2008 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: South-Central Minnesota Groundwater Monitoring of the Mt. Simon Aquifer
PROJECT MANAGER: James a. Berg
AFFILLITION: Minnesota Department of Natural Resources
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2008, Chap.367, Sec. 2, Subd. 4 (h).

APPROPRIATION AMOUNT: $894,000

Overall Project Outcome and Results

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

The combination of chemical residence time indictors, continuous water level data from nested well locations, and a general knowledge of the regional hydrostratigraphy, shows the Mt. Simon aquifer in this region has a very slow recharge rate from a large source area located south of the Minnesota River, and a smaller source area located in the northern portion of the study area. The younger Carbon-14 residence time values of Mt. Simon groundwater (7,000-8,000 years) from this project roughly correspond to a time after the last ice sheet had receded from southern Minnesota suggesting groundwater in the Mt. Simon aquifer in this region began as precipitation that infiltrated during the post-glacial period. The stable isotope data of oxygen and hydrogen support this conclusion. A recharge estimate of the Mt. Simon aquifer south of the Minnesota River based on these minimum residence time data suggest an infiltration rate of approximately 2 cm/year. The resulting 5 billion gallons/year of recharge from the southern source area is approximately equal to permitted volumes (volume of water that the users are allowed to pump) for appropriators in this area. At current groundwater extraction rates the region appears to be in a steady state. A major accomplishment of this project was the creation of a network of observation well nests, base line water level data, and geochemical data in this region that will enable future hydrologists to evaluate the local and regional affects of any future expansion of Mt. Simon groundwater pumping beyond current volumes. This effort is documented in a report “South-Central Minnesota Groundwater Monitoring of the Mt. Simon Aquifer” (http://files.dnr.state.mn.us/publications/waters/south_central_mn_gw_monitoring.pdf).

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

Project Results Use and Dissemination

The reports from this project will be available on the DNR website during the summer of 2011. An abstract of the project results will be submitted to the Geological Society of America for the national conference in Minneapolis during October 2011. In addition, a summary of the project will be submitted to the Minnesota Groundwater Association for inclusion in the quarterly newsletter.

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

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

Date of Report: 8/30/11
Date of Next Status Report: 12/01/11, Final report for M.L.2008

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

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

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

	M.L. 2008	**M.L. 2009**	**Total**
Total Trust Fund Project Budget:	**$1,600,000**	**$2,695,000**	**$4,295,000**
DNR Total	*$894,000*	*$1,875,000*	*$2,769,000*
MGS Total	*$706,000*	*$820,000*	*$1,526,000*
DNR Trust Fund Appropriation	**$894,000**	**$1,875,000**	**$2,769,000**
Minus Amount Spent:	**$894,000**	**$1,277,063**	**$2,171,063**
DNR Equal Balance:	**$0**	**$597,937**	**$597,937**

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

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

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

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

II. 2008 FINAL PROJECT SUMMARY, AND 2009 PROJECT SUMMARY AND RESULTS:

M.L. 2008
Abstract

Overall Project Outcome and Results

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

The combination of chemical residence time indictors, continuous water level data from nested well locations, and a general knowledge of the regional hydrostratigraphy, shows the Mt. Simon aquifer in this region has a very slow recharge rate from a large source area located south of the Minnesota River, and a smaller source area located in the northern portion of the study area. The younger Carbon-14 residence time values of Mt. Simon groundwater (7,000-8,000 years) from this project roughly correspond to a time after the last ice sheet had receded from southern Minnesota suggesting groundwater in the Mt. Simon aquifer in this region began as precipitation that infiltrated during the post-glacial period. The stable isotope data of oxygen and hydrogen support this conclusion. A recharge estimate of the Mt. Simon aquifer south of the Minnesota River based on these minimum residence time data suggest an infiltration rate of approximately 2 cm/year. The resulting 5 billion gallons/year of recharge from the southern source area is approximately equal to permitted volumes (volume of water that the users are allowed to pump) for appropriators in this area. At current groundwater extraction rates the region appears to be in a steady state. A major accomplishment of this project was the creation of a network of observation well nests, base line water level data, and geochemical data in this region that will enable future hydrologists to evaluate the local and regional affects of any future expansion of Mt. Simon groundwater

pumping beyond current volumes. This effort is documented in a report "South-Central Minnesota Groundwater Monitoring of the Mt. Simon Aquifer" (http://files.dnr.state.mn.us/publications/waters/south_central_mn_gw_monitoring.pdf).

