Groundwater Delineation Work Plan

United Technologies Corporation
Delavan Spray Technologies Site
4334 Main Highway
US Highway 301 South
Bamberg, South Carolina

VCC 13-4762-RP

Prepared for:

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1.0 INTRODUCTION

The Delavan Spray Technologies Site is located at 4334 Main Highway (US Highway 301 South in the town of Bamberg, South Carolina (Figure 1). Previous assessments have documented chlorinated volatile organic compounds (VOCs) in soil and groundwater related to their historic use at the facility. Additional site background and history were reported in detail in Section 2.0 of the *Remedial Investigation (RI) Report* (AECOM, July 2014).

In 2014 an RI was completed at the site to assess soils, surface water, groundwater and vapor intrusion pathways. As part of the RI, a Baseline Risk Assessment (BRA) was performed to evaluate potential risks to human and ecological receptors. Based on comments received from the SC Department of Health and Environmental Control (SCDHEC) to the *RI Report* and to the subsequent *Fall 2014 Semi-Annual Groundwater Monitoring Report* (AECOM, January 2015), a Post-Remedial Investigation was conducted and report issued (AECOM, May 2016).

Upon review of the findings from the *Post-Remedial Investigation Report* and ongoing semi-annual groundwater monitoring program, SCDHEC issued a letter, dated July 12, 2016, which stated in part:

> *…..the groundwater plume must be fully delineated. The analytical results included in the referenced report indicate PCE concentrations exceeding the MCL of 5 ug/L in all three of the newly installed wells. Therefore, further assessment must be performed. A work plan for delineation of the shallow and deep groundwater plumes should be submitted to my attention….*

This Work Plan for groundwater delineation is being prepared in response to comments received from SCDHEC. The purpose of this Work Plan is to present the proposed approach and methods to acquire the additional environmental quality data to address SCDHEC concerns.

1.1 Groundwater Quality

Groundwater quality has been evaluated at the site and vicinity during conduct of the RI and Post-RI. In addition, the on-going semi-annual groundwater quality monitoring program also provides useful information on the distribution and concentration of VOCs beneath the Delavan site and vicinity. A copy of the site map and current monitoring well network is illustrated on Figure 2. The primary shallow horizontal groundwater flow direction is inferred to be toward the west, toward Halfmoon Branch. On the western portion of the site, at MW-24, tetrachloroethene (PCE) was reported in the shallow aquifer zone during the Spring 2016 monitoring in excess of 1 milligram per liter (mg/L) (AECOM, June 2016). The groundwater sampling results indicate that this well is out of the “source area” but still within the core of the PCE plume that is moving off-site to the west in shallow aquifer groundwater.

However, approximately 1000 feet downgradient of the site to the west/southwest, (MW-15 and MW-16) PCE is not detected in the shallow aquifer unit (Figure 3). There is no groundwater quality information beneath the Kinsey property lying between the two monitoring locations.

The inferred direction of horizontal groundwater flow from the site in the deeper limestone aquifer unit is to the south-southwest, which is consistent with regional topography, drainage and findings from prior investigations conducted at the site. PCE has migrated from the shallow aquifer downward into the deeper limestone aquifer unit. PCE concentrations exceed the United States Environmental Protection Agency (USEPA) maximum contaminant level (MCL) for drinking water in off-site down-gradient wells MW-22D (65.7 micrograms per liter [µg/L]), MW-25D (74.8 µg/L), and MW-26D (62.6 µg/L) (Figure 4) (AECOM, June 2016).

2.0 ADDITIONAL ASSESSMENT

Delineation of the shallow aquifer zone will help to define the leading edge of the PCE plume beneath the Kinsey property between MW-24 and the MW-15/MW-16 area. Delineation of the deeper limestone aquifer unit will determine the lateral extent of PCE plume migration off site beneath the forested land to the south / southwest of the Delavan site.

