IMFD–SEE 1 AUGUST 2018

MEMORANDUM FOR RECORD

SUBJECT: Fort Detrick Restoration Advisory Board (RAB) Meeting Summary,
1 AUGUST 2018

1. Summary Contents

Items addressed at the meeting are listed below, with corresponding section numbers indicated in the column on the right.

Please note: PowerPoint presentations were utilized during the RAB meeting. A copy of the presentations is attached to these minutes and is incorporated into these minutes by this reference.

Text contained within brackets [] has been added for clarification purposes.

2. Attendees

Members Present:

Dr. Gary Pauly, Community RAB Member, Co-Chair
Mr. Joseph Gortva, Army Co-Chair, Fort Detrick, Chief, Environmental Program
Mr. Barry Glotfelty, Frederick County Health Department
Dr. Elisabeth Green, Maryland Department of the Environment
Ms. Jennifer Hahn, Community RAB Member
Mr. Karen Harbaugh, Community RAB Member
Mr. George Rudy, Community RAB Member
Mr. Rob Thomson, US Environmental Protection Agency

Others Present:

Mr. Larry Brown, US Environmental Protection Agency
Mr. John Buck, US Army Corps of Engineers
Mr. John Cherry, ARCADIS
Mr. Brandon Fleming, USGS
Ms. Shelly Morris, On-Site Contractor to Fort Detrick Environmental Restoration Program
Mr. Gary Zolyak, Fort Detrick, SJA
Mr. Robert Law, Sierra Club
Ms. Kathleeen Rall, Sierra Club
Ms. Jennifer Kunze, Clean Water Action
Ms. Tracy Coleman, City of Frederick
Ms. Naki Frierson , Office of Sen. Chris Van Hollen
Mr. Nick Minecci, Fort Detrick, Public Affairs Office
Ms. Katrina Harris, Bridge Consulting Corp.

Members Absent:

Mr. Rolan Clark, Community RAB Member
Mr. Eli DePaula, Community RAB Member
Dr. Henry Erbes, Community RAB Member
Mr. Cliff Harbaugh, Community RAB Member
Mr. Barry Kissin, Community RAB Member

3. Meeting Opening / Remarks

Mr. Joe Gortva opened the meeting, welcomed everyone, and thanked everyone for attending. Mr. Gortva invited all to introduce themselves. Mr. Gortva said the meeting's ground rules are fairly simple and designed to get information out to the Board and the community. He stated Board members should feel free to ask clarifying questions during presentations; members of the public observing the meeting are asked to hold their questions until the end of all the presentations as there is time at the end of the meeting for open discussion and questions from the community.

Mr. Gortva introduced Dr. Gary Pauly, Community Co-Chair, and invited Mr. Pauly to offer any comments. Mr. Pauly stated he did not have any comments.

Mr. Gortva invited introductions and reminded everyone to sign-in on the sheets on the back table.

4. Meeting Minutes presented by Mr. Joseph Gortva, Fort Detrick

Mr. Gortva stated Ms. Shelly Morris had emailed the minutes from the last meeting. He requested any comments be sent to Ms. Morris in the next week and then the final version will be distributed.

Mr. Gortva said the final minutes will probably be sent by email as the web site is being re-designed. Mr. Nick Minecci advised the goal is to have the new web site in place by September 30.

Mr. George Rudy asked about the status of the operating procedures and whether the status of the community RAB members has been confirmed. Mr. Gortva requested Ms. Morris follow-up on the membership status of community members who have not been attending meetings and then send out the operating procedures for an e-mail vote.

5. Area B Landfill Cap Monitoring Network Expansion presented by Mr. John Buck, US Army Corps of Engineers, Baltimore District

Mr. John Buck reminded the Board 16 new groundwater monitoring well locations had been installed to supplement the existing network around various landfills on Area B. Mr. Buck displayed a map showing the locations of the new wells in purple and blue. He noted the new wells had been strategically located in coordination with the US Environmental Protection Agency (EPA) and Maryland Department of the Environment (MDE) to provide further information regarding what might be emanating from landfill areas. Mr. Gortva noted the wells are to make sure the Army is adequately monitoring each of the disposal areas.

Mr. Rudy asked about the monitoring frequency and whether the monitoring is in real time. Mr. Buck responded the wells will be monitored at least semi-annually, and the monitoring is not real-time monitoring. Ms. Morris noted there is a comprehensive program in place to monitor the landfills and caps including sampling the groundwater monitoring wells, monitoring the lysimeters, inspecting the caps, mowing, and cap maintenance. Mr. Gortva added that some of the wells are monitored for other purposes or may be sentinel wells so some of the wells could be monitored quarterly.

Mr. Buck displayed a chart showing the wells installed and their depths. He noted all had been successfully installed.

Mr. Buck showed a map and pointed out the locations of five wells that periodically became dry during dry weather conditions. He advised those wells have been replaced with new, deeper wells to ensure they will not go dry during dry seasons to further enhance the capability of

monitoring the landfills. Mr. Buck displayed a chart showing the wells installed and their depths.

Mr. Buck displayed a map showing the location of the lysimeters which he had discussed at a previous meeting. He stated the lysimeters provide another line of evidence to show the effectiveness of the landfill caps in minimizing infiltration of rainwater as conditions under the caps are compared to conditions outside the cap. Mr. Buck showed a chart of the lysimeters installed and their depths; he noted L4 could not be installed. Mr. Buck said the Army is currently working on how best to monitor the lysimeters and the monitoring frequency.

Mr. Rudy stated the nuclear industry has proven capped waste areas degrade over time and asked how the Army will prevent the migration of contaminants from the Area B landfills. Mr. Buck responded the purpose of the caps is to prevent contact with waste and minimize the infiltration of rainwater through waste into the groundwater, while simultaneously exploring how to remediate the groundwater. Mr. Gorta added that the Army is monitoring the performance of the caps over time. He explained that the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requires a formal review every five years at sites where waste is left in the ground. He continued explaining that the formal five-year reviews are to ensure remedies are still protective, and a report is prepared and submitted to EPA and MDE for their review and recommendations and also made available to the public. Mr. Gortva referenced the comprehensive monitoring program mentioned by Ms. Morris which looks for any issues so action can be taken. Mr. Rudy distributed the cover and a graphic from a report entitled "Engineered Covers for Waste Containment: Changes in Engineering Properties and Implications for Long-Term Performance Assessment" published by the US Nuclear Regulatory Commission. Mr. Rudy and Ms. Morris agreed to work on getting the full report in a format that can be distributed to other RAB members.

Ms. Jennifer Hahn referenced an email she had sent with questions about any potential impact from the recent heavy rains on the migration of contamination and stated she had not yet received a response. Ms. Morris and Dr. Elisabeth Green stated they had discussed the e-mail but had not yet gotten back to Ms. Hahn. Ms. Morris advised sampling had been conducted in early May, as well as last week; she noted results will be shared at the next RAB meeting which might answer Ms. Hahn's questions. Dr. Green added that as rainfall raises the water table, it is possible contamination normally above the water table, could come in contact with the groundwater. Ms. Hahn asked if other contaminants other than TCE and PCE would be part of the analyte list. Mr. Gortva responded that based on historical samplings and evaluations for many years, the contaminants of concern which have been detected and are mobile are volatile organic compounds such as TCE and PCE; other compounds are sampled and analyzed for as part of the semi-annual groundwater sampling. Mr. Gortva said if there would be a change in the contaminants of concern, it would be seen in the wells around the capped landfills.

Ms. Hahn said she was also concerned about the impact heavy rains and runoff from the proposed new roadway could have on the landfill caps. Mr. Gortva responded that before any roadway is constructed, the plans needs to be approved by the Army, MDE and EPA, followed by Army higher headquarters' approval to allow the granting of an easement. He stated Ms. Hahn's concern about runoff would also have to be addressed as part of the design process to

look at perhaps curbing runoff as part of the water management plan. Mr. Rudy stated vibrations from vehicles would also have to be considered. Mr. Rudy said he thought he had heard the road had been approved and asked Ms. Tracy Coleman for confirmation. Ms. Coleman confirmed the road has not been approved nor designed yet. Ms. Coleman advised to date only a geophysical analysis has been performed which requires very little disturbance of the ground, if any. Mr. Gortva stated the Army had advised the City that they had no reason to suspect disposal areas along the proposed pathway; the City then conducted its own geophysics and confirmed there were no disposal areas. Mr. Gortva advised the City is working on getting final approvals for the geotechnical borings, including waiting on the Army's approval for the dig permit which he anticipated will be issued in about a week. Mr. Rudy asked for confirmation that an environmental consultant will be providing support to Fox and Associates, and Ms. Coleman confirmed Fox and Associates is the lead consultant for the design and analysis team and has other consultants supporting them. Ms. Hahn requested the name of the environmental consultant supporting Fox and Associates be provided, and Ms. Coleman said she would provide this information.

6. Area B Pilot Study presented by Mr. John Cherry, Arcadis

Mr. John Cherry advised he would be presenting an update on two of Arcadis' recent efforts—a pilot study for Area B and the Site Inspection at Area A. He explained the pilot study will be looking at some potential remedial actions to assess their effectiveness so informed decisions can be made down the road during the Feasibility Study, Record of Decision, and Remedial Action phases. He continued explaining the Site Inspection at Area A had been discussed at previous meetings so tonight he would be giving an update.

Mr. Cherry expanded on the purpose of the pilot study. He stated the Army has reached the point in the investigation of Area B groundwater where EPA and MDE are willing to discuss ideas to assess potential response actions. He advised a work plan is being developed collaboratively with EPA and MDE. Mr. Cherry stated with the complex karst geology and a number of challenges with the nature of the contamination, a collaborative effort was undertaken to think about what can be tried and what gives the best shot of achieving the overall objective of mass removal to improve conditions. Mr. Cherry explained the purpose of the pilot study is not to try and clean up the whole plume which will be the objective of a full-scale remedy; the pilot study is the initial step to consider what options might be most effective. He continued explaining that several options had been identified for the pilot study. He said it is anticipated an Army contractor will be implementing the pilot study in six to eight months. Mr. Buck added that the Army is working to put a contract in place by September 30.

In response to a question from Mr. Rudy, Mr. Gortva said the work plan will be made available to the RAB membership after EPA's and MDE's review.

Mr. Cherry displayed an aerial photograph showing the distribution of volatile organic compounds in the groundwater at Area A, noting the black outline is the Area B boundary. He explained the pie charts are used to convey the magnitude or concentrations of volatile organic compounds, with bigger pie charts denoting monitoring wells with the higher concentrations of contamination; there are four primary contaminants: trichloroethene (TCE), tetrachloroethene

(PCE), chloroform, and cis-1,2 dichloroethane (DCE). He noted groundwater flow is generally to the east or southeast, with contamination starting at the western disposal area and migrating to the east/southeast. Mr. Rudy asked if the pie charts in the southeast are source points or the result of drainage from Area B, and Mr. Cherry said groundwater flow from Area B is impacting off-site areas. Mr. Rudy and Ms. Hahn asked about the contamination on the Waverley property which is the southwest; Ms. Hahn noted the property is now up for sale. Dr. Green stated the groundwater use restriction would remain on the Waverley property and would be part of the deed. Mr. Gortva said that dense non-aqueous phase liquid (DNAPL) follows gravity and can flow in a different direction than groundwater. Mr. Gortva said the Army drilled wells to 500 feet on the Waverley property to see if there was DNAPL on the property, and all evidence to date shows there is not DNAPL on the Waverley property, but there is some element of contaminated groundwater coming from Fort Detrick through the fracture system onto the Waverley property. He stated the contamination levels detected on the Waverley property are low, with the highest concentrations being detected along the fenceline.

Mr. Rudy asked if the groundwater at the residences on Kemp Lane which were connected to municipal water was contaminated. Mr. Gortva advised that the Army had initially provided bottled water to those homes as a precaution, but no exceedances were ever detected in these private wells.

Mr. Cherry said the objective is to tackle the contamination mass where it originates, knowing there are small pockets of contamination in other areas; however, by tackling it at the source, everything else improves over time.

Mr. Cherry showed a graphic of the conceptual site model and noted he would be taking about both groundwater and surface water components of the pilot study. He stated for the groundwater component the two remediation technologies to be tested are pump and treat and enhanced reductive dichlorination. He said the technology to be tested during the surface water component will be pond aeration using several techniques. Mr. Cherry advised the general schedule is to begin in early 2019 with the implementation of all the options taking about 2.5 years. He noted there will be drilling that needs to be done, along with a fairly long implementation phase. He noted the groundwater technologies will be done sequentially with the pump and treat test done first; this will allow the results to be independently assessed.

Mr. Cherry explained the pump and treat technology was an option the EPA hydrogeologist felt would be worthwhile testing. He said the technology involves installing two pumping wells downgradient from the monitoring wells with the highest concentrations of contaminants, pumping the water out of the ground, treating the water, testing the water to confirm it is clean using the full suite of analytes used during the remedial investigation, and discharging the water to local streams. Mr. Cherry explained that because of the karst environment the pumping rate would be in the range of 10 to 20 gallons per minute. He also explained the groundwater sampling will be used to design the treatment process. Mr. Cherry said the pilot-scale equipment will be flexible and able to accommodate future needs, such as the potential roadway, and be able to be scaled up to a full system if desired; more details will be provided at future meetings as the design starts to be developed. Mr. Gortva stated that starting with a smaller, pilot-scale system is cost-effective in case it is determined to not be a viable alternative.

Mr. Cherry stated baseline sampling will be conducted, along with regular testing during the approximate eight-month long study. He explained the sampling will be weekly in the beginning and then spaced out further. He said the objective is not to capture the whole plume, but to pump at a fairly low rate in contaminated zones and be able to assess how much mass can be removed. He said some mass would be removed during the test.

Mr. Cherry next discussed the second technology—enhanced reduction dechlorination. He said this technology has been successfully used for several decades. He explained this technology involves drilling 12 shallow injection points, injecting carbon solution (food-grade molasses) and monitoring the ground water. He explained the carbon solution stimulates the growth of the microbial community which degrades the volatile organic compounds. Mr. Gortva noted this technology is sometimes referred to as bioremediation.

Dr. Pauly asked if the pilot study would rely on bacteria already present. Mr. Cherry responded that the work plan calls for bioaugmentation which would be injecting a microbial community that is effective in degrading volatile organic compounds.

Mr. Cherry advised the second technology would be tested on the north side of the B-11 cap. He stated there is a good network of monitoring wells with a long history of sampling data that can be used for comparison purposes. He said the work plan calls for perhaps two or three injections so it will be a robust pilot study.

Mr. Cherry next discussed the surface water component of the pilot study. He explained the approach is to install and operate aeration technology in an off-post pond (Robinson Pond) to facilitate the removal of volatile organic compounds from surface water. He said the objective is to evaluate the treatment efficiency of aeration systems to reduce volatile organic compounds in the pond water and ultimately Carroll Creek. Mr. Cherry said calculations have been done to estimate the loading of contaminants detected in Robinson Pond to Carroll Creek, and the thinking is if the mass in Robinson Pond can be removed or reduced, the concentrations in Carroll Creek will also be reduced. Mr. Cherry said a right-of-entry agreement will be needed from the property owner; the project has been discussed with the property owner and he seems amenable to the proposed work.

Mr. Cherry displayed a map showing the highest levels of surface water TCE concentrations between 2012 and 2017 as well as non-detections. He stated the highest concentrations in Carroll Creek are an area referred to as the primary discharge area and are in the single digit range of 1 to 3 parts per billion. He said the concentrations moving away from the primary discharge area are very low at less than 1 part per billion compared to the maximum concentration allowed in drinking water which is 5 parts per billion. He noted there are some seeps and springs that feed into Carroll Creek that have higher concentrations in the 10 to 13 parts per billion range. Mr. Cherry advised the levels of PCE are lower than TCE concentrations.

Mr. Cherry said pore water samples were collected from the sediment at the base of the stream to assess the water flowing in Carroll Creek; there were low levels of TCE detected, with 4.9 parts per billion being the highest concentration detected.

Mr. Cherry said the screening criteria for an ecological assessment is 21 parts per billion in order to be protective of species found in the streams; the values detected are below this number. Mr. Cherry said human health calculations have also been performed based on the concentrations detected, and no human health risk has been found. In response to Mr. Rudy's question about whether any warnings needs to be issued by the County regarding recreational use of Carroll Creek, Mr. Gortva said the issue has been examined multiple times in the past based on concentrations detected in Carroll Creek, and all the values are below the recreational standard for consumption of fish. Mr. Gortva said the reason for the pilot test is to see if there is a reduction in the pond area, will it affect the entire stream or are there potentially other areas being discharged to the Creek. He continued explaining that the pilot test is being used as another tool to understand the nature and extent of contamination. Mr. Gortva said the Army needs to follow CERCLA which is a risk-based process, and if the values show no risk to human health or the environment, legally the Army cannot take action. Mr. Gary Zolyak stated Fort Detrick had met with Dr. Barbara Brookmyer about Carroll Creek approximately five years ago, and, after reviewing the data, Dr. Brookmyer had agreed there was not a need to prohibit any activities such as fishing or to post signs.

