

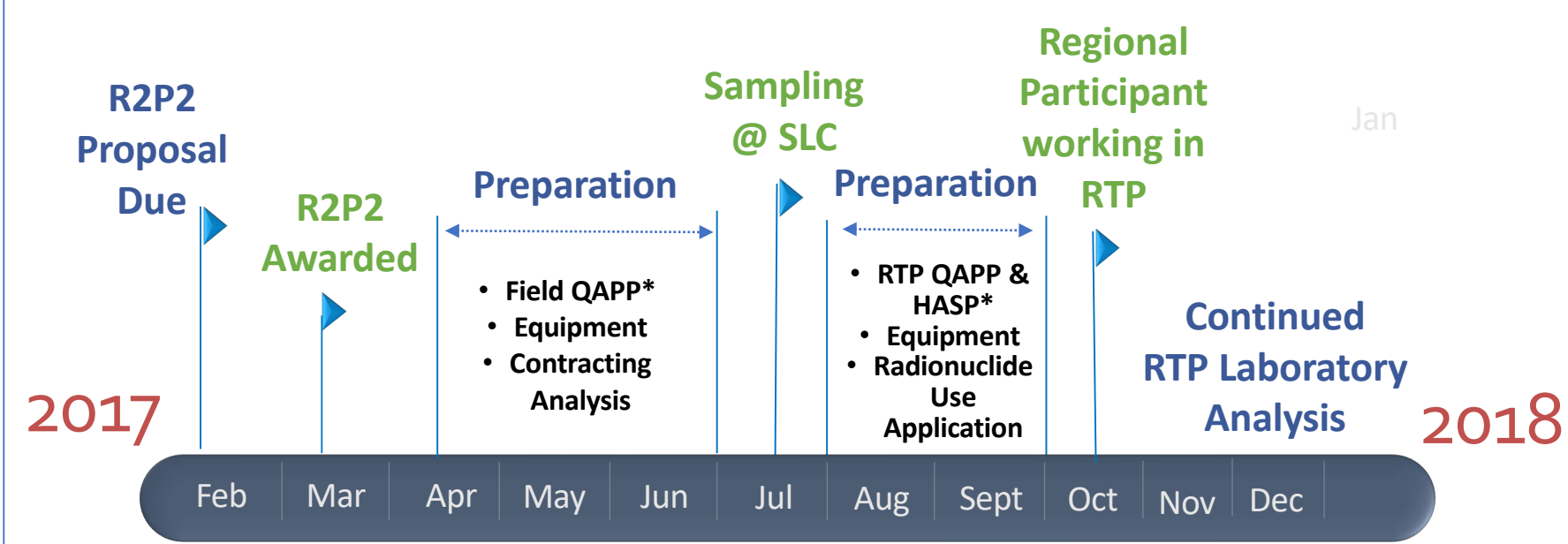
BACKGROUND

This project was part of the 2017 Regional Research Partnership Program (R2P2). R2P2 facilitates short term research opportunities for regional USEPA employees to work directly with Office of Research and Development (ORD) scientists and laboratory facilities. For this project, sediment was collected from the Safety Light Corporation (SLC) site, an active USEPA superfund site in Bloomsburg, Columbia County, PA. SLC formerly produced luminescent materials such as instrument dials, deck markers, exit signs, and other products which contained radioactive materials. The main radionuclides of concern (ROCs) onsite include: Ra-226, Cs-137, Sr-90, Am-241, and H-3, which were buried onsite in multiple "dump" areas and lagoons. The dumps and lagoons are in the floodplains of the Susquehanna River, and over the years have been affected by floods. This R2P2 project focused on understanding the fluvially-driven transport processes of radionuclides.

RESEARCH QUESTIONS

- Under what hydraulic, sediment property, and water quality conditions are ROCs transported in freshwater rivers?
- Is entrainment of the ROCs in drinking water intakes a cause for concern?

PROJECT TIMELINE



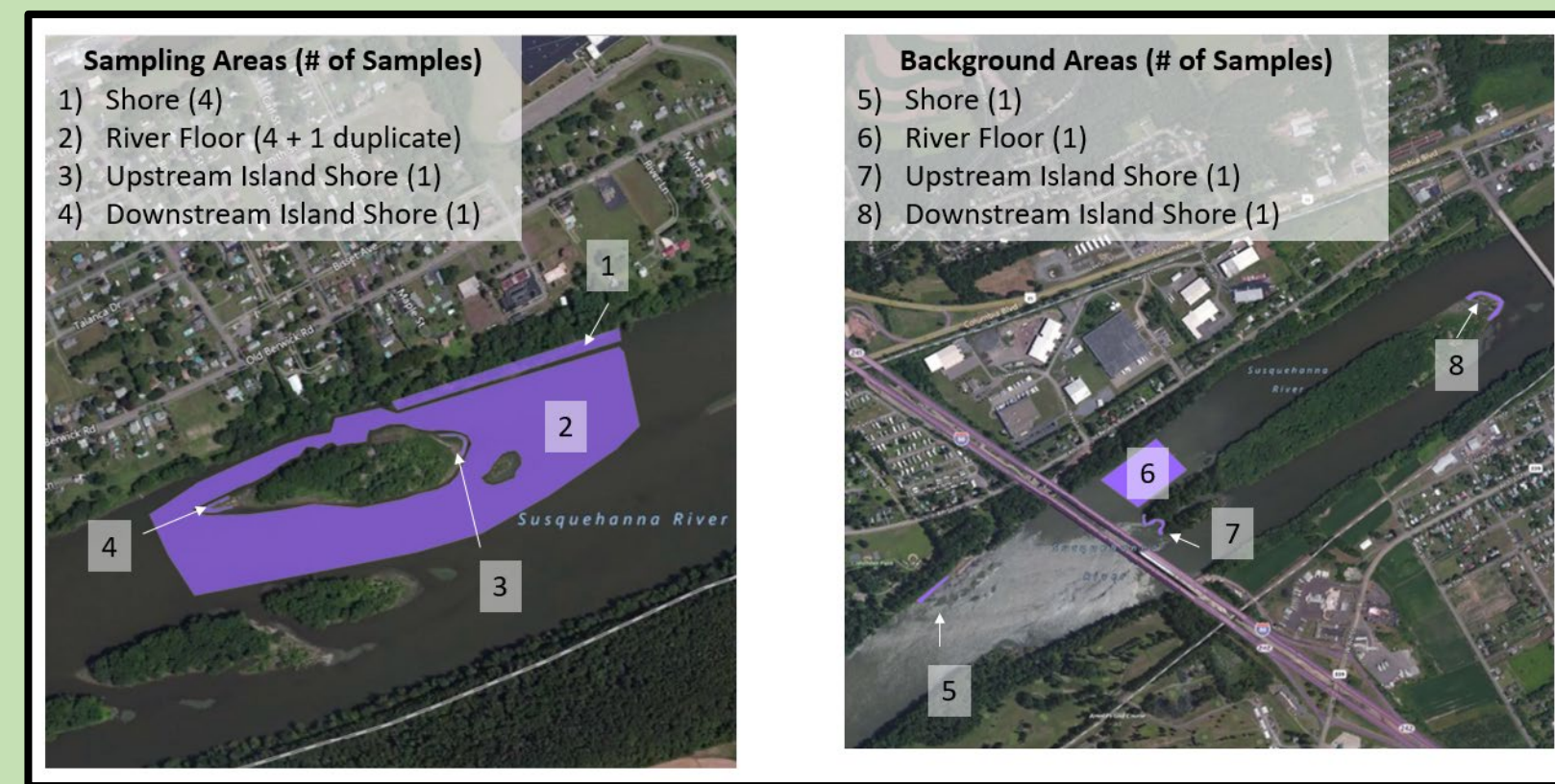
*QAPP = Quality Assurance Project Plan
*HASP = Health And Safety Plan