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

Project Results Use and Dissemination

The reports from this project will be available on the DNR website during the summer of 2011. An abstract of the project results will be submitted to the Geological Society of America for the national conference in Minneapolis during October 2011. In addition, a summary of the project will be submitted to the Minnesota Groundwater Association for inclusion in the quarterly newsletter.

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

M.L. 2009

The County Geologic atlas series provide information essential to sustainable management of ground water resources. They define aquifer boundaries, the connection of aquifers to the land surface, and the connection of aquifers to surface water resources. They facilitate and enhance the operations of natural resource management and regulation by state and local government units. Part A (geology) is completed by the Minnesota Geological Survey and Part B (groundwater and pollution sensitivity) is completed by the Minnesota Department of Natural Resources.

The deepest bedrock aquifer of south central Minnesota and the metro area – the Mt. Simon aquifer, supplies all or some of the water needs of over one million Minnesotans. The few water level measurements available from this aquifer in the Mankato and Twin Cities metro area indicate declining water levels in some areas. Critical recharge areas for the Mt. Simon aquifer exist in the northwestern and western metro area and portions of south central Minnesota. The recharge and physical characteristics of the Mt. Simon aquifer along this zone are poorly understood. This recharge zone will be investigated and characterized through monitoring well installations, water level monitoring, groundwater chemical analysis, and aquifer capacity testing to help determine recharge pathways and sustainable limits for this aquifer.

This project will be an expansion of the 2008 LCCMR funded project to investigate the Mt. Simon aquifer recharge zone in south central Minnesota and to fund additional Part A County Geologic Atlases. In addition, the 2009 project will fund the initiation and completion of Part B atlases. Part A is completed before work on part B commences. The Part B atlases focus on defining aquifer boundaries; natural water chemistry; ground water flow; and identifying the connection of aquifers to the land surface and surface water resources. Atlas reports facilitate and enhance the operations of natural resource management and regulation by state and local government units.

This project will support completion of County Geologic Atlas Part B reports by expanding production capacity by providing additional staff to existing staff of the ongoing Part B project and providing additional project funds for water sampling and analysis and report printing consistent with the ongoing project.

III. 2008 FINAL PROJECT SUMMARY AND 2009 PROGRESS SUMMARY

M.L. 2008

Overall Project Outcome and Results

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

Project Results Use and Dissemination

The reports from this project will be available on the DNR website during the summer of 2011. An abstract of the project results will be submitted to the Geological Society of America for the national conference in Minneapolis during October 2011. In addition, a summary of the project will be submitted to the Minnesota Groundwater Association for inclusion in the quarterly newsletter.

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M.L. 2009

12/1/09 **Result 2** All the drilling sites have been chosen and SHPO assessments have been requested. Currently we are seeking permission to drill on non-DNR public property in Wright and Sherburne Counties. Two well nests in McLeod County have been contracted for drilling.

12/1/09 **Result 6** One hydrologist 2 was hired as of Oct 14, 2009. The opening for the other hydrologist to be hired will likely be reposted. The opening for the Research Analyst (GIS) will be reposted. Due to staff changes an Information Officer 2 will be hired instead of Information Officer1 to provide the necessary level of expertise for the editing work. That opening has yet to be posted. The new hydrologist 2 has begun preliminary work on the Benton County Geologic Atlas Part B.