Mr. Cherry stated the water in Carroll Creek is not being used for drinking purposes. Dr. Green stated that as the Army starts to treat and reduce the mass of contamination at the source, the levels downgradient will also start to decrease.

Mr. Cherry stated the pilot study is being implemented at Robinsons Pond as a higher flow of groundwater is coming from the outfall of the pond compared to seeps and springs. He explained the pond would be aerated through two approaches.

Mr. Cherry said the first approach would be to use aeration fountains and volatilize the volatile organic compounds. He explained a fairly extensive monitoring program would be in place to initially collect samples weekly and then bi-weekly in the pond, seeps and springs, and in Carroll Creek. Mr. Cherry said air samples will also be collected at three locations around the pond to see if any TCE is detectable at the edge of the pond. He advised baseline sampling will be conducted for one month, and the test would run for two months with six rounds of data collected. Mr. Cherry said there would be a break, and then the next system would be tested.

Mr. Cherry said the second technology to be tested are air diffusers. He explained this would be a system of aeration devices typically in the shape of a tube placed along the bottom of the pond, similar to what is used in fish tanks, which transfers compressed air into the water to produce air bubbles and water-air mixing. Mr. Cherry said the diffusion technology would also be tested for two months with a similar sampling program as is being done for the aeration fountains technology.

Mr. Cherry said the surface water technology tests are independent of the ground water technology tests.

Mr. Rudy asked if signs would be placed around the pond during the testing. Mr. Cherry said the pond is on private property and there are not trespassers. He explained modeling has not shown there will be an issue as the levels are low in the pond; therefore, no signage is planned. Mr. Gortva added the amount of TCE that would be removed is a maximum of half an ounce a day, which is much lower than amounts used in dry cleaning facilities, auto repair facilities, or nail salons.

7. Area A Site Inspection presented by Mr. John Cherry, Arcadis

Mr. Gortva referenced archive search reports discussed at previous meetings which identified areas for additional study known as a Site Inspection. He stated ARCADIS has performed some initial sampling and is recommending some areas proceed to the next step of the CERCLA process, a remedial investigation. Since the previous presentation had run longer than anticipated, Mr. Gortva asked Mr. Cherry to present the highlights and allow the RAB members to review the hard copy of the presentation outside of the meeting.

Mr. Cherry noted the Site Inspection phase is at the very beginning stages of the CERCLA process. Mr. Cherry displayed a list of the type of sites included: former herbicide test plots; former incinerators; former TCE sites where TCE was used for refrigeration purposes; former petroleum, oil, and lubricant facilities; former simulant dispersion test areas; former vehicle maintenance areas; and, areas formerly used for disposal, storage, or other purposes. He explained the Site Inspection included sampling for soil and/or groundwater with the compounds analyzed for tailored to the historical activities and uses. Mr. Cherry showed an aerial photograph of Area A and noted the sites were scattered across Area A.

Mr. Cherry explained that during a Site Inspection sampling results are compared to the very lowest screening levels so it is a very careful, conservative process before sites are recommended for no further action.

Mr. Cherry advised 18 sites have been recommended for no further action, and 26 sites have been recommended for additional investigation. He summarized the recommendations for each group:

- Group 1, Former Herbicide Test Sites: An expanded SI for background inorganic concentrations is recommended.
- Group 3, Former Incinerator Sites: An expanded SI is recommended for soil at all sites. For groundwater, no further action is recommended for Clusters 1 and 3, and an expanded SI is recommended for the other sites.
- Group 4, Former TCE Sites: A Remedial Investigation is recommended for all three sites.
- Group 5, Former Petroleum, Oil, and Lubricant Sites: A Remedial Investigation is recommended for Building 900. No further action is recommended at the other sites.
- Group 6, Former Dispersion Test Areas: No further action is recommended at these sites.

- Group 7, Former Vehicle Maintenance Areas: An expanded Site Inspection is recommended for soil at the 700-Area and 900-Area sites. Remedial Investigations are recommended for the 700 Area Groundwater and 900 Area Groundwater. Further action is recommended to identify a potential subsurface feature found during the Building 922 ground penetrating survey.
- Group 8, General disposal, storage, or other use areas: Several sites recommended for further action. No further action recommended for soil at Buildings 924, B918, and B941. No further action recommended at the Flammable Storage Area.

Mr. Rudy asked if contamination from Area A could be moving into Carroll Creek. Mr. Cherry responded there is the potential for TCE contaminated groundwater to move from the east to the west towards Carroll Creek, but the concentrations at Area A are a fraction of the concentrations found at Area B.

Ms. Hahn asked if vapor intrusion testing had been performed at Area A. Mr. Gortva said vapor intrusion test was performed at 10 buildings near Building 568. He advised a decision has already been made to advance this site to a Remedial Investigation so more sampling and vapor intrusion testing will be performed.

8. USGS Project Introduction presented by Mr. Brandon Fleming, US Geological Survey

Mr. Brandon Fleming stated he would be presenting a brief overview of the US Geological Survey (USGS) and a new project USGS recently started at Fort Detrick.

Mr. Fleming advised USGS is a non-regulatory science agency within the Department of the Interior. He said USGS works with States, counties, other Federal agencies and municipalities to monitor, assess, conduct targeted research, and deliver information on water resources and conditions, including streamflow, groundwater, water quality, and water use and availability from locally to regionally to nationally.

Mr. Fleming explained USGS' study at Fort Detrick has three broad, overall objectives: conducting surface water and groundwater monitoring, providing a better understanding of groundwater geochemistry and groundwater ages, and characterizing subsurface flowpaths to understand where contamination is being transported. He stated all the work is funneled towards a better understanding of the conceptual site model.

Mr. Fleming said USGS is measuring streamflow in two locations on Carroll Creek. He said the instruments were installed about a year ago. Mr. Fleming showing two graphs depicting the information collected and noted the data will help understand how the stream responds to different events (including the recent heavy rains). He noted data is received every 15 minutes and can be viewed on USGS' web site; the web site addresses will be provided at the end of the presentation for this information and eventually for the groundwater data.

Mr. Rudy asked if monitoring is being done for any increases in contamination. Mr. Fleming said real time monitoring for volatile organic compounds is technically very difficult, and he is not sure it is being done anywhere. He noted that besides flow, temperature and specific

conductance is being measured which allows an understanding what components of flow are from storms and runoff events and which are more groundwater driven.

Mr. Fleming showed outlines of Area A and Area B and the approximate drainage areas of USGS' northernmost and southernmost gauges on Carroll Creek. He explained USGS will be measuring the volume of water moving pass both drainage areas, and capturing all the groundwater and surface water that is falling on the land surface and re-charging in order to develop a watershed-scale water budget of groundwater and runoff. He continued explaining this will help provide an understanding whether all of the discharge is coming from what we think is typically a west to east flow of groundwater or are we not accounting for all the water and is it going somewhere else as potentially part of a more regional, deeper flow system.

Mr. Fleming advised USGS is also measuring precipitation on Area B; with the instruments having been installed this past spring, data from the heavy rains were captured. He explained this data will help to provide an understanding of the timing of stream flow response to a rain event, including how fast does the stream come up, how fast does it recede afterwards, and how long does the flood persist.

Mr. Fleming next discussed the groundwater monitoring that USGS will be conducting. He noted in three southern sites there will be shallow and deep monitoring locations which will allow USGS to look vertically and laterally at which way groundwater is flowing and whether the flow changes over time, such as with significant rain events or drought conditions. He stated the data will be collected real time, in 15 minute increments, and will be posted on the web site within a few hours.

Mr. Fleming advised USGS is monitoring in the center and northern part of Area B, which is a different rock type, to understand whether groundwater responds similarly or differently to those rock types compared to rocks in the southern portion.

In response to questions about the sharing of the data, Mr. Gortva stated all the data will be incorporated into the ongoing remedial investigation, along with reviewing the results with MDE and EPA. He said he cannot provide at this time advise which contractor may be performing this work, as a decision has not yet been made.

Mr. Fleming said another component USGS has been working on is to understand groundwater geochemistry and age. He noted much geochemistry data has been collected over several decades, so USGS' first task was to compile and review the existing data and identify and summarize any data gaps including locations or constituents that may have been under sampled. Mr. Fleming advised USGS is in the process of summarizing that analysis, and then once data gaps are identified, USGS will design a sampling effort to fill in those gaps.

Mr. Fleming stated USGS can sample for groundwater age tracers. He explained there are chemicals in the atmosphere from open air and nuclear testing or industrial activities; these chemicals are in the atmosphere in known concentrations and when it rains, the water infiltrates the ground and re-charges and those concentrations are fixed. He continued explaining when groundwater is sampled for those compounds, it is possible to calculate the approximate age of

groundwater. Mr. Fleming said this would provide useful information in determining whether this system is flushing through quickly in perhaps months or are the groundwater flow paths years or decades.

Mr. Fleming advised USGS has also been reviewing existing geologic and geophysical data collected over the last 20 years, as well as results from dye trace studies.

Mr. Fleming said all of the data collected will be used to enhance the conceptual site model.

Mr. Fleming provided the URL's for the web pages containing the real time stream gauges.

Ms. Hahn commented that she thought the work being done by USGS will be helpful and asked who decided to bring USGS onboard. Mr. Gortva said since not everyone agrees with the dye trace study results, Ms. Laurie Haines from the Army Environmental Command suggesting having the USGS do some investigation and make some recommendations to move the process forward.

Mr. Barry Glotfelty asked how long the wells will be maintained, and Mr. Fleming responded that it will take a few years of data to do the water budget analysis.

9. RAB Member Open Discussion and General Community Comments

Mr. Gortva invited open discussion from the RAB members.

Ms. Hahn said she had a number of comments and questions regarding the integrity of the landfill caps in relation to the proposed roadway in light of information she had read in the Site Management Plan. Ms. Hahn read some of the information, and Mr. Gortva and Ms. Morris clarified that the land use and traffic restrictions apply to the caps themselves, and the road would not be built on the caps. Mr. Rudy requested a copy of the most recent Site Management Plan be sent to all the community members.

Mr. Gortva invited comments for the community members in the audience. A community member asked as the Area B pilot study moves forward, will there be updates and results provided to the community outside of the RAB meetings through press releases or community meetings. Mr. Gortva responded that information will be presented at RAB meetings and the public is welcome to attend RAB meetings. He added that before the studies begin, Fort Detrick's Public Affairs Office will be putting out press releases to the public.

10. Future Meeting Dates

Mr. Gortva said proposed future meeting dates are December 5, 2018, April 3, 2019, and August 7, 2019. Mr. Gortva said all the dates are tentative and invited anyone who had conflicts to let him know. Mr. Rudy said the Monocacy River Board is very interested in the RAB meetings, and he will check with their meeting schedule.

Mr. Gortva invited Board members to let him know about topics of interest for future meetings.

The meeting adjourned at approximately 8:58 p.m.

Reviewed by:

Approved/Disapproved

Enclosures:
Area B Landfill Cap Monitoring Well Network Expansion
Area B Pilot Study and Area A Site Inspection
USGS Area B Groundwater
Meeting Sign-In Sheet

DISTRIBUTION:
Each RAB Member (w/o enclosure)
Each Meeting Attendee (w/o enclosure)

ENVIRONMENTAL RESTORATION SERVICES FORT DETRICK, FREDERICK MD

Pilot Study for Three Potential Remedial Technologies

Overview of Area A Site Inspection Recommendations

August 1, 2018

John Cherry
Arcadis

Overview of Topics

- Three remedial technologies that will be tested as part of the Pilot Study
  1. Pump and Treat
  2. Enhanced Reductive Dechlorination
  3. Pond Aeration for Surface Water
- Recommendations of the Site Inspection performed at Area A

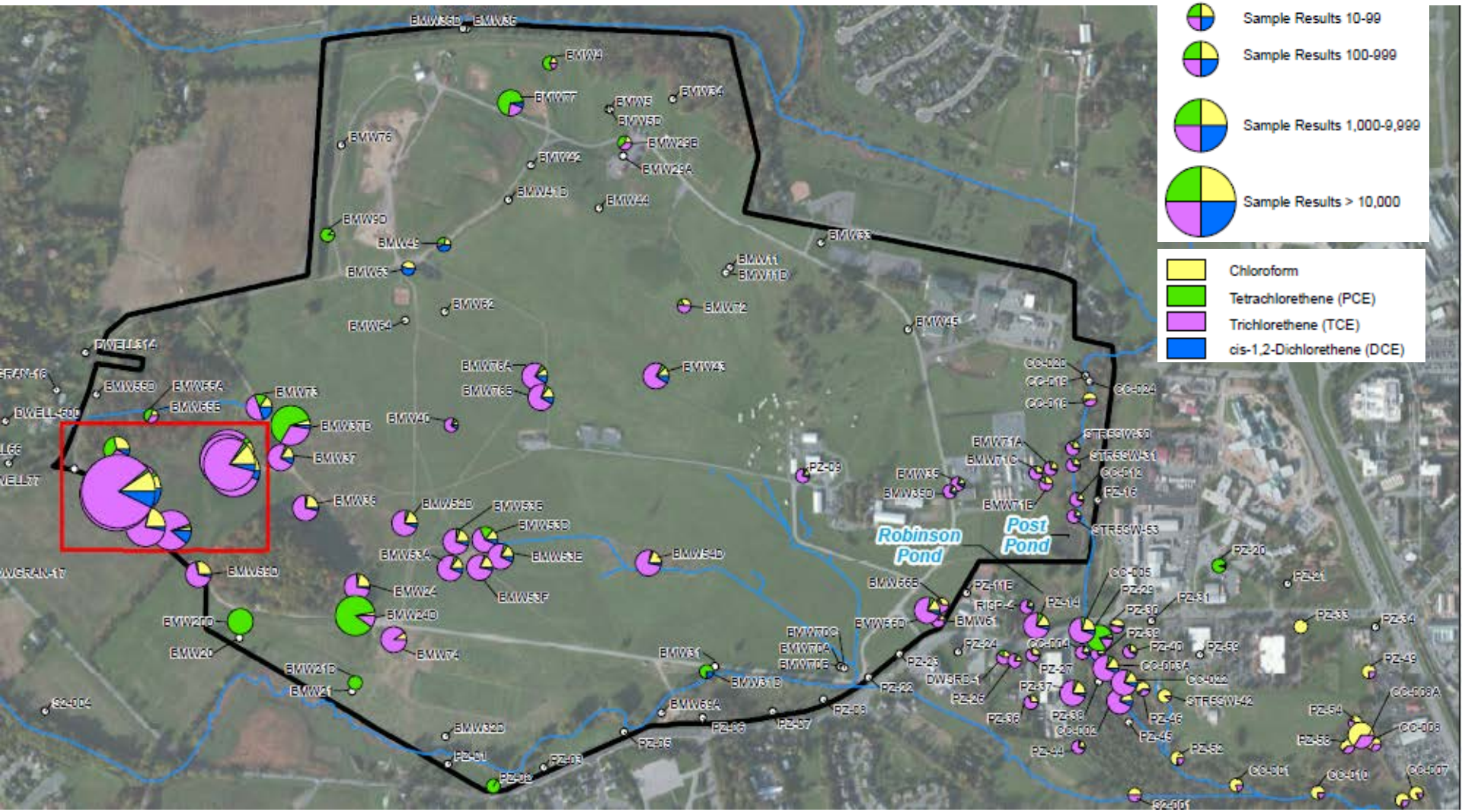
ARCADIS Design & Consultancy for natural and built assets

Area B Groundwater Pilot Study

Purpose of the Pilot Study

- Goal: Evaluate potential pilot study options that could be planned and tested to facilitate future selection of appropriate full-scale remedial actions
- Primary objective: Collect data needed to evaluate the effectiveness and feasibility of each proposed remedial technology for potential full-scale implementation at the site.
  - Data will be used to support decision making about the remedial strategy for the Site.
  - Potential remedial alternatives will be identified in a Feasibility Study for detailed evaluation of possible remedial approaches to address any potential risks to human health and the environment identified in the forthcoming RI report.

