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August 11, 2022

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Former Carborundum Facility
2040 Cory Drive, Sanborn, NY
NYSDEC Site No. 932102
Sequestration Pilot Study Summary Report

On behalf of Elm Holdings Inc., AECOM Technical Services, Inc. (AECOM) is pleased to provide this Sequestration Pilot Study Summary Report (Summary Report) detailing the completed pilot study to evaluate enhancements to the groundwater control and extraction and treatment program at the former Carborundum Facility located at 2040 Cory Drive in the Village of Sanborn, Town of Wheatfield, New York (Site), New York State Department of Environmental Conservation (NYSDEC) Site No. 932102.

The purpose of the pilot study was to determine to what extent an in-situ amendment (Emulsified Zero Valent Iron - EZVI™) could reduce remnant volatile organic compounds (VOCs) concentrations at select areas of the Site through a combination of sequestration, abiotic (i.e., β-elimination), and biotic (i.e., reductive dechlorination) processes. In addition, the data from the pilot study were to be evaluated to determine estimated parameters required to apply this potential remedial enhancement on a site-wide basis as part of ongoing remedial efforts at the Site. The pilot injections took place on May 19 and 20, 2021. Performance monitoring was performed approximately 30, 60, 90, 150, and 320 days post-injection (i.e., through April 2022). The pilot study was conducted in general accordance with the Sequestration Pilot Study Work Plan submitted to the NYSDEC on April 13, 2021.

I. Site Background

The following summary presents a brief description of Site history, previous investigation and remediation activities, Site Remedial Action Objectives (RAOs), and Site geology and hydrogeology.

Figure 1 shows the Project Location Plan and Figure 2 shows the Site Plan. The Site property is comprised of four parcels totaling approximately 40 acres. Currently, there are two manufacturing buildings (Pyrotek, Inc. doing business as Pyrotek and a subsidiary business Metaullics, Inc.) and associated administrative buildings on the property. Construction of the most recent addition to the manufacturing facilities on the northernmost parcel was completed in November 2011. The majority of land immediately adjacent to the north and south of the property is used for agricultural purposes. Light commercial development and vacant lands border to the east. Private residences border the property along the west. Surface topography generally slopes gently to the south toward the Niagara River. Surface water from the paved areas of the Site is collected by Metaullics' sewer system.

VOCs, including primarily trichloroethene (TCE), that were previously released to the environment during operations at the manufacturing facility, are being addressed under the direction of NYSDEC under a 1991 Order on Consent and associated modifications. TCE and its primary breakdown constituents, cis-1,2 dichloroethene (DCE) and vinyl chloride (VC), are present at select locations in the groundwater.

The 1991 Record of Decision (ROD) selected soil vapor extraction (SVE) for overburden soil and permitted groundwater recovery and treatment for bedrock groundwater. The recovery and treatment systems are operated with the goal of preventing offsite migration of dissolved VOCs.

The groundwater recovery system (GRS) began operation in mid-1993 and treats groundwater using air stripping technology and an activated carbon polish. The GRS is operated with goals to provide onsite hydraulic containment and to prevent offsite migration of groundwater containing dissolved VOCs. Post-treatment water is discharged via a NYSDEC permitted State Pollutant Discharge Elimination System (SPDES) outfall to Cayuga Creek, located to the east of the Site. Weekly discharge compliance samples are collected and analyzed in compliance with the SPDES permit.

A SVE system was operated in conjunction with the GRS from 1993 until 2001 and was subsequently decommissioned by 2007. In 2001, per discussions with NYSDEC, the bedrock groundwater recovery wells were reconfigured to extract groundwater from a shallower depth, focusing on the zones immediately at the top of bedrock and below the top of bedrock (Zone 1). Additional deeper bedrock Zones 2, 3, 4, and 5 were found to be less impacted and suitable for monitored natural attenuation (MNA). This reconfiguration reduced the volume of bedrock groundwater extracted, reduced flow through the GRS, and focused capture of groundwater in the source area(s). It also allowed deeper, less contaminated zones of groundwater to be monitored for natural attenuation. Figure 2 shows the location of Site purge wells (P- and PW-series wells) and monitoring wells (B-series wells).

Quarterly groundwater sampling began in 1988. In October 2005, NYSDEC agreed to revise the groundwater sampling program and reduce the number of groundwater samples collected on an annual basis. In February 2016, NYSDEC requested that an updated groundwater monitoring program be developed. In October 2016, an updated groundwater monitoring program including transition to a semi-annual program was presented to NYSDEC. The proposed program was conditionally approved in November 2016 and was initiated in December 2016. Vault 2 was decommissioned in September 2017.

A pilot study was conducted in 2018 to evaluate the effectiveness of in-situ chemical oxidation (ISCO) using sodium permanganate as an in-situ oxidant/amendment to reduce groundwater VOC concentrations. This pilot study was summarized in the PW-3 Injection Pilot Study Summary Report, dated March 21, 2019. The results of the ISCO Pilot Study and post-injection monitoring indicated that sodium permanganate was successful at reducing VOC concentrations in the area of the injections for a period of time. However, over time, VOC concentrations rebounded to some extent, suggesting that sodium permanganate may not be the most effective remedy choice for the Site.

Site Geology/Hydrogeology

Overburden

The native soils underlying the Site generally consist of unconsolidated glacial lake sediment and till, including interbedded silts and clays with discontinuous sporadic fine sand lenses (shallow overburden). A thin coarse-grained layer is located above the bedrock (deep overburden). Based on information presented in the Remedial Investigation Report (June 1990), the average thickness of the overburden is approximately 21 feet; ranging from seven feet in the northern portion of the site to 26 feet in the southern portion. More recent investigations have confirmed this description.

Overburden groundwater is first encountered as a discontinuous perched zone approximately three to five feet below grade. A more continuous water-bearing zone is encountered at the overburden bedrock interface (known as the “top of rock” [TOR] Zone). The natural flow of groundwater at the bedrock interface is to the south-southeast. Groundwater elevation contour maps for TOR and Zone 1 from the four 2021 quarterly groundwater level measurement events are presented in Appendix A.

VOCs in deep overburden soils may be introduced to the bedrock aquifer from fluctuations of bedrock groundwater elevations, which periodically penetrate the soil on a seasonal basis. South and southwest of the Site, groundwater is restricted to the bedrock throughout the year. While the overburden on Site is occasionally affected by higher levels of bedrock groundwater, its hydraulic conductivity is so low that it does not transmit significant amounts of groundwater laterally and is classified as an aquitard. The zone at the overburden-bedrock interface is referred to as “top of rock” and is considered bedrock groundwater.

Bedrock

Overburden at the Site is underlain by the Lockport Dolomite. The Lockport Group has been described as a massive- to medium-bedded, argillaceous dolomite with minor amounts of dolomite and shale. The upper 10 to 25 feet of this unit can be heavily weathered and often contains abundant bedding planes and vertical fractures enlarged by dissolution and glacial scour.

As noted above, a number of laterally definable fracture zones have been identified at the Site, including top of rock (at the overburden interface), and Zones 1, 2, 3, 4, and 5. The TOR Zone and Zone 1 are the bedrock groundwater recovery zones on which the GRS is focused. The deeper bedrock Zones 2, 3, 4, and 5 show limited VOC impact. Bedrock groundwater flow is primarily to the south, with a southwesterly component toward a rock quarry located west-southwest of the Site

II. Pilot Study Objectives

The purpose of the pilot study was to evaluate the effectiveness of an in-situ amendment (Emulsified Zero Valent Iron - EZVI™) to reduce remnant VOC mass within the targeted treatment zones (i.e., TOR and Zone 1) through a combination of abiotic and biotic processes. EZVI™ is comprised of emulsified vegetable oil (EVO) and nano- to micro-scale zero-valent iron (ZVI) particles in which the ZVI (a powder) is surrounded by oil to form micelles (an aggregate of molecules in a colloidal solution) that are hydrophobic and denser than water. EZVI™ is therefore capable of sinking through saturated soil to, and into fractured bedrock. EZVI™ utilizes both biotic and abiotic processes to sequester and degrade chlorinated VOCs (CVOCs).

Once injected, EZVI™ can facilitate the remediation of the Site groundwater by the following processes over many years:

- The vegetable oil prevents the iron from readily oxidizing;
- VOCs (as DNAPL or dissolved-phase contaminants of concern [COCs]) are hydrophobic and readily partition into the outer "shell" of oil (preferring oil to water), trapping DNAPL (if present) and reducing the concentration of VOCs in the groundwater;
- The EVO is not mobile, and therefore serves to sequester VOCs in place, reducing the mass flux of VOCs from the treated areas;
- The trapped VOCs are directly reduced to non-target, innocuous end products by the ZVI within the oil-water micelles through abiotic processes; and
- The emulsified oil degrades slowly and produces a long-term source of volatile fatty acids (VFAs) that stimulate enhanced reductive dechlorination (ERD) by indigenous bacteria (i.e., those already present).

Utilizing these processes, EZVI™ can:

1. Sequester and treat source area VOCs, including DNAPL (if present); and
2. Sequester and treat more diffuse VOCs near the downgradient property boundary, preventing off-site migration of VOCs.

More specifically, the objectives of the pilot study included the following:

- Evaluate the reduction of VOC concentrations following the EZVI™ injections;
- Assess the distribution and persistence of VOCs through post-injection performance monitoring;
- Evaluate the longer-term response of Site geochemistry following the EZVI™ injections;
- Identify data gaps; and
- Evaluate the potential to use of EZVI™ for a full-scale application.

The pilot study was conducted in two areas of the Site: 1) PW-3 Area located immediately east of PW-3, around well B-8M, north of the Metaullics manufacturing building; and 2) P-4 Area located east of P-4 in the southwest corner of the Site. The PW-3 Area and P-4 Area are shown on Figures 3 and 4, respectively.

A direct-push technology (DPT) drill rig operated by AECOM's subcontractor Innovative Environmental Technologies, Inc. of Pipersville, PA (IET) was used to advance exploratory borings and injection points through the overburden to the top of rock interface. Exploratory borings were advanced prior to the injections to evaluate the depth to the top of bedrock and the nature of the shallow bedrock fractures in each pilot study area.

III Pre-Injection Activities

Mobilization

AECOM submitted a United States Environmental Protection Agency (USEPA) Region 2 Underground Injection Control (UIC) Notification Form to USEPA with an inventory of the Class V Remediation Wells (injection points) to be used in the pilot study. Prior to beginning any intrusive activities, IET contacted the Underground Facilities Protection Organization (UFPO) to mark out utilities in the proposed investigation areas. The intended drilling locations were marked with spray paint or flagging and an independent utility mark out subcontractor called out to locate on-site utilities in drilling areas not covered by the UFPO. The independent utility markout was performed on May 12, 2021 by AECOM's subcontractor, Radar Solutions International, Inc., Buffalo, NY (RSI). RSI performed ground-penetrating radar (GPR) surveys to obtain information on subsurface conditions and features, including utilities or obstructions. In addition, Pyrotek Inc. was contacted to provide available utility information to assist in locating on-site underground utilities. As necessary based on utility locations, drilling locations were moved to avoid potential conflicts.

In addition, individual exploratory and injection point borings were hand cleared using a 2.5-inch diameter hand auger to advance each boring from the ground surface to approximately five feet below ground surface (ft-bgs) to further prevent contact with any potential underground utilities.

Exploratory Borings

On May 18, 2021, a total of seven exploratory borings were advanced in the two selected pilot testing areas of the Site. All exploratory boring locations were located in unpaved areas in the vicinity of pumping wells PW-3 and P-4 as shown on Figures 3 and 4, respectively. Three exploratory borings were advanced in the vicinity of pumping well PW-3, near monitoring wells B-08M and B-18M. Four exploratory borings were advanced near pumping well P-4, near monitoring wells B-13M and B-19M. Soil samples were collected in acetate liners through the entire depth of each boring for inspection and characterization by an AECOM geologist. Exploratory borings in the PW-3 Area were designated as PW-3 EXP-1, PW-3 EXP-2, and PW-3 EXP-3; exploratory borings completed in the P-4 Area were designated as P-4 EXP-1, P-4 EXP-2, P-4 EXP-3, and P-4 EXP-4. A summary of boring observations is provided on Table 1. A photographic log of the exploratory boring and injection program is provided as Appendix B.

Exploratory borings advanced in the vicinity of pumping well PW-3 (see Figure 3) encountered one to two feet of gravel (fill) under the lawn surface, and up to nine feet of dry to moist dark brown clayey silt and silty clay overlying bedrock. The depth to competent bedrock (refusal of the direct-push tooling) ranged from 10 to 12 ft-bgs. A thin interval of weathered, fractured bedrock was observed in the PW-3 area with thicknesses ranging from one to two inches. No borings exhibited visual or olfactory evidence of the presence of volatile organic compounds (VOCs).

Exploratory borings advanced in the vicinity of pumping well P-4 (see Figure 4) encountered a thin layer of fill material overlying approximately 20 feet of dry to moist silty clay, with varying amounts of moist, plastic clay near the bottom of each borehole, above the top of weathered bedrock. The thickness of weathered bedrock overlying competent bedrock was more variable in the P-4 pilot study area. Exploratory borings P-4 EXP-1 and P-4 EXP-2 encountered one to two inches of fractured bedrock upon refusal of the direct-push tooling; while exploratory borings P-4 EXP-3 and P-4 EXP-4 encountered approximately 4 feet and 1 foot of fractured rock prior to refusal, respectively. No borings exhibited visual/olfactory evidence of the presence of VOCs. Upon completion, the exploratory boreholes were filled with bentonite chips and hydrated in order to minimize the potential for short circuiting of injection fluids from adjacent injection points

III. Pilot Study Injections

Pilot study injection activities were performed on May 19 and 20, 2021. Following the completion of the exploratory borings and after deactivating the P-4 and PW-3 pumps, five direct-push borings were advanced in each of the two pilot test areas on May 19 and 20, 2021. The completed injection borings were completed: 1) P-4 Area located upgradient of P-4 and downgradient of monitoring wells B-13M and B-19M in a general linear pattern forming a permeable reactive zone between the wells; and 2) PW-3 Area with the injections in a circular pattern focused around monitoring well B-8M. At each of the respective injection locations the direct-push tooling was advanced to the top of bedrock. For the overall pilot study, a total of 470 gallons of EZVI™ was mobilized to the Site for injection. Each injection point received 47 gallons of injectate solution, targeting the overburden / top of rock interface and up to two feet above the top of rock.

Groundwater levels and field instrument measurements, including dissolved oxygen (DO), pH, oxidation-reduction potential (ORP), temperature, specific conductivity, and turbidity were collected before, during, and after completion of the injection work to identify notable changes that might be attributable to the injection of nitrogen gas used to open pathways for the emplacement of EZVI™, as well as changes that might be attributable to the injection of EZVI™. Visual observations and field instrument measurements from samples of water bailed from pumping wells P-4 and PW-3 and monitoring wells B-8M, B-18M, B-13M, and B-19M before and after the injections are summarized on Tables 2A and 2B, respectively. The locations of the monitoring wells are shown in Figures 3 and 4. Field observations for each of the two pilot test areas are summarized below.

Wells PW-3 and P-4 were both turned off on May 19, 2021. PW-3 was restarted on July 23, 2021. P-4 was restarted on August 19, 2021. P-4 was later turned off from March 26 through April 6, 2022, due to fouling with the EZVI™ injectate. The groundwater elevation contour maps presented in Appendix A show the changes created by the pump shutoff. The changes in TOR elevations when the pumps were off in June 2021 (Appendix A, Figure 5) are evident when compared to when the pumps were on (Figures 3, 7 and 9). Since most of the pumping occurs in the TOR, the groundwater elevation changes in Zone 1 (Appendix A, Figures 4, 6, 8 and 10) is less evident.

Amendment and Injection Procedures

The EZVI™ amendment was applied to the subsurface via DPT injections, targeting the bottom two feet of overburden and weathered zone immediately above competent bedrock. Injection of the solution was performed at discrete intervals within the bottom 2 feet of the borehole. Injection points were advanced using a Geoprobe® 7822DT DPT drill rig, using 1.5-inch diameter drill rods. Photos of the drilling and injection activities are presented in Appendix B.

The EZVI™ amendment was applied to the subsurface at a target volume of approximately 47 gallons per injection point. The "top-down" injection method was utilized at 7 of the locations due to the target zone being in the weathered zone immediately above competent bedrock, three locations were injected using bottom-up retractable tooling due to clogging of top-down tooling and total depth to DPT refusal at those locations. IET provided a report entitled Technology Discussion and Field Report following the completion of the field work and this document is provided as Appendix C to this document. Field observations from each of the pilot study areas are presented below. A photographic log of the injection program is provided as Appendix B.

P-4 Pilot Test Area

Prior to advancing injection tooling, "blind" tooling was advanced at each of the designated injection locations to confirm the depth to bedrock and, through the experience of the driller, to estimate the thickness of the fractured "top of rock". Once the fractured rock thickness was ascertained, injection tooling was then advanced to refusal, and a sequence of injection procedures was implemented as follows:

1. Nitrogen gas was injected into the subsurface at 150 to 175 pounds per square inch (psi) to develop subsurface pathways within the designed radius of influence into which EZVI™ could be injected;
2. EZVI® was injected into the subsurface at a pressure of 40 psi with observed flow rates ranging from 3.6 to 9.4 gallons per minute (gpm); and
3. Nitrogen gas was again injected at approximately 50 psi to "push" the remaining EZVI™ out of the injection hoses and to increase the radius of distribution from the injection borehole.

Once nitrogen and EZVI™ were delivered to the subsurface, a valve at the ground surface was closed to prevent injected materials from backing out of the borehole due to backpressure. While the pressure dissipated, injection tooling was then left in place while adjacent injection work was being conducted (to avoid short-circuiting to the ground surface through the previously advanced boreholes). The locations of the EZVI® injection locations are provided in Figure 4, and a summary of injection depths and observations is provided on Table 3A.

Where "blind" boreholes indicated a thin layer of fractured rock (i.e., less than 12 inches thick) top-down injection tooling was advanced to the top of bedrock. This tooling is capable of injecting amendments (e.g., EZVI™) through a two-foot injection interval with injection orifices nearest the bedrock surface. Where "blind" boreholes indicated a thicker layer of fractured rock, e.g., greater than 12 inches thick, retractable tooling was employed that is capable of injecting substrates through a two-foot injection interval that is situated six inches higher than the top-down injection tooling.

Due to the presence of moist, plastic, expansive clay near the bedrock surface, the injection orifices of the top-down tooling were frequently clogged, requiring the removal, clearing, and re-advancement of the top-down tooling through the same borehole at most wells where this injection method was employed. These issues were not encountered using the retractable tooling because the injection orifices of that tooling are not exposed to soil as the rods are driven to the target depth.

A total of 235 gallons of EZVI® was injected into the five P-4 area injection borings without evidence of surfacing at adjacent borings. Additional details related to the field injection program are provided in IET's report entitled Technology Discussion and Field Report which is provided as Appendix C. Field instrument measurements collected on May 19 indicated stable groundwater levels (after shutting pump P-4 off) and more reducing conditions following the injection of EZVI™. However follow-on measurements on May 20 suggest that these changes were more attributable to the limited volume of groundwater bailed from the monitoring wells (B-13M and B-19M) and pumping well (P-4). Though turbidity increased at the pumping and monitoring wells, no evidence of EZVI® intrusion was observed in the groundwater bailed from these wells. Field instrument measurements made before and after the injections are presented in Table 2A.

The following data associated with amendment delivery was collected during the injection process.

- Injection location;
- Injection interval;
- Injection solution flow rate;
- Injection pressure; and,
- Cumulative volume of injection solution delivered to the injection point.

After the injections were completed, injection boreholes were filled with bentonite chips and hydrated in order to minimize the potential for short circuiting of injection fluids from adjacent injection points. Table 3A presents the injection data recorded during P-4 Area injection activities.

PW-3 Pilot Test Area

As with the P-4 Area, “blind” tooling was advanced at each of the injection locations to identify the depth to bedrock and, through the experience of the driller, to estimate the thickness of the fractured “top of rock”. Once the fractured rock estimated thickness was ascertained, injection tooling was then advanced to refusal, and a sequence of injection procedures was implemented as follows:

1. Nitrogen gas was injected into the subsurface at 100 psi to develop subsurface pathways into which EZVI™ could be injected. Less injection pressure was required than the 150 to 175 psi used the P-4 Area, likely due to the thinner overburden.
2. EZVI™ was injected into the subsurface at pressures ranging from 40 to 50 psi and flow rates ranging from 2.14 to 4.27 gpm.
3. Nitrogen gas at was injected approximately 50 psi to “push” the remaining EZVI™ out of the injection hoses and to increase the radius of distribution from the injection borehole.

As with the P-4 Area, a valve at the ground surface was closed during the pressure dissipation to prevent injected materials from backing out of the borehole, and injection tooling was then left in place while adjacent injection work was being conducted. The locations of the EZVI™ injection locations are provided in Figure 3, and a summary of injection depths and observations is provided on Table 3B.

Since the thickness of fractured rock near PW-3 was only one to two inches, all injections were conducted using top-down injection tooling. Since the borings in the PW-3 Area were much shallower than the P-4 area and because numerous borings had previous been advanced in this area, injection rates and pressures were intentionally lowered to mitigate the potential for EZVI™ surfacing. A total of 232 gallons of EZVI™ was injected into the subsurface successfully in the PW-3 Area. Despite the efforts to mitigate surfacing, in the PW-3 Area approximately three gallons of EZVI™ surfaced through a historic boring of unknown origin about 10 feet from the injection point. The surfacing material, which included muddy groundwater, spread over a two-foot radius around the old borehole, and no further.

This borehole and another borehole were backfilled with bentonite chips that were subsequently packed into the borehole using the direct-push tooling. The surfacing, although unintended, demonstrated the injections were achieving the desired radius of influence. A photograph of the surfacing EZVI™ is provided in Appendix A. Additional details related to the field injection program are provided in IET's report entitled Technology Discussion and Field Report and is also provided as Appendix C.

Field instrument measurements collected on May 20 indicated possible increases in water levels at the adjacent monitoring wells (B-8M and B-18M) after the injection of EZVI™, and less reducing conditions following the injection of EZVI™, however these changes were likely attributable to the limited volume of water bailed from the monitoring wells (B-8M and B-18M) and pumping well (PW-3). As with the P-4 area, turbidity levels increased at the monitoring wells (but not pumping well PW-3), but no evidence of EZVI™ intrusion was observed in the water bailed from these wells. Field instrument measurements made before and after the injections are presented in Table 2B.

After the injections were completed, injection boreholes were filled with bentonite chips and hydrated in order to minimize the potential for short circuiting of injection fluids from adjacent injection points.

The following data associated with injectate delivery was collected during the injection process.

- Injection location;
- Injection interval;
- Injection solution flow rate;
- Injection pressure; and,
- Cumulative volume of injection solution delivered to the injection point.

Table 3B presents the PW-3 Area injection data recorded during injection activities.

IV. Pilot Study Groundwater Monitoring

Groundwater sampling and analysis to establish baseline conditions and monitor post-injection performance were conducted as part of the pilot study. The groundwater monitoring program established for the field pilot study consisted of three components:

1. Baseline groundwater monitoring;
2. Injection monitoring; and,
3. Post-injection (performance) groundwater monitoring at 30, 60, 90, 150 and 320 days.

Each component of the monitoring program is described in further detail below. Table 4 summarizes the monitoring program for the pilot study.

Baseline Groundwater Monitoring

Baseline groundwater monitoring was conducted on April 21 and 22, 2021, prior to the initiation of injection activities. The results obtained during this sampling event served as the basis for evaluating the overall efficacy of the pilot study. Baseline samples were collected from monitoring wells in the TOR and Zone 1 intervals in both pilot test areas. The wells included in the pilot test monitoring program are:

PW-3 AREA	P-4 AREA
B-8M	B-13M
B-18M	B-19M
PW-3	P-4

Each baseline monitoring well was sampled using low-flow groundwater sampling procedures as described in the current monitoring and maintenance plan for the site. The monitoring plan was specific to the objectives of the study and includes the following parameters:

- Static water level elevations;
- Field parameters including temperature, pH, specific conductance, ORP, and DO;
- Site-specific VOCs (EPA 8260B);
- Total organic carbon (SM 510C);
- Sulfate (300.0);
- Total ferric iron (unfiltered);
- Ferrous iron (filtered, 0.45 µM) (610C); and
- Dissolved gasses (methane, ethane, ethene, and carbon dioxide [CO2]) (RSK-175).

In addition to the analyses listed above, selected wells were also sampled for a microbial assay (QuantArray®-Chlor) to characterize the microbial population prior to the EZVI™ injections. Wells PW-3, B-8M, B-18M and B-13M were sampled for QuantArray®-Chlor during the October 2020 semi-annual sampling event, and this data served as the baseline values for these specific monitoring wells since the microbial community was unlikely to have changed significantly from that time to the initiation of the pilot study. Well P-4 was sampled for microbial assay during April 2021 baseline sampling to obtain microbial data in the downgradient portion of the pilot study area.

Samples were collected in laboratory-supplied pre-preserved glassware, placed in a cooler on ice, and transported under chain-of-custody documentation to the respective laboratories for analysis. The QuantArray®-Chlor analyses were performed by Microbial Insights (MI) of Knoxville, Tennessee. The remaining laboratory analyses were performed by EurofinsTestAmerica (Eurofins) Laboratory of Buffalo, New York.

Injection-period Monitoring

Water levels were measured periodically at PW-3, B-8M, PS-01, and PS-02 using an electronic water level indicator accurate to 0.01 feet. Water quality field parameters (temperature, pH, specific conductance, DO, and ORP) were monitored before and after the injection events using a YSI Model 556 water quality meter to evaluate groundwater geochemistry prior to and following the amendment injections. The field instrument measurements are presented on Tables 2A and 2B.

Negative values of ORP and low or decreasing DO concentrations reflect the development and/or presence of reducing conditions. Slight increases in specific conductance may be useful in tracking of EZVI™ dispersion.

Post-Injection Monitoring

Post-injection monitoring was conducted to evaluate the performance of the applied EZVI™ treatment with regards to shifts in subsurface geochemical conditions and the associated changes in VOC concentrations/VOC mass within the treatment area. Post-injection monitoring events were conducted at regular intervals corresponding to approximately 30, 60, 90, 150, and 320 days post-injection. During these monitoring events, PW-3, B-8M, and B-18M in the PW-3 Area and in wells P-4, B-13M, and B-19M in the P-4 Area were sampled. Post-injection monitoring included the same parameters as the baseline sampling described above. QuantArray®-Chlor analysis was performed on samples from wells PW-3, B-8M, B-18M, P-4 and B-13M during the 90-day post-injection sampling and from wells B-8M, P-4 and B-13M during the 150-day post-injection round to evaluate the change in microbial population resulting from the EZVI® injections. Post-injection monitoring took place as follows:

- 30 Day – June 28 and 29, 2021
- 60 Day – July 26 and 27, 2021
- 90 Day – August 23 and 24, 2021
- 150 Day – October 25, 2021
- 320 Day – April 14, 2022

Following collection, groundwater samples were placed in laboratory supplied containers, packaged on ice, and shipped to the laboratories for analysis of the parameters specified above.

