From: Fitzgerald, Conan <conan.fitzgerald@aecom.com>
Sent: Thursday, February 9, 2023 5:10 PM
To: Devlin, Cynde <devlincl@dhec.sc.gov>
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Subject: Revised On-Site Focused Feasibility Study - Delavan site

Cynde,

Attached please find the On-Site Focused Feasibility Study for the Delavan project site in Bamberg SC, revised per your comments dated December 1, 2022. Please contact me with any questions or comments. We can also assemble a hard copy if desired.

Concurrently we are preparing a work plan for the off-site Feasibility Study, which will propose some field data gathering activity, as well as the Groundwater report for the October 2022 monitoring event.

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February 7, 2023

Ms. Cynde L. Devlin, Project Manager
South Carolina Department of Health and Environmental Control
State Voluntary Cleanup Program
Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

Subject: Focused Feasibility Study and Response to Comments – Comment Letter dated December 1, 2022
Delavan Spray Technologies Site
Bamberg County
File #51778

Dear Ms. Devlin,

AECOM Technical Services of North Carolina, Inc. (AECOM), on behalf of Raytheon Technologies for Delavan Spray, LLC, is pleased to provide this On-Site Focused Feasibility Study to screen and evaluate remedial technologies for treatment of residual chlorinate volatile organic compounds (cVOCs) at the Delavan Spray Technologies Site (the Site). AECOM submitted an initial Feasibility Study to the South Carolina Department of Health and Environmental Control (SCDHEC) in November 2021 and SDHEC responded with comments in a letter dated December 1, 2022. In addition to the comments, the letter stated that off-Site groundwater contamination should be addressed in a separate Feasibility Study. As such, impacts to off-Site groundwater will be addressed in a separate Off-Site Focused Feasibility Study. Since additional data assessment needs have been identified, a work plan is being developed in the form of a Focused Feasibility Study Work Plan of off-Site areas. The attached On-Site Focused Feasibility Study was developed from the initial Feasibility Study and was revised based on the comments received in the December 1, 2022 letter. For ease of review, the comments from the aforementioned letter are included below along with AECOM responses in bold.

1. Table 2 (Comparison of Remedial Alternatives to Evaluate Criteria) should be revised to include a total score at the bottom of the table instead of an average score. Table 2 should also include a brief sentence or two for each criterion to justify the scoring.

AECOM Response: Scoring averages were replaced with scoring totals and a justification section was added for each criterion evaluation. See revised Table 2.

2. Revise the FS to include figures for each proposed remedial alternative. For example, figures for Alternative 2 would include the location of the proposed area of soil excavation, SSD system diagrams compared to soil contamination data and the location of extraction wells compared to groundwater contaminant concentrations.

AECOM Response: See additional details below:

- **Added Figure 13 to show conceptual layout of Remedial Alternative 2. The locations of the excavation areas are based on MIP data and unsaturated soil sample results (see Figure 7).**
- **Added Figure 14 to show conceptual layout of Remedial Alternative 3. The DPE well locations are based on MIP data, unsaturated soil sample results, saturated soil**

sample results, and elevated shallow groundwater impacts (see Figure 7, Figure 8, and Figure 9).

- **Added Figure 15 to show conceptual layout of Remedial Alternative 4. The ISCO injection well locations are based on MIP data, saturated soil sample results, and elevated shallow groundwater impacts (see Figure 8 and Figure 9).**
- **For Figures 13, 14, and 15, the SSD points cover the entire main facility building footprint due to potential vapor intrusion from impacted groundwater.**
- **Added Figure 16 to show conceptual layout of Remedial Alternative 5. SVE well locations represent the approximate as-built configuration. The AS/SVE well locations are based on MIP data, unsaturated soil sample results, saturated soil sample results, and elevated shallow groundwater impacts (see Figure 7, Figure 8, and Figure 9) and are intended to sufficiently eliminate impacts below the main facility building such that SSD is not necessary.**

3. Alternative descriptions in Section 8 (Evaluation of Remedial Technologies) should include more technology detail like that included in Section 7 where technologies are described in more detail.

AECOM Response: Additional details were added to the first section of each alternative under Section 8.2.

4. Section 8.2.1 (Detailed Analysis Alternative 1) should be revised to remove text related to natural attenuation. The No Action alternative is included as a baseline comparison only, so the assumption is that no remediation takes place. Including a discussion of natural attenuation is more appropriate for those alternatives that include monitored natural attenuation (MNA) as part of the remedy.

AECOM Response: Text related to natural attenuation was removed from Section 8.2.1.

5. Section 8.2.2.1 (Protection of Human Health and the Environment) describes how Alternative 2 would protect human health and the environment. The first paragraph states that soil excavation within the source area would remove a large portion of the source mass. The second paragraph states that a large portion of the elevated VOC impacts would remain in place. Please add clarification to this section regarding why a large mass would remain following excavation.

AECOM Response: Text added to Section 8.2.2.1 clarifying that the depth of an excavation would be limited by practical considerations (e.g., access, shoring logistics, dewatering, safety, and soil stability) and would not address all source mass within saturated soils.

6. Revise the FS to include a discussion of how the SVE system has operated as an interim action when describing Alternative 5.

AECOM Response: Text describing the SVE interim action performance since start-up was added to Section 8.2.5. Additionally, tables summarizing the SVE performance monitoring data were added as Appendix B.

7. Include estimated time frames to reach remedial goals for onsite source area contamination and offsite groundwater contamination in the Detailed Analysis section for comparison purposes.

AECOM Response: Estimated time frames of active remediation and MNA to reach on-Site remedial goals were added to the implementability section for each alternative under Section 8.2. Estimated durations of active remediation on-Site were also added to Table 3. Off-Site groundwater will be addressed in a separate Off-Site Focused Feasibility Study.

8. Revise the FS to include a discussion of long-term treatment, maintenance, and current contamination levels of impacted residential wells. Include a map showing the residential wells in relation to the groundwater contaminant plume.

AECOM Response: The impacted residential wells are discussed in Sections 3.2, 3.3 and their current contamination levels are discussed in Sections 5.3. Figure 11 has been revised to show all off-Site detections along with the PCE groundwater plume in the limestone aquifer. However, off-Site groundwater and long-term treatment and maintenance of the residential well systems will be addressed in a separate Off-Site Focused Feasibility Study.

9. Table 1 (Remedial Goals for Site Specific Chlorinated VOCs) should be revised to include toluene. Toluene has been routinely detected in groundwater at the site.

AECOM Response: Toluene and it's respective MCL and maximum detected concentration were added to Table 1.

10. Section 9.0 (Remedial Alternative Selection) should be removed. A preferred alternative recommendation may be included in the cover letter to the FS; however, the FS cannot include a recommendation for a specific alternative.

AECOM Response: Removed section discussing Remedial Alternative recommendation.

11. MNA is not considered an active remediation technology and should be included as a polishing step following an active remediation alternative. The FS should be revised accordingly.

AECOM Response: The description of MNA was revised accordingly.

12. The Overall Protection of Human Health criteria evaluation for each alternative should include more detail. The criteria include consideration for the way the alternative protects human health and the environment based on the way site-related risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

AECOM Response: Additional details were added to each alternative explaining how the described technologies protects human health and the environment.

13. Please revise Section 8.1 (Evaluation Criteria) of the FS to change ALARs to Applicable or Relevant and Appropriate Requirements (ARAR).

AECOM Response: ALAR replaced with ARAR throughout report.

14. The Short-Term Effectiveness criteria evaluation for each alternative should be more detailed to include the risk the alternative poses to on-site workers, the surrounding community, or the environment during implementation as well as the length of time needed to implement the alternative.

AECOM Response: Additional details were added to the Short-Term Effectiveness section for each remedial alternative.

15. Criteria evaluation for the Reduction of Toxicity, Mobility, or Volume through Treatment should include more detail when compared to other technologies with regard to the degree to which each alternative employs treatment to reduce the harmful effects of contaminants, their ability to move in the environment and the amount of contamination present.

AECOM Response: Additional details were added to the Reduction of Toxicity, Mobility, and Volume for each remedial alternative.

If there are any questions or concerns regarding this report, please contact Conan Fitzgerald at (919) 461-1260.

Sincerely,

Conan Fitzgerald, PE
AECOM Engineering Manager
conan.fitzgerald@aecom.com

Attachments: 1. On-Site Focused Feasibility Study

cc: Cynde L. Devlin - South Carolina Department of Health and Environmental Control
Paul DiNardo - Raytheon Technologies Corporation
Todd McLeod - Delavan Spray Technologies
Project File: 60314964\60656814\60681452

AECOM

On-Site Focused Feasibility Study

Delavan Spray Technologies Site

4334 Main Highway
US Highway 301 South
Bamberg, South Carolina

VCC 13-4762-RP

Prepared by:
AECOM Technical Services, Inc.
5438 Wade Park Boulevard, Suite 200
Raleigh, North Carolina 27607

February 2023

Delivering a better world

ON-SITE FOCUSED FEASIBILITY STUDY

DELAVAN SPRAY TECHNOLOGIES SITE
BAMBERG, SOUTH CAROLINA

RESPONSIBILITY PARTY VOLUNTARY CLEANUP CONTRACT NUMBER 13-4762

The undersigned certify that they have reviewed the attached document and that the document is in material compliance with the guidelines and requirements of the State of South Carolina and the South Carolina Department of Health and Environmental Control (SCDHEC) and specifically, requirements under the SCDHEC Voluntary Cleanup Contract (VCC). The data presentations contained herein are consistent with generally accepted practices in the environmental profession.

Prepared by:

Conan Fitzgerald, PE
AECOM Engineering Manager

February 7, 2023
Date

Ian J. Ros, PE
AECOM Remediation Engineer

February 7, 2023
Date

Reviewed by:

Caleb Krouse, PE
South Carolina PE No. 29910
AECOM Senior Environmental Engineer

February 7, 2023
Date

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1.0 INTRODUCTION

AECOM Technical Services, Inc. (AECOM) has prepared this On-Site Focused Feasibility Study for the Delavan Spray Technologies Site (the Site) to screen and evaluate remedial technologies for treatment of on-Site residual chlorinated volatile organic compounds (cVOCs). The On-Site Focused Feasibility Study is being submitted in accordance with the Voluntary Cleanup Contract (VCC) (VCC 13-4762-RP) signed by the South Carolina Department of Health and Environmental Control (SCDHEC) and Delavan Spray, LLC in July 2013. Impacts to off-Site groundwater will be addressed in a separate Off-Site Focused Feasibility Study.

2.0 SITE DESCRIPTION

The Site is located at 4334 Main Highway in Bamberg, South Carolina (**Figure 1**). The Site is comprised of a main manufacturing building and smaller associated support buildings, which are located on approximately 20 acres (**Figure 2**). A chain-link fence surrounds the operational portion of the Site and an old family cemetery is located within a small, discrete portion of the 20-acre Site.

An unnamed creek flows through the area immediately north and northwest of the Site and enters Halfmoon Branch approximately 300 feet (ft) west of the Site. The City of Bamberg wastewater treatment plant (WWTP) is located to the northwest beyond the creek and approximately 500 ft from the Site perimeter, with its surrounding spray infiltration fields extending to within approximately 200 ft of the Site. Properties to the northeast across Log Branch Road consist of residential properties and the County of Bamberg Rhodes Senior Center. Properties to east and southeast across Main Highway (US Highway 301 South) include a propane distribution facility, Jeff's Auto Care, and a sparsely populated residential area. Remaining properties to the south across Main Highway are undeveloped and used for silviculture. Properties to the southwest consist of a sparsely populated residential area, a junk yard, and a machinery shop (**Figure 2**).

Surrounding properties are under either Bamberg County or City of Bamberg zoning. The Site and the commercial businesses to the east of the Site (propane distribution facility and Jeff's Auto Body) are zoned Industrial by Bamberg County. Properties to the northeast, east, southeast, south, and southwest are zoned by Bamberg County as Rural District. The Bamberg WWTP facilities and spray fields to the west and northwest of the Site are zoned by the City of Bamberg as Industrial. Properties to the north of the Site are zoned R-15 (residential) by the City of Bamberg (Hart & Hickman, August 1, 2013).

3.0 SITE HISTORY

The following sections provide a summary of historical Site operations, investigation activities, and remediation activities.

3.1 Site Operations History

The Site was developed by Delavan Spray Technologies from previously undeveloped land for the manufacture of fuel metering equipment and spray nozzles in the late 1960s to early 1970s. The Site has been used for manufacturing of fuel metering equipment and spray nozzles from the early 1970s to present by various entities including Delavan Corporation (early 1970s to 1984), Delavan, Inc. (1984 to 2002), and Delavan Spray, LLC (2002 to present). During its ownership and operations, Delavan Spray, LLC has operated the business as Delavan Spray Technologies and continues to operate the facility for the manufacturing of several types of metal spray nozzles for fuel oils.

The property (**Figure 2**) contains an approximate 50,000 square foot (sf) manufacturing building, a storage warehouse, a virgin material and hazardous waste storage building (oil shed), aboveground storage tank (AST) containment areas, a maintenance building, and a combustion lab. The manufacturing building was constructed between approximately 1969 and 1973. A wastewater pre-treatment plant was constructed in the mid-1980s to treat plant mop water and wastewater generated in an acid dip operation (used to de-bur spray nozzles). The pre-treatment plant has since been decommissioned and all associated equipment removed from the Site.

Chlorinated solvents were reportedly utilized at the Site from the early 1970s until 2002. Delavan Spray Technologies personnel indicated that tetrachloroethene (PCE) was historically stored in a 750-gallon underground storage tank (UST) that was located along the southern side of the manufacturing building (**Figure 2**). The PCE UST was reportedly closed by removal from the ground sometime in the 1970s. PCE was also historically stored in ASTs (a 1,000-gallon virgin PCE AST and a 2,000-gallon used PCE AST) in a concrete secondary containment area located along the southeast corner of the manufacturing building. According to facility personnel, the ASTs were removed from the containment area in 2002. No specific release incidents are reported to have occurred at the Site.

3.2 Previous Investigations

Multiple phases of environmental assessments have been performed at the Site to characterize the subsurface geology and groundwater quality since December 2002. Previous reports submitted to SCDHEC to document these investigations have included, but are not limited to, the following:

- *Ground Water Assessment Report,* Hart & Hickman, August 29, 2003
- *Report of HRC Injection and Pre- and Post-Injection Ground Water Monitoring,* Hart & Hickman, January 31, 2006
- *Supplemental Site Assessment Report,* Hart & Hickman, December 5, 2012
- *Remedial Investigation Report*, AECOM, July 3, 2014

- *Post Remedial Investigation Report*, AECOM, May 17, 2016
- *Groundwater Delineation Report,* AECOM, June 23, 2017
- *Residential Sampling Activities and Results*, AECOM, February 15 and June 4, 2018
- *Fall 2019 Residential Sampling Activities and Results,* AECOM, February 21, 2020
- *Deep Groundwater Delineation Technical Memorandum,* AECOM, June 10, 2020
- *Fall 2020 Residential Sampling Activities and Results,* AECOM, March 5, 2021
- *High-Resolution Source Characterization Report,* AECOM, March 9, 2021

Following the *Post Remedial Investigation Report* (AECOM, May 17, 2016), SCDHEC requested a work plan to delineate Site related constituents of concern (COCs) in the shallow (surficial) and deep (limestone) groundwater beneath the Site. The *Groundwater Delineation Work Plan* (AECOM, September 13, 2016), which included groundwater screening with temporary wells and permanent monitoring well installation, was approved by SCDHEC in correspondence dated October 31, 2016, and was implemented between March 27, 2017 and May 10, 2017. The results of the investigation, which are documented in the *Groundwater Delineation Report* (AECOM, June 23, 2017), confirmed the presence of PCE at concentrations greater than the United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) in the limestone aquifer monitoring wells located approximately 3,200 ft south/southwest of the Site. SCDHEC approved the *Groundwater Delineation Report* in correspondence dated June 26, 2017 and agreed with the report's recommendation that additional delineation was needed for PCE in the limestone aquifer south/southwest of the monitoring well network.

Regular sampling and analysis of Site monitoring wells has been conducted at the Site since 2003. Semi-annual groundwater sampling and reporting has occurred each spring and fall since October 2014. In accordance with SCDHEC directives, a formal groundwater quality monitoring program was established for the Site in 2017 and is currently being performed on a semiannual basis. The analytical results are evaluated and submitted to SCDHEC as spring and fall semi-annual groundwater monitoring reports, respectively, and include tables of available historical groundwater data. The most recently submitted report was the *Spring 2022 Semi-Annual Groundwater Monitoring Report* (AECOM, July 28, 2022), which documents groundwater monitoring performed in April 2022.

In correspondence dated December 18, 2017, SCDHEC requested the sampling of select private residential water supply wells along Lemon Creek and Orange Grove Roads. Subsequently, residential well sampling activities were conducted and documented in two separate technical memoranda submitted to SCDHEC on February 15, 2018 and June 4, 2018. In nine of the 27 residential well samples collected between January 4, 2018 and April 19, 2019, PCE was detected at trace levels below the respective MCL. Eight of the residential wells with PCE detections are used for drinking water and one is used for irrigation water for a pond. PCE was not detected in the remaining residential well samples (AECOM, February 15, 2018, and June 4, 2018). During subsequent monitoring, PCE was detected in two additional wells, also well below the MCL. As discussed further in **Section 3.3**, granular activated carbon (GAC) treatment systems were installed at each of the residential wells where PCE was detected (with the concurrence of the property owners). As documented in correspondence from SCHDEC dated June 27, 2018, it was agreed that the impacted private wells would be resampled during the 2018 sampling event and annually thereafter. PCE concentrations below the MCL were detected in two additional properties during the fall 2018 sampling event. Additionally, a well that did not have a working pump on previous sampling visits was sampled in April 2019 which exhibited a PCE concentration below the MCL. In total, PCE has been detected above the laboratory detection limit but below the MCL in 11 of the 27 residential water supply wells sampled. In accordance with SCDHEC's annual sampling request, the impacted water supply wells were again sampled in October 2019 and October 2020. Results for those sampling events were documented in technical memoranda submitted to SCDHEC on February 21, 2020 and March 5, 2021. Remedial activities performed for the residential wells are further discussed in **Section 3.3.**

The *Limestone Aquifer Assessment Work Plan* (AECOM, October 13, 2017) was implemented in November 2019 and results were documented in the *Deep Groundwater Delineation Technical Memorandum* (AECOM, June 10, 2020). Surface water sampling results determined that PCE impacted groundwater in the limestone aquifer discharged to Lemon Creek and/or the lower reaches of Half Moon Branch limiting further migration in the limestone aquifer. Furthermore, PCE concentrations in groundwater decreased below the detection limit before reaching monitoring wells approximately 6,500 ft south (downgradient) of the Delavan Spray Technologies facility. A map showing the extent of monitoring wells installed for all assessments performed at the Site is provided in **Figure 3**.

In July 2020, AECOM performed a High-Resolution Source Characterization (HRSC) at the Site to further assess the elevated concentrations of cVOCs that have previously been detected in residual source areas beneath and adjacent to the manufacturing facility. Specifically, these residual source areas included the two former PCE degreasers, the former PCE AST secondary containment area, and the former PCE UST location. The purpose of the HRSC was to identify the subsurface locations where the highest concentrations of cVOCs reside and obtain subsurface permeability information in those locations to gain a better understanding of the zones of high and low contaminant mass flux and potential transport pathways. The HRSC activities included a membrane interface hydraulic profiling tool (MiHPT) investigation, the collection of soil and groundwater samples using direct push technology (DPT), as well as the installation of one permanent monitoring well. The MiHPT and DPT boring locations were chosen to address data gaps in understanding the vertical and horizontal extent of the cVOC plume in addition to further characterizing the hydrogeology of the Site. The results from the HRSC concluded that the highest concentrations of PCE in the unsaturated zone were in the immediate vicinity of the former PCE degreaser, located in the northern portion of the facility, which impacted shallow groundwater and may also contribute to groundwater impacts in the limestone aquifer. The highest concentrations of PCE in the saturated zone were in the immediate vicinity of the former PCE UST area which likely contributes to groundwater impacts in the limestone aquifer. The results also concluded that soils in the shallow aquifer exhibited low to moderate permeability and hydraulic conductivity, while the limestone aquifer exhibited high permeability, with estimated hydraulic conductivity values exceeding 75 feet per day (ft/day). The results of the investigation were submitted to SCDHEC in the *High-Resolution Source Characterization Report* (AECOM, March 9, 2021). HRSC investigation results are discussed further in **Section 5**.

3.3 Previous Remediation Activities

In 2005, Hart & Hickman, PC (H&H) injected Hydrogen Release Compound® (HRC) into shallow groundwater at three locations to stimulate natural biodegradation of chlorinated compounds in groundwater (H&H, January 31, 2006). The injections occurred near MW-1 (near the former PCE AST secondary containment area), MW-9 (outside of the northeastern corner of the developed portion of the facility), and MW-10 (located in the woods north of the facility). It should be noted that the injection areas near MW-9 and MW-10 are not known to be release points for PCE and are not considered source areas. However, the injection area near MW-1 is adjacent to the source areas discussed further in **Section 5.1**.

Post-injection monitoring was conducted by H&H between 2005 and 2007. Concentrations of PCE have decreased in monitoring wells located near the HRC injections, but it is doubtful that these decreases are attributed to injection activities. Geochemical conditions were not affected by the HRC injection and the rate of decrease of PCE is relatively slow. It is, therefore, likely that decreases in PCE at these locations are due to natural attenuation processes such as dilution and dispersion. Groundwater VOCs at these locations remain at concentrations exceeding the MCL.

As discussed in **Section 3.2**, PCE has been detected above the laboratory detection limit but below the MCL in 11 residential water supply wells located southwest of the Site. Although the PCE detections in the residential wells were well below the MCL, installation of GAC treatment units was proposed at no cost to the residents whose drinking water wells had detections of PCE. All 11 residential property owners with wells exhibiting PCE detections that were also used for drinking water elected to have the GAC units installed. The GAC treatment units were installed in July 2018 and October 2019. Technical memorandums documenting the installation of GAC treatment systems were submitted to SCDHEC on January 15, 2019 and February 21, 2020. Following installation, AECOM performed annual sampling of the residential wells with GAC systems installed as well as performed routine maintenance of the systems. The results from the annual sampling have concluded that no detections were found in post-treatment (after GAC system) samples, confirming that the GAC systems are performing as intended. The residential well sampling results are discussed further in **Section 5.3**.

A call was held with SCDHEC on June 1, 2021 to discuss interim measures to address soil impacts at the Site. Subsequent to this call, an *Interim Removal Action Work Plan* (AECOM, June 18, 2021), for installation of a soil vapor extraction (SVE) system beneath the main manufacturing building was submitted and was approved by SCDHEC in correspondence dated June 28, 2021. Implementation of the SVE interim measure began in August 2021 and the SVE system was activated in June 2022. Additional details of the SVE system construction and installation were provided in the *Construction Completion Report* submitted on August 11, 2022 (AECOM, August 11, 2022). Additional details of the SVE system performance are discussed in **Section 8.2.5.**

4.0 GEOLOGICAL SETTING

4.1 Regional Setting

The Site lies within the western portion of the South Carolina Coastal Plain Province, which is characterized as a seaward thickening wedge of sediments from the fall line to the coast. These sediments consist of sands, silts, clays and limestones; representing a variety of non-marine and marine depositional environments. Changes in depositional environment are due, in part, to changes in sea level. During transgression (rising sea level), sedimentary units tend to fine upward. During regression (falling sea level) sedimentary units tend to coarsen upward. During periods of regression, sediments can be left exposed and subject to erosion. The resulting geologic complexity can make it challenging to correlate geologic units over long distances (Logan and Euler, 1989).

The surficial geologic units that have been identified in the Bamberg County area of South Carolina include the Huber/Lisbon/Barnwell Formations of Eocene age, the Duplin Formation of Pliocene age, and the Penholoway Formation of Pleistocene age. The undifferentiated sands and clays in that occur in the vicinity of the Delavan Spray Technologies Site are likely Pliocene in age and are assigned to the Duplin Formation (Willoughby and others, 2005).

The Santee Limestone (of middle Eocene age) underlies the Site at depths of approximately 12 to 20 ft. The Santee Limestone is used extensively in the southeastern part of the Coastal Plain as a groundwater resource for private, municipal, and industrial use. Often, the limestone is not confined and is hydraulically connected to underlying and overlying units. In these cases, the units are often referred to as the Floridan or Tertiary Limestone Aquifer system (Logan and Euler, 1989).

Bamberg County and thus, the Site, lie within the Ashepoo, Combahee and Edisto (ACE) River Basin of South Carolina. The ACE Basin is drained by the Ashley-Cooper, Combahee-Coosawhatchie, and Edisto rivers. The Town of Bamberg is located at the junction between the Salkehatchie River and Edisto River watersheds, with the South Fork Edisto River being the closest major river to the Site, located approximately four miles to the northeast.

Groundwater occurrence in the Coastal Plain is typically within the intergranular pore spaces of the sands, silts, and limestones (primary porosity) and within solution cavities or fractures of indurated sediments (secondary porosity). Primary production of groundwater occurs from within the more permeable units, while lower permeability clay layers typically retard groundwater movement. Recharge for significant aquifers in the Coastal Plain occurs both as transport from up-dip areas toward the Fall Line, where the sediments are generally exposed at the land surface, and as leakage from adjacent aquifer units through the aquitards.

Groundwater flow in deeper confined aquifer units is typically to the south and southeast toward the coast. Locally, the water-table surface can subtly mimic land surface topography, with recharge of shallow unconfined aquifers occurring from direct infiltration of precipitation in upland areas and discharge occurring within nearby creeks and streams.

4.2 Site Geology

For the purposes of characterization, Site geology has been subdivided into three general geologic zones by previous investigators. The upper zone consists of undifferentiated sands, clayey sands, sandy clays, and silts. In the northern portion of the Site, these sediments tend to contain a higher percentage of clay and silty layers. The middle zone consists of fossiliferous limestone; with a layer of pale yellow, poorly cemented, coarse shell fragments overlying a layer of white, poorly to moderately cemented limestone containing finer-grained shell fragments. The lower geologic zone has been described as a loose- to moderately cemented, calcareous, fine- to medium-grained clayey sandstone based on borings for monitoring wells MW-3D1 and MW-15D1 (H&H, August 1, 2013). However, this zone was not encountered during the limestone aquifer delineation downgradient (south) of the Site, where the white, cemented limestone and shell fragments were observed to become finer-grained and persist to a depth of at least 84 ft below ground surface. These relationships are illustrated in the cross-sections provided in **Figure 4**.

4.3 Site Hydrogeology

Groundwater occurrence in the Coastal Plain is typically within the intergranular pore spaces of the sands, silts, and limestones (primary porosity) and within solution cavities or fractures of indurated sediments (secondary porosity). Primary production of groundwater occurs from within the more permeable units, while lower permeability clay layers typically retard groundwater movement. Recharge for significant aquifers in the Coastal Plain occurs both as transport from up-dip areas, toward the Fall Line, where the sediments are generally exposed at the land surface and as leakage from adjacent aquifer units through lower permeability aquitards.