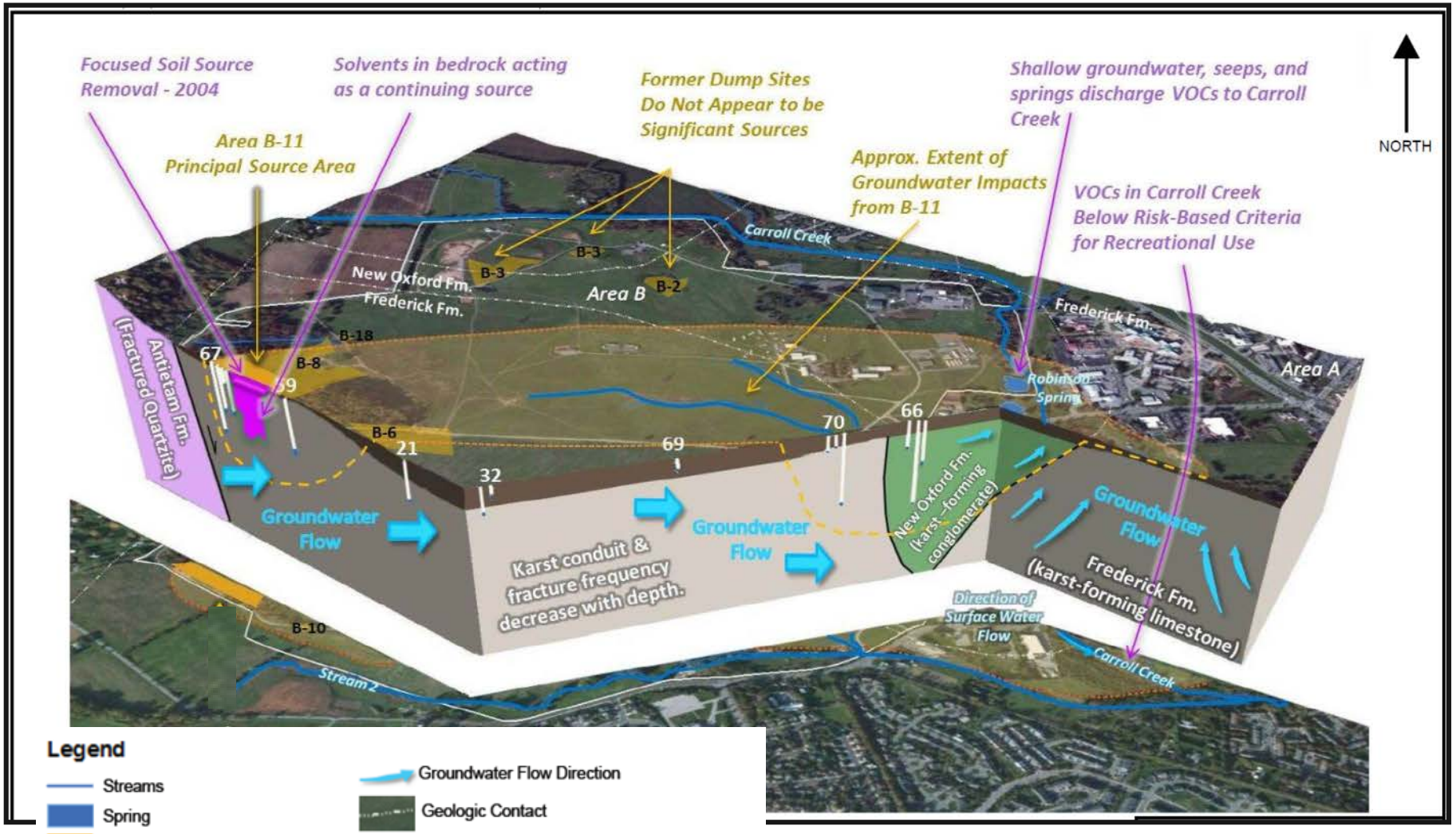
Distribution of VOCs



The Maximum Contamination Level (MCL) is the maximum level allowed of a contaminant in water which is delivered to any user of a public water system and is set by USEPA.

The MCL for both TCE and PCE is 5 µg/L.

Conceptual Site Model

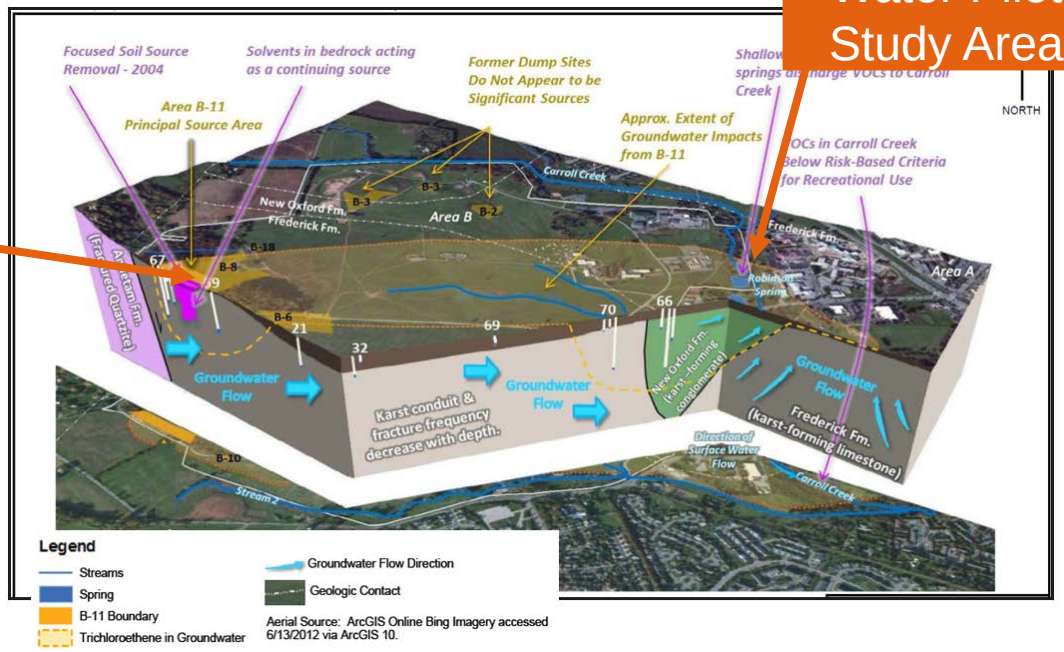


Three Pilot Study Technologies in Two Areas

- Source Area – Groundwater
  - Pump and Treat
  - Enhanced Reductive Dechlorination (ERD)
- Downgradient Area - Surface Water
  - Pond Aeration

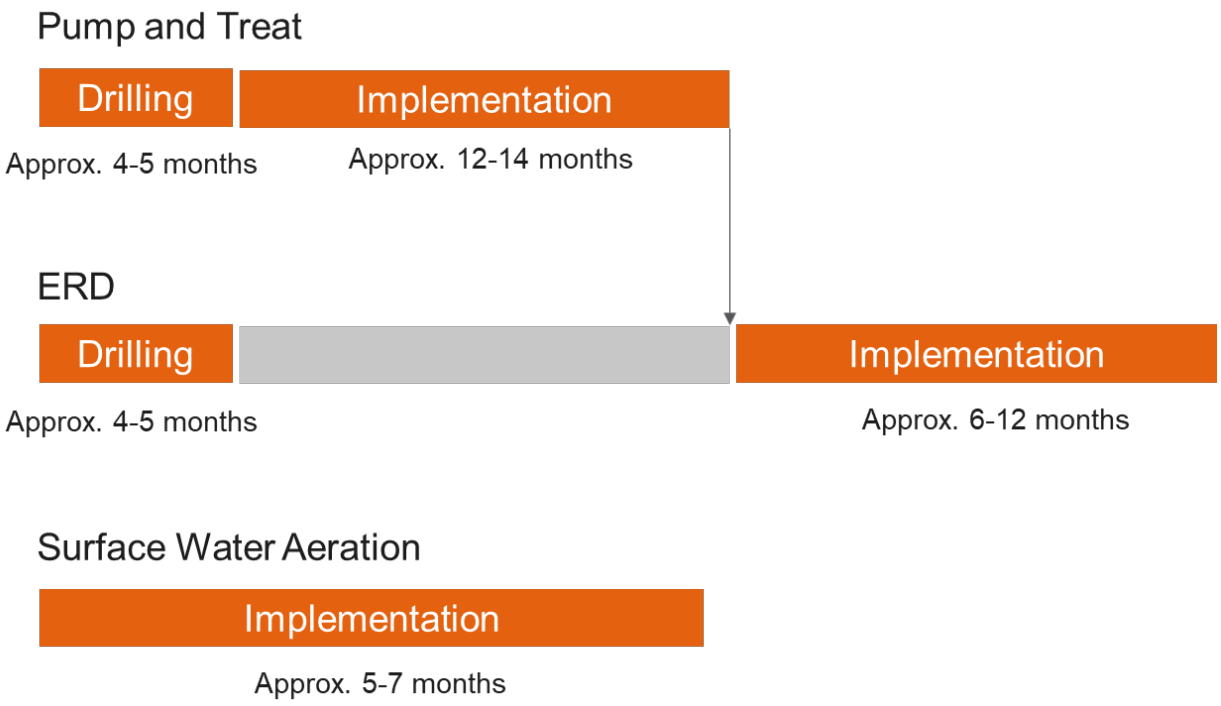
Surface Water Pilot Study Area

Groundwater Pilot Study Area



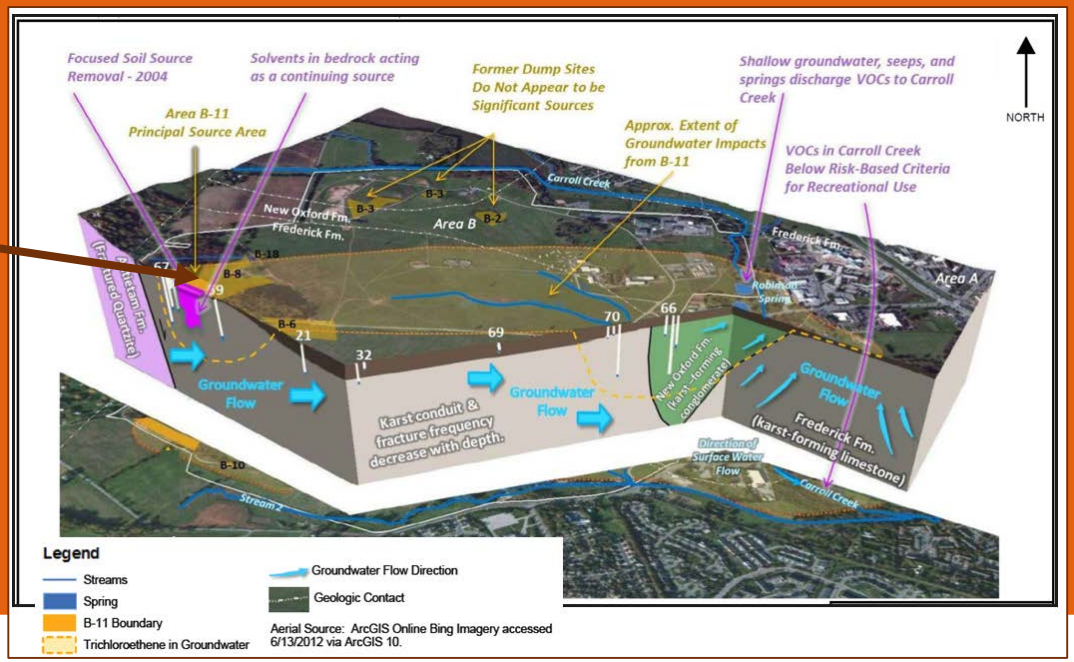
General Pilot Study Schedule

- Assumes drilling work will start in early 2019
- Implementation of all options will take approximately 2.5 years



1st Technology: *Pump and Treat*

Groundwater Pilot Study Area



1st Technology: Pump and Treat

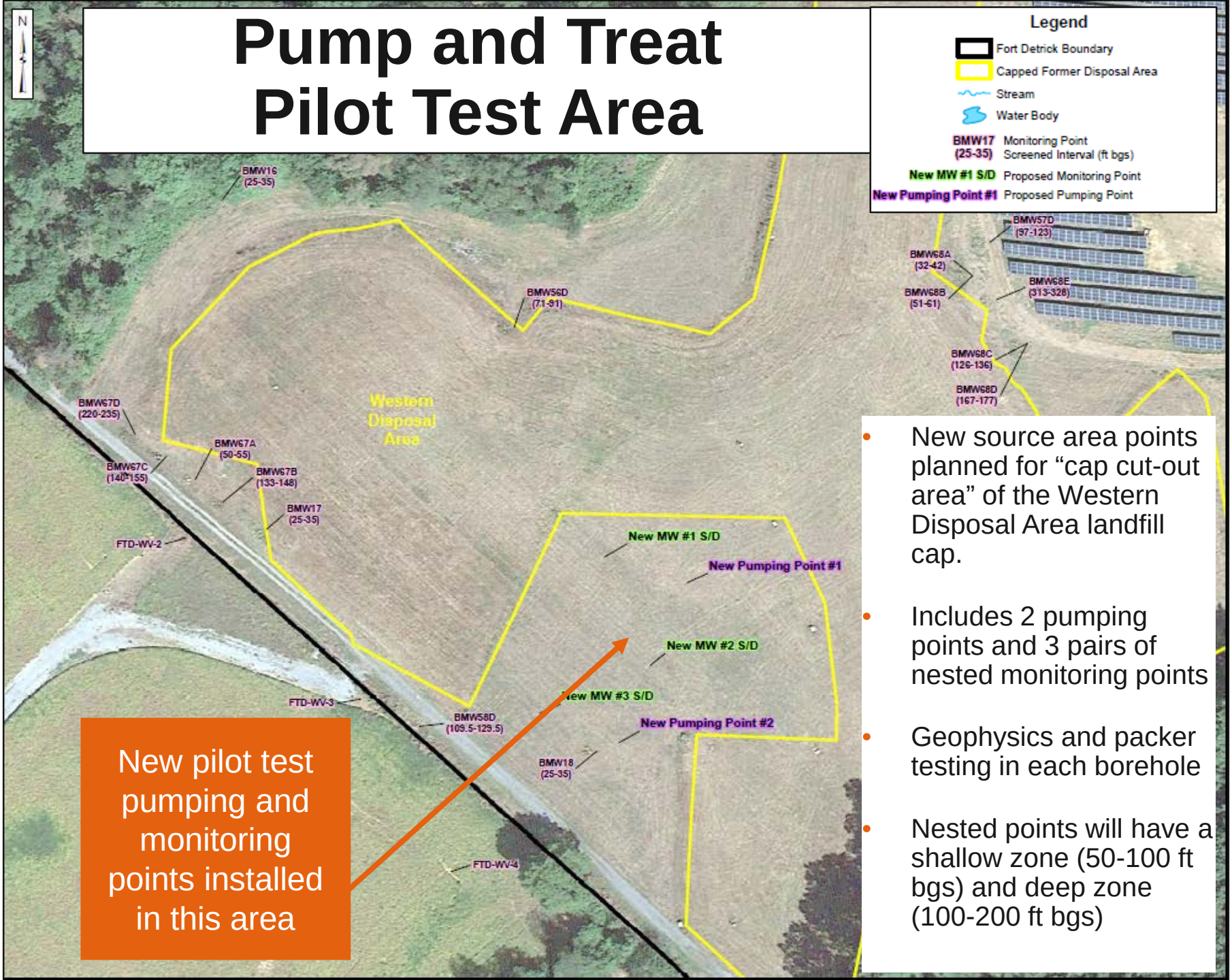
Approach

- Groundwater will be pumped from two newly installed points; water will be treated to remove potential contaminants; clean water will be discharged to nearby stream

Objective:

- Evaluate the feasibility of pumping and treating groundwater to reduce VOC concentrations in karst bedrock groundwater near the capped area; assess whether this approach could be expanded for full-scale implementation.

