Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2016 Work Plan

Date of Report: February 10, 2016

Date of Next Status Update Report: December 30, 2016

Date of Work Plan Approval: TBD

Project Completion Date: June 30, 2019

Does this submission include an amendment request? No

PROJECT TITLE: Protection of the State's Confined Drinking Water Aquifers—Phase 2

Project Manager: Jared Trost, Hydrologist

Organization: U. S. Geological Survey

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Location: statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$433,000**
	Amount Spent:	**$0**
	Balance:	**$433,000**

Legal Citation: M.L. 2016, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

I. PROJECT TITLE: Protecting the State's Confined Drinking-Water Aquifers

II. PROJECT STATEMENT:

This project completes an on-going LCCMR project to assess the quality and long-term availability of water from confined glacial drinking-water aquifers. This second phase will add two additional study sites that are needed to complete our understanding of the variability in the hydraulic properties of confining units and confined glacial aquifers throughout the state.

This project would focus on important questions about confining units and confined aquifers:

- What is the source of water replenishing confined aquifers?
- How long does it take water to move along the flow pathways?
- How much water moves along the flow pathways?
- What are the pathways for water and contaminant movement through confining units?
- What are best estimates of long-term sustainable pumping from confined drinking-water aquifers?
- How extensive and variable are confining units across the state?

Many glacial aquifers in Minnesota, used as sources of drinking water, are overlain by clayey glacial deposits (confining units, see visual elements). These confined aquifers are critical state resources because they provide the only sources of clean, reliable drinking water to tens of thousands of urban and outstate residents of Minnesota. The confining units overlaying confined aquifers are a vitally important part of aquifer systems because they form protective barriers for the confined aquifers from land-surface contamination. The confining units also, however, limit water flow (infiltration) to confined aquifers, so replenishing water in confined aquifers is a slow and limited process. We need to better understand the hydraulic properties of confining units to ensure sustainable use of water from these important drinking-water aquifers. This project will continue the assessment of the hydraulic properties of the state's important glacial confining units, such as the Des Moines and Superior lobe till confining units (see visual elements). Detailed, site-specific information about protective confining units will be measured at two additional study sites that represent the state's important confining units. The overall project is a collaborative effort among the U. S. Geological Survey (USGS), the Minnesota Geological Survey (MGS), and the Minnesota Department of Natural Resources, and the Minnesota Department of Health (MDH). It augments work completed by the County Geologic Atlas Program.
The project is a major step forward in protecting confined glacial aquifers by measuring the hydrogeological properties of these important aquifers. The work will result in a wide assessment of information about the aquifers. The project is needed to protect the quality of water in these units and to define the amount of water that can be pumped from confined aquifers (MDNR appropriation permit process) on a long-term and sustainable basis.

Problem: Confined glacial aquifers provide water to many residents in Minnesota. An important factor affecting the long-term sustainable availability of water from these aquifers is infiltration through overlying glacial till confining units. Few data exist, however, on the vertical hydraulic properties and infiltration rates through till. The lack of detailed infiltration and hydraulic data hinders the state's efforts to define the sustainability of confined aquifers. There is also a need to understand the regional variability of the properties of these confining units across the state.

It is important to protect confined drinking-water aquifers from non-sustainable over-pumping. To accomplish the goal of long-term sustainability, the sources, rates and quality of water infiltrating into confined aquifers must be understood. An important factor defining sustainable water use from confined aquifers is the rate of water movement (infiltration) through overlying confining units that replenish confined drinking-water aquifers. We currently lack information about infiltration to confined aquifers because infiltration depends upon the

hydraulic properties of the overlying confining units. Infiltration-rate information is needed to manage confined aquifers so that they are protected for the future. Although the MGS and MDNR have an active County Geologic Atlas Program, which maps the extent and thickness of protective confining layers, the program needs supplementary information about hydraulic properties and infiltration to confining units. Filling this gap in understanding is also required for the MDNR water appropriation-permit process to ensure long-term sustainability of water supply from confined aquifers. This project contributes toward filling that gap in information by providing detailed site-specific data about the confining units at two study sites that represent the state's most important confining units-- the Des Moines and Superior lobe till deposits (see visual elements). Direct field measurements will provide information needed to estimate the water-bearing and water-transmitting characteristics of these aquifers.