The most recent groundwater elevation data for the Site are based on water levels measured in April 2022 and documented in the *Spring 2022 Semi-Annual Groundwater Monitoring Report* (AECOM, July 28, 2022). A potentiometric map of the water-table surface based on data for monitoring wells completed in the shallow aquifer zone was included in the referenced report. A copy of the shallow potentiometric map is attached to this On-Site Focused Feasibility Study as **Figure 5**. The spring 2022 water levels within the shallow aquifer zone occurred between 134.12 and 140.94 ft in elevation. Shallow flow patterns inferred from the Spring 2022 water level measurements were 1.64 ft higher, on average, than those collected during the Fall 2021 groundwater monitoring event (October 2021) and 0.29 ft lower, on average, than those collected during the Spring 2021 groundwater monitoring event (April 2021). However, shallow groundwater flow remained consistent with previously observed patterns at the Site. A phenomenon previously recognized in the RI Work Plan (H&H, August 1, 2013) and characterized as a “groundwater trough”, has been observed to extend to MW-6 and MW-20 during previous field investigation efforts. The variances in groundwater elevation and flow directions in this portion of the Site could be the result of preferential flow pathways resulting from higher permeability zones due to local facies changes or induced drainage from the sanitary sewer line or incised drainage ditch, which forms the northern boundary of the facility. However, the primary shallow horizontal groundwater flow direction is inferred to be toward the west, toward Halfmoon Branch, which is consistent with findings from previous investigations conducted at the Site. The wells west of the facility have historically indicated an isolated groundwater mound at MW-27, which has been observed intermittently during previous groundwater monitoring events.

Based on the April 2022 water level elevations within the deeper limestone aquifer zone, the potentiometric surface occurred between 128.56 and 135.58 ft in elevation. A copy of the deep potentiometric map is attached to this On-Site Focused Feasibility Study as **Figure 6**. From the equal potential lines, the inferred horizontal groundwater flow direction is to the south-southwest which is consistent with regional topography, drainage, and results from previous investigations conducted at the Site.

Vertical gradients between the shallow aquifer and deeper limestone aquifer are typically downward for most well pairs and ranged from 2.17E-02 feet per foot (ft/ft) at MW-3/MW-3D to 1.24E-01 ft/ft at MW-9/MW-9D in April 2022. For the deeper limestone aquifer to sandstone aquifer well pair (MW-3D/MW-3D1), the gradient was upward at -2.99E-0 ft/ft. Upward gradients are generally evident in the vicinity of Halfmoon Branch (i.e., at MW-15/MW-15D), indicating groundwater discharge to surface water.

Slug tests have been used to estimate the horizontal hydraulic conductivity of the uppermost aquifer units beneath the Site. Slug tests were performed in shallow monitoring wells MW-27, MW-28, and MW-29 and deeper monitoring wells MW-30D, MW-31D, and MW-32DR to evaluate hydrologic properties of the aquifer units (AECOM, June 14, 2017). The estimated horizontal hydraulic conductivity values calculated for the shallow monitoring wells ranged from 0.215 ft/day in MW-28 to 0.701 ft/day in MW-29, with a geometric mean of 0.355 ft/day. The estimated horizontal hydraulic conductivity values for the deeper limestone aquifer monitoring wells ranged from 10.7 ft/day in MW-31D to 161 ft/day in MW-30D, with a geometric mean of 63.5 ft/day. These values were similar to those previously estimated for shallow and deeper aquifer wells in the Site vicinity. Slug tests have also been performed in limestone monitoring wells MW-33D, MW-34D, MW-35D, and MW-36D to evaluate hydrologic properties of the limestone aquifer. The estimated horizontal hydraulic conductivity values from these limestone aquifer monitoring wells ranged from 45.22 ft/day in MW-33D to 121.6 ft/day in MW-36D, with a geometric mean of 85.57 ft/day. These values are within the range of those previously estimated for deeper aquifer wells in the Site vicinity (AECOM, June 23, 2017).

5.0 SUMMARY OF CONCEPTUAL SITE MODEL

A conceptual site model (CSM) has been developed based on available investigation results to provide a technical basis for the identification, evaluation, and selection of remedial alternatives. The following sections present key components of the CSM.

5.1 Contaminant Source Areas

Elevated cVOC impacts have been identified in unsaturated and saturated soils beneath the locations of the former northern PCE degreaser and the former PCE UST. Lesser soil and groundwater cVOC impacts are also present at the former PCE AST and secondary containment area. The former northern PCE degreaser source area is located beneath the concrete slab floor of the main manufacturing building, and the former PCE UST source area, is located along the front of the main manufacturing building to the south. RI soil samples indicated the presence of cVOC impacts in these areas which were later confirmed during the HRSC investigation. **Figure 7** shows the maximum PCE and trichloroethylene (TCE) concentrations, as well as peak membrane interface probe (MIP) halogen-specific detector (XSD) responses in unsaturated soils (0 to 15 ft) underneath the main manufacturing building. **Figure 8** shows the maximum PCE and TCE concentrations, as well as peak MIP XSD responses in saturated soils (16 to 35 ft) underneath the main manufacturing building. Additionally, groundwater cVOC concentrations in these areas represent the highest concentrations at the Site. **Figure 9** shows the most recent (April 2022) results for PCE concentrations in shallow aquifer groundwater at the Site and **Figure 10** shows the most recent (April 2022) results for PCE concentrations in the limestone aquifer groundwater at the Site.

In summary, Site investigations have delineated the cVOC source areas at the Site within the manufacturing building footprint and directly adjacent to the building footprint near the southeast corner of the building. As shown on **Figure 9**, these areas exhibit elevated dissolved concentrations contained within a relatively small sub-section of the overall Site plume. In addition to the dissolved concentrations shown these areas exhibit elevated concentrations in unsaturated and saturated soil as shown in **Figure 7** and **Figure 8**. Based on the elevated dissolved-phase concentrations and presence of adsorbed cVOC mass in soil, these areas likely continue to represent the majority of cVOC mass present in the subsurface. Importantly, the areas also contain the cVOC source mass that contributes to the downgradient dissolved phase plumes within shallow groundwater (generally traveling west as shown on **Figure 9**) and the deeper limestone aquifer (generally traveling southwest as shown on **Figure 10**).

5.2 Constituents of Concern, Potential Receptors and Exposure Pathways

A *Baseline Risk Assessment (BRA)* was performed as part of the Remedial Investigation (RI) to evaluate risks to human health and the environment under current and likely future exposure scenarios (AECOM, July 3, 2014). The Human Health Risk Assessment (HHRA) portion of the BRA was completed to evaluate chemicals detected in Site-related media, including groundwater, soil vapor, surface and subsurface soils, and surface water. Potential risks to human health under current and future land use scenarios were quantitatively evaluated. As the current receptor, an industrial worker was evaluated and was assumed to come in contact with cVOCs in soil vapor via vapor intrusion to indoor air. As potential future receptors, an industrial worker, a construction worker, and residents (adult and child) assumed to live on the Site and off the Site were evaluated. The industrial worker was assumed to be exposed to cVOCs in soil vapor via vapor intrusion to indoor air and the construction worker was assumed to be exposed to subsurface soil. Both the potential future on-Site and potential future off-Site resident were evaluated based on exposure to groundwater used as potable water, while the potential future on-Site resident was also evaluated for exposure to soil vapor via vapor intrusion. The HHRA determined that site conditions at the time did not pose a significant risk to on-Site workers that would necessitate remedial action, assuming the current commercial/industrial use of the property was maintained. However, human health COCs were identified in the HHRA based on the risk and hazard calculations. Human health COCs were identified for a hypothetical future on-Site resident and for an off-Site resident assumed to regularly consume and use groundwater. Five compounds exceeded their respective MCLs (chloroform, cis-1,2-dichloroethylene [DCE], methylene chloride, PCE, and TCE). PCE is the dominant COC and has therefore been selected as the surrogate compound for the purposes of assessment and treatment given its high concentrations in groundwater relative to the other COCs and its relatively low MCL of 5 micrograms per liter (μg/L). Additional details can be found in the *RI Report* (AECOM, July 3, 2014).

5.3 Migration Pathways

As discussed in **Section 5.1**, source areas of cVOC mass distributed across multiple phases, including adsorbed phase, dissolved phase, and vapor phase impacts, are present below and directly adjacent to the manufacturing building. Hydrogeologic information developed to date suggests that the primary pathway for dissolved phase cVOC migration from beneath these source areas is downward, into the more permeable limestone aquifer. From there, the transport is primarily horizontal within the more permeable limestone aquifer unit. Dissolved phase cVOCs are also migrating to a lesser extent within the shallow aquifer zone. CVOCs attenuate as they move through the limestone aquifer to the south and are not found to exceed the MCL either within or beyond the surface water features of Halfmoon Branch or Lemon Creek. Based on the most recent data, COC concentrations detected in private residential water supply wells remain below the MCLs. **Figure 11** illustrates the most recent occurrence of PCE in off-Site areas of the deeper limestone aquifer and downgradient private residential water supply wells.

As part of this On-Site Focused Feasibility Study, remedial actions will be evaluated that could be effective in addressing the following potential migration pathways for COCs:

- Leaching/dissolution of COCs from saturated and unsaturated zone source areas into dissolved and vapor phases on-Site, and
- Migration of dissolved COCs in shallow groundwater on-Site to the deeper limestone aquifer and off-Site locations.

This On-Site Focused Feasibility Study evaluates remedial technologies for treatment of on-Site impacts only. Impacts to off-Site groundwater will be addressed in a separate Off-Site Focused Feasibility Study.

6.0 IDENTIFICATION OF REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

This section describes the specific Remedial Action Objectives (RAOs) and Remedial Goals (RGs) for the contaminant source areas identified in **Section 5.1** based on the potential risks identified in the RI Report.

6.1 Target Media and Contaminants of Concern

This On-Site Focused Feasibility Study recognizes that there are no current or immediate risks to on-Site human receptors given the current property usage. Therefore, the objectives are to mitigate potential future risks and to address groundwater COC exceedances on-Site. The media that will be addressed through remedial actions include unsaturated zone subsurface soils, saturated zone subsurface soils, soil vapor, and groundwater of the shallow and limestone aquifers containing COCs. Specifically, active remediation should target the residual source areas of COCs within these zones that are impacting shallow groundwater and may continually contribute to groundwater impacts in the underlying limestone aquifer.

The primary site-specific compounds, or COCs, at the Site are PCE and PCE daughter products of degradation including TCE, cis-1,2- DCE, and vinyl chloride. These along with other compounds detected in groundwater, including 1,1,1-trichloroethane, 1,1-DCE, chloroform, methylene chloride, and toluene, collectively form the list of targeted COCs.

6.2 Remedial Action Objectives

RAOs can be divided into short-term and long-term objectives and are defined as the following:

- Short-term – Protection of human health and the environment by substantially reducing COC impacts in source areas where the most COC mass is present. Mitigating COC levels in these areas will minimize continued leaching to groundwater and reduce the future risk potential of direct exposure via vapor intrusion to on-Site workers.
- Long-term - Meet RGs for groundwater on-Site.

The bounds of the remedial action will be focused on the locations of the source areas at the former northern PCE degreaser and the former PCE UST area, as well as COC impacted shallow groundwater underneath the main manufacturing building at the Site. These locations were chosen due to the magnitude and persistence of COC impacts relative to the other areas at the Site which may continue to contribute mass to the dissolved groundwater plume in the shallow aquifer and deep limestone aquifer. The considered remedial alternative should include remedial technologies that are most capable of achieving the RAOs.

6.3 Remedial Goals

For the purposes of this On-Site Focused Feasibility Study, RGs are defined as numerical criteria for environmental media that, when exceeded, result in a violation of statutory regulations. For the State of South Carolina, the RGs are based on USEPA MCLs. **Table 1** presents the MCLs for the COCs in groundwater at the Site. The COCs include the site-specific compounds identified in the HHRA as well as additional site-specific compounds that were selected based on historical detections in groundwater at concentrations exceeding their respective MCLs. The considered remedial alternative should include remedial technologies that are most capable of achieving the RGs.

7.0 SCREENING OF REMEDIAL TECHNOLOGIES

Based on the class of COCs that are present at the Site, a list of applicable remedial technologies was developed as a preliminary screening step in the evaluation process.

Candidate technologies are screened based on the following criteria:

- Applicability and appropriateness to the Site
- Technical feasibility and implementability
- Relative cost

Applicability and appropriateness of a potential technology must consider the specific constituents present; the media; the nature, extent, and status of sources of contamination; the physical condition of the Site and surroundings; and the ability of the technology to achieve the stated RAOs.

Technical feasibility and implementability of a potential technology must consider steps and procedures required to implement the remedy; site-specific conditions (size, topography, current and future land use, drainage routes, surface conditions, and other permanent conditions); practicality; and probability of success. In assessing practicality and probability of success, the remedial approach performance history and implementation impacts to public welfare and the environment must also be considered.

Relative cost of a technology examines the expected level of expense required to implement the technology at the Site relative to the other remedial technologies. This is not a detailed cost estimate but, rather, a general judgment based on experience implementing the technology at similar sites.

The remedial technologies and respective applicable media that were evaluated as part of the preliminary screening process are summarized in the table below:

Remedial Technology	Media to be Treated
No Action	None
Institutional Controls (ICs)	None
Source Area Excavation	Unsaturated Soil
Monitored Natural Attenuation (MNA)	Groundwater
Sub-Slab Depressurization (SSD)	Soil Vapor
Soil Vapor Extraction (SVE)	Unsaturated Soil and Soil Vapor
Groundwater Capture and Recovery	Groundwater
Dual Phase Extraction (DPE)	Soil, Soil Vapor, and Groundwater

Remedial Technology	Media to be Treated
Air Sparging (AS)	Saturated Soil and Groundwater
In Situ Chemical Oxidation (ISCO)	Saturated Soil and Groundwater
Enhanced Reductive Dechlorination (ERD)	Saturated Soil and Groundwater

Technologies that meet all the three screening criteria were retained for incorporation into the remedial alternatives and evaluation.

7.1 No Action

No Action is included as a benchmark for the comparison of costs and benefits associated with other technologies.

7.2 Institutional Controls

ICs, in the form of land use restrictions imposed by a Declaration of Environmental Controls, have been implemented at the Site. The ICs were recorded on March 14, 2022 in the office of the Register of Deeds for Bamberg County. ICs are tools designed to protect human health, the environment, and to maintain the current and future integrity of the remedy at contaminated sites. The ICs are administrative and legal controls that minimize or eliminate the potential for human exposure to contamination and protect the integrity of a remedy. These are designed to work by limiting land and resource use at a site, and by providing guidance to help modify human behavior at a site. ICs that are implemented via deed restrictions offer greater risk control than local or regional zoning. ICs for the Site include, but are not limited to, the following:

1. Site property shall not be used for any purpose other than commercial or industrial uses that under applicable law do not require the Site property to meet environmental clean-up or remediation standards for residential uses. The Site property shall not be used for any of the following uses: single or multi-family residential, school, daycare, group home, nursing home, hospital, meeting hall, church or other place of congregation or worship, hotel, motel, or other type of lodging, playground or other recreational use or other residential use.

2. No surface or subsurface water at, on or under the Site property shall be used for consumption by humans or animals, irrigation or any other purpose that might bring it into contact, directly or indirectly, with humans or animals.

There is relatively minimal cost associated with the implementation of ICs. ICs are a technically feasible remedial alternative and have been implemented at the Site. However, the ICs for the Site do not address potential future risk to off-Site receptors.

7.3 Source Area Excavation

Excavation involves the physical removal of impacted source area soils for treatment and/or off-Site disposal. Excavation is an appropriate technology for the remediation of impacted soils. However, the implementation of this technology would be difficult and costly as it would involve access to the inside of the building with heavy equipment, opening the concrete slab floor, shoring, vertical excavation, and restoration. Currently, the building is an active manufacturing facility and access is limited due to many large/precision milling machines and other equipment. This equipment is in constant use and cannot be shut down or moved without disrupting product manufacturing. Costs to implement source area excavation are expected to be high and would involve a temporary shutdown of manufacturing operations, manufacturing equipment relocation, heavy equipment operations indoors, air monitoring, and manual labor. Due to the access limitations described above, the implementability of this option is very low. This technology, however, was retained for further evaluation.

7.4 Monitored Natural Attenuation

MNA is not considered an active remediation technology and is widely utilized as a polishing step following an active remediation alternative, or, as a stand-alone method at sites that pose a relatively low risk to human or ecological receptors. MNA involves tracking the natural degradation of contaminants without the introduction of foreign microorganisms, nutrients, oxygen, or mechanical enhancement. MNA is implemented by performing preliminary studies that determine the natural mechanisms resulting in degradation of target constituents. Periodic sampling is then performed to monitor actual degradation rates of target constituents. Natural attenuation is typically most effective for maintaining low and decreasing levels of COCs in groundwater.

MNA would be easily implemented at the Site at a relatively low cost as it would incorporate the existing monitoring well network and sampling and analysis costs are relatively low. However, community and regulatory acceptance could prevent implementation of MNA as a stand-alone remedy. This technology was retained for further evaluation.

7.5 Sub-Slab Depressurization

SSD is a form of vapor abatement used to remove volatile COCs in the subsurface. This process involves removal of the COCs entrained in soil vapor that has collected directly underneath the concrete slab floor via off-gassing from impacted soil and/or groundwater in order to reduce the risk of harmful vapors migrating to indoor air. To accomplish SSD, penetrations are generally made through the concrete slab floor and conveyance piping is installed and sealed to the floor. The conveyance piping can be connected to vertical vapor points or to gravel filled sumps installed beneath the concrete flooring. The piping is then connected to fans or blowers that create a negative pressure and remove the vapors. Modeling of anticipated cVOC loading in the air discharge would be performed to determine if the recovered vapors would need to be directed through a treatment process (e.g., granular activated carbon) or if permitting would be required to vent the vapors directly to the atmosphere.

Effective implementation would involve coring through the manufacturing facility’s concrete slab floor in multiple locations, installing PVC piping in short runs of saw-cut trenches to the nearest wall or column, and directing that piping up along those walls or columns to a common header. The header piping would be connected to fan(s) or blower(s) to create a partial vacuum and the exhaust would then be directed outside of the building for treatment/discharge.

The cost for SSD is relatively low to moderate. Similar to source area excavation, implementation of the technology may prove difficult as equipment would have to be avoided during installation which may also interfere with facility operations. However, this technology was retained for further evaluation.

7.6 Soil Vapor Extraction

SVE is another form of vapor abatement used to remove volatile COCs in the subsurface. Similar to SSD, SVE can reduce the risk of harmful vapors migrating to indoor air. However, SVE can also remove COC mass from source area unsaturated soils. As opposed to SSD, SVE is implemented through vapor extraction wells that are installed and screened deeper within the vadose zone (unsaturated soil) rather than specifically targeted within the sub-slab. Additionally, SVE utilizes higher vacuum and air flowrates when compared to SSD to pull air through the impacted soil at an increased rate. This increased rate of flow targeting the entire vadose zone continuously exchanges, or flushes, the soil vapor increasing the volatilization of COCs. To accomplish SVE, vertical vapor extraction wells can be installed underneath a facility through penetrations in the concrete slab floor or horizontal vapor extraction wells can be installed underneath a facility using directional drilling at entry points located outside of the facility footprint. Conveyance piping can be connected to the vertical vapor extraction wells through trenches inside the facility and supported by columns or walls or to the horizontal vapor extraction wells through trenches outside the facility footprint. The conveyance piping is then joined at a common header which is connected to a blower designed for higher vacuum and air flowrates (relative to SSD) to induce negative pressure and remove the vapors. Modeling of anticipated COC loading in the air discharge would be performed to determine if the recovered vapors would need to be directed through a treatment process (e.g., granular activated carbon) or if permitting would be required to vent the vapors directly to the atmosphere.

As discussed in **Section 3.3**, SVE was implemented as an interim measure at the Site in June 2022. The primary objectives of the SVE system were to remove COC mass from unsaturated soils and mitigate COCs in soil vapor underneath the main manufacturing building footprint. An as-built drawing illustrating the layout of the SVE system is provided in **Figure 12**. Additional details of the SVE system performance are discussed in **Section 8.2.5.**

This technology was retained for further evaluation.

7.7 Groundwater Capture and Recovery

The groundwater capture and recovery technology would include the installation of groundwater extraction wells in the shallow and limestone aquifer units downgradient of the source areas to capture and remove COC-impacted groundwater in order to prevent off-Site migration. The recovered groundwater would be pumped to an equalization tank and then treated with an air stripper and/or GAC. The treated groundwater would then be discharged either to the municipal sanitary sewer or to a nearby surface water body (stream). Treated groundwater could also potentially be re-injected into the aquifer up-gradient of the COC-impacted source areas.

Groundwater capture and recovery would be intended to contain the dissolved phase plumes from migrating to off-Site receptors. At some point dissolved phase impacts already downgradient of the recovery system would naturally attenuate via diffusion, dispersion, and advection. Groundwater capture and recovery is also typically used in conjunction with a source area treatment technology. Thus, groundwater recovery systems can operate from a few years to several decades depending on the effectiveness of the source treatment performed. Numerical flow and transport modeling would be performed to determine the number of wells, well depths, well spacing and anticipated flowrates. Permitting would be required for the discharge of treated water and modeling of air discharges would also be performed to determine if an air discharge permit would be required for release of COCs into the atmosphere from the air stripper. Additionally, groundwater capture and recovery operations and maintenance could require a licensed wastewater treatment operator.

The cost for groundwater capture and recovery is moderate to high and does not directly address source areas beneath the facility. However, the remedy is implementable and could partially achieve the RAOs. This technology was retained for further evaluation.

7.8 Dual Phase Extraction

DPE is a technology that involves the combination of SVE and groundwater recovery to remove impacted groundwater and vapors from the subsurface. DPE utilizes extraction wells to create airflow through unsaturated soils as well as saturated soils by lowering the groundwater table near each well to expose previously saturated areas in the subsurface. Above ground, the extracted vapor and groundwater are separated, treated, and then discharged. Numerical flow and transport modeling would be performed to determine the number of wells, well depths, well spacing and anticipated flowrates. Permitting would be required for the discharge of treated water and modeling of air discharges would also be performed to determine if an air discharge permit would be required for release of COCs into the atmosphere. Additionally, groundwater treatment operations and maintenance could require a licensed wastewater treatment operator.

This technology could be implemented to address the source areas at the Site with moderate to high cost and high effort. Effective implementation would involve installation of horizontal and vertical extraction wells to target the COC source areas beneath and adjacent to the main manufacturing building. Horizontal extraction wells would be installed underneath the main manufacturing building near the northern former PCE degreaser and vertical extraction wells would be installed just outside the building footprint near the former PCE UST area. Conveyance piping from the DPE wellheads would be trenched to a treatment compound where a treatment building and equipment would be located. This technology was retained for further evaluation.

7.9 Air Sparging

AS is a technology that involves injecting air into the impacted groundwater to increase volatilization of compounds in saturated soil and groundwater. AS is typically combined with SVE as it requires vapor capture to control the increased off-gassing. AS is implemented utilizing an air compressor, manifold, and controls which are connected through conveyance piping to sparge points or wells installed in the targeted area. AS would allow for short or long-term remediation and potential for adjustment to optimize remedial effectiveness. An underground injection control (UIC) permit would be required for AS implementation.

The cost for AS is relatively moderate. Effective implementation would involve installation of horizontal and vertical extraction wells to target the COC source areas in saturated soils and groundwater beneath and adjacent to the main manufacturing building. Horizontal extraction wells would be installed underneath the main manufacturing building and vertical extraction wells would be installed just outside the building footprint near the former PCE UST area. AS has been proven to be very effective at removing volatile COCs from groundwater and saturated soil and can be implemented at the Site. This technology was retained for further evaluation.

7.10 In Situ Chemical Oxidation

ISCO involves the chemical destruction of organic contaminants in groundwater and saturated soil via subsurface injection of strong oxidant solutions. Effective treatment requires the selection of oxidants that will react with the specific types of contaminants present at the Site. For treatment of COCs found at the Site, oxidants such as hydrogen peroxide, sodium persulfate, and sodium permanganate are typically effective.

In preparing for an ISCO remedy, a bench scale study would be required to determine the optimum oxidant dosing concentrations for soils and COCs at the Site. A UIC permit would be required for ISCO implementation. This technology may be difficult to implement effectively because it is a passive distribution technique relying on dispersive mechanisms, thus typically requiring a relatively high density of injection points. The injected oxidant can follow preferential pathways and may miss materials that have diffused into less transmissive geologic strata. This condition is often observed by short-term reduction of dissolved COC concentrations followed by a rebound in constituent concentrations resulting in multiple subsequent injection events. Secondary water quality issues such as discoloration due to permanganate, or daylighting of oxidant solutions during injection could also be an issue. However, ISCO does not require long-term maintenance of system equipment.

The cost for ISCO is relatively moderate to high, depending on the amount of subsequent injection events that are required. Effective implementation would involve installation of horizontal injection wells to be drilled from locations outside the footprint of the facility to target the COC source areas in groundwater beneath and adjacent to the main manufacturing building. This technology was retained for further evaluation.

7.11 Enhanced Reductive Dechlorination

ERD involves the delivery of an organic substrate into the subsurface in order to stimulate microbial growth and activity by creating an anaerobic groundwater treatment zone and generating hydrogen through fermentation reactions. The creation of anaerobic, hydrogen producing conditions is a favorable environment for the microbiological process of reductive dechlorination. This technology is proven to sequentially dechlorinate chlorinated ethenes to the non-toxic end products ethene and ethane.

This technology can be implemented with relatively moderate to high cost. Concerns regarding secondary water quality issues (e.g., ferrous iron, methane, volatile fatty acids) and accumulation of daughter products from incomplete dechlorination (e.g., vinyl chloride) may preclude its implementation along property boundaries. A UIC permit would also be required. As with ISCO, this technology would be difficult to implement effectively because it is a passive distribution technique relying on dispersive mechanisms, thus typically requiring a relatively high density of injection points. Effective implementation would also involve horizontal injection wells to be drilled from locations outside the footprint of the main manufacturing building to target the COC source areas in saturated soils and groundwater.

As stated in **Section 3.3,** a previous field-scale ERD injection was performed at the Site (H&H, January 2006). This investigation did not support a conclusion that ERD is effective in stimulating biotic degradation of cVOCs. Further, data collected during ongoing groundwater monitoring also demonstrated minimal evidence for presence of biotic degradation mechanisms for chlorinated ethenes. Biotic degradation of chlorinated ethenes is an anaerobic process and the dissolved oxygen and oxidation-reduction potential (ORP) values in groundwater were relatively high in treatment area, which is indicative of aerobic conditions. Additionally, the pH of the shallow groundwater is relatively low (less than 6 standard units), which is sub-optimal for biotic dechlorination. Therefore, this technology was not retained for further evaluation.

8.0 EVALUATION OF REMEDIAL ALTERNATIVES

The remedial technologies identified in **Section 7** that were retained for further evaluation were incorporated into remedial alternatives. Five alternatives were developed based on various combinations of the retained remedial technologies and are listed below.

- **Alternative 1 -** No Action
- **Alternative 2 -** Excavation, Groundwater Capture and Recovery, SSD, MNA, and ICs.
- **Alternative 3 -** DPE, SSD, MNA, and ICs.
- **Alternative 4 -** ISCO, SSD, MNA, and ICs.
- **Alternative 5** - SVE, AS, MNA, and ICs.