V. Results and Data Interpretation

Data obtained as part of the baseline and post-injection performance monitoring sampling events has been evaluated to assess the performance of the injection program, as well as to evaluate the efficacy and applicability of EZVI™ as an enhancement to the current remedy that could be applied across the Site to address residual groundwater VOC contamination. The data have been interpreted to evaluate the effectiveness of the pilot study injections in terms of amendment distribution, trending of aquifer geochemical conditions (i.e., field parameter data), and contaminant reduction. It should be noted that significant contaminant mass reduction was not the primary goal of the pilot study. The quantity and application area of the EZVI™ amendment was limited in the pilot study areas, such that the existing monitoring wells could be utilized to track the subsurface geochemical conditions; if the volume of EZVI™ amendment had been increased the amendment would have directly impacted the groundwater within the wells and the reported VOC concentrations would have been significantly lower and not representative of the overall subsurface conditions. Performance monitoring data for the PW-3 and P-4 Areas are presented in Tables 5A and 5B, respectively.

Field Parameters

The field parameters most indicative of the effects of EZVI™ are DO and ORP. These generally showed decreasing trends, indicative of increasingly anaerobic/reducing conditions, which are conducive to the reductive dechlorination of the site-specific chlorinated VOCs. Additionally, pH is another key parameter in that pH values need to remain in a range of ~6 to 8 standard units (s.u.) in order to support microbial activity associated with reductive dechlorination. During the 90-day sampling event in August 2021, the DO and ORP values deviated from this trend and showed an increase, but the decreasing trend was again observed by 150 days. This suggests the possibility of an equipment malfunction during the 90-day sampling.

PW-3 Pilot Test Area

Within the PW-3 Area, DO values measured in wells PW-3, B-8M and B-18M during the Baseline sampling were generally aerobic, ranging from 0.86 to 1.94 milligrams per liter (mg/L); ORP values were mildly oxidizing, ranging from 19.7 to 59.5 millivolts (mV); and pH values were circumneutral ranging from 7.21 to 7.66 s.u.

Over the course of the post-injection performance monitoring period, DO values were observed to generally decrease in the treatment area, especially in the area of B-8M (located in the center of the five EZVI™ injection points). At monitoring well B-18M, DO was also observed to decrease over the performance monitoring period. In PW-3, the DO generally decreased through Day-150 and then increased at the end of the performance monitoring period (likely attributable to the resumption in pumping at PW-3). At B-8M, ORP values were observed to decrease over the performance monitoring period to as low as -189.9 mV indicating that reducing conditions in the vicinity of this well were established. At B-18M ORP values were also observed to decrease over the performance monitoring period; however, the ORP values were not as low as at B-8M likely attributable to the fact that B-18M was located outside and slightly sidegradient from the five injection locations in the area of B-8M. In addition, B-18M is a Zone 2 well and B-8M is a TOR well. At PW-3, DO and ORP values initially remained higher than either B-8M or B-18M but the values did decrease towards the end of the performance monitoring period. This behavior is expected due to the fact that PW-3 is located upgradient of the treatment area and delayed changes in geochemistry would be expected. In all of the wells in the PW-3 Area, pH values remained within the 6 to 8 s.u. range throughout the performance monitoring period.

The field parameter data for PW-3, B-8M and B-18M, over the course of the pilot study, are presented in Figures 5 through 7, respectively.

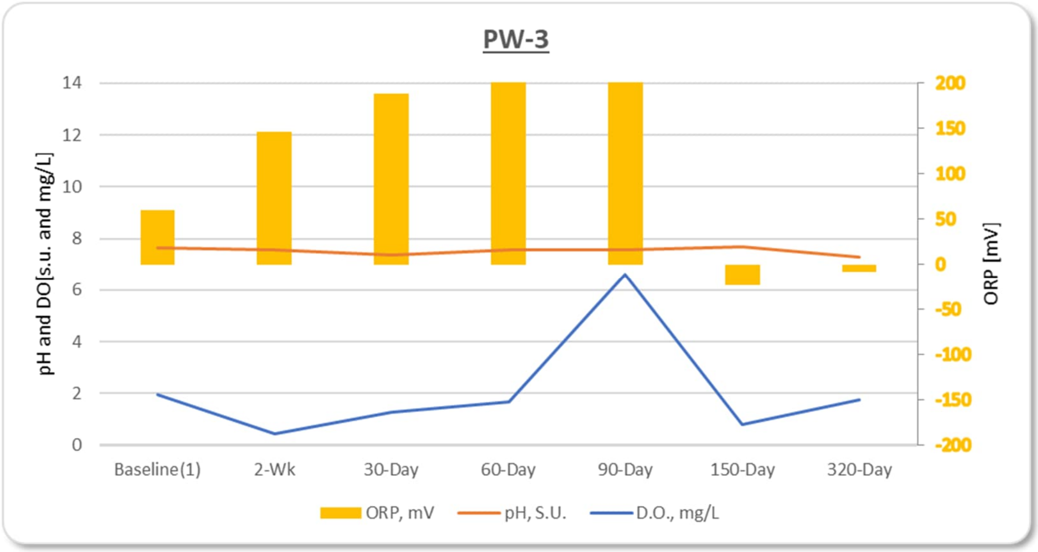

Figure 5 Performance Monitoring Field Parameters in PW-3

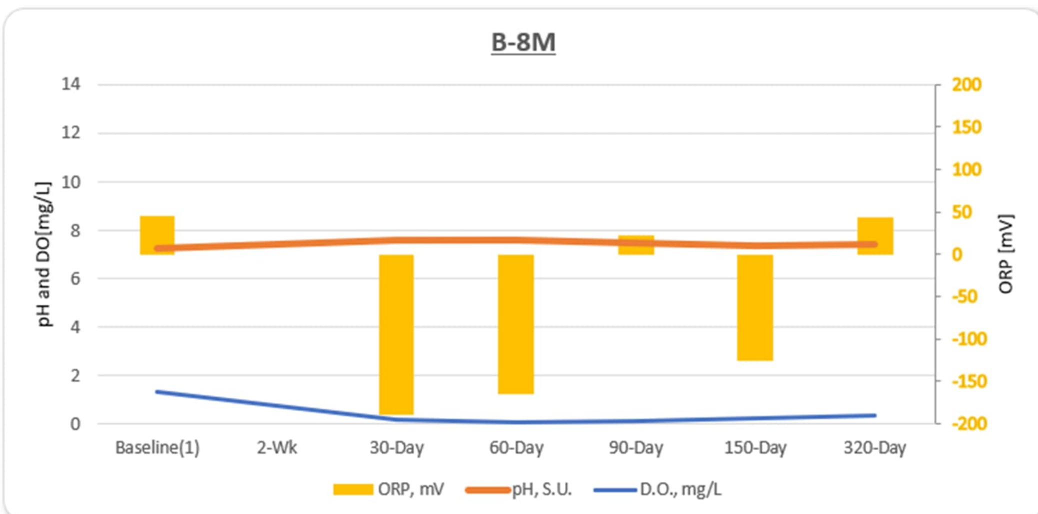

Figure 6 Performance Monitoring Field Parameters in B-8M

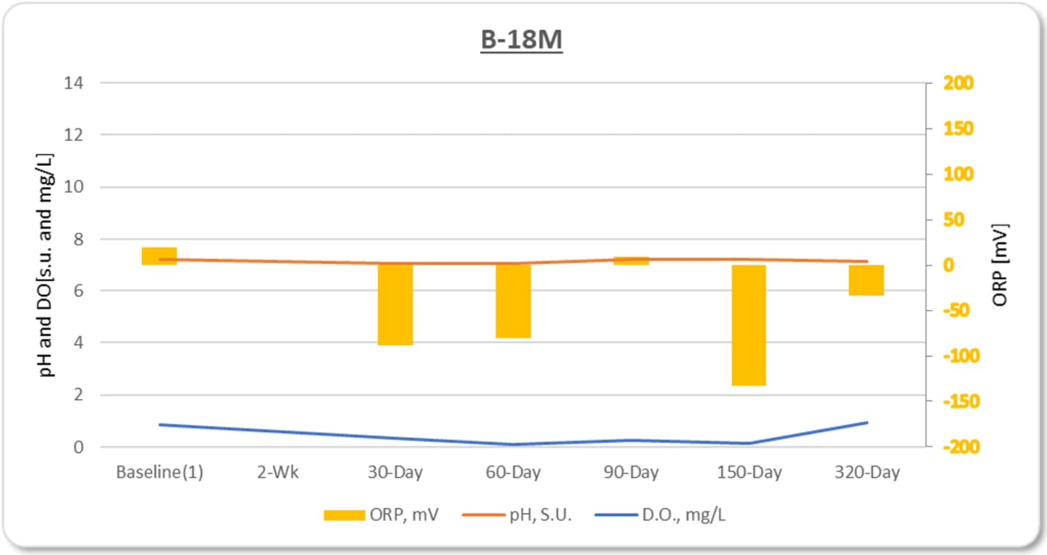

Figure 7 Performance Monitoring Field Parameters in B-18M

P-4 Pilot Test Area

In the P-4 Area, baseline DO measurements were somewhat higher than in the PW-3 area, ranging from 3.48 to 8.05 mg/L. In P-4, DO decreased through the 30-day sampling, then increased to baseline levels. DO in B-13M increased through the 30-day sampling, then decreased through the end of the study. The DO in MW-19M decreased after the injections and remained low through the study. In all of the P-4 Area wells, the ORP decreased immediately following the injections and remained low through the 320-day sampling event.

In the P-4 Area, DO values measured in wells P-4, B-13M and B-19M during the Baseline sampling were generally aerobic, ranging from 3.48 to 8.05 mg/L; ORP values were mildly oxidizing, ranging from 68.5 to 113.1 mV; and pH values were circumneutral, ranging from 6.86 to 7.40 s.u.

Over the course of the post-injection performance monitoring period, DO values were observed to generally decrease in monitoring wells B-13M and B-19M (located slightly upgradient of the treatment area). In P-4, the DO values initially decreased when pumping was resumed at this well, and then increased when the pumping was ceased in August 2021 due to the presence of emulsified oil in the produced water. With respect to ORP values, both B-13M and B-19M exhibited decreasing ORP values (as low as -206.4 mV) during the performance monitoring period, indicating that reducing conditions had been established in this area. In P-4, ORP values initially decreased and then rebounded slightly following the cessation of pumping in August 2021. It is also noted that within the permeable reactive zone (located downgradient of B-13M and B-19M) subsurface geochemical conditions were likely even more reducing, but there is no monitoring well located within the treatment area and data is not available. All of the wells in the P-4 Area indicated that pH values remained within the 6-8 s.u. range throughout the performance monitoring period.

The field parameter data for P-4, B-13M and B-19M, over the course of the pilot study, are presented in Figures 8 through 10, respectively.

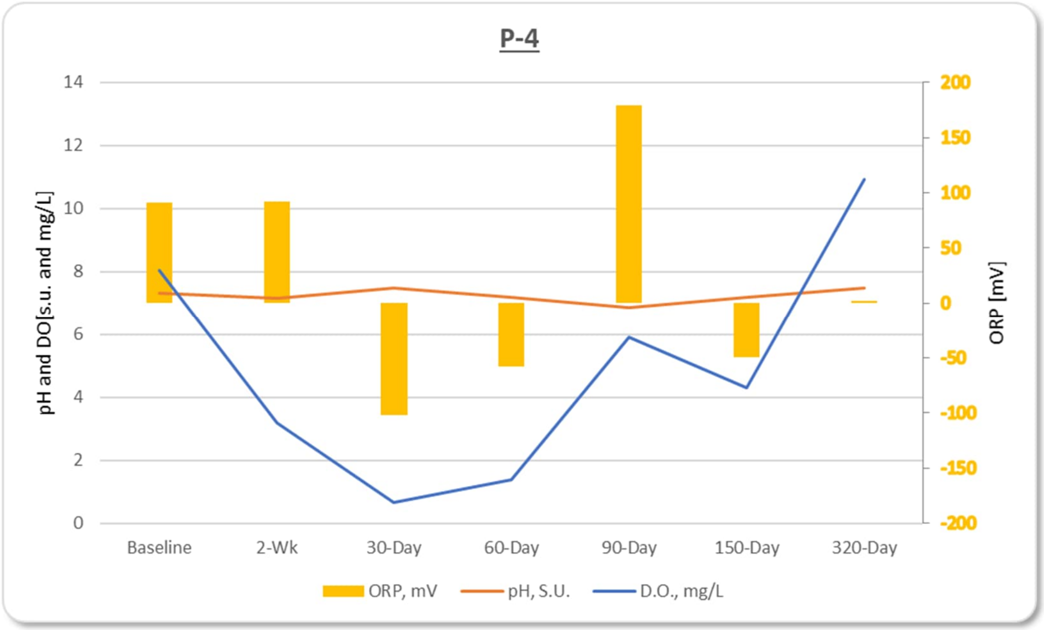

Figure 8 Performance Monitoring Field Parameters in P-4

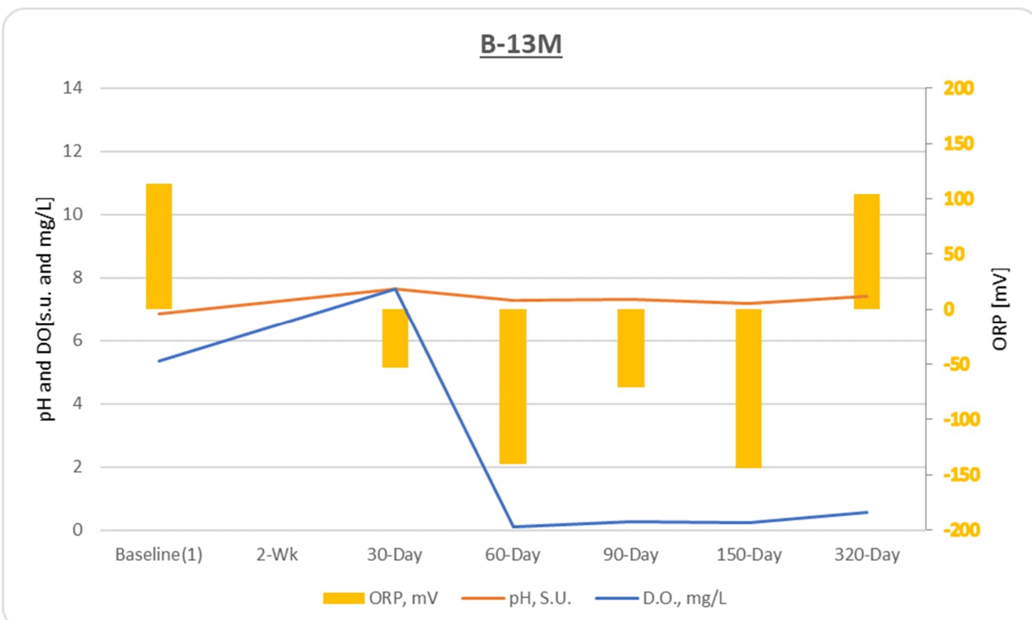

Figure 9 Performance Monitoring Field Parameters in B-13M

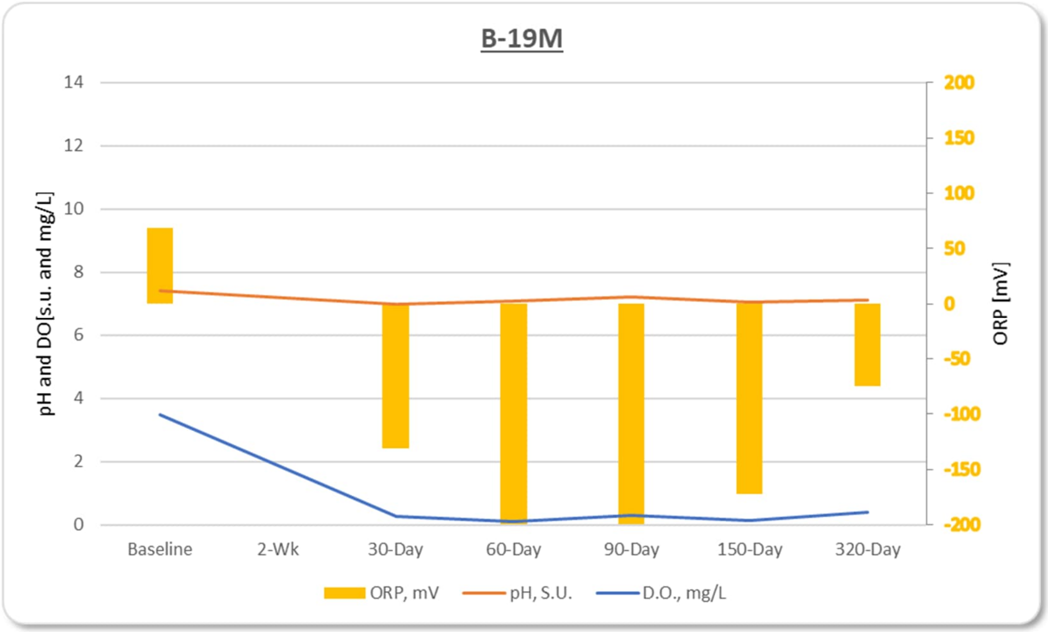

Figure 10 Performance Monitoring Field Parameters in B-19M

Overall, while the field parameter data is somewhat mixed, the majority of the data indicate that the injections generally contributed a more anaerobic and reducing environment conducive to reductive dechlorination.

Analytical Results – VOCs

Performance monitoring data for the PW-3 and P-4 Areas is presented in Tables 5A and 5B, respectively. As mentioned earlier, significant changes in VOC concentrations were not anticipated or expected as part of the pilot study since the design of the injection program was intended to demonstrate that subsurface geochemical conditions could be manipulated to provide for ongoing reductive dechlorination. A larger-scale application of EZVI™ would result in in lower VOC concentrations throughout the treatment area since the volume of amendment would be higher and distributed over a larger area, thus sequestering more contaminant mass. That said, over the course of the performance monitoring period the generation of degradation products was observed, indicating that reductive dechlorination has been enhanced within the treatment areas.

PW-3 Pilot Test Area

Within the TOR Zone in the PW-3 Area (wells PW-3 and B-8M), analytical results indicate an initial immediate reduction in concentrations (Table 5A). At PW-3, total VOC concentrations dropped to nearly below detectable levels at 30 days, followed by a return to baseline and long-term total VOC trend concentrations 60 days through 320 days post-injection. At B-8M, VOC concentrations increased somewhat through the study, with concentrations at 320 days slightly higher than baseline values. Vinyl chloride was detected during the 150- and 320-day sampling events, indicating the reductive dechlorination of DCE. VOC concentrations were low at the start of the study and remained generally unchanged over the course of the study. Within the bedrock Zone 2, B-18M had fairly low VOC concentrations in the baseline sampling and these remained basically unchanged through the course of the study. Even though VOC concentrations in the PW-3 Area did not change significantly during the pilot study, the appearance and/or increase of degradation products such as DCE and VC (especially in the vicinity of B-8M) are indicative of enhanced reductive dechlorination. In B-8M, the ratio of TCE concentration to DCE concentration decreased from 10.9 during the baseline sampling to 0.8 within 60 days. Given that the PW-3 Area is a known source of VOC impacts to groundwater, the overall mass of contaminants in the subsurface precludes any significant mass reduction until additional amendment is introduced into the subsurface as part of a larger-scale remedial effort.

The VOC data for PW-3, B-8M and B-18M, over the course of the pilot study, are presented in Figures 11 through 13, respectively.

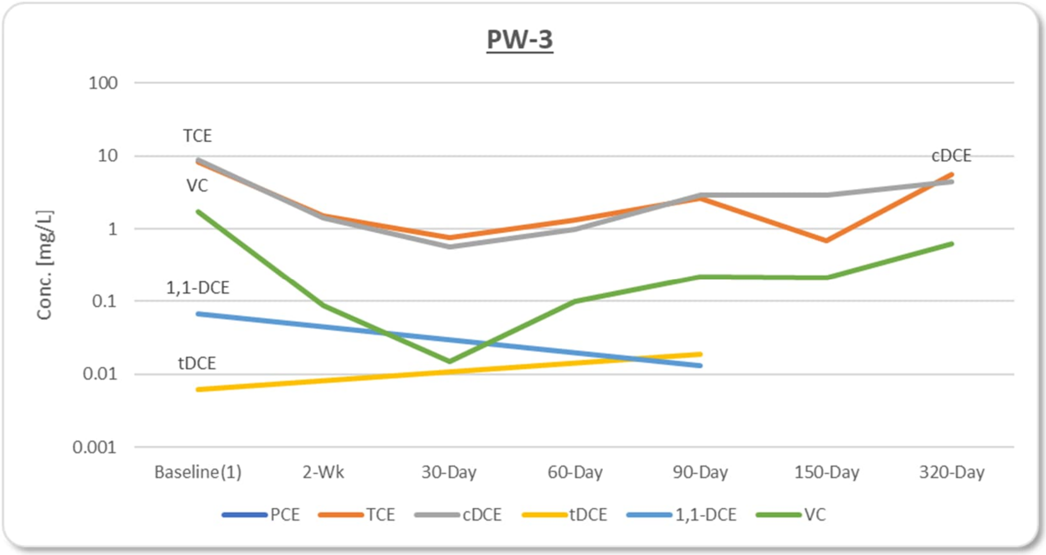

Figure 11 Performance Monitoring VOCs in PW-3

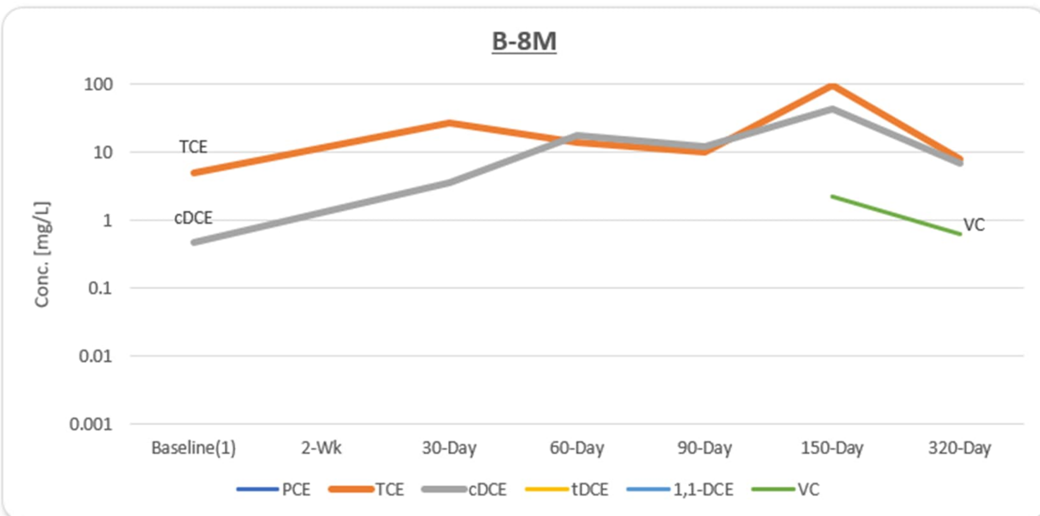

Figure 12 Performance Monitoring VOCs in B-8M

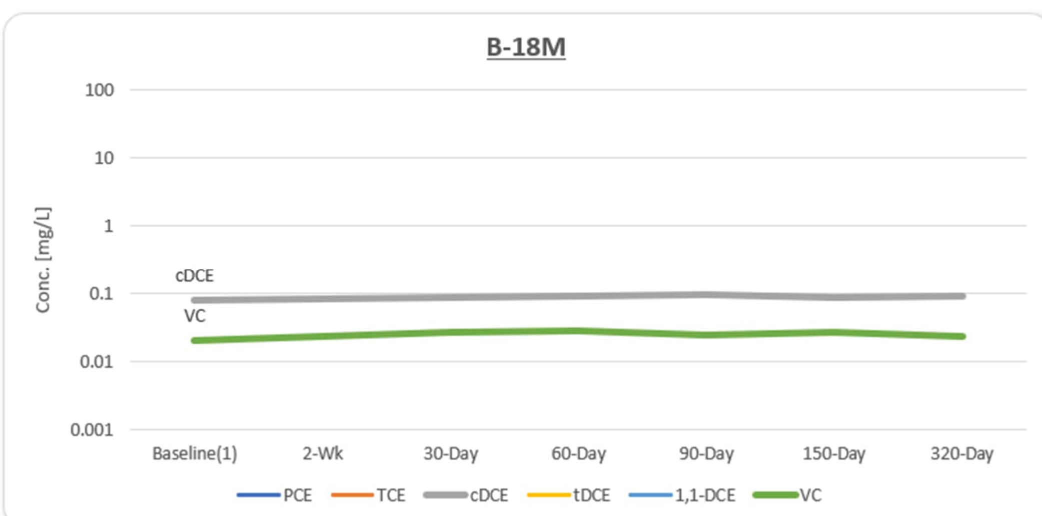

Figure 13 Performance Monitoring VOCs in B-18M

P-4 Pilot Test Area

In the P-4 Area, VOC concentrations did not change significantly over the course of the Pilot Study (Table 5B). However, increases in degradation products (DCE and VC) were observed at monitoring wells B-13M and B-19M. This is pertinent in the sense that the permeable reactive zone was installed just downgradient of these well locations and groundwater is being impacted from the “halo effect” around the reactive zone. This is again indicative that reductive dechlorination has been enhanced due to the injection of the EZVI™ amendment.

The VOC data for P-4, B-13M and B-19M, over the course of the pilot study, are presented in Figures 14 through 16, respectively.

