rock or sediment. An initial assessment of the geologic data is then completed to focus additional data gathering including shallow and deep drilling programs and geophysical, geochemical, and geochronologic surveys. Analysis of the data set is then completed and maps and associated databases are formalized and prepared for use in geographic information systems and distribution via DVD and web. Most of the products are also printed for use in the field, and by users who prefer this format. The number of counties we can map with these funds will be affected by the size, geologic complexity, and data availability of the counties that are chosen.

ENRTF BUDGET: \$1,240,000

Outcome	Completion Date
1. Completion of atlases initiated on prior grants (see list above). Some may not be completely finished by this date.	June 30, 2021
2. Continuing digital release of geologic mapping and databases for subproject areas of the Lake and St. Louis project. The series of subprojects that cover parts of these counties allows us to put more people on the job with fewer delays. This will also allow us to complete and digitally publish subproject maps much sooner than maps of the entire county.	all bedrock products open-filed by 1/1/2018. Quaternary products by 12/2020.
3. Progress on new atlas projects (mapping and associated databases). New projects have been initiated in Pipestone, Lincoln, Lac Qui Parle, Otter Tail, and Cook counties. Discussions are underway with other counties likely to pursue atlas projects. We especially pursue those where water sensitivity, population, growth, water growth, or other management issues are present.	June 30, 2021

First Update December 21, 2018

Kandiyohi County geologic atlas is nearly complete and will be printed in this next period. Work continues on existing atlas projects in St. Louis, Lake, Aitkin, Rock, Nobles, Steele, Pennington, Lac Qui Parle, and Otter Tail counties. Cook County is establishing locations for wells, Mille Lacs is considering initiating a project, and Yellow Medicine County has signed an agreement and is starting the well location work.

Second Update June 28, 2019:

The Kandiyohi County Geologic Atlas is complete. At this time bedrock and surficial mapping in Lake and St. Louis counties is about 75% complete. Field work is essentially complete for both the bedrock and surficial. We are using federal funds to cost-share the compilation of the mapping into one map for each county. In Aitkin County, the bedrock map is nearly ready for review; the bedrock topography is about 75% complete. The Aitkin

surficial map is nearly complete, and work on the cross sections and sand models is underway. For the Rock and Nobles CGAs the bedrock maps are about 85% complete and the bedrock topography is nearly ready for review. The surficial geology for both counties is complete, and the work on the cross sections and sand models is underway. Similarly, in Steele County all bedrock and surficial maps are near completion and work on the cross sections and sand models is underway. The work in Pennington, Lac Qui Parle, Lincoln and Pipestone, and Ottertail counties is still in the early stages with mostly field work underway to support maps. We will conduct rotary sonic drilling in all of these counties (underlined) starting this fall. New atlases have started in Yellow Medicine, Cook, Chippewa, Polk, and Red Lake (non-ENRTF funded) counties.

Third Update December 26, 2019

Dodge County is at the printers. Olmsted County is in final production and should be ready to print within the next 3 months. Rock and Nobles counties are in editing and should be ready for printing within the next 6 months or so. Work continues on St. Louis, Lake, Steele and Aitkin counties. All field work is complete. We are currently processing and interpreting data as well as drawing maps and cross sections. Elements of these atlases require at least another year of effort before they will be ready for editing and production. Rotary sonic drilling in Pennington, Lac Qui Parle, Otter Tail, and Dakota counties started this fall and will be complete early next year. Work in Lincoln, Pipestone, Yellow Medicine, Cook, Chippewa, Polk, and Red Lake counties is in various stages of completion. Lincoln and Pipestone are further along while other counties have just finished their first field season. New counties that have just signed on for an atlas include Douglas, Grant, Faribault, Waseca, and Lake of the Woods.

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Final Report Summary

As this is an ongoing project, many of the previous updates include efforts on County Geologic Atlases (CGA) funded by concurrent awards or partner agencies. This final update will outline activities that were undertaken specifically during the term of the M.L. 2018 award which we starting spending about October 2018 through January 2020. During this time, we completed the Kandiyohi CGA. This county was initiated in 2015 and was funded exclusively by the ENRTF 2015, 2017, and 2018 awards. Activities in the final months include compiling cross sections of the glacial sediments from which we can identify sand and gravel layers that may be potential aquifer resources. This is usually the last plate to be completed. It must then be reviewed, revised, edited, and prepared for publication. Once all the plates are finalized, we compile all of the digital files to DVD and post to our website.