It also is important to protect confined drinking-water aquifers from contamination. The quality of water in confined aquifers is presumed to be protected by overlying confining beds. Confining units, composed of till, are assumed to provide protection to confined groundwater supplies because infiltration water passes more slowly through these confining units than through surficial sand-and-gravel aquifers. Because of the increased transport time and reduced infiltration through till, however, water that was contaminated, say 20 years ago, may not have yet reached underlying confined drift aquifers. Thus, there may be a delayed adverse response from human activities on groundwater quality Scattered and isolated information suggests that groundwater and contaminants can flow from land surface through confining units to confined aquifers at varying rates. Thus, there is a critical need to understand how confining units protect the water quality of confined aquifers. These concerns identify our need to better understand the state's two important confining units.

Benefits: Information on the spatial variability of hydraulic properties and groundwater infiltration rates through till is necessary to plan for long-term water sustainability. In addition, this hydraulic information is essential for the MDH's wellhead protection program and will improve our ability to accurately evaluate contributing areas and develop appropriate protection plans for wells completed in confined-drift aquifers, which are more complex than unconfined aquifers. Accurate simulation of infiltration through glacial till also is a critical component for calibrating groundwater flow models. Because accurate estimates of infiltration rates are lacking, model analyses must largely rely on inferred data or results of laboratory tests.

The proposed study will increase the MDNR's understanding of the role of till confining units in water supply and the hydrologic cycle, resulting in more appropriate management decisions in glacial drift areas. Results from the specific data-collection sites will be regionalized such that results will be beneficial in other areas of this state where data are lacking. The Minnesota Pollution Control Agency (MPCA) will benefit from the study by gaining a better understanding of the vulnerability and susceptibility of confined drift aquifers to contamination. By obtaining a better understanding of infiltration through glacial till, the Twin Cities Metropolitan Council, MPCA, and environmental consultant firms will be able to more accurately simulate groundwater movement in confined aquifers. Study results will provide the MGS, colleges, and universities with basic knowledge important to educating the public on basic science. Local water utilities, where the individual hydraulic tests will be conducted, will benefit directly from results of this study. By comparing various methods of estimating groundwater leakage, study results will be beneficial to future USGS studies of recharge and infiltration through confining units in other areas of the state and the country.

Scope and Objectives: This project will estimate the hydraulic properties of two of the state's important glacial confining units, such as the Des Moines and Superior lobe till confining units. The approach involves conducting two additional detailed field studies in areas representing different confining unit types. Study sites will be selected in areas with existing high-capacity pumping wells (likely municipal-supply wells) to understand how pumping stress affects water movement. Scientific bore holes will be completed in the confining units and into the underlying confined aquifers. Field analyses will include hydraulic, geophysical and chemical tests. These tests may include multi-well aquifer tests, single-well pump tests, geophysical logging (e.g. gamma, temperature, fluid resistivity measurements) and measures of water chemistry.

The location of the two sites has yet to be determined. Site selection and access permission is a significant part of this study and will take place when the study begins. Study-site selection will be a collaborative effort with the MDNR, MGS, and the MDH. Study sites are will be located near appropriate municipal production wells in areas with approved wellhead protection plans.

The specific objectives of the study are as follows:

1. Explore available information to select appropriate study sites representing the primary glacial confining units in the state.
2. Quantify the variability of hydrologic properties and infiltration through glacial confining units at two representative sites.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of December 30, 2016:

Project Status as of June 30, 2017:

Project Status as of December 29, 2017:

Project Status as of June 29, 2018:

Project Status as of December 31, 2018:

Project Status as of June 30, 2019:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Select sites for detailed study which represent the primary glacial confining units in the state. Construct scientific boreholes and hydraulic testing.

Description: Two additional field study sites will be selected for detailed hydrologic investigation. The sites will be located in two of three possible principal glacial confining units: the Des Moines lobe glacial till, the Superior lobe glacial till, or the Wadena lobe glacial till. Study sites will be identified and selected in consultation with staff from the MDH, MDNR, and the MGS. Study sites will be located near municipal water-supply wells that pump from confined glacial-drift aquifers where well-head protection plans have been approved by the MDH. At both study sites small-diameter observation well clusters, or piezometers, will be installed in the confined-drift aquifer, the confining unit overlying the confined aquifer, and in the surficial unconfined-drift aquifer. Two well-nest installations will be located at each of the two study sites. One well cluster at each study site will be located in proximity to the municipal water-supply well. The second well-cluster at each study site will be located at some distance from the municipal-supply wells. The exact locations of the well nests will be determined after the study sites are selected. Well nest placement will be based on local site and access conditions and on results of preliminary groundwater modeling simulation of local groundwater pumping and hydrologic settings. Observation wells (completed in aquifers) and piezometers (completed in confining units) will be planned and sited during the first six months of the study. Wells and piezometers will be installed in the summer of 2017. Observation wells and piezometers will be installed in scientific boreholes after geophysical testing of the