Amendment Requested (12/1/09)

Result 6 The “Personnel –wages and benefits” was reduced $4,000 to 1) cover costs for a GIS workstation for each of the new hydrologists (total $3,000) and 2) cover costs of expendable water sampling supplies. Ordinary desktop computers do not have sufficient memory, hard drive, or graphics card capability to meet the intensive GIS needs of the hydrologist positions. The delayed hire will cover the costs. Software is departmental standard software. These computers will continue to be used as GIS workstations for future County Geologic Atlas projects. See the attached project status

chart. The expendable water sampling supplies ($1,000) include bottles and other supplies that are either one-use only or are consumed in the sampling process.

Amendment Approved: (12/21/09)

Amendment Request (2/24/10)
Result 6 Two changes are requested to assure the county geologic atlas work is both accurate and done efficiently. The “Personnel – wages and benefits”, if approved, will be reduced $2,700 to cover the increased cost of an approved GIS workstation for the new Hydrologist 2 hire and also the cost of a third GIS workstation for the new Research Analyst (GIS) hire. These GIS workstations incorporate a higher rated graphics card and a second monitor for larger on-screen active work area. Experience has shown that an ordinary desktop computer does not have the memory or graphics capability for the intensive GIS work that is needed to complete the atlas projects. These GIS workstations will continue to be used on future County Geologic Atlas projects.

Also, the “Personnel – wages and benefits”, if approved, will be reduced an additional $1,500 and a separate line item added for “GIS training of new hires”. Experience with new hires has shown that this training is needed to bring the new hires up to the advanced level needed to execute the atlas work efficiently. New hires, especially hydrogeologists, have not worked with GIS intensively or at the advanced level the atlas projects require; they are hired primarily for their hydrogeologic expertise and not their GIS capability. The Research Analyst (GIS) position is entry level and will need minimal advanced training to work effectively with other atlas staff working at advanced levels.

GIS Training could be provided by commercial vendors at much higher cost, typically $900 to $1500 per class or the GIS training could be provided by DNR for $150 or $300 per class. We have confirmed with the DNR GIS training manager that DNR GIS training is funded by class fees only and not General Fund. Therefore, this allocation would not conflict with the supplanting of General Funds restrictions of the ENRTF. The DNR offers a series of three increasingly higher-level GIS classes specially focused on the GIS skills needed and data used by DNR atlas projects staff. The three classes include “ArcMap” ($300), “Editing ArcMap” ($300), and “ArcToolbox” ($150). The proposed training budget was calculated based on new hire training needs of 1 – ArcMap class, 3 - Editing ArcMap classes, and 2 – ArcToolbox classes, totaling $1,500.

Amendment Approved: (3/18/10)

7/15/10 **Result 2** Eight wells at four locations in McLeod, Wright, and Sherburne counties have been drilled. A drilling company has been contracted for the remaining 6 locations in Sherburne, Isanti, Anoka, and Hennepin Counties.

7/15/10 **Result 6** The remaining three hires for the atlas staff have been accomplished. The approved four staff for Result 6 include two project hydrogeologists, one technical editor, and one research analyst. Well sampling for the Benton part B atlas is scheduled to begin the middle of July and will be complete in early August. The Todd part B is in final review draft and in preparation for printing. Chisago Part B has been initiated and is

currently focused on development of the well sampling design; well sampling is to be completed late summer or fall 2010.

Amendment Requested: (7/15/10)

Result 2 The budget for lab analysis of groundwater samples was increased to cover the possibility of submitting a greater number of samples for the expensive carbon 14 analysis. We won't know the exact number of samples that we will submit for this analysis until we drill the remaining wells in the northern portion of the study area. If the geologic conditions suggest the Mt. Simon is very open to recent recharge we may submit fewer samples for carbon 14 analysis. The increased costs for this budget item are offset by a decrease in the wages line item. The decrease in the wages budget will be offset by using the remainder of the wages budget from the 2008 project and by using a less expensive DNR hydrologist (not normally compensated by general fund) for some of the routine data logger tasks.