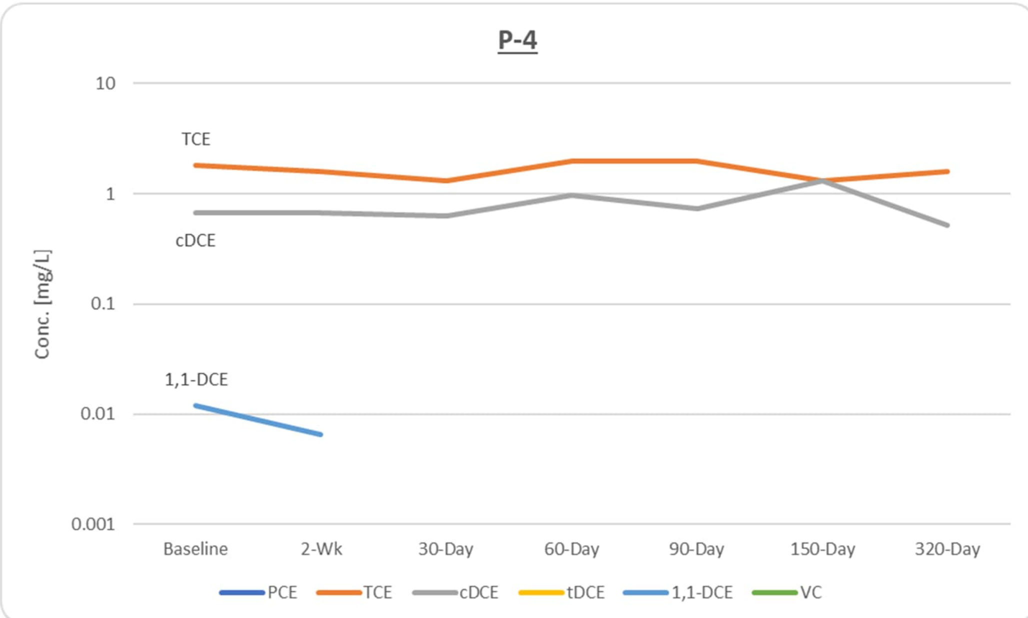

Figure 14 Performance Monitoring VOCs in P-4

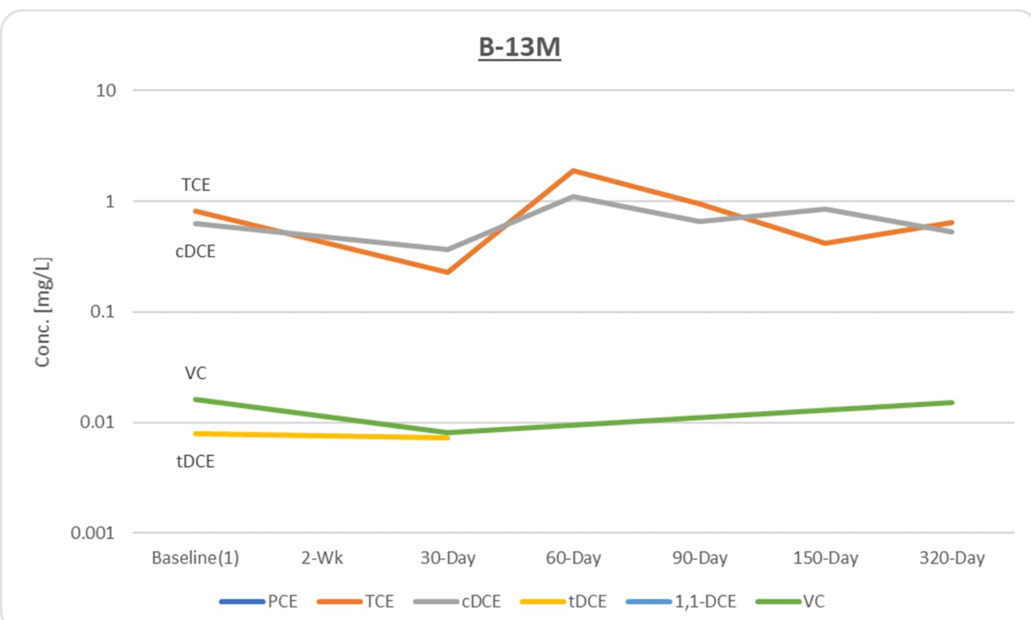

Figure 15 Performance Monitoring VOCs in B-13M

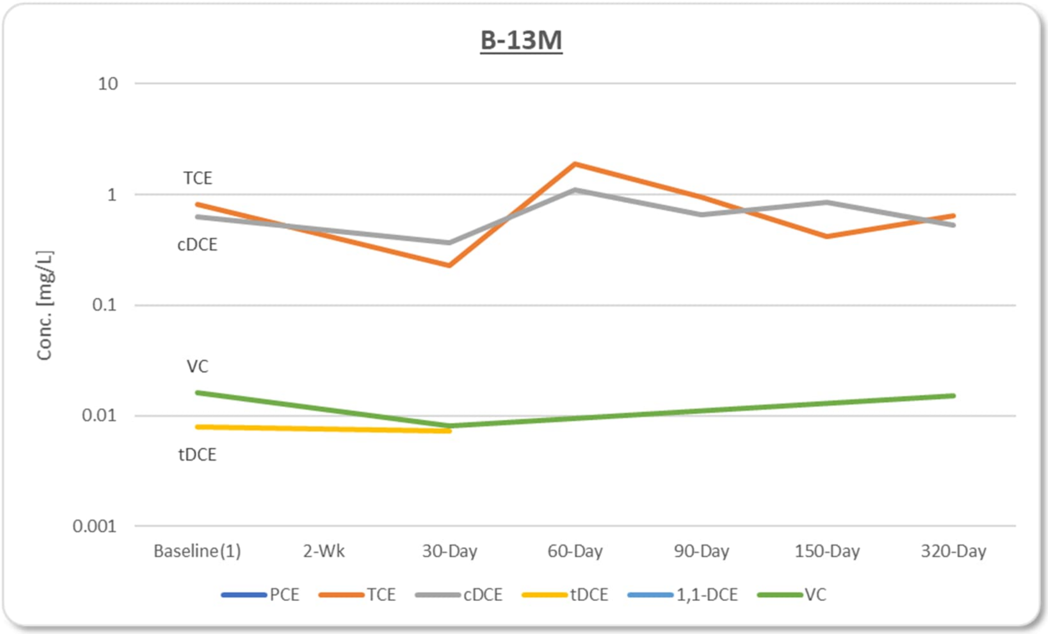

Figure 16 Performance Monitoring VOCs in B-19M

Analytical Results – Dissolved Gasses

The dissolved gasses evaluated in this study include methane, ethane and ethene (MEE). Ethene and ethane are generated as innocuous end products of chlorinated ethene and ethane degradation via reductive dechlorination. Elevated levels of ethene and ethane can indicate reductive dechlorination of chlorinated VOCs. Methane is generated during fermentation in highly reducing environments. The presence of elevated methane concentrations indicates anaerobic conditions conducive to anaerobic degradation.

PW-3 Pilot Test Area

In the PW-3 Area, MEE concentrations generally increased over the pilot study period except for monitoring well B-18M where MEE levels remained rather consistent throughout the pilot study. This is not unexpected, as B-18M is screened in Zone 2. The largest overall increases of MEE were observed at monitoring well B-8M, which is situated within the area outlined by the five EZVI™ injection points. This provides another line of evidence with respect to the enhancement of reducing conditions in the pilot study area. The MME values at PW-3 also indicate that subsurface conditions were enhanced during the pilot study period. Monitoring well B-18M showed little change in MEE concentrations over the course of the pilot study, as would be expected due to the well being screened in Zone 2.

The MEE data for PW-3, B-8M and B-18M, over the course of the pilot study, are presented in Figures 17 through 19, respectively.

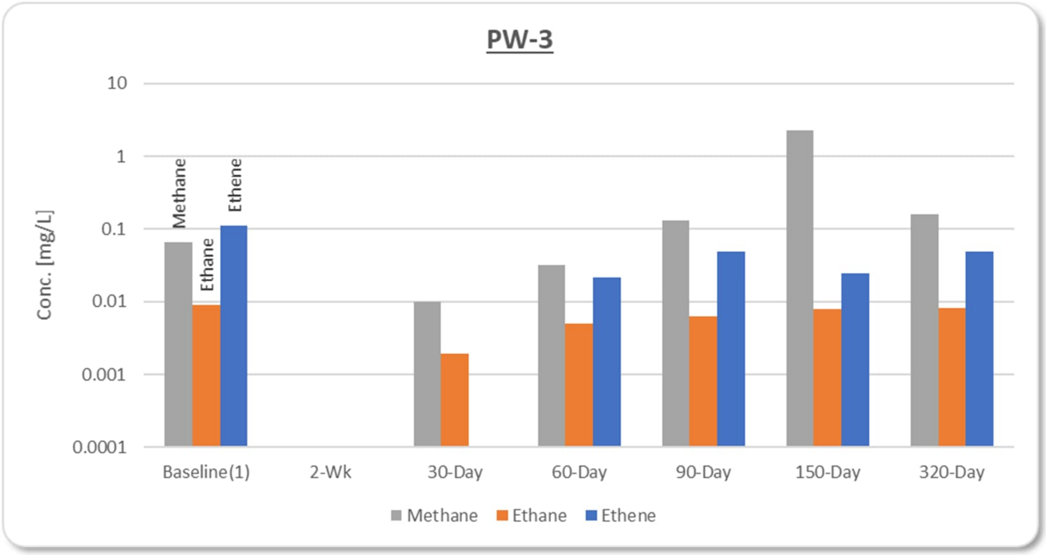

Figure 17 Performance Monitoring Dissolved Gasses in PW-3

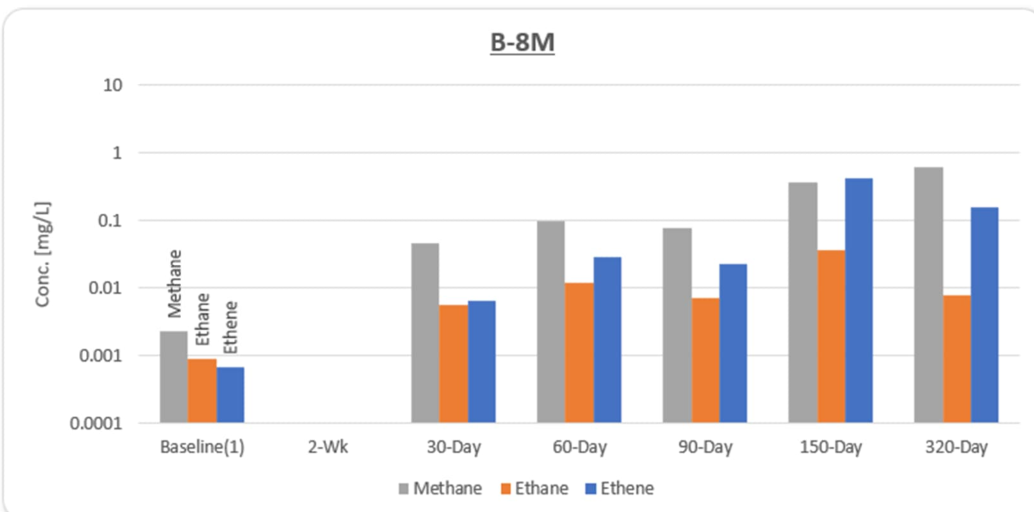

Figure 18 Performance Monitoring Dissolved Gasses in B-8M

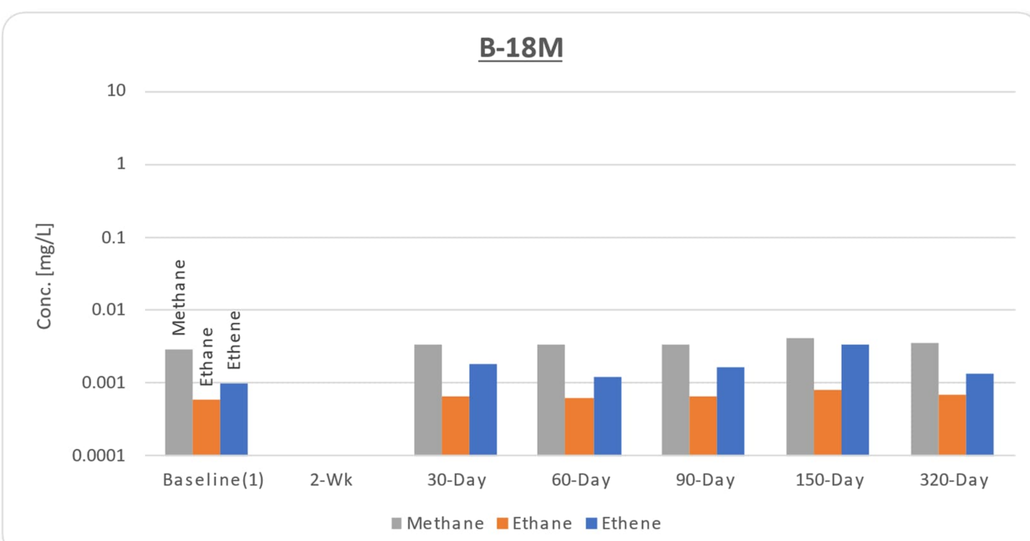

Figure 19 Performance Monitoring Dissolved Gasses in B-18M

P-4 Pilot Test Area

In the P-4 Area, MEE concentrations generally showed enhanced conditions (i.e., more conducive to reductive dechlorination) at the end of the pilot study as compared to the baseline levels. At P-4, methane increased by an order of magnitude and ethene concentrations went up consistently over the pilot study period. Additionally, in monitoring wells B-13M and B-19M, ethene concentrations were not detectable in baseline sampling, but were detected and generally increased throughout the pilot study period. These observations provide another line of evidence with respect the enhancement of reducing conditions in the pilot study area.

The MEE data for P-4, B-13M and B-19M, over the course of the pilot study, are presented in Figures 20 through 22, respectively.

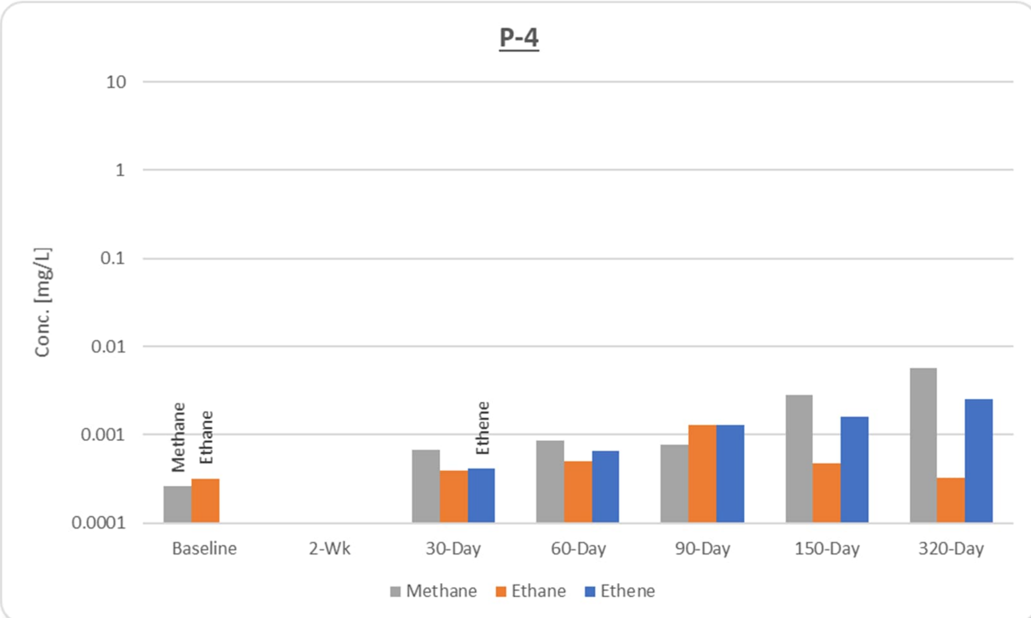

Figure 20 Performance Monitoring Dissolved Gasses in P-4

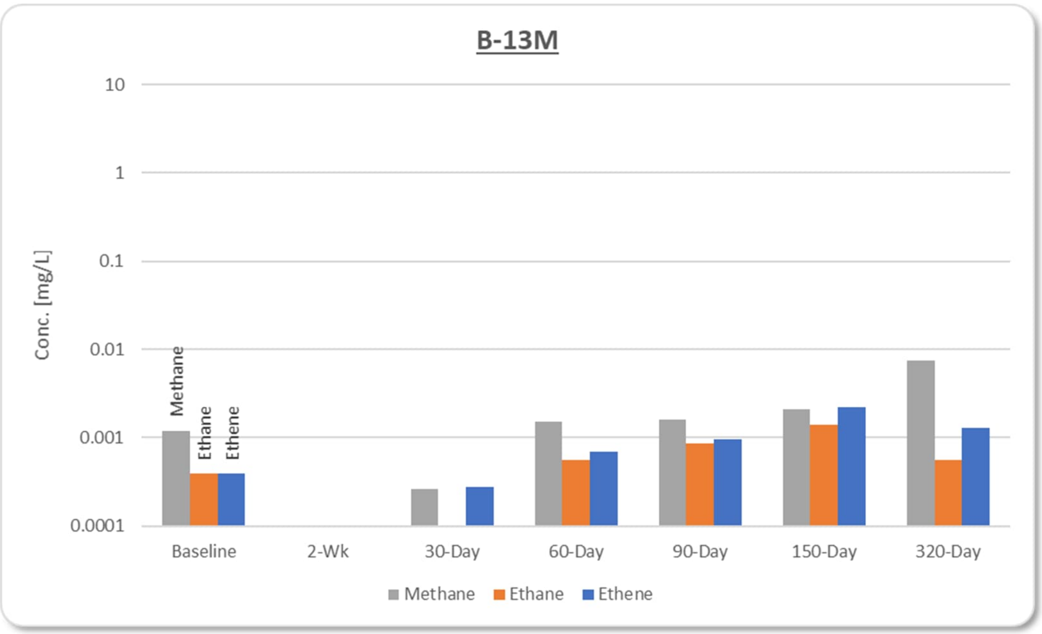

Figure 21 Performance Monitoring Dissolved Gasses in B-13M

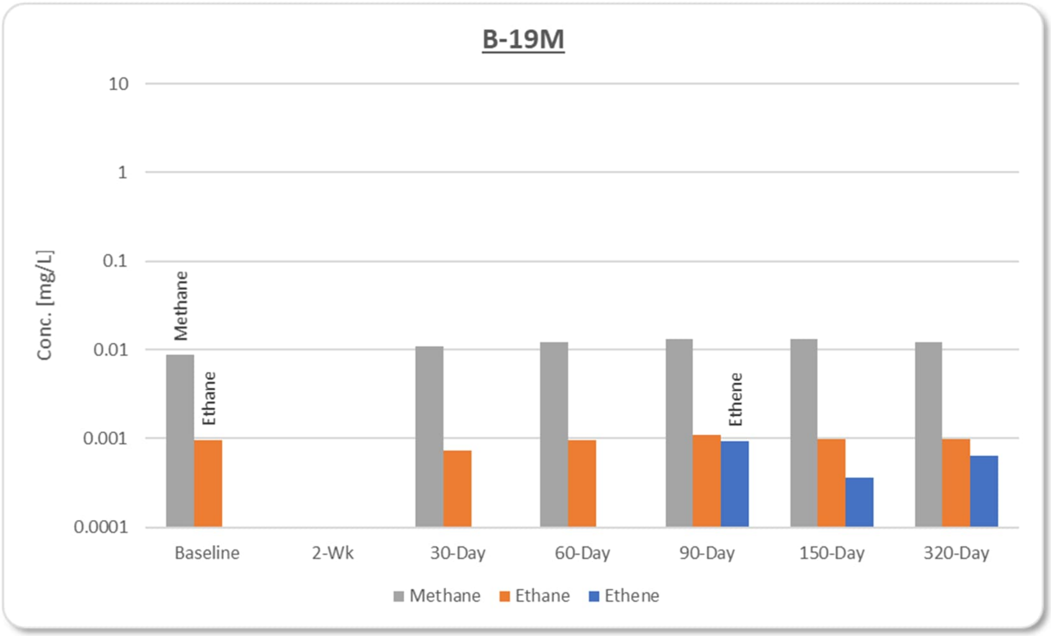

Figure 22 Performance Monitoring Dissolved Gasses in B-19M

Analytical Results – Inorganics

As part of the pilot study performance monitoring program a number of inorganic/wet chemistry parameters were measured during the respective sampling events including, total organic carbon (TOC), sulfate, and ferrous/ferric iron.

TOC

TOC is an indicator of the presence of organic matter, including VOCs, organic amendments and their metabolites. TOC concentrations of at least 20 mg/L are typically desired to facilitate enhanced degradation processes. Instances where these levels were achieved were;

- B-8M as high as 26 mg/L (Day-30).
- P-4 at 29 mg/L (Day-150) and 23 mg/L (Day-320). It is also noted that the EZVI™ amendment was observed at P-4 after pumping was resumed in August 2021.

PW-3 Pilot Test Area

In the PW-3 Area, TOC concentrations in PW-3 and B-18M did not increase over the course of the study. However, in monitoring well B-8M, TOC increased from a baseline concentration of 3.4 mg/L to 19 mg/L over the course of the pilot study. This result indicates that the EZVI™ injections were able to distribute TOC within the treatment area which could then be utilized to enhance in-situ degradation processes. The observed TOC responses are consistent with other observations of enhanced conditions within the area proximal to the EZVI™ injections, and little to no response in B-18M which is screened in Zone 2.

P-4 Pilot Test Area

In the P-4 Area, TOC levels in pumping well P-4 were observed to gradually increase (~1 order of magnitude) over the course of the pilot study. This is likely attributable to the resumption of pumping at P-4 and the resulting migration of some of the injected amendment towards the well. In the other monitoring wells (located slightly upgradient of the permeable reactive zone), TOC in monitoring well B-13M increased through much of the pilot study period and then declined in the last sampling event (Day-320); in monitoring well B-19M, TOC concentrations remained relatively constant over the pilot study period.

Overall, the TOC results are not remarkable and are likely attributable to the limited area and volume of EZVI™ amendment that was utilized in the pilot study application. That said, the fact that positive responses were observed at B-8M (PW-3 Area) and also at P-4 (P-4 Area) does provide additional support related to the applicability of sequestration as an enhancement to the existing remedy, particularly at a larger scale.

Sulfate

Sulfate can be an alternate electron acceptor during anaerobic microbial respiration, following the reduction of oxygen, nitrate, manganese and ferric iron. Depletion of sulfate compared to baseline levels can be an indicator that reductive dechlorination coupled with sulfate reduction is an active process.

PW-3 Pilot Test Area

In pumping well PW-3, sulfate decreased by approximately 50% through Day-150 of the pilot study and then returned to near baseline levels at Day-320. This may be attributable to an influx of precipitation infiltration in the wet months of early Spring. In monitoring well B-8M (within the EZVI™ treatment area) sulfate levels were observed to steadily decrease throughout the pilot study, as would be expected with the enhancement of in-situ biodegradation. In monitoring well B-18M, sulfate levels were generally unchanged throughout the pilot study as anticipated, since this well is screened in a different zone than the one in which the injections took place.

P-4 Pilot Test Area

In the P-4 Area, sulfate concentrations decreased somewhat in B-13M, but generally remained unchanged in pumping well P-4 or monitoring well B-19M, which is screened in Zone 2. These results are not unexpected due to the orientation of the permeable reactive barrier (PRB) where the EZVI™ amendment was injected.

Overall, the observations related to sulfate are unremarkable for the pilot study. Generally, a sulfate concentration of 20 mg/L or less is desirable as in indicator of reductive dechlorination, however, none of the observed concentrations approached this value with the exception of B-8M which reached a level of ~40 mg/L. It is noted that significant changes in sulfate levels were not expected during the pilot study with the limited injection of amendment and the associated locations of the injection points. With the observed response at B-8M (PW-3 Area) it is likely that a broader application of amendment will have an impact on sulfate concentrations.

Ferrous and Ferric Iron

Ferric iron is an alternate electron acceptor in the absence of oxygen and nitrate. Reduction of ferric iron (Fe III) produces ferrous iron (Fe II). Ferric iron levels were generally observed to be relatively low in the pilot study areas, and ferrous iron was only detected in a limited number of sampling events in either the PW-3 or P-4 Areas.

Analytical Results – Microbial Analysis

In addition to the organic and inorganic parameters collected as part of the pilot study performance monitoring, groundwater samples were also analyzed for the presence and populations of microbial communities that are present in the subsurface, as well as for changes in those communities and/or populations that are attributable to the addition of the EZVI™ amendment and the associated geochemical changes in the subsurface.

Baseline sampling, prior to EZVI™ amendment injection, was completed at the well locations in both of the pilot study areas (PW-3 and P-4). Following the completion of the EZVI™ injections and throughout the performance monitoring period, groundwater samples from select monitoring and/or pumping well locations were also collected and analyzed for microbial parameters. Microbial Insights, Inc. (MI) of Nashville, TN was utilized to complete the various microbial analyses. For this pilot study, quantitative polymerase chain reaction (qPCR) was utilized with MI's QuantArray®-Chlor suite.

Additionally, the qPCR results were also evaluated against the MI Microbial Database (MI Database) which allowed for the comparison of the site-specific data to the results against thousands of other sites that have been input into the MI Database. The comparison provides a result in the form of a percentage. (i.e., the site-specific result is greater than X% of all sites in the database).

The QuantArray®-Chlor and relative percentage results are presented and discussed in the following sections.

qPCR Results

QuantArray®-Chlor quantifies key microorganisms (e.g., Dehalococcoides, Dehalobacter, etc.) and functional genes (e.g., vinyl chloride reductase, methane monooxygenase, etc.) to assess potential for reductive dechlorination and aerobic cometabolism of chlorinated solvents such as TCE.

PW-3 Pilot Test Area

In the PW-3 Area baseline microbial samples (QuantArray®-Chlor) were taken in October 2020 from well PW-3, B-8M, and B-18M, prior to the EZVI™ amendment injection. Post- EZVI™ injection samples were collected at select locations over the post-injection performance monitoring period. It is noted that not all well locations were sampled as part of specific monitoring events, with the exception of the final performance monitoring period in April 2022. A summary of the microbial data from the PW-3 Area is provided as Table 6A.

The DHC and associated reductase genes (TCE, BVC and VCR data for PW-3, B-8M and B-18M), over the course of the pilot study, are presented in Figures 23 through 25.

In the PW-3 Area, microbial populations (cells/mL) generally increased over the course of the pilot study period. This is especially notable in the area of monitoring well B-8M where Dehalococcoides (DHC) populations increased. The associated reductase genes, responsible for degrading the parent product (TCE) completely to ethene also generally increased in B-8M. Recovery well PW-3, located downgradient of B-8M, also demonstrated a similar pattern, indicating that the enhanced geochemical conditions are being propagated downgradient of injection points. This agrees with other observed parameters, as previously discussed. The only exception was the relative stability of the microbial results at B-18M where DHC and reductase genes remained relatively constant or slightly lower throughout the performance monitoring period. However, B-18M was located away from the EZVI™ amendment injection, and is screened in Zone 2, so it would not be expected to respond the same as B-8M. That said, the fact that DHC and the associated reductase genes are detected at B-18M indicates that if EZVI™ were to be injected in this area it would be expected to react in a similar manner as B-8M. Figures 23 through 25 depict the QuantArray®-Chlor results, discussed above, in graphical fashion. Where bars on the charts are not present, this means either the results were non-detect or the location was not sampled during a particular event.