boreholes is completed. Pressure transducers will be installed in observation wells and piezometers to continuously measure water levels and hydraulic head over the duration of the study. Water levels and hydraulic heads will be measured in wells and in piezometers for the duration of the study. In a subset of the wells, water levels and hydraulic heads will be continuously monitored and archived in the USGS data base. Identification of well sites and piezometer-nest locations will involve a considerable amount of time and effort to ensure that the sites represent conditions typical for the primary confining units of the state. Much of the cost for this activity is for contact drilling. The MGS contract, for both activities, will be completed for $20,000. This includes assistance for site selection, field logging, core descriptions, borehole geophysics, textural and stratigraphic analysis, archiving of drilling cores, and preparation of a summary report.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 260,100
Amount Spent: $ 0
Balance: $ 260,100

Activity Completion Date: September 2017

Outcome	Completion Date
1. **Identify 2 study sites in different principal glacial confining units**. At each study site, locate positions for 2 well nests near existing high-capacity municipal pumping wells. Sites will be selected based on input from the MGS, MDNR and MDH. Selection will be from municipal wells with well-head protection plans in place and based on evaluation of local geological conditions.	**October 2016**
2. **Obtain site access and site-use permission.** Obtain drilling permits and well variances if needed. Meet with city officials. Travel and reconnaissance of potential sites.	**December 2016**
3. **Install boreholes and instrument sites for hydraulic, geophysical and chemical tests to define hydraulic properties of confining units.** Install 4 to 6 observation wells or piezometers per nest (totaling 16-24 wells) using a contract driller. Conduct geophysical surveys of boreholes. Install pressure transducers and water level recording equipment at least 12 wells. Measure, record and archive water levels in USGS databases. Much of the cost for this activity is contract drilling. Field logging, core descriptions, borehole geophysics, textural and stratigraphic analysis, core archiving, and geologic report preparation will be completed by MGS.	**June 2019**

Activity Status as of December 30, 2016:

Activity Status as of June 30, 2017:

Activity Status as of December 29, 2017:

Activity Status as of June 29, 2018:

Activity Status as of December 31, 2018:

Activity Status as of June 30, 2019:

Final Report Summary:

ACTIVITY 2: Conduct hydraulic, physical, geophysical and chemical testing of aquifers and confining beds. Analyze data from tests at each of two sites to determine hydraulic and hydrogeological properties of confining beds and aquifers at each of two study locations using computer simulations.

Description: Activity 2 will be conducted during the second and third years of the study. This activity is focused on defining hydraulic and hydrogeological properties of two of the state's most important confining units. The approach is to conduct two detailed field tests-- one in each of two areas that represent a principal confining unit in the state. The field study sites will be located adjacent to existing high-capacity municipal pumping wells to observe how pumping stress affects water movement based on properties of the confining beds. Scientific bore holes are being completed in and through the confining units and aquifers to collect the required data. Field analyses will include hydraulic, geophysical and chemical tests and conceptual groundwater modeling. These tests will include aquifer tests, geophysical logging (e.g. gamma, temperature, and fluid resistivity) and measures of water chemistry.

This activity is focused on testing and analyses of local hydraulic and hydrogeological properties to determine infiltration rates and physical properties of confining units and aquifers. Geophysical, geotechnical, isotopic, chemical and hydraulic testing at each site will be conducted. These properties of the confining beds will include infiltration and leakage rates, grain-size and soil texture, vertical and horizontal hydraulic conductivity, and hydrologic storage. Geologic, geophysical and water chemistry samples are being collected from boreholes and observation wells installed for the study. Hydraulic-head data from piezometers and observation wells completed in aquifers and confining beds will be analyzed based on the hydraulic responses to pumping. Water levels will be measured continuously in some observation wells using pressure transducers and data loggers. Vertical hydraulic conductivity and infiltration rates will be estimated for the confining units based on analytical techniques and on results from hydrologic models at each of the sites, under pumping conditions measured in underlying and overlying aquifers. The rates of infiltration to confined aquifers also will be determined using environmental tracers such as chlorofluorocarbons, sulfur hexafluoride, or tritium by measuring vertical profiles of these environmental tracer concentrations through the confining units. The average rates of infiltration also will be computed based on the vertical gradient of water movement through the confining unit. Test and observations should prove useful in evaluating the effects of till weathering and fracturing. Site-scale groundwater flow models will be used to simulate individual hydraulic tests and to test hypotheses regarding recharge through till. A USGS Scientific Investigations Report will be published. The report will summarize the project, the data collected during the project and the results of the analyses of data collected from the project.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 172,900
Amount Spent: $ 0
Balance: $ 172,900