EQUIPMENT & ANALYSIS PROCUREMENT

Item	Supplier	Notes
Boat	Region 3 Dive Team	Water depths in the Susquehanna were low during field work, so a small zodiac was necessary.
Sediment Corer & Ponar Sampler	Region 3 EAID Wheeling, WV	It would have been ideal to have disposable sheaths for sediment cores, but the only corer we could find had 2.75" sheathing which is only made to custom order.
Sediment Radionuclide Analysis	USEPA's Office of Land and Emergency Management's CMAD DATS Contractor	USEPA's National Analytical Radiological Laboratory (NAREL) was under construction during this project and methods did not meet some necessary detection limits. Also explored using several interagency agreements, but costs were prohibitive.
Water Radionuclide Analysis	USEPA's NAREL	Samples included field blanks, rinseate blanks of sediment corer, and wastewater generated in RTP.
ICP-MS	USEPA's ORD NHEERL	Cesium Analysis

FIELD WORK

Sample Plan



Sample locations were selected using Generalized Random Tessellation Stratified (GRTS) theory developed by the USEPA for the National Environmental Monitoring and Assessment Program (Stevens and Olsen, 2004). The package "spurvey" (written in the programming language R) was used to obtain the GRTS sample coordinates (Kincaid, 2016). An equally-weighted stratified design type was used to place samples within the areas depicted in the photo above.

Sample Collection & Processing



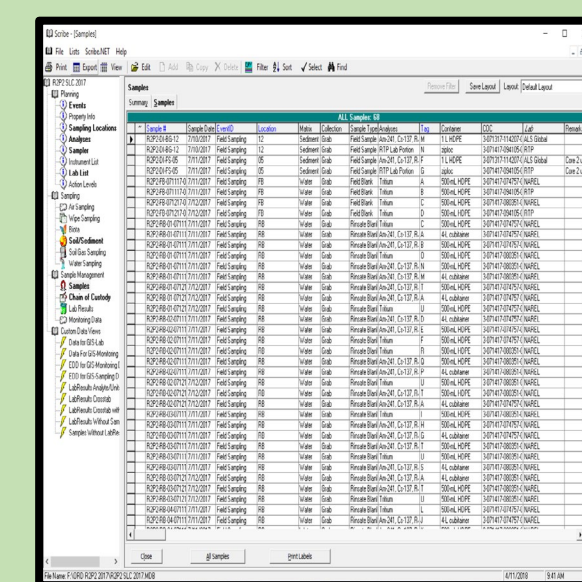
A) US EPA Region 3 Office of Preparedness and Response (OPR) staff worked with agency attorneys to determine property boundaries along PA waterways, PA Fish and Boat Commission to obtain approval to enter the water from their Bloomsburg area boat launch, the Region 3 dive team to acquire a boat and operator, and the regional SHEM manager to ensure the boat contained all safety supplies necessary. A drafted float plan outlined how personnel would be involved in boating activities and detailed the safety precautions taken while working on the water.

B) The team employed the use of many technology-based aids to assist with sample collection. Proposed sampling points were loaded into the ArcGIS Collector app and used on team members' mobile devices in the field. The USEPA Region 3 GIS team created a field site sample map in the collector app, and members of the field team uploaded photos, amended sample collection points, recorded sample date and time, and provided further descriptions of the samples using the app.

C) The team worked with SLC site personnel to process sediment samples in a safe location that did not interfere with active remediation.

Data Management

The team used the Scribe database software to organize sample data and create sample labels and chains of custody. The USEPA Emergency Response Team (ERT) created Scribe for the Removal Program in order to collect and organize information and analytical data for samples collected on removal sites. Scribe has many customizable features, making it suitable for various types of sampling events. Databases can be uploaded to scribe.net, allowing others to easily access, subscribe and view the data. Because the team used Scribe to manage field sampling data, it was easy to produce and share information when needed.



Health and Safety

The team had to abide by site safety rules. Each field team member participated in required radiation training and was issued a Thermoluminescent Dosimeter (TLD) as part of the US EPA's Radiation Protection Program. In situ sediment screening ensured radiation levels were within the guidelines set onsite for radiation health and safety.