8.1 Evaluation Criteria

Detailed evaluation of the remedial alternatives was performed using the following criteria:

- **Protection of human health and the environment, including attainment of remediation goals.** The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.
- **Compliance with applicable or relevant and appropriate requirements.** The assessment against this criterion describes how the alternative complies with applicable or relevant and appropriate requirements (ARARs) or if a waiver is required and how it is justified. The assessment also addresses other information from advisories, criteria, and guidance that the lead and support agencies have agreed is "to be considered." The ARARs can be chemical specific, location specific and action specific. Chemical specific ARARs are generally numerical values, thus the chemical ARARs for the Site will be MCLs. Location specific ARARs place restrictions on the conduct of the cleanup activities because they are in a particular location. Action specific ARARs are related to implementation of the technology.
- **Short-term effectiveness.** The assessment of alternatives against this criterion examines the short-term effectiveness in protecting human health and the environment during the construction and implementation of a remedy as it pertains to the RAOs.
- **Long-term effectiveness and permanence.** The assessment of alternatives against this criterion evaluates the long-term effectiveness in maintaining protection of human health and the environment after conclusion of active remediation activities as it pertains to the RAOs.
- **Reduction of toxicity, mobility, and volume through treatment.** The assessment of alternatives against this criterion evaluates the anticipated performance of the specific treatment technologies to reduce the toxicity, mobility and/or volume of COCs significantly and permanently.

- **Implementability.** The assessment of alternatives against this criterion evaluates the technical and administrative feasibility as well as the availability of required goods and services.
- **Cost.** The assessment of alternatives against this criterion evaluates the capital and operation and maintenance (O&M) costs of each alternative.
- **Community and state acceptance.** This assessment reflects the community and state's (or supporting agency's) apparent preferences or concerns about the alternatives. These criteria are assessed formally after public comment and, therefore, are not further discussed in this On-Site Focused Feasibility Study.

Table 2 provides a comparison of each of the following remedial alternatives with respect to the evaluation criteria listed above. **Table 3** summarizes the costs and estimated duration of the active remedies for each of the following remedial alternatives. Detailed cost estimates and associated assumptions are provided in **Appendix A**.

8.2 Detailed Analysis

8.2.1 Alternative 1

Alternative 1 is the approach in which no active action is taken. No action means no remediation activities will be performed at the Site, including monitoring and sampling.

No Action is a benchmark that is useful for comparison to the other remedial alternatives. The benefit of any proposed remedial alternative must be greater than No Action to justify consideration.

8.2.1.1 *Protection of Human Health and the Environment; Attainment of Remediation Goals*

The No Action alternative is likely to benefit from naturally occurring attenuation of COCs via such pathways as microbial degradation, volatilization, and dilution. However, without a monitoring plan, the rate of natural attenuation will be unknown, as will the progress of the Site toward meeting the RAOs.

8.2.1.2 *Compliance with Applicable or Relevant and Appropriate Requirements*

This alternative will not comply with chemical specific ARARs until groundwater MCLs are met and would not have a monitoring plan in place to demonstrate future compliance with MCLs. Since no remedial activities would be conducted under this alternative, action specific ARARs are not applicable. Location specific ARARs also do not apply to this alternative.

8.2.1.3 *Short-term Effectiveness*

The No Action alternative does not provide any immediate or short-term effect on-Site conditions.

8.2.1.4 *Long-term Effectiveness and Permanence*

Over the long term, No Action may meet the criterion of effectiveness and permanence as many natural degradation processes can be permanent. However, for areas with especially high concentrations of COCs, the time required to meet the RGs would not be within an acceptable timeframe.

8.2.1.5 *Reduction of Toxicity, Mobility, and Volume*

Over time, the No Action alternative may reduce contaminant mass, mobility, and toxicity through natural attenuation processes; however, the time required to achieve RGs throughout the Site would not be within an acceptable timeframe.

8.2.1.6 *Implementability*

This alternative is easily implemented as it does not require work plans, design, equipment, or construction.

8.2.1.7 *Cost*

There are no costs associated with implementation as no remedial activities will be performed at the Site.

8.2.2 Alternative 2

Alternative 2 includes the combination of excavation, SSD, and groundwater capture to address on-Site COCs. This Alternative includes the ICs in place and MNA would be performed as a polishing step.

The excavation remedy would include removal of unsaturated soil from beneath the main manufacturing building near the northern former PCE degreaser and the former PCE UST areas. For cost purposes, both excavation areas are assumed to measure approximately 25 ft by 15 ft and extend to a depth of 10 ft below ground surface for a total volume of approximately 280 cubic yards.

The groundwater capture remedy would include installation of groundwater recovery wells located downgradient of the source areas to intercept impacted groundwater prior to migrating off-Site. The recovery wells would be connected via conveyance piping and trenching to a treatment building and compound. The treatment building would include necessary equipment (e.g., an equalization tank, bag filters, an air stripper, GAC units, etc.). For cost purposes, the groundwater capture remedy is assumed to require six recovery wells and operate for approximately 30 years. Extracted groundwater would be treated by air stripping and GAC adsorption prior to discharge to either a municipal sewer or surface water.

The SSD remedy would include the installation of suction points and conveyance piping connected to blower equipment housed inside a treatment building and compound. SSD would be installed within the main manufacturing building. For cost purposes, the SSD system is assumed to require 46 suction points and operate for up to ten years.

The conceptual layout for Remedial Alternative 2 is illustrated on **Figure 13.**

8.2.2.1 *Protection of Human Health and the Environment; Attainment of Remediation Goals*

Excavation within the source areas would remove a large portion of the COC mass in unsaturated soils. However, the extent of the excavations would have to be stopped at a safe and practical depth due to access, shoring, dewatering, and soil stability considerations including the need to ensure that compaction requirements could be met during backfilling so that repairs to the concrete slab floor would be structurally sound. Therefore, COC mass would be left in place within the source areas, especially in saturated soils. SSD and groundwater capture would only contain the remaining source area impacts and would not provide any further source area treatment. Without active treatment of the remaining source area impacts, dissolved groundwater COC concentrations would persist above the RGs for many years.

Groundwater capture would be utilized to intercept the connection between the source area and the off-Site dissolved plume.

SSD would remove vapor-phase COCs prior to reaching indoor air to mitigate potential exposure caused by vapor intrusion.

MNA would be utilized as a polishing step after implementation of the active remedies of this alternative until long-term RAOs were attained.

ICs in place (**Section 7.2**) eliminate the potential for human exposure to COC impacted soil and groundwater at the Site.

8.2.2.2 *Compliance with Applicable or Relevant and Appropriate Requirements*

This alternative is expected to meet chemical specific ARARs, but it would require a long time period. There are no location specific ARARs for this alternative and a discharge permit for treated groundwater would be required to fulfill action specific ARARs. A discharge permit for treated vapor is not expected to be required to fulfill action specific ARARs. Additionally, groundwater treatment O&M could require a licensed wastewater treatment operator.

8.2.2.3 *Short-term Effectiveness*

Implementation of this alternative is not expected to result in adverse impacts to the surrounding environment or community. Engineering controls such as fans for proper ventilation inside the main manufacturing building and establishment of exclusion zones would be utilized to eliminate short-term risks to on-Site workers.

The excavation would immediately address COC impacts in soil that are contributing to groundwater impacts by significantly reducing COC mass in unsaturated soil. The groundwater capture would immediately address dissolved phase COCs migrating off-Site in shallow groundwater by providing a barrier of hydraulic control between the source areas and downgradient property boundaries. SSD would immediately address COC impacts in soil vapor that may have the potential to create inhalation exposure pathways.

8.2.2.4 *Long-term Effectiveness and Permanence*

The combination of excavation, groundwater capture, and SSD would permanently remove subsurface COCs. However, for areas with especially high concentrations of COCs, the time required to meet the RGs would not be within an acceptable timeframe.

8.2.2.5 *Reduction of Toxicity, Mobility, and Volume*

Excavation would reduce the mobility and volume of COCs by removing a significant volume of unsaturated soils exhibiting elevated COC concentrations which would effectively eliminate their potential to further contribute to groundwater impacts.

Groundwater capture would reduce mobility and volume of COCs in groundwater by capturing, removing, and treating dissolved phase COCs downgradient of the source areas. As a secondary effect, groundwater capture would increase the hydraulic gradient by creating a cone of depression at each recovery well. This increased hydraulic gradient would increase the rate of flushes through the impacted pore volumes accelerating attenuation and reducing toxicity and volume of COCs.

8.2.2.6 *Implementability*

Excavation would be highly difficult and costly to implement as it would involve access to the inside of the main manufacturing with heavy equipment, opening the concrete slab floor, shoring, vertical excavation, and restoration. Effective implementation of the source area excavations would involve a temporary shutdown of manufacturing operations and manufacturing equipment relocation due to the high level of industrial manufacturing activity and limited space available. The excavation can be expected to be completed in less than one year.

Groundwater capture and recovery would be of low difficulty to implement as recovery wells, conveyance piping, and treatment equipment would be located outside of the building footprint. Implementation would involve heavy equipment operations to install and construct the recovery wells, treatment building, groundwater conveyance systems, and the treatment compound. The groundwater capture and recovery remedy is anticipated to operate for up to 30 years.

SSD would be of moderate to high difficulty to implement as it would also involve access to inside of the main manufacturing building, cutting and removing concrete, trenching, and elevated work to install vapor conveyance piping. Effective implementation of SSD may involve a limited temporary shutdown of manufacturing operations and manufacturing equipment relocation. Heavy equipment would be required to trench the vapor conveyance piping outside of the building to the SSD treatment building located within the same compound as the groundwater treatment building. The SSD remedy is anticipated to operate for up to ten years.

Implementation of all remedial technologies would require air monitoring, manual labor, and installation of engineering controls. Routine O&M of the groundwater treatment and SSD systems would be required, along with periodic performance monitoring. Proper use of engineering controls, personal protective equipment (PPE), and adhering to a site-specific health and safety plan (HASP) would minimize or eliminate risks during construction, O&M, and sampling activities.

ICs are in place and MNA would be relatively easily implemented with on-Site activities consisting of periodic groundwater monitoring using the existing wells. The MNA remedy may last over 30 years to achieve on-Site RGs depending on the effectiveness of the active remedies of this alternative.

8.2.2.7 *Cost*

The 30-year present worth of an opinion of probable costs for this alternative is approximately $5,344,000. The present worth cost was calculated using a discount rate of 5 percent. Remedial alternative costs are summarized in **Table 3**. Details of the probable cost and key assumptions are included in **Appendix A**. It should be noted that these costs are for comparison of alternatives and actual costs of implementation may vary. An assumed variance of -30 to +50 percent was applied for comparison purposes.

8.2.3 Alternative 3

Alternative 3 includes the combination of DPE and SSD to address on-Site COCs. This Alternative includes the ICs in place and MNA would be performed as a polishing step.

The DPE remedy would be utilized for source area treatment of COCs. The DPE remedy would include the installation of four horizontal extraction wells with screened sections located within the highest COC concentrations in groundwater near the northern former PCE degreaser. Additionally, five vertical extraction wells would be installed within the highest COC concentrations in groundwater near the former PCE UST area. The extraction wells would be connected via conveyance piping and trenching to a treatment building and compound. The treatment building would include necessary equipment (e.g., a blower, a moisture separator tank, an equalization tank, bag filters, an air stripper, GAC units, etc.). Extracted vapor and groundwater would be separated then treated prior to discharge. Groundwater would be treated using air stripping and/or GAC adsorption and then discharged to either a municipal sewer or surface water. Extracted vapor would be treated using GAC and then discharged to the atmosphere. For cost purposes, an operational time of approximately five years is assumed.

The SSD remedy would include the installation of suction points and conveyance piping connected to blower equipment housed inside a treatment building and compound. SSD would be installed within the main manufacturing building. For cost purposes, the SSD system is assumed to require 46 suction points and operate for up to ten years.

The conceptual layout for Remedial Alternative 3 is illustrated in **Figure 14.**

8.2.3.1 *Protection of Human Health and the Environment; Attainment of Remediation Goals*

DPE within the source areas would remove a significant portion of the COC mass. DPE would affect a larger subsurface volume than excavation as it would address unsaturated soils and shallow saturated soils. It is expected that DPE operations would sufficiently reduce source zone impacts to reduce future off-Site migration of groundwater COCs. When compared to Alternative 2, the DPE source area treatment would accelerate attenuation of the downgradient dissolved plumes such that attainment of long-term RAOs would be expected within a shorter time frame.

SSD would remove vapor-phase COCs prior to reaching indoor air to mitigate potential exposure caused by vapor intrusion.

MNA would be utilized as a polishing step after implementation of the active remedies of this alternative until long-term RAOs were attained.

ICs in place (**Section 7.2**) eliminate the potential for human exposure to COC impacted soil and groundwater at the Site.

8.2.3.2 *Compliance with Applicable or Relevant and Appropriate Requirements*

This alternative is expected to meet chemical specific ARARs, but it would require a long time period. There are no location specific ARARs for this alternative and a discharge permit for treated groundwater would be required to fulfill action specific ARARs. A discharge permit for treated vapor is not expected to be required to fulfill action specific ARARs. Additionally, groundwater treatment O&M could require a licensed wastewater treatment operator.

8.2.3.3 *Short-Term Effectiveness*

Implementation of this alternative is not expected to result in adverse impacts to the surrounding environment or community. Engineering controls such as fans for proper ventilation inside the main manufacturing building and establishment of exclusion zones would be utilized to eliminate short-term risks to on-Site workers.

DPE would immediately address elevated COCs in groundwater near the source areas that are migrating downgradient and contributing to dissolved phase impacts. The combination of DPE and SSD would immediately address COC impacts in soil and soil vapor that are contributing to groundwater impacts or that may have the potential to create inhalation exposure pathways.

8.2.3.4 *Long-term Effectiveness and Permanence*

DPE and SSD would permanently remove subsurface COCs. DPE source area treatment would substantially reduce source area COC mass, increasing the long-term effectiveness of natural attenuation of the remaining dissolved plume impacts.

8.2.3.5 *Reduction of Toxicity, Mobility, and Volume*

DPE and SSD would result in the reduction of toxicity, mobility, and volume of COCs on Site. DPE would reduce the toxicity and volume of COCs by removing COC mass from unsaturated soil as well as shallow saturated soil within the source areas by lowering the groundwater table and creating airflow through the exposed soils. During the lowering of the groundwater table (or drawdown), DPE would reduce the mobility and volume of COCs by capturing, extracting, and treating groundwater from source areas exhibiting the highest COC concentrations on the Site.

8.2.3.6 *Implementability*

DPE would be of low to moderate difficulty to implement as extraction wells would be installed from outside the building footprint. Conveyance piping and treatment equipment would also be located outside of the building footprint. Implementation would involve heavy equipment operations to install and construct the extraction wells, treatment building, conveyance systems, and the treatment compound. The DPE remedy is anticipated to operate for up to five years.

SSD would be of moderate to high difficulty to implement as it would also involve access to inside of the main manufacturing building, cutting and removing concrete, trenching, and elevated work to install vapor conveyance piping. Effective implementation of SSD may involve a limited temporary shutdown of manufacturing operations and manufacturing equipment relocation. Heavy equipment would be required to trench the vapor conveyance piping outside of the building to the SSD treatment building located within the same compound as the DPE treatment building. The SSD remedy is anticipated to operate for up to ten years.

Implementation of all remedial technologies would require air monitoring, manual labor, and installation of engineering controls. Routine O&M of the DPE and SSD systems would be required, along with periodic performance monitoring. Proper use of engineering controls, PPE, and adhering to a site-specific HASP would minimize or eliminate risks during construction, O&M, and sampling activities.

ICs are in place and MNA would be relatively easily implemented with on-Site activities consisting of periodic groundwater monitoring using the existing wells. The MNA remedy may last over 30 years to achieve on-Site RGs depending on the effectiveness of the active remedies of this alternative.

8.2.3.7 *Cost*

The 30-year present worth of an opinion of probable costs for this alternative is approximately $3,546,000. The present worth cost was calculated using a discount rate of five percent. Remedial alternative costs are summarized in **Table 3**. Details of the probable cost and key assumptions are included in **Appendix A**. It should be noted that these costs are for comparison of alternatives and actual costs of implementation may vary. An assumed variance of -30 to +50 percent was applied for comparison purposes.

8.2.4 Alternative 4

Alternative 4 includes the combination of ISCO and SSD to address on-Site COCs. This Alternative includes the ICs in place and MNA would be performed as a polishing step.

The ISCO remedy would be utilized for source area treatment of COCs. ISCO would include the installation of horizontal injection wells with screened sections located within the highest COC concentrations in groundwater near the northern former PCE degreaser and the former PCE UST area. The targeted treatment area is assumed to be approximately 8,100 sf with a targeted interval thickness of 15 ft (5 to 20 ft below ground surface). For cost purposes, the ISCO remedy is assumed to include installation of eight permanent horizontal injection wells with four injection events over a 12-month period.

The SSD remedy would include the installation of suction points and conveyance piping connected to blower equipment housed inside a treatment building and compound. SSD would be installed within the primary manufacturing building. For cost purposes, the SSD system is assumed to require 46 suction points and operate for up to ten years.

The conceptual layout for Remedial Alternative 4 is illustrated on **Figure 15.**

8.2.4.1 *Protection of Human Health and the Environment; Attainment of Remediation Goals*

The use of ISCO in the saturated zone soils would result in the rapid destruction of COCs. Similar to Alternative 2, elevated COC impacts would be left in place within the source areas as ISCO would only treat saturated soils while unsaturated soils above the 5-foot depth would not be effectively treated by the injections. Without active treatment of the remaining source area impacts, dissolved groundwater COC concentrations could rebound and persist above the RGs and require additional injection events. However, the ISCO treatment would accelerate attenuation of the downgradient dissolved plumes such that attainment of long-term RAOs would be expected within a shorter time frame when compared to Alternative 2.

SSD would remove vapor-phase COCs prior to reaching indoor air to mitigate potential exposure caused by vapor intrusion.

MNA would be utilized as a polishing step after implementation of the active remedies of this alternative until long-term RAOs were attained.

ICs in place (**Section 7.2**) eliminate the potential for human exposure to COC impacted soil and groundwater at the Site.

8.2.4.2 *Compliance with Applicable or Relevant and Appropriate Requirements*

This alternative is expected to meet chemical specific ARARs but would require a long time period. There are no location specific ARARs for this alternative and a UIC permit would be required to fulfill action specific ARARs. A discharge permit for treated vapor is not expected to be required to fulfill action specific ARARs.

8.2.4.3 *Short-term Effectiveness*

Implementation of this alternative is not expected to result in adverse impacts to the surrounding community. Engineering controls such establishment of exclusion zones would be utilized to eliminate short-term risks to on-Site workers during injection events. The use of ISCO may result in adverse impacts to the surrounding environment such as temporary issues regarding secondary water quality (e.g., colored groundwater, increases in metals, etc.) as well as increased off-gassing of COCs.

ISCO could immediately address elevated COCs in saturated soil and groundwater within the source areas that are migrating downgradient and contributing to dissolved phase impacts. SSD would immediately address COC impacts in soil vapor that may have the potential to create inhalation exposure pathways.

8.2.4.4 *Long-term Effectiveness and Permanence*

The combination of ISCO and SSD would permanently remove subsurface COCs. However, due to inherent variability in subsurface geologic and hydrogeologic conditions, some areas may be less effectively treated than others. Therefore, dissolved COC concentrations in the areas of the Site that are not effectively treated may exhibit a gradual rebound as residual COCs bound to soils partition back into the groundwater. Despite the potential for post-injection rebound, ISCO source area treatment would substantially reduce source area COC mass, increasing the long-term effectiveness of natural attenuation of the remaining dissolved plume impacts.

8.2.4.5 *Reduction of Toxicity, Mobility, and Volume*

ISCO and SSD would result in the reduction of toxicity, mobility, and volume of COCs on Site. ISCO would reduce the toxicity, mobility, and volume of COCs via destruction of COC mass in saturated soils and groundwater within the source areas assuming sufficient distribution and effective treatment throughout the targeted volume.

8.2.4.6 *Implementability*

The radius of influence of the ISCO injection wells is anticipated to be on the order of about 5 to 10 ft, which would require a relatively dense network of vertical injection wells. Based on the required density, injections inside the building using DPT or through permanent vertical wells would be of high difficulty and may involve a limited temporary shutdown of manufacturing operations and manufacturing equipment relocation. Thus, effective implementation of ISCO would involve the utilization of horizontal wells which would be installed through entry points outside of the facility footprint. Implementation of ISCO utilizing horizontal wells would be of low to moderate difficulty and would involve heavy equipment operations to install the horizontal injection wells. Additionally, implementation would require multiple mobilizations across multiple injection events. The duration of the ISCO remedy is anticipated to be one to three years depending on the number of injections events that are required.

SSD would be of moderate to high difficulty to implement as it would also involve access to inside of the main manufacturing building, cutting and removing concrete, trenching, and elevated work to install vapor conveyance piping. Effective implementation of SSD may involve a limited temporary shutdown of manufacturing operations and manufacturing equipment relocation. Heavy equipment would be required to install and construct the vapor conveyance systems, treatment building, and the treatment compound. The SSD remedy is anticipated to operate for up to ten years.

Implementation of all remedial technologies would require air monitoring, manual labor, and installation of engineering controls. Routine O&M of the SSD system would be required, along with periodic performance monitoring. Proper use of engineering controls, PPE, and adhering to a site-specific HASP would minimize or eliminate risks during construction, O&M, and sampling activities.

ICs are in place and MNA would be relatively easily implemented with on-Site activities consisting of periodic groundwater monitoring using the existing wells. The MNA remedy may last over 30 years to achieve on-Site RGs depending on the effectiveness of the active remedies of this alternative.

8.2.4.7 *Cost*

The 30-year present worth of an opinion of probable costs for this alternative is approximately $2,706,000. The present worth cost was calculated using a discount rate of five percent. Remedial alternative costs are summarized in **Table 3**. Details of the probable cost and key assumptions are included in **Appendix A.** It should be noted that these costs are for comparison of alternatives and actual costs of implementation may vary. An assumed variance of -30 to +50 percent was applied for comparison purposes.

8.2.5 Alternative 5

Alternative 5 includes the combination of AS and SVE to address on-Site COCs. This Alternative includes the ICs in place and MNA would be performed as a polishing step.

AS would be utilized for treatment of COCs in saturated soil and groundwater underneath the main manufacturing building footprint. The AS remedy would include installation of six horizontal sparge wells with screened sections that span the entire length of the SVE capture radius which would include the area of elevated COCs concentrations in groundwater near the northern former PCE degreaser. Additionally, five vertical sparge wells would be installed within the highest COC concentrations in groundwater near the former PCE UST area. The sparge wells would be connected via conveyance piping and trenching to air compressor equipment housed inside an equipment building and compound. For cost purposes, an operational time of approximately three years is assumed.

As discussed in **Section 3.3**, SVE was implemented as an interim measure at the Site in June 2022. The primary objectives of the SVE system were to remove COC mass from unsaturated soils and mitigate COCs in soil vapor underneath the main manufacturing building footprint.

A total of seven SVE wells (SVE-1 through SVE-7) were installed below the main manufacturing building via horizontal directional drilling (HDD) techniques. The horizontal well screens were installed to a target depth of approximately 6 ft below the building slab within the unsaturated soils. Conveyance piping installed within trenches connected the SVE wells to the SVE equipment compound located near the southwest corner of the Site. An as-built drawing illustrating the layout of the SVE system is provided in **Figure 12**. Additional details of the SVE system construction and installation were provided in the *Construction Completion Report* (AECOM, August 11, 2022).

Since the SVE system operation began in June 2022, AECOM has been monitoring and evaluating performance of the interim action on a monthly basis. To monitor performance of the SVE system, vacuum readings were collected from sub-slab vapor pins (installed within sub-slab void space) and vapor monitoring points (installed within soil 2 ft below concrete slab floor surface) located throughout the main manufacturing building. To evaluate performance of the SVE system, a vacuum of 0.10 inches of water column (in-WC) was retained as the benchmark for vacuum influence. During the monitoring period extending from June 15, 2022 to November 21, 2022, average vacuum measurements collected from the sub-slab vapor pins and vapor monitoring points ranged from 0.25 to 4.90 in-WC and 1.06 to 10.35 in-WC, respectively. This data suggests sufficient vacuum throughout the unsaturated soils to mitigate COC impacted vapors underneath the main manufacturing building. Additionally, the SVE blower is operating at half of the maximum speed indicating additional vapor capture potential, if needed in the future.

Analytical data was also collected from the SVE system vapor stream on a monthly basis to evaluate COC mass removal. It should be noted that since the vapor stream does not undergo any active treatment (e.g., discharged directly to atmosphere), the influent and effluent concentrations are assumed to be equal. Based on the analytical results and mass calculations during the same monitoring period, influent concentrations peaked during the first day of operation and reached near asymptotic levels after two months of operation. For example, the influent PCE concentration during the first day of operation was 34,300 micrograms per cubic meter ($\mu g/m^3$) and the average influent concentration from August 29, 2022 to November 21, 2022 was 1,983 $\mu g/m^3$. Additionally, the SVE system averaged a COC mass removal rate of 0.4 pounds per day (lbs/day) with an estimated total of 16.3 lbs of COC mass removed during the monitoring period. This data indicates mass removal and reduction of COCs in unsaturated soils underneath the main manufacturing building.

During the monitoring period, the SVE system operated with a runtime efficiency of 92 percent before experiencing downtime due to a full condensate storage tank during the months of December 2022 and January 2023. The cumulative runtime efficiency of the SVE system was 73 percent as of January 19, 2023. The performance monitoring data tables for the SVE system are provided in **Appendix B**.

In this alternative, SVE would be utilized for source area treatment of COCs in unsaturated soils as well as provide vapor mitigation replacing the need for the SSD remedy. For cost purposes, the SVE system is assumed to operate for approximately three years.

The conceptual layout for Remedial Alternative 5 is illustrated on **Figure 16.**

8.2.5.1 *Protection of Human Health and the Environment; Attainment of Remediation Goals*

Implementation of AS and SVE would remove a large portion of the source mass in unsaturated soil, saturated soil, and groundwater. As compared to the other alternatives, the more extensive treatment area achieved by AS and SVE is expected to accelerate attenuation of the downgradient dissolved plumes such that attainment of long-term RAOs would be expected within a shorter time frame.

SVE would serve the purpose of SSD in the previous alternatives as the active vapor extraction would remove vapor-phase COCs prior to reaching indoor air mitigating the potential for exposure caused by vapor intrusion.

MNA would be utilized as a polishing step after implementation of the active remedial alternative.

ICs in place (**Section 7.2**) eliminate the potential for human exposure to COC impacted soil and groundwater at the Site.

8.2.5.2 *Compliance with Applicable or Relevant and Appropriate Requirements*

This alternative is expected to meet chemical specific ARARs, but it would require a long time period. There are no location specific ARARs for this alternative and a UIC permit would be required to fulfill action specific ARARs. A discharge permit for treated vapor is not expected to be required to fulfill action specific ARARs.

8.2.5.3 *Short-Term Effectiveness*

Implementation of this alternative is not expected to result in adverse impacts to the surrounding environment or community. Engineering controls such as establishment of exclusion zones during construction would be utilized to eliminate short-term risks to on-Site workers.