Field data acquisition methodologies are designed to be in general accordance with the USEPA Region 4 Science and Ecosystem Support Division (SESD) Field Branches Quality System and Technical Procedures document (http://www.epa.gov/region4/sesd/fbqstp/) (most recent version). To be consistent with the RI and Post-RI, those specific field methods, analytical procedures, and quality assurance/quality control (QA/QC) procedures applicable to the scope of work will follow those presented in Section 1 (Field Sampling and Analysis) and Section 2 (Field Quality Assurance Samples) of Appendix B to the RI Work Plan (Hart & Hickman, August 2013).

In the shallow and deeper limestone aquifer zones, the groundwater delineation will be conducted by first installing series of boreholes to obtain groundwater samples. The samples will be screened in the field for site-related chlorinated VOCs (specifically PCE). This screening level information will be used guide the investigation to fully delineate the occurrence of PCE in groundwater above its MCL. Once screening-level data are received and evaluated, locations will be selected for the installation of permanent groundwater monitoring wells to provide long-term monitoring of the PCE plume in the off-site areas.

The means and methods to perform the groundwater delineation are presented in the following subsections.

2.1 Pre-Investigation Activities

2.1.1 Site Access

The soil borings and monitoring wells proposed for this PCE plume delineation will be located on properties not owned by Delavan Spray Technologies; therefore, an updated access agreement may need to be obtained or renegotiated between UTC and the respective property owners prior to conducting intrusive sampling activities on their respective properties. Should UTC have difficulties in gaining access to the off-site properties, SCDHEC will be notified.

2.1.2 Monitoring Well Approval

A monitoring well approval letter will be obtained from SCDHEC for all anticipated work. A monitoring well approval application and proposed well construction details are included in Appendix A of this Work Plan. If additional borings or monitoring wells are deemed necessary based on an evaluation of the field data,

SCDHEC will be contracted for authorization to install additional borings / wells to complete the delineation of the PCE plume.

2.1.3 Subsurface Utility Locating

Upon obtaining off-site property access and prior to conducting intrusive sampling activities, the South Carolina One-Call public utility service will be contacted to mark public utilities at the site and vicinity. A private utility locator will also be contracted to confirm the one-call markings and to mark the location of potential private subsurface utilities in the areas of the proposed sampling locations.

2.2 Additional Groundwater Assessment

In accordance with SCDHEC's correspondence of July 12, 2016 for further groundwater delineation, additional assessment activities will be conducted in the shallow and deeper limestone aquifer units in the site vicinity. For the purposes of this work plan, PCE was chosen as a surrogate compound for the other chlorinated VOCs based on its occurrence and concentration in each of the aquifer units beneath the site vicinity. PCE is the only site-related compound to occur in off-site areas at concentrations in excess of its USEPA maximum contaminant level (MCL), which for PCE is 5 ug/L.

Groundwater delineation will be conducted by first installing series of boreholes to obtain groundwater samples. The groundwater samples will be analyzed by an analytical laboratory with 24-hour turnaround time for PCE analysis. This information will be used guide the investigation to fully delineate the occurrence of PCE in groundwater.

Once the screening analytical data are received and evaluated, locations will be selected for the installation of permanent groundwater monitoring wells to provide long-term monitoring of the plume. An estimated one to two additional shallow Type II monitoring wells (estimated to be about 20 ft deep) and two to three additional deeper Type III limestone aquifer monitoring wells (estimated to be about 50 ft deep) are proposed to be drilled and installed using sonic drilling techniques. However, other technologies may be used, if necessary, such as: direct push technology (DPT), hollow-stem auger or mud rotary.

PCE concentrations detected during the most recent semi-annual monitoring event (AECOM, June 2016) are illustrated on Figure 3 for the shallow aquifer zone and on Figure 4 for the deeper limestone aquifer unit. The approximate locations of the proposed boreholes, therefore, are based on likely down-gradient locations that would represent the leading edge of PCE in each of the groundwater aquifer zones.

2.2.1 Shallow Aquifer Groundwater Screening

Delineation of the shallow aquifer zone beneath the Kinsey property will be conducted as a tiered (phased) approach. Tier 1 borings will consist of a line of up to four sampling locations GW-DPT-1S through GW-DPT-4S, which will initially be evaluated by advancing a soil boring from land surface to approximately 20 feet below land surface (bls) penetrating the upper shallow sand/clay aquifer unit (Table 1 and Figure 3). The soils will be continuously sampled using a Geoprobe® or mini-sonic drilling rig and a continuous core sampler. The lithology of the soils will be described by an AECOM geologist. The soils will be screened in the field using a photo ionization detector (PID) for the presence of VOCs. The soils will also be examined for visual signs of impact and any observations will be measured and recorded. Borehole drilling methods are described in further detail in Section 2.3 below.