LABORATORY WORK

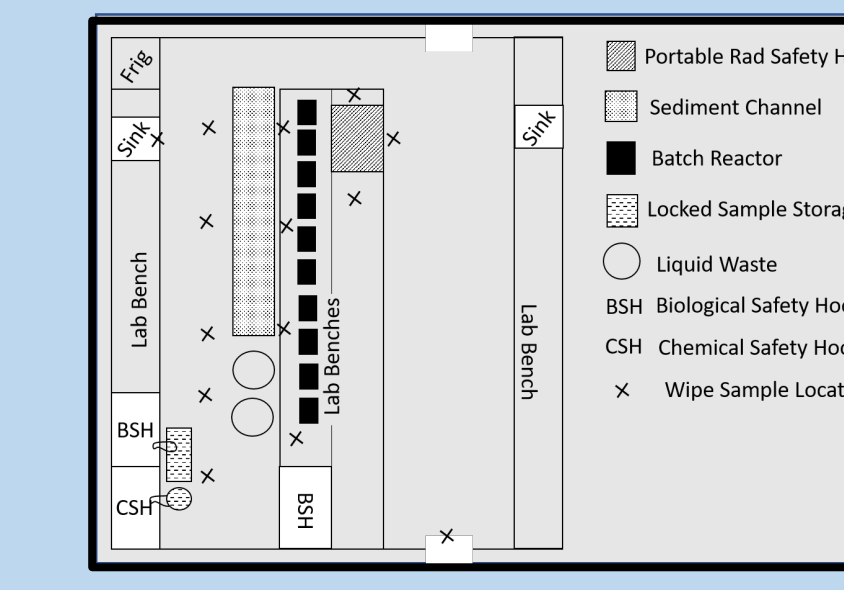
Preparation

Bringing potentially radiologically contaminated sediment to Research Triangle Park (RTP) from a superfund site required substantial planning. The project team worked closely with the Radiation Safety Officer (RSO) in RTP to ensure planning documents were completed properly and that the sediment brought to the lab maintained the RTP NRC site license requirements. This included:

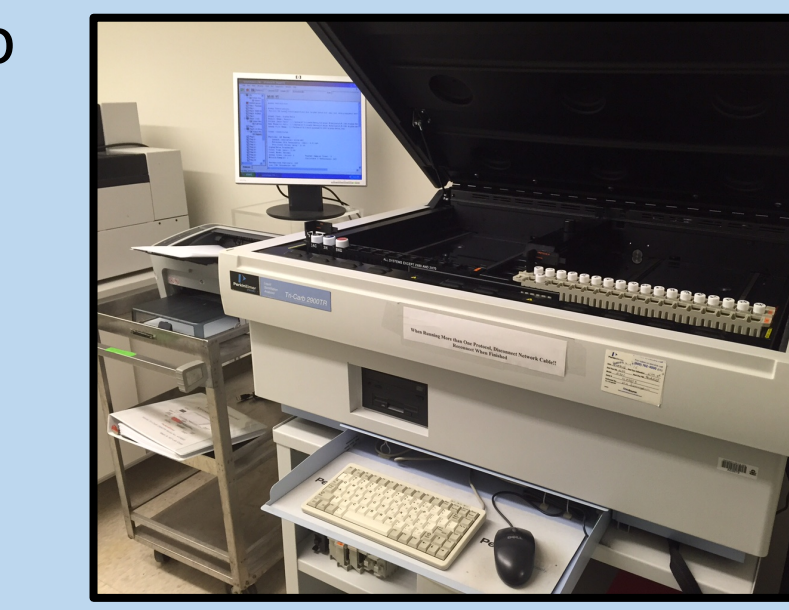
- Analysis of samples for radionuclide concentrations prior to bringing samples to RTP
- Completing a Radiological Use Application that provided:
 - Locked space for sample storage
 - Contamination control wipe sampling plan
 - Disposal plan for waste sediment and water
 - Demarcation of laboratory work stations



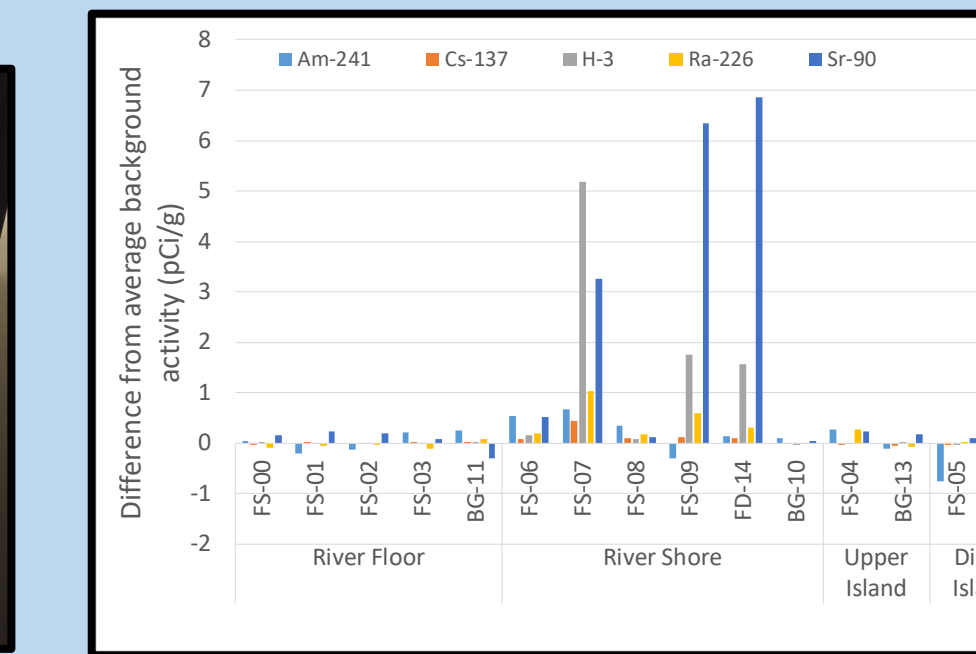
Geiger counter



Wipe sample locations



Liquid Scintillation Counter (LSC)