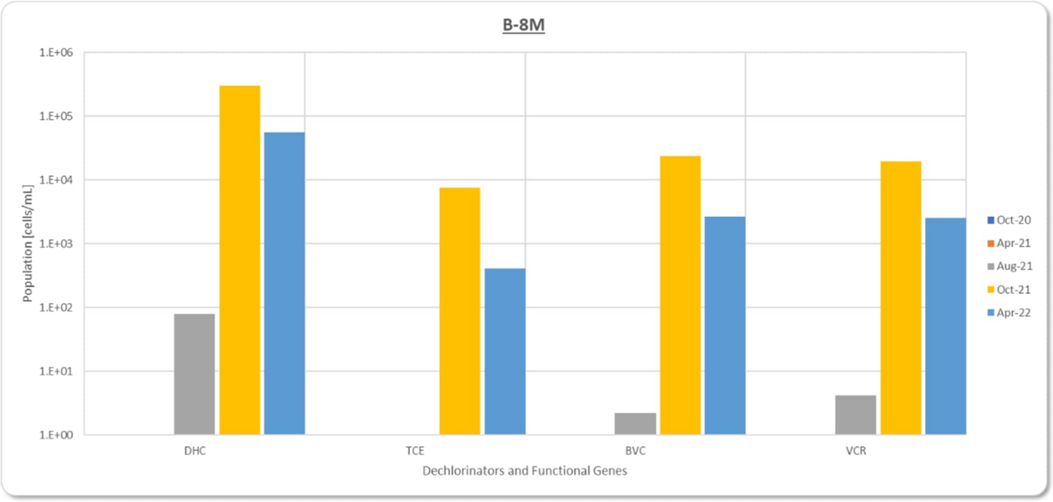

Figure 23 Performance Monitoring DHC and Reductase Genes in B-8M

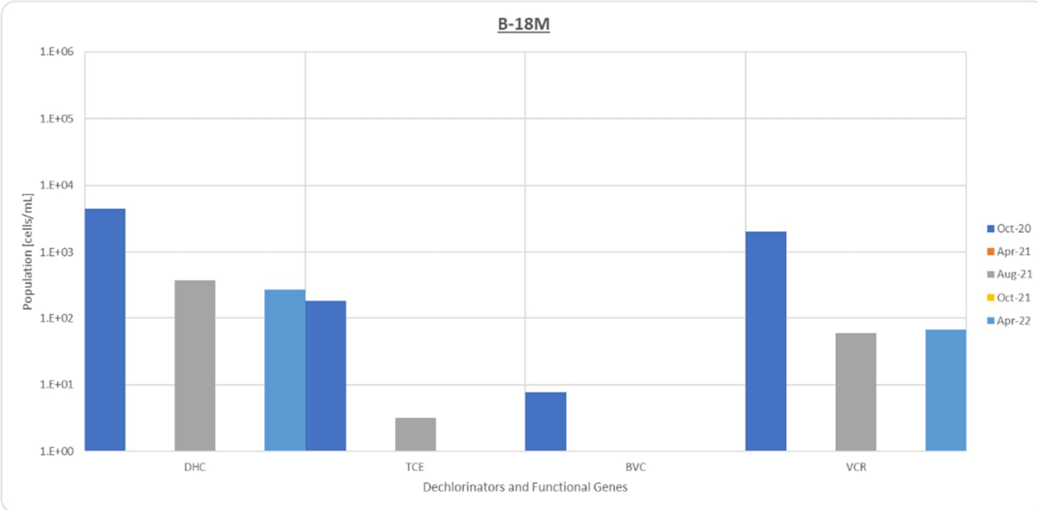

Figure 24 Performance Monitoring DHC and Reductase Genes in B-18M

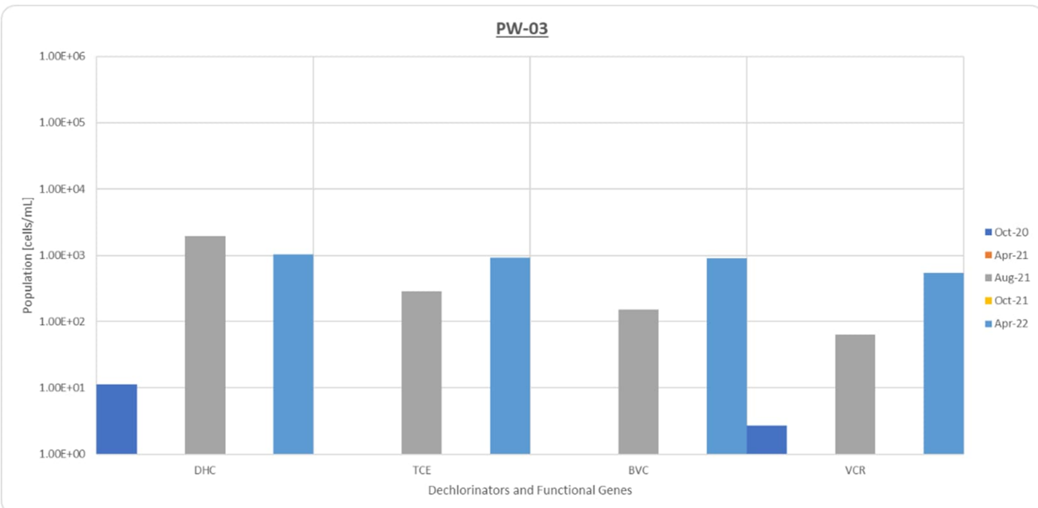

Figure 25 Performance Monitoring DHC and Reductase Genes in PW-3

P-4 Pilot Test Area

In the P-4 Area baseline microbial samples (QuantArray®-Chlor) were also taken in October 2020 from well P-4, B-13M, and B-19M, prior to the EZVI™ amendment injection. Post-EZVI™ injection samples were collected at select locations over the post-injection performance monitoring period. As in the PW-3 Area not all well locations were sampled as part of specific monitoring events, with the exception of the final performance monitoring period in April 2022. A summary of the microbial data from the P-4 Area is provided as Table 6B.

The DHC and associated reductase genes (TCE, BVC and VCR data for P-4, B-13M and B-19M), over the course of the pilot study, are presented in Figures 26 through 28.

In the P-4 Area, microbial populations (cells/mL) behaved somewhat differently than in the PW-3 Area. This is attributable to the way the EZVI™ injection points were located (i.e., in a linear PRB fashion as compared to surrounding a well location as at B-8M). With the PRB arrangement, monitoring wells B-13M and B-19M are located upgradient of the PRB. Even though B-13M and B-19M were located upgradient of the injection area DHC and the associated reductase genes were observed to be higher at the end of the performance monitoring period and this is attributed to the enhancement of subsurface geochemical conditions in the area of the PRB. B-19M is also screened in Zone 2, below the EZVI™ TOR injections. At pumping well P-4, microbial data is observed to fluctuate somewhat over the performance monitoring period and this is attributable to the on and off operation of P-4 during the monitoring period. However, and similar to PW-3, the fact that DHC and the associated reductase genes are detected at P-4 indicates that the impact of the EZVI™ injections were able to propagate downgradient over the course of the study. It is again noted that where bars on the charts are not present, this means either the results were non-detect or the location was not sampled during a particular event.

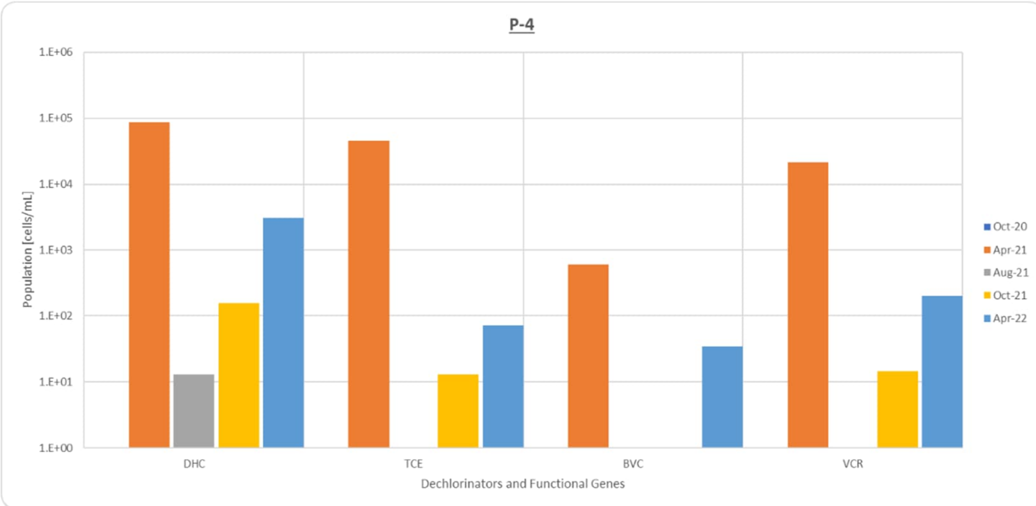

Figure 26 Performance Monitoring DHC and Reductase Genes in P-4

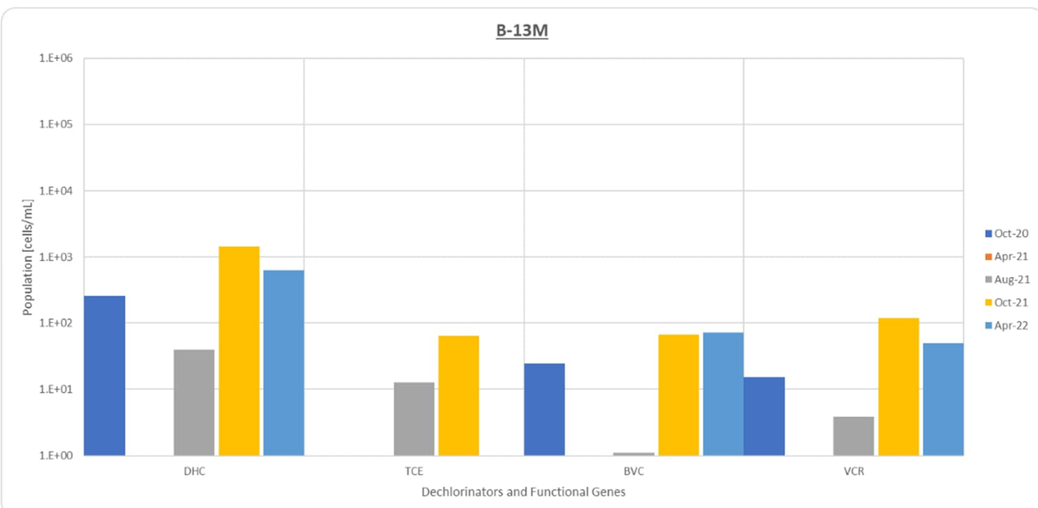

Figure 27 Performance Monitoring DHC and Reductase Genes in B-13M

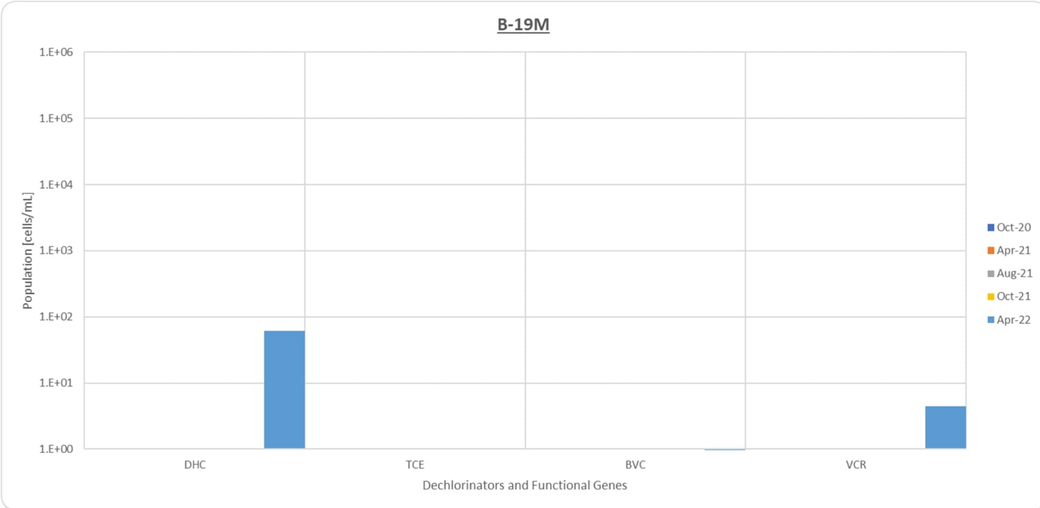

Figure 28 Performance Monitoring DHC and Reductase Genes in B-19M

MI Database Percentage Results

QuantArray®-Chlor quantifies key microorganisms (e.g., Dehalococcoides, Dehalobacter, etc.) and functional genes (e.g., vinyl chloride reductase, methane monooxygenase, etc.) to assess potential for reductive dechlorination and aerobic cometabolism of chlorinated solvents such as TCE.

The MI Database contains microbial data (CENSUS® qPCR and QuantArray®) results for more than 50,000 samples from various sites around the world. The data within the MI Database represents the largest collection of field concentrations of key microorganisms and functional genes of any lab in the world. In practice, biodegradation depends not just on the presence but the actual concentrations of the contaminant degrading microorganisms. The percentile ranks retrieved from the MI Database answer the question “Is that low, medium or high?” by comparing your results to those of the thousands of other environmental samples submitted to MI for analysis over the last 20+ years.

PW-3 Pilot Test Area

In the PW-3 Area, the results from the microbial sampling were input to and subsequently compared to the MI Database. The resulting reported percentages were tabulated, and these values are also presented in Table 6A. Additionally, the reported percentage comparisons for DHC and the associated functional genes (TCE, BVC and VCR) data for PW-3, B-8M and B-18M as compared to the MI Database, are presented in Figures 29 through 31. For the graphs the green dots represent baseline values and red dots represent final values from April 2022.

In the PW-3 Area, for wells PW-3 and B-8M showed notable increases over the course of the performance monitoring period. The increase in percentage values indicates that the microbial populations are better than 60% to as much as 90% of the values observed other sites in the MI Database. This is even more significant when comparing the baseline values in the two wells where the percentages ranged from 0% to 50% better than other sites in the MI Database. The only exception was the apparent decrease in percentage values at monitoring well B-18M when comparing early values to values at the end of the performance monitoring period. It is again noted that B-18M is located away from the EZVI™ amendment injection and is screened in Zone 2, so it would not be expected to respond the same as B-8M.

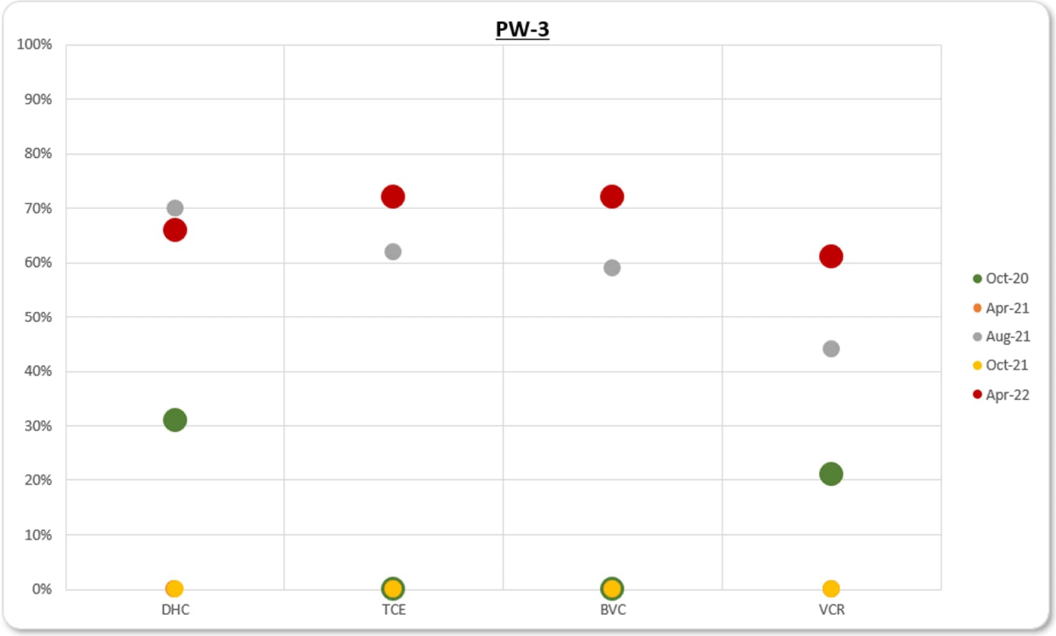

Figure 29 Performance Monitoring Microbial Percentage Comparison in PW-3

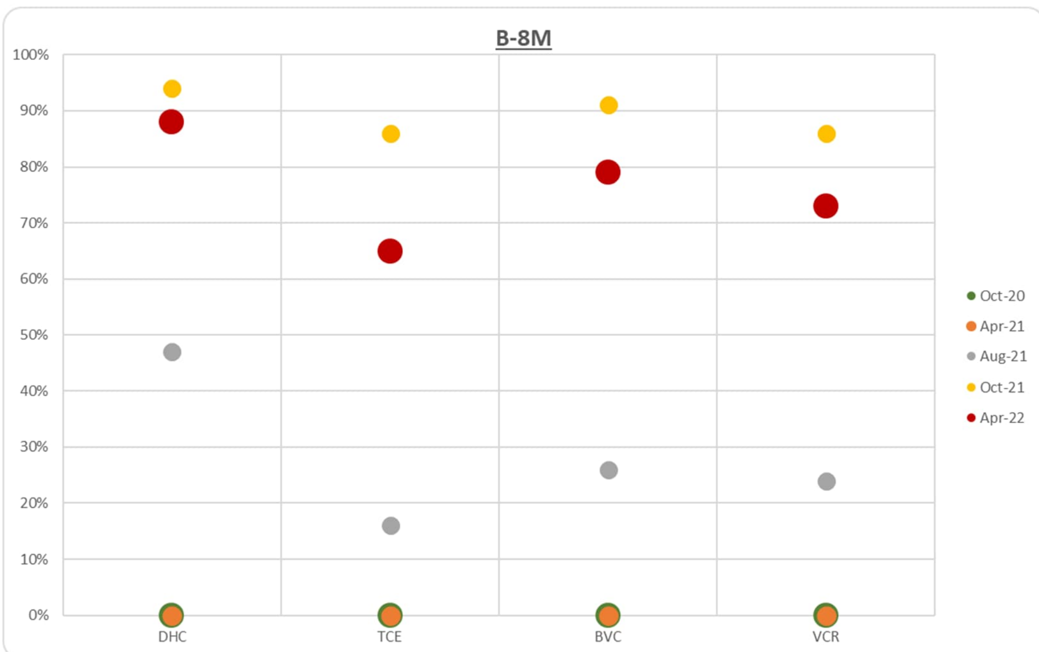

Figure 30 Performance Monitoring Microbial Percentage Comparison in B-8M

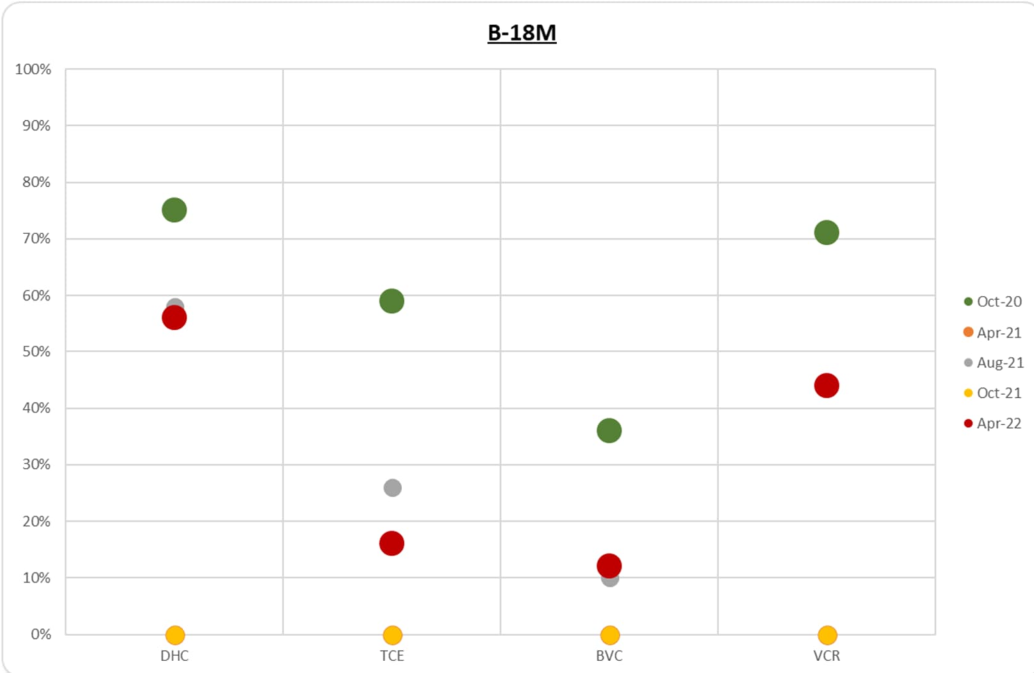

Figure 31 Performance Monitoring Microbial Percentage Comparison in B-18M

P-4 Pilot Test Area

In the P-4 Area, the results from the microbial sampling were also, input to, and subsequently compared to the MI Database. The resulting reported percentages were tabulated and these values ae also presented in Table 6B. Additionally, the reported percentage comparisons for DHC and the associated functional genes (TCE, BVC and VCR) data for P-4, B-13M and B-19M as compared to the MI Database, are presented in Figures 32 through 34. For the graphs, the green dots represent baseline values and red dots represent final values from April 2022.

In the P-4 Area, for all the wells the final percentage values (P-4, B-13M and B-19M) were higher than the baseline values and ranged from 10% to greater than 70% better than all of the values in the MI Database. Given the orientation of the wells in the P-4 Area compared the linear PRB injection points, these data are very promising with respect to the enhancement of subsurface conditions and the associated potential to increase biological activity.

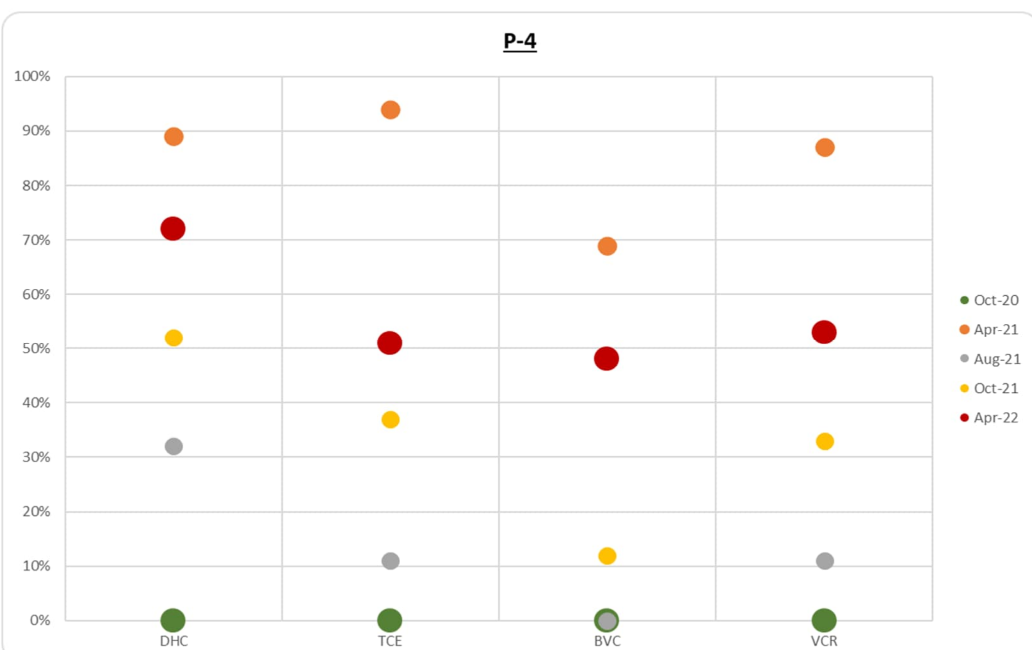

Figure 32 Performance Monitoring Microbial Percentage Comparison in P-4

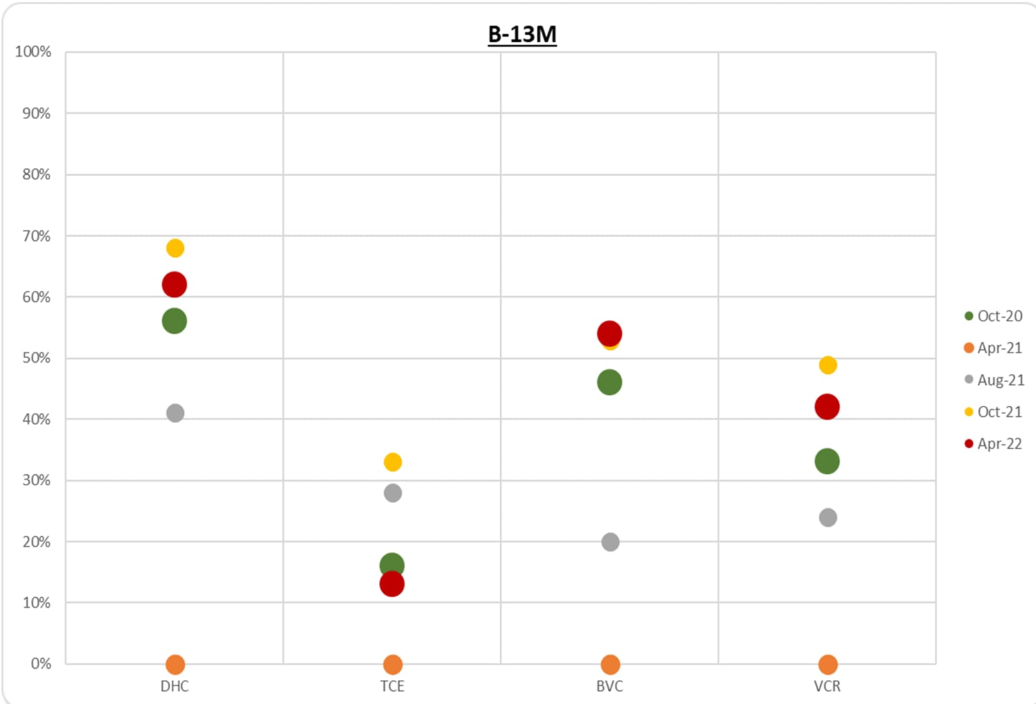

Figure 33 Performance Monitoring Microbial Percentage Comparison in B-13M

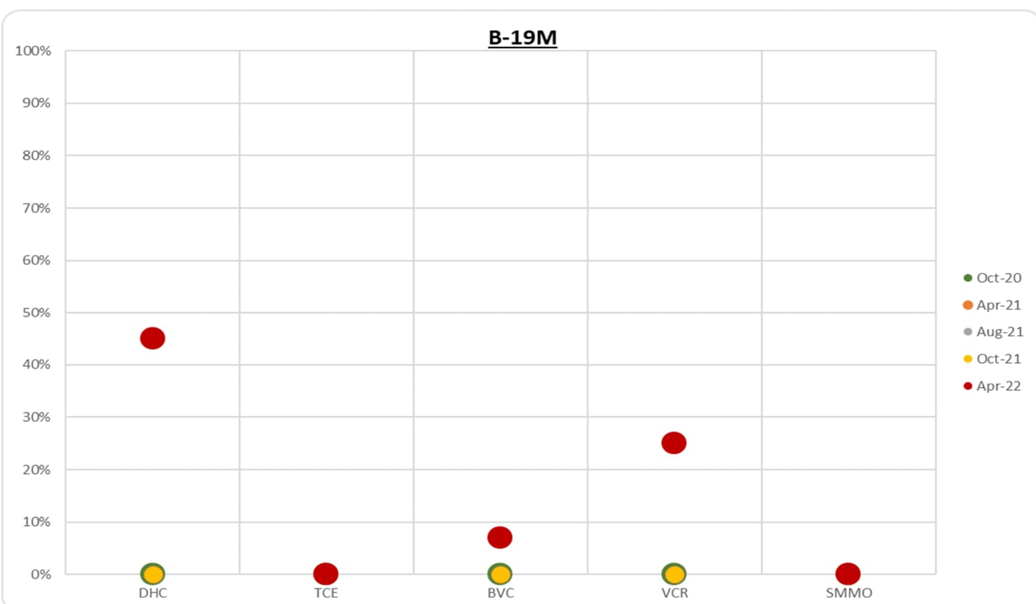

Figure 34 Performance Monitoring Microbial Percentage Comparison in B-19M

VI. Discussion

As presented in Section III, a significant amount of data was collected over the course of the pilot study and the results yielded information related to a number of lines of evidence (LOEs) that are pertinent to evaluating the potential efficacy and applicability of an in-situ remedial approach (i.e., EZVI™ injections). As presented earlier, the primary LOEs focus on the evaluation of static water levels, field measure geochemical parameters, VOC concentrations, a number of inorganic/natural attenuation parameters, dissolved gases, and microbial population and functional gene analyses.

The evaluation, documented herein, also coincides with the primary objective of the pilot study, which was to evaluate a potential approach to augment and potentially replace the current/the existing groundwater collection and treatment system.

The following bullets present a summary discussion of the various LOEs.

