**PROJECT TITLE: Predicting Contaminant Transport in Fractured Aquifers**

**I. PROJECT STATEMENT**

We will develop a powerful tool that can predict contaminant transport in fractured aquifers. The developed tool will greatly aid to more economically and efficiently remediate contaminated groundwater sites in Minnesota. Groundwater contamination of fractured aquifers is an urgent problem as exemplified by the recent settlement of $850 million between the state of Minnesota and the 3M Company and the construction of a new $4.5 million groundwater treatment plant in Edina-St. Louis Park. Although contaminated fractured aquifers are widespread in Minnesota, no practical tools for predicting contaminant transport in fractured aquifers are currently available. The principal investigator of this project has developed a predictive tool for subsurface contaminant transport over the past 10 years, and the co-investigator of this project has extensive experience in Minnesotan fractured aquifers. This state-of-the-art tool has been documented in multiple journal publications and has shown great promise by predicting tracer tests at a fractured bed rock site in France.

The tool will be first applied and validated at the Platteville Formation, from which a previously funded Environmental Trust Fund project has accumulated a large amount of data on fractured rock properties and flow (Runkel, 2016-2019). To successfully implement the tool, we need a good understanding of fracture flow properties and field tracer experiment results. Fracture flow properties accumulated from the previous Environmental Trust Fund project and past investigations provide the basis for an accurate model of how groundwater flows through the fractured Platteville Formation. A contaminant transport tool will be constructed using this flow model and field tracer experiments that will be conducted at several monitoring wells on the University of Minnesota campus.

Once validated, the tool will be extended to predict contaminant transport at a contaminated fractured bedrock site where supporting field data exist. Potential sites include Superfund sites in southeastern and northeastern Minnesota, where contaminant flow in fractured bedrock has proved to be particularly difficult to predict. The validated tool will be packaged into a simple software that can be freely downloaded and run on a personal computer. The tool and supporting documentation will be freely available to interested users. Time-lapse images of contaminant plume migration will help land and water resource managers both understand and communicate results of their remediation work. Prospective users of the tool include both local and state water resource managers, including the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) and the Department of Natural Resources (DNR). We have discussed this proposal with the state agencies.

This project includes several activities:

* Synthesize fracture flow properties and construct a flow model
* Conduct field tracer experiments and construct a tool for contaminant transport prediction in the Platteville formation.
* Apply and validate the tool at a contaminated fractured aquifer site where supporting field data exist.
* Publish a user-friendly tool for contaminant transport prediction.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1:Synthesizing fracture flow properties and constructing a flow model of the Platteville formation**

A flow model of the Platteville formation will be generated by synthesizing fracture flow properties and the results from the prior Environmental Trust Fund Platteville Project.

**ENRTF BUDGET: $ 80,409**

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| **Outcome** | **Completion Date** |
| 1. Synthesize fracture flow properties of the Platteville formation | March 2021 |
| 2. Develop a flow model for the Platteville Formation | August 2021 |

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| **Activity 2: Validate the flow model and contaminant transport prediction tool by conducting tracer tests on the University of Minnesota campus.**  Single well injection-extraction tracer experiments and cross borehole tracer experiments will be conducted at multiple depths to validate the Platteville Formation flow and transport model. The validated model will then be converted into a user-friendly tool capable of predicting contaminant transport in similar geologic settings.  **ENRTF BUDGET: $ 136,934** | |  | |
| **Outcome** | **Completion Date** | |
| 1. Conduct tracer transport experiments at multiple boreholes at multiple depths | November 2021 | |
| 2. Construct a contaminant transport tool based on the numeric flow model | June 2022 | |

**Activity 3:Applying the tool at a contaminated fractured aquifer site**

A potential site for the tool application is currently under discussion with the state agencies. The tool will be applied at the selected contaminated field site.

**ENRTF BUDGET: $ 92,565**

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| **Outcome** | **Completion Date** |
| 1**.** Perform site characterization to obtain flow and transport properties | December 2022 |
| 2. Apply the tool at a contaminated field site | March 2023 |

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| **Activity 4: Publishing a user-friendly tool** |
| The established tool will be released as an open-source software that can be easily downloaded and executed in personal computers. Training sessions will be given at State agencies such as MPCA, DNR and MDH to help interested parties or individuals to utilize the tool.  **ENRTF BUDGET: $ 40,756** | |

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| **Outcome** | **Completion Date** |
| 1. Publish a user-friendly tool that can be easily downloaded and executed | June 2023 |
| 2. Give tutorial presentations to interested parties | June 2023 |

**III. PROJECT PARTNERS:**

**A. Partners receiving ENRTF funding**

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| **Name** | **Title** | **Affiliation** | **Role** |
| Anthony Runkel | Chief Geologist | Minnesota Geological Survey | Co-Investigator and responsible for field site identification and hydrogeological assessments. |
| Jessica Meyer | Assistant Professor | University of Iowa | Technical suport for tracer and aquifer testings. Prof. Meyer’s unique expertise in borehole logging and tracer tests will be critical to this project. |

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

The proposed tool will assist current practices of groundwater contamination management. The tool can be extended to different sites. We will seek collaborations with agencies such as MPCA and MDH and actively apply for further research grants (federal, state and industry) to continue extending our predictive tool across the Minnesota. If this proposal gets funded, PI Kang will commit $30K of his research startup funds.