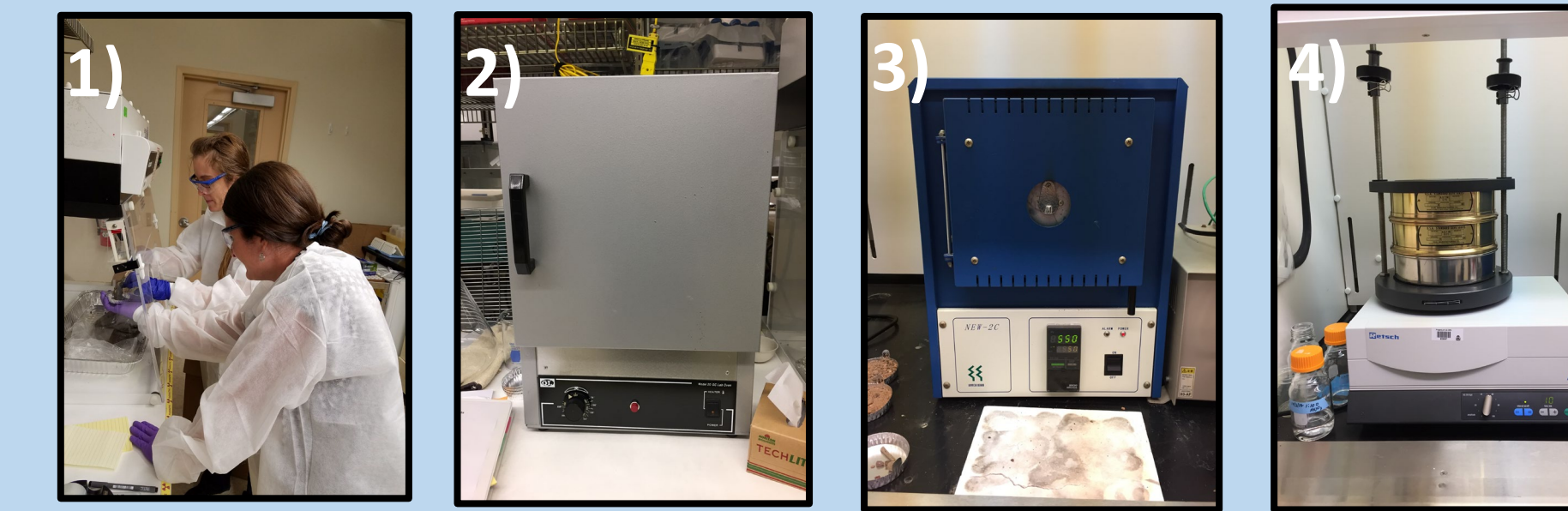


ROC activity in SLC samples

Experiments

Sediment Characterization

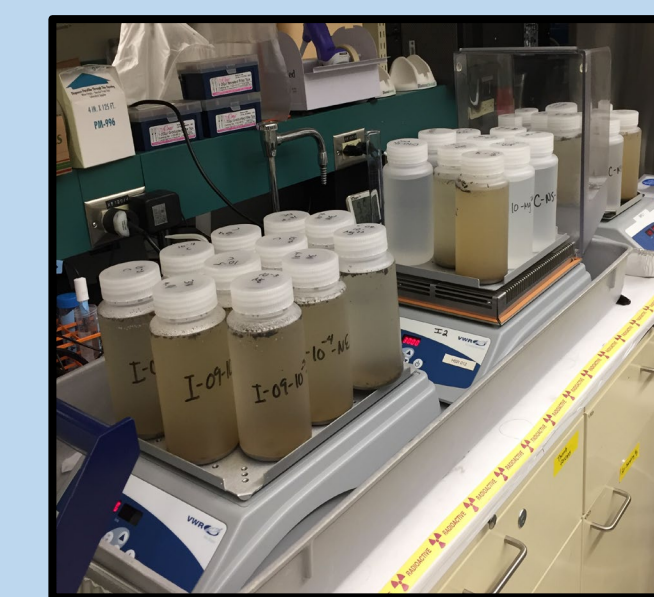
1. Weigh triplicate subsamples from 14 locations
2. Dry at 100 °C
3. Remove organics in muffle furnace at 550 °C
4. Sieve to separate gravel, sand, and mud-sized fractions



Batch Reactor Experiments

Understanding Cesium Sorption

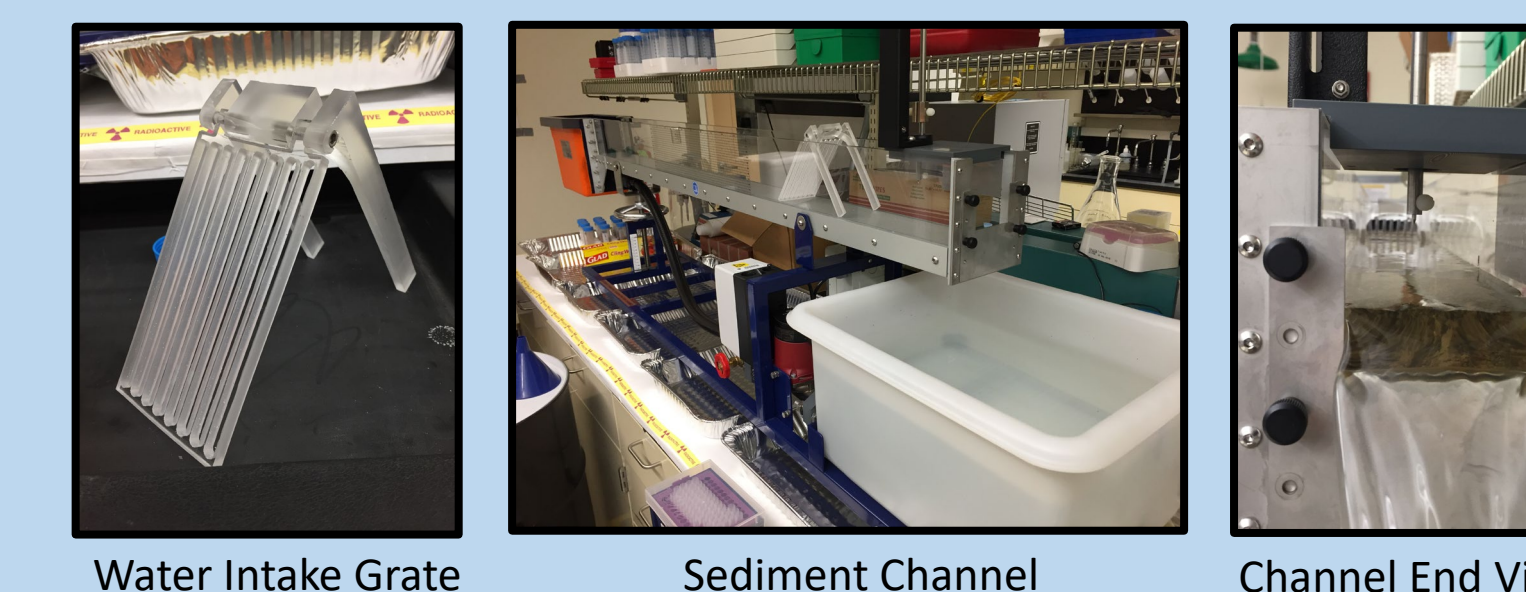
- Kinetic experiments (2 water types & samples collected at 8 time points)
- Isotherm experiments (different Cs-133 concentrations over 5 logs)
- Ionic strength and cation type experiments (with Mg²⁺, Na⁺, K⁺)



Shaker tables with samples

Sediment Channel Experiments

Higher Total Suspended Solids with Grate Presence?