AS would immediately address elevated COCs in groundwater near the source areas that are migrating downgradient and contributing to dissolved phase impacts. SVE would immediately address COC impacts in unsaturated soil and soil vapor that are contributing to groundwater impacts or that may have the potential to create inhalation exposure pathways.

8.2.5.4 *Long-term Effectiveness and Permanence*

AS and SVE would permanently remove subsurface COCs. AS and SVE source area treatment would substantially reduce source area COC mass, increasing the long-term effectiveness of natural attenuation of the remaining dissolved plume impacts.

8.2.5.5 *Reduction of Toxicity, Mobility, and Volume*

The combination of AS and SVE would result in the reduction of toxicity, mobility, and volume of COCs on Site. AS would reduce the toxicity and volume of COCs by effectively stripping COC mass from saturated soil and groundwater underneath the main manufacturing building footprint. SVE would reduce the toxicity, mobility, and volume of COCs by capturing and removing COC mass within soil and soil vapor as well as vapors produced by AS operation.

8.2.5.6 *Implementability*

AS would be of low to moderate difficulty to implement as the sparge wells would be installed from outside the building footprint. Conveyance piping and air compressor equipment would also be located outside of the building footprint. Implementation would involve heavy equipment operations to install and construct the sparge wells, equipment building, conveyance systems, and the treatment compound. The AS remedy is anticipated to operate for up to three years.

As stated in **Section 3.3**, the SVE remedy was effectively implemented as an interim measure in June 2022.

Implementation of all remedial technologies would require air monitoring, manual labor, and installation of engineering controls. Routine O&M of the AS and SVE systems would be required, along with periodic performance monitoring sampling. Proper use of engineering controls, PPE, and adhering to a site-specific HASP would minimize or eliminate risks during construction, O&M, and sampling activities.

ICs are in place and MNA would be relatively easily implemented with on-Site activities consisting of periodic groundwater monitoring using the existing wells. The MNA remedy may last over 30 years to achieve on-Site RGs depending on the effectiveness of the active remedies of this alternative.

8.2.5.7 *Cost*

The 30-year present worth of an opinion of probable costs for this alternative is approximately $2,962,000. The present worth cost was calculated using a discount rate of 5 percent. Remedial alternative costs are summarized in **Table 3**. Details of the probable cost and key assumptions are included in **Appendix A**. It should be noted that these costs are for comparison of alternatives and actual costs of implementation may vary. An assumed variance of -30 to +50 percent was applied for comparison purposes.

9.0 REFERENCES

Logan, W.R., and Euler, G.M., 1989. *Geology and Ground-water Resources of Allendale, Bamberg, and Barnwell Counties and part of Aiken County, South Carolina.* South Carolina Water Resources Commission, Report Number 155.

USEPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. EPA 540-R-00-002. OSWER 9355.0-75. July 2000.

Hart & Hickman, August 29, 2003, *Ground water assessment report, Delavan Spray Technologies Facility, Bamberg, South Carolina.*

Willoughby and others, 2005. *Generalized geologic map of South Carolina, South Carolina Department of Natural Resources.*

Hart & Hickman, January 31, 2006, *Report of HRC Injection and Pre- and Post-Injection Ground Water Monitoring,* Delavan Spray Technologies Facility, Bamberg, South Carolina.

Hart & Hickman, December 5, 2012, *Supplemental Site Assessment Report, Delavan Spray Technologies Site, Bamberg, South Carolina.*

SCDHEC, July 3, 2013. Voluntary Cleanup Contract 13-4762-RP.

Hart & Hickman, August 1, 2013, *Remedial Investigation Work Plan, Delavan Spray Technologies Site, Bamberg, South Carolina.*

AECOM, July 3, 2014. *Remedial Investigation Report, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, May 17, 2016. *Post Remedial Investigation Report*, *United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, September 13, 2016. *Groundwater Delineation Work Plan, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, June 14, 2017. *Spring 2017 Semi-Annual Groundwater Monitoring Report, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 13-4762-RP.*

AECOM, June 23, 2017. *Groundwater Delineation Report, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, July 12, 2017. *Focused Feasibility Study, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, October 13, 2017. *Limestone Aquifer Assessment Work Plan, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 13-4762-RP.*

AECOM, February 15, 2018. *Residential Sampling Activities and Results, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, June 4, 2018. *Residential Sampling Activities and Results, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, June 10, 2020. *Deep Groundwater Delineation Technical Memorandum, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, July 30, 2020. *Spring 2020 Semi-Annual Groundwater Monitoring Report, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 13-4762-RP.*

AECOM, March 5, 2021. *Fall 2020 Residential Sampling Activities and Results, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, March 9, 2021. *High-Resolution Source Characterization Report, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 12-4762-RP*.

AECOM, July 30, 2021. *Spring 2021 Semi-Annual Groundwater Monitoring Report, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 13-4762-RP.*

AECOM, June 18, 2021. *Interim Removal Action Work Plan, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 13-4762-RP.*

National Oceanic and Atmospheric Administration [NOAA] National Climatic Data Center [NCDC], 2021. www.weatherbase.com for Bamberg, South Carolina.

AECOM, July 28, 2022. *Spring 2022 Semi-Annual Groundwater Monitoring Report, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 13-4762-RP.*

AECOM, August 11, 2022. *Construction Completion Report – Soil Vapor Extraction System, United Technologies Corporation, Delavan Spray Technologies Site, 4334 Main Highway, US Highway 301 South, Bamberg, South Carolina, VCC 13-4762-RP.*

TABLES

Table 1
Remedial Goals for Site-Specific Constituents of Concern
Delavan Spray Technologies Site
Bamberg, South Carolina

Site-Specific Compounds[1]	MCL[2] (µg/L[4])	Maximum Detected Concentration[3] (µg/L)
1,1,1-Trichloroethane	200	245
1,1-Dichloroethylene	7	520
Chloroform	80	299
cis-1,2-Dichloroethylene	70	4,250
Methylene chloride	5	765 J[5]
Tetrachloroethylene	5	136,000
Toluene	1,000	98.7 J
Trichloroethylene	5	626
Vinyl Chloride	2	114

Notes:

[1] Site-Specific Compounds were selected based on historical detections in groundwater at concentrations exceeding their respective Maximum Contaminant Level (MCL).

[2] MCL - United States Environmental Protection Agency Maximum Contaminant Level (April, 2012), or, as defined by South Carolina Department of Health and Environmental Control (SCDHEC) R.61-68 Water Classifications and Standard (June 27, 2014).

[3] Based on comprehensive historical groundwater data collected at the Site from June 2003 to April 2021 (AECOM, July 2021).

[4] µg/L - micrograms per liter.

[5] J - Estimated concentration above the laboratory method detection limit and below the laboratory reporting limit.

Table 2
Comparison of Remedial Alternatives to Evaluation Criteria
Delavan Spray Technologies Site
Bamberg, South Carolina

Remedial Alternative	Criterion	Evaluation Score	Score Justificaiton
Alternative 1 No Action	Overall Protection of human health and the environment	1	Rate of natural attenuation and potential impacts to receptors will be unknown.
	Compliance with Applicable or Relevant and Appropriate Requirements	0	Does not comply with chemical specific ARARs until groundawter MCLs are met.
	Short-term effectiveness	1	Does not provide any immediate or short-term effect on Site conditions.
	Long-term effectiveness and permanence	1	Time required to meet the RGs would not be within an acceptable timeframe.
	Reduction of toxicity, mobility and volumes	1	Time required to meet the RGs would not be within an acceptable timeframe.
	Implementability	4	Does not require work plans, designs, equipment, or construction.
	Cost	4	No costs assosciated with implementation.
	State and community acceptance	--	These criteria are assessed formally after public comment.
Alternative 2 Excavation, Groundwater Capture, SSD, MNA, and ICs	Overall Protection of human health and the environment	2	Excavation would stop at a safe and practical depth above the water table. Therefore, a large portion of elevated cVOC impacts would be left in place, specifically in saturated soil.
	Compliance with Applicable or Relevant and Appropriate Requirements	2	Would meet chemical specific ARARs but would require a long time period. Would require discharge permit for treated groundwater. System O&M may require licensed operator.
	Short-term effectiveness	3	Would immediately address cVOC impacts in unsaturated soil and soil vapor that are contributing to groundwater impacts.
	Long-term effectiveness and permanence	2	Would permanently remove subsurface COCs but not within an acceptable timeframe.
	Reduction of toxicity, mobility and volumes	3	Would reduce volume of COCs in unsaturated soils and reduce mobility of COCs in groundwater and soil vapor.
	Implementability	1	Difficult to implement due to a temporary shutdown of operations and equipment relocation due to the high level of industrial manufacturing activity and limited space available.
	Cost	1	High cost due to difficulty of implementation, equipment required, and O&M.
	State and community acceptance	--	These criteria are assessed formally after public comment.
Alternative 3 DPE, SSD, MNA and ICs	Overall Protection of human health and the environment	3	DPE would address a larger subsurface volume than excavation including saturated soils.
	Compliance with Applicable or Relevant and Appropriate Requirements	3	Would meet chemical specific ARARs but would require a long time period. Would require discharge permit for treated groundwater. System O&M may require licensed operator.
	Short-term effectiveness	3	Would address cVOC impacts in soil and soil vapor that are contributing to groundwater impacts.
	Long-term effectiveness and permanence	3	Would reduce source area COCs increasing long-term effectiveness of natural attentuation of remaining dissolved plume impacts.
	Reduction of toxicity, mobility and volumes	3	Would reduce volume of COCs by removing cVOC mass from vadoes zone soil, saturated soil, and groundwater within the source areas.
	Implementability	2	Difficult to implement due to a temporary shutdown of operations and equipment relocation due to the high level of industrial manufacturing activity and limited space available.
	Cost	2	Moderate to high cost due to difficulty of implementation, equipment required, and O&M.
	State and community acceptance	--	These criteria are assessed formally after public comment.
Alternative 4 ISCO, SSD, MNA, and ICs	Overall Protection of human health and the environment	2	ISCO would address dissolved phase COCs within source areas and accelerate attenuation of downgradient dissolved plumes. Unsaturated soils would not be treated.
	Compliance with Applicable or Relevant and Appropriate Requirements	3	Would meet chemical specific ARARs but would require a long time period. Would require injection permit for ISCO injections.
	Short-term effectiveness	3	Would address cVOC impacts in saturated soil, soil vapor, and groundwater but may cause temporary issues regarding secondary water quality and increased off-gassing of cVOCs.
	Long-term effectiveness and permanence	2	May not completely treat targeted areas due to inherent variablility in subsurface geologic/hydrolgeoloigc conditions resulting in rebound of COC concentrations.
	Reduction of toxicity, mobility and volumes	3	ISCO would reduce cVOC mass in saturated soil and groundwater. SSD would be relied upon to address cVOC impacts in soil and soil vapor over a longer time period.
	Implementability	2	Difficult to implement due to temporary relocation of facility manufacturing equipment and interruptions to facility operations for mutliple injection events.
	Cost	3	Moderate to high cost due to difficulty of implementation and equipment required for multiple injection events.
	State and community acceptance	--	These criteria are assessed formally after public comment.
Alternative 5 AS, SVE, MNA, and ICs	Overall Protection of human health and the environment	4	Would remove large portion of source area COC mass in soil and groundwater.
	Compliance with Applicable or Relevant and Appropriate Requirements	3	Would meet chemical specific ARARs but would require a long time period. Would require injection permit for AS.
	Short-term effectiveness	4	Would address cVOC impacts in soil, soil vapor, and groundwater.
	Long-term effectiveness and permanence	3	Would permanently remove subsurface COCs increasing long-term effectiveness of natural attenuation.
	Reduction of toxicity, mobility and volumes	4	Would reduce cVOC mass in soil, soil vapor, and groundwater. SVE would be more effective than SSD at addressing cVOC impacts in vadose zone soil and soil vapor.
	Implementability	4	Implementation would occur outside of main manufacturing building.
	Cost	3	Moderate to high cost due to implementation and equipment required.
	State and community acceptance	--	These criteria are assessed formally after public comment.

Summary of Remedial Alternatives Evaluation Scores

Criterion	Alternative 1 No Action	Alternative 2 Excavation, Groundwater Capture, SSD, MNA, and ICs	Alternative 3 DPE, SSD, MNA and ICs	Alternative 4 ISCO, SSD, MNA, and ICs	Alternative 5 AS, SVE, MNA, and ICs
Overall Protection of human health and the environment	1	2	3	2	4
Compliance with applicable federal, state and local regulations	0	2	3	3	3
Short-term effectiveness	1	3	3	3	4
Long-term effectiveness and permanence	1	2	3	2	3
Reduction of toxicity, mobility and volumes	1	3	3	3	4
Implementability	4	1	2	2	4
Cost	4	1	2	3	3
State and community acceptance	--	--	--	--	--
Total Evaluation Score	**12**	**14**	**19**	**18**	**25**

Notes:

Numeric ranking assigned according to following scale:
- 0 = Unacceptable
- 1 = Poor
- 2 = Fair
- 3 = Good
- 4 = Ideal

ICs = Institutional Controls
SSD = Sub-slab Depressurization
DPE = Dual Phase Extraction
ISCO = In Situ Chemical Oxidation
AS = Air Sparging
SVE = Soil Vapor Extraction
MNA = Monitored Natural Attenuation

-- = Not Ranked
ARARs = Applicable or Relevant and Appropriate Requirements
RGs = Remedial Goals
cVOCs = Chlorinated Volatile Organic Compounds
COCs = Constituents of Concern
MCLs = Maximum Contaminant Levels

Table 3
Comparison of Costs for Remedial Alternatives
Delavan Spray Technologies Site
Bamberg, South Carolina

Remedial Alternative	Description	Pre-Construction Cost	Construction Cost	Institutional Controls Cost	O&M Cost	Active Remedy Duration (Estimated)	Total Cost (Rounded)	Total Probable Cost Range (-30% to 50%)
1	No Action	$ -	$ -	$ -	$ -	--	$ -	$ - to $ -
2	Excavation, Groundwater Capture, SSD, MNA, and ICs	$ 325,900	$ 1,238,000	$ 30,000	$ 3,749,777	Excavation: less than 1 year SSD: 1-10 years Groundwater Capture: 1-30 years	$ 5,344,000	$ 3,740,574 to $ 8,015,516
3	DPE, SSD, MNA, and ICs	$ 325,900	$ 1,544,700	$ 30,000	$ 1,645,476	DPE: 1-5 years SSD: 1-10 years	$ 3,546,000	$ 2,482,253 to $ 5,319,114
4	ISCO, SSD, MNA, and ICs	$ 325,900	$ 1,628,700	$ 30,000	$ 721,060	ISCO: 1-3 years SSD: 1-10 years	$ 2,706,000	$ 1,893,962 to $ 4,058,490
5	AS, SVE, MNA, and ICs	$ 325,900	$ 1,930,700	$ 30,000	$ 675,302	AS: 1-3 years SVE: 1-3 years	$ 2,962,000	$ 2,073,331 to $ 4,442,853

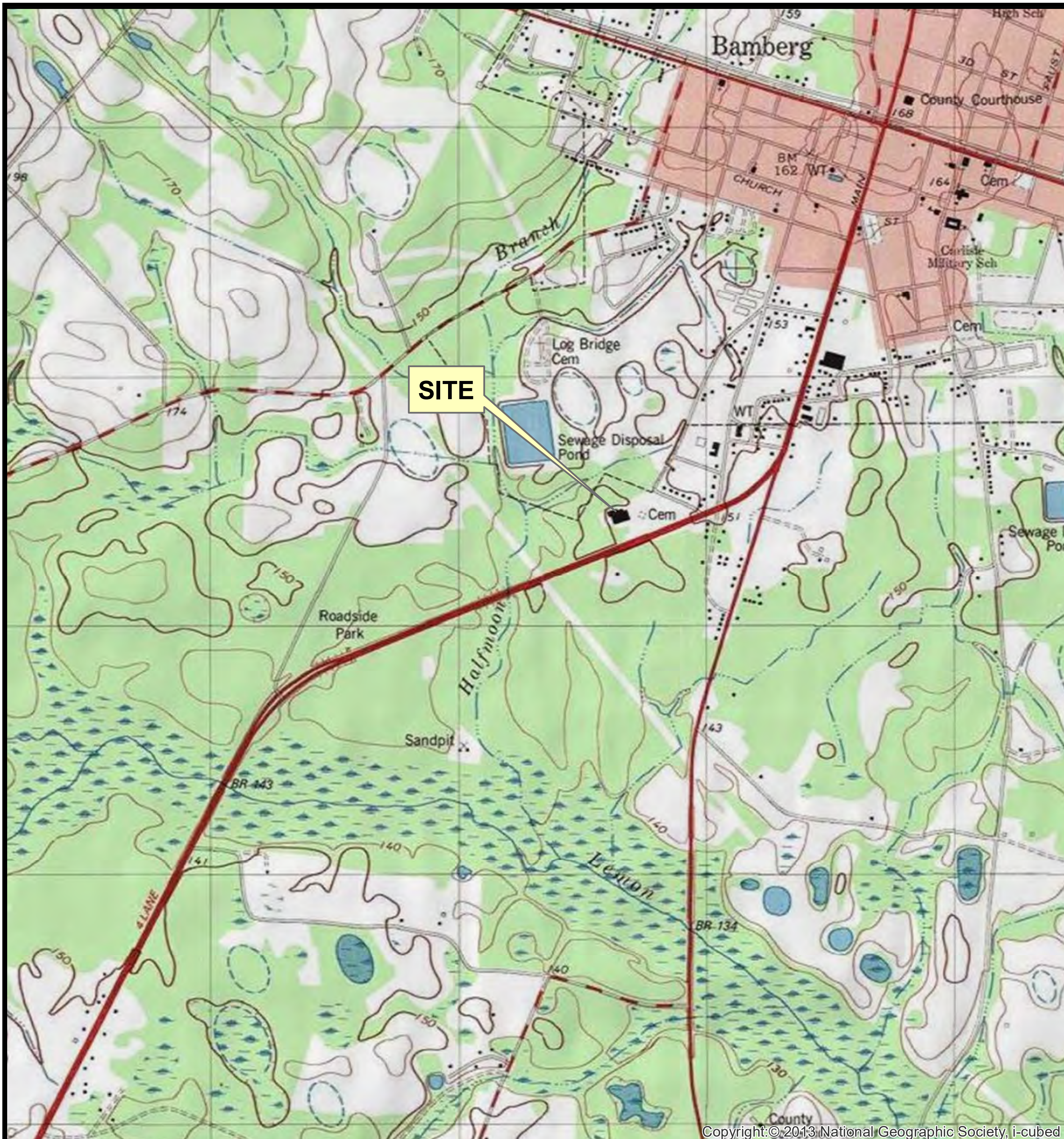
Notes:

Operation and maintenance costs calculated as net present value assuming the estimated durations shown and a discounted rate of 5%. Includes cost of 30-year MNA.

Costs for Remedial Alternatives do not include costs due to potential business disruption during construction.

ICs - Institutional Controls
DPE - Dual Phase Extraction
ISCO - In Situ Chemical Oxidation
SSD - Sub-Slab Depressurization
AS - Air Sparging
SVE - Soil Vapor Extraction
MNA - Monitored Natural Attenuation
O&M - Operation and Maintenance

FIGURES



N

0 500 1,000 2,000 3,000 4,000 Feet

U.S.G.S. QUADRANGLE MAP

BAMBERG, SC 1979 (PHOTO REVISED 1987)

QUADRANGLE
7.5 MINUTE SERIES (TOPOGRAPHIC)

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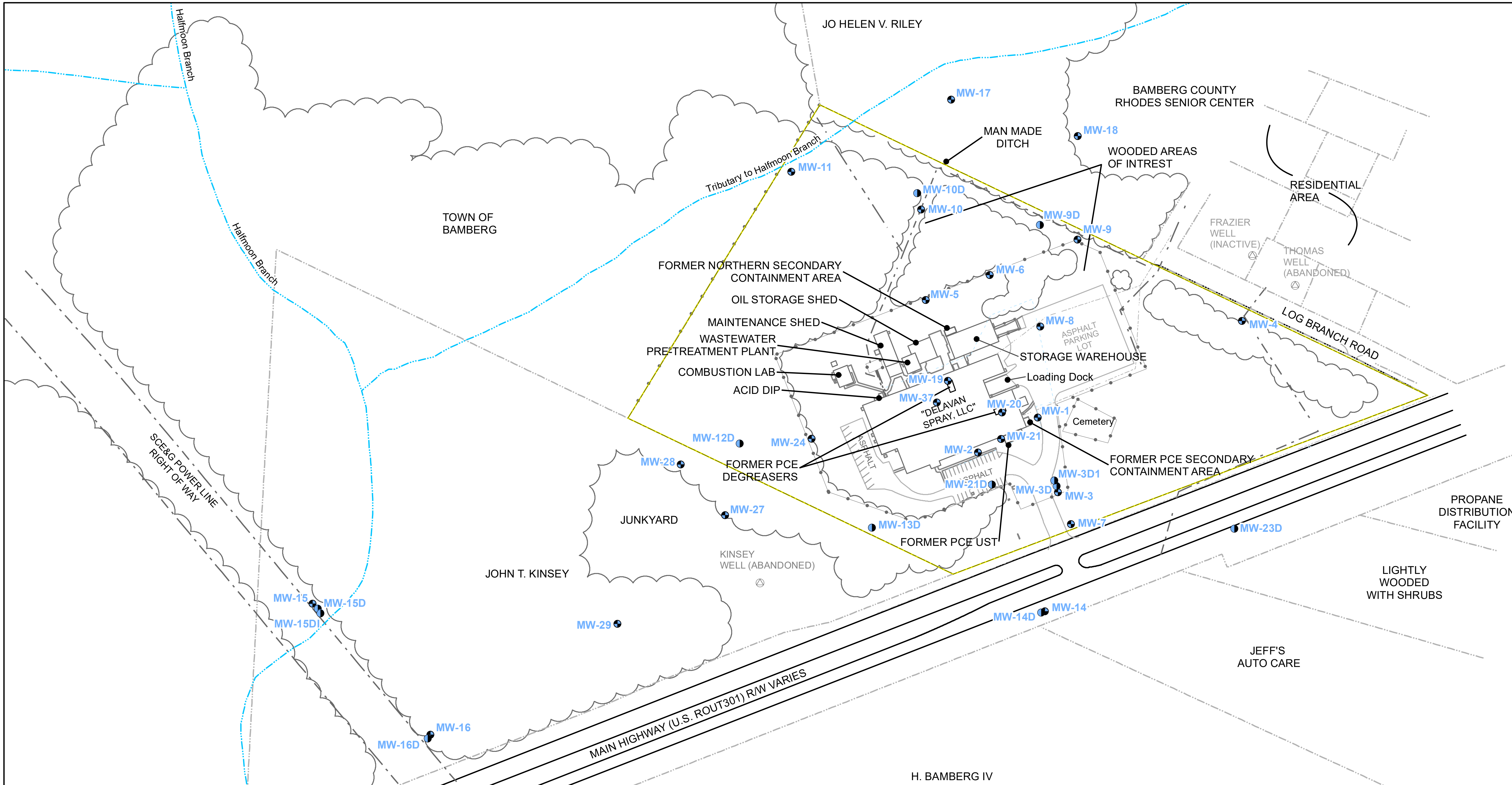
Delavan Spray Technologies Site
Bamberg, South Carolina

Site Location Map

Project No.	Prepared by	Date	
60656814	KCG	June 2021	Figure 1

Path: L:\Projects\60314964 - Bamberg\900-CAD-GIS\920 GIS-Graphics\Maps\Maps June 2021\Figure 1 Site Location Map.mxd



Legend

- ABANDONED OR INACTIVE WELL
- DEEP WELL
- SHALLOW WELL
- SURFACE WATER FEATURE
- FENCE LINE
- PROPERTY BOUNDRY
- OVERHEAD POWER LINE
- ROAD
- SANITARY SEWER LINE
- STORM DRAIN
- SUBJECT PROPERTY BOUNDRY

Notes:
H&H - Hart & Hickman
RI - Remedial Investigation
HRSC - High Resolution Site Characterization

1. Base map obtained from surveys prepared by Edisto Engineers & Surveyors, Inc. (dated 6/3/2011 and 4/14/2014) and from Work Plan maps provided by H&H (August 2013).
2. 2012 sample locations were surveyed on 8/28/2012 and RI sample locations were surveyed on 3/20/2014. Post RI assessment locations were surveyed on 1/26/2016. Groundwater delineation locations were surveyed on 5/10/2017. Limestone Aquifer delineation locations were surveyed 12/5/2019. HRSC locations were surveyed on 8/17/2020.
3. Surface water flowlines from a geodatabase "NHDH_SC.gdb" obtained from the USGS, National Hydrography Dataset.

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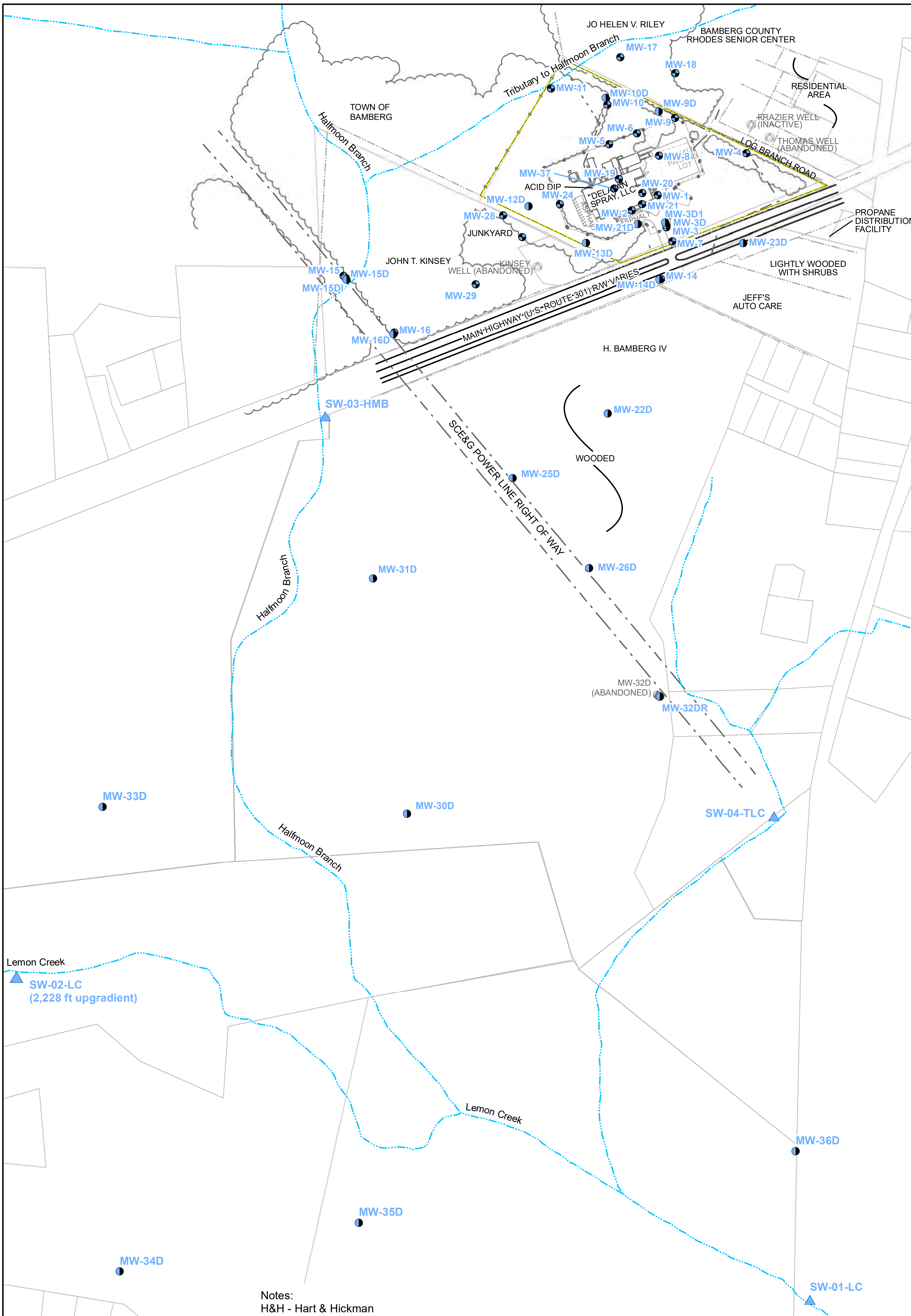
Delavan Spray Technologies Site
Bamberg, South Carolina
Site Layout Map

Project No.	Prepared by	Date	
60656814	K. Clark	June 2021	Figure 2

Path: L:\Projects\60314964 - Bamberg\900-CAD-GIS\920 GIS-Graphics\Maps\Maps June 2021\Figure 2 Site Layout11x17 Landscape.mxd



Notes:
H&H - Hart & Hickman
HRSC - High Resolution Site Characterization
RI - Remedial Investigation

1. Base map obtained from surveys prepared by Edisto Engineers & Surveyors, Inc. (dated 6/3/2011 and 4/14/2014) and from Work Plan maps provided by H&H (August 2013).
2. 2012 sample locations were surveyed on 8/28/2012 and RI sample locations were surveyed on 3/20/2014. Post RI assessment locations were surveyed on 1/26/2016. Groundwater delineation locations were surveyed on 5/10/2017. Limestone aquifer delineation locations were surveyed on 12/5/2019. HRSC locations were surveyed on 8/17/2020.
3. Surface water flowlines from a geodatabase "NHDH_SC.gdb" obtained from the USGS, National Hydrography Dataset.