In early 2019, we started work on 4 new counties including Cook, Yellow Medicine, Polk and Chippewa. In the early stages of a CGA, work is focused on locating water wells. This is done primarily by the county with training and assistance from the MGS staff. Water well records provide a description of the sediments and rock that the

driller encountered below the land surface. While not all records provide adequate information, the sheer volume of data makes this an invaluable resource for our mapping. Some time was spent doing field work—describing outcrops, taking hand samples, and drilling shallow soils borings. This work provides data that will be interpreted into the surficial map plate. Work continues on these counties under the new 2019 award. We are heading into our second field season for surficial mapping. Field work for bedrock mapping will also be underway soon. We hope to drill in Lincoln, Pipestone, Yellow Medicine and Chippewa counties later this Fall.

Over the past two years we have drilled in Steele, Pennington, Otter Tail, Lac Qui Parle, St. Louis, Lake, Aitkin, Rock and Nobles counties. The shallowest hole was only 67 ft and the deepest 325 ft. Samples from these cores are vital to our understanding of the subsurface geology. The texture and density of buried sediments allows us to interpret how quickly water can flow through these sediments. Geochemical analyses on these samples will help us correlate sediments across distances.

Cores from Pennington County were taken to the North Dakota core library in Grand Forks for storage and logging. This collaboration with the North Dakota Geological Survey was useful for both parties as their geologists were able to view and sample the cores and interact with our geologists. Being able to use their facility saved us travel time and expense.

We continued work on 11 counties that were started with funding prior to this 2018 award. These counties are in various stages of completion. Rock and Nobles counties are currently being reviewed and will be published within the next 3 months. In Rock and Nobles counties, we incorporated a new method of identifying sand bodies using geostatistics on water well data. The method is known to work in some areas, however, there is so little sand within the glacial sediments in the southwestern part of the state, that it was difficult to assess the usefulness of the technique in this case.

St. Louis, Lake, Steele, and Aitkin counties should be winding down within the next 12 to 18 months.

Cost sharing opportunities allow for us to stretch our funding dollars. We typically leverage funds from the United States Geological Survey (USGS) with elements of our CGA mapping. For the past couple of years, we have matched funding to complete bedrock mapping in St. Louis and Lake counties. This year, our match will be for both the surficial and bedrock mapping in Cook County.

The only real issue that has arisen is that the Lake Superior Band of Chippewa will not grant us access to tribal lands near Grand Portage in Cook County. While we have had many positive interactions with tribal nations throughout the state, this current situation has opened our eyes to the fact that our efforts may not welcome everywhere. We are currently investigating ways that we can better communicate who we are and what we do in case there is some misunderstanding of our intent or actions. We only wish to provide quality geologic information for everyone. We will, of course, abide by the wishes of tribal communities within the counties where we are working.

In terms of overall program outcomes, the CGA program has been operating for nearly 40 years. Over time, we have adapted our products to better respond to the needs of the citizens, communities, counties, and the state. Whereas our earliest atlases included the most basic paper maps, we now provide digital products that can be fully integrated into any GIS system. Counties can add our maps and data directly into their working projects. We also provide detailed subsurface data and interpretations that allow users to model groundwater flow, and to respond to the ever increasing problems of water quantity and quality. We are now able to answer questions that we didn't even know to ask 40 years ago. It is because of these advancements that we find ourselves being asked to update atlases for counties that were completed many years ago. The geology doesn't change, but with additional data and better techniques for analyzing and presenting those data, our understanding of the geology improves.

Our CGA mapping in Washington County (a recently updated atlas) is now being used to create a groundwater model that will be used to inform decisions regarding long-term drinking water supply options in the East metro.

