

2009 Project Abstract

For the Period Ending June 30, 2011

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

Project Manager: Jeff Green

Affiliation: Minnesota DNR-Division of Waters

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: ML 2009, Chap.[143], Sec.[2], Subd.3D.

APPROPRIATION AMOUNT: \$250,000

Overall Project Outcome and Results

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

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

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

Solinst level-temperature-conductivity loggers were purchased in the second year of the project. The data from them has shown that Prairie du Chien formation springs can be monitored for minor temperature fluctuations. Detecting these fluctuations has allowed

us to conclude that the monitored springs are affected by snowmelt runoff. This information will be used for spring assessment protocol development.

Project Results Use and Dissemination

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

Environment and Natural Resources Trust Fund 2009 Work Program Final Report

Date of Report: 15 Sept. 2011

Final Report

Date of Work Program Approval: 16 June 2009

Project Completion Date: 30 June 2011

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Web Site Address:

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

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

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

Appropriation Language: Springshed Mapping for Trout Stream Management.

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

II. and III. FINAL PROJECT SUMMARY AND RESULTS:

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

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springsheds. The expanded boundary springsheds were in the Watson Creek and South Fork Root watersheds, target areas for the local, state and federal Root River Initiative. The new springsheds are in the Crystal Creek watershed. These traces enhanced MDA watershed research and education efforts.

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

IV. OUTLINE OF PROJECT RESULTS:

Result 1: Innovative Trout Springshed Maps and Reports

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

Summary Budget Information for Result 1:

Trust Fund Budget:	\$ 440,211.00
(to U of MN.)	\$ (190,211)
(to MNDNR)	\$ (250,000)
Amount Spent (MNDNR):	\$ 246,930
Balance (MNDNR):	\$ 3,070

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

Location on page 1, maps and reports of completed traces and spring parameter monitoring)		
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(See also the companion U of M project work program Result 1)

Results

Galena limestone tracing:

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

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

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

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

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

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

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

Borson Northeast (Winona County) - This trace was from a disappearing stream in a tributary valley to Rush Creek. It is northeast of Borson Spring, one of the three springs that were found to have dye in them during the first St. Lawrence dye trace. The sinking point was located using the new LiDAR imagery. The points of the first

traces from Ahrensfeld Creek were examined on the LiDAR image. The stream channel literally disappears at the sinking point. When the LiDAR image for the Borson NE valley was examined, it had a similar morphology. Discussions with the landowner revealed that a stream did in fact sink there. This breakthrough is being used to locate other potential St. Lawrence sinking streams. The dye trace from this sink connected to Borson spring, one of the three that had dye from the Ahrensfeld Creek trace. Dye was also detected at another spring near Borson that also forms a coldwater tributary to Rush Creek.

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

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

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

Final Report Summary:

15 July 2011

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

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

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

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

V. TOTAL TRUST FUND PROJECT BUDGET:

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

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

TOTAL TRUST FUND PROJECT BUDGET: \$ 500,000

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

VI. PROJECT STRATEGY:

A. Project Partners:

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

Dr. E. Calvin Alexander, Jr. will be the project manager of the companion U of M project and will be responsible for carrying out the U of M share of project activities.

Dr. Yongli Gao will be a contractor who is responsible for developing the GIS-based web site for public access to the springshed maps and updating the Minnesota Karst Features Database (MN KFDB) to make it more user friendly and accessible (Result 2 of the companion U of M study). Gao designed and implemented the current MN KFDB and is currently working with the USGS on a National Karst Features Data System. He is an Assistant Professor at East Tennessee State University in Johnson City, TN.

Dr. Anthony C. Runkel will be contributing stratigraphic information to Result 1 of this project. Tony is the Minnesota State Geologist with the Minnesota Geological Survey. He has done extensive work on the karst hydrostratigraphy of southeastern Minnesota.

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

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

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

Karst ground water flow is the most complex hydrogeologic environment in Minnesota. Springs are the natural features that return groundwater to surface waters. Karst springs respond much faster to surface recharge than is expected from conventional hydrology theory. Karst springs exhibit a wide range of rapid responses to recharge events. Springs integrate all of the natural and anthropogenic processes that occur in their recharge areas – in their individual springsheds. Springshed mapping is critical component of karst aquifer characterization. Long-term resources are needed to gather and maintain the parameters necessary to realistically, effectively manage karst springs in Minnesota and to train staff and resource managers in the use of the available karst data. LCMR and LCCMR have played a leading role in the effort to understand and manage Minnesota's karst springs

The availability of high-resolution LiDAR maps, scheduled for July 2009, will produce a flood of new information showing the locations of karst features. We anticipate that new information will have a major impact on the springshed mapping project.

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

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

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

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

31 December 2010

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

15 July 2010

In March, an MPR reporter accompanied me on a snow-melt runoff dye trace near Frego Creek in Fillmore County. The reporter (Stephanie Hemphill) went with me to change background samplers; we then crossed some very muddy fields to three different sinkholes where I poured dye. The report she produced is on-line at <http://minnesota.publicradio.org/display/web/2010/03/29/karst-hydrology/>. In May, I

spent the day with Federal agency managers from the Midwest. I went with them on their tour of the Root River basin and explained about the karstlands of southeast Minnesota. I took considerable time to discuss springs and their importance to the streams and fish populations of the southeast.

15 January 2011

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

30 June 2011

Presentation on southeast Minnesota, karst and springshed mapping to the Whitewater Watershed Project.

Presentation on our St. Lawrence work to DNR EcoWaters and Fisheries staff in Lake City.

Brownbag seminar presentation of the project at the Edward's Aquifer Authority in San Antonio, TX.

Presentation on springshed mapping at the Wisconsin Geological and Natural History Survey for University and state agency staff.

Presentation on springshed mapping at the EcoWaters Environmental Review coordinators meeting.

Presented the St. Lawrence dye tracing work at the 12th Karst Conference in St. Louis and prepared a manuscript for publication in the conference proceedings.

Presented the St. Lawrence work at a brown bag seminar at the MGS.

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

IX. RESEARCH PROJECTS:

Attachment A: updated 11/8/11 (using **Revised Budget**)

Project Title: Innovative Springshed Mapping for Trout Stream Management-Continuation

Project Manager Name: Jeff Green (DNR)

Trust Fund Appropriation: \$250,000 (DNR only)

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

Total Spent FY10-11

\$246,929.72