Activity Completion Date: September 2019

Outcome	Completion Date
1. **Conduct hydraulic, geotechnical, geophysical and isotopic tests at the 2 study sites to determine hydraulic properties of aquifers and confining units.** Includes aquifer tests on at least 16 of the monitoring wells and piezometers, groundwater sampling and chemical analyses.	October 2017

2. **Analyze and interpret hydraulic test and geochemistry data to define hydraulic properties and infiltration rates at each study site**	December 2017
3**. Conduct conceptual groundwater modeling of pumping responses to further quantify aquifer and confining bed properties**	May, 2019
4. **Prepare report manuscript and obtain USGS publication approval.**	September, 2019
5**.Seal and abandon test wells according to state well code**	September, 2019

Activity Status as of December 30, 2016:

Activity Status as of June 30, 2017:

Activity Status as of December 29, 2017:

Activity Status as of June 29, 2018:

Activity Status as of December 31, 2018:

Activity Status as of June 30, 2019:

Final Report Summary:

V. DISSEMINATION:

Description: Project milestone results will be communicated to LCCMR staff and to project partners with semi-annual written results. Final results from the project will be presented at a scientific conference and through the publication of a USGS Scientific Investigations Report. The final report will be delivered by December 31, 2019

Status as of December 30, 2016:

Status as of June 30, 2017:

Status as of December 29, 2017:

Status as of June 29, 2018:

Status as of December 31, 2018:

Status as of June 30, 2019:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel:	$195,900	studies chief at 3 % FTE for 3 years ($12,900); project chief at 18 % FTE for 3 years ($49,800); support hydrologist at 17 % FTE for 3 years ($35,700); hydrologic technician at 17 % FTE for 3 years ($38,200); student technician at 10 % FTE for 3 years ($12,700); groundwater technical specialist at 1 % FTE for 3 years ($5,000); water quality technical specialist at 1 % FTE for 3 years ($4,000); spatial analysis and modeling technical specialist at 1 % FTE for 3 years ($4,600); database manager at 1 % FTE for 3 years ($3,700); 2 IT technicians at 2 % FTE each for 3 years ($11,900); 2 administrative assistants at 1.7% FTE each for 3 years ($12,500); contract administrator at 1.7 % FTE for 3 years ($4,900);
Professional/Technical/Service Contracts:	$199,300	Minnesota Geological Survey (MGS) support of glacial geologic interpretation and well siting. The MGS contract, includes assistance for site selection, field logging, core descriptions, borehole geophysics, textural and stratigraphic analysis, archiving of drilling cores, and preparation of a summary report.($20,000) Drilling contracts: drilling, well installation, well sealing, and abandonment TBD through competitive bid ($150,000) Groundwater data collection and data processing and archival in USGS database--internal USGS subcontract ($16,800) Contract for chemical analyses of water samples at USGS laboratories.($6,500) Reports: USGS contract feel for USGS report preparation, editing and production (Science Publishing network- This includes electronic publishing and distribution of report products ($6,000)
Equipment/Tools/Supplies:	$14,200	Field supplies and data collection: pumps, pressure transducers, electronic recording devices, well packers, well casing, and shelters.
Travel Expenses in MN:	$22,100	Mileage ($4,100), lodging ($11,600), meals ($6,400)
Other: See detailed budget	$ 1,500	Postage and shipping
TOTAL ENRTF BUDGET:	**$ 433,000**	

Explanation of Use of Classified Staff: NA

Explanation of Capital Expenditures Greater Than $5,000: NA

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 2.3

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 2.2 (estimated)

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state: (USGS matching funds)	157,430	0	30% of direct and indirect costs minus exempted contract costs. Covers indirect project costs.
TOTAL OTHER FUNDS:	$157,430	$ 0	

VII. PROJECT STRATEGY:

A. A. Project Partners: U. S. Geological Survey, Minnesota Geological Survey, Minnesota Department of Natural Resources, Minnestoa Department of Health

P**roject Team/Partners**

B.