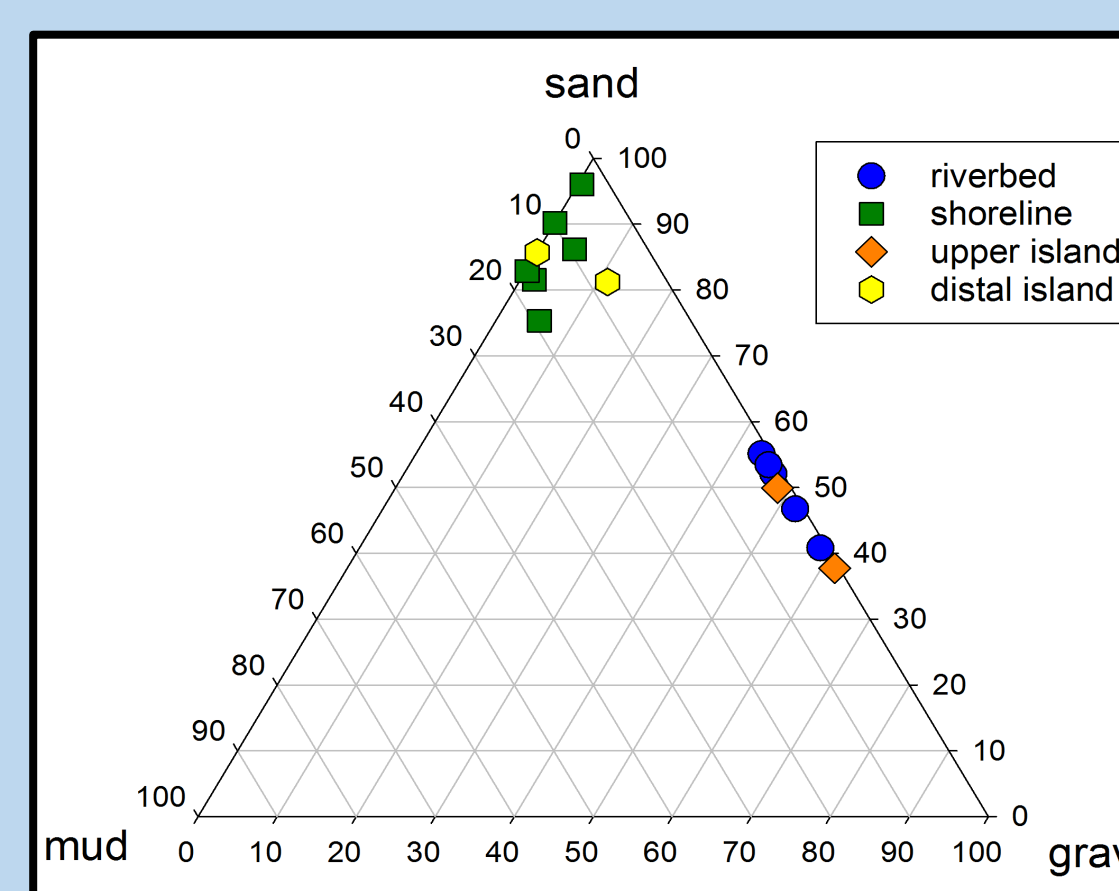
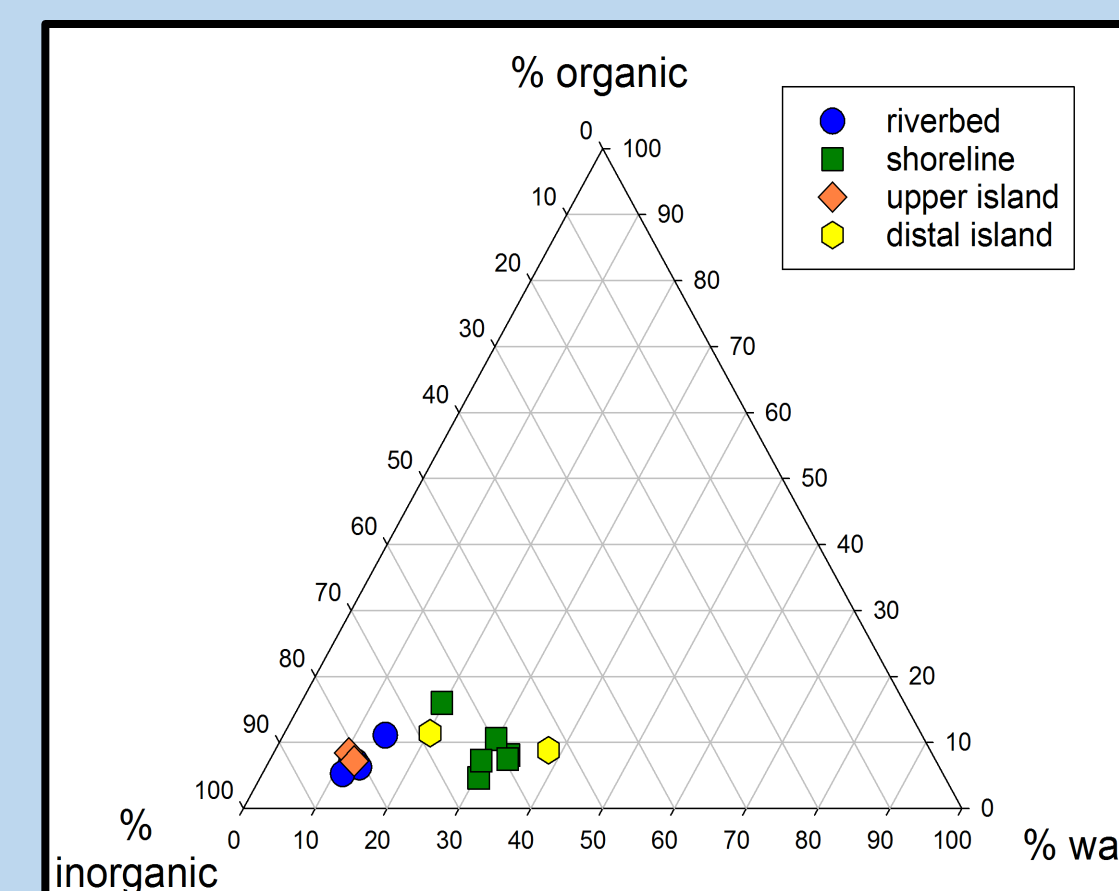
Water Intake Grate

