**PROJECT TITLE: Our Future Drinking Water: Nitrate, Tile, and Climate**

**I. PROJECT STATEMENT**

**• Summary: *We will evaluate how to reduce nitrate in rural drinking water and how tile drainage and climate change impact replenishment of drinking water, i.e., groundwater recharge.***

Using the Vermillion River watershed in Dakota County as our test site, we will do the following:

• Find where groundwater recharge occurs (replenishment of drinking water), and how tile drainage reduces it. *This is quantitatively unknown.*

• Find where on the landscape nitrate originates. *Spatial targeting.*

• Evaluate alternative land-management practices to reduce this nitrate, in terms of the following:

• How much is nitrate reduced? *Testing the options.*

• How much does it cost to reduce nitrate? Is it cost-effective? *This is usually ignored.*

• How long will it take to see the improvement? *This is virtually unknown.*

• Evaluate what drinking water supply will be over the next 80 years. *This is virtually unknown.*

**• Rationale:**

**• Rural Minnesota deserves abundant and clean drinking water**

• The quality of rural drinking water (groundwater) is commonly compromised by nitrate pollution. We need realistic solutions based on effectiveness, cost, and response time.

• The supply of rural drinking water is reduced by tile drainage and threatened by climate change, but no one knows by how much.

**• The Vermillion River watershed in Dakota County is an important test case.**

The watershed is largely agricultural with sandy soils overlying fractured bedrock aquifers, making the area susceptible to groundwater pollution. *In the eastern watershed, most drinking-water supply wells are contaminated with nitrate above background levels and commonly above the drinking-water limit. And the problem is getting worse.*

**II. PROJECT ACTIVITIES AND OUTCOMES**

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| **Activity 1:** **Quantify drinking-water replenishment and identify nitrate hotspots:** ***How much and how bad?***  **Description:** We will calculate groundwater recharge (replenishment of rural drinking water) using the Soil and Water Assessment Tool (SWAT), a watershed simulation program that accounts for complex soils, detailed agricultural practices, crop growth, tile drainage and all aspects of the hydrologic cycle (infiltration, runoff, and evapotranspiration) at a daily time step. The impact of tile drainage on recharge can be estimated by comparing simulation results with, and without, tile drainage activated. SWAT tracks nitrate through the watershed, from its application as fertilizer, storage in soils, uptake in plants, release from plant decomposition, and transport through the watershed in surface runoff or groundwater flow. SWAT will identify which subbasins are nitrate hotspots, which practices within each subbasin are the greatest nitrate generators, and how much of that nitrate is entering the shallow aquifer.  **Dissemination:** Report and data output to Dakota County; blog post to select newsletters.  **ENRTF BUDGET: $130,000** |

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| **Outcome** | **Completion Date** |
| *1. Build and calibrate a simulation of Vermillion River watershed* | *March 2021* |
| *2. Quantify recharge amounts and test impact of tile drainage* | *September 2021* |

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| **Activity 2:** **Evaluate BMPs for effectiveness, response time, and cost: *What can we do? How long will it take?***  **Description:** SWAT can simulate a number of best management practices (BMPs) to test for which are the most effective in reducing nitrate loads to surface and groundwaters. But we feel BMPs must also be evaluated for the cost and time effectiveness. Which BMPs are prohibitively expensive? Which might provide a positive return to the farmer? And how long will it take to see a difference in the receiving waters?  **Dissemination:** Report to Dakota County; presentation at state conference; blog post to select newsletters.  **ENRTF BUDGET: $90,000** |

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| **Outcome** | **Completion Date** |
| *1. BMP testing for effectiveness* | *February 2022* |
| *2. Cost and response-time evaluation of most effective BMPs* | *June 2022* |

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| **Activity 3:** **Evaluate future drinking water supply:**  ***How will it change with climate?***  **Description:** Regardless of cause, climate change is already impacting Minnesota. Groundwater recharge is highly sensitive to small changes in climate: total precipitation, its intensity, its seasonality, and its temperature (snow or rain). We will extract and downscale output from Global Climate Models (GCMs) and run it through our SWAT model of the Vermillion watershed to forecast groundwater recharge over the next 80 years.  **Dissemination:** Report to Dakota County; presentation at state conference; blog post to select newsletters.  **ENRTF BUDGET: $110,000** |

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| **Outcome** | **Completion Date** |
| *1. Compilation of future climate data* | *December 2022* |
| *2. Quantification of groundwater recharge and nitrate pollution under future climate* | *June 2023* |

**III. PROJECT PARTNERS AND COLLABORATORS:**

This project is coordinated with, and complementary to, a sister proposal put forth by Dakota County, which will collect streamflow, tile-flow, and water-quality data to better characterize the nitrate conditions in the Vermillion watershed. Their project will also construct a groundwater model to identify source areas of selected water-supply wells, particularly those for the city of Hastings. Their data collection component will help inform our SWAT modeling effort, and the groundwater-recharge results of our SWAT model will help inform the County’s groundwater model. ***Neither of our projects is dependent on the other; however both will be improved by the other.***  We will meet semi-annually to update each other on our joint progress.

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

This project will provide proof of concept for several important issues: (a) how to combine surface-water and groundwater studies, (b) how to evaluate BMPs on more realistic basis including cost and how long it may take to see results, and (c) how climate change may impact our most precious, hidden resource. We anticipate similar future projects in other sensitive study areas.

**V. SEE ADDITIONAL PROPOSAL COMPONENTS:**

**A. Proposal Budget Spreadsheet**

**B. Visual Component or Map**

**F. Project Manager Qualifications and Organization Description**

**G. Letter or Resolution**

**H. Financial Capacity**