Name	**Affiliation**	**Role**
James Walsh *	Minnesota Department of Health	Site selection—Site selection support
Steve Robertson *	Minnesota Department of Health	Site selection support
Jared Trost	United States Geological Survey	Project Chief
Andrew Berg	United States Geological Survey	Drilling support and data collection
Studies Section Chief	United States Geological Survey	Project Management
Angela Hughes	United States Geological Survey	Administrative Support
Jim Berg*	Minnesota Department of Natural Resources	Site selection support
Tony Runkel*	Minnesota Geological Survey	Glacial Stratigraphy-Hydraulic testing, Reporting
Bob Tipping	Minnesota Geological Survey	Glacial stratigraphy- Hydraulic testing, Reporting

* Participation as collaborator and advisor not receiving ENRTF funding

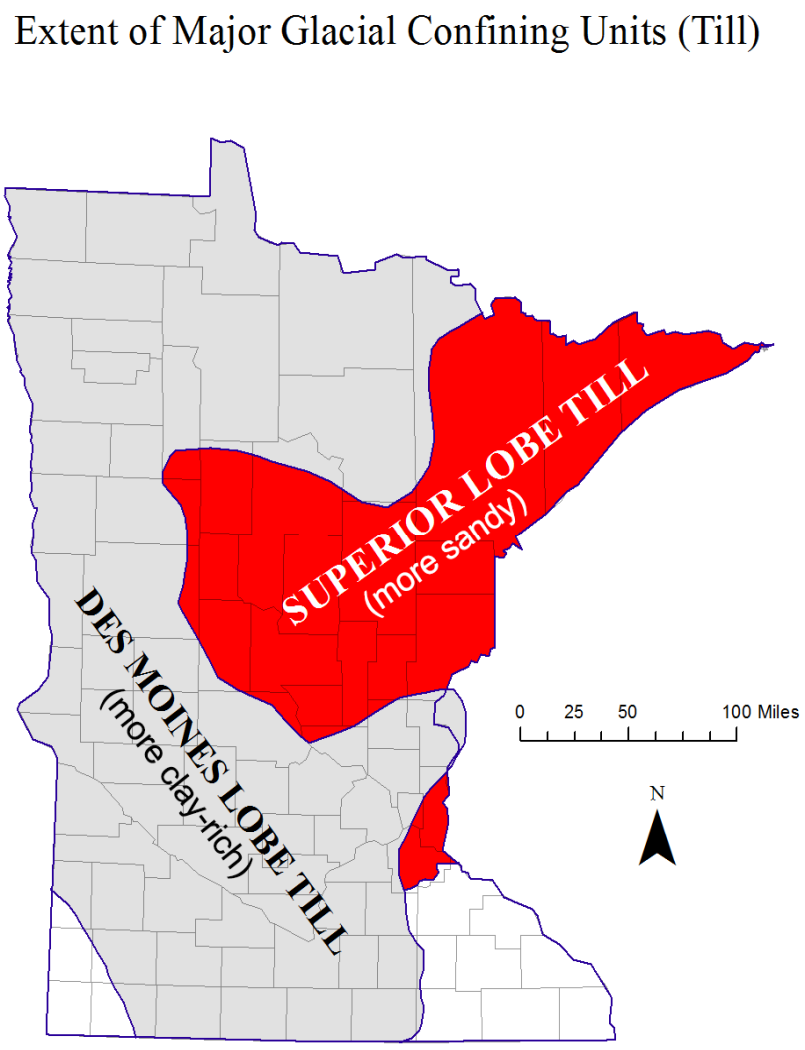
Project Impact and Long-term Strategy: This project provides critical information for sustainable management of Minnesota's groundwater resources. The project complements and augments work being done by the County Geologic Atlas Program (MGS and MDNR) and fits with MDNR's planned changes to MDNR water appropriation-permit program. The project fulfills strategic directions for understanding water budgets described in the University of Minnesota's Water Sustainability Framework. The project represents a major step toward defining the hydrogeological properties of the important protective Des Moines and Superior confining till units throughout the state. The project is similar to an ongoing LCCMR project focused on confining properties of the St. Lawrence bedrock confining unit.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
ENRTF funding—phase 1, M.L. 2014, Chp. 226, Sec. 2, Subd. 03h	2014-2017	$ 394,000
USGS marching funds	2014-2017	$ 96,000