- Measured groundwater levels were not significantly impacted as a result of the EZVI™ injections. The introduction of the amendment into the subsurface did not appear to adversely impact recovery from any of the nearby pumping wells, indicating that the hydraulic conductivity of the subsurface remained unchanged.
- In both the PW-3 and P-4 Areas, following the injection of the EZVI™ amendment, both DO and ORP values were observed to decrease, indicating the enhancement of reducing conditions, and thus improving conditions for enhanced reductive dechlorination. Towards the end of the pilot study (Day-320), some increases back toward baseline levels were observed, but this is likely attributable to a combination of the relatively low volume of amendment that was used in the treatment areas and a significant amount of rainfall/precipitation infiltration in the early part of 2022.
- Additionally, in both the PW-3 and P-4 Areas, no changes in pH values were observed during the course of the pilot study and pH values were maintained within the generally accepted range that is considered appropriate for supporting microbial populations in the subsurface (i.e., between 6 – 8.5 s.u.).
- In both the PW-3 and P-4 Areas, significant decreases in VOC concentrations were not observed during the pilot study. However, the increased generation of degradation products (i.e., DCE and VC) was observed indicating the reductive dechlorination was enhanced over the course of the pilot study. The lack of significant VOC concentration decreases was not unexpected due to the designed application of the EZVI™ amendment. For this pilot study the intent of the amendment addition was to provide sufficient amendment to evaluate the changes in subsurface geochemistry and the potential to enhance reductive dechlorination. If additional amendment had been introduced, VOC concentrations could have been reduced but the available monitoring wells would have been compromised with respect to providing the results to support the overall project objectives.
- In both the PW-3 and P-4 Areas, the results from the dissolved gasses (i.e., MEE) sampling provided positive results. Overall, a general increase in the concentrations of all dissolved gasses was observed over the course of the pilot study; in some cases (P-4 Area) the appearance of detectable concentrations of ethene were observed following the EZVI™ injections. The increase in dissolved gasses provides another LOE with respect to the enhancement of reductive dechlorination following the amendment addition.
- In both the PW-3 and P-4 Areas, TOC concentrations were influenced to a limited extent, mainly in areas that were proximal to amendment injection locations (B-8M in the PW-3 Area; and P-4 in the P-4 Area following the resumption of pumping from P-4). These results are also not unexpected due to the same reason previously highlighted with respect to limited injection points and volumes.
- In both the PW-3 and P-4 Areas, sulfate provided mixed results over the course of the pilot study. Depletion of sulfate compared to baseline levels can be an indicator that reductive dechlorination coupled with sulfate reduction is an active process. In the PW-3 Area, decreases in sulfate were observed in the vicinity of B-8M and also downgradient in PW-3; this is attributed to the addition of the EZVI™ in the subsurface. In the P-4 Area, sulfate levels remained relatively unchanged. It is noted that significant changes in sulfate levels were not expected during the pilot study with the limited injection of amendment and the associated locations of the injection points. That said, it is likely that a broader application of amendment will result in the desired decrease in sulfate concentrations.
- In both the PW-3 and P-4 Areas, iron provided limited results over the course of the pilot study. In a reducing environment created by the presence of EZVI™, reduction of ferric iron (Fe III) produces ferrous iron (Fe II). Overall, the Fe III levels were low and Fe II levels were fairly low and/or only detected in a limited number of sampling events. As the levels of iron in the aquifer are low, it is not a strong indicator of the effect of the EZVI™ injections.
- In both the PW-3 and P-4 Areas, the microbial data provided positive results with respect to the enhancement and DHC and the associated functional genes (responsible for the complete degradation of TCE → ethene).

- In the PW-3 Area DHC populations and the functional genes steadily increased in the area of monitoring well B-8M (in the area of the EZVI™ injections) indicating that enhanced reductive dechlorination was stimulated.
  - DHC and functional gene increases were also observed in pumping well PW-3 over the course of the study indicating that the enhanced reductive dechlorination conditions generated around B-8M can be propagated outward radially when PW-3 is turned off and the gradient is negligible (Appendix A, Figure 5).
  - At monitoring well B-18M, slight increases in population of DHC and the functional genes were observed, but to a lesser extent, and this is attributable to the location / monitored zone of this monitoring well (Zone 2) compared to the injection locations (TOR).
  - In comparing the DHC and functional gene values for the PW-3 Area to a world-wide database of values (developed by Microbial Insights), the Site-specific data improved throughout the course of the pilot study and the final values indicated that conditions in the PW-3 Area are better than the values in the entire database by anywhere from >60 to 90%. This indicates that the area should be able to be successfully manipulated to facilitate enhanced reductive dechlorination.
- In the P-4 Area, enhancement of DHC and functional gene population were again observed but to a lesser degree than in the PW-3 Area.
  - In monitoring wells B-13M and B-19M (located upgradient of the EZVI® injection points) DHC and functional gene populations increased and/or were detected for the first time by the end of the pilot study, respectively. This suggests that 1) conditions within the zone of the EZVI™ injection locations would very likely be even more enhanced (no monitoring well was located in this Area); and 2) the amendment was effective at enhancing conditions in a “halo” effect outside of the area of direct injection.
  - In pumping well P-4, DHC and functional genes were not detected in baseline samples but were detected throughout the remainder of the pilot study, following the EZVI™ injections. This again supports the enhancement of conditions in the subsurface conducive to reductive dechlorination. There was some variability in the results from P-4, but this is attributed to the on/off/on pumping conditions that occurred in the course of the pilot study. Full-scale injections will be designed to be effective in non-pumping conditions.
  - In the P-4 Area, comparisons of the Site-specific DHC and functional gene values against the Microbial Insights database showed that the percentage values were slightly lower than in the PW-3 Area, but it is noted that percentage values increased from essentially 0% in the baseline results to percentage values ranging from 10% to greater than 70% better than all of the values in the Microbial Insights database. Given the orientation of the wells in the P-4 Area compared to the linear PRB injection points, these data are very promising with respect to the enhancement of subsurface conditions and the associated potential to increase biological activity.
- Overall, the results of the pilot study generated multiple LOEs that indicates the use of EZVI™ can effectively improve subsurface conditions to provide for enhanced reductive dechlorination. While not all of the LOEs were as definitive as others, that fact that improvements were observed suggests that a more aggressive/full-scale application will further enhance the reductive dechlorination approach as an enhancement and potential alternative to the existing pump and treat system that will address contamination in a more sustainable manner.

VII. Conclusions and Recommendations

In accordance with the approved work plan, a pilot study was performed in the areas near pumping wells PW-3 and P-4 to evaluate the performance of an in-situ remediation amendment/injectate (EZVI™) to determine the efficacy of this approach from an implementability and performance perspective, as well as the potential effectiveness of the amendment to provide for ongoing VOC mass reduction within the treatment zone.

The pilot study was successfully completed and the implementability of the approach was demonstrated through the targeted delivery of the EZVI™ amendment. Based on the results of the completed pilot study, the following conclusions and recommendations are presented:

CONCLUSIONS

- The pilot study was successfully implemented, and the subsequent performance monitoring period yielded sufficient data to meet the overall project objectives, outlined earlier in this report;
- Modifications to injection tooling and amendment delivery approaches were developed to maximize the amendment delivery to the subsurface and minimize the potential for surfacing during the injection process;
- The data collected during the performance monitoring period from April 2021 through April 2022 indicated that the EZVI™ in-situ amendment is capable of enhancing subsurface conditions to facilitate the efficacy of reductive dechlorination for the chlorinated VOCs of concern at the Site;
- Based on the results of the pilot study, an in-situ remedial approach to potentially augment the existing pump and treat system has been identified. The use of EZVI™ will provide for:
  - The in-situ sequestration of high concentration areas of chlorinated VOCs;
  - Enhanced biotic (reductive dechlorination) and other abiotic processes to facilitate the destruction of existing VOC mass;
  - Reduced mass flux from known source areas to provide for the enhanced biodegradation of VOCs in the downgradient areas of the Site and the concurrent mitigation of future off-site impacts; and
  - The ability to evaluate the transition of the Site from active pump and treat to a greener, more sustainable in-situ treatment approach.

RECOMMENDATIONS

- Based on the results of the competed pilot study, a larger-scale EZVI™ application in the area of pumping wells PW-3 and P-4 is recommended.
- In the PW-3 Pilot Study Area, using B-8M as the central point, the expanded treatment area is recommended to extend west towards PW-3, to the north of B-8M, south towards the recovery vaults in the Metaullics building, and east towards existing well PS-02. The treatment area would utilize a gridded injection approach. Further details are presently being developed to illustrate the potential treatment area, the distribution of injection points and volume of EZVI™ to be injected.
- In the P-4 Pilot Study Area, using the existing five EZVI™ injection points as the central point, the expanded treatment area is recommended to extend north-northwest away from the current injection points, and south-southeast from the current injection points. The treatment area would utilize the PRB concept and be designed to extend the PRB to areas of the Site where VOCs have the potential to migrate off-site. Further details are presently being developed to illustrate the potential treatment area, the distribution of injection points and volume of EZVI™ to be injected.
- An EZVI™ application should also be conducted in the area around pumping well PW-1.

If you have any questions regarding this submission, please do not hesitate to contact Mark Becker at (973) 883-8500 or via email at mark.becker@aecom.com.

Sincerely,

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enclosures: Attachments

cc: Project File 60481767.102

Tables

TABLE 1
EXPLORATORY BORING OBSERVATIONS
SEQUESTRATION PILOT STUDY
FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK

PW-3 Area

Boring Location	Date	Time (24-hour)	Depth to Top of Rock (feet)	Estimated Thickness of Fractured Rock (inches)	Observations
PW-3 EXP-1	5/18/2021	9:42	11	1 - 2	Dark brown, moist clayey silt w/little gravel
PW-3 EXP-2	5/18/2021	10:00	10	1 - 2	Dark brown, moist clayey silt w/little gravel. Increasing moisture just before refusal at bedrock.
PW-3 EXP-3	5/18/2021	10:42	12	1 - 2	Dark brown, moist clayey silt w/little gravel. Increasing moisture just before refusal at bedrock.

P-4 Area

Boring Location	Date	Time (24-hour)	Depth to Top of Rock (feet)	Estimated Thickness of Fractured Rock (inches)	Observations
P-4 EXP-1	5/18/2021	12:15	22	1 - 2	Moist dense gray clay at approximately 20 feet bgs.
P-4 EXP-2	5/18/2021	10:42	23.5	1 - 2	Moist dense gray clay at approximately 20 feet bgs.
P-4 EXP-3	5/18/2021	10:42	20	48	Moist-wet from 12 to 17.5 feet bgs. Silty clay at 15 feet bgs. Fat clay at 18 feet to 20 feet bgs. Resistance at 20 feet leading through 4 feet of saturated fractured bedrock to 24.4 feet bgs.
P-4 EXP-4	5/18/2021	10:42	22.5	12	Refusal at 7 feet bgs at first location - stepped off two feet to the north. Refusal at 23.5 feet bgs after advancing through 1 feet of fractured moist to wet rock.

TABLE 2A
WATER LEVELS AND FIELD INSTRUMENT MEASUREMENTS - P-4 AREA
SEQUESTRATION PILOT STUDY
FORMER CARBORUNDUM SITE
SANBORN, NEW YORK

PRE-INJECTION WATER ELEVATIONS				
P-4 Area Well ID	Date	Time (24-hour)	Depth to Water (feet)	Depth to Bottom (feet)
P-4	5/18/2021	9:51	30.04	34.10
B-19M	5/18/2021	10:54	21.02	26.31
B-13M	5/18/2021	13:28	23.04	36.20

PRE-INJECTION WATER ELEVATIONS AND FIELD INSTRUMENT MEASUREMENTS										
P-4 Area Well ID	Date	Time (24-hour)	Depth to Water (feet)	Depth to Bottom (feet)	Temp (°C)	pH (S.U.)	DO (mg/L)	ORP (mV)	Sp. Cond. (mS/cm)	Turbidity (NTU)
P-4	5/19/2021	8:32	25.61	NM	11.6	6.97	6.84	98.4	1.603	1.71
B-19M	5/19/2021	9:08	21.11	NM	11.1	7.34	7.63	26.8	1.370	1.15
B-13M	5/19/2021	8:56	23.56	NM	11.2	7.37	7.44	22.3	0.792	0.41

INTERIM (MIDDLE OF INJECTION) WATER ELEVATIONS				
P-4 Area Well ID	Date	Time (24-hour)	Depth to Water (feet)	Depth to Bottom (feet)
P-4	5/19/2021	11:02	20.05	34.10
B-19M	5/19/2021	11:02	21.30	26.31
B-13M	5/19/2021	11:02	21.85	36.20

POST INJECTION WATER ELEVATIONS AND FIELD INSTRUMENT MEASUREMENTS										
P-4 Area Well ID	Date	Time (24-hour)	Depth to Water (feet)	Depth to Bottom (feet)	Temp (°C)	pH (S.U.)	DO (mg/L)	ORP (mV)	Sp. Cond. (mS/cm)	Turbidity (NTU)
P-4	5/19/2021	15:10	19.43	34.10	14.5	7.03	4.55	-61.9	1.584	37.82
B-19M	5/19/2021	15:25	21.21	26.30	13.2	7.36	7.86	-9.5	1.376	4.46
B-13M	5/19/2021	15:30	22.79	36.28	12.9	7.29	5.04	-59.1	1.352	38.41

POST-INJECTION WATER ELEVATIONS AND FIELD INSTRUMENT MEASUREMENTS										
P-4 Area Well ID	Date	Time (24-hour)	Depth to Water (feet)	Depth to Bottom (feet)	Temp (°C)	pH (S.U.)	DO (mg/L)	ORP (mV)	Sp. Cond. (mS/cm)	Turbidity (NTU)
P-4	5/20/2021	12:34	NM	NM	11.8	7.36	5.83	27.4	1.637	14.7
B-19M	5/20/2021	12:24	NM	NM	12.3	7.68	7.70	39.0	1.411	2.62
B-13M	5/20/2021	12:31	NM	NM	11.0	7.51	7.12	1.4	1.18	9.57

Notes:

°C : Degrees Centigrade
S.U. : Standard Units
mg/L : milligrams per Liter
mV : MillVOlts
mS/cm : microSiemens per centimeter
NTU : Nephelometric Turbidity Units

TABLE 2B
WATER LEVELS AND FIELD INSTRUMENT MEASUREMENTS - PW-3 AREA
SEQUESTRATION PILOT STUDY
FORMER CARBORUNDUM SITE
SANBORN, NEW YORK

PRE-INJECTION WATER ELEVATIONS				
PW-3 Area Well ID	**Date**	**Time** (24-hour)	**Depth to Water** (feet)	**Depth to Bottom** (feet)
PW-3	5/18/2021	9:31	8.02	18.38
B-18M	5/18/2021	9:30	10.09	50.52
B-8M	5/18/2021	9:27	8.17	17.86
PS-01	5/18/2021	9:26	6.97	NM
PS-02	5/18/2021	9:25	7.32	12.40

PRE-INJECTION WATER ELEVATIONS AND FIELD INSTRUMENT MEASUREMENTS										
PW-3 Area Well ID	**Date**	**Time** (24-hour)	**Depth to Water** (feet)	**Depth to Bottom** (feet)	**Temp** (°C)	**pH** (S.U.)	**DO** (mg/L)	**ORP** (mV)	**Sp. Cond.** (mS/cm)	**Turbidity** (NTU)
PW-3	5/20/2021	8:33	8.38	NM	11.1	7.84	4.21	-25.3	1.022	1.00
B-18M	5/20/2021	8:35	10.9*	NM	10.4	7.80	4.73	-6.3	1.175	0.04
B-8M	5/20/2021	8:35	8.65	NM	10.6	7.64	2.10	-152.9	2.202	12.12

POST-INJECTION WATER ELEVATIONS AND FIELD INSTRUMENT MEASUREMENTS										
PW-3 Area Well ID	**Date**	**Time** (24-hour)	**Depth to Water** (feet)	**Depth to Bottom** (feet)	**Temp** (°C)	**pH** (S.U.)	**DO** (mg/L)	**ORP** (mV)	**Sp. Cond.** (mS/cm)	**Turbidity** (NTU)
PW-3	5/20/2021	11:29	9.36*	18.1	12.9	7.73	4.33	7.6	4.031	0.73
B-18M	5/20/2021	11:30	10.46	50.40	11.2	7.27	3.19	3.9	1.180	2.08
B-8M	5/20/2021	11:31	8.35	17.90	10.7	7.28	3.85	-107.4	2.777	71.4

Notes:
* : Misread
°C : Degrees Centigrade
S.U. : Standard Units
mg/L : milligrams per Liter
mV : MillVOlts
mS/cm : microSiemens per centimeter
NTU : Nephelometric Turbidity Units

TABLE 3A
EZVI INJECTION PARAMETERS AND OBSERVATIONS - P-4 AREA
SEQUESTRATION PILOT STUDY
FORMER CARBORUNDUM SITE
SANBORN, NEW YORK

PILOT-TEST INJECTION OBSERVATIONS

P-4 Area Injection Location	IET Field ID	Date	Depth to Top of Rock[1] (feet)	Estimated Thickness of Fractured Rock (inches)	Injection Start Time (24-hour)	Injection End Time (24-hour)	Fracture Pressure (psi)	Injection Pressure (psi)	Volume EZVI Injected (gallons)	Calculated EZVI Injection Rate (gpm)	Observations
PINJ-2C	P4-PINJ-1	5/19/2021	25	1 - 2	9:51	10:00	175	40	47	5.22	Top-down injection method employed after removal of clay-clogged tooling, and readvancement through the same borehole.
PINJ-2B	P4-PINJ-2	5/19/2021	22	1 - 2	10:54	10:59	175	40	47	9.40	Top-down injection method employed after removal of clay-clogged tooling, and readvancement through the same borehole.
PINJ-2A	P4-PINJ-3	5/19/2021	21	12	13:28	13:37	175	40	47	5.22	Retractable screen method after clay clogged the tooling during 4 unsuccessful attempts to conduct top-down injection method.
PINJ-2D	P4-PINJ-4	5/19/2021	25.5	48	14:12	14:22	150	40	47	4.70	Retractable screen method employed.
PINJ-2E	P4-PINJ-5	5/19/2021	25	36	14:56	15:09	150	40	47	3.62	Clogged tooling. Retractable screen method employed, with 1-foot sump.

[1] A "blind" pilot boring was advanced at all injection locations to identify the depth to top of rock and to gauge the extent of fracturing at each location.

Notes:

psi : Pounds per square inch
gpm : Gallons per minute

TABLE 3B
EZVI INJECTION PARAMETERS AND OBSERVATIONS - PW-3 AREA
SEQUESTRATION PILOT STUDY
FORMER CARBORUNDUM SITE
SANBORN, NEW YORK

PILOT-TEST INJECTION OBSERVATIONS											
PW-3 Area **Injection Location**	**IET Field ID**	**Date**	**Depth to Top of Rock** (feet)	**Estimated Thickness of Fractured Rock** (inches)	**Injection Start Time** (24-hour)	**Injection End Time** (24-hour)	**Fracture Pressure** (psi)	**Injection Pressure** (psi)	**Volume EZVI Injected** (gallons)	**Calculated EZVI Injection Rate** (gpm)	**Observations**
PINJ-1E	PINJ-1E	5/20/2021	11.5	1 - 2	8:40	8:51	100	40	47	4.27	Top-down injection method.
PINJ-1D	PINJ-1D	5/20/2021	12	1 - 2	8:53	9:05	100	40	47	3.92	Top-down injection method. EZVI was observed near the ground surface at the location of a former borehole where potassium permanganate may have previously been injected. Bentonite chips were added to this borehole and driven into the subsurface with the drill rig tooling to seal the hole to prevent additional surfacing.
PINJ-1C	PINJ-1C	5/20/2021	12	1 - 2	9:24	9:42	100	50	47	2.61	Top-down injection method. Pulled up a couple of inches to initiate the delivery of nitrogen gas. Subsequent EZVI pumping was slow, and pressures were increase from 40 psi to 60 psi. Decided to delay pulling injection tooling from the second boring injection location in order to keep surfacing from being exacerbated (i.e., in addition to surfacing observed nearby during injection at PINJ-1D) boring location) near PINJ-1D.
PINJ-1B	PINJ-1B	5/20/2021	11.5	1 - 2	10:05	10:18	100	40	47	3.62	Top-down injection method.
PINJ-1A	PINJ-1A	5/20/2021	11	1 - 2	10:42	11:04	100	40	47	2.14	Top-down injection method. Pumping was suspended from 10:55 to 10:59 to reducing surfacing of EZVI (approx. 2 to 3 gallons) and groundwater from a nearby borehole (near PINJ-1B) where potassium permanganate may have previously been injected. Bentonite chips were added to the borehole to prevent additional surfacing from occurring.

Notes:
psi : Pounds per square inch
gpm : Gallons per minute

TABLE 4
PERFORMANCE MONITORING ANALYTICAL PROGRAM
SEQUESTRATION PILOT STUDY
FORMER CARBORUNDUM SITE
SANBORN, NEW YORK

Sampling Round	Well ID	Date	Analytical Testing: VOCs (1)	TOC	Dissolved Gases (2)	Sulfate	Ferrous Iron	Ferric Iron	Microbial Assay (3)	Field Paramaters (4)
Baseline	PW-3	4/21/2021	✓	✓	✓	✓	✓	✓	✓	✓
	B-8M	4/22/2021	✓	✓	✓	✓	✓	✓	✓	✓
	B-18M	4/21/2021	✓	✓	✓	✓	✓	✓	✓	✓
	P-4	4/21/2021	✓	✓	✓	✓	✓	✓	✓	✓
	B-19M	4/22/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-13M	4/22/2021	✓	✓	✓	✓	✓	✓	✓	✓
15-Day	PW-3	6/15/2021	✓	X	X	X	X	X	X	✓
	P-4	6/15/2021	✓	X	X	X	X	X	X	✓
30-Day	PW-3	6/29/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-8M	6/28/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-18M	6/28/2021	✓	✓	✓	✓	✓	✓	X	✓
	P-4	6/29/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-19M	6/28/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-13M	6/29/2021	✓	✓	✓	✓	✓	✓	X	✓
60-Day	PW-3	7/26/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-8M	7/26/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-18M	7/26/2021	✓	✓	✓	✓	✓	✓	X	✓
	P-4	7/27/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-19M	7/26/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-13M	7/27/2021	✓	✓	✓	✓	✓	✓	X	✓
90-Day	PW-3	8/23/2021	✓	✓	✓	✓	✓	✓	✓	✓
	B-8M	8/23/2021	✓	✓	✓	✓	✓	✓	✓	✓
	B-18M	8/23/2021	✓	✓	✓	✓	✓	✓	✓	✓
	P-4	8/23/2021	✓	✓	✓	✓	✓	✓	✓	✓
	B-19M	8/24/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-13M	8/23/2021	✓	✓	✓	✓	✓	✓	✓	✓
150-Day	PW-3	10/25/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-8M	10/25/2021	✓	✓	✓	✓	✓	✓	✓	✓
	B-18M	10/25/2021	✓	✓	✓	✓	✓	✓	X	✓
	P-4	10/25/2021	✓	✓	✓	✓	✓	✓	✓	✓
	B-19M	10/25/2021	✓	✓	✓	✓	✓	✓	X	✓
	B-13M	10/25/2021	✓	✓	✓	✓	✓	✓	✓	✓
330-Day	PW-3	4/14/2022	✓	✓	✓	✓	✓	✓	✓	✓
	B-8M	4/14/2022	✓	✓	✓	✓	✓	✓	✓	✓
	B-18M	4/14/2022	✓	✓	✓	✓	✓	✓	✓	✓
	P-4	4/14/2022	✓	✓	✓	✓	✓	✓	✓	✓
	B-19M	4/14/2022	✓	✓	✓	✓	✓	✓	✓	✓
	B-13M	4/14/2022	✓	✓	✓	✓	✓	✓	✓	✓

Notes:
(1) Site-Specific VOCs - Method 8260B
(2) Methane, ethane, ethene and CO_2
(3) QuantArray®-Chlor by Microbial Insights
(4) Temperature, pH, specific conductivity, ORP, DO, water level
✓ Sample analyzed for indicated parameter
X Sample not analyzed for indicated parameter

TABLE 5A
PERFORMANCE MONITORING DATA - PW-3 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

Well ID	PW-3						
Sampling Event Date	Baseline(1) 04/21/21	2-Wk 06/15/21	30-Day 06/29/21	60-Day 07/26/21	90-Day 08/23/21	150-Day 10/25/21	320-Day 04/14/22
Target VOCs, µg/L							
Tetrachloroethene	<30	<14	<8.8	<8.8	<8.8	<44	ND
Trichloroethene	8,200	1,500	750	1,300	2,600	690	5,500
cis-1,2-Dichloroethene	8,900	1,400	570	980	2,900	2,900	4,400
trans-1,2-Dichloroethene	6.1	<36	<10	<10	19	<51	ND
1,1-Dichloroethene	67	<12	<9.8	<9.8	13	<49	ND
Vinyl chloride	1,700	88	15	98	220	210	630
Other VOCs, µg/L							
1,1,1-Trichloroethane	<48	<33	<9.6	<9.6	<9.6	<48	ND
1,1-Dichloroethane	<34	<15	<9.4	<9.4	<9.4	<47	ND
Dissolved Gases, µg/L							
Ethene	110	NA	<7.3	22	49	25	49
Ethane	9	NA	1.9	5	6.3	7.9	8.2
Methane	66	NA	10	32	130	2,300	160
Wet Chemistry, mg/L							
Ferrous Iron	<0.023	NA	<0.023	<0.023	<0.023	<0.023	ND
Ferric Iron	<0.023	NA	<0.023	<0.023	<0.023	<0.023	4
Total Iron	<0.026	NA	<0.083	<0.083	<0.083	<0.083	4
Sulfate	110	NA	110	82	68	47	100
Total Organic Carbon	5.5	3.7	3.1	3.4	3.6	3	3.9
Field Instrument Measurements							
Temperature, °C	9.61	11	14.6	14.7	15.2	14.8	11.4
pH, S.U.	7.66	7.57	7.37	7.55	7.58	7.68	7.27
D.O., mg/L	1.94	0.42	1.28	1.67	6.62	0.78	1.74
ORP, mV	59.5	146	188.3	206.5	248.9	-23.4	-8.6
SC, mS/cm	2.853	3.677	2.86*	1.94	2.1	3.06	2.96

Notes
µg/L : Micrograms per liter
mg/L : Milligrams per liter
°C : Degrees Centigrade
S.U. : Standard Units
D.O. : Dissolved Oxygen
ORP : Oxidation-Reduction Potential
mV : millVolts
SC : Specific Conductance
mS/cm : milliSiemens per centimeter

TABLE 5A
PERFORMANCE MONITORING DATA - PW-3 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