Pump and Treat Pilot Test Area



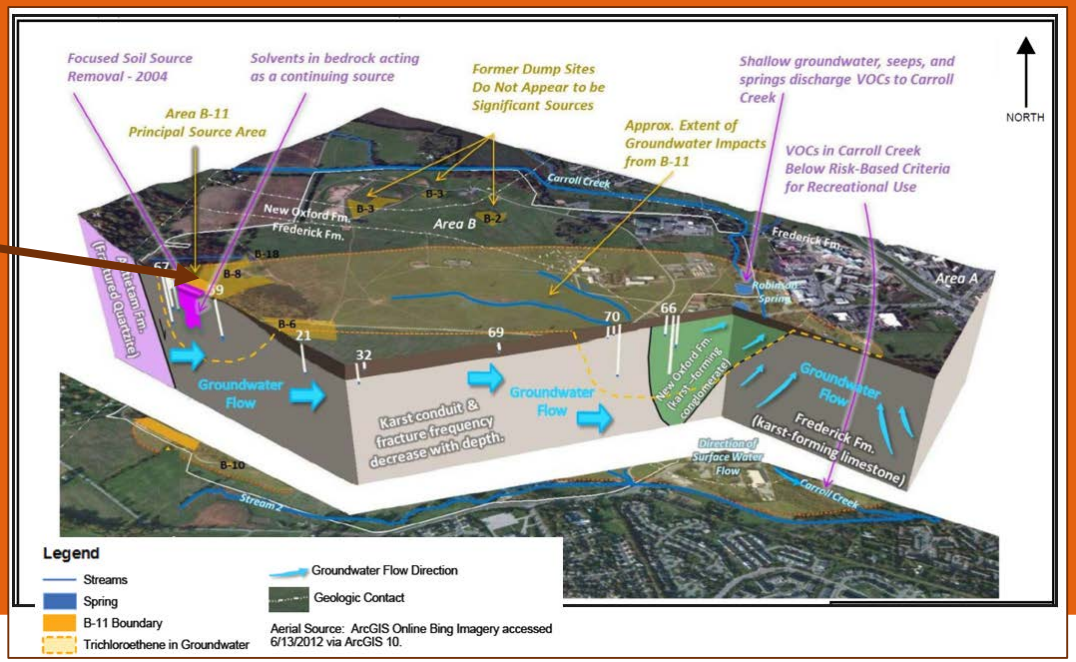
- New source area points planned for “cap cut-out area” of the Western Disposal Area landfill cap.
- Includes 2 pumping points and 3 pairs of nested monitoring points
- Geophysics and packer testing in each borehole
- Nested points will have a shallow zone (50-100 ft bgs) and deep zone (100-200 ft bgs)

1st Technology: Pump and Treat

- Baseline sampling at 6 new points,10 existing points, and Robinson Spring
- Step drawdown test to determine pumping rate
- Treatment system will be built based on pumping rates and analytical results
  - New building will house treatment system
  - Treated clean water will be discharged to nearby Area B stream with regular confirmatory testing
- Pumping test, water treatment, and sampling will occur for 8 months

2nd Technology: *Enhanced Reductive Dechlorination*

Groundwater Pilot Study Area



2nd Technology: Enhanced Reduction Dechlorination (ERD)

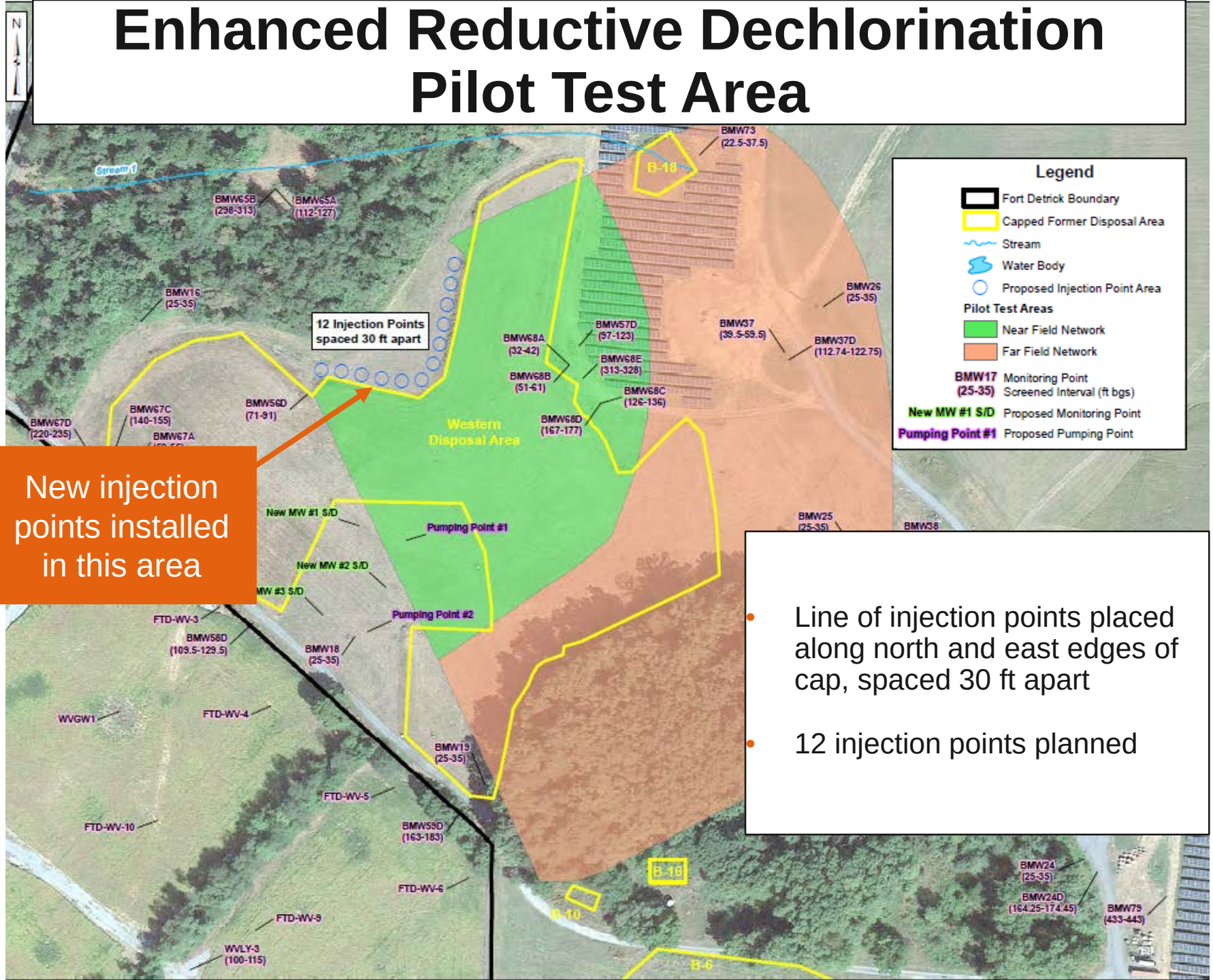
Approach

- Injection of carbon solution (e.g., molasses) via 12 shallow injection points (~30 feet deep) to stimulate microbial degradation of VOCs in groundwater.

Objective:

- Evaluate the effectiveness of the ERD technology to reduce VOC concentrations and assess whether this proven approach could be implemented as a full-scale remedy in the karst environment

Enhanced Reductive Dechlorination Pilot Test Area



New injection points installed in this area

- Line of injection points placed along north and east edges of cap, spaced 30 ft apart
- 12 injection points planned

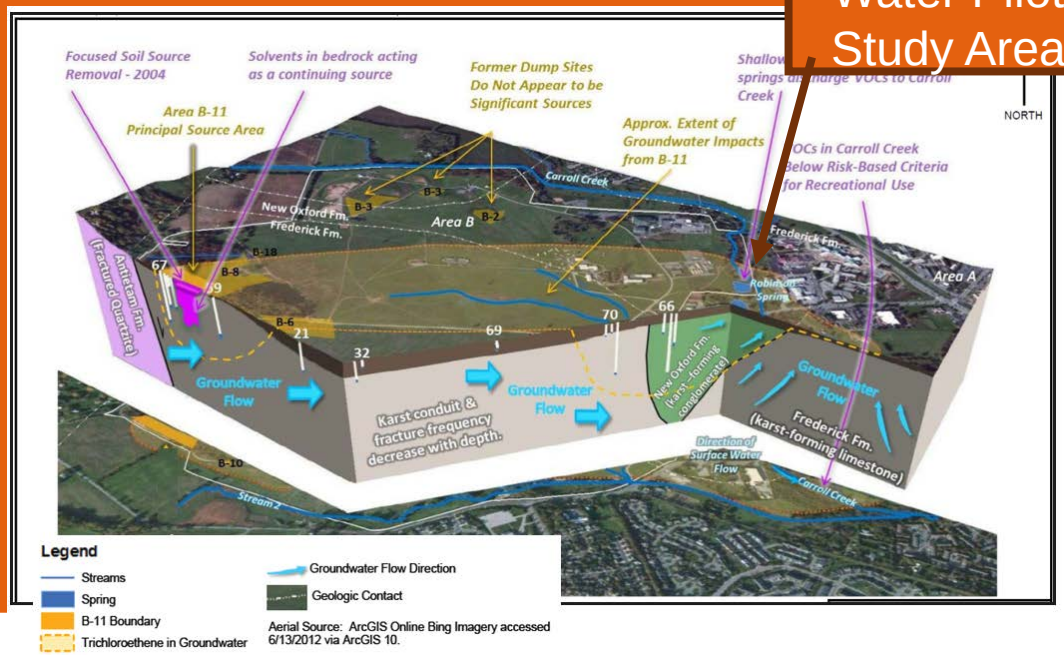
2nd Technology: Enhanced Reduction Dechlorination (ERD)

- Baseline sampling at all wells within the performance monitoring network
- Reagent injection
  - Organic carbon substrate (dilute molasses)
    - 2% solution of food grade molasses is typically adequate to support sustained microbial activity
  - Initial injection event
    - Understand the distribution of injected substrate in the subsurface following injection, as well as the impact of carbon utilization on the geochemical environment
    - Injected volume is expected to be approximately 2,000 gallons of injectate per injection point (1 gallon per minute injection rate)
    - During injection, monitoring of water levels and field parameters will be performed at Near Field wells to evaluate the radius of influence of injection.
  - Follow-up injection events
    - Up to 2 additional events may be performed depending on monitoring results

2nd Technology: Enhanced Reduction Dechlorination (ERD)

- Bioaugmentation
  - Sampling to identify naturally occurring microbial organisms known to degrade VOCs.
  - If necessary, target dechlorinating organisms will be added to the in-situ treatment area to facilitate the remediation of the VOCs
- Pilot Test Monitoring
  - Weekly monitoring in the injection area to assess carbon substrate distribution.
  - Monthly sampling at select points for VOCs, geochemical parameters, and water quality parameters.

3rd Technology: *Pond Aeration*



3rd Technology: Pond Aeration Pilot Test

Approach:

- Install and operate aeration technology(ies) in off-post pond (typical pond fountains and pond diffusers).

Objective

- Evaluate the treatment efficiency of aeration systems to reduce VOC concentrations in the pond water and ultimately in Carroll Creek.

✓ *Completing this test will require a right-of-entry agreement with the property owner. Army has had initial discussions with the property owner to discuss the proposed plans.*

Review of TCE Concentrations in Surface Water (2012-2017)

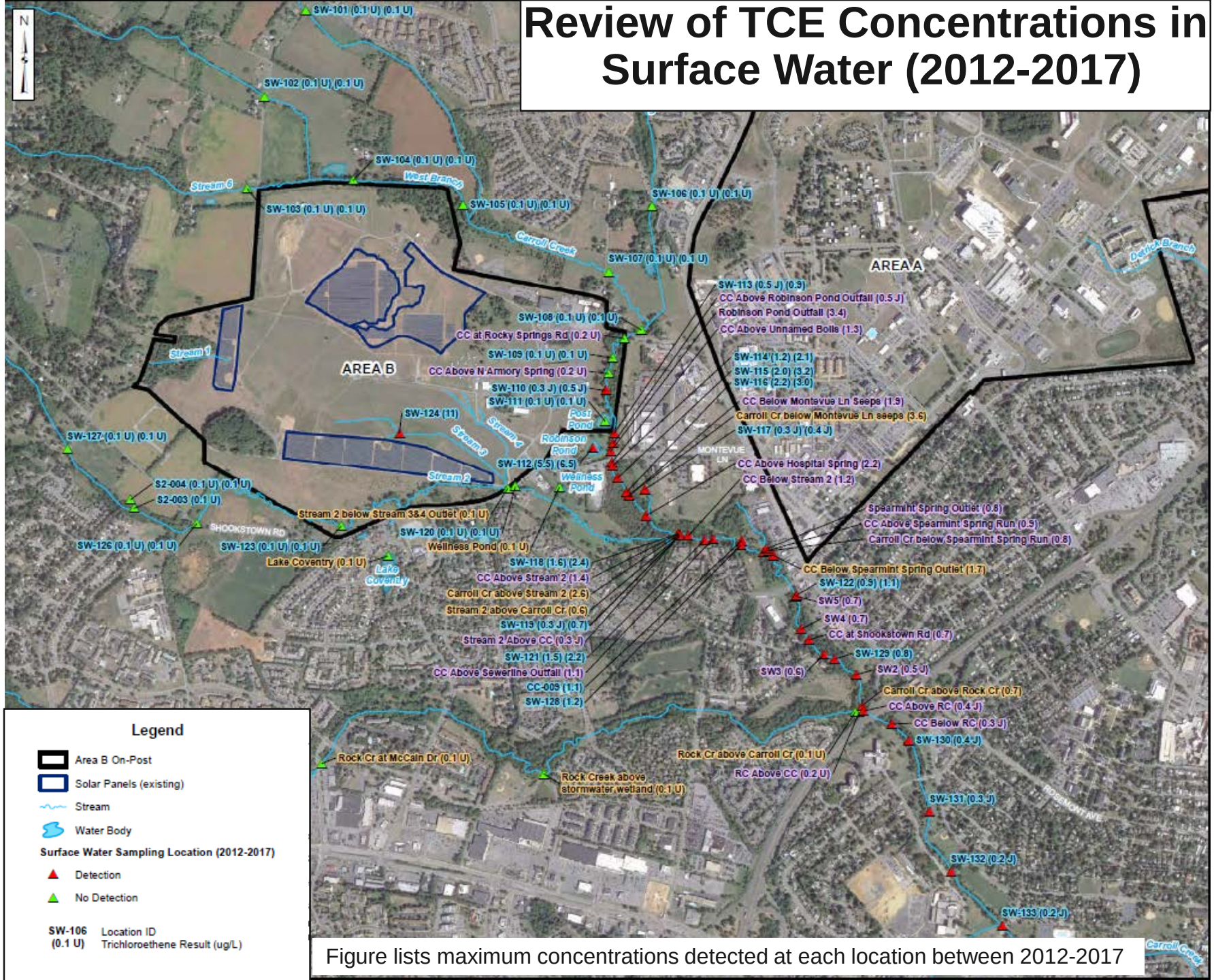


Figure lists maximum concentrations detected at each location between 2012-2017

Review of TCE Concentrations in Surface Water (2012-2017)

- 2017 Field Work – Observations

Surface Water (Carroll Creek)

- 22 surface water samples collected in 2017.
- Highest TCE detections were in the primary discharge area at 2.2 and 3.4 µg/L. Concentrations decrease further downstream.
- Low estimated PCE detections at 4 locations (up to 0.2 J µg/L).

Pore Water (water in Carroll Creek sediments)

- 20 water samples collected in 2017.
- TCE was detected in pore water at up to 4.9 µg/L in the primary discharge area (near Montevue Lane).
- Low estimated PCE detections at 4 locations (up to 0.4 J µg/L).

Comparison criteria for Surface Water

- Surface water screening criteria (USEPA Region III Biological Technical Assistance Group) for TCE is 21 µg/L to be protective of sensitive species.
- No samples exceeded the SW screening criteria; therefore, further action is not risk driven.

Review of TCE Concentrations in Surface Water (2012-2017)

- 2017 Field Work – Observations

Seeps and Springs

- 14 seep and spring samples collected in 2017.
- Concentrations and locations with detections in 2017 were very similar to 2012 results.
- Highest TCE detection in seeps was at CC-21 in the primary discharge area at 13 µg/L.
- Low PCE detections in the primary discharge area (up to 0.6 µg/L compared to drinking water standard of 5 µg/L).