0 250 500 750
Feet

Legend

- ABANDONED OR INACTIVE WELL
- SURFACE WATER SAMPLE (APPROXIMATE)
- DEEP WELL
- SHALLOW WELL
- SURFACE WATER FEATURE
- FENCE LINE
- PROPERTY BOUNDRY
- OVERHEAD POWER LINE
- ROAD
- SANITARY SEWER LINE
- STORM DRAIN
- SUBJECT PROPERTY BOUNDRY

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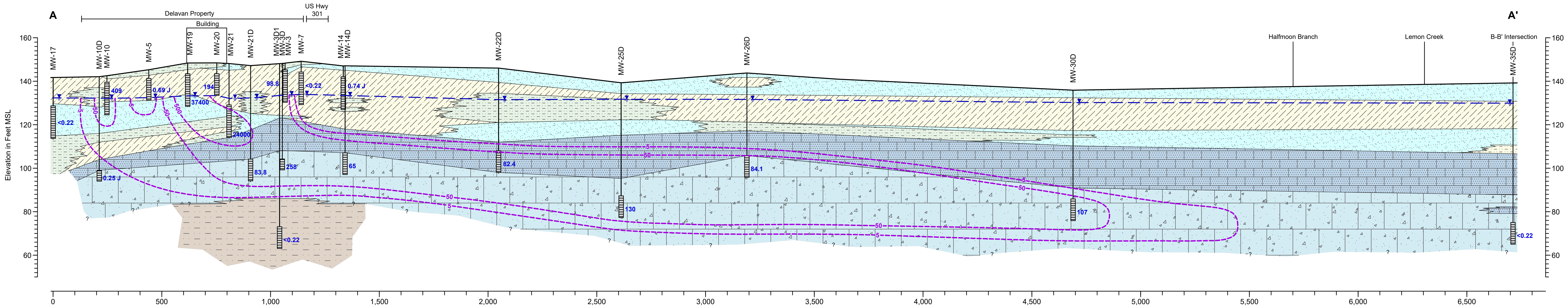
Delavan Spray Technologies Site
Bamberg, South Carolina

Monitoring Well Location Map

Project No.	Prepared by	Date	
60681452	K. Clark	July 2022	Figure 3

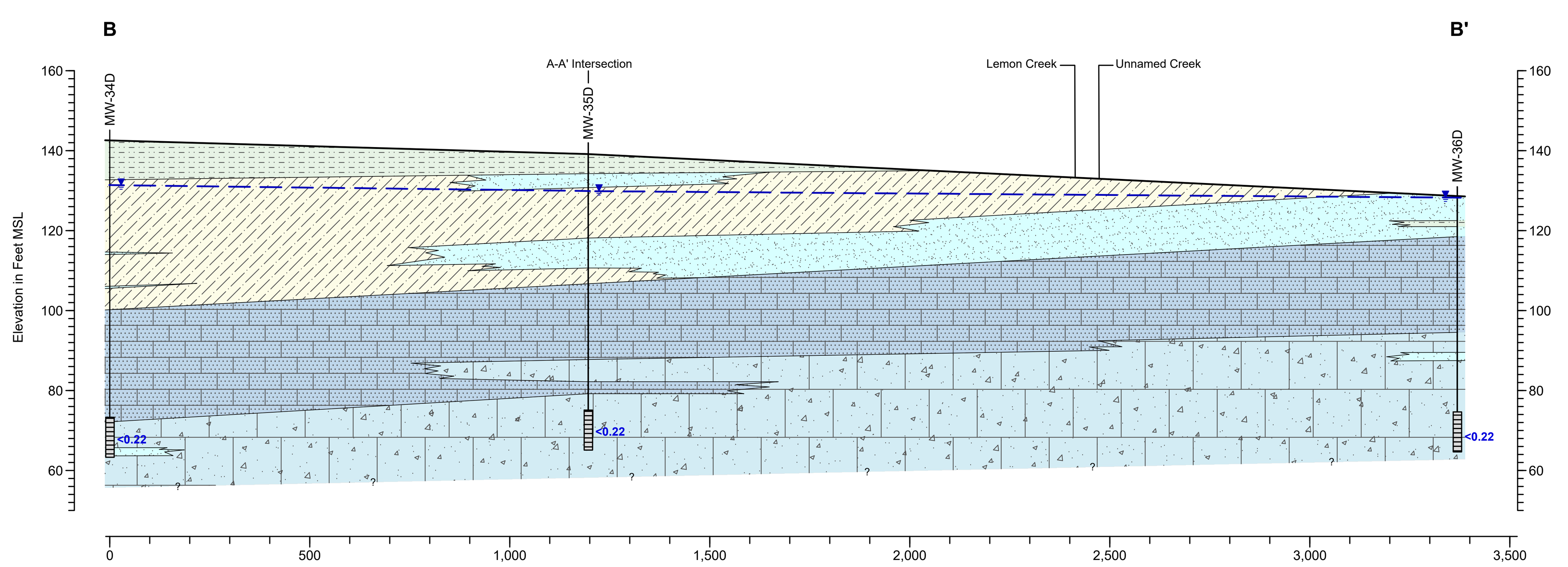
Path: \\na.aecomnet.com\lfs\AMER\Greenville-USGRN1\Legacy\Projects\60314964 - Bamberg\900-CAD-GIS\920 GIS-Graphics\Maps\Maps June 2022\Figure 3 Monitoring Well Locations.mxd



Cross-Section A-A'

0 150 300 600 900
HORIZONTAL SCALE IN FEET

0 15 30 60 90
VERTICAL SCALE IN FEET
Vertical Exaggeration = 10.0X

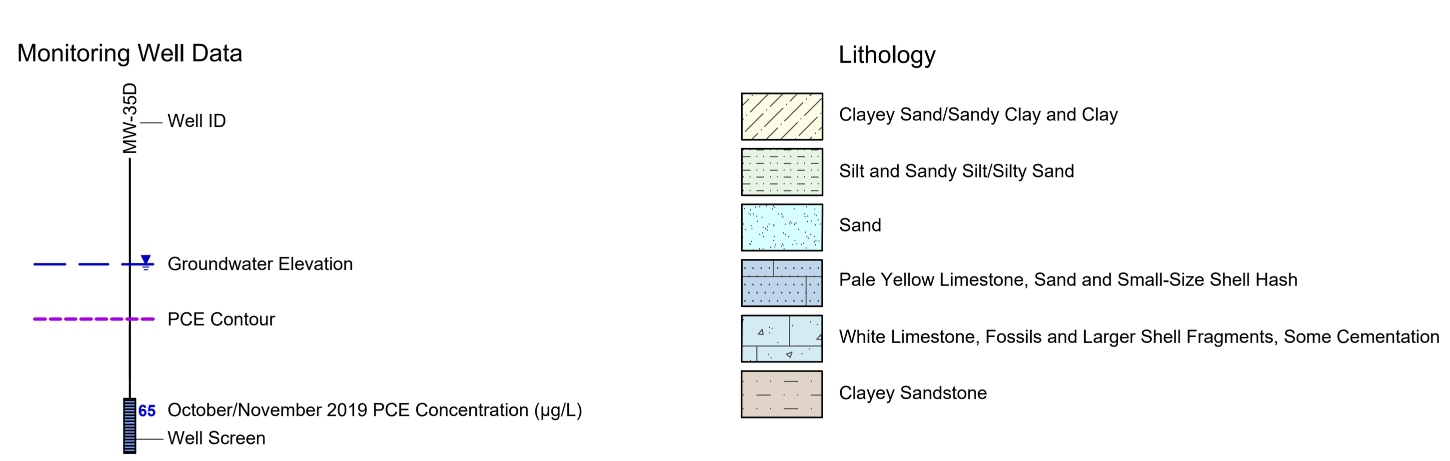


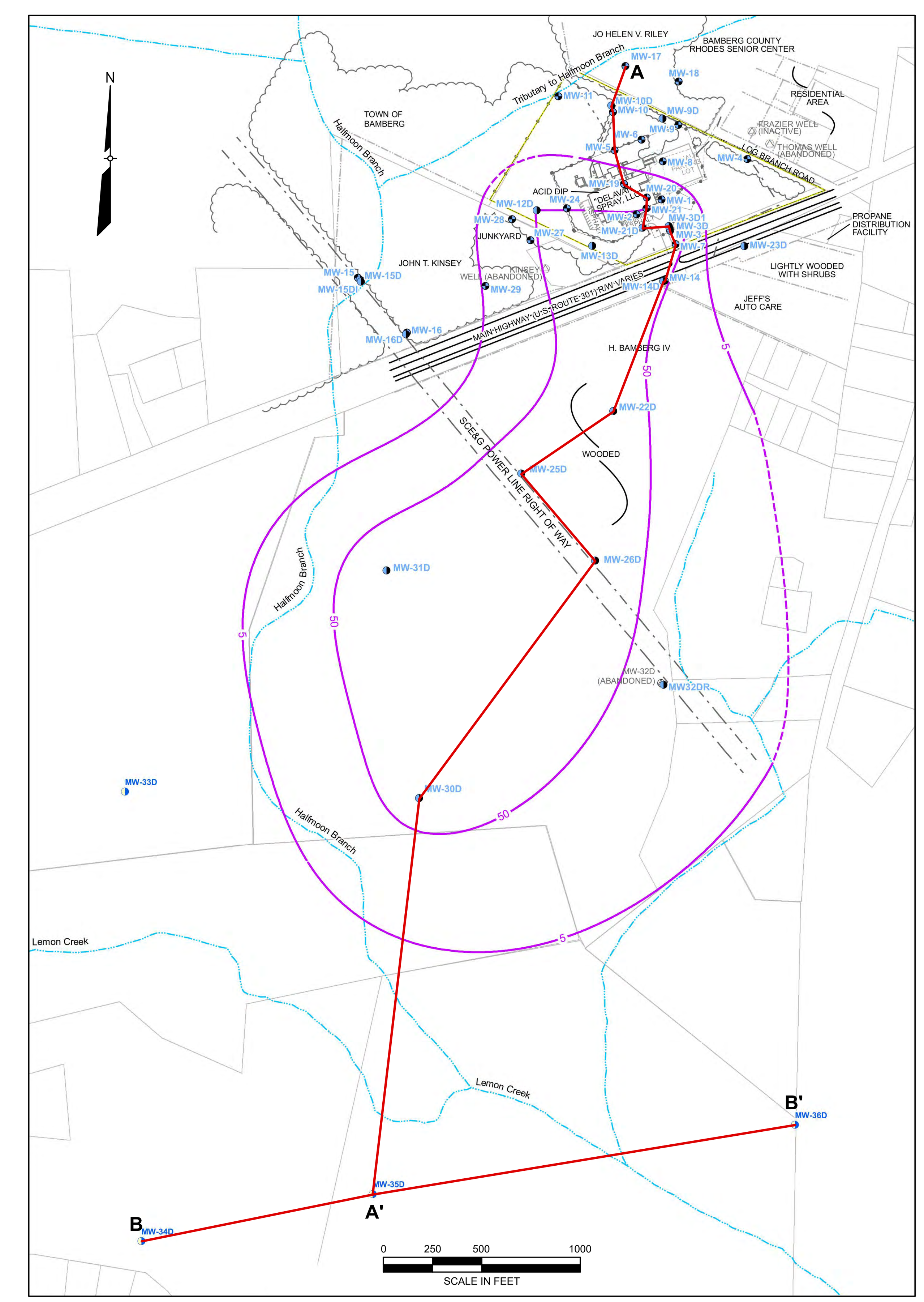
Cross-Section B-B'

0 150 300 600 900
HORIZONTAL SCALE IN FEET

0 15 30 60 90
VERTICAL SCALE IN FEET
Vertical Exaggeration = 10.0X

Legend





KEY MAP

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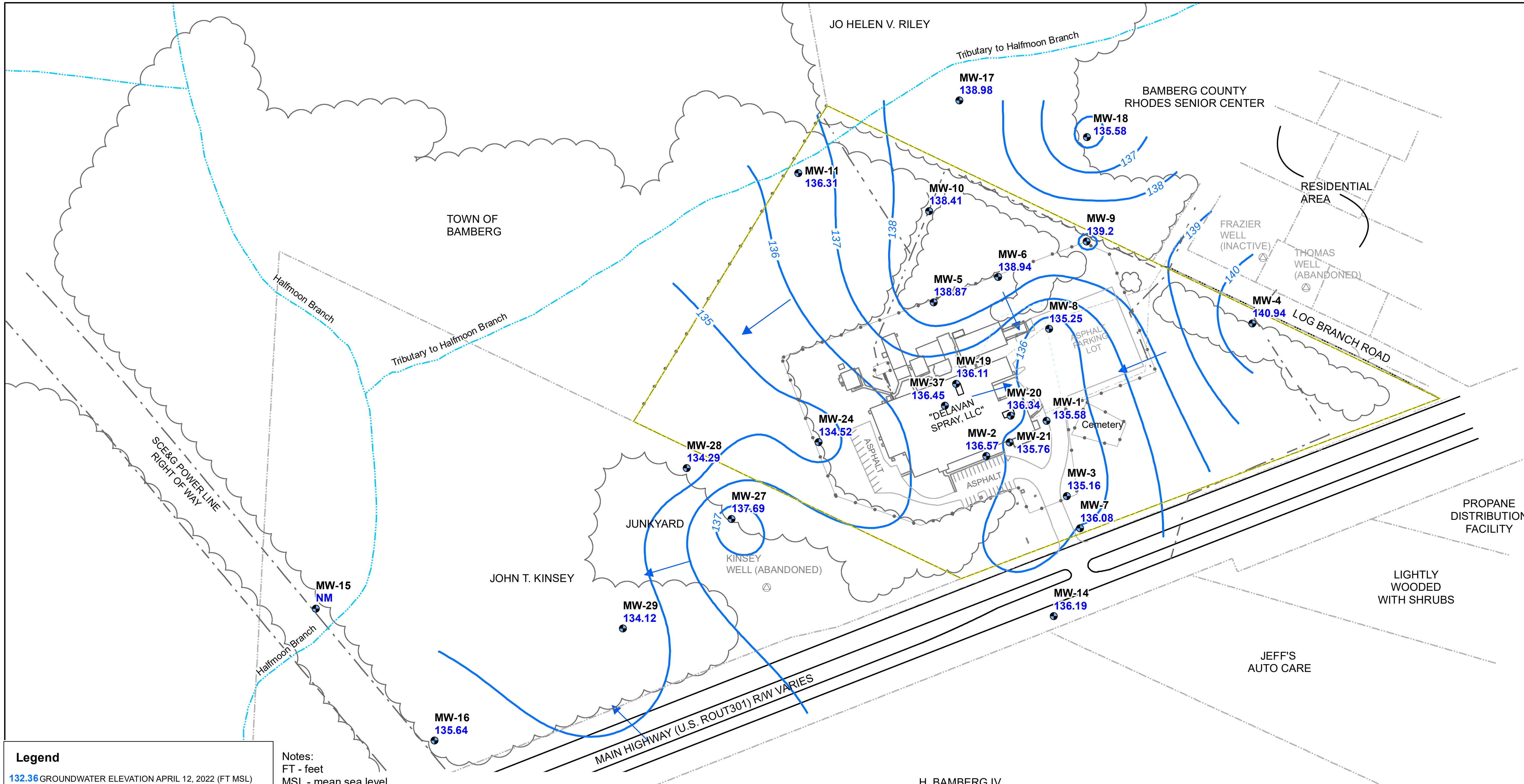
Cross-Section A-A' and Cross-Section B-B'

Delavan Spray Technologies Site
Bamberg, South Carolina

PROJECT NO.	DRAWN BY:	DATE:	
60590866	RJS	April 2020	Figure 4

\\USGRN1FP001\Data\Projects\60314964 - Bamberg\900-CAD-GIS\910 CAD_BIM\Cross-Sections A-A' and B-B' with PCE.dwg, 5/20/2020 3:30:42 PM



Legend

- 132.36 GROUNDWATER ELEVATION APRIL 12, 2022 (FT MSL)
- ABANDONED OR INACTIVE WELL
- SHALLOW WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- GROUNDWATER ELEVATION CONTOUR (FT)
- SURFACE WATER FEATURE
- FENCE LINE
- PROPERTY BOUNDRY
- OVERHEAD POWER LINE
- ROAD
- SANITARY SEWER LINE
- STORM DRAIN LINE
- SUBJECT PROPERTY BOUNDRY

Notes:
FT - feet
MSL - mean sea level
H&H - Hart & Hickman
HRSC - High Resolution Site Characterization
RI - Remedial Investigation

1. Base map obtained from surveys prepared by Edisto Engineers & Surveyors, Inc. (dated 6/3/2011 and 4/14/2014) and from Work Plan maps provided by H&H (August 2013).
2. 2012 sample locations were surveyed on 8/28/2012 and RI sample locations were surveyed on 3/20/2014. Post RI assessment locations were surveyed on 1/26/2016. Groundwater delineation locations were surveyed on 5/10/2017. Limestone delineation locations were surveyed on 12/5/2019. Limestone Aquifer delineation locations were surveyed 12/5/2019. HRSC locations were surveyed on 8/17/2020.
3. Water levels were collected by AECOM on April 12, 2022.
4. Surface water flowlines from a geodatabase "NHDH_SC.gdb" obtained from the USGS, National Hydrography Dataset.

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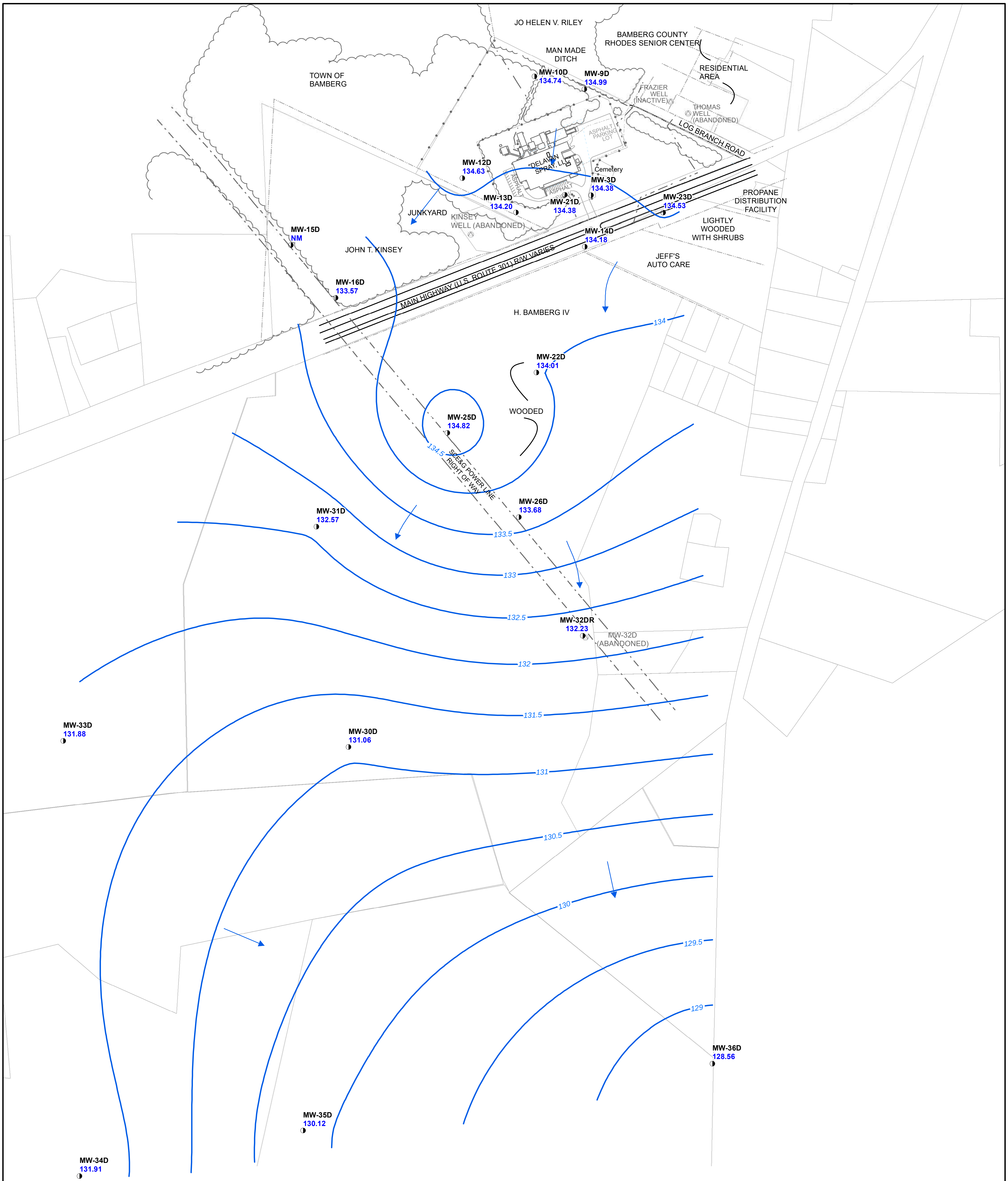
Delavan Spray Technologies Site
Bamberg, South Carolina

Shallow Potentiometric Map
April 2022

Project No.	Prepared by	Date	
60681452	K. Clark	July 2022	Figure 5

Path: \\na.aecomnet.com\lfs\AMER\Greenville-USGRN1\Legacy\Projects\60314964 - Bamberg\900-CAD-GIS\920 GIS-Graphics\Maps\Maps June 2022\Figure 4 ShallowPot.mxd



Legend

- 128.48 GROUNDWATER ELEVATION APRIL 12, 2022 (FT MSL)
- ABANDONED OR INACTIVE WELL
- DEEP WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- GROUNDWATER ELEVATION CONTOUR (FT)
- SURFACE WATER FEATURE
- FENCE LINE
- PROPERTY BOUNDRY
- OVERHEAD POWER LINE
- ROAD
- SANITARY SEWER LINE
- STORM DRAIN LINE
- SUBJECT PROPERTY BOUNDRY

Notes:
H&H - Hart & Hickman
RI - Remedial Investigation
HRSC - High Resolution Site Characterization
NS - Not Sampled; Posted result is from October 2020

1. Base map obtained from surveys prepared by Edisto Engineers & Surveyors, Inc. (dated 6/3/2011 and 4/14/2014) and from Work Plan maps provided by H&H (August 2013).
2. 2012 sample locations were surveyed on 8/28/2012 and RI sample locations were surveyed on 3/20/2014. Post RI assessment locations were surveyed on 1/26/2016. Groundwater delineation locations were surveyed on 5/10/2017. Limestone Aquifer delineation locations were surveyed 12/5/2019. HRSC locations were surveyed on 8/17/2020.
3. Water levels were collected by AECOM on April 12,2022.
4. Surface water flowlines from a geodatabase "NHDH_SC.gdb" obtained from the USGS, National Hydrography Dataset.
5. Contours a re da shed where they a re inferred.

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Delavan Spray Technologies Site
Bamberg, South Carolina

Deep Potentiometric Map April 2022

Project No.	Prepared by	Date	
60681452	K. Clark	July 2022	Figure 6

Legend

- Monitoring Well Location
- Prior DPT Location
- 11.6 — PCE Concentration in Unsaturated Soil - 2014-2020 (µg/kg)
- <0.77 — TCE Concentration in Unsaturated Soil - 2014-2020 (µg/kg)
- PCE Isoconcentration Contour - Unsaterated Soil - 2014-2020 (µg/kg)
- Former PCE Degreaser
- Storm Drain
- Sanitary Sewer

Investigation

- Northern PCE Degreaser MIP
- Northern PCE Degreaser DPT
- Southern PCE Degreaser MIP
- Southern PCE Degreaser DPT
- PCE Secondary Containment Area
- PCE Secondary Containment Area
- PCE UST MIP
- PCE UST DPT

Maximum XSD (µV)

High : 2,560,000

Low : 40,000

Map Projection: NAD 83, South Carolina State Plane, Feet, FIPS 3900

Notes:

µg/kg - Microgram per Kilogram
BGS - Below Ground Surface
DAF - Dilution Attenuation Factor
DPT - Direct Push Technology
HQ - Hazard Quotient
MCL - Maximum Contaminant Level
PCE - Tetrachloroethene
TCE - Trichloroethene
MIP - Membrane Interface Probe
XSD - Halogen Specific Detector
µV - microVolts
SSL - Soil Screening Level
USEPA - United States Environmental Protection Agency

1. Data was contoured using log and anti-log grid math and the kriging gridding method in Surfer Version 16.
2. Half the detection limit was used to contour non-detect values.
3. The MCL-based SSL for PCE is 2.3 µg/kg and for TCE is 1.8 µg/kg. Values are from the USEPA RSL Table and are based on a DAF of 1 (USEPA, May 2020).
4. The Industrial RSL for PCE is 39,000 µg/kg and for TCE is 1,900 µg/kg. Values are from the USEPA RSLTable based on risk of 10 -6 for carcinogens and HQ of 0.1 for noncarcinogens (May 2020).
5. The posted concentration value is the maximum value detected for the depth interval.