Well ID	B-18M						
Sampling Event Date	Baseline(1) 04/21/21	2-Wk 06/15/21	30-Day 06/29/21	60-Day 07/26/21	90-Day 08/23/21	150-Day 10/25/21	320-Day 04/14/22
Target VOCs, µg/L							
Tetrachloroethene	<0.6	NS	<1.8	<1.8	<1.8	<1.8	ND
Trichloroethene	<0.4	NS	<1.8	<1.8	<1.8	<1.8	ND
cis-1,2-Dichloroethene	79	NS	88	93	96	89	93
trans-1,2-Dichloroethene	1.0	NS	<2.0	<2.0	<2.0	<2.0	ND
1,1-Dichloroethene	<0.76	NS	<2.0	<2.0	<2.0	<2.0	ND
Vinyl chloride	20	NS	27	28	24	27	23
Other VOCs, µg/L							
1,1,1-Trichloroethane	<0.96	NS	<1.9	<1.9	<1.9	<1.9	ND
1,1-Dichloroethane	<0.68	NS	<1.9	<1.9	<1.9	<1.9	ND
Dissolved Gases, µg/L							
Ethene	1.0	NS	1.8	1.2	1.6	3.4	1.3
Ethane	0.59	NS	0.65	0.61	0.65	0.81	0.7
Methane	2.8	NS	3.4	3.3	3.3	4.0	3.5
Wet Chemistry, mg/L							
Ferrous Iron	<0.023	NS	<0.023	<0.023	0.024	<0.023	ND
Ferric Iron	0.05	NS	<0.023	<0.023	<0.023	0.11	0.11
Total Iron	0.05	NS	<0.083	<0.083	<0.083	0.11	0.11
Sulfate	220	NS	250	230	220	270	230
Total Organic Carbon	1.4	NS	1.7	1.4	1.4	1.6	1.9
Field Instrument Measurements							
Temperature, °C	11.05	NS	13.5	14.9	14.8	12.4	12.4
pH, S.U.	7.21	NS	7.07	7.08	7.24	7.24	7.14
D.O., mg/L	0.86	NS	0.32	0.09	0.26	0.13	0.95
ORP, mV	19.7	NS	-88.8	-80.7	8.9	-132.5	-33.5
SC, mS/cm	0.719	NS	1.14*	0.93	0.92	1.14	1.02

Notes:
µg/L : Micrograms per liter
mg/L : Milligrams per liter
°C : Degrees Centigrade
S.U. : Standard Units
D.O. : Dissolved Oxygen
ORP : Oxidation-Reduction Potential
mV : millVolts
SC : Specific Conductance
mS/cm : milliSiemens per centimeter

TABLE 5A
PERFORMANCE MONITORING DATA - PW-3 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

Well ID	B-8M						
Sampling Event Date	Baseline(1) 04/21/21	2-Wk 06/15/21	30-Day 06/29/21	60-Day 07/26/21	90-Day 08/23/21	150-Day 10/25/21	320-Day 04/14/22
Target VOCs, µg/L							
Tetrachloroethene	<30	NS	<88	<440	<150	<1,800	ND
Trichloroethene	5,100	NS	27,000	14,000	10,000	97,000	8,100
cis-1,2-Dichloroethene	470	NS	3,600	18,000	12,000	44,000	7,000
trans-1,2-Dichloroethene	<38	NS	<100	<510	<170	<2,000	ND
1,1-Dichloroethene	<38	NS	<98	<490	<160	<2,000	ND
Vinyl chloride	<40	NS	<90	<450	<150	2,200	620
Other VOCs, µg/L							
1,1,1-Trichloroethane	<48	NS	<96	<480	<160	<1,900	ND
1,1-Dichloroethane	<34	NS	<94	<470	<160	<1,900	ND
Dissolved Gases, µg/L							
Ethene	0.67	NS	6.3	29	23	420	160
Ethane	0.89	NS	5.6	12	7.2	37	7.7
Methane	2.3	NS	47	99	79	360	610
Wet Chemistry, mg/L							
Ferrous Iron	<0.023	NS	<0.023	<0.023	<0.023	<0..12	ND
Ferric Iron	0.37	NS	3.7	5.3	<0.023	7.9	3.2
Total Iron	0.37	NS	3.7	5.3	<0.083	7.9	3.2
Sulfate	180	NS	110	110	82	96	49
Total Organic Carbon	3.4	NS	26	6.2	7.5	19	4.3
Field Instrument Measurements							
Temperature, °C	8.73	NS	15.5	15.8	16.2	14.6	10
pH, S.U.	7.28	NS	7.62	7.63	7.48	7.34	7.44
D.O., mg/L	1.33	NS	0.16	0.05	0.14	0.22	0.36
ORP, mV	45.4	NS	-189.9	-164.1	22.5	-125.6	43.4
SC, mS/cm	2.43	NS	5.46*	3.66	1.99	3.75	1.49

Notes
µg/L : Micrograms per liter
mg/L : Milligrams per liter
°C : Degrees Centigrade
S.U. : Standard Units
D.O. : Dissolved Oxygen
ORP : Oxidation-Reduction Potential
mV : millVolts
SC : Specific Conductance
mS/cm : milliSiemens per centimeter

TABLE 5B
PERFORMANCE MONITORING DATA - P-4 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

Well ID	P-4						
Sampling Event Date	**Baseline 04/21/21**	**2-Wk 06/15/21**	**30-Day 06/29/21**	**60-Day 07/27/21**	**90-Day 08/23/21**	**150-Day 10/25/21**	**320-Day 04/14/22**
Target VOCs, µg/L							
Tetrachloroethene	<6.0	<7.2	<18	<18	<18	<18	ND
Trichloroethene	1,800	1,600	1,300	2,000	2,000	1,300	1,600
cis-1,2-Dichloroethene	680	680	630	980	730	1,300	520
trans-1,2-Dichloroethene	13	<18	<20	<20	<20	<20	ND
1,1-Dichloroethene	12	6.5	<20	<20	<20	<20	ND
Vinyl chloride	<8.0	<18	<18	<18	<18	<18	ND
Other VOCs, µg/L							
1,1,1-Trichloroethane	17 J	26	20 J	29 J	25 J	19 J	ND
1,1-Dichloroethane	39 J	31	21 J	26 J	21 J	19 J	24
Dissolved Gases, µg/L							
Ethene	<0.27	NA	0.41	0.66	1.3	1.6	2.5
Ethane	0.32	NA	0.39	0.5	1.3	0.47	0.33
Methane	0.26	NA	0.68	0.86	0.78	2.8	5.7
Wet Chemistry, mg/L							
Ferrous Iron	<0.023	NA	<0.023	0.051	<0.023	<0.023	ND
Ferric Iron	0.68	NA	1.1	0.63	<0.023	12	2.6
Total Iron	0.68	NA	1.1	0.68	<0.083	12	2.6
Sulfate	140	NA	170	140	140	160	120
Total Organic Carbon	2.1	3.3	6.6	11	14	29	23
Field Instrument Measurements							
Temperature, °C	10.9	11.3	12.4	13.6	15.5	11.4	11.8
pH, S.U.	7.32	7.14	7.47	7.18	6.86	7.18	7.49
D.O., mg/L	8.05	3.17	0.67	1.39	5.9	4.31	10.94
ORP, mV	91.5	92.4	-102.4	-57.6	178.7	-49.5	2.3
SC, mS/cm	1.547	1.56	1.58*	1.35	1.28	1.42	0.509

Notes:
µg/L : Micrograms per liter
mg/L : Milligrams per liter
°C : Degrees Centigrade
S.U. : Standard Units
D.O. : Dissolved Oxygen
ORP : Oxidation-Reduction Potential
mV : millVolts
SC : Specific Conductance
mS/cm : milliSiemens per centimeter

TABLE 5B
PERFORMANCE MONITORING DATA - P-4 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

Well ID	B-19M						
Sampling Event Date	Baseline 04/22/21	2-Wk 06/15/21	30-Day 06/28/21	60-Day 07/26/21	90-Day 08/24/21	150-Day 10/25/21	320-Day 04/14/22
Target VOCs, µg/L							
Tetrachloroethene	<0.15	NS	<0.44	<0.44	<0.44	<0.44	ND
Trichloroethene	0.21	NS	<0.44	<0.44	<0.44	<0.44	ND
cis-1,2-Dichloroethene	3	NS	1.8	2.8	2.1	2.8	2.6
trans-1,2-Dichloroethene	<0.19	NS	<0.51	<0.51	<0.51	<0.51	ND
1,1-Dichloroethene	<0.19	NS	<0.49	<0.49	<0.49	<0.49	ND
Vinyl chloride	0.89 J	NS	0.71	0.91	1.3	0.91	1.9
Other VOCs, µg/L							
1,1,1-Trichloroethane	<0.24	NS	<0.48	<0.48	<0.48	0.48	ND
1,1-Dichloroethane	0.33 J	NS	<0.47	<0.47	<0.47	<0.47	ND
Dissolved Gases, µg/L							
Ethene	<0.27	NS	<0.27	<0.27	0.94	0.36	0.64
Ethane	0.96	NS	0.74	0.97	1.1	0.99	0.98
Methane	8.7	NS	11	12	13	13	12
Wet Chemistry, mg/L							
Ferrous Iron	<0.023	NS	<0.023	0.041	0.023	<0.023	0.035 J
Ferric Iron	0.22	NS	<0.023	0.16	0.034	<0.023	0.085
Total Iron	0.22	NS	<0.083	0.2	<0.083	<0.083	0.12
Sulfate	480	NS	1,100	940	1,200	1,000	790
Total Organic Carbon	1.4	NS	1.9	1.7	1.7	1.7	1.8
Field Instrument Measurements							
Temperature, °C	10.49	NS	14.1	13.5	14	11.3	10.9
pH, S.U.	7.4	NS	6.98	7.1	7.23	7.04	7.12
D.O., mg/L	3.48	NS	0.25	0.1	0.29	0.13	0.39
ORP, mV	68.5	NS	-131.2	-206.4	-203.1	-172.3	-75.1
SC, mS/cm	1.136	NS	2.1*	1.88	1.52	2	1.69

Notes:
µg/L : Micrograms per liter
mg/L : Milligrams per liter
°C : Degrees Centigrade
S.U. : Standard Units
D.O. : Dissolved Oxygen
ORP : Oxidation-Reduction Potential
mV : millVolts
SC : Specific Conductance
mS/cm : milliSiemens per centimeter

TABLE 5B
PERFORMANCE MONITORING DATA - P-4 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

Well ID	**B-13M**						
Sampling Event Date	**Baseline(1) 04/22/21**	**2-Wk 06/15/21**	**30-Day 06/29/21**	**60-Day 07/27/21**	**90-Day 08/23/21**	**150-Day 10/25/21**	**320-Day 04/14/22**
Target VOCs, µg/L							
Tetrachloroethene	3	NS	<5.5	<22	<22	<22	ND
Trichloroethene	810	NS	230	1,900	960	420	ND
cis-1,2-Dichloroethene	630	NS	370	1,100	660	860	530
trans-1,2-Dichloroethene	7.9	NS	7.2	<26	<26	<26	ND
1,1-Dichloroethene	7.5	NS	<6.1	<25	<25	<25	ND
Vinyl chloride	16	NS	8.1	<23	<23	<23	15
Other VOCs, µg/L							
1,1,1-Trichloroethane	4.4 J	NS	<6.0	26 J	<24	<24	ND
1,1-Dichloroethane	16 D	NS	<5.9	24 J	<24	<24	10
Dissolved Gases, µg/L							
Ethene	0.39	NS	0.28	0.69	0.95	2.2	1.3
Ethane	0.39	NS	<0.29	0.56	0.85	1.4	0.56
Methane	1.2	NS	0.26	1.5	1.6	2.1	7.5
Wet Chemistry, mg/L							
Ferrous Iron	<0.023	NS	<0.023	<0.023	<0.023	<0.023	ND
Ferric Iron	0.07	NS	0.33	4.7	<0.023	1.9	0.55
Total Iron	0.07	NS	0.33	4.7	<0.083	1.9	0.55
Sulfate	370	NS	240	170	170	170	160
Total Organic Carbon	2	NS	2.3	7.9	4.3	5.7	2.7
Field Instrument Measurements							
Temperature, °C	10.09	NS	14	12.3	12.5	11.6	10.7
pH, S.U.	6.86		7.63	7.27	7.31	7.19	7.42
D.O., mg/L	5.34		7.63	0.11	0.27	0.22	0.56
ORP, mV	113.1		-53.3	-140.9	-71.3	-143.8	104.2
SC, mS/cm	1.784	NS	1.94*	1.56	1.17	1.61	1.16

Notes:
µg/L : Micrograms per liter
mg/L : Milligrams per liter
°C : Degrees Centigrade
S.U. : Standard Units
D.O. : Dissolved Oxygen
ORP : Oxidation-Reduction Potential
mV : millVolts
SC : Specific Conductance
mS/cm : milliSiemens per centimeter

TABLE 6A
MICROBIAL PERFORMANCE MONITORING DATA - PW-3 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

PW-03

Microbial Analyte	10/28/20		04/22/21		08/24/21		10/26/21		04/15/22	
	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile
Dehalococcoides spp.	11.3	31%	NA	n/a	1.96E+03	70%	NA	n/a	1.04E+03	66%
tceA Reductase	ND	n/a	NA	n/a	285	62%	NA	n/a	932	72%
BAV1 Vinyl Chloride Reductase	ND	n/a	NA	n/a	150	59%	NA	n/a	917	72%
Vinyl Chloride Reductase	2.70	21%	NA	n/a	64	44%	NA	n/a	535	61%
cerA Reductase	ND	n/a	NA	n/a	2.10	24%	NA	n/a	29.4	55%
Dehalobacter spp.	ND	n/a	NA	n/a	4.58E+03	48%	NA	n/a	4.78E+03	49%
Chloroform Reductase	ND	n/a	NA	n/a	25.8	34%	NA	n/a	104	55%
Dehalobacter DCM	ND	n/a	NA	n/a	ND	n/a	NA	n/a	ND	n/a
Dehalobium chlorocoercia	1.57E+03	43%	NA	n/a	2.21E+03	50%	NA	n/a	2.35E+04	90%
Dehalogenimonas spp.	ND	n/a	NA	n/a	3.31E+04	77%	NA	n/a	1.86E+05	92%
Desulfitobacterium spp.	2.11E+03	42%	NA	n/a	3.97E+04	79%	NA	n/a	1.03E+05	89%
Desulfuromonas spp.	5.00	10%	NA	n/a	1.73E+04	80%	NA	n/a	5.06E+03	70%
Total Eubacteria	1.38E+04	14%	NA	n/a	6.30E+06	77%	NA	n/a	5.77E+06	76%
Sulfate Reducing Bacteria	7.11E+04	56%	NA	n/a	1.00E+05	61%	NA	n/a	3.91E+05	81%
Ethene Monooxygenase	980	67%	NA	n/a	4.98E+04	98%	NA	n/a	2.33E+05	99%
Epoxyalkane Transferase	574	60%	NA	n/a	1.71E+05	100%	NA	n/a	9.25E+05	99%
Methanogens	2.00	21%	NA	n/a	14.5	35%	NA	n/a	ND	n/a
PCE Reductase 1	ND	n/a	NA	n/a	ND	n/a	NA	n/a	ND	n/a
PCE Reductase 2	ND	n/a	NA	n/a	209	54%	NA	n/a	1.39E+03	78%
Phenol Hydroxylase	242	34%	NA	n/a	8.77E+03	79%	NA	n/a	3.83E+04	91%
Toluene Monooxygenase 2	3.29E+03	69%	NA	n/a	5.48E+03	75%	NA	n/a	5.43E+03	75%
Toluene Monooxygenase	ND	n/a	NA	n/a	1.59E+04	82%	NA	n/a	2.49E+04	86%
Soluble Methane Monooxygenase	ND	n/a	NA	n/a	147	49%	NA	n/a	ND	n/a
trans-1,2-DCE Reductase	ND	n/a	NA	n/a	ND	n/a	NA	n/a	ND	n/a
Toluene Dioxygenase	ND	n/a	NA	n/a	54	51%	NA	n/a	ND	n/a

Notes:
cells/mL : Cells per milliLiter
ND : Not detected
NA : Not analyzed
n/a : not applicable

TABLE 6A
MICROBIAL PERFORMANCE MONITORING DATA - PW-3 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

B-8M

Microbial Analyte	10/28/20		04/22/21		08/24/21		10/26/21		04/15/22	
	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile
Dehalococcoides spp.	ND	n/a	NA	n/a	78.1	47%	2.97E+05	94%	5.53E+04	88%
tceA Reductase	ND	n/a	NA	n/a	0.9	16%	7.54E+03	86%	406	65%
BAV1 Vinyl Chloride Reductase	ND	n/a	NA	n/a	2.20	26%	2.34E+04	91%	2.67E+03	79%
Vinyl Chloride Reductase	ND	n/a	NA	n/a	4.20	24%	1.94E+04	86%	2.55E+03	73%
cerA Reductase	ND	n/a	NA	n/a	ND	n/a	82.3	69%	246	82%
Dehalobacter spp.	37.4	8%	NA	n/a	6.03E+03	52%	3.14E+04	75%	396	22%
Chloroform Reductase	ND	n/a	NA	n/a	ND	n/a	135	60%	ND	n/a
Dehalobacter DCM	20.1	10%	NA	n/a	ND	n/a	1.29E+03	73%	ND	n/a
Dehalobium chlorocoercia	ND	n/a	NA	n/a	6.96E+03	74%	9.56E+03	79%	1.12E+04	81%
Dehalogenimonas spp.	ND	n/a	NA	n/a	7.20E+03	53%	2.89E+05	94%	3.01E+05	94%
Desulfitobacterium spp.	ND	n/a	NA	n/a	5.60E+03	55%	6.24E+04	84%	5.92E+03	55%
Desulfuromonas spp.	0.8	3%	NA	n/a	2.60E+04	83%	8.26E+04	91%	5.39E+04	88%
Total Eubacteria	5.58E+04	21%	NA	n/a	1.17E+06	52%	7.10E+06	79%	2.04E+06	61%
Sulfate Reducing Bacteria	1.05E+03	14%	NA	n/a	4.57E+04	49%	1.70E+05	70%	1.67E+05	70%
Ethene Monooxygenase	ND	n/a	NA	n/a	649	61%	307	51%	957	67%
Epoxyalkane Transferase	ND	n/a	NA	n/a	1.29E+03	70%	1.20E+03	69%	2.37E+03	78%
Methanogens	ND	5%	NA	n/a	4.80	27%	43.9	43%	25.5	38%
PCE Reductase 1	ND	n/a	NA	n/a	ND	n/a	35	17%	ND	n/a
PCE Reductase 2	ND	n/a	NA	n/a	ND	n/a	1.02E+04	95%	2.95E+03	85%
Phenol Hydroxylase	ND	n/a	NA	n/a	348	38%	558	45%	334	38%
Toluene Monooxygenase 2	ND	n/a	NA	n/a	408	36%	999	51%	1.55E+03	58%
Soluble Methane Monooxygenase	ND	n/a	NA	n/a	176	52%	ND	n/a	120	22%
trans-1,2-DCE Reductase	ND	n/a	NA	n/a	ND	n/a	3.37E+03	52%	426	9%
Toluene Dioxygenase	4.10	14%	NA	n/a	72.3	56%	836	85%	77.5	57%

Notes:
cells/mL : Cells per milliLiter
ND : Not detected
NA : Not analyzed
n/a : not applicable

TABLE 6A
MICROBIAL PERFORMANCE MONITORING DATA - PW-3 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

B-18M

Microbial Analyte	10/28/20		04/22/21		08/24/21		10/26/21		04/15/22	
	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile
Dehalococcoides spp.	4.43E+03	75%	NA	n/a	371	58%	NA	n/a	268	56%
tceA Reductase	184	59%	NA	n/a	3.20	26%	NA	n/a	0.9	16%
BAV1 Vinyl Chloride Reductase	7.70	36%	NA	n/a	0.4	10%	NA	n/a	0.5	12%
Vinyl Chloride Reductase	2.03E+03	71%	NA	n/a	60.3	44%	NA	n/a	66.9	44%
cerA Reductase	1.10	17%	NA	n/a	0.6	11%	NA	n/a	2.10	24%
Dehalobacter spp.	160	15%	NA	n/a	702	27%	NA	n/a	18	6%
Chloroform Reductase	ND	n/a	NA	n/a	ND	n/a	NA	n/a	ND	n/a
Dehalobacter DCM	ND	n/a	NA	n/a	ND	n/a	NA	n/a	ND	n/a
Dehalobium chlorocoercia	699	28%	NA	n/a	1.58E+03	43%	NA	n/a	3.67E+03	61%
Dehalogenimonas spp.	4.51E+03	46%	NA	n/a	4.32E+03	46%	NA	n/a	1.07E+04	60%
Desulfitobacterium spp.	175	18%	NA	n/a	ND	n/a	NA	n/a	4.92E+03	53%
Desulfuromonas spp.	16.8	17%	NA	n/a	44.4	26%	NA	n/a	ND	n/a
Total Eubacteria	2.59E+05	33%	NA	n/a	5.71E+05	42%	NA	n/a	2.21E+05	32%
Sulfate Reducing Bacteria	4.91E+04	50%	NA	n/a	7.48E+04	56%	NA	n/a	2.77E+04	42%
Ethene Monooxygenase	ND	n/a	NA	n/a	223	46%	NA	n/a	200	44%
Epoxyalkane Transferase	ND	n/a	NA	n/a	676	62%	NA	n/a	347	53%
Methanogens	0.5	10%	NA	n/a	1.00	15%	NA	n/a	0.6	11%
PCE Reductase 1	ND	n/a	NA	n/a	n/a	n/a	NA	n/a	ND	n/a
PCE Reductase 2	ND	n/a	NA	n/a	n/a	n/a	NA	n/a	ND	n/a
Phenol Hydroxylase	0.3	0%	NA	n/a	403	40%	NA	n/a	14.1	8%
Toluene Monooxygenase 2	ND	n/a	NA	n/a	3.50	1%	NA	n/a	ND	n/a
Toluene Monooxygenase	ND	n/a	NA	n/a	155	24%	NA	n/a	ND	n/a
Soluble Methane Monooxygenase	ND	n/a	NA	n/a	217	57%	NA	n/a	1.50	2%
trans-1,2-DCE Reductase	ND	n/a	NA	n/a	38.3	45%	NA	n/a	ND	n/a
Toluene Dioxygenase	ND	n/a	NA	n/a	ND	n/a	NA	n/a	ND	n/a

Notes:
cells/mL : Cells per milliLiter
ND : Not detected
NA : Not analyzed
n/a : not applicable

TABLE 6B
MICROBIAL PERFORMANCE MONITORING DATA - P-4 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

P-4

Microbial Analyte	10/28/20		04/22/21		08/24/21		10/26/21		04/15/22	
	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile
Dehalococcoides spp.	NA	n/a	8.66E+04	89%	13	32%	155	52%	3.08E+03	72%
tceA Reductase	NA	n/a	4.54E+04	94%	0.5	11%	13	37%	71	51%
BAV1 Vinyl Chloride Reductase	NA	n/a	598	69%	0.1	0%	0.5	12%	34.7	48%
Vinyl Chloride Reductase	NA	n/a	2.13E+04	87%	0.6	11%	14.6	33%	201	53%
cerA Reductase	NA	n/a	7.70	37%	ND	n/a	ND	n/a	1.40	18%
Dehalobacter spp.	NA	n/a	1.16E+05	89%	3.51E+03	45%	1.84E+04	68%	6.11E+03	53%
Chloroform Reductase	NA	n/a	129	59%	ND	n/a	ND	n/a	17.7	26%
Dehalobacter DCM	NA	n/a	7.52E+03	93%	ND	n/a	ND	n/a	ND	n/a
Dehalobium chlorocoercia	NA	n/a	5.63E+04	96%	ND	n/a	557	25%	6.57E+03	73%
Dehalogenimonas spp.	NA	n/a	5.61E+04	83%	ND	n/a	ND	n/a	3.03E+03	40%
Desulfitobacterium spp.	NA	n/a	9.89E+04	89%	8.83E+03	61%	2.07E+04	71%	3.14E+04	77%
Desulfuromonas spp.	NA	n/a	1.38E+03	58%	550	50%	590	51%	753	52%
Total Eubacteria	NA	n/a	3.15E+07	92%	2.50E+06	64%	1.10E+07	84%	1.97E+06	60%
Sulfate Reducing Bacteria	NA	n/a	1.67E+06	94%	2.27E+04	40%	5.14E+04	51%	1.08E+05	63%
Ethene Monooxygenase	NA	n/a	6.80E+03	87%	24.9	16%	84.1	31%	4.73E+03	84%
Epoxyalkane Transferase	NA	n/a	2.16E+04	94%	234	47%	326	52%	1.09E+04	90%
Methanogens	NA	n/a	ND	n/a	3.20	24%	0.9	14%	122	50%
PCE Reductase 1	NA	n/a	764	58%	ND	n/a	1.50E+03	66%	ND	n/a
PCE Reductase 2	NA	n/a	1.10E+04	96%	ND	n/a	4.81E+03	90%	709	70%
Phenol Hydroxylase	NA	n/a	5.10E+04	93%	2.03E+03	62%	4.00E+04	91%	8.66E+03	78%
Toluene Monooxygenase 2	NA	n/a	3.67E+04	92%	284	31%	6.07E+04	95%	1.23E+04	84%
Toluene Monooxygenase	NA	n/a	6.61E+04	93%	3.02E+03	61%	1.12E+04	78%	4.16E+04	90%
Soluble Methane Monooxygenase	NA	n/a	ND	n/a	ND	n/a	248	59%	58.4	31%
trans-1,2-DCE Reductase	NA	n/a	ND	n/a	ND	n/a	ND	n/a	ND	n/a
Toluene Dioxygenase	NA	n/a	ND	n/a	105	61%	48.1	49%	ND	n/a

Notes:
cells/mL : Cells per milliLiter
ND : Not detected
NA : Not analyzed
n/a : not applicable

TABLE 6B
MICROBIAL PERFORMANCE MONITORING DATA - P-4 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

B-13M

Microbial Analyte	10/28/20		04/22/21		08/24/21		10/26/21		04/15/22	
	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile
Dehalococcoides spp.	255	56%	NA	n/a	39.6	41%	1.43E+03	68%	624	62%
tceA Reductase	0.9	16%	NA	n/a	12.6	28%	64.1	33%	0.6	13%
BAV1 Vinyl Chloride Reductase	24.6	46%	NA	n/a	1.10	20%	66.4	53%	72.2	54%
Vinyl Chloride Reductase	15.3	33%	NA	n/a	3.90	24%	119	49%	49.6	42%
cerA Reductase	ND	n/a	NA	n/a	ND	n/a	0.8	12%	0.1	0%
Dehalobacter spp.	ND	n/a	NA	n/a	ND	n/a	724	28%	ND	n/a
Chloroform Reductase	ND	n/a	NA	n/a	ND	n/a	ND	n/a	ND	n/a
Dehalobacter DCM	ND	n/a	NA	n/a	ND	n/a	ND	n/a	ND	n/a
Dehalobium chlorocoercia	ND	n/a	NA	n/a	381	20%	530	24%	1.88E+04	88%
Dehalogenimonas spp.	ND	n/a	NA	n/a	ND	n/a	1.97E+03	33%	1.15E+03	26%
Desulfitobacterium spp.	ND	n/a	NA	n/a	ND	n/a	441	25%	6.52E+03	56%
Desulfuromonas spp.	ND	n/a	NA	n/a	123	35%	5.60	11%	4.10E+03	69%
Total Eubacteria	1.23E+05	27%	NA	n/a	1.51E+04	14%	1.24E+05	27%	6.35E+06	78%
Sulfate Reducing Bacteria	395	10%	NA	n/a	ND	n/a	1.76E+04	37%	1.31E+05	66%
Ethene Monooxygenase	ND	n/a	NA	n/a	ND	n/a	ND	n/a	1.27E+03	71%
Epoxyalkane Transferase	ND	n/a	NA	n/a	ND	n/a	ND	n/a	2.35E+03	78%
Methanogens	ND	n/a	NA	n/a	ND	n/a	0.9	14%	ND	n/a
PCE Reductase 1	ND	n/a	NA	n/a	ND	n/a	ND	n/a	ND	n/a
PCE Reductase 2	ND	n/a	NA	n/a	ND	n/a	59	31%	4.63E+03	89%
Phenol Hydroxylase	ND	n/a	NA	n/a	ND	n/a	706	48%	5.62E+03	74%
Toluene Monooxygenase 2	ND	n/a	NA	n/a	ND	n/a	178	24%	1.80E+04	88%
Toluene Monooxygenase	ND	n/a	NA	n/a	ND	n/a	299	32%	1.77E+04	83%
Soluble Methane Monooxygenase	ND	n/a	NA	n/a	24.1	16%	1.20	19%	ND	n/a
trans-1,2-DCE Reductase	ND	n/a	NA	n/a	ND	n/a	ND	n/a	ND	n/a
Toluene Dioxygenase	1.90	9%	NA	n/a	ND	n/a	ND	n/a	ND	n/a