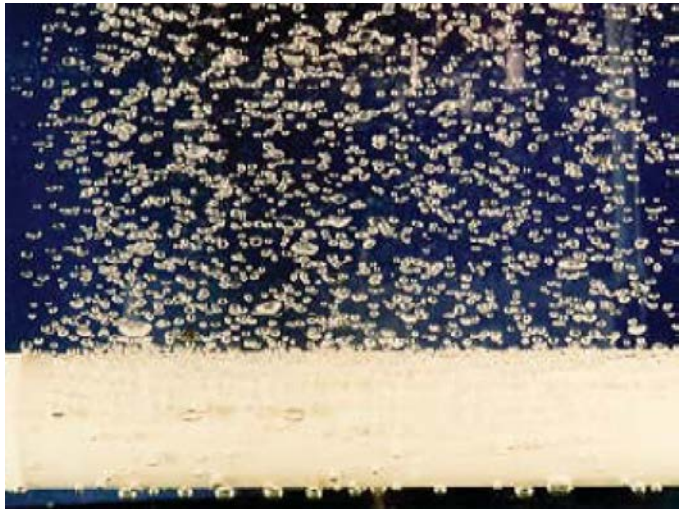
Pond Aeration Pilot Test - Fountains

- First system: Fountains with a motor that powers a rotating impeller
- Impeller pumps water from its surroundings and expels it into the air phase in a cascading, trumpet-shaped spray
- Multiple fountains will be planned to maximize treatment effectiveness

Example of Pond Fountain for Pilot Test

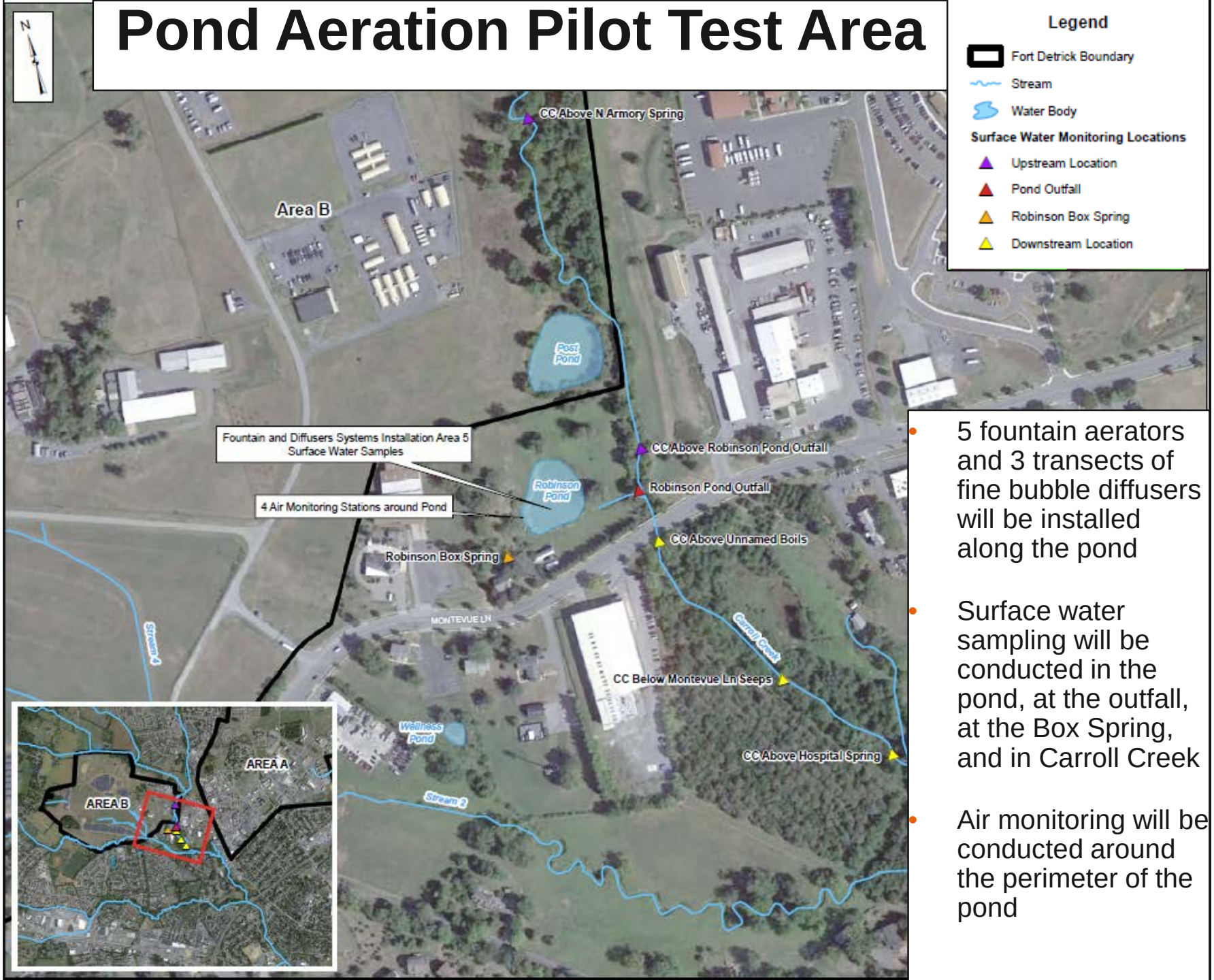
Pond Aeration Pilot Test - Diffusers

- Second system: Air diffuser system, composed of an aeration device typically in the shape of a tube used to transfer air into the water
- Compressed air is forced through perforated or porous diffusers to produce air bubbles that rise through the water and produce turbulence resulting in effective water-air mixing
- Evaluating whether pond is deep enough to allow for testing the diffusion technology.



Example of Fine Porous Well Screen Air Diffuser Proposed for Pilot Test

Pond Aeration Pilot Test Area



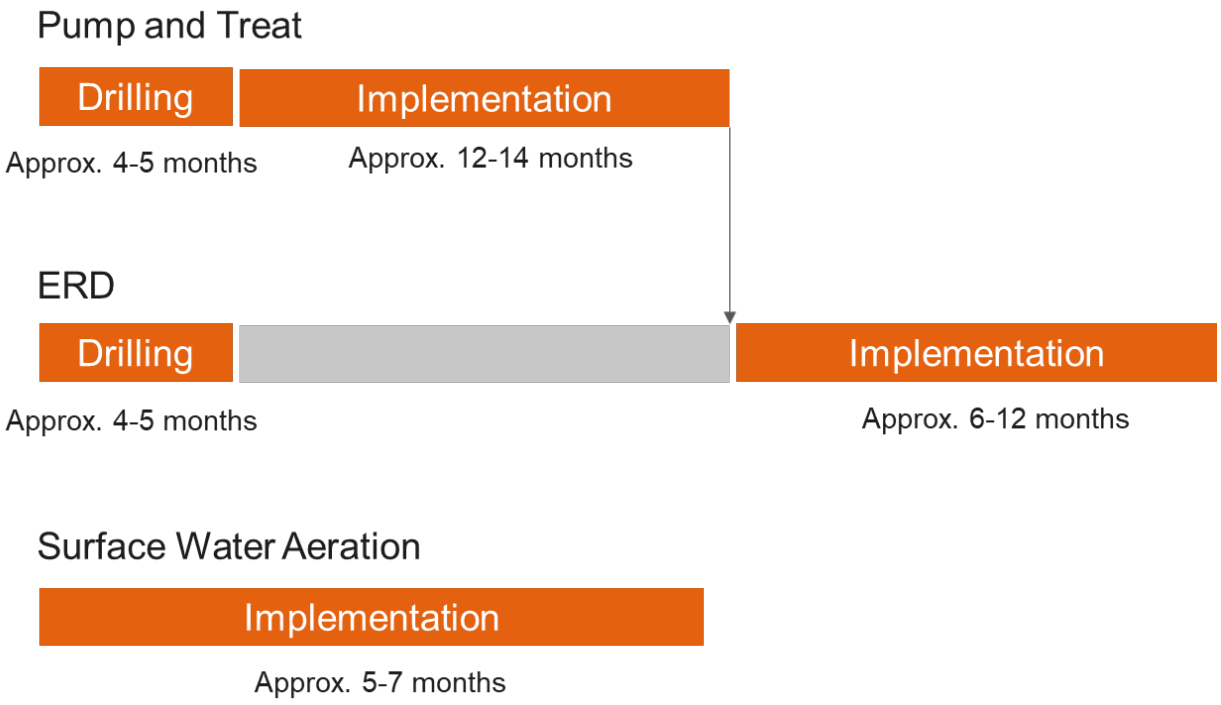
- 5 fountain aerators and 3 transects of fine bubble diffusers will be installed along the pond
- Surface water sampling will be conducted in the pond, at the outfall, at the Box Spring, and in Carroll Creek
- Air monitoring will be conducted around the perimeter of the pond

Pond Aeration Pilot Test - Implementation

- Each system will be run for 2 months, with an expected 6 month study duration
  - Baseline sampling will be conducted for a month prior to fountain system operation
  - Fountain test will be conducted for 2 months (with accompanying sampling)
  - Second baseline sampling will be conducted for a month prior to diffuser system operation
  - Diffuser test will be conducted for 2 months (with accompanying sampling)

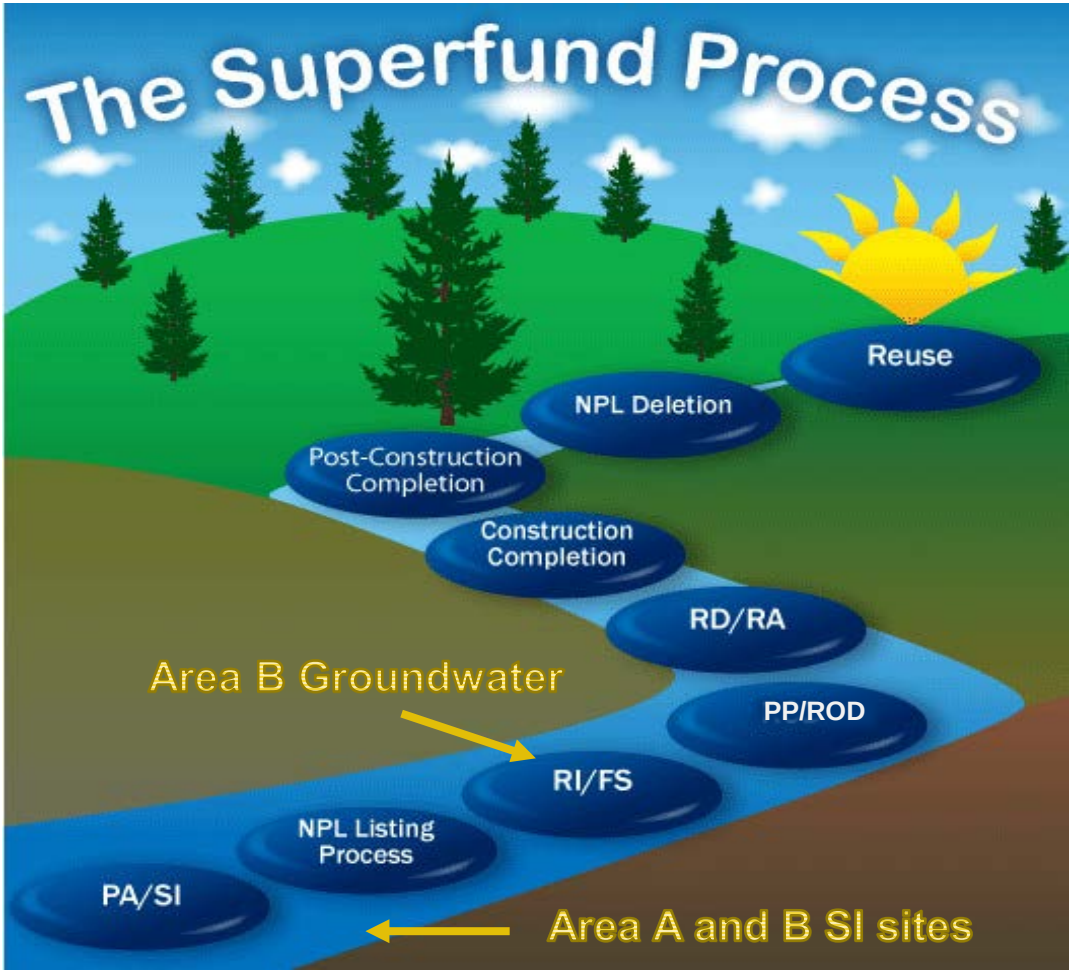
General Pilot Study Schedule

- Assumes drilling work will start in early 2019
- Implementation of all options will take approximately 2.5 years



Fort Detrick Area A SI Update

What is a CERCLA SI?



Remedial Action (RA)-Implement selected remedy

Remedial Design (RD)- Work plan and design of selected remedy

Record of Decision (ROD)- Final legal document selecting remedy

Proposed Plan (PP)- public document to solicit input on preferred remedy

Feasibility Study (FS)- Assessment of possible remedies

Remedial Investigation (RI)- Thorough investigation; develop conceptual site model, complete risk assessment

Site Inspection (SI)- Initial sampling to test for a release of hazardous substances to the environment

Preliminary Assessment (PA)- Initial review to identify sites that may pose a threat to the environment

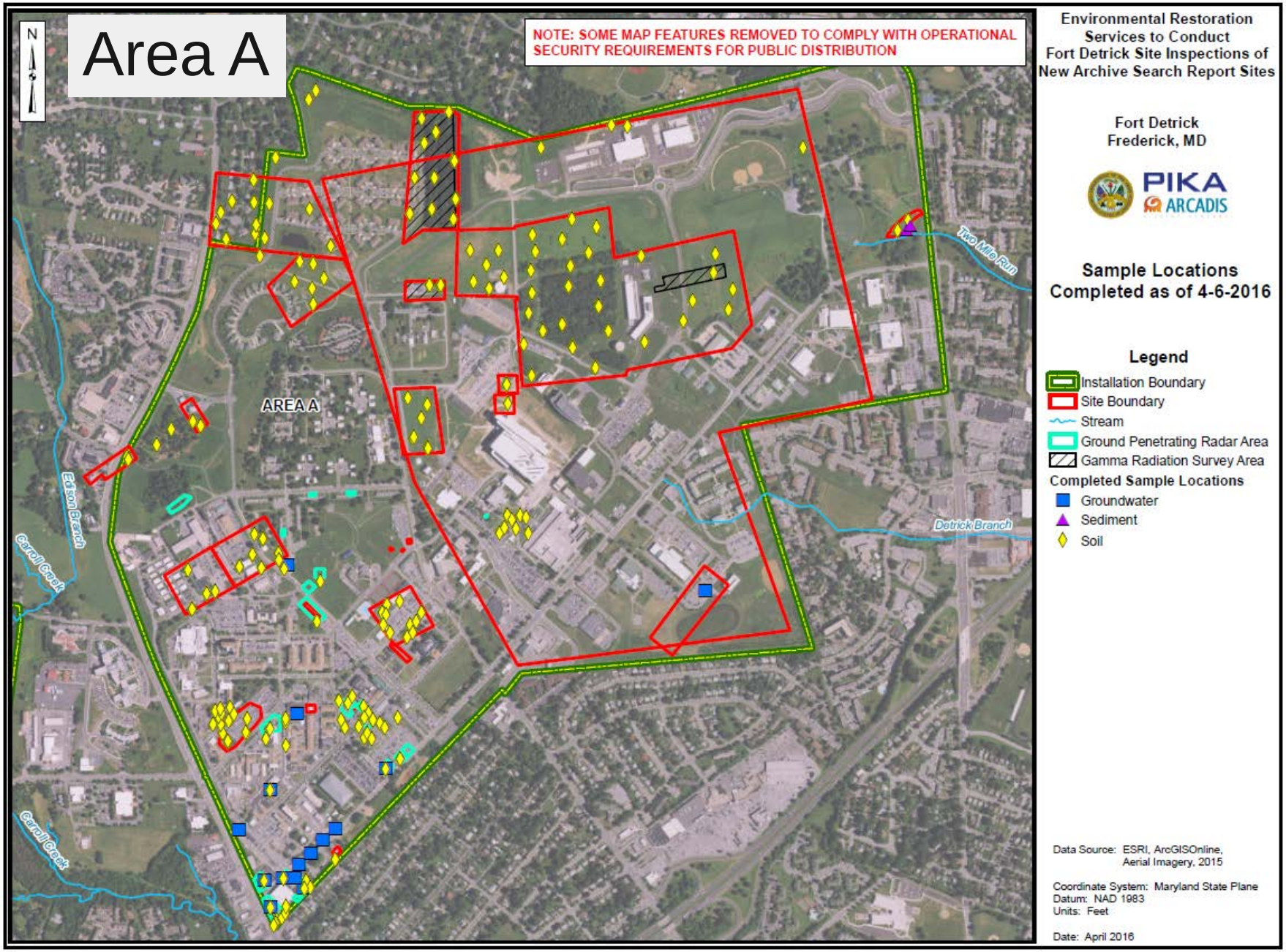
The SI reports will make recommendations to EPA/MDE for the next steps (if any) at each site

Identifying Historical Activities of Potential Concern

- Former herbicide test plots
- Former incinerators
- Former TCE sites (facilities where TCE was used for refrigeration purposes)
- Former petroleum, oil, and lubricant facilities
- Former dispersion test areas (for testing dispersion of simulants)
- Former vehicle maintenance areas
- Areas used formerly for disposal, storage, or other purposes

SI Scope included sampling for soil and/or groundwater with analyses tailored to historical activities and uses in these areas.

