Research within the FY16 to FY19 planning cycle is ongoing. A milestone has been completed showing the impacts of heterogeneity on mass discharge. Three levels of heterogeneity were investigated, and the results demonstrated that there is a strong influence of the wider plume relative to the well downgradient control plane, reflecting the conditions tested, and increased uncertainty under simplified conditions. Screening level investigations were derived that can be used to facilitate the collection of reliable mass discharge measurements.

How will the contaminant plume respond to flushing? How should we manage long term ground water flow? How will the contaminant plume respond to changes in contaminant source mass, and therefore changes in contaminant flux?

Milestones and products in the current FY16 to FY19 planning cycle

Selected Research:  • Risks for all conditions tested ranged from 0 to 60%, and was strongly influenced by the method used to measure groundwater flux. Uncertainty ranged from 0% to 20% for all conditions tested, and increased as heterogeneity increased.  • Uncertainty was less for all methods at the downstream control plane, reflecting the influence of the wider plume relative to the well downgradient control plane.  • The diversity of the results provides a strong basis for the development of appropriate predictive models to better link characterization, prediction, and decision making.

Planned Product:  • A High Resolution Passive Flux Meter Approach Based on a Fractured Rock Aquifer Using Passive Flux Meters

Purpose: evaluate the performance of innovative tools - a spectrally resolved passive flux meter and modified classical passive flux meter – to measure groundwater flow velocity and mass fluxes in a fractured bedrock setting and to compare the results to current technologies. (The research group is a separate project in this area being performed by Dr. Cett for an example of a Regional ORD collaboration.)

The lower right graphic above shows results from experiments conducted to investigate the use of Gates tubes (upper right) as a field-based analysis method for passive flux meters. Passive flux meters are used to measure contaminant flux, and a conceptual depiction is shown in the left graphic above.

Application & Translation

Example applications:  • Research within the FY16 to FY19 planning cycle is ongoing, and its too early to identify specific applications from current research.  • Example applications associated with previous research include mass discharge reduction as an interim remedial goal for source treatment at two sites in Region 10, and mass discharge being used to assess contributions from multiple sources at a site in Region 9.

Research results will:  • Be used to improve source zone characterization.  • Improve predictions of source zone behavior.  • Provide a better understanding of flux measurement uncertainty.  • Improve reliability of flux measurements.

Planned Product:  • Flux-Based Site Management Summary Report

This product will summarize research that has been completed under a collaborative research project funded by the Strategic Environmental Research and Development Program (SERDP) to investigate effective field scale approaches based on flux measurements that can be coupled with appropriate predictive models to better link characterization, prediction, and decision making. This product will include research on the uncertainty of flux measurements and provide assistance in method selection (See Milestone at right).

The graphic above illustrates the concept of fitting models to site scale data, based on well sample analysis, production, and decision making.

The divided number of organizations illustrate the wide interest in flux measurements for contaminated site management purposes. Moreover, many of these organizations have been active participants in the research and have contributed to its development.

Lessons Learned

• Research within the FY16 to FY19 planning cycle is ongoing.  • A milestone has been completed showing the impacts of heterogeneity on mass flux measurements.  • A report is being completed summarizing results from a RARE project that investigated contaminant flux measurements in a fractured rock setting.  • Lessons learned from previous research: quantified the benefits of aggressive source zone remediaiton, and showed that significant (>90%) reductions in source mass discharge can occur.  • Derived screening-level equations for the uncertainty of contaminant flux measurements.

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SUSTAINABLE & HEALTHY COMMUNITIES RESEARCH PROGRAM

Purpose/Utility of Research

- How should we manage long term contamination problems?
- A key element needed to address this question is an understanding of how the contaminant source behaves over time, and how it responds to remedial treatment. This provides a foundation for making more accurate predictions, and thus improves management decisions.

A simple mass balance statement
Consider the box outlined with the white dashed line: Change in mass inside the box = Mass entering - Mass leaving - Mass destruction

J(t) = Contaminant flux [mass per unit area per unit time]

J(t) A = Contaminant mass discharge [mass per unit time]

- Flux combines two important features of contaminant risk: concentration and contaminant mobility.
- Flux based site management entails the use of contaminant flux and mass discharge measurements for site management purposes.

Science Questions

The following science questions summarize research goals that have been, and currently are being pursued within this research activity. Letters associated with Science Questions map research highlights to science questions.

- How do you collect field-scale measurements of contaminant flux?
- What is the uncertainty associated with contaminant flux measurements?
- How can we minimize the cost and maximize the certainty of contaminant flux measurements?
- How can we predict contaminant flux and mass discharge?
- How will the contaminant plume respond to changes in contaminant source zone mass, and therefore changes in contaminant flux?