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Maximum PCE and TCE Concentrations in Unsaturated Soils - 0 Ft to 15 Ft March 2014 to July 2020

Delavan Spray Technologies Site
Bamburg, South Carolina

PROJECT NO.	PREPARED BY:	DATE:	
60584969	RJS	March 2021	Figure 7

\\USGRN1FP001\Data\Projects\60314964 - Bamberg\900-CAD-GIS\920 GIS-Graphics\Maps\Maps December 2020 HRSC Investigation\Figure 4 Max PCE and TCE in Unsat Soils .mxd

Notes:

µg/kg - Microgram per Kilogram
BGS - Below Ground Surface
DAF - Dilution Attenuation Factor
DPT - Direct Push Technology
HQ - Hazard Quotient
MCL - Maximum Contaminant Level
PCE - Tetrachloroethene
TCE - Trichloroethene
MIP - Membrane Interface Probe
XSD - Halogen Specific Detector
µV - microVolts
SSL - Soil Screening Level
USEPA - United States Environmental Protection Agency

1. Data was contoured using log and anti-log grid math and the kriging gridding method in Surfer Version 16.
2. Half the detection limit was used to contour non-detect values.
3. The MCL-based SSL for PCE is 2.3 µg/kg and for TCE is 1.8 µg/kg. Values are from the USEPA RSL Table and are based on a DAF of 1 (USEPA, May 2020).
4. The Industrial RSL for PCE is 39,000 µg/kg and for TCE is 1,900 µg/kg. Values are from the USEPA RSLTable based on risk of 10 -6 for carcinogens and HQ of 0.1 for noncarcinogens (May 2020).
5. The posted concentration value is the maximum value detected for the depth interval.

Legend

- Monitoring Well Location
- Prior DPT Location
- 885 PCE Concentration in Saturated Soil - 2014-2020 (µg/kg)
- 2.8 TCE Concentration in Saturated Soil - 2014-2020 (µg/kg)
- PCE Isoconcentration Contour - Saturated Soil - 2014-2020 (µg/kg)
- Former PCE Degreaser
- Storm Drain
- Sanitary Sewer

Investigation

- Northern PCE Degreaser MIP
- Northern PCE Degreaser DPT
- Southern PCE Degreaser MIP
- Southern PCE Degreaser DPT
- PCE Secondary Containment Area
- PCE Secondary Containment Area
- PCE UST MIP
- PCE UST DPT

Maximum XSD (uV)

High : 2,560,000
Low : 40,000

20 10 0 20
Feet

Map Projection: NAD 83, South Carolina State Plane, Feet, FIPS 3900

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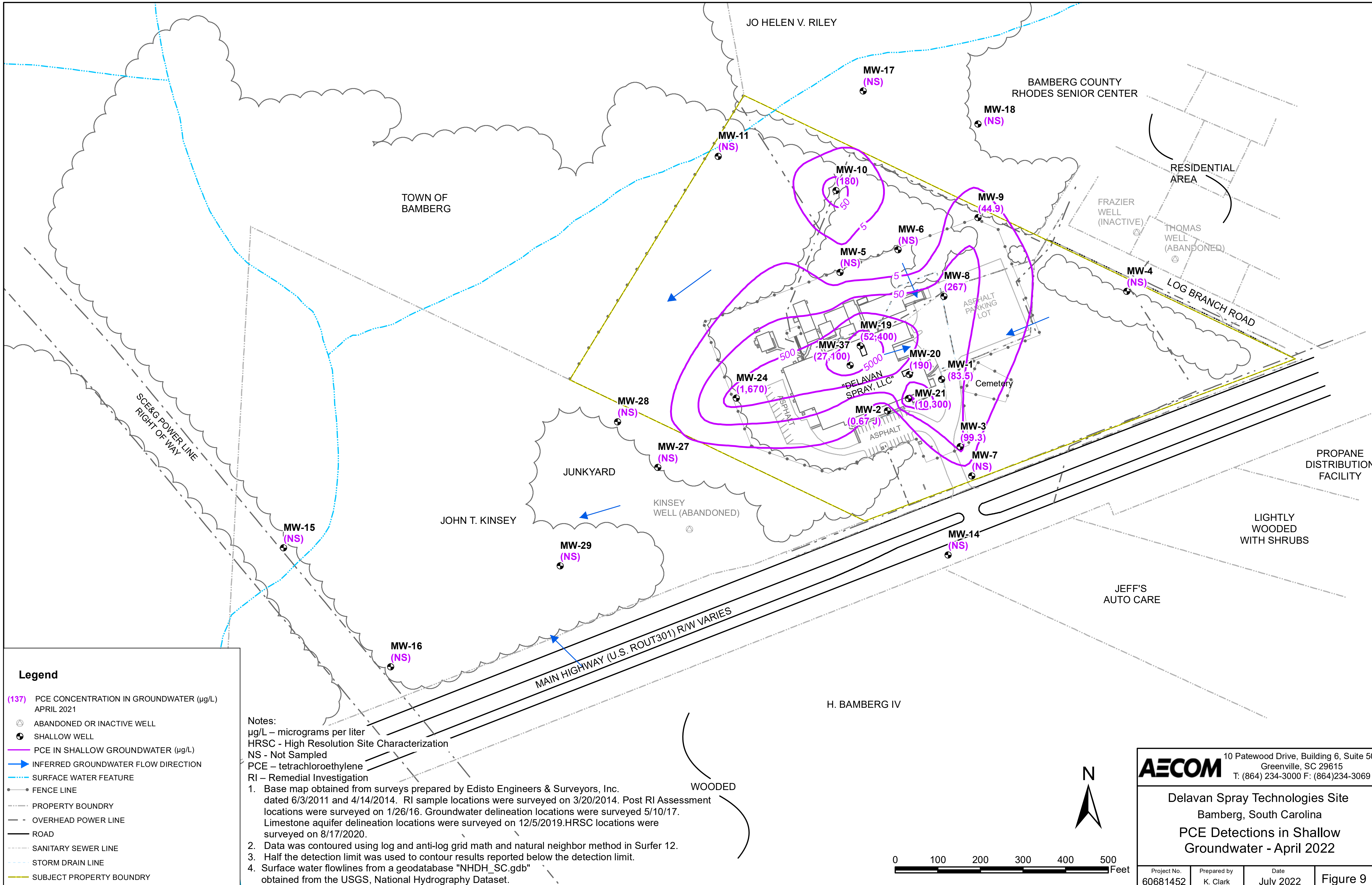
Maximum PCE and TCE Concentrations in Saturated Soil - 16Ft to 35 Ft March 2014 to July 2020
Delavan Spray Technologies Site
Bamburg, South Carolina

PROJECT NO.	PREPARED BY:	DATE:	
60584969	RJS	March 2021	Figure 8

\\USGRN1FP001\Data\Projects\60314964 - Bamberg\900-CAD-GIS\920 GIS-Graphics\Maps\Maps December 2020 HRSC Investigation\Figure 5 Max PCE and TCE in Sat Soils.mxd



Legend

- (137) PCE CONCENTRATION IN GROUNDWATER (µg/L) APRIL 2021
- ABANDONED OR INACTIVE WELL
- SHALLOW WELL
- PCE IN SHALLOW GROUNDWATER (µg/L)
- INFERRED GROUNDWATER FLOW DIRECTION
- SURFACE WATER FEATURE
- FENCE LINE
- PROPERTY BOUNDRY
- OVERHEAD POWER LINE
- ROAD
- SANITARY SEWER LINE
- STORM DRAIN LINE
- SUBJECT PROPERTY BOUNDRY

Notes:
µg/L – micrograms per liter
HRSC - High Resolution Site Characterization
NS - Not Sampled
PCE – tetrachloroethylene
RI – Remedial Investigation

1. Base map obtained from surveys prepared by Edisto Engineers & Surveyors, Inc. dated 6/3/2011 and 4/14/2014. RI sample locations were surveyed on 3/20/2014. Post RI Assessment locations were surveyed on 1/26/16. Groundwater delineation locations were surveyed 5/10/17. Limestone aquifer delineation locations were surveyed on 12/5/2019.HRSC locations were surveyed on 8/17/2020.
2. Data was contoured using log and anti-log grid math and natural neighbor method in Surfer 12.
3. Half the detection limit was used to contour results reported below the detection limit.
4. Surface water flowlines from a geodatabase "NHDH_SC.gdb" obtained from the USGS, National Hydrography Dataset.

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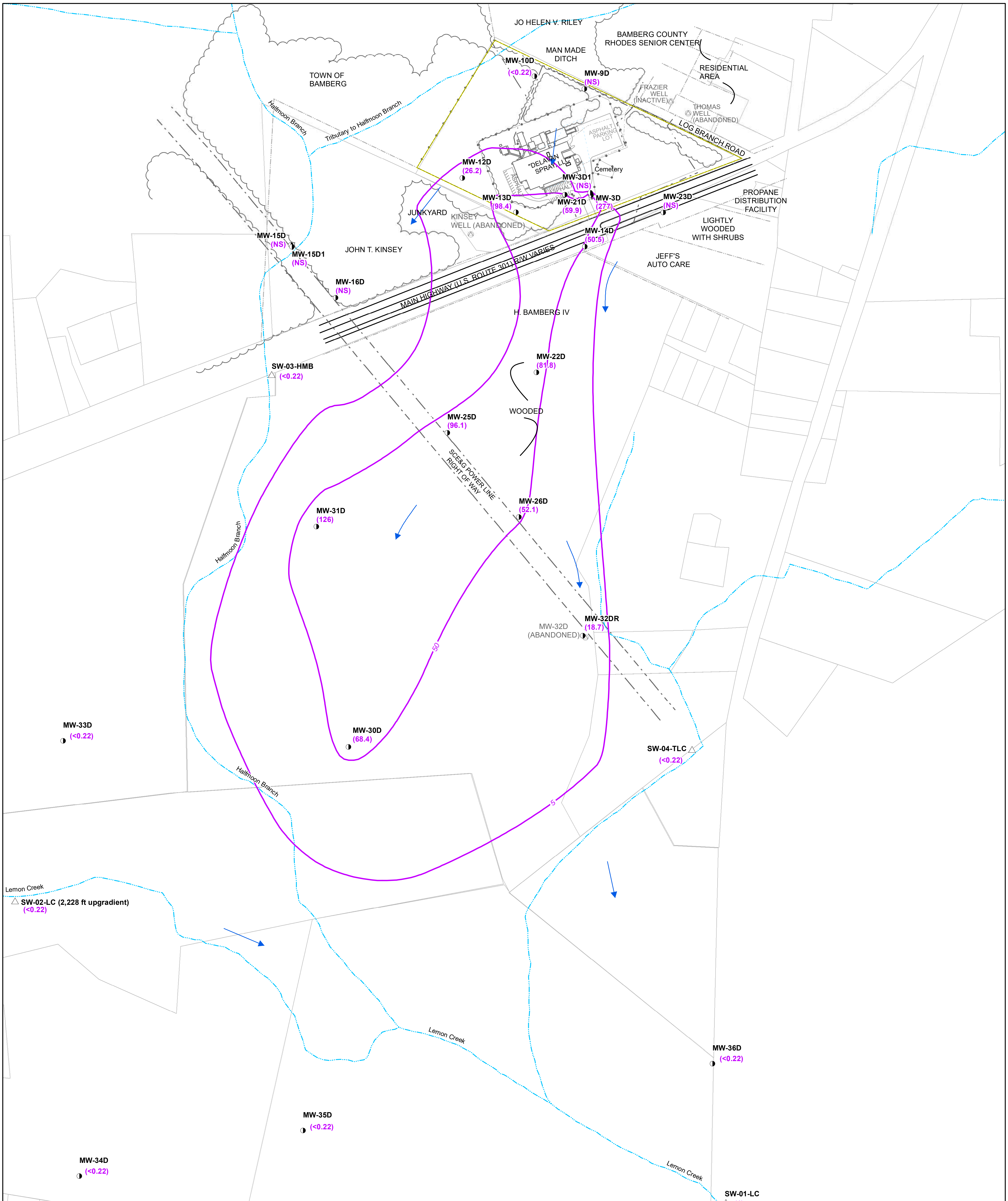
Delavan Spray Technologies Site
Bamberg, South Carolina

PCE Detections in Shallow Groundwater - April 2022

Project No.	Prepared by	Date	
60681452	K. Clark	July 2022	Figure 9

Path: \\na.aecomnet.com\lfs\AMER\Greenville-USGRN1\Legacy\Projects\60314964 - Bamberg\900-CAD-GIS\920 GIS-Graphics\Maps\Maps June 2022\Figure 6 ShallowPCE.mxd



Legend

- (<0.22) PCE CONCENTRATION IN GROUNDWATER (µg/L) APRIL 2022
- ABANDONED OR INACTIVE WELL
- SURFACE WATER SAMPLE (APPROXIMATE)
- DEEP WELL
- PCE IN SHALLOW GROUNDWATER (µg/L)
- INFERRED GROUNDWATER FLOW DIRECTION
- SURFACE WATER FEATURE
- FENCE LINE
- PROPERTY BOUNDRY
- OVERHEAD POWER LINE
- ROAD
- SANITARY SEWER LINE
- STORM DRAIN LINE
- SUBJECT PROPERTY BOUNDRY

Notes:
µg/L – micrograms per liter
HRSC - High Resolution Site Characterization
NS - Not Sampled
RI - Remedial Investigation
PCE – tetrachloroethylene

1. Base map obtained from surveys prepared by Edisto Engineers & Surveyors, Inc. dated 6/3/2011 and 4/14/2014.
   RI sample locations were surveyed on 3/20/2014.
   Post RI assessment locations were surveyed on 1/26/2016.
   Groundwater delineation locations were surveyed 5/10/17.
   Limestone aquiferdelineation locations were surveyed on 12/5/2019.
   HRSC locations were surveyed on 8/17/2020.
2. Data was contoured using log and anti-log grid math and natural neighbor gridding method in Surfer 12.
3. Half the detection limit was used to contour results reported below the detection limit.
4. Surface water flowlines from a geodatabase "NHDH_SC.gdb" obtained from the USGS, National Hydrography Dataset.

N

0 250 500 750 Feet

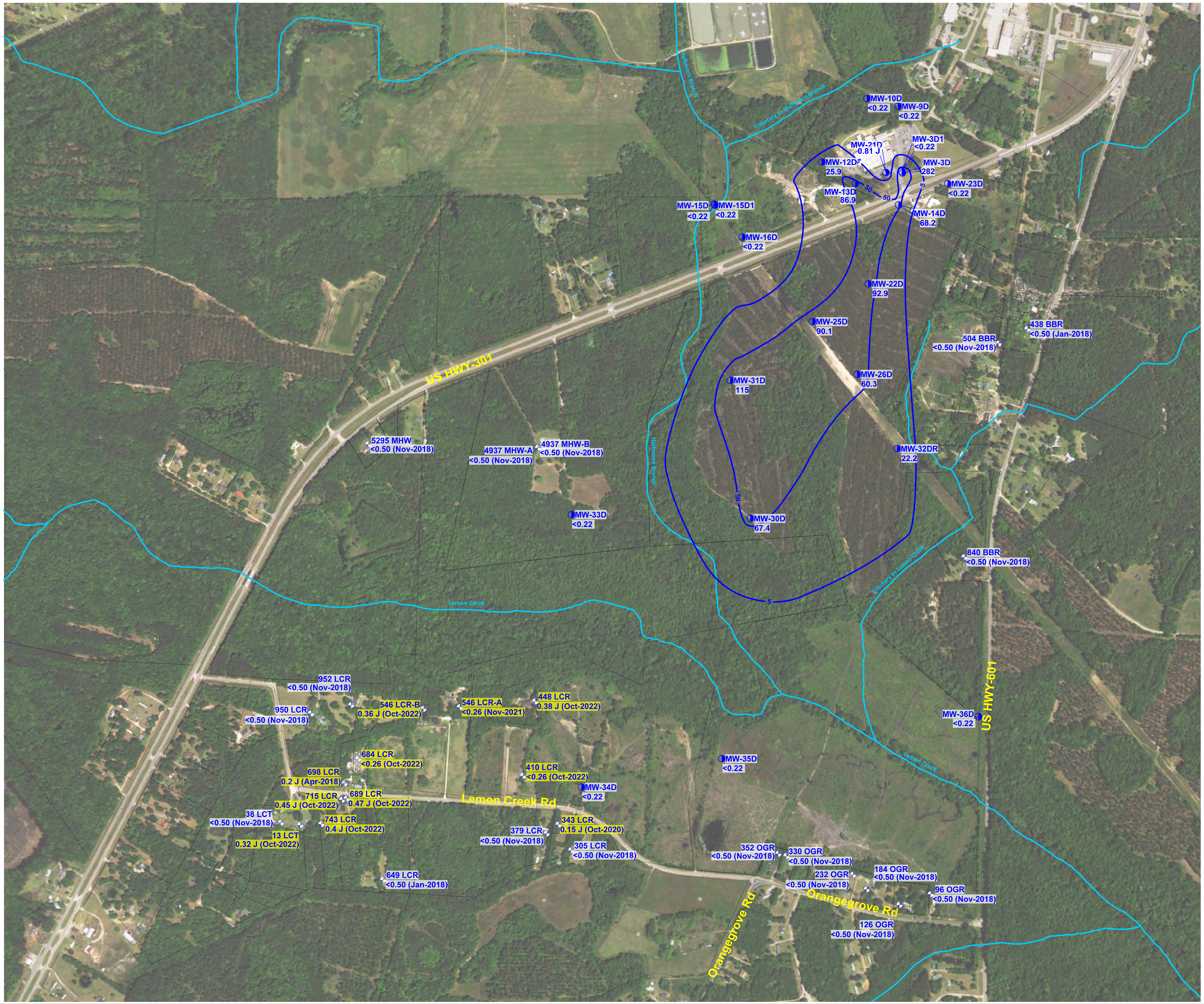
AECOM
10 Patewood Drive, Building 6, Suite 500
Greenville, SC 29615
T: (864) 234-3000 F: (864)234-3069

Delavan Spray Technologies Site
Bamberg, South Carolina

PCE Detections in Deeper Groundwater - April 2022

Project No.	Prepared by	Date	
60681452	K.Clark	July 2022	Figure 10

Path: \\na.aecomnet.com\lfs\AMER\Greenville-USGRN1\Legacy\Projects\60314964 - Bamberg\900-CAD-GIS\920 GIS-Graphics\Maps\Maps June 2022\Figure 10 DeepPCE.mxd



LEGEND

438BBR	Well Sample ID
	Residential Well Sample Location
	Deep Monitoring Well
	Property Boundary
	Surface Water
	PCE Isoconcentration Contour - October 2022 (ug/L)
< 0.26	Monitoring Well PCE Concentration (ug/L) - October 2022
< 0.26	PCE Concentration (ug/L) for Residential Well With POU System Installed
< 0.26	PCE Concentration (ug/L) for Residential Well Without POU System Installed

Notes:
ug/L - micrograms per liter
PCE - Tetrachloroethene
POU - Point-of-Use
Data Qualifiers:
I, J - The reported value is between the laboratory method detection limit and the practical quantitation limit.
1) Surface water flowlines from a geodatabase "NHDH_SC.gdb" obtained from the USGS, National Hydrography Dataset.
2) Imagery obtained from the USGS, The Nation map orthoimagery https://www.usgs.gov/core-science-systems/national-geospatial-program/national-map.
3) The most recent sampling data is provided for each residential well. Sampling dates (month-year) are shown in parentheses.

N

0 121.92024384 243.84048768
FEET

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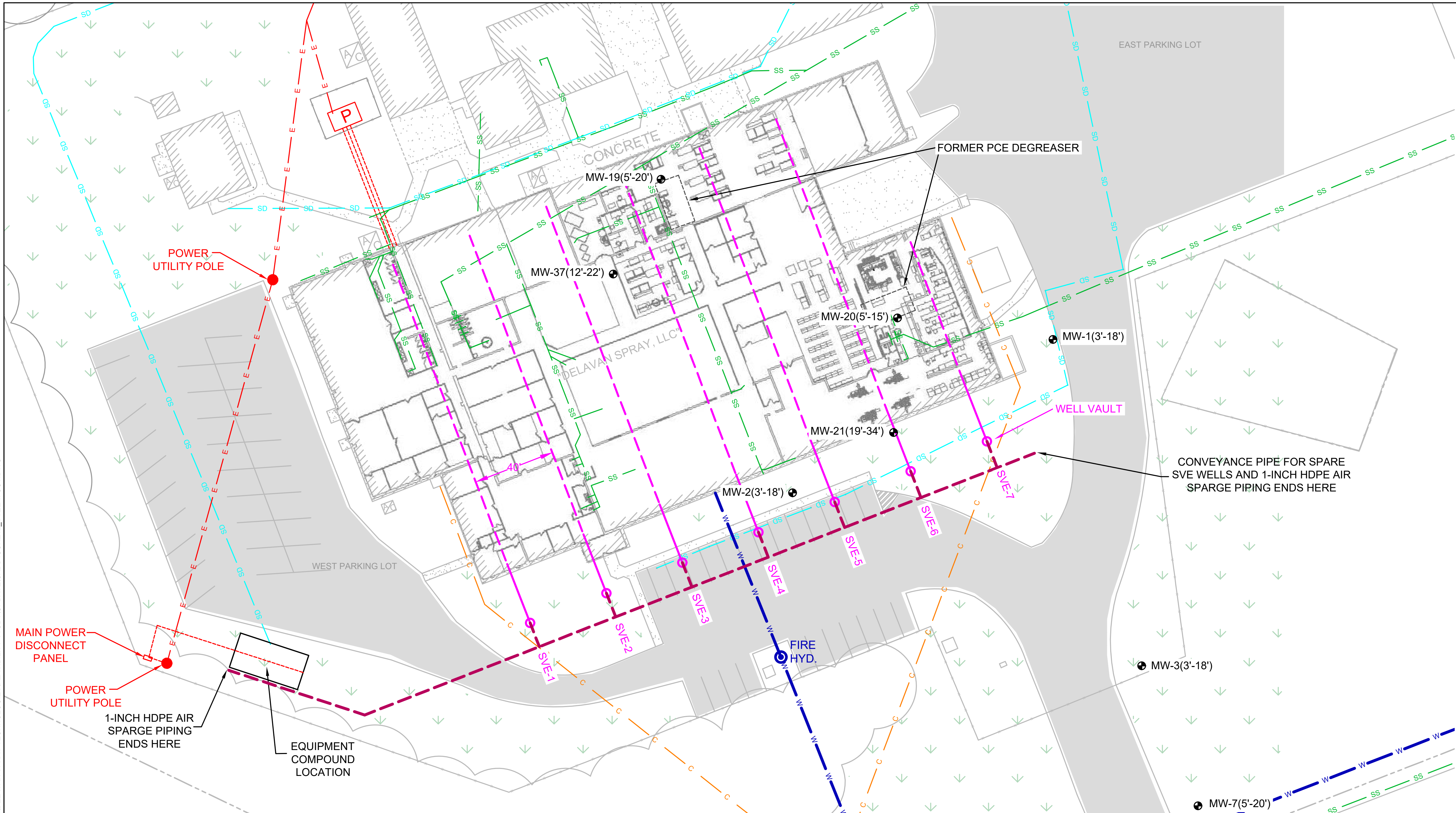
Delavan Spray Technologies Site
Bamberg, South Carolina

PCE Concentrations in Deep Monitoring Wells and Residential Groundwater Samples

Project No.	Prepared by	Date	Figure 11
60629985	L. Alexander	January 2023	



LEGEND

- MONITORING WELL LOCATION
- (3'-18') WELL SCREEN INTERVAL IN FEET
- PROPERTY BOUNDARY
- SS — SANITARY SEWER LINE (APPROXIMATE)
- SD — STORMWATER DRAIN LINE (APPROXIMATE)
- W — WATER LINE (APPROXIMATE)
- E — OVERHEAD ELECTRICAL LINES (APPROXIMATE)
- UNDERGROUND ELECTRICAL LINES (APPROXIMATE)
- C — COMMUNICATIONS UTILITY (APPROXIMATE)
- FENCE
- SVE WELL RISER SECTION
- SVE WELL SCREENED SECTION
- SVE CONVEYANCE PIPE TRENCH
- ASPHALT
- GRASS
- CONCRETE

N

0 25 50 100

SCALE IN FEET

AECOM

PROJECT

FOCUSED FEASIBILITY STUDY

4334 Main Highway
Bamberg, South Carolina 29003

PREPARED FOR

Delavan Technologies

PREPARED BY

AECOM Technical Services, Inc.
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919.461.100 tel 919.461.1235 fax
www.aecom.com

DATE

FEBRUARY 2023

PROJECT NUMBER

60650133

SHEET TITLE

SVE REMEDIATION SYSTEM LAYOUT

FIGURE NUMBER

12

Approved:JZ Checked:IR Designer:ID Project Management Initials:

Filename: C:\USERS\IAN.ROS\DESKTOP\MY PROJECTS\RAYTHEON UTC\DELAVAN SPRAY TECHNOLOGIES\FEASIBILITY STUDY\UPDATE\CAD\FIGURE12_SVELAYOUT.DWG

LEGEND

- MONITORING WELL LOCATION
- PROPERTY BOUNDARY
- FENCE
- INFERRED GROUNDWATER FLOW DIRECTION
- 5 — PCE IN SHALLOW GROUNDWATER (ug/L)
- PROPOSED EXCAVATION AREA (25' x 15')
- PROPOSED SSD POINT LOCATION
- ESTIMATED SSD RADIUS OF INFLUENCE
- PROPOSED GROUNDWATER RECOVERY WELL
- ESTIMATED RECOVERY WELL RADIUS OF INFLUENCE
- PROPOSED TRENCH FOR UNDERGROUND CONVEYANCE PIPING
- ASPHALT
- GRASS
- CONCRETE

NOTE:
TRENCHING AND ABOVEGROUND SSD CONVEYANCE PIPING INSIDE FACILITY NOT SHOWN. TREATED GROUNDWATER DISCHARGE PIPING AND LOCATION ALSO NOT SHOWN.

0 25 50 100
SCALE IN FEET

N

AECOM

PROJECT
FOCUSED FEASIBILITY STUDY

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Bamberg, South Carolina 29003

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Delavan Technologies

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DATE
FEBRUARY 2023

PROJECT NUMBER
60650133

SHEET TITLE
REMEDIAL ALTERNATIVE 2 CONCEPTUAL LAYOUT

FIGURE NUMBER
13

Project Management Initials: Designer:ID Checked:IR Approved:JZ
Filename: C:\USERS\IAN.ROSI\DESKTOP\MY PROJECTS\RAYTHEON UTC\DELAVAN SPRAY TECHNOLOGIES\FEASIBILITY STUDY\UPDATE\CAD\FIGURE13_REMEDIALALTERNATIVE2_REV1.DWG

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Project Management Initials: Designer:ID Checked:IR Approved:JZ

LEGEND

- MONITORING WELL LOCATION
- PROPERTY BOUNDARY
- FENCE
- INFERRED GROUNDWATER FLOW DIRECTION
- 5 — PCE IN SHALLOW GROUNDWATER (ug/L)
- PROPOSED DPE WELLHEAD
- PROPOSED DPE WELL CASING
- PROPOSED DPE WELL SCREEN
- PROPOSED SSD POINT LOCATION
- ESTIMATED SSD RADIUS OF INFLUENCE
- PROPOSED TRENCH FOR UNDERGROUND CONVEYANCE PIPING
- ASPHALT
- GRASS
- CONCRETE

NOTE:
TRENCHING AND ABOVEGROUND SSD CONVEYANCE PIPING INSIDE FACILITY NOT SHOWN. TREATED GROUNDWATER DISCHARGE PIPING AND LOCATION ALSO NOT SHOWN.