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS: NA

IX. VISUAL COMPONENT or MAP(S):



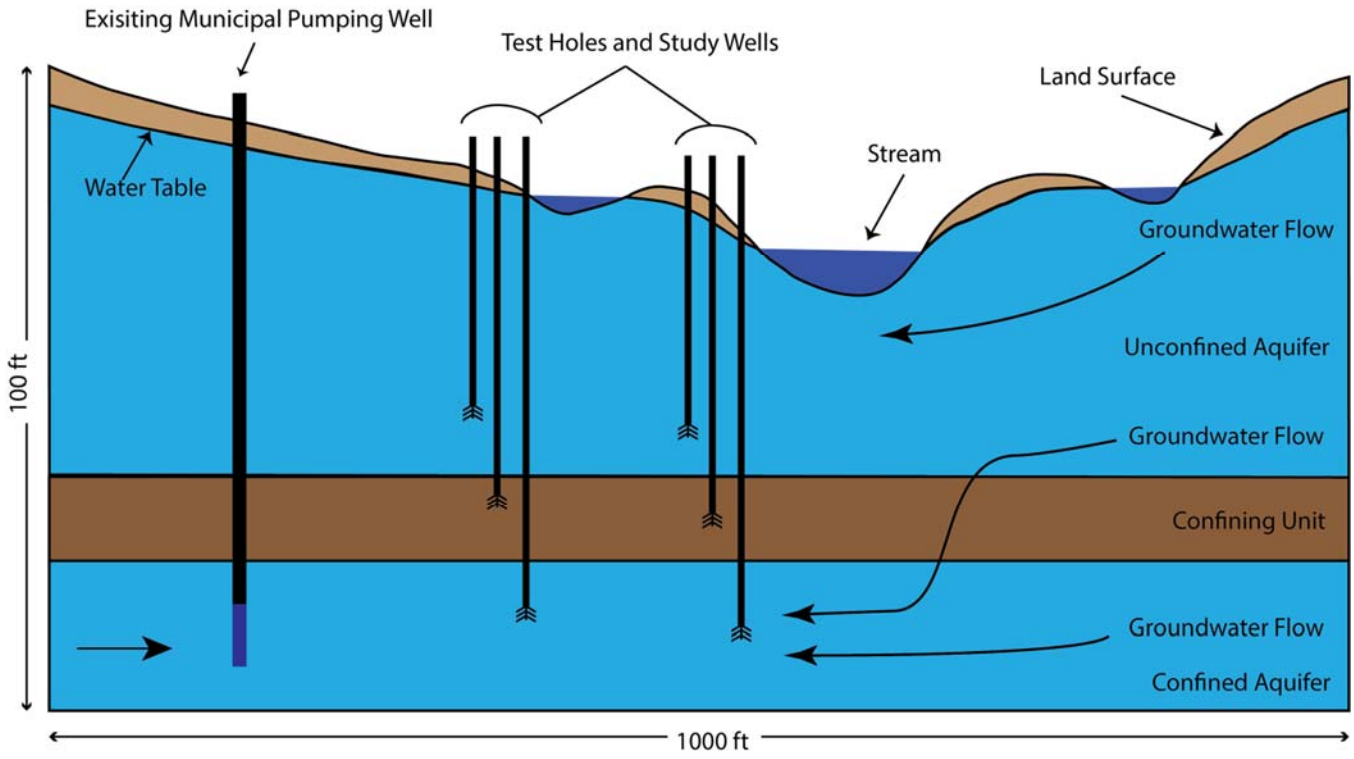


Figure 2. Expected well and piezometer installation site plan

X. RESEARCH ADDENDUM: A detailed proposal is being prepared and will be reviewed and revised according to USGS policy. The approved proposal will then be added to this document. The expected date of proposal approval is February 15, 2016.