Notes:
cells/mL : Cells per milliLiter
ND : Not detected
NA : Not analyzed
n/a : not applicable

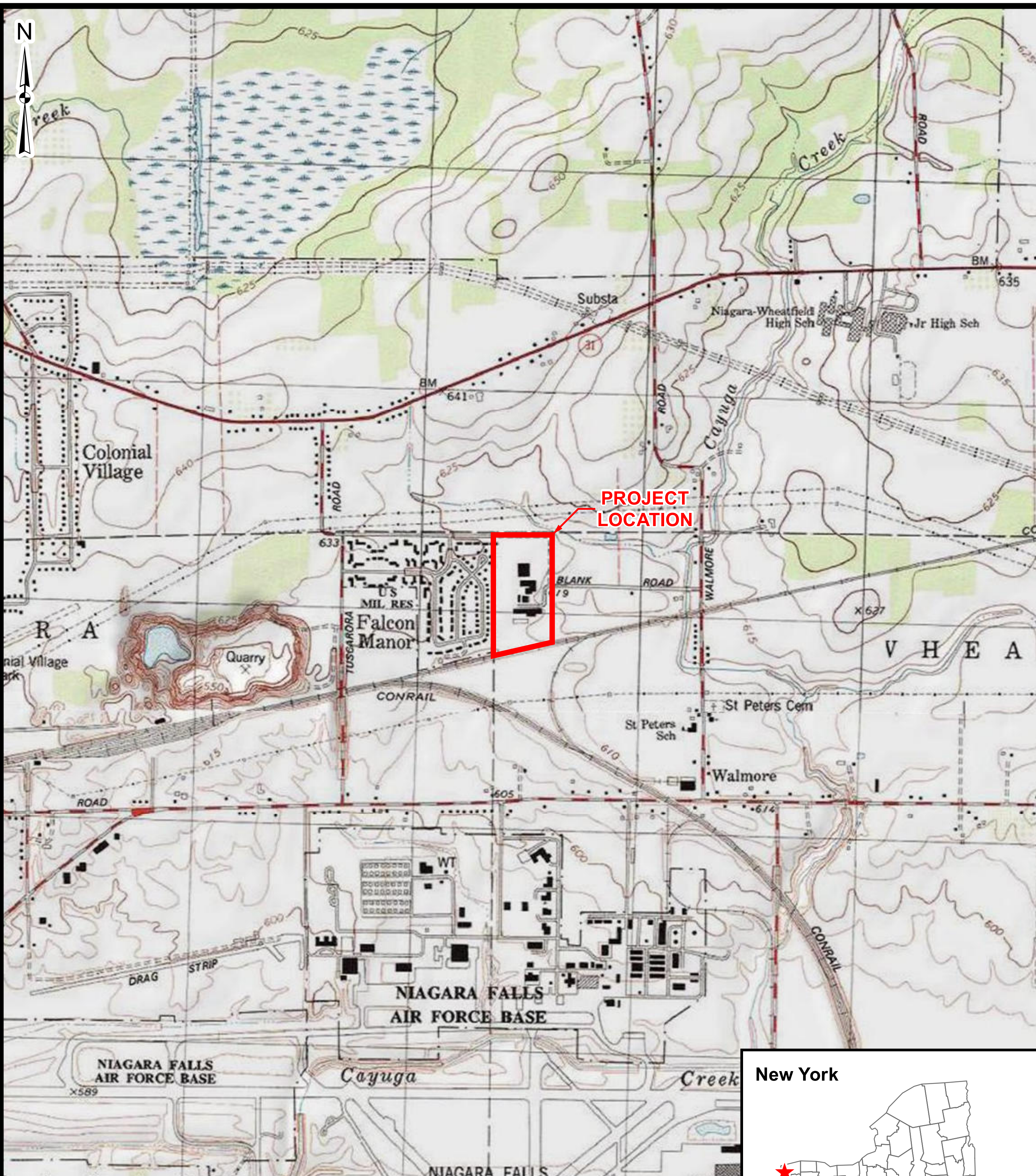
TABLE 6B
MICROBIAL PERFORMANCE MONITORING DATA - P-4 AREA
SEQUESTRATION PILOT STUDY
FORMER CORBORUNDUM FACILITY
SANBORN, NEW YORK

B-19M

Microbial Analyte	10/28/20		04/22/21		08/24/21		10/26/21		04/15/22	
	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile	cells/mL	Percentile
Dehalococcoides spp.	NA	n/a	NA	n/a	NA	n/a	NA	n/a	61.1	45%
tceA Reductase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a
BAV1 Vinyl Chloride Reductase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	0.3	7%
Vinyl Chloride Reductase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	4.50	25%
cerA Reductase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	0.1	0%
Dehalobacter spp.	NA	n/a	NA	n/a	NA	n/a	NA	n/a	1.47E+03	35%
Chloroform Reductase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a
Dehalobacter DCM	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a
Dehalobium chlorocoercia	NA	n/a	NA	n/a	NA	n/a	NA	n/a	5.34E+03	68%
Dehalogenimonas spp.	NA	n/a	NA	n/a	NA	n/a	NA	n/a	5.32E+03	49%
Desulfitobacterium spp.	NA	n/a	NA	n/a	NA	n/a	NA	n/a	332	23%
Desulfuromonas spp.	NA	n/a	NA	n/a	NA	n/a	NA	n/a	63.8	29%
Total Eubacteria	NA	n/a	NA	n/a	NA	n/a	NA	n/a	7.28E+05	46%
Sulfate Reducing Bacteria	NA	n/a	NA	n/a	NA	n/a	NA	n/a	1.76E+05	71%
Ethene Monooxygenase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	69.4	29%
Epoxyalkane Transferase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a
Methanogens	NA	n/a	NA	n/a	NA	n/a	NA	n/a	0.8	14%
PCE Reductase 1	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a
PCE Reductase 2	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a
Phenol Hydroxylase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	1.08E+03	54%
Toluene Monooxygenase 2	NA	n/a	NA	n/a	NA	n/a	NA	n/a	170	23%
Toluene Monooxygenase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	4.81E+03	68%
Soluble Methane Monooxygenase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a
trans-1,2-DCE Reductase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a
Toluene Dioxygenase	NA	n/a	NA	n/a	NA	n/a	NA	n/a	ND	n/a

Notes:
cells/mL : Cells per milliLiter
ND : Not detected
NA : Not analyzed
n/a : not applicable

Figures



Source: USA Topo Maps, ESRI Map Service;
1:24,000-scale USGS Topographic Map,
Ransomville, 1996
Tonawanda West, 1996

2,000 0 2,000 Feet

J:\Projects\60481767_BPIPO\MISC\GIS\Sanborn\Maps\2018\Q1\PROJECT LOCATION.mxd 5/15/2018

AECOM

FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
PROJECT LOCATION PLAN

FIGURE 1

L:\DCS\Projects\60481767_BPIPO\MISC\GIS\Sanborn\Maps\WorkPlan\SITE PLAN.mxd 6/23/2022

Source: NYSDOP High Resolution Statewide Imagery, Niagara County, 2017

FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
PW-3 PILOT STUDY AREA

AECOM

FIGURE 3

L:\DCS\Projects\60481767_BPIPOIMISC\GIS\Sanborn\Maps\WorkPlan\PW-3 Pilot Study Area.mxd 6/23/2022

Source: NYSDOP High Resolution Statewide Imagery, Niagara County, 2017

FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
P-4 PILOT STUDY AREA

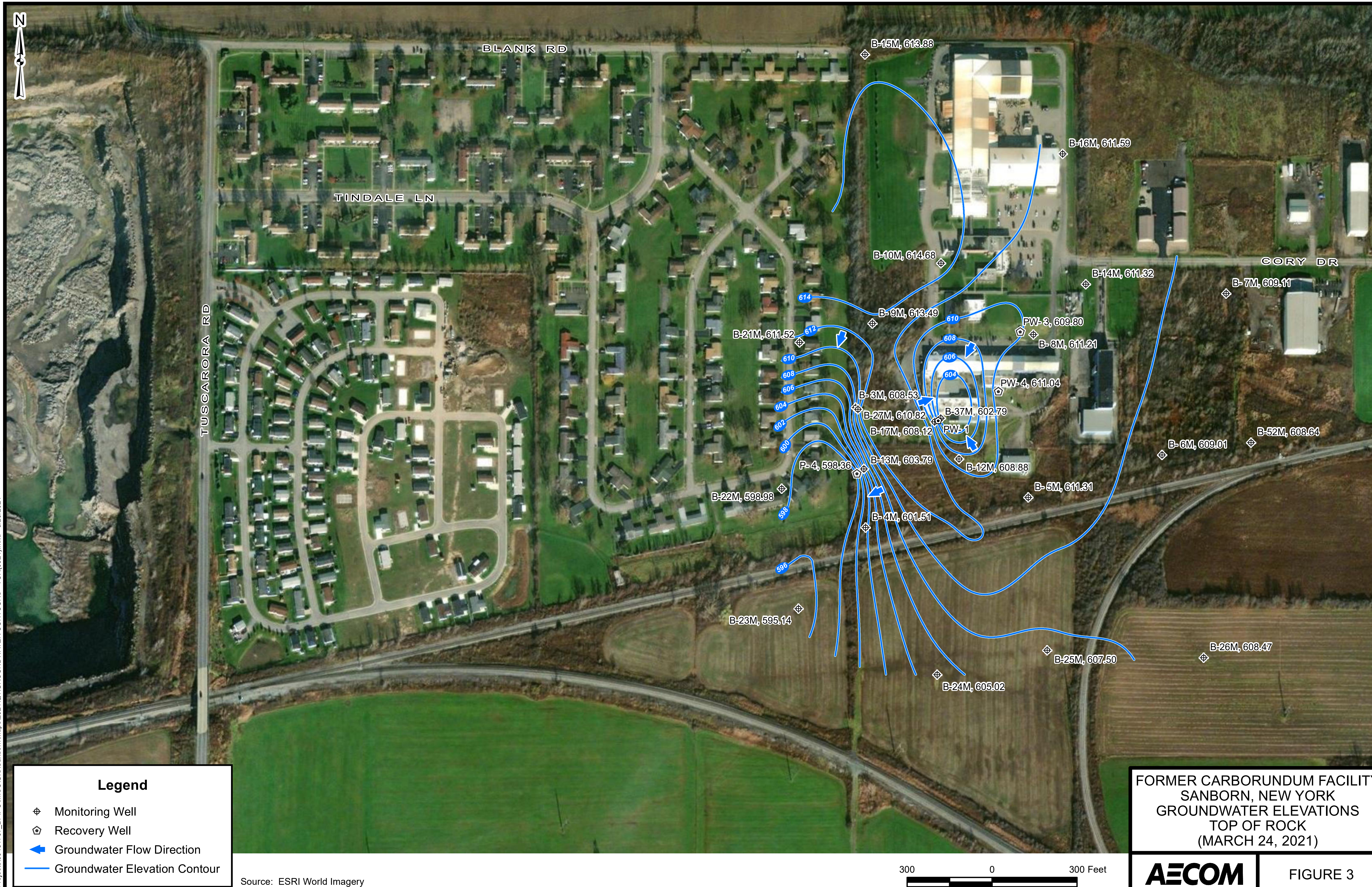
AECOM

FIGURE 4

L:\DCS\Projects\60481767_BPIPO\MISC\GIS\Sanborn\Maps\WorkPlan\P-4 Pilot Study Area.mxd 6/23/2022

Appendix A

2021 Groundwater Elevation Contour Maps



FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
GROUNDWATER ELEVATIONS
TOP OF ROCK
(MARCH 24, 2021)

AECOM

FIGURE 3

J:\Projects\60481767_BPIPO\MISC\GIS\SanbornMaps\2021\Q1\GROUNDWATER CONTOURS - TOR(0321).mxd 6/23/2021

FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
GROUNDWATER ELEVATIONS
ZONE 1
(MARCH 24, 2021)

AECOM

FIGURE 4

J:\Projects\60481767_BPIPO\MISC\GIS\Sanborn\Maps\2021\Q1\GROUNDWATER CONTOURS - Z1(0321).mxd 6/23/2021

Legend

- Monitoring Well
- Recovery Well
- Groundwater Flow Direction
- Groundwater Elevation Contour

Source: ESRI World Imagery

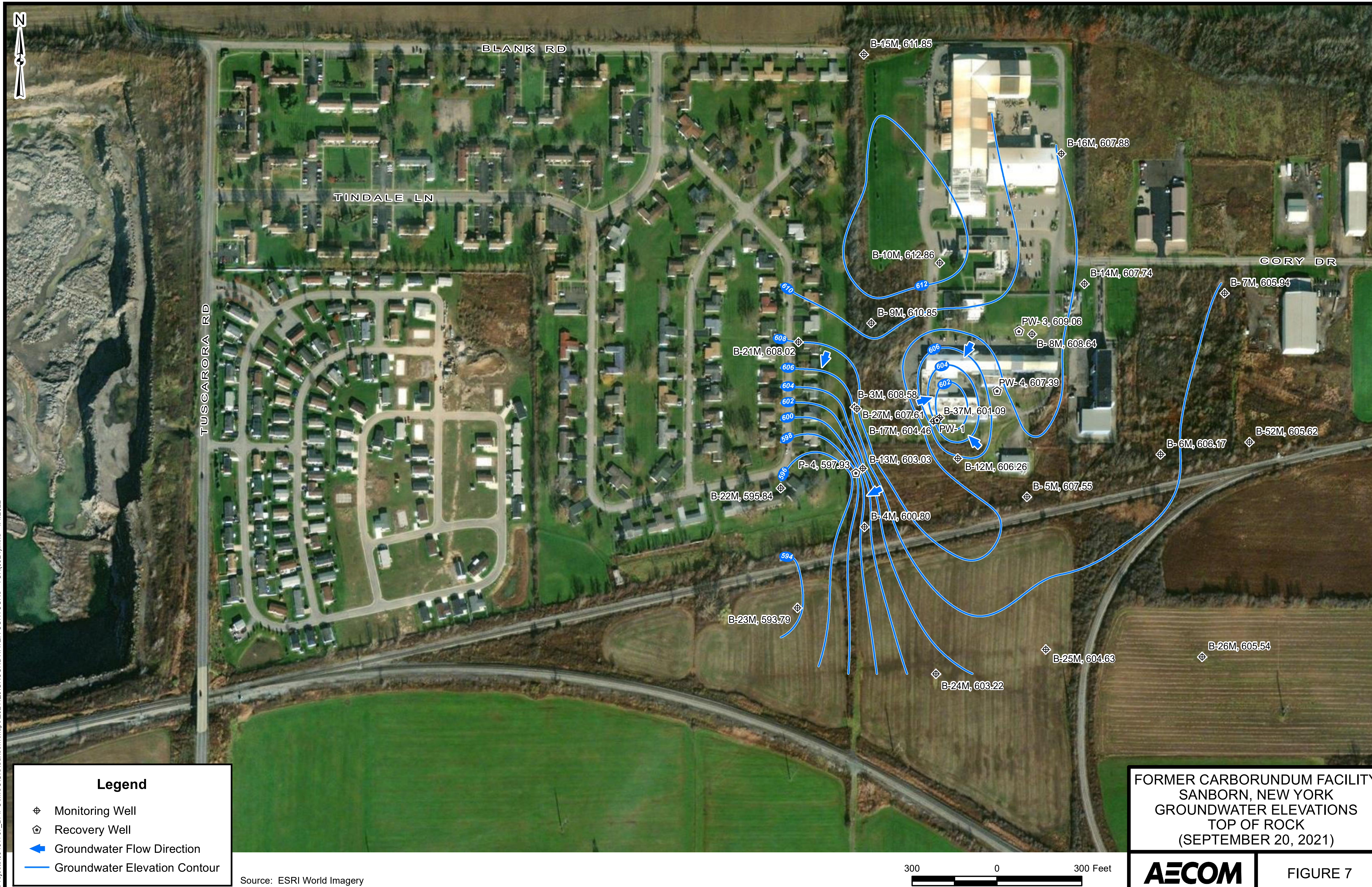
FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
GROUNDWATER ELEVATIONS
TOP OF ROCK
(JUNE 1, 2021)

AECOM

FIGURE 5

J:\Projects\60481767_BPIPOM\SC\GIS\Sanborn\Maps\2021\Q2\GROUNDWATER CONTOURS - TOR.mxd 6/7/2021

J:\Projects\60481767_BP\POM\SC\GIS\Sanborn\Maps\2021\Q2\GROUNDWATER CONTOURS - Z1.mxd 4/19/2022



FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
GROUNDWATER ELEVATIONS
TOP OF ROCK
(SEPTEMBER 20, 2021)

AECOM

FIGURE 7

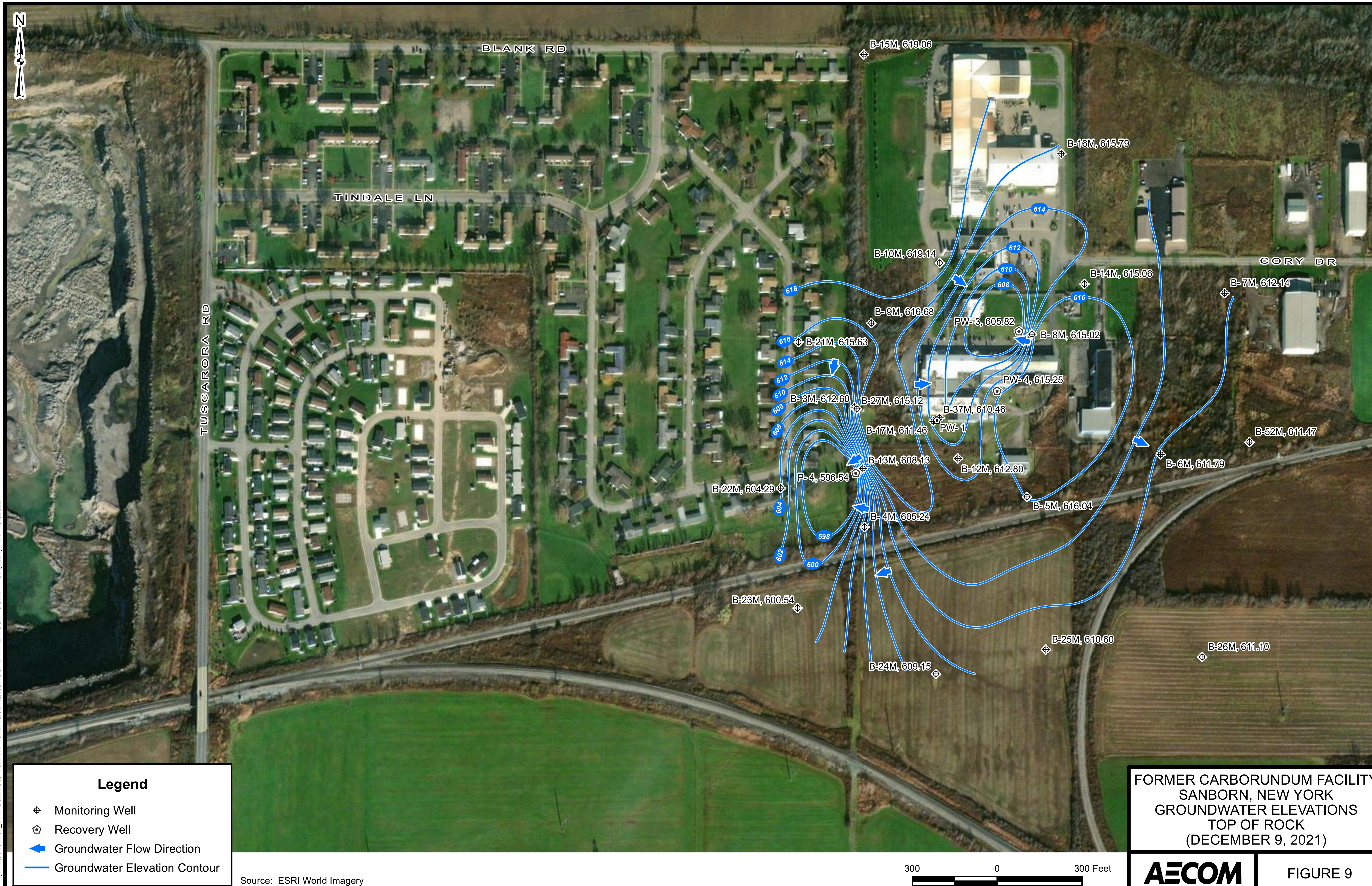
J:\Projects\60481767_BPIPOM\MISC\GIS\Sanborn\Maps\2021\Q3\GROUNDWATER CONTOURS - TOR(0921).mxd 1/4/2022

FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
GROUNDWATER ELEVATIONS
ZONE 1
(SEPTEMBER 20, 2021)

AECOM

FIGURE 8

J:\Projects\60481767_BPIPOMISC\GIS\Sanborn\Maps\2021\Q3\GROUNDWATER CONTOURS - Z1(0921).mxd 1/4/2022



FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
GROUNDWATER ELEVATIONS
TOP OF ROCK
(DECEMBER 9, 2021)

AECOM

FIGURE 9

J:\Projects\60481767_BP\POM\SC\GIS\Sanborn\Maps\2021\Q4\GROUNDWATER CONTOURS - TOR(1221).mxd 1/4/2022

Legend

- Monitoring Well
- Recovery Well
- Groundwater Flow Direction
- Groundwater Elevation Contour

Source: ESRI World Imagery
Note: NM - Not Measured

300 0 300 Feet

FORMER CARBORUNDUM FACILITY
SANBORN, NEW YORK
GROUNDWATER ELEVATIONS
ZONE 1
(DECEMBER 9, 2021)

AECOM

FIGURE 10

J:\Projects\60481767_BPIPO\MISC\GIS\Sanborn\Maps\2021\Q4\GROUNDWATER CONTOURS - Z1(1221).mxd 1/4/2022

Appendix B

Photographic Log

AECOM 257 West Genesee Street Suite 400 Buffalo, NY 14202	PHOTOGRAPHIC DOCUMENTATION	
CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 1	**Date:** 5/19/21	
Description: Facing northeast, direct-push rig set up at exploratory boring PW-3 EXP-3. Well B-08M is shown in the foreground.		

AECOM 257 West Genesee Street Suite 400 Buffalo, NY 14202		**PHOTOGRAPHIC DOCUMENTATION**
CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 2	**Date:** 5/19/21	
Description: Fractured top of rock core from approximately 10 feet below the ground surface at direct-push exploratory boring PW-3 EXP-1.		

AECOM 257 West Genesee Street
Suite 400
Buffalo, NY 14202

PHOTOGRAPHIC DOCUMENTATION

CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 3	**Date:** 5/20/21

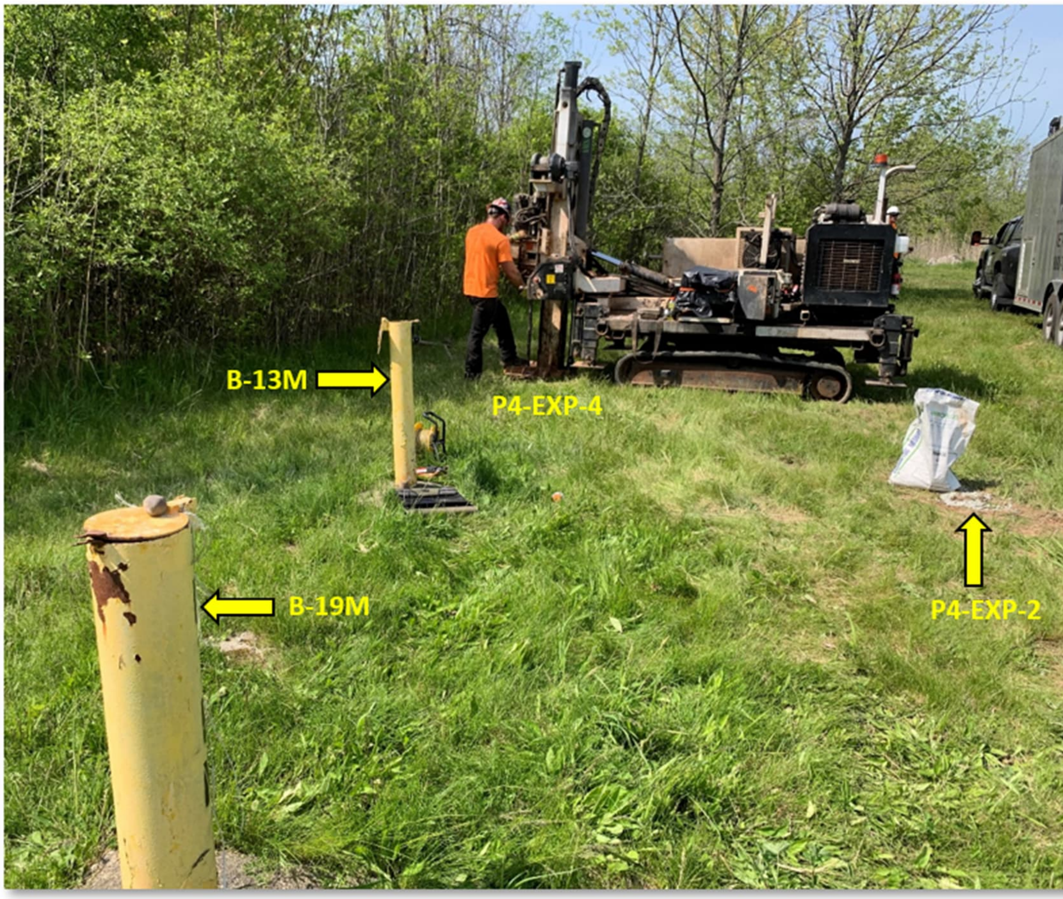
Description:
Fractured top of rock core from approximately 20 to 24 feet below the ground surface at direct-push exploratory boring P4 EXP-3.