Based on the PID field screening results, one or two groundwater screening samples will be collected from the surficial aquifer at each drilling location using a screen point sampler as described in Section 2.4 below. Borings and/or temporary wells installed for groundwater screening will be abandoned by forced injection grouting from total depth to land surface with a non-shrink neat bentonite/cement grout.

Based on the results of the field screening of the soils and groundwater from the initial four Tier 1 locations (i.e., GW-DPT-1S through GW-DPT-4S), the data will be evaluated and up to five additional Tier 2 locations may be drilled and sampled (Table 1 and Figure 3). As field screening and data evaluation is a dynamic assessment strategy, the number and locations of borings to be advanced in the surficial aquifer may vary based on the results of the environmental data collected. The proposed drilling and sampling locations may be adjusted in the field, as necessary, due to the presence of utilities, drill rig accessibility, etc. keeping in mind, however, the overall goal is delineation of PCE in shallow groundwater. Note: if the Tier 2 borings do not define the extent of PCE below the MCL, downgradient wells MW-15 and MW-16 provide delineation below the detection limit for PCE.

Once the PCE plume has been fully defined based on field screening and existing downgradient monitoring well data, one or two Type II surficial monitoring wells will be drilled and installed at strategic locations and depths determined based on field screening results to provide long-term monitoring of the plume (Table 2). Monitoring well drilling and installation methods are described in further detail in Sections 2.3 and 2.5 below. The proposed monitoring well construction details including total depth and estimated screen intervals are presented on Table 2 and in Appendix A.

2.2.2 Deeper Limestone Aquifer Groundwater Screening

Figure 4 illustrates the known occurrence of PCE in the deeper limestone aquifer unit in the Delavan site vicinity. Based on this information, additional locations were selected for assessment to fully delineate the occurrence of PCE further to the south / southwest of the site, beyond the locations of monitoring wells MW-25D and MW-26D where PCE exceeds the MCL in groundwater.

In order to determine the extent of the PCE plume to the south of the Delavan site and the MW-26D location, up to four additional locations along the SCE&G power line right of way (GW-DPT-1D through GW-DPT-4D) will initially be evaluated by advancing a soil boring from land surface to approximately 50 feet bls (Table 1 and Figure 4). The soils will be continuously sampled using a Geoprobe® or mini-sonic drilling rig and a continuous core sampler. The lithology of the soils will be described by an AECOM geologist. The soils will be screened in the field using a PID for the presence of VOCs. The soils will also be examined for visual signs of impact and any observations will be measured and recorded. Borehole drilling methods are described in further detail in Section 2.3 below.

Based on the PID field screening results, one or two groundwater screening samples will be collected from the bedrock aquifer at each drilling location using a screen point sampler as described in Section 2.4 below. Borings and/or temporary wells installed for groundwater screening will be abandoned by forced injection grouting from total depth to land surface with a non-shrink neat bentonite/cement grout.

In order to determine the extent of the PCE plume further to the south-southwest of the Delavan site and the MW-25D/MW-26D locations, up to six additional locations are proposed to be installed along an existing logging road (GW-DPT-4D through GW-DPT-10D) (Table 1 and Figure 4).

Based on the results of the field screening of the soils and groundwater, additional locations may be drilled and sampled if deemed necessary. This strategy will be continued until the plume is determined to be defined using the field screening methods. As field screening and data evaluation is a dynamic assessment strategy, the number and locations of borings to be advanced in the limestone aquifer unit may vary based on the results of the environmental data collected. The proposed drilling and sampling locations may also be adjusted in the field, as necessary, due to the presence of utilities, drill rig accessibility, field results, etc. keeping in mind, however, overall goal of delineation of PCE in the deeper limestone aquifer unit. Once the PCE plume appears to be fully defined based on field screening, two or three deep Type III monitoring wells will be drilled and installed to depths of approximately 50 feet bls at strategic locations to provide long-term monitoring of the plume (Table 2). Monitoring well drilling and installation methods are described in further detail in Sections 2.3 and 2.5 below. The proposed monitoring well construction details including total depth, surface casing depths (for the deeper wells), and estimated screen intervals are presented on Table 2 and in Appendix A.