Result 6 Attachment A shows a minor adjustment between cost categories to assure that adequate sampling supplies are available for the planned work. These sampling supplies are primarily expendable materials that are used in the sampling protocol. The additional cost is offset by a reduction in the travel expense item.

Amendment Approved: 10/5/10

12/1/10 **Result 2** All of the wells for the project (17 wells at 10 locations) have been completed. All of the wells except two have been sampled for laboratory chemical analysis and all of the wells except four have continuous water level measurement data loggers installed.

12/1/10 **Result 6** The Todd County Geologic Atlas, Part B was printed November 2010. The Carlton County Geologic Atlas, Part B, is in report preparation. All chemistry sampling in Benton County is complete and submitted for laboratory analysis, except the carbon-14 sampling planned for spring 2011. Chemistry sampling in the other three project counties (Chisago, Carver, and McLeod) is at least half completed and will be essentially complete in spring 2011. The Benton atlas project is well on track and report preparation will be underway in the fall 2011. The hydrologist hired for the Chisago atlas project was released from state service in early December 2010; that position will be refilled as soon as possible. Administrative approval to rehire has been obtained.

7/1/11 **Result 2**
Since 12/1/10 all the wells have been sampled and all data loggers have been installed. Data from the water level data loggers have been retrieved twice.

7/1/11 **Result 6**

The Carlton County Geologic Atlas, Part B, was printed June 2011. Paper copies of the report will be delivered to the county in August 2011. The report will be presented to county commissioners and staff in September 2011. Report plate PDFs are posted on-line and the GIS data are being prepared for on-line distribution in August 2011. A

training workshop for the Carlton County Geologic Atlas, Part B, is tentatively planned for October 2011. Report preparation of the Benton County Geologic Atlas, Part B, is underway and publication is planned for December 2011. Three other Part B atlases are in progress: Chisago, Carver, McLeod. Almost all planned water sampling has been completed and most analytical data has been received. Filling the hydrologist vacancy for the Chisago project has proven extremely difficult; the position has been vacant since December 2010. Finally, a candidate has been identified who should start in early September.

Future atlas projects planned to start during FY12 include Blue Earth, Nicollet, and Sibley. The exact schedule depends on delivery of data for these projects from the Minnesota Geological Survey and DNR atlas staff availability.

Amendment Requested: (8/30/11)

Result 2 The budget for drilling contracts and continuous water level monitoring equipment was increased to cover actual costs. This increase was covered by funds from the chemistry, SHPO assessment, well pumping supplies, wages, and travel expenses budgets.

Result 6 The budget for field expenses (travel and supplies) has been increased by $10,000 to cover expected costs in the final year of the project that had been underestimated in the original budget. In addition, the budget for laboratory expenses has been increased by $25,000 to cover half of the laboratory expenses for a new atlas project (Blue Earth County Geologic Atlas, Part B) that is starting in FY12. This increase was covered by funds from wages and benefits which has more funds than needed to cover wages and benefits for staff during the final year of the project. Delayed hires and a six-month Hydrologist 2 position vacancy resulted in salary savings. During the vacancy, other project staff worked on the project that had been started (Chisago) as time allowed from their project (Benton) so that the planned well water sampling was accomplished, with the exception of ten carbon-14 samples for age dating. Those samples are planned for September 2011. Because of the vacancy, progress on both the Benton and Chisago projects has been delayed, with most of the impact on the Chisago project. The Benton atlas Part B report is currently in production with publication planned about December 2011.