0 25 50 100
SCALE IN FEET

N

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PROJECT
FOCUSED FEASIBILITY STUDY

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DATE
FEBRUARY 2023

PROJECT NUMBER
60650133

SHEET TITLE
REMEDIAL ALTERNATIVE 3 CONCEPTUAL LAYOUT

FIGURE NUMBER
14

LEGEND

- MONITORING WELL LOCATION
- PROPERTY BOUNDARY
- FENCE
- INFERRED GROUNDWATER FLOW DIRECTION
- 5 — PCE IN SHALLOW GROUNDWATER (ug/L)
- PROPOSED SSD POINT LOCATION
- ESTIMATED SSD RADIUS OF INFLUENCE
- PROPOSED ISCO INJECTION WELLHEAD
- PROPOSED ISCO INJECTION WELL CASING
- PROPOSED ISCO INJECTION WELL SCREEN
- PROPOSED TRENCH FOR UNDERGROUND CONVEYANCE PIPING
- ASPHALT
- GRASS
- CONCRETE

NOTE:
TRENCHING AND ABOVEGROUND SSD CONVEYANCE PIPING INSIDE FACILITY NOT SHOWN.

0 25 50 100
SCALE IN FEET

N

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PROJECT
FOCUSED FEASIBILITY STUDY

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DATE
FEBRUARY 2023

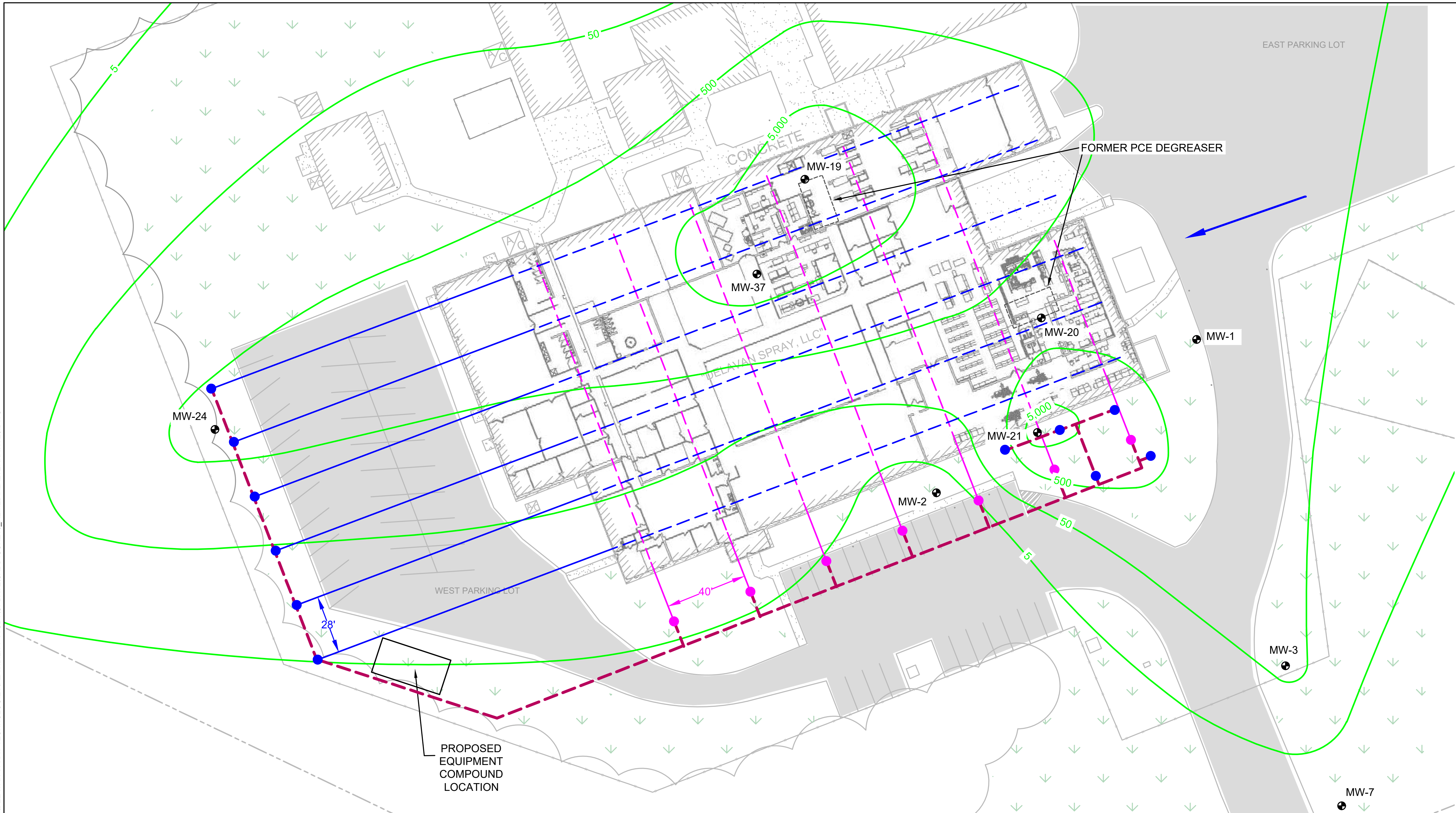
PROJECT NUMBER
60650133

SHEET TITLE
REMEDIAL ALTERNATIVE 4 CONCEPTUAL LAYOUT

FIGURE NUMBER
15

Project Management Initials: Designer:ID Checked:IR Approved:JZ

Filename: C:\USERS\IAN.ROS\DESKTOP\MY PROJECTS\RAYTHEON UTC\DELAVAN SPRAY TECHNOLOGIES\FEASIBILITY STUDY\UPDATE\CAD\FIGURE15_REMEDIALALTERNATIVE4_REV1.DWG



LEGEND

- MONITORING WELL LOCATION
- PROPERTY BOUNDARY
- FENCE
- INFERRED GROUNDWATER FLOW DIRECTION
- 5 — PCE IN SHALLOW GROUNDWATER (ug/L)
- SVE WELLHEAD
- SVE WELL CASING
- SVE WELL SCREEN
- PROPOSED AS WELLHEAD
- PROPOSED AS WELL CASING
- PROPOSED AS WELL SCREEN
- PROPOSED TRENCH FOR UNDERGROUND CONVEYANCE PIPING
- ASPHALT
- GRASS
- CONCRETE

N

0 25 50 100

SCALE IN FEET

AECOM

PROJECT

FOCUSED FEASIBILITY STUDY

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www.aecom.com

DATE

FEBRUARY 2023

PROJECT NUMBER

60650133

SHEET TITLE

REMEDIAL ALTERNATIVE 5
CONCEPTUAL LAYOUT

FIGURE NUMBER

16

Project Management Initials: Designer:ID Checked:IR Approved:JZ

Filename: C:\USERS\IAN.ROS\DESKTOP\MY PROJECTS\RAYTHEON UTC\DELAVAN SPRAY TECHNOLOGIES\FEASIBILITY STUDY\UPDATE\CAD\FIGURE16_REMEDIALALTERNATIVES.DWG

APPENDIX A

Remedial Alternative Cost Estimates and Assumptions

Appendix A-1
Alternative 2 Cost Estimate

			DESCRIPTION	NOTES	UNITS	QUANTITY	UNIT COST ($)	TOTAL COST ($)
I.	**Pre-Construction Costs**							
	1.	Office Preparation						
		a.	Remedial Action Plan		ls	1	$41,800	$41,800
		b.	Work Plan		ls	1	$18,000	$18,000
		c.	HASP Update		ls	1	$15,600	$15,600
		d.	Erosion Plan		ls	1	$18,000	$18,000
			Subtotal Office Preparation					*$93,400*
	2.	Pre-Design Investigation						
		a.	Pre-Design Investigation		ls	1	$119,500	$119,500
			Subtotal Pre-Design Investigation					*$119,500*
			Subtotal Pre-Construction Prior to Services					*$212,900*
	3.	Services						
		a.	Contingency (20% Pre-Design Investigation)		ls	1	$42,580	$42,600
		b.	Project Management/Coordination	A	ls	1	$17,032	$17,100
		c.	Engineering Design	B	ls	1	$31,935	$32,000
		d.	Construction Management	C	ls	1	$21,290	$21,300
			Subtotal Pre-Construction Services					*$113,000*
			Total Pre-Construction Costs					**$325,900**

Appendix A-1
Alternative 2 Cost Estimate

II.	**Construction Costs**							
	1.	Site Preparation						
		a. Utility Locate and Survey		ls	1	$4,600	$4,600
		b. Equipment Decontamination Pad		ls	1	$12,300	$12,300
		Subtotal Site Preparation					*$16,900*
	2.	Excavation					
		a. Mobilization		ls	1	$12,000	$12,000
		b. Break Concrete		bcyd	53	$300	$15,900
		c. Excavation		bcyd	287	$12	$3,500
		d. Backfill and Recompaction		bcyd	241	$72	$17,400
		e. Gravel Backfill		bcyd	46	$49	$2,300
		f. Infiltration piping		lf	35	$54	$1,900
		g. Off-site disposal (hazardous soil)		tons	361	$478	$172,700
		h. Off-site disposal (non-hazardous concrete)		tons	56	$45	$2,600
		i. Excavation Confirmation Survey		ls	1	$1,700	$1,700
		j. Monitoring		day	3	$1,700	$5,000
		k. Confirmation Sampling		ea	5	$544	$2,800
		Subtotal Excavation					*$237,800*
	3.	Sub-Slab Depressurization Install					
		a. SSD Testing		ea	1	$15,600	$15,600
		b. Pipe Installation		lf	6000	$7	$43,000
		c. Point installation		ea	46	$836	$38,500
		d. SSD Equipment		ls	1	$77,700	$77,700
		e. SSD Equipment Installation		ls	1	$23,900	$23,900
		f. Confirmation Sampling		ls	1	$6,000	$6,000
		g. AECOM Oversight		day	5	$1,700	$8,500
		Subtotal SSD Install Costs					*$213,200*
	4.	Repair to Prior Conditions					
		a. Repair Concrete		cy	53	$500	$26,500
		b. Re-install Monitoring Wells		ea	2	$6,700	$13,400
		c. Disposal Cost Drums (non-hazardous)		ea	4	$150	$600
		Subtotal Repair to Prior Conditions Costs					*$40,500*
	5.	Recovery Well Install					
		a. Recovery Well Install		ea	6	$17,300	$104,300
		b. Down Well Equipment		ea	6	$6,000	$36,500
		c. Non-Hazardous Off-site Waste T&D		drum	36	$150	$5,900
		d. Survey		ls	1	$1,700	$2,200
		Subtotal Recovery Well Install Costs					*$148,900*
	6.	Pump and Treat System Installation					
		a. OWS Building and System		ls	1	$96,800	$96,800
		b. Mechanical and Electrical Contractors		ls	1	$47,800	$47,800
		c. Trenching & backfill (off-site)		ls	500	$30	$15,000
		d. Home Run Piping		ls	1,100	$11	$12,100
		e. Disposal Cost (non-hazardous)		tons	222	$45	$10,000
		f. Detection Tape		ls	1	$239	$300
		g. AECOM Oversight		day	5	$1,700	$8,500
		Subtotal Pump and Treat Installation Costs					*$190,500*
		Subtotal Construction Costs Prior to Services					*$847,800*
	7.	Services					
		a. Contingency (20% Construction Costs)		ls	1	$169,560	$169,600
		b. Project Management/Coordination	A	ls	1	$50,868	$50,900
		c. Engineering Design	B	ls	1	$101,736	$101,800
		d. Construction Management	C	ls	1	$67,824	$67,900
		Subtotal Construction Services					*$390,200*
		Total Construction Costs					**$1,238,000**

Appendix A-1
Alternative 2 Cost Estimate

III.	**Institutional Control**							
	1.	Institutional Controls						
		a.	NFA Letter and Deed Restriction for Soils and Groundwater		ls	1	$30,000	$30,000
			Subtotal Institutional Controls					*$30,000*
			Total Institutional Control Costs					**$30,000**
IV.	**O&M Costs**							
	1.	MNA Year 1						
		a.	Quarterly Well Gauging		ea	4	$600	$2,400
		b.	Groundwater Reporting (annual)		yr	1	$12,000	$12,000
		c.	Quarterly VOC Sampling		ea	4	$9,000	$36,000
		d.	Quarterly Geochemical Sampling		ea	4	$3,000	$12,000
		e.	Quarterly Waste Stream Sampling		ea	4	$1,200	$4,800
			Subtotal Year 1 MNA					*$67,200*
	2.	MNA Years 2-30 (Annual Cost)						
		a.	Annual Well Gauging		ea	1	$600	$600
		b.	Groundwater Reporting (annual)		yr	1	$12,000	$12,000
		c.	Annual VOC Sampling		ea	1	$9,000	$9,000
		d.	Annual Geochemical Sampling		ea	1	$3,000	$3,000
		e.	Annual Waste Stream Sampling		ea	1	$1,200	$1,200
			Subtotal Year 2-30 MNA					*$390,640*
	3.	O&M SSD Years 1-10 (Annual Cost)						
		a.	Utilities		mo	12	$300	$3,600
		b.	Monthly O&M	D	mo	12	$870	$10,500
			Subtotal Year 1 -10 SSD					*$114,320*
	4.	O&M GW Recovery (Years 1-30) (Annual)						
		a.	Weekly System O&M	D	ea	52	$2,270	$118,100
		b.	Utilities		mo	12	$1,200	$14,400
		c.	Carbon O&M	D	ea	0.5	$6,000	$3,000
		d.	Water Disposal (assumes POTW discharge)		1000 gal	15768	$0.94	$14,900
			Subtotal Year 1-30 GW Recovery					*$2,427,617*
			Subtotal O&M Costs Prior to services					*$2,999,777*
	5.	Services						
		a.	Contingency (20% O&M Costs)	D	ls	1	$599,955	$600,000
		b.	Project Management/Coordination	A	ls	1	$149,989	$150,000
			Subtotal O&M Services					*$750,000*
			Total O&M Costs					**$3,749,777**

Appendix A-1
Alternative 2 Cost Estimate

COST SUMMARY			
I.	Pre-Construction Costs		$325,900
II.	Construction Costs		$1,238,000
III.	Institutional Control		$30,000
IV.	O&M Costs	D	$3,749,777
	TOTAL PROBABLE COSTS		**$5,343,677**
	TOTAL PROBABLE COSTS RANGE (-30%)		**$3,740,574**
	TOTAL PROBABLE COSTS RANGE (+50%)		**$8,015,516**

Notes/Key Assumptions:

A Project management/coordination costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (10%), 100K-500K (8%); 500K-2M (6%); 2M-10M (5%); >10M (5%)

B Engineering design costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (20%), 100K-500K (15%); 500K-2M (12%); 2M-10M (8%); >10M (6%)

C Construction management costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (15%), 100K-500K (10%); 500K-2M (8%); 2M-10M (6%); >10M (6%)

D Operation and maintenance costs calculated as net present value assuming the estimated durations shown and a discounted rate of 5%.

Appendix A-2
Alternative 3 Cost Estimate

			DESCRIPTION	NOTES	UNITS	QTY	UNIT COST ($)	TOTAL COST ($)
I.	**Pre-Construction Costs**							
	1.	Office Preparation						
		a.	Remedial Action Plan		ls	1	$41,800	$41,800
		b.	Work Plan		ls	1	$18,000	$18,000
		c.	HASP Update		ls	1	$15,600	$15,600
		d.	Erosion Plan		ls	1	$18,000	$18,000
			Subtotal Office Preparation					*$93,400*
	2.	Pre-Design Investigation						
		a.	Pre-Design Investigation		ls	1	$119,500	$119,500
			Subtotal Pre-Design Investigation					*$119,500*
			Subtotal Pre-Construction Prior to Services					*$212,900*
	3.	Services						
		a.	Contingency (20% Pre-Design Investigation)		ls	1	$42,580	$42,600
		b.	Project Management/Coordination	A	ls	1	$17,032	$17,100
		c.	Engineering Design	B	ls	1	$31,935	$32,000
		d.	Construction Management	C	ls	1	$21,290	$21,300
			Subtotal Pre-Construction Services					*$113,000*
			Total Pre-Construction Costs					**$325,900**

II.	**Construction Costs**							
	1.	Site Preparation						
		a.	Utility Locate and Survey		ls	1	$4,600	$4,600
		b.	Equipment Decontamination Pad		ls	1	$12,300	$12,300
			Subtotal Site Preparation					*$16,900*
	2.	Sub-Slab Depressurization Install						
		a.	SSD Testing		ea	1	$15,600	$15,600
		b.	Pipe Installation		lf	6000	$7	$43,000
		c.	Point installation		ea	46	$836	$38,500
		d.	SSD Equipment		ls	1	$77,700	$77,700
		e.	SSD Equipment Installation		ls	1	$23,900	$23,900
		f.	Confirmation Sampling		ls	1	$6,000	$6,000
		g.	AECOM Oversight		day	5	$1,700	$8,500
			Subtotal SSD Install Costs					*$213,200*
	3.	DPE Well Install (Vertical)						
		a.	Break Concrete		bcyd	0	$300	$0
		b.	Recovery Well Install		ea	5	$17,300	$86,500
		c.	Down Well Equipment		ea	5	$6,000	$30,000
		d.	Repair Concrete		cy	0	$500	$0
		e.	Off-site disposal (non-hazardous concrete)		tons	0	$45	$0
		f.	Hazardous Off-site Waste T&D (Wells in Source Zone)		drum	30	$540	$16,200
		g.	Non-Hazardous Off-site Waste T&D (Wells outside Source Zone)		drum	0	$150	$0
		h.	Survey		ls	1	$1,700	$1,700
			Subtotal Vertical DPE Well Install Costs					*$134,400*
	4.	DPE Well Install (Horizontal)						
		a.	Horizontal Well		lf	1600	$240	$384,000
		b.	Hazardous Off-site Waste T&D (Wells in Source Zone)		bcyd	146	$480	$70,100
			Subtotal Horizontal DPE Well Install Costs					*$454,100*
	5.	DPE System Installation						
		a.	Treatment Building and Equipment		ls	1	$143,300	$143,300
		b.	Mechanical and Electrical Contractors		ls	1	$47,800	$47,800
		c.	Trenching & backfill (off-site)		ls	480	$30	$14,400
		d.	Home Run Piping		ls	1,400	$11	$15,400
		e.	Disposal Cost (non-hazardous)		tons	213	$45	$9,600
		f.	Detection Tape		ls	1	$240	$300
		g.	AECOM Oversight		day	5	$1,700	$8,500
			Subtotal DPE System Installation Costs					*$239,300*
			Subtotal Construction Costs Prior to Services					*$1,057,900*
	5.	Services						
		a.	Contingency (20% Construction Costs)		ls	1	$211,580	$211,600
		b.	Project Management/Coordination	A	ls	1	$63,474	$63,500
		c.	Engineering Design	B	ls	1	$126,948	$127,000
		d.	Construction Management	C	ls	1	$84,632	$84,700
			Subtotal Construction Services					*$486,800*
			Total Construction Costs					**$1,544,700**

Appendix A-2
Alternative 3 Cost Estimate

III.	**Institutional Control**							
	1.	Institutional Controls						
		a.	NFA Letter and Deed Restriction for Soils and Groundwater		ls	1	$30,000	$30,000
			Subtotal Institutional Controls					*$30,000*
			Total Institutional Control Costs					**$30,000**
IV.	**O&M Costs**							
	1.	MNA Year 1						
		a.	Quarterly Well Gauging		ea	4	$600	$2,400
		b.	Groundwater Reporting (annual)		yr	1	$12,000	$12,000
		c.	Quarterly VOC Sampling		ea	4	$9,000	$36,000
		d.	Quarterly Geochemical Sampling		ea	4	$3,000	$12,000
		e.	Quarterly Waste Stream Sampling		ea	4	$1,200	$4,800
			Subtotal Year 1 MNA					*$67,200*
	2.	MNA Years 2-30 (Annual Cost)						
		a.	Annual Well Gauging		ea	1	$600	$600
		b.	Groundwater Reporting (annual)		yr	1	$12,000	$12,000
		c.	Annual VOC Sampling		ea	1	$9,000	$9,000
		d.	Annual Geochemical Sampling		ea	1	$3,000	$3,000
		e.	Annual Waste Stream Sampling		ea	1	$1,200	$1,200
			Subtotal Year 2-30 MNA					*$390,640*
	3.	O&M SSD Years 1-10 (Annual Cost)						
		a.	Utilities		mo	12	$300	$3,600
		b.	Monthly O&M	D	mo	12	$870	$10,500
			Subtotal Year 1-10 SSD					*$114,320*
	4.	O&M DPE Recovery (Annual Cost)						
		a.	Weekly System O&M	D	ea	52	$2,270	$118,100
		b.	Utilities		mo	12	$1,500	$18,000
		c.	Carbon O&M	D	ea	0.5	$6,000	$3,000
		d.	Water Disposal (assumes POTW discharge)		1000 gal	23652	$0.94	$22,300
			Subtotal Year 1-5 DPE					*$733,716*
			Subtotal O&M Costs Prior to services					*$1,305,876*
	5.	Services						
		a.	Contingency (20% O&M Costs)	D	ls	1	$261,175	$261,200
		b.	Project Management/Coordination	A	ls	1	$78,353	$78,400
			Subtotal O&M Services					*$339,600*
			Total O&M Costs					**$1,645,476**

Appendix A-2
Alternative 3 Cost Estimate

		COST SUMMARY	
I.	Pre-Construction Costs		$325,900
II.	Construction Costs		$1,544,700
III.	Institutional Control		$30,000
IV.	O&M Costs		$1,645,476
		TOTAL PROBABLE COSTS	**$3,546,076**
		TOTAL PROBABLE COSTS RANGE (-30%)	**$2,482,253**
		TOTAL PROBABLE COSTS RANGE (+50%)	**$5,319,115**

Notes/Key Assumptions:

A Project management/coordination costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (10%), 100K-500K (8%); 500K-2M (6%); 2M-10M (5%); >10M (5%)

B Engineering design costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (20%), 100K-500K (15%); 500K-2M (12%); 2M-10M (8%); >10M (6%)

C Construction management costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (15%), 100K-500K (10%); 500K-2M (8%); 2M-10M (6%); >10M (6%)

D Operation and maintenance costs calculated as net present value assuming the estimated durations shown and a discounted rate of 5%.

Appendix A-3
Alternative 4 Cost Estimate

			DESCRIPTION	NOTES	UNITS	QTY	UNIT COST ($)	TOTAL COST ($)
I.	**Pre-Construction Costs**							
	1.	Office Preparation						
		a.	Remedial Action Plan		ls	1	$41,800	$41,800
		b.	Work Plan		ls	1	$18,000	$18,000
		c.	HASP Update		ls	1	$15,600	$15,600
		d.	Erosion Plan		ls	1	$18,000	$18,000
			Subtotal Office Preparation					*$93,400*
	2.	Pre-Design Investigation						
		a.	Pre-Design Investigation		ls	1	$119,500	$119,500
			Subtotal Pre-Design Investigation					*$119,500*
			Subtotal Pre-Construction Prior to Services					*$212,900*
	3.	Services						
		a.	Contingency (20% Pre-Design Investigation)		ls	1	$42,580	$42,600
		b.	Project Management/Coordination	A	ls	1	$17,032	$17,100
		c.	Engineering Design	B	ls	1	$31,935	$32,000
		d.	Construction Management	C	ls	1	$21,290	$21,300
			Subtotal Pre-Construction Services					*$113,000*
			Total Pre-Construction Costs					**$325,900**

Appendix A-3
Alternative 4 Cost Estimate

II.	**Construction Costs**								
	1.	Site Preparation							
		a.	Utility Locate and Survey		ls	1	$4,600	$4,600
		b.	Equipment Decontamination Pad		ls	1	$12,300	$12,300
			Subtotal Site Preparation					*$16,900*
	2.	Sub-Slab Depressurization Install						
		a.	SSD Testing		ea	1	$15,600	$15,600
		b.	Pipe Installation		lf	6000	$7	$43,000
		c.	Point installation		ea	46	$836	$38,500
		d.	SSD Equipment		ls	1	$77,700	$77,700
		e.	SSD Equipment Installation		ls	1	$23,900	$23,900
		f.	Confirmation Sampling		ls	1	$6,000	$6,000
		g.	AECOM Oversight		day	5	$1,700	$8,500
			Subtotal SSD Install Costs					*$213,200*
	3.	Horizontal Injection Well Install						
		a.	Horizontal Well		lf	2000	$240	$480,000
		b.	Hazardous Off-site Waste T&D (Wells in Source Zone)		bcyd	182	$480	$87,400
			Subtotal Horizontal Injection Well Install Costs					*$567,400*
	4.	Injection Events						
		a.	Mobilization		ea	4	$1,200	$4,800
		b.	Injection Manifold		ls	1	$8,960	$9,000
		c.	Injectate		lbs	116,000	$2.66	$308,900
			Subtotal Injection Event Costs					*$317,900*
			Subtotal Construction Costs Prior to Services					*$1,115,400*
	5.	Services						
		a.	Contingency (20% Construction Costs)		ls	1	$223,080	$223,100
		b.	Project Management/Coordination	A	ls	1	$66,924	$67,000
		c.	Engineering Design	B	ls	1	$133,848	$133,900
		d.	Construction Management	C	ls	1	$89,232	$89,300
			Subtotal Construction Services					*$513,300*
			Total Construction Costs					**$1,628,700**

III.	**Institutional Control**							
	1.	Institutional Controls						
		a.	NFA Letter and Deed Restriction for Soils and Groundwater		ls	1	$30,000	$30,000
			Subtotal Institutional Controls					*$30,000*
			Total Institutional Control Costs					**$30,000**
IV.	**O&M Costs**							
	1.	MNA Year 1						
		a.	Quarterly Well Gauging		ea	4	$600	$2,400
		b.	Groundwater Reporting (annual)		yr	1	$12,000	$12,000
		c.	Quarterly VOC Sampling		ea	4	$9,000	$36,000
		d.	Quarterly Geochemical Sampling		ea	4	$3,000	$12,000
		e.	Quarterly Waste Stream Sampling		ea	4	$1,200	$4,800
			Subtotal Year 1 MNA					*$67,200*
	2.	MNA Years 2-30 (Annual Cost)						
		a.	Annual Well Gauging		ea	1	$600	$600
		b.	Groundwater Reporting (annual)		yr	1	$12,000	$12,000
		c.	Annual VOC Sampling		ea	1	$9,000	$9,000
		d.	Annual Geochemical Sampling		ea	1	$3,000	$3,000
		e.	Annual Waste Stream Sampling		ea	1	$1,200	$1,200
			Subtotal Year 2-30 MNA					*$390,640*
	3.	O&M SSD Years 1-10 (Annual Cost)						
		a.	Utilities		mo	12	$300	$3,600
		b.	Monthly O&M	D	mo	12	$870	$10,500
			Subtotal Year 1-10 SSD					*$114,320*
			Subtotal O&M Costs Prior to services					*$572,160*
	4.	Services						
		a.	Contingency (20% O&M Costs)	D	ls	1	$114,432	$114,500
		b.	Project Management/Coordination	A	ls	1	$34,330	$34,400
			Subtotal O&M Services					*$148,900*
			Total O&M Costs					**$721,060**

Appendix A-3
Alternative 4 Cost Estimate

COST SUMMARY		
I.	Pre-Construction Costs	$325,900
II.	Construction Costs	$1,628,700
III.	Institutional Control	$30,000
IV.	O&M Costs	$721,060
	TOTAL PROBABLE COSTS	**$2,705,660**
	TOTAL PROBABLE COSTS RANGE (-30%)	**$1,893,962**
	TOTAL PROBABLE COSTS RANGE (+50%)	**$4,058,490**

Notes/Key Assumptions:

A Project management/coordination costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (10%), 100K-500K (8%); 500K-2M (6%); 2M-10M (5%); >10M (5%)

B Engineering design costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (20%), 100K-500K (15%); 500K-2M (12%); 2M-10M (8%); >10M (6%)

C Construction management costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (15%), 100K-500K (10%); 500K-2M (8%); 2M-10M (6%); >10M (6%)

D Operation and maintenance costs calculated as net present value assuming the estimated durations shown and a discounted rate of 5%.