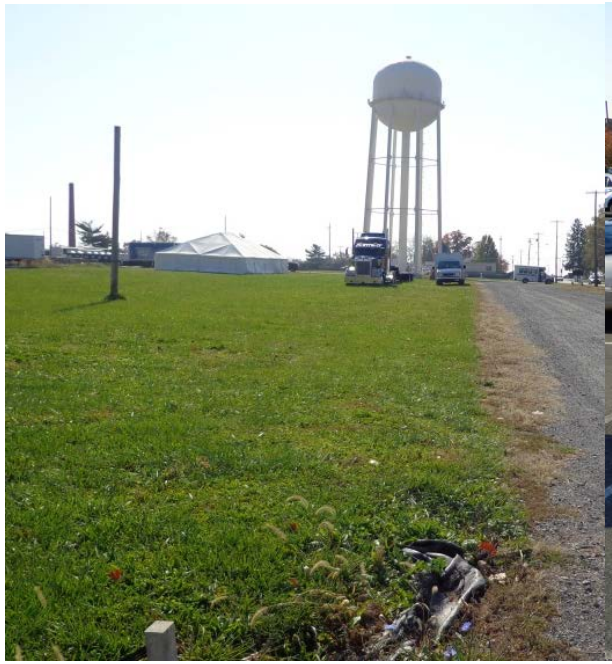
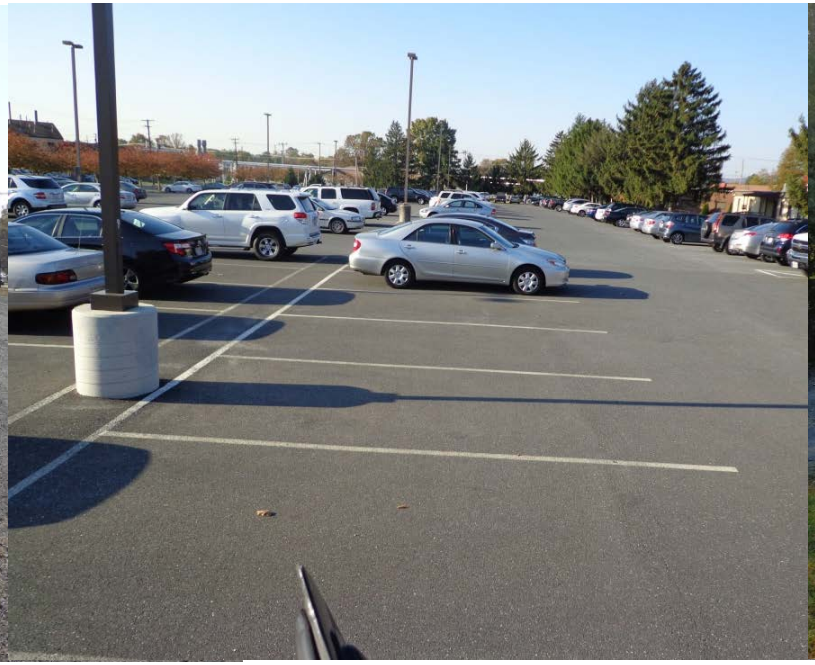
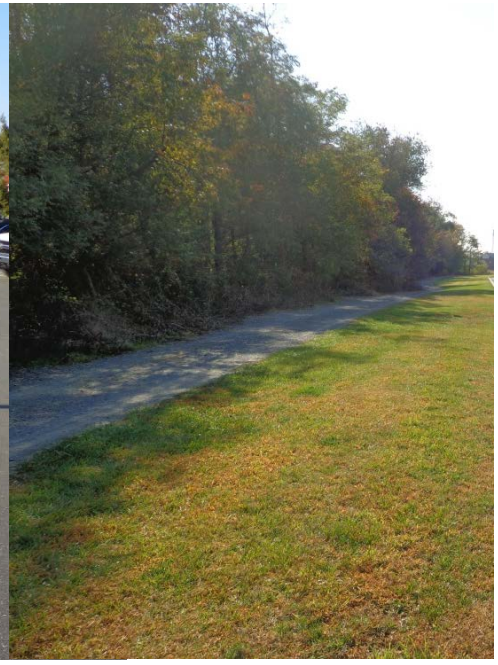
Field work completed January to August 2016.



Distribution of SI Sites Across Area A

Group 1: Former Herbicide Test Sites

- Ten historical anti-crop herbicide sites were identified for sampling, though records indicated a low likelihood for detecting residual herbicides.
- These are areas where historical aerial imagery or other records indicate controlled field experiments may have been conducted on small test plots during the 1940s and 1950s.
- Today these areas are covered by a mix of parking lots, buildings, trees, and grassy areas.
- Analytical suite included herbicides, dioxins, and total metals in soil.

Area A Former Herbicide Test Sites: Field A, Field C/D, Field E, Field F, Nallin Farm Rice Paddy, Small Crop Plots, Ditto Ave

SI Results and Recommendations

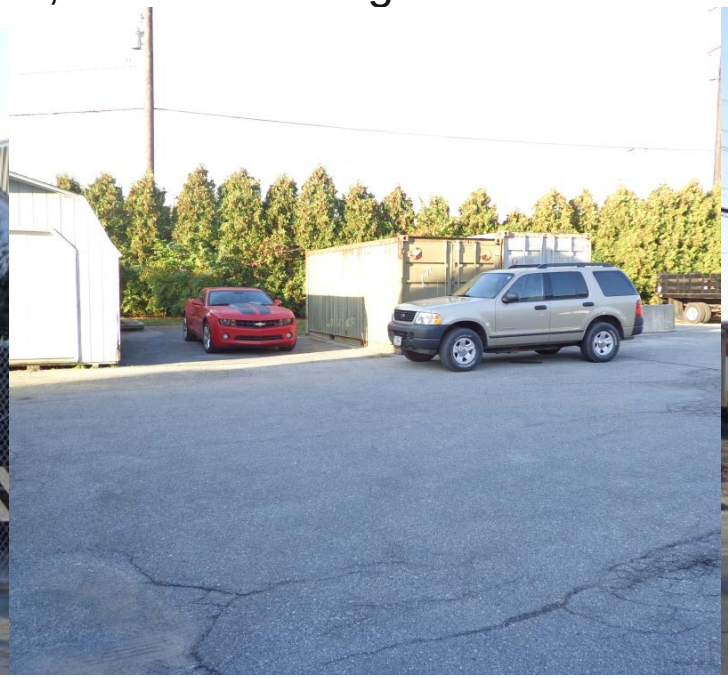
- The dioxin, TCDD, was not detected above RSL in the surface and subsurface soil samples collected across Area A; however, TCDD-TEQ does exceed RSLs at several sites.
- Arsenic and dioxin detections were evaluated in comparison to background levels for western MD, EPA RSLs for residential soil, and ecological soil screening levels.
- Gamma radiation survey negative.
- Arsenic and dioxin detections do not pose significant risks or hazards to potential human or ecological exposures.
- An expanded SI with an investigation of background inorganic concentrations is recommended.

Why test for Dioxins?

Dioxin (specifically TCDD) is known to be a contaminant from the manufacture of 2,4,5-T, which is an acetic herbicide used in the formulation of Agent Orange. Dioxins are also persistent in the environment so testing for dioxin many decades after potential application provides a way to assess whether 2,4,5-T was used during the experiments in the 1940s and 1950s.

Group 3: Former Incinerator Sites

- Three former incinerator areas dating back to World War II previously used for disposal of burnable wastes and decontamination of air from test facilities.
- Sampling plan evaluated (1) potential environmental impacts from air deposition in the vicinity of these locations; and (2) potential impacts from the historical use and storage of fuel oil for firing the incinerators.
- Most locations have been reutilized for other purposes for many decades.
- Analytical suite included polycyclic aromatic hydrocarbons (PAHs), total metals, total petroleum hydrocarbons (TPH) (diesel and gasoline range organics, DRO/GRO), and dioxins in soil; DRO/GRO in groundwater.



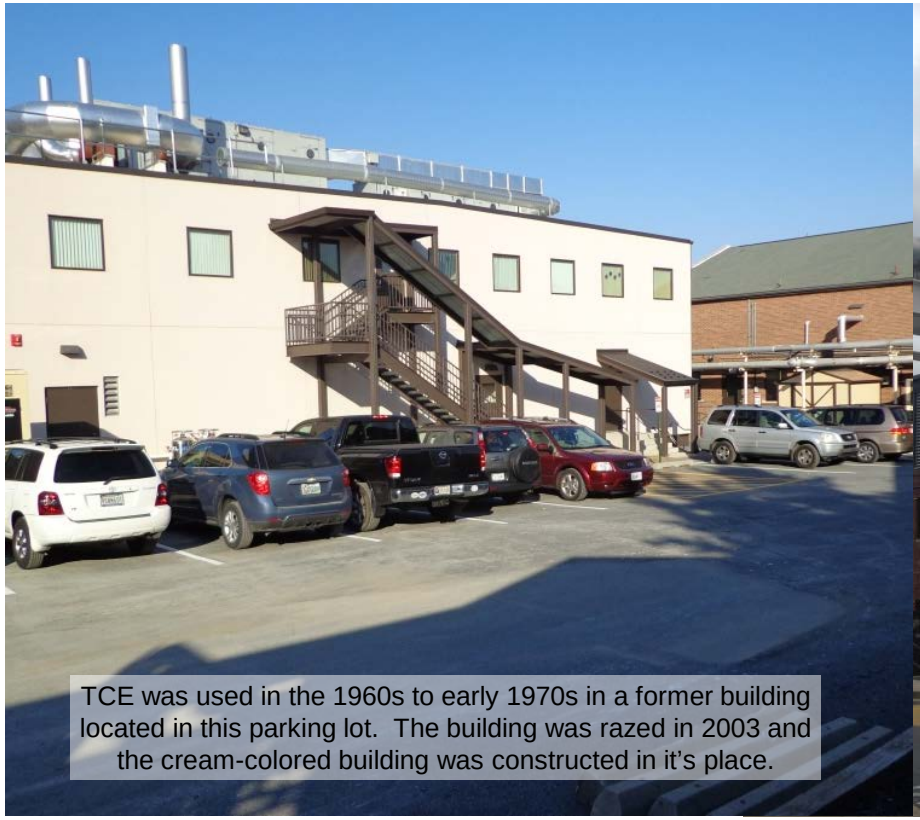
Area A Incinerator Sites:
Incinerator Cluster 1, Incinerator Cluster 2, Incinerator Cluster 2, and Building 1414

SI Results and Recommendations

- Soil: Expanded SI is recommended for all sites due to:
  - Cluster 1: Arsenic, dioxin, and PAH
  - Cluster 2: Arsenic and DRO
  - Cluster 3: Arsenic and PAH
  - Building 1414: Arsenic and dioxin
- Groundwater
  - Clusters 1 and 3: No further action needed
  - Cluster 2: Expanded SI due to DRO/GRO detections
  - Building 1414: Expanded SI due to DRO detections

Group 4: Former TCE Sites

- Records identified the documented use of TCE in three Area A buildings for refrigeration and/or freeze-drying purposes. These activities were associated with test chambers and other activities dating back to the 1960s. One of the buildings had been inactive since 1971 and was razed in 2003.
- Sampling plan focused on evaluating potential groundwater impacts near these buildings.
- Analytical suite included volatile organic compounds (VOCs) in groundwater.



TCE was used in the 1960s to early 1970s in a former building located in this parking lot. The building was razed in 2003 and the cream-colored building was constructed in it's place.

Area A TCE Sites:
Building 376, Building 470, and Building 1412

SI Results and Recommendations

- TCE was detected in groundwater at all sites in Group 4, and the detected concentrations of TCE in groundwater at Building 376 are at levels exceeding MCLs.
- All three sites had exceedances of the chloroform RSL. All three Group 4 TCE sites are recommended for further investigation (remedial investigation) of chloroform in groundwater.Building 470 had two samples that exceeded the tap water RSL for bromodichlormethane.
- Further action (RI) is recommended for all three sites.

Group 5: Former Petroleum, Oil, and Lubricant (POL) Sites

- Records identified 15 locations with historic POL storage, use, or dispensing. These locations include former underground fuel lines, pumping/dispensing areas, and possible underground storage tanks.
- Sampling plan focused on evaluating potential environmental impacts due to the historical use of gasoline, diesel, and fuel oil in these areas.
- Analytical suite included VOCs, SVOCs, and DRO/GRO in soil; VOCs and DRO/GRO in groundwater.

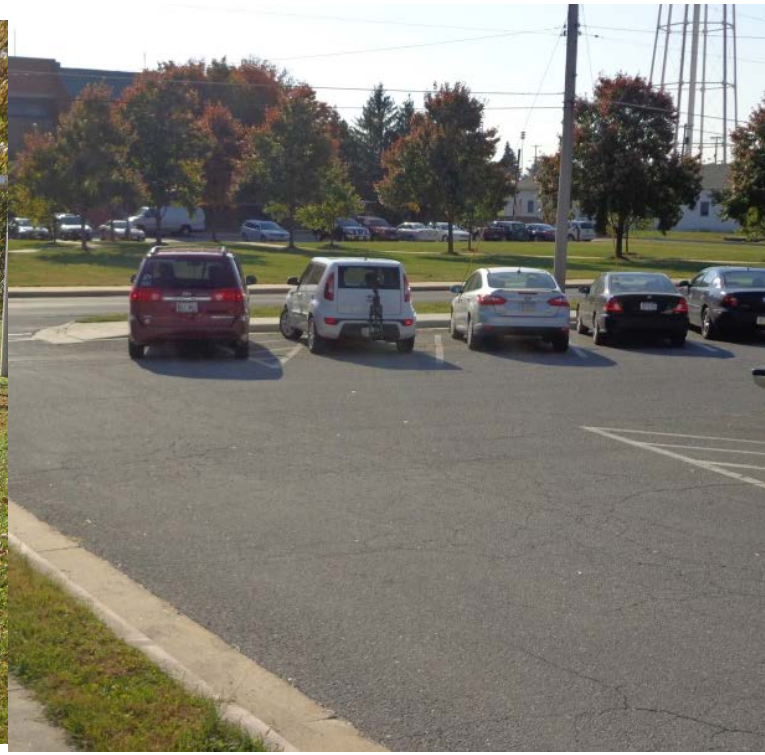
Area A Petroleum, Oil, and Lubricant Sites: Buildings 100, 271, 365, 513, 705, 900, 946, 1000, 1012, 1013, 1014, 1015, Combined Fuel Area QM Fuel Dispensing, Aircraft Fuel Dispensing, Four Aircraft Fueling Pits

SI Results and Recommendations

- Further action (RI) is recommended for DRO at Building 900 due to the exceedance of its tap water RSL. VOC and GRO results did not exceed the laboratory detection limits.
- No evidence of a release was observed at any of the other buildings; therefore, no further action is needed at the remaining sties.

Group 6: Former Dispersion Test Areas

- Records identified 3 areas in Area A that were previously used as outdoor test grids for simulants for crop agents. The tests were intended to evaluate how the simulants, such as a yeast slurry, were dispersed from 20mm rounds and small-arms fire (e.g., shotgun shells).
- The likelihood for environmental impacts was considered low based on historical information. The sampling plan was focused on evaluating potential impacts to soil in these areas.
- Analytical suite included total metals and explosives in soil.



Area A Dispersion Test Sites:
Temporary Test Grid, 20mm Test Area, Assessment Division Grid

SI Results and Recommendations

- The detected concentrations of the COCs in soil at all the Group 6 sites are at levels below RSLs and/or below laboratory detection limits.
- No further action needed at any of the sites.

Group 7: Former Vehicle Maintenance Areas

- Historical records review identified two former vehicle maintenance areas, including motor repair shops, wash racks, and a gasoline station.
- Sampling plan focused on assessing whether these historical activities could have impacted soil or groundwater and to determine if USTs may still be present.
- Analytical suite included VOCs, DRO/GRO, and total metals in soil; VOCs, DRO/GRO, and total and dissolved metals in groundwater.

Gas station and motor repair shop located in this area until the 1950s.

Motor repair shop and wash rack located in this area until 1975.

Area A Vehicle Maintenance Areas: 700 Area and 900 Area

SI Results and Recommendations

- Soil: further action (expanded SI) is warranted for arsenic in soil at both the 700-Area and the 900-Area site.
- 700 Area Groundwater: DRO exceeded its RSL in the one groundwater sample. Further investigation (RI) recommended for DRO in groundwater.
- 900 Area Groundwater: Because samples could not be collected at the 900-Area site, SI objectives were not met for 900-Area groundwater. Based on recommended further action at the 700-Area, Building 900, and Building 946, further action (RI) will be needed.
- Further action warranted to identify potential subsurface feature found during the Building 922 GPR survey.

Group 8: General disposal, storage, or other use areas

- This group includes a mix of sites, including small storage/test sheds, a locomotive shed, a photo lab, paint shops, and former storage or disposal areas.
- Site inspection sampling included tailored sampling plans based on the types of historical activities and uses in each individual area.
- Analytical suite varied by site but included VOCs, DRO/GRO, and metals in soil; VOCs, DRO/GRO, herbicides, dioxins, and metals in groundwater.

Group 8: General disposal, storage, or other use areas

SI Results and Recommendations

New Area 2-Drum Storage

- One GW sample had elevated levels of total metals.
- While this may be attributed to turbidity, further investigation (RI) is recommended due to these elevated concentrations.

Building 924 Locomotive Shed

- Soil: No VOC or TPH concentrations in soil exceeded their respective laboratory detection limits. No further action needed.
- Groundwater: All VOC concentrations at the Locomotive Shed are below their respective MCLs. However, chloroform and TCE exceeded their respective tap water RSLs. Further action (RI) recommended for chloroform and TCE to discover the source of these compounds.