IV. DISSEMINATION:

Description: Every atlas is produced in portable document format (PDF), as geographic information system files (GIS), and in printed form. The digital files are available as a DVD, and are also available from the University of Minnesota Digital Conservancy, and via link from the MGS web page http://www.mnms.umt.edu/county_atlas/countyatlas.htm. Each project culminates with a meeting held in the project area to present the results to the county staff, and any other interested parties. At these meetings the products are described, access to the products is explained, and examples of applications of the products to common resource management situations are demonstrated. The products of subprojects in St. Louis and Lake counties are being released in digital form immediately following technical review. When all the subproject areas are complete county-wide compilations will be created and distributed digitally and in print. The printed copies are shared with the county, who in turn can distribute them to libraries, schools, townships, and other agencies. They are also distributed by the MGS map sales office. Products are also made available to earth science teachers and other educators for classroom exercises. Atlas products are also displayed and explained at educational events for SWCD staff and onsite sewage treatment system contractors.

First Update December 21, 2018

Components of the St. Louis and Lake atlas products are being open-filed as they are completed for immediate use. When all components are complete they will be compiled and printed as atlas packages for each county. At that time a workshop will be held to introduce the products and demonstrate their applications. The Cass and Hubbard workshops will be held jointly as soon as agreement on a date is reached. A workshop for Hennepin will be scheduled.

Second Update June 28, 2019

Completed atlas products have been posted to the MGS website and linked to the University's Digital Conservancy:

Kandiyohi, C-46 (2019) < <https://conservancy.umt.edu/handle/11299/202737>>

Interim products that will become the St. Louis and Lake County Atlases are also available:

OFR-16-4 < <https://conservancy.umt.edu/handle/11299/183258>>

Completed atlas products have been posted to the MGS website and linked to the University's Digital Conservancy as noted above. PDF products as well as all of the related GIS data are available on these pages.

In addition, the MGS hosts an [Open Data Portal](#) on which many of our county geologic atlases are presented as "Story Maps" that allow for direct access of the data without any special software or interface.

The Hennepin County (LCCMR-17 funding) workshop was held on April 22 at the County Library in Ridgedale. An article about the atlas and related workshop was published by the [SWNewsMedia](#). Formal presentations for [Cass](#) and Hubbard counties (LCCMR-17 funding) were held on March 6 in Backus and Park Rapids, respectively. An update to the Cass County Board was held last summer and written up by the [Echo Journal](#).

Third Update December 26, 2019

The Dodge County atlas (LCCMR-17 funding) was published in December 2019.
Dodge, C-50 (2019) < <https://conservancy.umn.edu/handle/11299/211642>>

Components of the St. Louis and Lake atlas products are being open-filed as they are completed for immediate use. When all components are complete they will be compiled and printed as atlas packages for each county. Recent updates to the open –file page include: <https://conservancy.umn.edu/handle/11299/183258>

Northern Arrowhead Surficial Geologic Map (2019)
SE Arrowhead Quaternary Stratigraphy and Sand Distribution (2019)

In addition, the MGS hosts an [Open Data Portal](#) on which many of our county geologic atlases are presented as “Story Maps” that allow for direct access of the data without any special software or interface. New content is being added throughout the year including some state-wide [aeromagnetic data](#) that was supported by the LCMR back in the 1980s and 90s.

Representatives from MGS and DNR met with representatives of Lyon, Roseau, Lake of the Woods counties to discuss the CGA program. Lyon and Lake of the Woods have both agreed to move forward with an atlas.

Representatives from MGS and DNR participated in various field trips, meetings, and strategic planning sessions highlighting aspects of the CGA program and discussing geology and groundwater issues:

LCCMR field tour and strategic planning dinner in SE MN

LCCMR strategic planning luncheon in Minneapolis

Clean Water Council field trip to SE MN

Whitewater State Park Centennial field trip

Washington County-PFAS field trip

Fourth Update June 23, 2020

The Olmsted County atlas was published in April 2020.

Olmsted, C-49 (2020) < <https://conservancy.umn.edu/handle/11299/212007>>

Components of the St. Louis and Lake atlas products are being open-filed as they are completed for immediate use. When all components are complete they will be compiled and printed as atlas packages for each county. Recent updates to the open –file page include: <https://conservancy.umn.edu/handle/11299/183258>

In addition, the MGS hosts an [Open Data Portal](#) on which many of our county geologic atlases are presented as “Story Maps” that allow for direct access of the data without any special software or interface.

Dodge County Story Map < <https://storymaps.arcgis.com/stories/b9d876a3ae4e4bda9be245283b5c878c>>

Olmsted County Story Map < <https://storymaps.arcgis.com/stories/511dbfd7a5ce406b8b68bf635b23f81b>>

Representatives from MGS and DNR met with representatives of Ramsey, Swift, and Scott counties to discuss the CGA program. All have agreed to move forward with an atlas.