Amendment Approved:

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

Summary Budget Information for Result 1:

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

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

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

Final Report Summary:

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

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

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

This document is intended to provide the DNR with a guide to build the backbone network that will support the state's current and future groundwater level monitoring

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

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

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

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

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

Summary Budget Information for Result 2:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$861,000**	**$985,000**	**$1,846,000**
Amount Spent:	**$861,000**	**$837,885**	**$1,698,885**
Balance:	**$0**	**$147,115**	**$147,115**

Deliverable	Completion Date	Budget	Status
1. All the drilling sites will have been chosen and several of the wells will have been installed, instrumented and sampled. The drilling logs, geophysical logs, flow logs, locations, well construction diagrams, and water level data from the wells that have been installed by this date will be available.	12/01/08	$250,000	complete
2. Same as above with several more sites completed (M.L. 2008)	7/1/09	$250,000	complete
3. Same as above with several more sites completed (M.L. 2008). Sites have been chosen for M.L. 2009 and contractor bidding, SHPO reviews and access permission requests are underway. Several of the wells will have been installed.	12/1/09	$250,000 (2008) $250,000 (2009)	complete
4. All the monitoring wells will have been installed, instrumented, and sampled. During the remaining one-year period The data loggers will downloaded and maintained on a regular basis. Remaining data compilation and interpretation will continue and creation of final report will begin (M.L. 2008). Several more well nests for the M.L. 2009 will have been completed and associated data loggers installed.	7/1/10	$37,000 (2008) $300,000 (2009)	complete
5. Same as above with more data compilation and progress toward completion of final report (M.L. 2008). All of the well nests will have been completed, associated data loggers installed, and water samples collected and submitted for lab analysis (M.L. 2009).	12/1/10	$37,000 (2008) $300,000 (2009)	complete
6. Project completion (M.L. 2008) and final report to include maps summarizing	6/30/11	$37,000 (2008)	complete

thickness and extent of Mt. Simon aquifer in project area. Interpretation of collected water level data and chemistry and implications for sustainable use of Mt. Simon aquifer. Recommendations for future investigations and/or monitoring. Routine downloading of data loggers, data compilation, interpretation and report preparation (M.L. 2009)		$33,750 (2009)	
7. Routine downloading of data loggers, data compilation, interpretation and report preparation (M.L. 2009)	7/1/11	$33,750 (2009)	
8. Same as above (M.L. 2009)	12/1/11	$33,750 (2009)	
9. Project completion (M.L. 2009) and final report to include maps summarizing thickness and extent of Mt. Simon aquifer in project area integrated with 2008 project results. Report will include interpretation of collected water level data and chemistry and implications for sustainable use of Mt. Simon aquifer. Recommendations for future investigations and/or monitoring.	6/30/12	$33,750 (2009)	

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

M.L. 2008 Final Report Summary:
Drilling, well installation, groundwater sampling, and data logger installations have been completed at all the 2008 project sites for a total of 27 wells at 14 sites in 5 counties. All wells drilled have been mud logged and gamma logged. In addition, rock and sediment samples have been sent to the Minnesota Geological Survey for analysis.

Result 2 Status (M.L. 2009) as of 12/1/09:
All the 2009 project drilling sites have been chosen and SHPO assessments have been requested. Currently we are seeking permission to drill on non-DNR public property in Wright and Sherburne Counties. Two well nests in McLeod County have been contracted for drilling.

Result 2 Status (M.L. 2009) as of 7/15/10:
Eight wells at four locations in McLeod, Wright, and Sherburne counties have been drilled. A drilling company has been contracted for the remaining 6 locations in Sherburne, Isanti, Anoka, and Hennepin Counties.

Result 2 Status (M.L. 2009) as of 1/10/11:

All of the wells for the project (17 wells at 10 locations) have been completed. All of the wells have been sampled for laboratory chemical analysis, and all of the wells except four have continuous water level measurement data loggers installed.