Sediment Channel

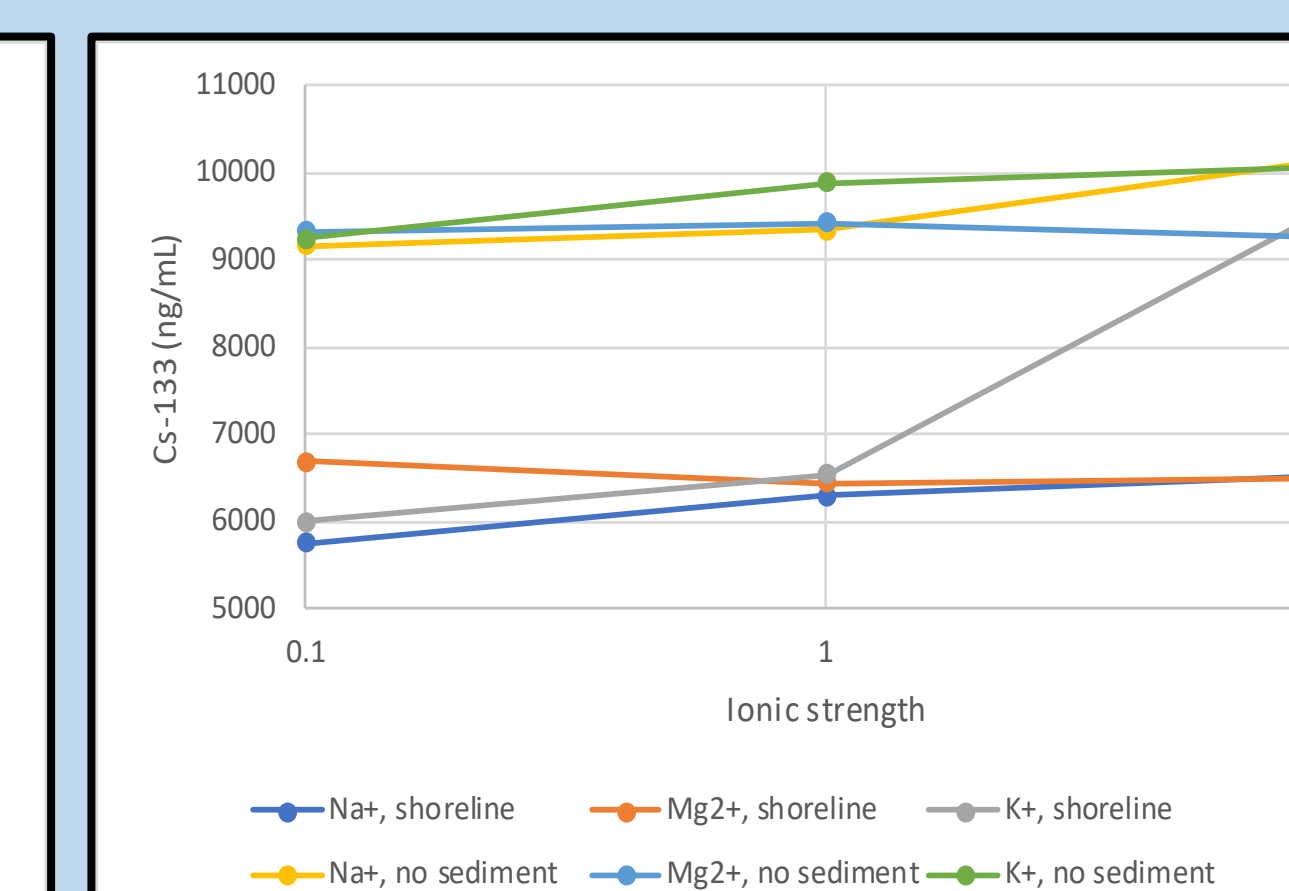
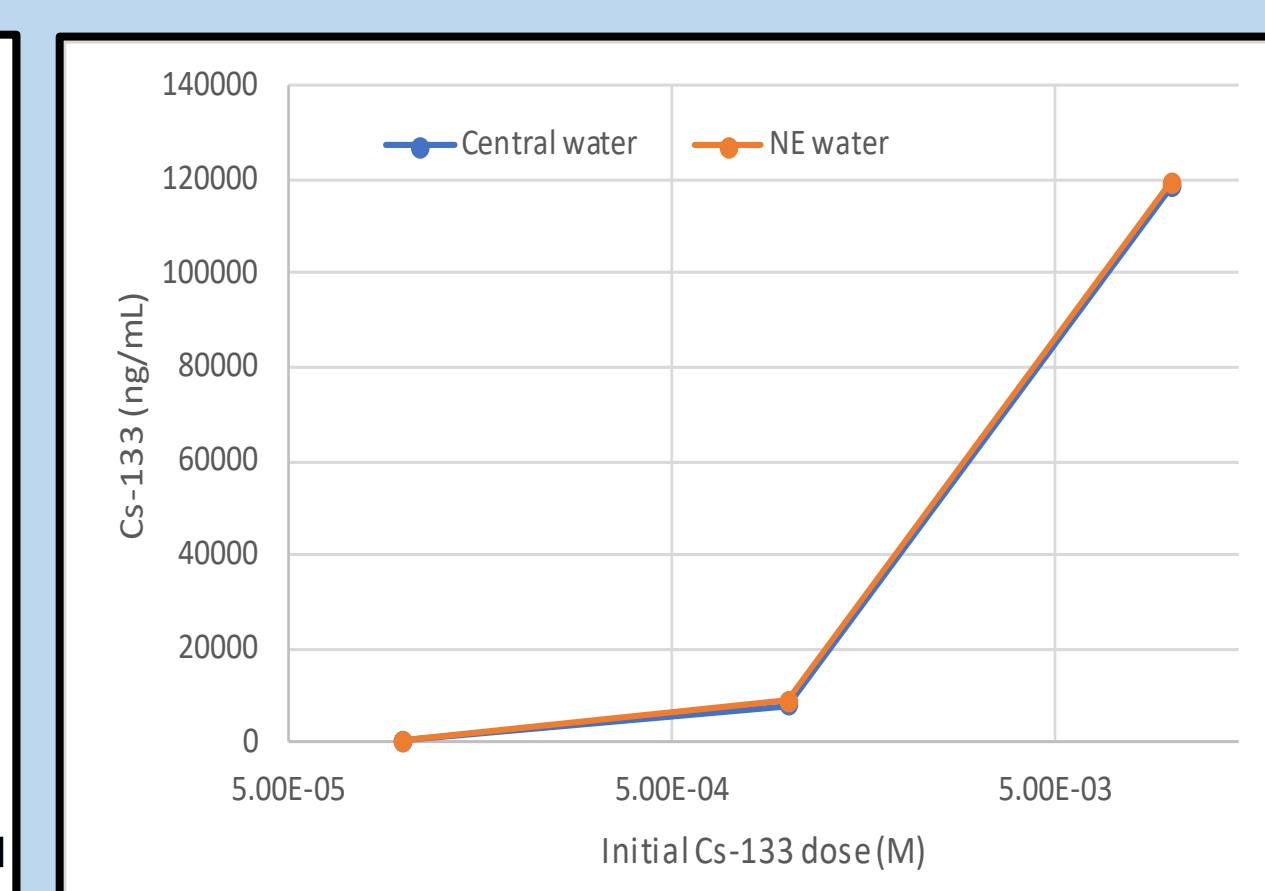