Group 8: General disposal, storage, or other use areas

SI Results and Recommendations

Buildings 11 and 817 Former Photo Labs

- Soil: An expanded SI with an investigation of background inorganic concentrations is recommended, due to elevated arsenic levels.
- Groundwater: An expanded SI is proposed for VOCs in groundwater, because groundwater samples could not be collected as part of this investigation.

Former Paint Shops (Buildings B918 and B941)

- Soil: Metals concentrations, except for arsenic, were below their respective site-specific background levels. Arsenic only slightly exceeded its background level of 3.79 mg/kg with a concentration of 3.88 mg/kg, but it does not seem to be indicative of a release. No further action needed.
- Groundwater: An expanded SI is proposed for VOCs in groundwater, because groundwater samples could not be collected as part of this investigation.

Flammable Storage Areas

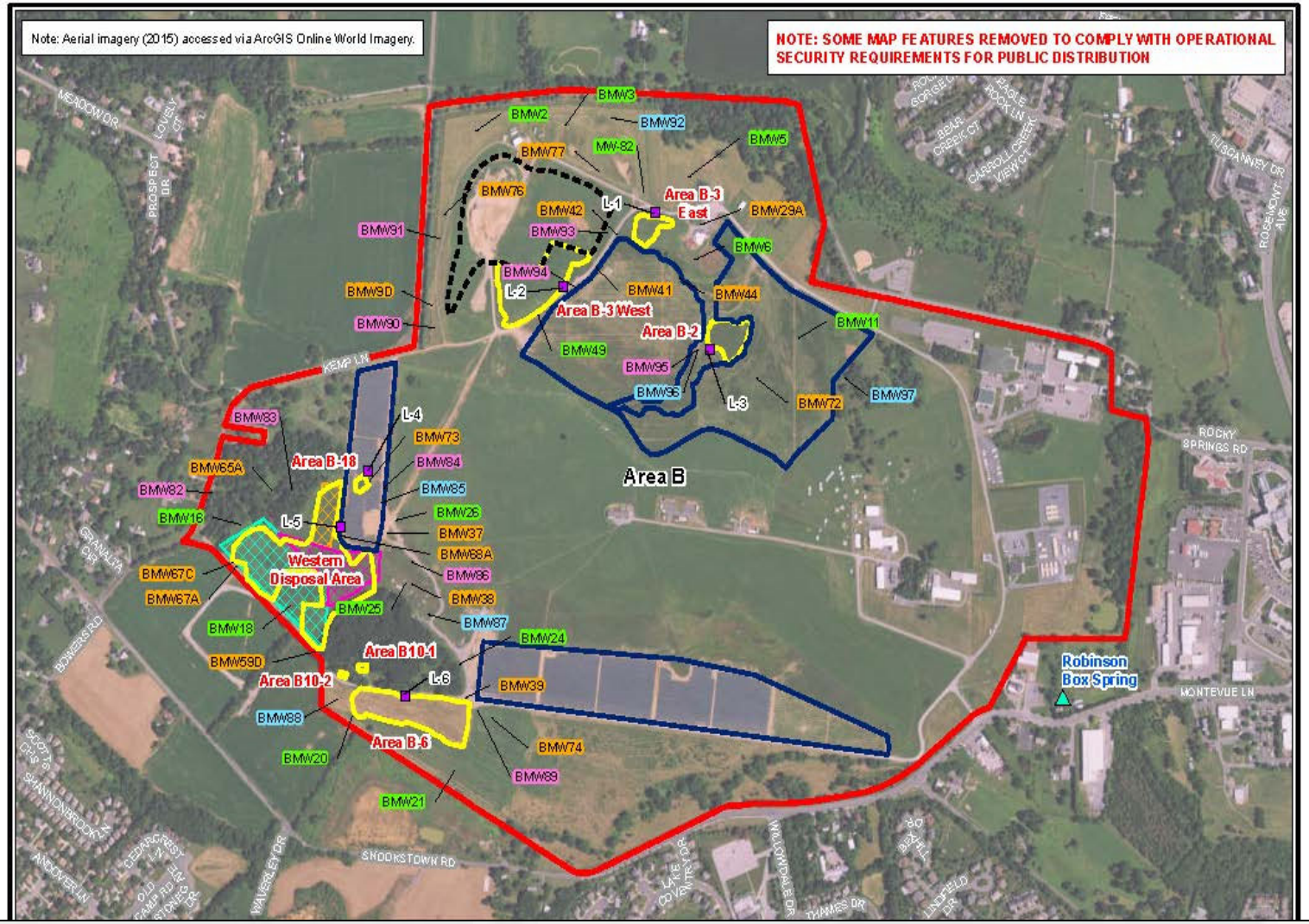
- Soil and Groundwater: No further action needed.

Fort Detrick Area B
Completion Update
Landfill Cap
Monitoring Network Expansion

U.S. Army Corps of Engineers

August 1, 2018

New Well Locations

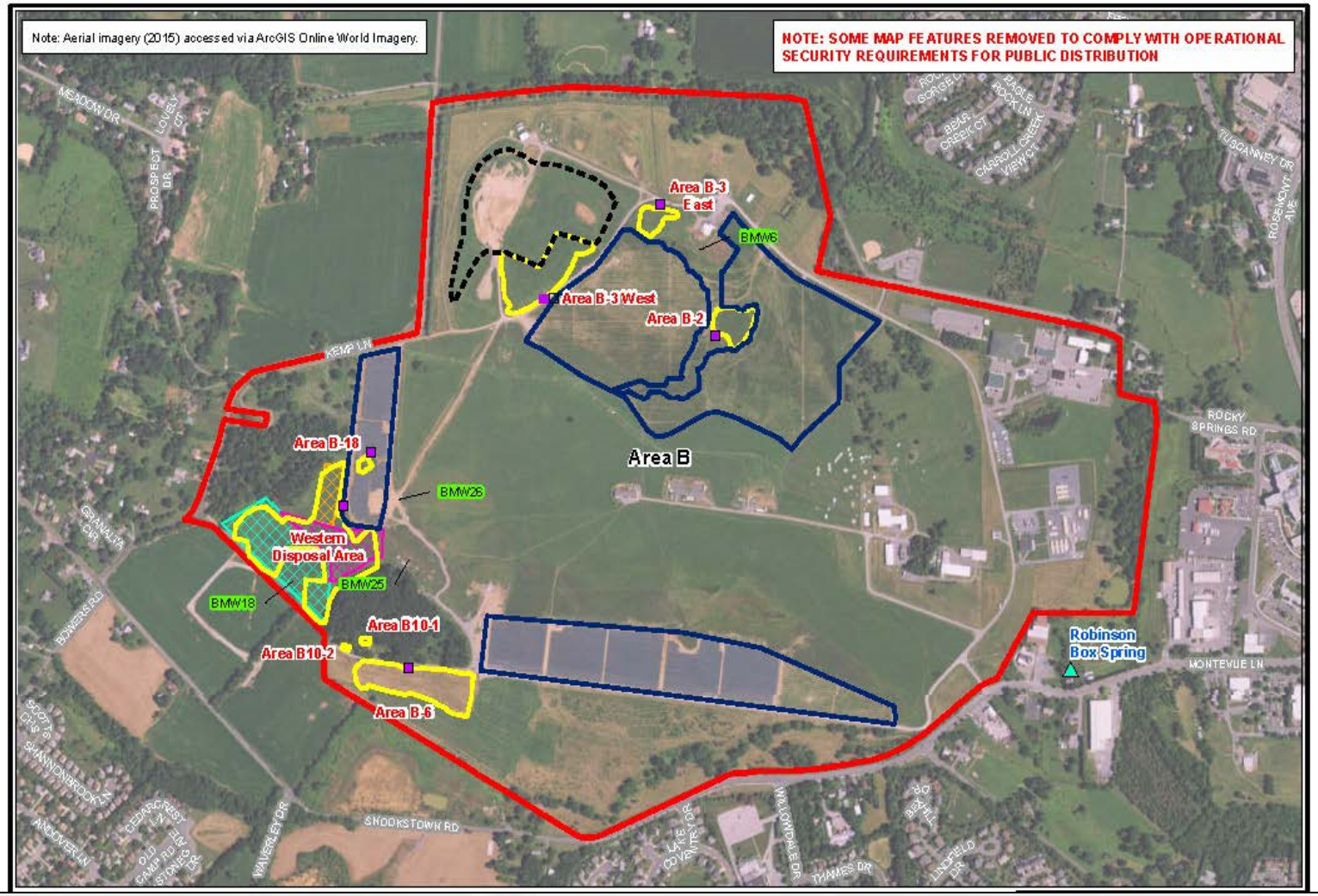


BUILDING STRONG®

Completed New Monitoring Wells

Monitoring Well	Depth (ft)
BMW86	46
BMW88	60
BMW89	90
BMW90	51
BMW91	83
BMW92	54
BMW93	48
BMW87	46
BMW82/98	75
BMW83	80
BMW97	35
BMW84	40
BMW85	45
BMW94	54
BMW95	87
BMW96	32

Replacement Well Locations

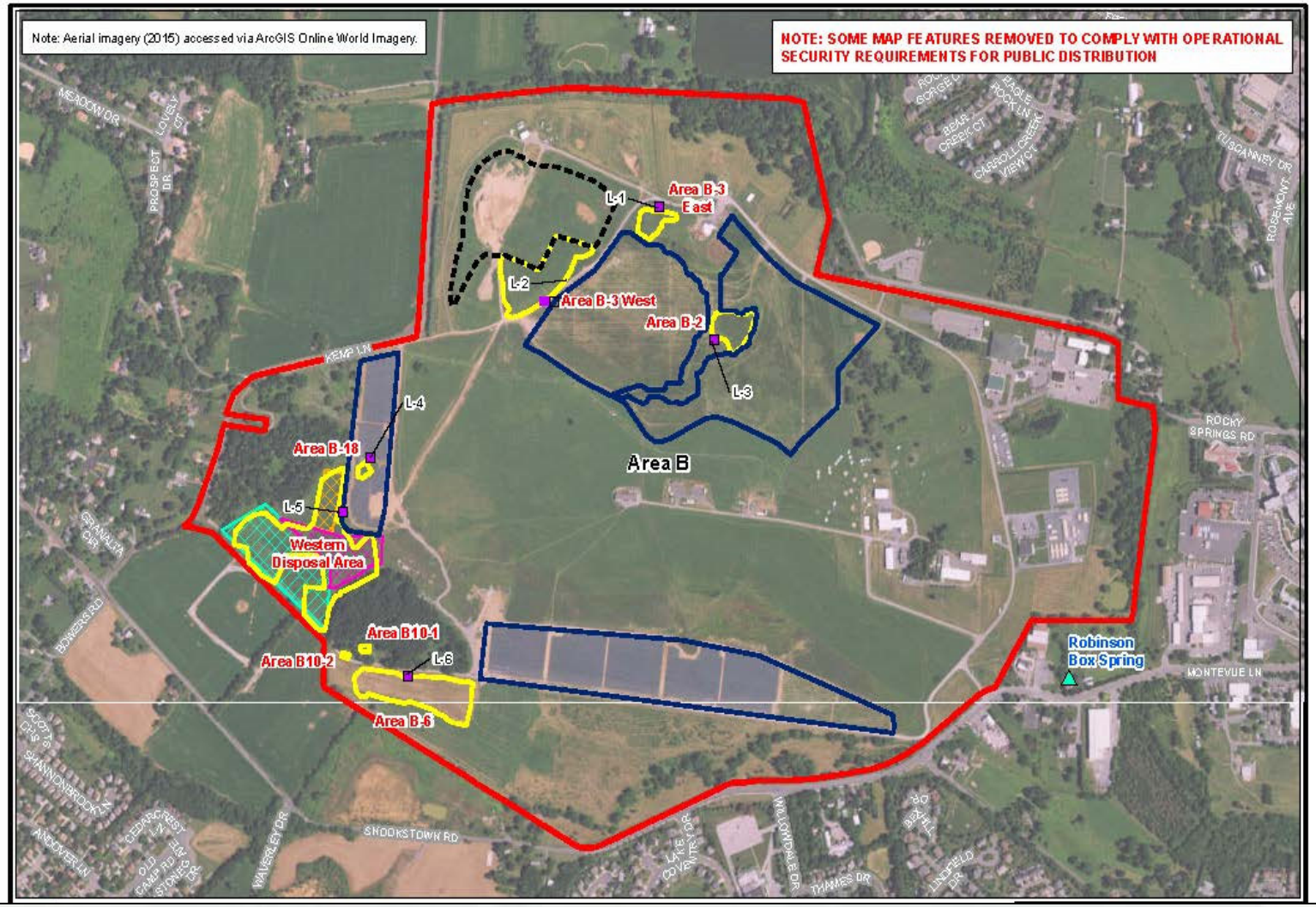


BUILDING STRONG®

Completed Replacement Wells

Monitoring Well	Depth (ft)
BMW6R	90
BMW18R	64
BMW25R	61
BMW26R	45
BMW81R	55

Lysimeter Locations



BUILDING STRONG®

Completed New Lysimeters

Monitoring Well	Depth (ft)
L1	23
L2 Control	20
L2	20
L3 Control	25
L3	21
L5 Control	25
L6 Control	25
L6	25

USGS
science for a changing world

Fort Detrick Area B Groundwater Investigation

Restoration Advisory Board
August 1, 2018

Brandon J. Fleming, Hydrologist
USGS MD-DE-DC Water Science Center

U.S. Department of the Interior
U.S. Geological Survey

Outline

- U.S. Geological Survey
- USGS Ft. Detrick Study
  - Surface water and groundwater monitoring
  - Characterize groundwater geochemistry and groundwater ages
  - Characterize subsurface flowpaths

USGS

U.S. Geological Survey

- The USGS is a non-regulatory science agency in the Department of the Interior.
- The USGS works with partners to monitor, assess, conduct targeted research, and deliver information on a wide range of water resources and conditions including streamflow, groundwater, water quality, and wateruse and availability.

USGS

Outline

- U.S. Geological Survey
- USGS Ft. Detrick Study
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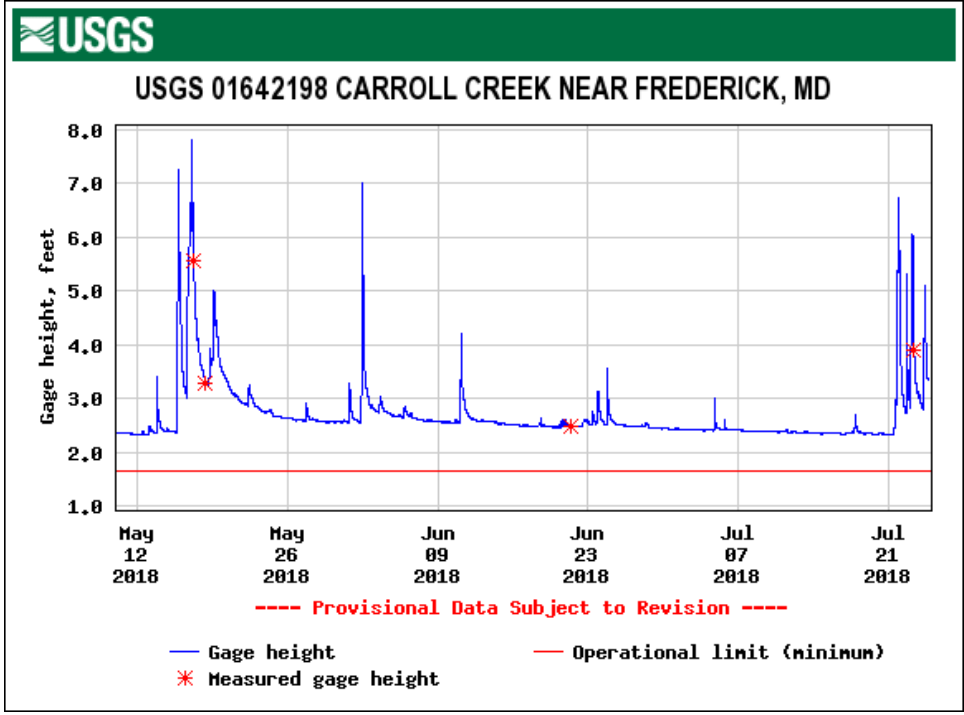
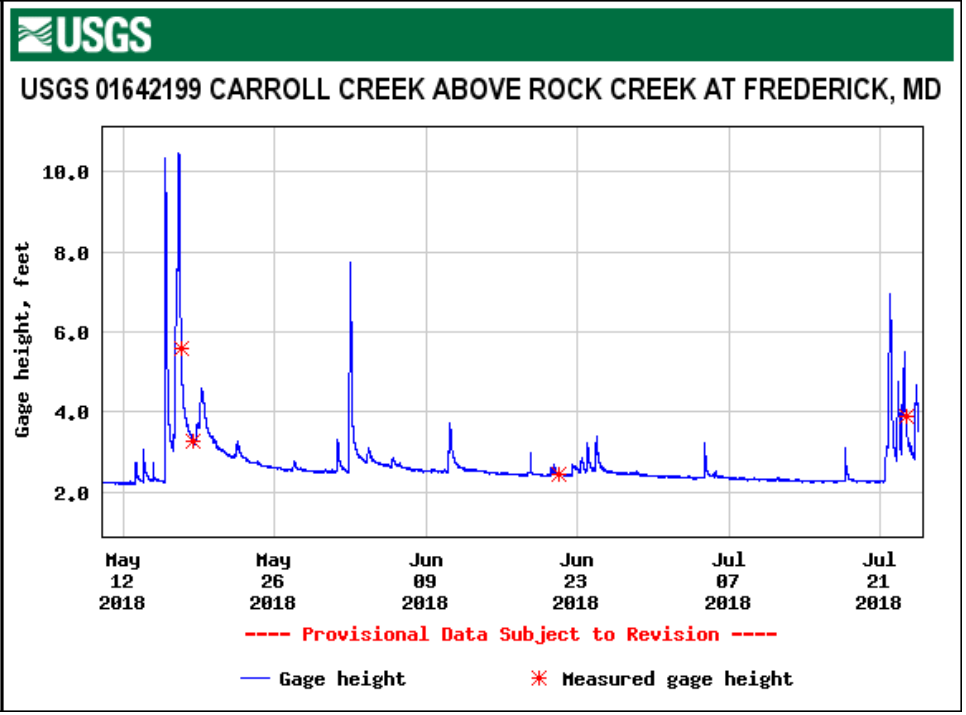
  - Characterize subsurface flowpaths