2.3 Borehole Drilling

For both the shallow and deeper borings and monitoring wells, sonic drilling techniques are expected to be used to advance each boring to the target depth. However, other technologies may be used, if necessary, such as: DPT, hollow-stem auger or mud rotary. It is expected that the sonic rig will utilize a 6-inch diameter outer casing and a 4-inch diameter inner core barrel. Soil samples will be extruded from the inner core barrel into plastic sleeves for lithological logging and soil screening by an AECOM geologist. Pending approval by SCDHEC, it is expected that a permanent surface casing will not be

needed for the bedrock aquifer monitoring wells if sonic techniques are used – the temporary drill casing will be sufficient to seal the upper surficial aquifer during drilling and well installation. Soil cuttings will be containerized in 55-gallon drums and temporarily stored on-site as investigation-derived waste (IDW) until they are profiled and disposed, as described in Section 2.13 below.

2.4 Screen Point Groundwater Sampling

Groundwater screening will be conducted using the Geoprobe® SP-16 groundwater sampling system or equivalent technology. The SP-16 groundwater sampling system will use expendable points, which will be left in the ground as the probe rods are withdrawn. To obtain a discrete groundwater sample, a new borehole will be pushed for each selected sample interval.

Upon reaching the desired sampling depth, the screen point will be opened. Polyethylene tubing fitted with a stainless steel check valve will be inserted through the probe rods into the screened interval to allow for groundwater sample collection. The AECOM drilling subcontractor will provide sampling tubing and check valves for the groundwater sampling.

Groundwater from the screened interval will be purged to ensure a representative sample is collected. During purging, pH, temperature, specific conductance, dissolved oxygen, oxidation reduction potential, and turbidity will be measured and recorded. Purging will continue until pH, temperature, and specific conductance have stabilized to within 10 percent (0.2 s.u. for pH).

Groundwater samples collected for analysis of PCE will be kept chilled on ice to about 4 degrees Celsius under chain of custody protocol after collection. The samples will be delivered via courier to Shealy Environmental Services (Shealy), located in West Columbia, SC for analysis by USEPA Method 8260B. Shealy is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory and State of South Carolina certified laboratory. Sample results are expected to be requested for 1-day turn-around-time.

2.5 Monitoring Well Installation

All monitoring wells will be installed through the center of the sonic core barrel and will be constructed of 2-inch diameter Schedule 40 polyvinylchloride (PVC) casing and 10 to 15 feet of 0.010-inch machine slotted PVC screen. Filter sand will be placed into the annular space of each well to approximately two-feet above the top of the well screens. A pelletized bentonite clay seal approximately 2 feet thick will be placed in the annular space above the filter sand and hydrated with potable water, as necessary. As the filter sand and bentonite clay are added, the core barrels will be pulled from the borehole to ensure the annulus is completely filled. Depths to sand and bentonite will be monitored with a weighted tape measure as the installation progresses. A neat cement-bentonite grout will then be injected from above the bentonite seal to land surface via a tremie pipe as the core barrel is pulled.

The surface completions for the shallow (Type II) and deep (Type III) monitoring wells will be completed in accordance with the land owners preference: Either an above-grade surface completion within a 4-inch square lockable protective casing set to approximately 2.5 feet above land surface or within an at-grade 8-inch diameter cast-iron vault with a bolt down lid. Whether completed above-grade or at-grade, the protective covers will be set into a two-foot by two-foot square by 6-inch thick concrete pad, which will act as a surface seal. The construction details for Type II and Type III monitoring wells are illustrated in Appendix A.