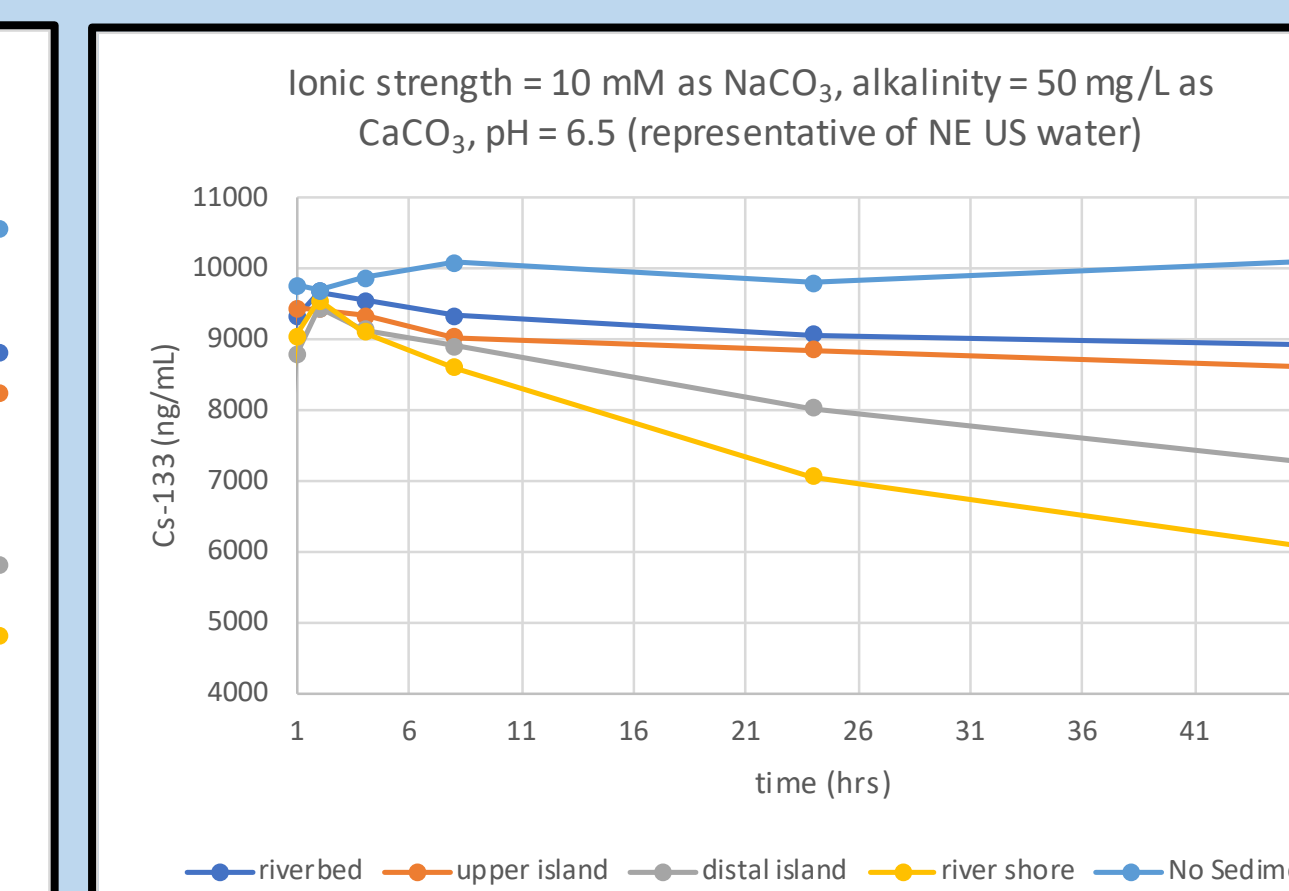
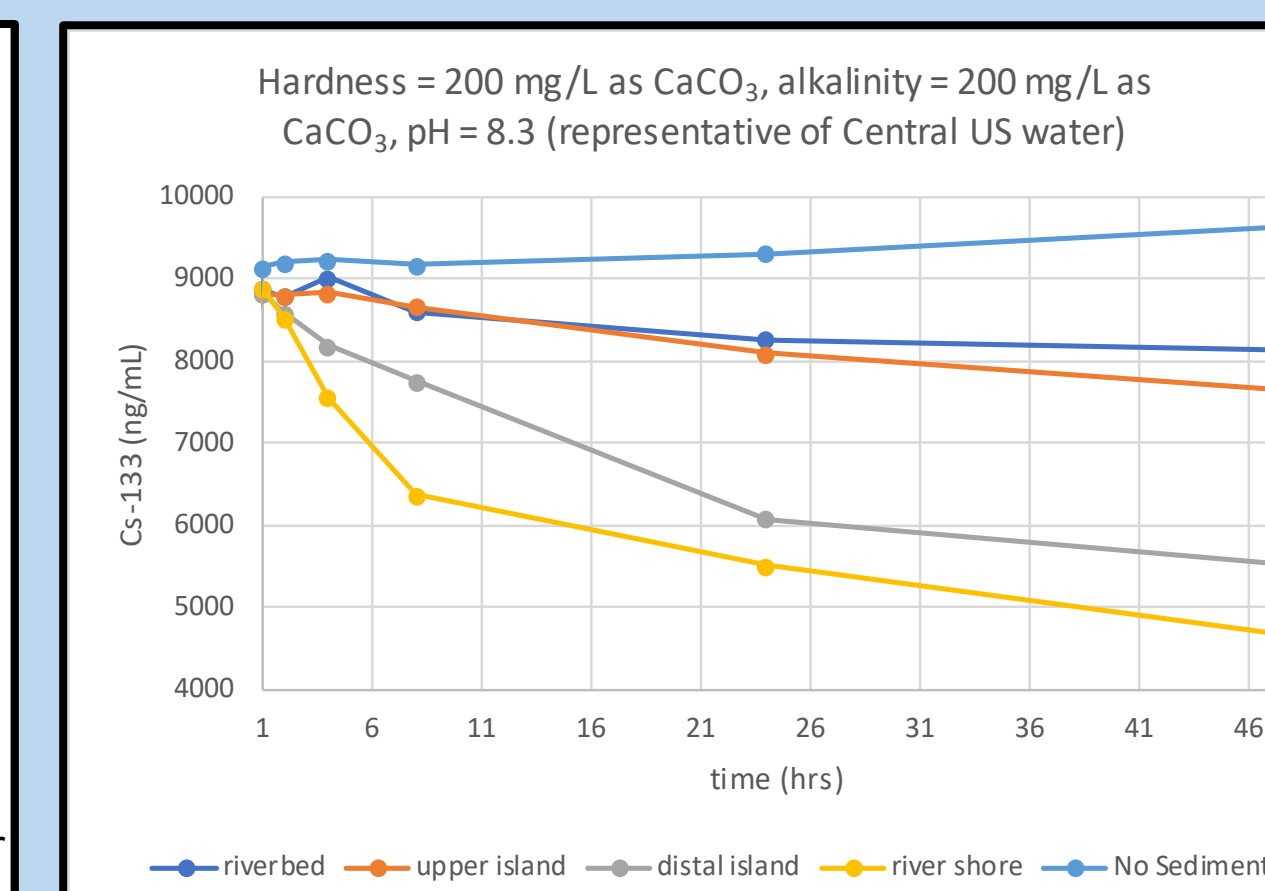
Channel End View