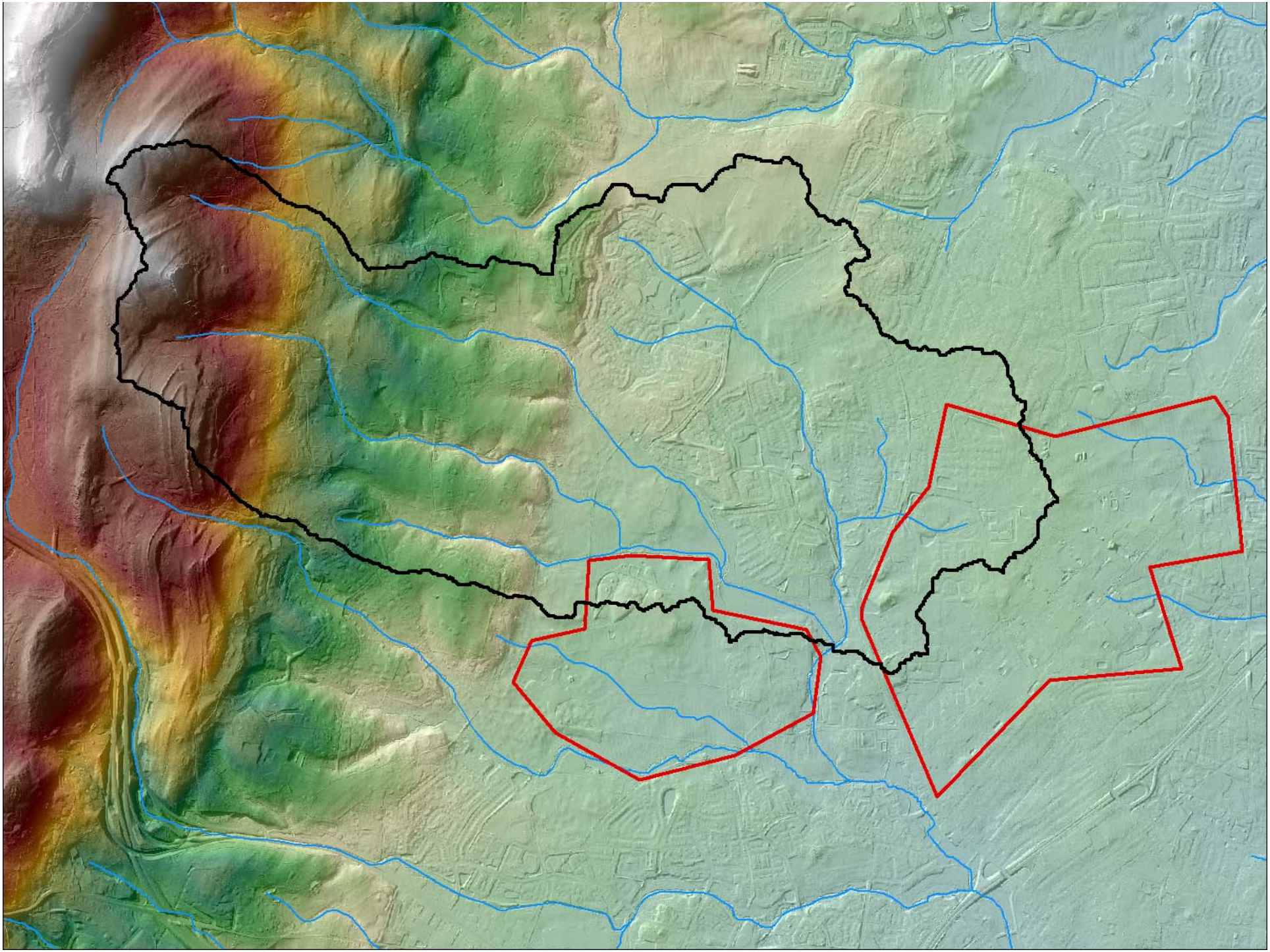
USGS

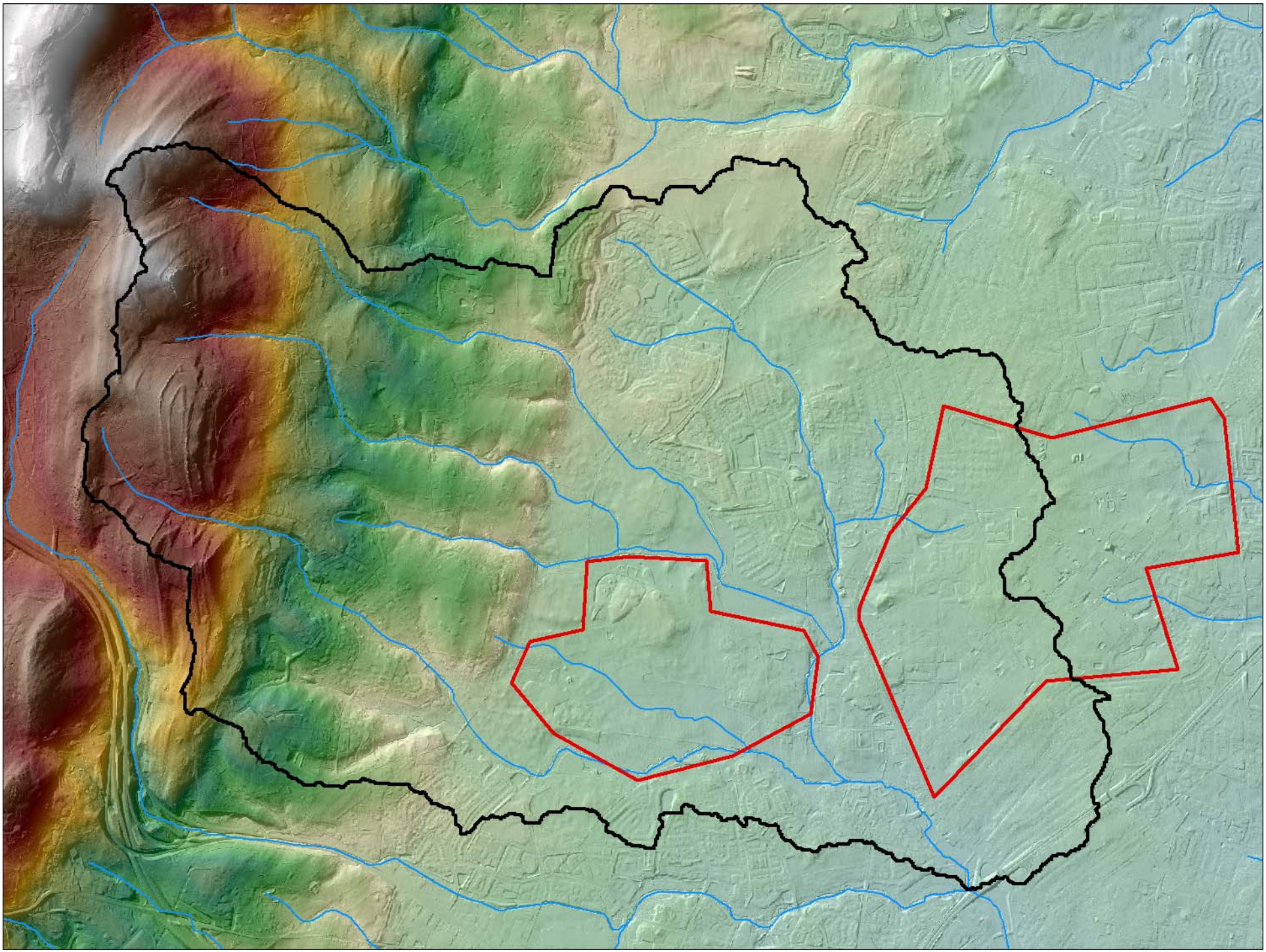
Surface water and groundwater monitoring

- Measuring streamflow in near real-time on Carroll Creek.



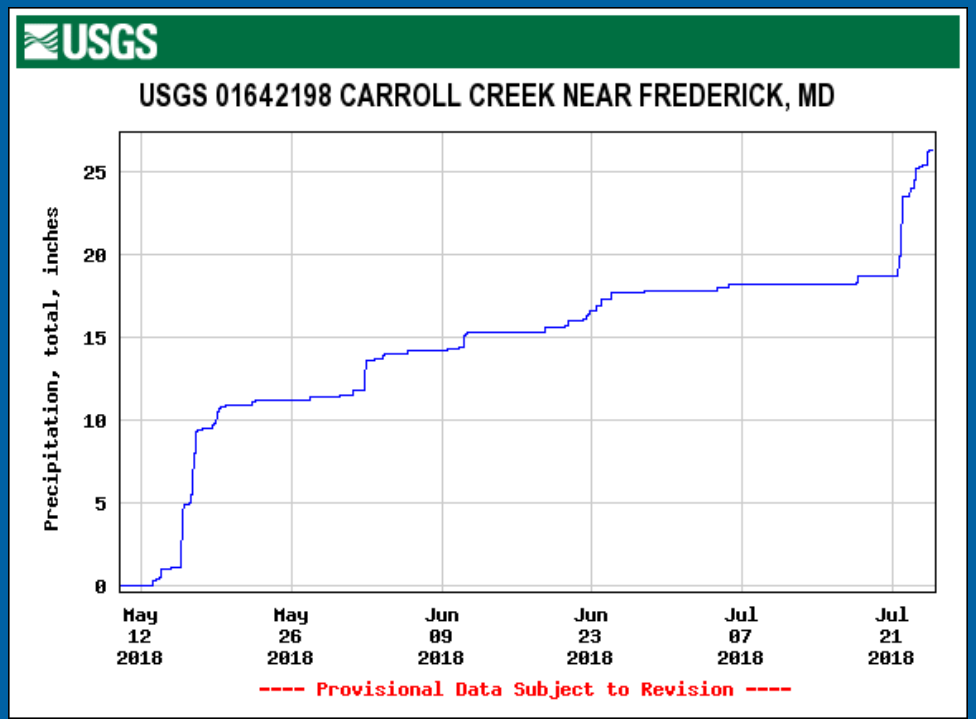






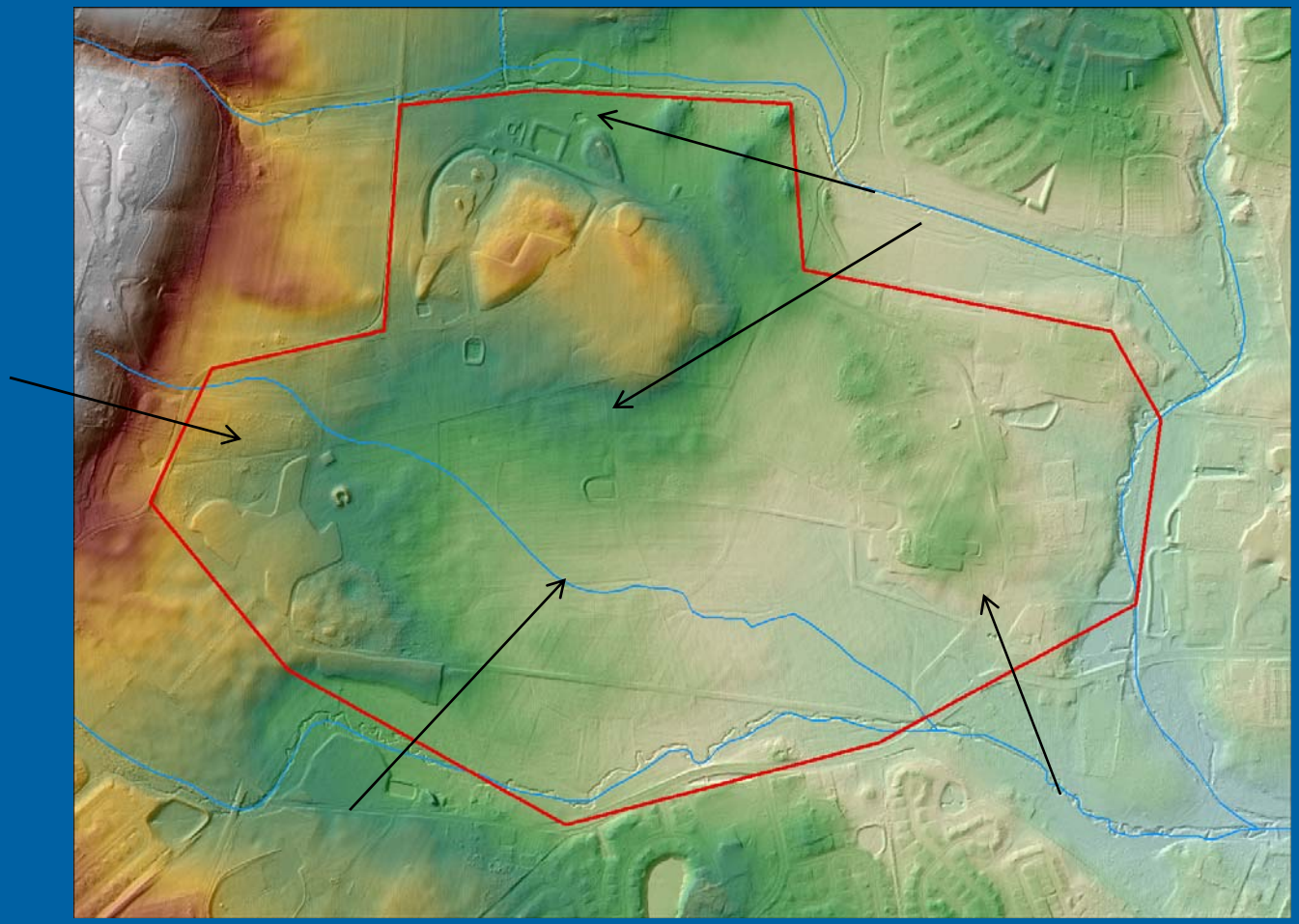
Surface water and groundwater monitoring

- Measuring streamflow in near real-time on Carroll Creek.
- Precipitation



USGS

Groundwater Monitoring



Surface water and groundwater monitoring

- Provide data to support water budget analysis.
- Provide hydrologic context to other information. Ex. Water quality results.
- Help us understand how groundwater flow may change under varying conditions.

USGS

Characterize groundwater geochemistry and age

- Compile and review existing geochemical data.
- Identify and summarize data gaps
- Design sampling effort to fill in data gaps.
  - Possible constituents include major ions, nutrients, groundwater age tracers, stable Isotopes.

USGS

Characterize subsurface flowpaths

- Review Geophysical logs
- Monitor for background dyes.
- Review results of previous qualitative dye studies.
- Incorporate results from surface and groundwater monitoring, water budget analysis, groundwater ages, existing water quality data, background dye monitoring to inform the conceptual site model.

USGS

Thank you

URL's for streamgages

- https://waterdata.usgs.gov/md/nwis/inventory/?site_no=01642198
- https://waterdata.usgs.gov/md/nwis/inventory/?site_no=01642199

Brandon J. Fleming, Hydrologist, USGS MD-DE-DC WSC
443 498 5561
bjflemin@usgs.gov

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