Appendix A-4
Alternative 5 Cost Estimate

			DESCRIPTION	NOTES	UNITS	QTY	UNIT COST ($)	TOTAL COST ($)
I.	**Pre-Construction Costs**							
	1.	Office Preparation						
		a.	Remedial Action Plan		ls	1	$41,800	$41,800
		b.	Work Plan		ls	1	$18,000	$18,000
		c.	HASP Update		ls	1	$15,600	$15,600
		d.	Erosion Plan		ls	1	$18,000	$18,000
			Subtotal Office Preparation					*$93,400*
	2.	Pre-Design Investigation						
		a.	Pre-Design Investigation		ls	1	$119,500	$119,500
			Subtotal Pre-Design Investigation					*$119,500*
			Subtotal Pre-Construction Prior to Services					*$212,900*
	3.	Services						
		a.	Contingency (20% Pre-Design Investigation)		ls	1	$42,580	$42,600
		b.	Project Management/Coordination	A	ls	1	$17,032	$17,100
		c.	Engineering Design	B	ls	1	$31,935	$32,000
		d.	Construction Management	C	ls	1	$21,290	$21,300
			Subtotal Pre-Construction Services					*$113,000*
			Total Pre-Construction Costs					**$325,900**

Appendix A-4
Alternative 5 Cost Estimate

II.	**Construction Costs**							
1.	Site Preparation							
	a.	Utility Locate and Survey		ls	1	$4,600	$4,600
	b.	Equipment Decontamination Pad		ls	1	$12,300	$12,300
		Subtotal Site Preparation					*$16,900*
2.	SVE Well Install						
	a.	Horizontal Well		lf	1300	$240	$312,000
	b.	Hazardous Off-site Waste T&D		bcyd	24	$480	$11,600
	c.	Non-hazardous Off-site Waste T&D		tons	134.4	$45	$6,100
		Subtotal Horizontal SVE Well Install Costs					*$329,700*
3.	SVE System Installation						
	a.	Treatment Building and Equipment		ls	1	$60,000	$60,000
	b.	Mechanical and Electrical Contractors		ls	1	$47,800	$47,800
	c.	Trenching & backfill (off-site)		ls	490	$30	$14,700
	d.	Home Run Piping		ls	1,960	$11	$21,600
	e.	Disposal Cost (non-hazardous)		tons	218	$45	$9,800
	f.	Detection Tape		ls	1	$240	$300
	g.	AECOM Oversight		day	5	$1,700	$8,500
		Subtotal SVE System Installation Costs					*$162,700*
4.	AS Well Install (Vertical)						
	a.	Break Concrete		bcyd	0	$300	$0
	b.	AS Well Install		ea	5	$600	$3,000
	c.	Down Well Equipment		ea	0	$6,000	$0
	d.	Repair Concrete		cy	0	$500	$0
	e.	Off-site disposal (non-hazardous concrete)		tons	0	$45	$0
	f.	Hazardous Off-site Waste T&D (Wells in Source Zone)		drum	35	$540	$18,900
	g.	Non-Hazardous Off-site Waste T&D (Wells outside Source Zone)		drum	0	$150	$0
	h.	Survey		ls	0	$1,700	$0
		Subtotal Vertical AS Well Install Costs					*$21,900*
5.	AS Well Install (Horizontal)						
	a.	Horizontal Well		lf	2520	$240	$604,800
	b.	Hazardous Off-site Waste T&D		bcyd	0	$480	$0
	c.	Non-hazardous Off-site Waste T&D		tons	322	$45	$14,500
		Subtotal Horizontal AS Well Install Costs					*$619,300*
6.	AS System Installation						
	a.	Treatment Building and Equipment		ls	1	$75,000	$75,000
	b.	Mechanical and Electrical Contractors		ls	1	$47,800	$47,800
	c.	Trenching & backfill (off-site)		ls	187	$30	$5,700
	d.	Home Run Piping		ls	2,785	$11	$30,700
	e.	Disposal Cost (non-hazardous)		tons	83	$45	$3,800
	f.	Detection Tape		ls	1	$240	$300
	g.	AECOM Oversight		day	5	$1,700	$8,500
		Subtotal AS System Installation Costs					*$171,800*
		Subtotal Construction Costs Prior to Services					*$1,322,300*
5.	Services						
	a.	Contingency (20% Construction Costs)		ls	1	$264,460	$264,500
	b.	Project Management/Coordination	A	ls	1	$79,338	$79,400
	c.	Engineering Design	B	ls	1	$158,676	$158,700
	d.	Construction Management	C	ls	1	$105,784	$105,800
		Subtotal Construction Services					*$608,400*
		Total Construction Costs					**$1,930,700**

III.	**Institutional Control**							
	1.	Institutional Controls						
		a.	NFA Letter and Deed Restriction for Soils and Groundwater		ls	1	$30,000	$30,000
			Subtotal Institutional Controls					*$30,000*
			Total Institutional Control Costs					**$30,000**
IV.	**O&M Costs**							
	1.	MNA Year 1						
		a.	Quarterly Well Gauging		ea	4	$600	$2,400
		b.	Groundwater Reporting (annual)		yr	1	$12,000	$12,000
		c.	Quarterly VOC Sampling		ea	4	$9,000	$36,000
		d.	Quarterly Geochemical Sampling		ea	4	$3,000	$12,000
		e.	Quarterly Waste Stream Sampling		ea	4	$1,200	$4,800
			Subtotal Year 1 MNA					*$67,200*
	2.	MNA Years 2-30 (Annual Cost)						
		a.	Annual Well Gauging		ea	1	$600	$600
		b.	Groundwater Reporting (annual)		yr	1	$12,000	$12,000
		c.	Annual VOC Sampling		ea	1	$9,000	$9,000
		d.	Annual Geochemical Sampling		ea	1	$3,000	$3,000
		e.	Annual Waste Stream Sampling		ea	1	$1,200	$1,200
			Subtotal Year 2-30 MNA					*$390,640*
	3.	O&M SVE (Annual Cost)						
		a.	Utilities		mo	12	$600	$7,200
		b.	Monthly O&M	D	mo	12	$500	$6,000
		c.	Carbon O&M	D	ea	0.5	$1,650	$900
			Subtotal Year 1-3 SVE					*$40,318*
	4.	O&M AS (Annual Cost)						
		a.	Utilities		mo	12	$600	$7,200
		b.	Monthly System O&M	D	mo	12	$500	$6,000
			Subtotal Year 1-3 AS					*$37,744*
			Subtotal O&M Costs Prior to services					*$535,902*
	5.	Services						
		a.	Contingency (20% O&M Costs)	D	ls	1	$107,180	$107,200
		b.	Project Management/Coordination	A	ls	1	$32,154	$32,200
			Subtotal O&M Services					*$139,400*
			Total O&M Costs					**$675,302**

Appendix A-4
Alternative 5 Cost Estimate

COST SUMMARY		
I.	Pre-Construction Costs	$325,900
II.	Construction Costs	$1,930,700
III.	Institutional Control	$30,000
IV.	O&M Costs	$675,302
	TOTAL PROBABLE COSTS	**$2,961,902**
	TOTAL PROBABLE COSTS RANGE (-30%)	**$2,073,331**
	TOTAL PROBABLE COSTS RANGE (+50%)	**$4,442,852**

Notes/Key Assumptions:

A Project management/coordination costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (10%), 100K-500K (8%); 500K-2M (6%); 2M-10M (5%); >10M (5%)

B Engineering design costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (20%), 100K-500K (15%); 500K-2M (12%); 2M-10M (8%); >10M (6%)

C Construction management costs based on Table 5-8 from "A guide to developing and documenting cost estimates during the feasibility study" ; Capital costs <100K (15%), 100K-500K (10%); 500K-2M (8%); 2M-10M (6%); >10M (6%)

D Operation and maintenance costs calculated as net present value assuming the estimated durations shown and a discounted rate of 5%.

APPENDIX B

SVE System Performance Monitoring Data Tables

TABLE 1: WELL CONSTRUCTION DETAILS

Facility Name: Delavan Spray Technologies Site
4334 Main Hwy
Bamberg, SC 29003

Well ID	Orientation	Well Diameter (in)	Average Screen Depth (ft bgs)	Total Well Length (ft)	Screen Interval (ft)
SVE-1	Horizontal	4	5.88	200	50 - 200
SVE-2	Horizontal	4	5.99	200	50 - 200
SVE-3	Horizontal	4	6.04	200	50 - 200
SVE-4	Horizontal	4	6.36	204	54 - 204
SVE-5	Horizontal	4	7.34	205	55 - 205
SVE-6	Horizontal	4	6.23	200	50 - 200
SVE-7	Horizontal	4	5.91	120	50 - 120

Notes:
in = inches
ft = feet
bgs = below ground surface
SVE = soil vapor extraction

TABLE 2: SVE SYSTEM VISIT SUMMARY

Facility Name: Delavan Spray Technologies Site
4334 Main Hwy
Bamberg, SC 29003

Date	Type	System Maintenance Description
6/15/2022	Startup	System Startup (day-1). Collected influent/effluent air samples.
6/16/2022	Startup	System Startup (day-1). Collected influent/effluent samples.
7/6/2022	O&M	Routine system inspection. Blower and pump hour meters not working.
7/13/2022	Alarm Response	System down due to MS tank high-high level. Pump y-strainer screen restricting flow. Screen removed. System restarted.
7/27/2022	O&M	Routine system inspection. Collected water sample from storage tank. Collected effluent air sample.
8/29/2022	O&M	Routine system inspection. Collected effluent air sample. Issue with VFD, won't control blower speed.
9/27/2022	O&M	Enviro-equipment onsite to install ambient thermostat and hi-temp alarm, install check-valve @ MS Tank transfer pump, replace surge supressor @ control panel, and investigate VFD control issue. Collected effluent air sample.
10/27/2022	O&M	Routine system inspection. Collected effluent air sample. Greased blower and motor. Added 1 Qt. of oil to blower. Evidence of wear at blower belt.
11/21/2022	O&M/Alarm Response	System down due to MS tank high-high level. Inline filter at flowmeter clogged with debris. Removed debris and cleaned filter. System restarted. Collected effluent air sample.
1/18/2023	System Restart	System down due to high-high level alarm at storage tank and MS tank. Condensate in storage tank and MS tank emptied and hauled off site (~550 gallons). SVE system restarted. Blower speed reduced (33hz to 30hz).
1/19/2023	O&M	Routine system inspection. Collected effluent air sample.

Notes:
SVE = Soil vapor extraction
O&M = Operation and maintenance

TABLE 3: SVE SYSTEM PERFORMANCE SUMMARY

Facility Name: Delavan Spray Technologies Site
4334 Main Hwy
Bamberg, SC 29003
Startup Date: 6/15/2022

			SVE Blower						Influent				Effluent			Moisture Separation				System Runtime					
Site Visit Date	Days Between Site Visits	Days Since Startup	Blower Hour Meter B-100	Daily Designed Runtime (hours/day)	VFD Amps	Blower Speed (Hz)	HMI Blower Vacuum Reading VT-120 (in-WC)	Vacuum at Blower VI-103 (in-Hg)	Vacuum at Particulate Filter VI-102 (in-Hg)	Vacuum at MS VI-101 (in-Hg)	Dilution Air Valve Open (%)	Influent Temperature TI-101 (degrees F)	Discharge Temperature TI-102 (degrees F)	Discharge Flow FIT-100 (CFM)	Discharge Pressure (in-WC)	MS Pump Hours P-200	MS Pump Totalizer FT-200 (gallons)	MS Tank Level (in) High = 27.5 in	Storage Tank Level (in) High = 54.5 in	Period Hours of Operation	Cumulative Hours of Operation	Scheduled Downtime (hours)	Period Runtime (%)	Cumulative Runtime (%)	Process Status
06/15/22			610.6	24	--	32	45	6.5	5	--	0	80	105	423.5	3	0	146	--	--	0	0	0	--	--	2
06/16/22	1	1	610.6	24	--	32	47	4.5	3	2.5	0	80	105	427.5	3	0	231	--	--	24.0	24.0	0	100.0%	100.0%	1
07/06/22	20	21	610.6	24	22.8	32	51.4	5.5	4.4	3.3	0	80	106	426.6	1.5	0	231	22.5	10	480.0	504.0	0	100.0%	100.0%	1
07/13/22	7	28	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20	--	--	0	--	--	2
07/27/22	14	42	943.2	24	32.93	33	51.9	5.5	4.5	3.5	0	83	107	477.5	1.282	4.1	--	18.5	29	332.6	836.6	0	99.0%	83.0%	1
08/29/22	33	75	1733.4	24		33	52.9	3.5	3.2	2	0	74	103	448.8	1.0	4.1	384.66	7.75	29	790.2	1626.8	0	99.8%	90.4%	1
09/27/22	29	104	2426.4	24	22.5	33	49	3.5	3.5	3	0	72	95	448	1.0	4.1	383.81	9.75	33.5	693.0	2319.8	0	99.6%	92.9%	1
10/27/22	30	134	3113.0	24	22.4	33	48.9	4.0	3.5	3	0	68	95	423.3	1.0	4.1	383.81	18.25	33.25	686.6	3006.4	0	95.4%	93.5%	1
11/21/22	25	159	3618.0	24	24	33	51.5	4.0	3.5	3	0	54	75	430	1.0	190.5	384.11	24.5	44	505.0	3511.4	0	84.2%	92.0%	2
01/18/23	58	217	3915.7	24	23	33	49	4.0	3.5	3	0	56	85	452	1.0	190.9	659.23	29.5	64.5	297.7	3809.1	0	21.4%	73.1%	2
01/19/23	1	218	3939.6	24	22.2	30	46.5	4.0	3.5	3	0	60	80	378	1.0	190.9	659.23	4.5	0	23.9	3833.0	0	99.6%	73.3%	1

Notes:
SVE = Soil vapor extraction
VFD = variable frequency drive
Hz = Hertz
in-WC = inches of water column
in-Hg = inches of mercury
F = Fahrenheit
CFM = cubic feet per minute
HMI = human-machine interface
MS = moisture seperator

Process Status Codes

Code	Arrive	Depart
1	on	on
2	off	on
3	off	off
4	on	off

TABLE 4: SVE WELL MONITORING DATA

Facility Name: Delavan Spray Technologies Site
4334 Main Hwy
Bamberg, SC 29003

WELL ID	SVE-1	SVE-2	SVE-3	SVE-4	SVE-5	SVE-6	SVE-7
DIAMETER (in)	4	4	4	4	4	4	4
WELL LENGTH (ft)	200	200	200	204	205	200	120
SCREEN INTERVAL (ft)	50 - 200	50 - 200	50 - 200	54 - 204	55 - 205	50 - 200	50 - 120

Date	Vacuum	PID	Vacuum	PID	Vacuum	PID	Vacuum	PID	Vacuum	PID	Vacuum	PID	Vacuum	PID
6/15/2022	4.0	7.0	5.0	10.7	4.0	11.1	4.0	6.0	4.5	28.3	4.5	7.1	4.5	6.2
6/16/2022	2.5	--	2.5	--	2.5	--	2.5	--	3.0	--	3.0	--	2.75	--
7/6/2022	3.3	1.1	4.5	6.7	3.8	57.9	3.5	0.0	3.5	7.2	3.7	0.5	3.4	10.6
7/13/2022	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7/27/2022	3.0	3.2	4.5	1.2	3.5	1.1	3.5	1.2	4.0	2.6	4.0	0.9	4.0	0.6
8/29/2022	2.0	6.7	2.9	15.9	2.5	32.8	2.4	14.1	2.3	37.1	2.5	8.4	2.5	17.5
9/27/2022	2.0	--	2.5	--	2.5	--	3.0	--	2.8	--	2.5	--	3.0	--
10/27/2022	2.0	--	2.5	--	2.5	--	2.5	--	3.0	--	2.5	--	3.0	--
11/21/2022	2.5	1.1	3.0	0.9	3.0	0.3	2.5	0.1	3.0	1.5	3.0	0.0	3.0	0.3
1/18/2023	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1/19/2023	2.5	--	2.5	--	3.0	--	3.0	--	3.0	--	2.5	--	3.0	--

Notes:
Vacuum = inches of mercury (Hg)
PID = total VOC concentration in parts per million via photo-ionization detector
in = inches
ft = feet
-- = not measured

TABLE 5: SVE SYSTEM ANALYTICAL SUMMARY

Facility Name: Delavan Spray Technologies Site
4334 Main Hwy
Bamberg, SC 29003

Sample Location	Sample Date	Cumulative Operating Hours	Air Flowrate (CFM)	Acetone (2-Propanone)	Benzene	Bromomethane	Carbon Disulfide	Chloromethane	Cyclohexane	1,2-Dibromoethane (EDB)	1,1-Dichloroethylene	trans-1,2-Dichloroethylene	cis-1,2-Dichloroethylene	Dichlorodifluoromethane	m-Dichlorobenzene	Ethanol	Ethylbenzene	Ethyl Acetate	4-Ethyltoluene	Heptane	Hexane	2-Hexanone	Isopropyl Alcohol
Effluent	06/15/22	0.0	423.5	118	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	20	ND	ND	ND	ND	ND
Effluent	06/16/22	24.0	427.5	128	315	ND	ND	ND	9.6	ND	8.3	8.3	12	ND	ND	58	105	28	29	21	7.8	ND	12
Effluent	07/27/22	836.6	477.5	114	540	ND	ND	2.7	ND	ND	ND	ND	3.8	ND	ND	15	ND	ND	ND	ND	ND	ND	117
Effluent	08/29/22	1,626.8	448.8	23	19	ND	ND	ND	ND	ND	ND	ND	5.6	2.4	ND	5.3	ND	33	ND	ND	ND	ND	107
Effluent	09/27/22	2,319.8	448.0	37.3	43.8	ND	ND	ND	ND	ND	ND	ND	4.4	1.8	ND	3.4	ND	13	ND	ND	ND	ND	366
Effluent	10/27/22	3,006.4	423.3	52.0	295	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	23	ND	ND	24	39.8	ND	ND
Effluent	11/21/22	3,511.4	430.0	14	21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11	ND	15	ND	ND	ND	ND	49.9

Sample Location	Sample Date	Methylene Chloride	Methyl ethyl ketone	Propylene	Styrene	1,1,1-Trichloroethane	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	2,2,4-Trimethylpentane	Tertiary Butyl Alcohol	Tetrachloroethylene	Tetrahydrofuran	Toluene	Trichloroethylene	Trichlorofluoromethane	Vinyl Acetate	m,p-Xylene	o-Xylene	Xylenes (total)	Mass Removal Rate (lbs/day)	Mass Removed (lbs)	Total Mass Removed (lbs)
Effluent	06/15/22	18	47.5	ND	ND	152	ND	ND	ND	ND	ND	34,300	1,150	22	27	ND	ND	ND	ND	ND	1.361	1	1
Effluent	06/16/22	18	75.8	10	ND	43	ND	70.8	25	14	ND	13,000	98.5	381	32	ND	ND	426	144	569	0.600	0.300	0.981
Effluent	07/27/22	5.9	11	ND	ND	7.1	ND	ND	ND	ND	ND	2,710	4.4	5.3	5.1	6.7	ND	ND	ND	ND	0.152	5.143	6.123
Effluent	08/29/22	1.8	3.5	ND	ND	7.6	ND	1.9	ND	ND	ND	1,970	3.2	6.4	11	5.6	ND	2.8	ND	2.8	0.089	2.930	9.054
Effluent	09/27/22	1.8	5.6	ND	ND	5.5	ND	ND	ND	ND	ND	2,180	17	2.9	11	6.7	ND	3.1	2	5.2	0.109	3.144	12.197
Effluent	10/27/22	ND	ND	1580	ND	ND	ND	ND	ND	ND	ND	ND	ND	177	ND	ND	ND	43	ND	43	0.086	2.472	14.669
Effluent	11/21/22	7.6	18	ND	ND	7.6	ND	ND	ND	ND	ND	1800	104	ND	14	5.5	ND	ND	ND	ND	0.080	1.677	16.346

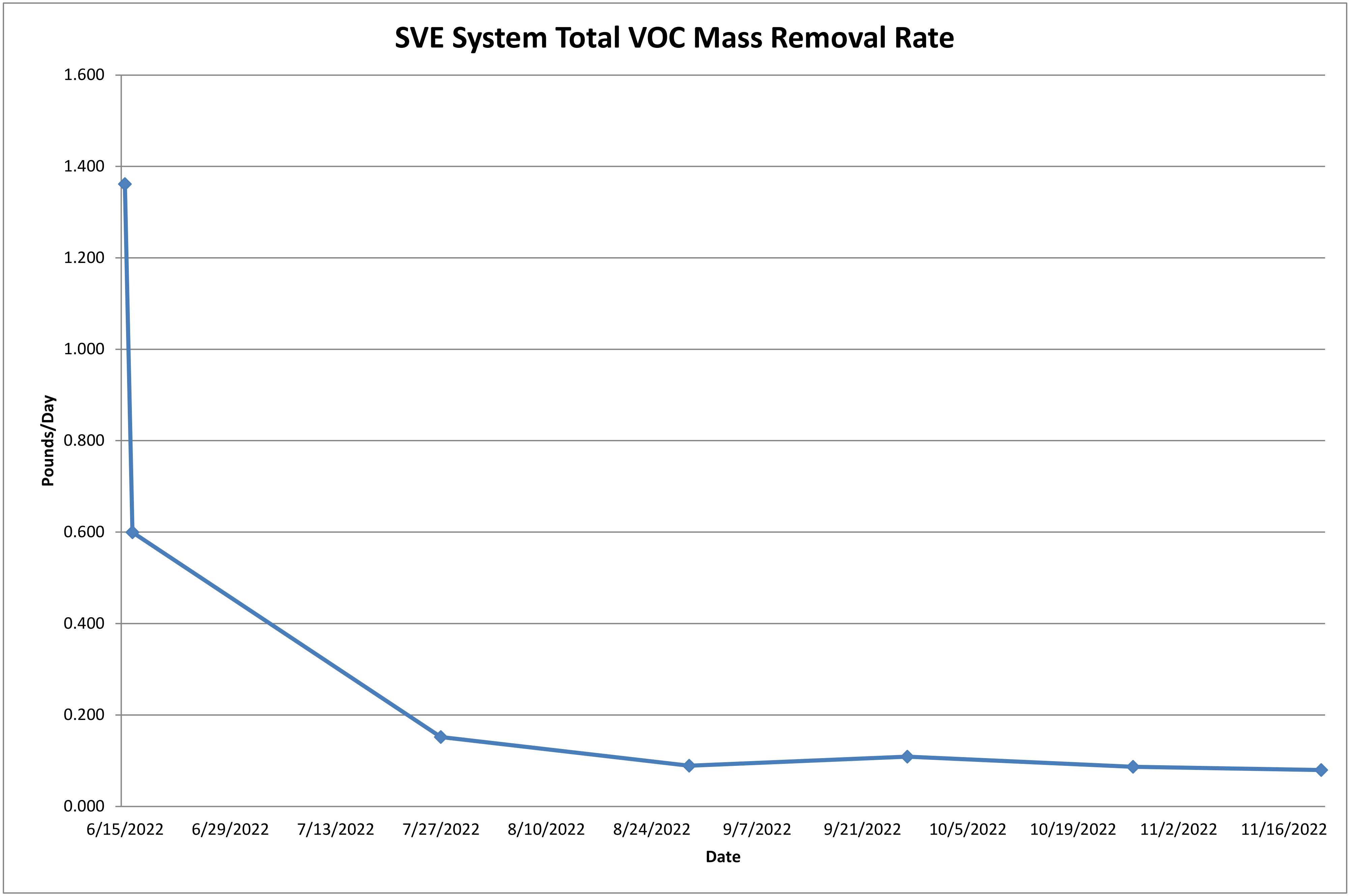
Notes:
ND = Non-detect
Analytical Results = ug/m^3
ug/m^3 = Micrograms per cubic meter
lbs = Pounds
lbs/day = Pounds per day
CFM = cubic feet per minute

TABLE 6: VAPOR MONITORING POINT DATA

Facility Name: Delavan Spray Technologies Site
4334 Main Hwy
Bamberg, SC 29003

POINT ID	VMP-1	VMP-2	VMP-3	VMP-4	VMP-5	VMP-6	SSV-1	SSV-2	SSV-3	SSV-4	SSV-5	SSV-6
Date	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**
9/8/2021	10.5	3.2	1.4	1.1	0.66	0.446	--	0.149	--	--	0.3	0.326
6/15/2022	13.5	4.7	3.5	3.2	1.5	0.9	--	0.3	--	--	4.4	3.1
6/16/2022	13.6	4.8	3.7	3.5	1.8	1.0	--	0.326	--	--	4.4	3.5
7/6/2022	5.653	--	3.9	3.9	2.0	1.2	--	--	--	--	5.021	3.855
7/13/2022	--	--	--	--	--	--	--	--	--	--	--	--
7/27/2022	--	--	--	--	--	--	--	--	--	--	--	--
8/29/2022	5.583	5.409	4.075	4.083	2.010	1.168	0.274	0.333	1.313	3.689	5.460	4.055
9/27/2022	--	--	--	--	--	--	--	--	--	--	--	--
10/27/2022	--	--	--	--	--	--	--	--	--	--	--	--
11/21/2022	13.40	5.27	3.60	3.62	1.77	1.05	0.22	0.30	1.23	3.37	5.23	3.59
1/18/2023	--	--	--	--	--	--	--	--	--	--	--	--
1/19/2023	>3.365	>3.365	>3.365	>3.365	1.847	1.05	0.172	0.283	1.218	>3.365	>3.365	>3.365

Notes:
Vacuum = inches of mercury (Hg)
PID = total VOC concentration in parts per million via photo-ionization detector
in = inches
ft = feet
-- = not measured
N/A = not applicable


SVE System Total VOC Mass Removal Rate
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Pounds/Day
6/15/2022
6/29/2022
7/13/2022
7/27/2022
8/10/2022
8/24/2022
9/7/2022
9/21/2022
10/5/2022
10/19/2022
11/2/2022
11/16/2022
Date