Results

Sediment Characterization



Batch Reactors



Greater Cs-133 sorption with higher fraction clay/organic content (shore & distal island)

Over the range of flow velocities tested (mimicking allowable conditions at a water intake), very little sediment was entrained (undetectable), both with and without the water intake grate.

PROJECT PARTNERSHIPS

This project was designed to assist both Region 3 Office of Preparedness and Response (OPR) and ORD National Homeland Security Research Center (NHSRC) with research and analytical needs. Project partnerships like this allow for two separate initiatives to be addressed with one project. Beyond consolidating efforts to complete tasks, the networking opportunities were immense and the project facilitated communication between agency employees and our response and research partners.

The project was developed with the hope that it would help NHSRC further research needs outlined in their Homeland Security Strategic Research Action Plan for 2016-2019. The plan calls for more research regarding large area radiation contamination events. Results from this project will be used to help further research in Topic 2, Water System Security and Resilience and Topic 3 Remediating Wide Areas.

This project will also benefit Region 3's Remedial program. Results from the previous sediment samples collected onsite and downstream of the site during the remedial investigation were rejected during validation. The results from the sediment samples collected during this project will be filed with the SLC site to fill in data gaps resulting from the rejected results to support decisions made about future actions onsite.

This project required many groups to ensure the work was completed safely and competently. These included:

- Region 3 Hazardous Site Cleanup Division (HSCD) OPR and Office of Superfund Site Remediation (OSSR)
- Office of Research and Development (ORD) National Homeland Security Research Center (NHSRC) and National Health and Environmental Effects Research Laboratory (NHEERL)
- USEPA Consequence Management Advisory Division (CMAD)
- USEPA National Analytical Radiation Environmental Laboratory (NAREL)
- Oak Ridge Institute for Science and Education (ORISE)
- Region 3 Dive Team
- Region 3 Wheeling Office
- Environmental Assessment and Innovation Division (EAID)
- RTP Radiation Safety Officer (RSO)
- RTP Machine Shop
- Region 3 Science Liaison (RSL)
- Safety Light Corporation Site Crew
- PA Department of Environmental Protection Bureau of Radiation Protection (PADEP BRP)
- Region 3 HSCD Office of Regional Counsel (ORC)
- PA Fish and Boat Commission



RESEARCH OPPORTUNITIES

- NHSRC will continue batch reactor research testing with different water quality parameters to determine under what conditions radionuclides will be transported in flow versus remain sorbed to stationary sediment.
- NHSRC will continue to use the sediment flow channel to study radionuclide transport in overland flow on impervious materials.

DISCLAIMER: The United States Environmental Protection Agency (EPA), through its Office of Research and Development's National Homeland Security Research Center, funded and managed this investigation through contract number EP-C-15-008. This poster was peer and administratively reviewed and has been approved for presentation as an Environmental Protection Agency document. It does not necessarily reflect the views of the Environmental Protection Agency. No official endorsement should be inferred. This report includes photographs of commercially-available products. The photographs are included for purposes of illustration only and are not intended to imply that EPA approves or endorses the product or its manufacturer. EPA does not endorse the purchase or sale of any commercial products or services.