Status as of December 30, 2016:

Status as of June 30, 2017:

Status as of December 29, 2017:

Status as of June 29, 2018:

Status as of December 31, 2018:

Status as of June 30, 2019:

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than: December 30, 2016, June 30, 2017, December 29, 2017, June 29, 2018, December 31, 2018, and June 30, 2019. A final report and associated products will be submitted to the USGS review process between June 30 and September 15, 2019. The expected date of published final report is expected to be December 30, 2019.

Environment and Natural Resources Trust Fund

M.L. 2016 Project Budget

Project Title: Protection of the State's Confined Drinking Water Aquifers—Phase 2

Legal Citation:

Project Manager: Jared Trost

Organization: U. S. Geological Survey

M.L. 2016 ENRTF Appropriation: $*433,000*

Project Length and Completion Date: ***3 Years, June 30, 2019***

Date of Report: December 4, 2015

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Fill in your activity title here.***			***Fill in your activity title here.***				
Personnel (Wages and Benefits)	$62,300	$0	$62,300	$133,600	$0	$133,600	$195,900	$195,900
Investigation's Section Chief (Studies Chief): (72% salary, 28 % benefits): 3 % FTE each year for 3 years ($12,900)								
Jared Trost (project chief- hydrologist): (71% salary, 29% benefits): 18% FTE each year for 3 years ($49,800)								
USGS Hydrologist (hydrologist): (71% salary, 29% benefits): 17% FTE each year for 3 years ($35,700)								
Richard Kiesling (Water Quality Technical Specialist): (78 % salary, 22% benefits): 1 % FTE each year for 3 years ($4,000)								
Melinda Erickson (Groundwater Technical Specialist): (73 % salary, 27 % benefits): 1 % FTE each year for 3 years ($5,000)								
Chris Sanocki (Spatial Analysis and Modeling Technical Specialist): 73 % salary, 27 % benefits): 1 % FTE each year for 3 years ($4,600)								
Andrew Berg (hydrologic technician): (73% salary, 27 % benefits): 17% FTE each year for 3 years ($38,200)								
student employee (hydrologic technician): (80% salary, 20 % benefits): 10% FTE each year for 3 years ($12,700)								
Tim Cowdery (database administrator):(73 % salary, 27 % benefits): 1% FTE each year for 3 years ($3,700)								
2 IT specialists: (72% salary, 28 % benefits): 2 % FTE each person each year for 3 years ($11,900)								
2 administrative assistants:(73% salary, 27 % benefits): 1.7% FTE each person each year for 3 years ($12,500)								
Lisa Syde-Hagen (Contract administrator) (72 % salary, 28 % benefits): 2 % FTE each year for 3 years ($4,900)								

Professional/Technical/Service Contracts								
Professional/Technical/Service Contracts: Contracted drilling services. Competitive bid. Cost is an estimate. Includes the installation of wells and piezometers and well abandonment.	$140,000		$140,000	$10,000		$10,000	$150,000	$150,000
Professional/Technical/Service Contracts: Minnesota Geological Survey (MGS). Technical support for description and interpretations of geological materials from drill sites. Includes $2,100 in travel expenses	$13,900		$13,900	$6,100		$6,100	$20,000	$20,000
Professional/Technical/ Service Contracts: USGS contract fee for water-level data collection, data processing and data-base maintenance and data quality control.	$16,800		$16,800				$16,800	$16,800
Professional/Technical/ Service Contracts: contract fee for chemical analyses of water samples at USGS laboratories.	$0			$6,500		$6,500	$6,500	$6,500
Professional/Technical/ Service Contracts: USGS contract fee for USGS report preparation, editing and production (Scientific Publications Network). This includes electronic publishing and distribution of report products.	$0			$6,000		$6,000	$6,000	$6,000
Equipment/Tools/Supplies								
Equipment/Tools/ Supplies: Miscellaneous field equipment and supplies for data collection. Includes pumps, pressure transducers, electronic recording devices, well packers, well casing and well screens	$11,100		$11,100	$3,100		$3,100	$14,200	$14,200
Travel expenses in Minnesota								
USGS travel to field sites and to local meetings; Includes expenses for presenting at local conferences, vehicles, and lodging and meals	$15,000		$15,000	$7,100		$7,100	$22,100	$22,100
Other Expenses								
Additional budget item: Expenses for shipping and laboratory expenses for MGS and USGS laboratories. Describe the expense—one row per type/category. Add rows as needed. Be specific.	$1,000		$1,000	$500		$500	$1,500	$1,500
COLUMN TOTAL	$260,100			$172,900			$433,000	$433,000