Result Status (M.L. 2009) as of 6/30/11: *All of the wells for the project (17 wells at 10 locations) have been completed. All of the wells have been sampled for laboratory chemical analysis, and all of the wells have continuous water level measurement data loggers installed.*

Result Status as of 7/1/11: *All of the wells for the project (17 wells at 10 locations) have been completed. All of the wells have been sampled for laboratory chemical analysis, and all of the wells have continuous water level measurement data loggers installed.*

Result Status as of 12/1/12:

Result Status as of 6/30/12:

M.L. 2009 Final Report Summary:

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

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

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

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

Summary Budget Information for Result 6:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	**$0**	**$890,000**	**$890,000**
Amount Spent:	**$0**	**$333,882**	**$333,882**
Balance:	**$0**	**$556,118**	**$556,118**

Deliverable	Completion Date	Budget	Status
1. Additional staff hired (2 hydrologists; research analyst; half-time editor) to support additional atlas projects to be developed and completed during the project. Support continuation of ongoing projects: Todd County. Support publication of Todd County Part B.	12/01/09	$205,333	active
2. Support continuation of ongoing work. Start Benton, and Chisago counties. Support start of Carlton, McLeod, and Carver Counties.	7/1/10	$153,333	active
3. Continue ongoing projects.	12/1/10	$123,333	active
4. Continue ongoing projects. Support publication of Carlton County Part B.	7/1/11	$147,333	active
5. Continue ongoing projects. Support publication of Part B for McLeod and Carver counties	12/1/11	$133,334	
6. Publish Part B for Benton and Chisago counties.	6/30/12	$127,334	

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

Result 6 Status as of 12/01/09:
One hydrologist 2 was hired as of Oct 14, 2009. The opening for the other hydrologist to be hired will likely be reposted. The opening for the Research Analyst (GIS) will be

reposted. Due to staff changes an Information Officer 2 will be hired instead of Information Officer1 to provide the necessary level of expertise for the editing work. That opening has yet to be posted. The new hydrologist 2 has begun preliminary work on the Benton County Geologic Atlas Part B.

Result 6 Status as of 7/15/10:
The second hydrologist 2 was hired April 19, 2010 and will work on the Chisago Part B atlas. At about that same time the Chisago Part A atlas data was available from the MGS. The technical editor (Information Officer 2) was hired May 17, 2010. The research analyst-GIS was hired June 29, 2010. Work on the Benton atlas Part B has proceeded to the point that well water sampling for about 100 wells is scheduled to begin mid-July 2010. To better understand water table conditions in part of Benton County the project hydrologist has initiated a series of synoptic water level measurements. Work on the Chisago atlas Part B has been initiated with planning for well sampling for about 100 wells. The sampling will take place late summer or fall 2010.The Todd atlas Part B report is in final draft form following peer review and being prepared for print production. Other atlas program projects including Carlton, McLeod, and Carver are underway by base program hydrologists.

Result 6 Status as of 1/10/11: *The Todd County Geologic Atlas, Part B, was printed November 2010. The paper copies of the report will be delivered to the county in January 2011 when the contents of the report will be presented to local staff and the public. Report plate PDFs are posted on-line (http://www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/toddcga.html) and the GIS data are being prepared for on-line distribution in January 2011. A training workshop for the Todd Atlas is tentatively planned for spring 2011. The report preparation of the Carlton Atlas, Part B, is underway and on schedule; printing of this report is planned for June 2011. Chemistry sampling of 100 wells in Benton County is complete, except the ten carbon-14 samples planned for spring 2011. The 100 Benton samples have been submitted for laboratory analysis. Chemistry sampling of 100 wells in each of the other three project counties, (Chisago, Carver, and McLeod) is at least half completed and will be essentially complete in spring 2011. The collected samples to date in those areas have been submitted for laboratory analysis. The Benton Atlas, Part B, project is well on track and report preparation will be underway by the fall 2011. The Benton project hydrologist will incorporate into the atlas report the result of the several synoptic measurements of the water table completed in part of Benton County. The hydrologist hired for the Chisago atlas project was released from state service in early December 2010; that position will be refilled as soon as possible. Administrative approval to rehire has been obtained.*