Final Report Summary

Every atlas is produced in portable document format (PDF), as geographic information system files (GIS), and in printed form. The digital files are available as a DVD, and are also available from the University of Minnesota Digital Conservancy, and via link from the MGS web [page https://cse.umn.edu/mgs/county-geologic-atlas](https://cse.umn.edu/mgs/county-geologic-atlas). Each project culminates with a meeting held in the project area to present the results to the county staff, and any other interested parties. At these meetings the products are described, access to the products is explained, and examples of applications of the products to common resource management situations are demonstrated. The products of subprojects in St. Louis and Lake counties are being released in digital form immediately following technical review. When all the subproject areas are complete county-wide compilations will be created and

distributed digitally and in print. The printed copies are shared with the county, who in turn can distribute them to libraries, schools, townships, and other agencies. They are also distributed by the MGS map sales office. Products are also made available to earth science teachers and other educators for classroom exercises. Atlas products are also displayed and explained at educational events for SWCD staff and onsite sewage treatment system contractors.

Kandiyohi, C-46 (2019) < <https://conservancy.umn.edu/handle/11299/202737>>

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Completed atlas products have been posted to the MGS website and linked to the University’s Digital Conservancy as noted above. PDF products as well as all of the related GIS data are available on these pages. In addition, the MGS hosts an [Open Data Portal](#) on which many of our county geologic atlases are presented as “Story Maps” that allow for direct access of the data without any special software or interface.

V. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview:

BUDGET ITEM (See "Guidance on Allowable Expenses")	AMOUNT
Personnel	\$ 975,195
Professional/Technical/Service Contracts (drilling \$160,263, printing \$0, analyses, \$16,100)	\$ 176,363
Equipment/Tools/Supplies	\$ 25,511
Travel	\$ 62,931
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 1,240,000

Explanation of Use of Classified Staff:

Total Number of Full-time Equivalent (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 25,000	Divide by 2,080 = TOTAL FTE: 12
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Total Number of Full-time Equivalent (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: not possible to calculate. Cost by foot, printed sheet, or analyses.	Divide by 2,080 = TOTAL FTE:
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B. Other Funds:

SOURCE OF AND USE OF OTHER FUNDS	Amount Proposed	Amount Spent	Status and Timeframe: July 2018 through June 2020

Other Non-State \$ To Be Applied To Project During Project Period:			
USGS STATEMAP cost share	\$ 200,000	\$ 196,652	St. Louis and Lake Counties bedrock mapping
USGS Great Lakes Mapping cost share	\$75,000	\$110,710	Dodge County Stratigraphy and drilling support (Pennington, Lac Qui Parle, Otter Tail, Dakota)
Other State \$ To Be Applied To Project During Project Period:			
Clean Water Funds	\$250,000	\$308,893	Dodge, Olmsted, Dakota, and Red Lake counties.
DNR contract	\$557,000	\$348,498	Dodge and Olmsted counties; Drilling support
Past and Current ENRTF Appropriation: see table below			

Funding Source and Use of Funds	M.L. 2007 or FY08-10	M.L. 2008 or FY09-12	M.L. 2009 or FY10-13	M.L. 2010 or FY11-14	M.L. 2011 or FY12-14	M.L. 2013 or FY14-16	M.L. 2015 or FY16-18	M.L. 2017 or FY 18-20
ENRTF Benton and Chisago	\$400,000							
ENRTF Blue Earth, Nicollet, Sibley		\$706,000						
ENRTF Anoka and Wright			\$820,000					
ENRTF Sherburne and Morrison and related research				\$1.13 mill.				
ENRTF Redwood, Meeker, Brown					\$1.2 mill.			
ENRTF Wadena, Hubbard, Becker						\$1.2 mill		
ENRTF St. Louis, Lake, Olmsted, Kandiyohi, Aitkin							\$2.04 mill.	
ENRTF Hennepin, Isanti, Cass, Rock, Nobles, Steele, Pennington,								\$2.0 mill.

Otter Tail, Lac Qui Parle, Lincoln, Pipestone								
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VI. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Under a separate workplan and budget DNR Waters and Ecological Services is receiving funds to work on Part B of County Geologic Atlases, and county partners will supply in-kind services.			