257 West Genesee Street Suite 400 Buffalo, NY 14202	**PHOTOGRAPHIC DOCUMENTATION**

CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 4	**Date:** 5/20/21

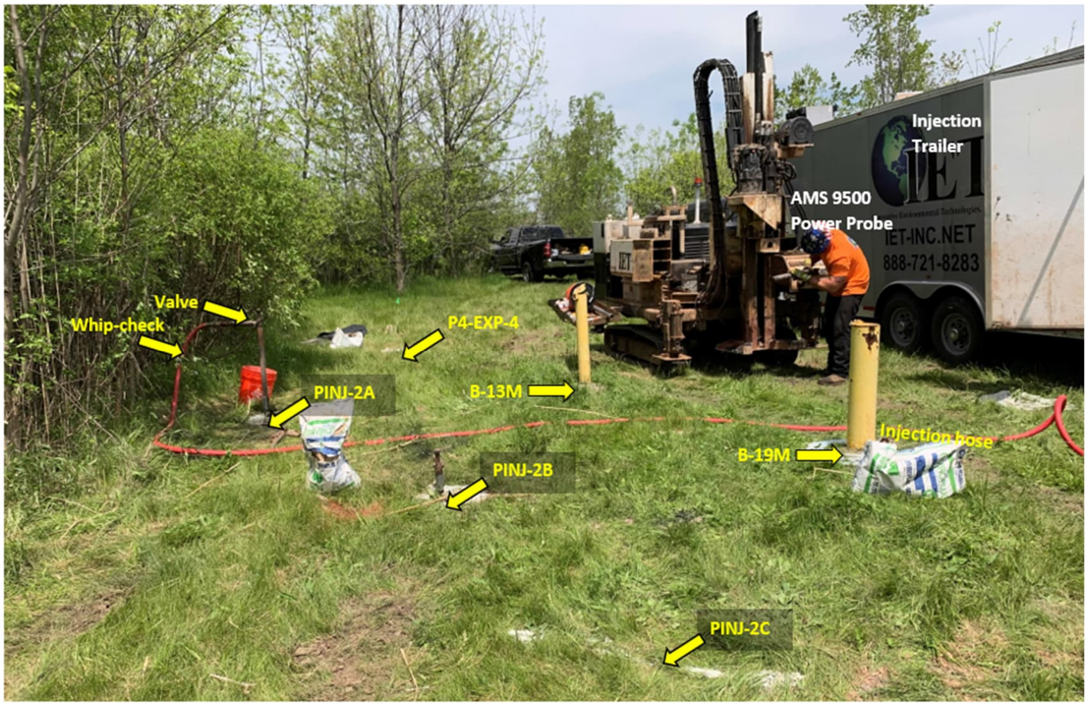
Description:
Direct-push rig set up at exploratory boring P4-EXP-4.



257 West Genesee Street Suite 400 Buffalo, NY 14202	**PHOTOGRAPHIC DOCUMENTATION**	
CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

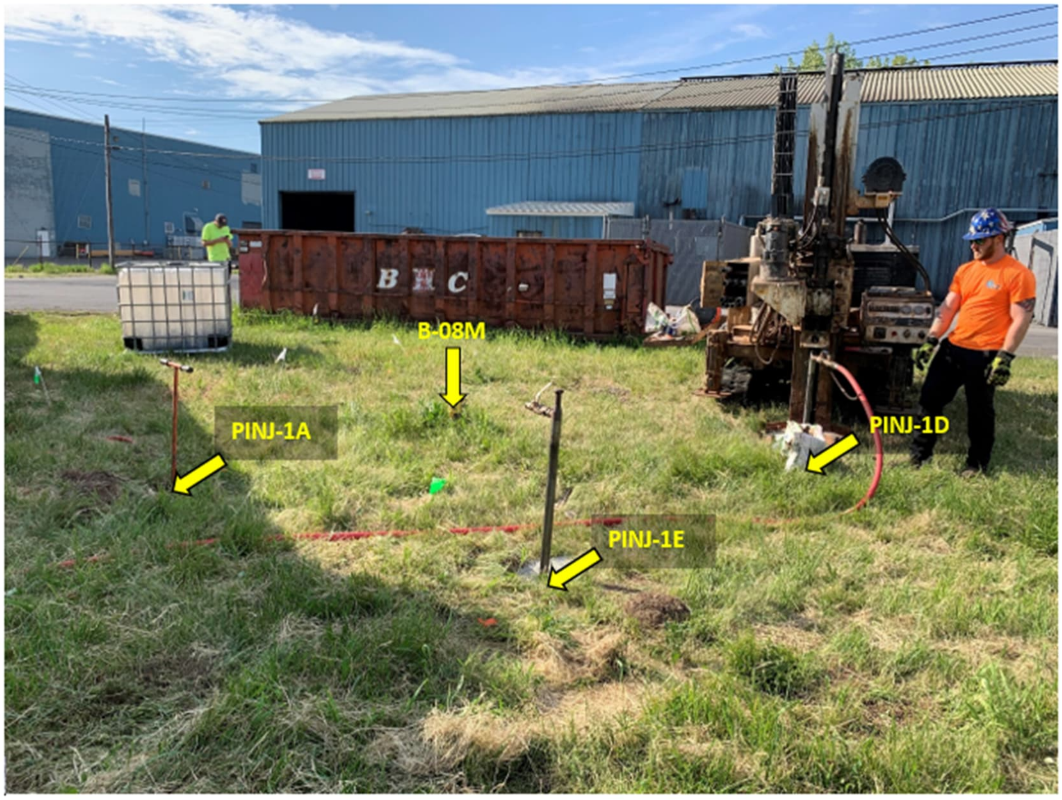
Photo No. 5	**Date:** 5/21/21

Description:
View facing north: Direct-push injection of EZVI at PINJ-2A after completing injection locations PINJ-2C and PINJ-2B. Location PINJ-2B is shown with the injection tooling still in the ground and plugged to prevent short-circuiting of EZVI to the ground surface during injection at PINJ-2A. Similarly, monitoring wells B-13M and B-19M were outfitted with snug J-plugs to prevent EZVI from entering the wells during injection at PINJ-2A, -2B, and -2C.



AECOM 257 West Genesee Street Suite 400 Buffalo, NY 14202	**PHOTOGRAPHIC DOCUMENTATION**	
CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 6	**Date:** 5/21/21
Description: View facing southeast: Direct-push injection of EZVI at PINJ-1D after completing injection location PINJ-1E. Injection location PINJ-1E is shown with the direct-push tooling still in the ground and with the injection valve closed to prevent short-circuiting of EZVI to the ground surface during injection at PINJ-1D. After removing injection tooling, all holes were immediately backfilled with hand-compacted bentonite crumbles. Monitoring well location B-08M is central to the injection of EZVI on approximately 10-foot radii.	



AECOM 257 West Genesee Street Suite 400 Buffalo, NY 14202	**PHOTOGRAPHIC DOCUMENTATION**	
CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 7	**Date:** 5/21/21

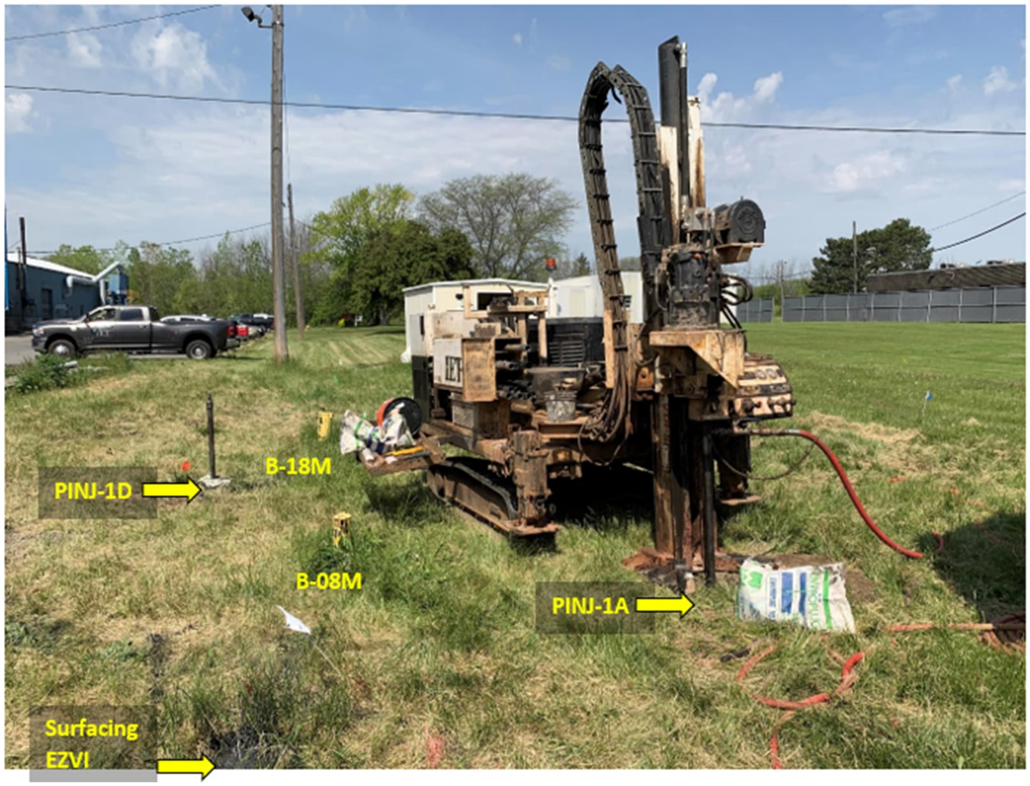
Description:
The top-down tooling (top) and the retractable screen tooling (bottom).

257 West Genesee Street Suite 400 Buffalo, NY 14202	**PHOTOGRAPHIC DOCUMENTATION**

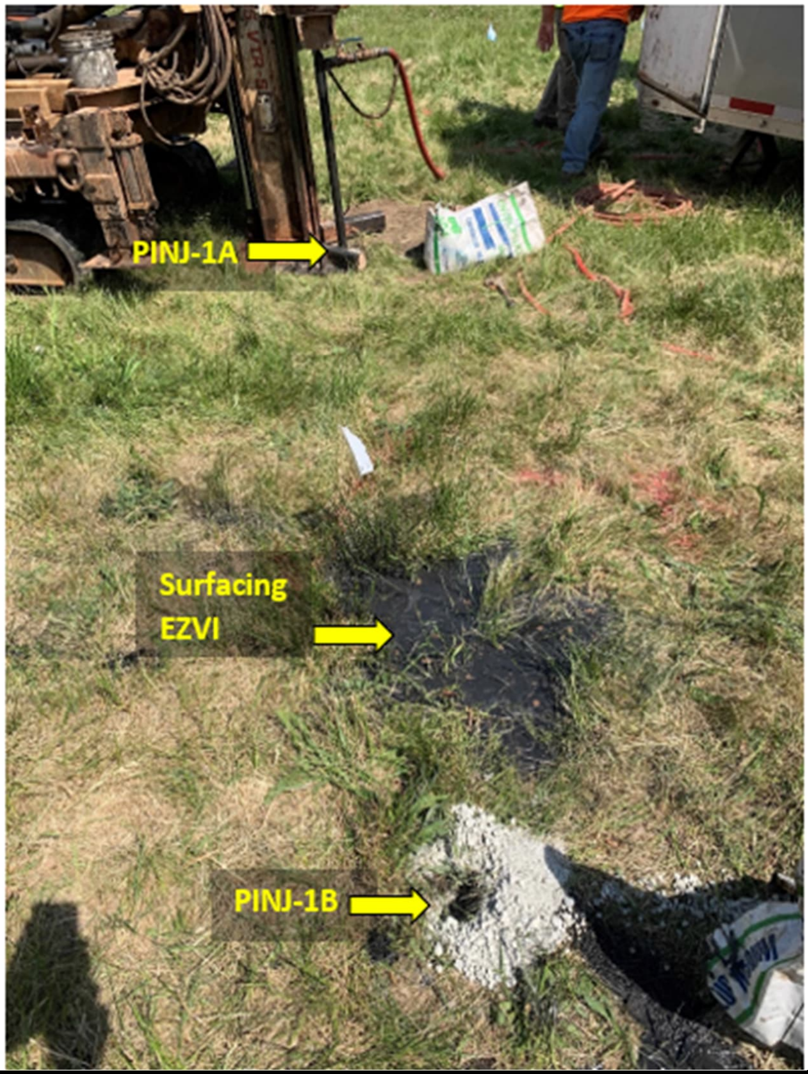
CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 8	**Date:** 5/21/21

Description:
View facing west: Direct-push injection of EZVI at PINJ-1A after completing injection locations PINJ-1E, -D, -C, and -B. Injection location PINJ-1D is shown with the direct-push tooling still in the ground and with the injection port plugged to prevent short-circuiting of EZVI. Slight surfacing of EZVI was observed at the location of an apparent historic boring located near PINJ-1D. Black staining in the foreground is similarly due to EZVI surfacing through an apparent historic boring located near the location of PINJ-1B (not shown).

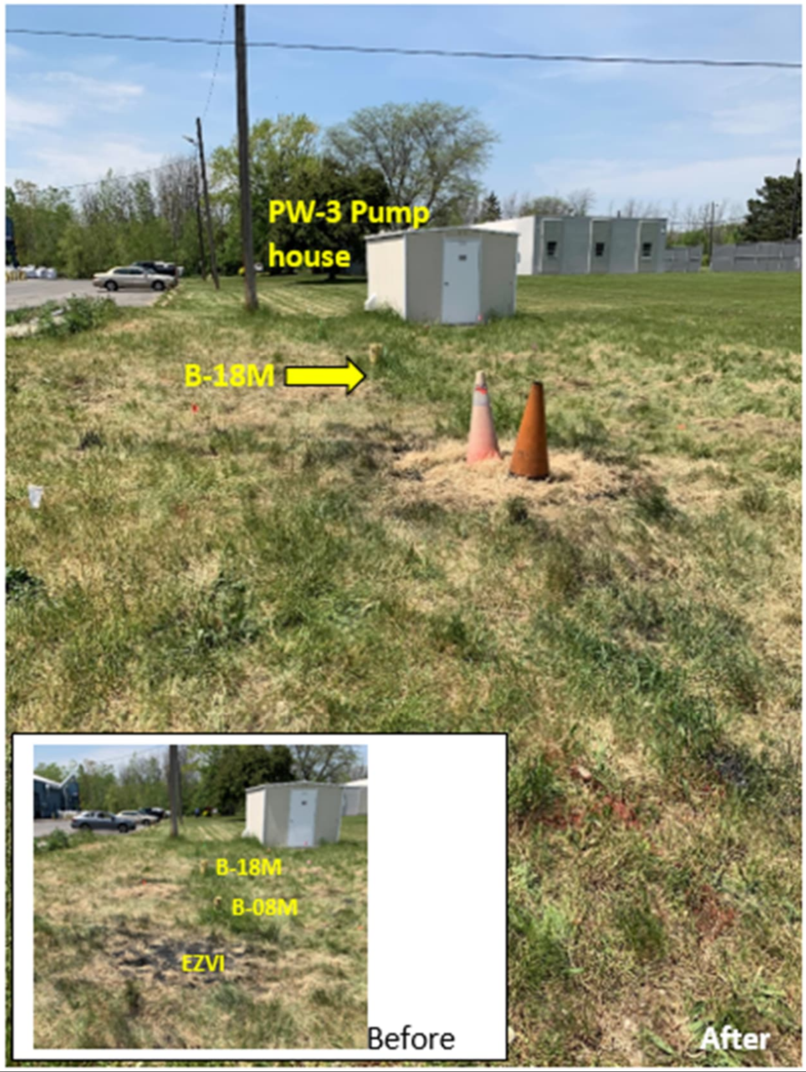


AECOM 257 West Genesee Street Suite 400 Buffalo, NY 14202		**PHOTOGRAPHIC DOCUMENTATION**
CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 9	**Date:** 5/21/21	
Description: View facing north - mild surfacing of EZVI and groundwater (~3 gallons) was observed at an apparent historic boring located adjacent injection location PINJ-1B. Note that no surfacing had previously occurred during the injection of EZVI at PINJ-1B, located only two feet from the apparent historic boring location. Also, no surfacing occurred at PINJ-1B – which had been backfilled with compacted bentonite crumbles – during the injection of EZVI at PINJ-1A.		

AECOM 257 West Genesee Street Suite 400 Buffalo, NY 14202	**PHOTOGRAPHIC DOCUMENTATION**	
CLIENT NAME: Elm Holdings	**PROJECT NAME:** IPO: Sanborn	**AECOM PROJECT:** 60481767

Photo No. 10	**Date:** 5/21/21
Description: Facing west – site restoration. The area of surfacing EZVI was backfilled with bentonite crumbles, covered with mown grass, and demarcated by traffic cones pending the setting of the bentonite.	



Appendix C

EIT Injection Report

Innovative Environmental Technologies, Inc.

Technology Discussion and Field Report

To

AECOM

For

The Pilot Scale Application Of

"In-Situ Reductive Dechlorination of Soil and Groundwater via Emulsified Zero Valent Iron (EZVI)"

At

Former Carborundum
Sanborn, NY

May 2021

Innovative Environmental Technologies, Inc.
6071 Easton Road
Pipersville, PA 18947
(888) 721-8283
www.iet-inc.net

Pipersville, PA • Columbus, OH • Concord, NC

Contents

Executive Summary

On behalf of AECOM, Innovative Environmental Technologies, Inc. (IET) has prepared the following injection report. This report has been prepared to document remediation activities conducted at the site.

The injection program was implemented from May 18th to May 20th, 2021. The remedial approach included the completion of 7 soil borings prior to the injection of emulsified zero valent iron (EZVI) in order to address chlorinated volatile organic compound (CVOC) impacts defined at the subject site. Two pilot areas were defined by AECOM. These areas were identified as follows: Pilot Area B-8M and Pilot Area P-4.

The design volume of prescribed EZVI was introduced throughout the treatment areas. Slight field modifications regarding injection depths were implemented due to the undulating nature of competent bedrock within the two areas identified during the pre-injection soil sampling program. Daylighting of remedial material was encountered at one location within the B-8M pilot area (PINJ-1A) from an old borehole present within the targeted area where approximately 3-4 gallons of EZVI and water surfaced. The point-by-point dosages along with instances of surfacing are noted in the attached field logs.

Introduction

The Former Carborundum site located in Sanborn, New York was identified as having soils and groundwater impacted by the historical release of chlorinated solvents. The primary compound of concern was Trichloroethene (TCE). An injection program was proposed with a focus on the soil bedrock interface for the remediation of CVOC impacts within two pilot areas defined by AECOM.

Remediation Implementation

Injection Procedures

IET completed the 10 injection locations throughout the pilot areas. The "top-down" injection method was utilized at 7 of the locations due to the target zone being immediately above competent bedrock, three locations were injected using bottom-up retractable tooling due to clogging of top-down tooling and total depth to DPT refusal at those locations. Details regarding each injection attempt are provided in the field logs in the Appendix.

FIGURE 1: AMS DIRECT PUSH RIG

Direct-Push-Driven Perforated Rod Placement

A AMS DPT unit comparable to the one pictured in Figure 1, was utilized to drive the injection screen to depths ranging from 11 to 25 feet below ground surface (bgs). It is at these depths, that the likelihood exists of being in close proximity to the impacted zones that were identified during characterization of the site.

Subsurface Pathway Development

Compressed nitrogen was used to propel all injectants into the subsurface. Compressed nitrogen was first injected into the subsurface at approximately 100-175 pounds per square inch (psi) until a significant pressure drop was observed at the injection pressure vessel. The intent of this step is to open pathways in the subsurface for the injectants to follow. These pathways are believed to be those more permeable pathways along which CVOCs are more likely to have migrated, both in the vadose and saturated zones.

EZVI Injection

A predetermined volume of EZVI was immediately injected into the subsurface fractures and voids that were developed during the compressed nitrogen injection step.

Liquid Rinse

A small amount of water was injected to clear the injection lines of the injectant intermittently throughout the injection program.

Post Injection Line Purge

Compressed nitrogen was injected to clear the lines of all material and to force the remedial components further into the formation before moving to the next injection location.

Site Maps

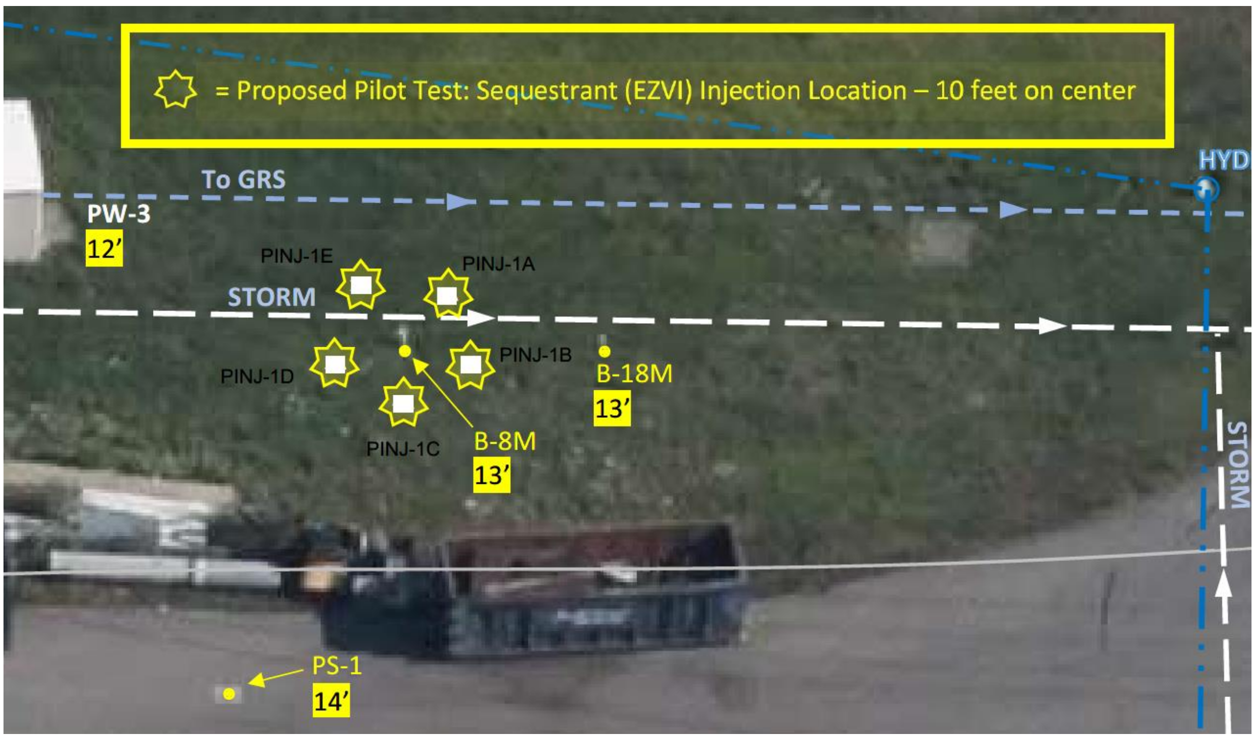


FIGURE 2: GENERAL INJECTION IMPLEMENTATION – INJECTION LOCATIONS B-8M

FIGURE 3: GENERAL INJECTION IMPLEMENTATION – INJECTION LOCATIONS P-4

Conclusion

The injection program at the Former Carborundum site was implemented based on the proposed design and was implemented with only minimal field modifications regarding injection depths. All proposed injectants were introduced at the targeted depths just above competent bedrock across the two pilot areas. It is expected that the injection event will yield positive results in these areas and IET looks forward the assessing the data following future sampling events.

Appendix A – Injection Logs

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: **AECOM - Former Carborundum**
B-8M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: **5/20/2021**

8:40

8:51

PINJ-1E

Injection Point Summary	Actual	Proposed
Target Injection Zone	9.5-11.5'	11-13'
Duration of Fracture (seconds):	2	3
Pressure of Pre-injection pathway development	100	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors:

Field Observations: 11.5' to bedrock

top-down tooling

pumped @ 40 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: **AECOM - Former Carborundum**
B-8M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: **5/20/2021**

8:53

9:05

PINJ-1D

Injection Point Summary	Actual	Proposed
Target Injection Zone	10-12'	11-13'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	100	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors:

Field Observations: Bedrock @ 12' bgs

pumped @ 40 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: **AECOM - Former Carborundum**
B-8M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: **5/20/2021**

9:24

9:42

PINJ-1C

Injection Point Summary	Actual	Proposed
Target Injection Zone	10-12'	11-13'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	100	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors:

Field Observations: Bedrock @ 12.0' bgs

Pumped @ 50 psi

Connected to old boring near PINJ-1D

during post injection clearing

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: AECOM - Former Carborundum
B-8M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: 5/20/2021

10:05

10:18

PINJ-1B

Injection Point Summary	Actual	Proposed
Target Injection Zone	9.5-11.5'	11-13'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	100	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors: ______

Field Observations: Bedrock @ 11.5' bgs

pumped at 40 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: **AECOM - Former Carborundum**
B-8M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: 5/20/2021

10:42, 10:59

10:55, 11:04

PINJ-1A

Injection Point Summary	Actual	Proposed
Target Injection Zone	9-11'	11-13'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	100	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors: ______________________

Field Observations: Bedrock @ 11' bgs, pumped @ 40 psi

Slight surface escape noted near PINJ-1B @ old boring

location, Stopped pump, let sit than finished injection

top-down tooling used

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: **AECOM - Former Carborundum**
B-8M Area

In-Situ Chemical Reduction using EZVI

Date of Injections: 5/20/2021

Injection Summary

	Injection Summary	
Injection Point Summary	Actual	Proposed
Target Injection Zone	9-12'	11-13'
Gallons of EZVI	235	235

Innovative Environmental Technologies, Inc.

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: AECOM - Former Carborundum
B-13M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: 5/19/2021

9:51

10:00

P-4 PINJ-1

Injection Point Summary	Actual	Proposed
Target Injection Zone	23-25'	21-23'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	175	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	100	50

Odors:

Field Observations: DPT refusal @ 25', re-drilled location due to soil clog

top-down tooling used

injected @ 40 psi

Innovative Environmental Technologies, Inc.

Job Name:	**AECOM - Former Carborundum**
	B-13M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: 5/19/2021

10:54

10:59

P-4 PINJ-2

Injection Point Summary	Actual	Proposed
Target Injection Zone	20-22'	21-23'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	175	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors: ______________________

Field Observations: Pre-drilled location, 3 attempts to successfully inject

(clay in rods), top-down tooling used

Injected @ 40 psi

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: AECOM - Former Carborundum
B-13M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: 5/19/2021

13:28

13:37

P-4 PINJ-3

Injection Point Summary	Actual	Proposed
Target Injection Zone	19-21'	21-23'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	175	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors:

Field Observations: Pre-drilled, 4 attempts (unsuccessful), switched to
retractable (bottom-up tooling), Injected @ 40 psi
rinsed 5 gallons water

Innovative Environmental Technologies, Inc.

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: AECOM - Former Carborundum
B-13M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: 5/19/2021

14:12

14:22

P-4 PINJ-4

Injection Point Summary	Actual	Proposed
Target Injection Zone	23-25'	21-23'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	150	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors:

Field Observations: DPT refusal @ 25.5'

Retractable tooling used

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: AECOM - Former Carborundum
B-13M Area

In-Situ Chemical Reduction using EZVI

Time:

Date of Injection: 5/19/2021

14:56

15:09

P-4 PINJ-5

Injection Point Summary	Actual	Proposed
Target Injection Zone	23-24'	21-23'
Duration of Fracture (seconds):	3	3
Pressure of Pre-injection pathway development	150	100
Estimated Radius of Influence	5	5
Gallons of EZVI	47	47
Pressure of Post-injection pathway dev.	50	50

Odors:

Field Observations: DPT refusal @ 25'

Retractable tooling used, 1' extension on screen

Innovative Environmental Technologies, Inc.

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: AECOM - Former Carborundum
B-13M Area

In-Situ Chemical Reduction using EZVI

Date of Injections: 5/19/2021

Injection Summary

	Injection Summary	
Injection Point Summary	**Actual**	**Proposed**
Target Injection Zone	19-25'	21-23'
Gallons of EZVI	235	235

INNOVATIVE ENVIRONMENTAL TECHNOLOGIES, INC.

Job Name: **AECOM - Former Carborundum**
Summary

In-Situ Chemical Reduction using EZVI

Date of Injections: **5/19, 5/20/2021**

Injection Summary

	Injection Summary	
Injection Point Summary	**Actual**	**Proposed**
Target Injection Zone	**9-25'**	**11-23'**
Gallons of EZVI	**470**	**470**