Result 6 Status as of 7/1/11: *The Carlton County Geologic Atlas, Part B, was printed June 2011. Paper copies of the report will be delivered to the county in August 2011. The report will be presented to county commissioners and staff in September 2011. Report plate PDFs are posted on-line (http://www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/carlcga.html) and the GIS data are being prepared for on-line distribution in August 2011. A training workshop for the Carlton County Geologic Atlas, Part B, is tentatively planned for October 2011. Report preparation of the Benton County Geologic Atlas, Part B, is*

underway and publication is planned for December 2011. Three other Part B atlases are in progress: Chisago, Carver, McLeod. Almost all planned water sampling has been completed (about 100 wells in each project area) and most analytical data has been received. Assembling the remaining analytical data is a priority the next couple of months. Filling the hydrologist vacancy for the Chisago project has proven extremely difficult; the position has been vacant since December 2010. During the vacancy, other staff completed planned water sample collection with the exception of ten carbon-14 sample for age dating. Finally, a candidate has been identified who should start in early September.

Additional atlas projects planned to start during FY12 include Blue Earth, Nicollet, and Sibley. The exact schedule depends on delivery of data for these projects from the Minnesota Geological Survey and DNR atlas staff availability.

Result 6 Status as of 12/1/11:

Result 6 Status as of 6/30/12:

V. TOTAL TRUST FUND PROJECT BUDGET:

M.L. 2008

DNR Staff or Contract Services:	
Hydrologist 3, unclassified, 1.0 FTE x 2years (results 1 and 2)	$132,000
Drilling contractors	$694,474
Laboratory analysis of 30 ground water samples tritium, deuterium and 18 oxygen	$7,989
Archeological site assessment (SHPO)	$6,799
DNR Equipment:	
Down-hole geophysical logging tool (gamma, magnetic induction)	$0
Field computer	$4,267
Submersible sample pump, reel, tubing and cable (or contracted sampling services)	$8,645
Continuous water level monitoring equipment for 27 wells	$18,298
DNR Other:	
Overnight expenses	$9,253
Mileage	$9,835
Supplies	$2440
SUBTOTAL DNR PROJECT BUDGET:	$894,000
SUBTOTOTAL MGS (see MGS WP) **PROJECT BUDGET:**	$706,000
TOTAL TRUST FUND PROJECT BUDGET:	$1,600,000

M.L. 2009

DNR Staff or Contract Services (Result 2):

Hydrologist 3, unclassified, 1.0 FTE x 2years	$105,595
Drilling contractors	$812,145
Laboratory analysis of 17 ground water samples cations, anions, trace elements, tritium, stable isotopes, and 14 carbon	$32,862
Archeological site assessment (SHPO)	$5,325
Well pumping equipment for aquifer tests and sampling	$6,273
DNR Staff or Contract Services (Result 6):	
Hydrologist 2, unclassified. 2.0FTE x 2.5 years	$369,600
Research Analyst (GIS), unclassified 1.0 FTE x 2.5 years	$159,600
Information Officer 2, unclassified 1.0 FTE x 2.5 years	$161,600
GIS training for 3 new hires (2-Hydrogeologist 2's, 1-Research Analyst (GIS)	$1,500
Printing	$38,000
Laboratory analysis of 80 groundwater samples/county for cations, anions, trace elements, tritium and several 14 C	$133,000
DNR Equipment:	
(Result 2):	
Continuous water level monitoring equipment for 17 wells	$12,512
(Result 6):	
Three GIS Workstations	$5,672
DNR Other:	
(Result 2)	
Overnight expenses	$2,288
Mileage	$7,000
Supplies	$1,000
(Result 6)	
Overnight expenses (70 days @ $100/day)	$9,000
Mileage (4,167 miles @ $.48/mile)	$4,000
Supplies	$8,028
SUBTOTAL DNR PROJECT BUDGET:	$1,875,000
SUBTOTOTAL MGS (see MGS WP) **PROJECT BUDGET:**	$820,000
TOTAL TRUST FUND PROJECT BUDGET (2009):	$2,695,000