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

Final Report Summary

The County Geologic Atlas program has been underway for nearly 40 years. We have received consistent support from the Legislature and the LCCMR through the ENRTF since about 2007. Over the life of the program, we have completed 41 counties; 25 are currently underway (as of this report); and 21 have not yet been started. At our current level of funding from all sources, we are able to complete about 5 counties per year. If that pace continues, we envision that we will finish the 87th county within the next decade.

VIII. REPORTING REQUIREMENTS:

- The project is for 3 years, will begin on July 1, 2018, and end on June 30, 2021.
- Periodic project status update reports will be submitted December 31 and June 30 of each year.
- A final report and associated products will be submitted between June 30 and August 15, 2021.

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

- A. Budget Spreadsheet
- B. Visual Component or Map

FINAL Attachment A:
 Environment and Natural Resources Trust Fund
 M.L. 2018 Budget Spreadsheet



Project Title: County Geologic Atlases - Part A
 Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03a
 Project Manager: Barbara Lusardi (change approved 12/5/18)
 Organization: Minnesota Geological Survey, Univ. of Minnesota
 College/Department/Division: College of Science and Engineering
 M.L. 2018 ENRTF Appropriation: \$1,240,000
 Project Length and Completion Date: 3 years, June 30, 2021
 Date of Report: July 24, 2020

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget 07/09/2020	Amount Spent	Activity 1 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM					
Personnel (Wages and Benefits)					
Between 20 and 25 MGS staff (mostly geologists but also GIS, hydrogeologist, editor, database specialists, field assistants) will be assigned to work on geologic atlases on a part time basis; chosen based on the skill sets necessary for the geology of the selected counties. The total effort averages about 4 FTE per atlas or about 12 FTE for this proposal. The cost includes the University fringe benefits (27.2% to 33.5% depending on class).	\$975,195	\$975,195	\$0	\$975,195	\$0
Professional/Technical/Service Contracts					
Rotary-sonic test hole drilling (awarded by a competitive bidding process). Generally 4-6 holes per county. Rotary-sonic method yields 4" undisturbed core of unconsolidated deposits. Average hole cost is \$12,767 but varies with depth. Depth corresponds to depth of bedrock surface. Drilling costs are shared with support from our DNR contract (about one quarter) if that contract is viable.	\$160,263	\$160,263	\$0	\$160,263	\$0
Professional/Technical/Service Contracts					
Offset printing; awarded by competitive bid; typically 350 copies of each of 6 plates (each 3' by 3' and four color) per county, current prices about \$14,000 per county. Print run has been lowered as there are more online users, and we are exploring means to lower this further. This amount would cover about 3 counties.	\$0	\$0	\$0	\$0	\$0
Professional/Technical/Service Contracts					
Geochemical and geochronological analyses to support aquifer correlation and delineation; laboratories will be evaluated based on cost and capabilities in accordance with U of M purchasing rules. Contracts or bids as necessary. We anticipate about 665 geochem analyses (\$29,925) and 6 geochron analyses (\$6,000).	\$16,100	\$16,100	\$0	\$16,100	\$0
Equipment/Tools/Supplies					
Equipment/Tools/Supplies: Field and lab expendables (batteries, sample bags, replacement augers as needed (\$305 each), Giddings Probe repair parts, maps, core boxes (\$7.75 each, about 950 boxes per county, \$7,362 per county, \$22,088 total, core to Hibbing repository), distilled water)	\$25,511	\$25,511	\$0	\$25,511	\$0
Travel expenses in Minnesota					
Travel: vehicle rental from U Fleet Services as needed, typically on weekly basis, and mileage (approx. \$245 sedan rental, \$0.17 per miles, \$275 per week truck, \$0.37 per mile); meals (up to \$46 per day); lodging as per University regulations. Amounts cannot be calculated until project locations (counties, distances) are known.	\$62,098	\$62,098	\$0	\$62,098	\$0
Travel expenses out of state (NEW)					
Travel: meals (up to \$46 per day); lodging as per University regulations in Grand Forks, North Dakota (only for work in Polk County and from now on we'll stay in East Grand Forks, MN)	\$833	\$833	\$0	\$833	\$0
COLUMN TOTAL	\$1,240,000	\$1,240,000	\$0	\$1,240,000	\$0