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

Down-hole geophysical logging tool (gamma, magnetic induction)
This tool is essential for any borehole subsurface investigation. The tool measures the natural gamma radiation and electrical conductivity (or resistivity) of the various downhole formations. A continuous profile of these downhole properties is created from this data that allows the geologist to determine what types of sediment (sand, silt, clay)

or layers of bedrock sandstone, shale etc.) exist at that location. Formations have characteristic profiles that aid in their identification and correlation. The physical properties of the aquifers (porosity and permeability) can also be estimated from this data. The use of this tool requires supporting equipment (truck, winch, cable computer, software) that the DNR currently possesses. At the end of this project this equipment will continue to be used as part of the DNR ground water level monitoring program and other related activities.

Field computer

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

Submersible sample pump, reel, tubing and cable

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

Continuous water level monitoring equipment for project wells

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

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

GIS Workstations for three new atlas projects hires

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

VI. OTHER FUNDS & PARTNERS/ PROJECT STRATEGY:

A. Project Partners

M.L. 2008

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

M.L. 2009

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

B. Other Funds proposed to be spent during the Project Period (2008 and 2009):

The report from Result 1 (Groundwater level monitoring guidance document) will be reviewed and edited by several senior staff at the DNR and other state and federal agencies. The project will be managed by existing DNR staff with salary paid through the general fund.

Result 6 (Acceleration of county geologic atlas Part B reports) will be supported by existing DNR staff with salary paid through the general fund. The project will be managed by existing DNR staff with salary paid through the general fund.

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

D. Time:

E. Project Impact and Long-term Strategy (2008 and 2009):

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

VII. DISSEMINATION:

The well logs, geophysical logs and well construction information from the borehole drilling will be submitted to the Minnesota Geological Survey (MGS) for inclusion in the county well index. The drill cuttings from the boreholes will be placed in sample bags and submitted to the MGS for archiving and analysis. Laboratory analysis results of water samples will be archived in a program database. The final report will be available on the DNR Waters website.

VIII. REPORTING REQUIREMENTS:

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

IX. RESEARCH PROJECTS:

Attachment A: Final Budget Detail for 2008 Projects

Project Manager Name: Jim Berg, DNR Waters

Trust Fund Appropriation: $ 894,000

Project Title: South-Central Minnesota Groundwater Monitoring and County Geological Atlases

Date: 6/30/11

2008 Trust Fund Budget	**Result 1 (DNR) Budget:**	**Amount Spent**	**Balance**	**Result 2 (DNR) Budget:**	**Amount Spent**	**Balance**	**TOTAL BUDGET**	**TOTAL BALANCE**
	Groundwater level monitoring guidance document			*Test drilling, monitoring well installation, sampling, laboratory analysis, water level measurement*				
BUDGET ITEM								
PERSONNEL: wages and benefits	33,000	33,000	0	99,000	99,000	0	132,000	0
						0		
Contracts						0		
University of Minnesota hydrogeochemistry lab -- lab analysis of ground water samples				7,989	7,989	0	7,989	0
Drilling contracts				694,474	694,474	0	694,474	0
SHPO assessments				6,799	6,799	0	6,799	0
						0		
Equipment						0		
Down-hole geophysical logging tool				0	0	0	0	0
Submersible sampling pump and accessories or contracted sampling services				8,645	8,645	0	8,645	0
Field computer				4,267	4,267	0	4,267	0
Continuous water level monitoring equipment				18,298	18,298	0	18,298	0
						0		
Travel expenses				19,088	19,088	0	19,088	0
						0		
Other						0		
Supplies				2440	2,440	0	2,440	0
COLUMN TOTAL	**$33,000**	**$33,000**	**$0**	**$861,000**	**$861,000**	**$0**	**$894,000**	**$0**