2.6 Well Development

Upon installation, the groundwater monitoring wells will be developed so that they produce representative groundwater samples. The monitoring wells will be developed by AECOM personnel by surging and purging with an electric submersible pump. Groundwater indicator parameters (e.g. temperature, specific conductivity, dissolved oxygen [DO], pH, oxygen reduction potential [ORP] and turbidity) will be measured using a water quality meter and recorded on AECOM Monitoring Well Development logs. Development of monitoring wells will continue until parameters have stabilized to +/- 10% (0.2 standard units for pH) and turbidity of the water is reduced as much as possible.

Purge water from well development will be containerized in 55-gallon drums and stored at a designated location on-site as IDW.

2.7 Water Level Measurements

The depth to water from a top of casing measuring point from the newly installed monitoring wells and the approved monitoring well network will be measured during one day and recorded. An electric water level indicator will be used to collect water level measurements in general accordance with the USEPA Region 4 SESD Groundwater Level and Well Depth Measurement Operating Procedure (January 2013). Depth to water will be corrected to groundwater elevations to provide an evaluation of groundwater levels and flow directions across the site and vicinity.

2.8 Groundwater Sampling

As part of the additional assessment activities, groundwater samples will be collected from the newly installed monitoring wells. Groundwater samples will be collected using low flow/low stress sampling methods in accordance with the *RI Work Plan* (Hart & Hickman, August 2013) and EPA's *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (EPA/540/S-95/504 dated April 1996) and as described in Appendix B of the *RI Work Plan*. Groundwater sampling will be completed using a peristaltic pump and flow-through cell for field parameter measurement.

A summary of the analytes is provided below:

- The groundwater samples will be analyzed for VOCs by USEPA Method 8260B.
- Field measurements of DO, pH, conductivity, temperature, and ORP will be collected from the sampled monitoring wells using a flow through cell.

Groundwater samples from permanent monitoring wells will be kept chilled to about 4 degrees Celsius on ice under chain-of-custody protocol until they are shipped via Federal Express to Accutest Laboratories, a NELAP-accredited laboratory and State of South Carolina certified laboratory located in Orlando, Florida. Standard turn-around-time will be requested for definitive groundwater samples obtained from the monitoring wells installed as part of this assessment work.

As requested by SCDHEC, the entire network of monitoring wells will be sampled during the next planned semi-annual groundwater monitoring event, currently scheduled for late October 2016. If the groundwater delineation field work outlined in this work plan coincides with the planned semi-annual sampling program, the newly installed wells will be sampled at that time. As part of this semi-annual effort, a site-wide round of water level measurements will also be collected from the existing wells and newly installed wells. Data from this event will be used to update groundwater potentiometric and flow maps of each aquifer unit.

2.9 Quality Assurance/Quality Control

To provide quantitative data on the precision and accuracy of the sampling and analysis program, quality assurance and quality control (QA/QC) samples consisting of duplicate, matrix spike / matrix spike duplicate (MS/MSD), equipment blank, and trip blank samples will be collected, as detailed in Appendix B of the *RI Work Plan* (Hart & Hickman, August 2013) and in Tables 2 and 3, quality control samples for groundwater. In summary, the QA/QC samples will be collected as specified below for the definitive groundwater samples collected from the newly installed monitoring wells:

- Duplicate – 1 duplicate sample per 20 groundwater samples.
- MS / MSD – 1 MS and 1 MSD sample per 20 groundwater samples.
- Equipment Blank – 1 equipment blank from groundwater sampling equipment (screen point sampler) for each 20 samples.
- Trip Blank – 1 trip blank for each cooler containing investigative samples that require VOC analysis.

All QA/QC samples will be analyzed by Accutest Laboratories, located in Orlando, Florida along with the primary samples.

With the exception of trip blanks, QA/QC samples will not be collected for the groundwater screening samples collected from the temporary borings.

2.10 Surveying

Following the boring (i.e., groundwater grab sample locations) and well installation, the top of casing and land surface elevations and the horizontal locations of the borings and new monitoring wells will be surveyed by a professional surveyor licensed in South Carolina. Horizontal locations will be reported in South Carolina State Plane Coordinates referenced to the North American Datum of 1983 (NAD-83) to the nearest 0.01 foot. Ground surface elevations and well top of casing measuring point elevations will be referenced to the North American Vertical Datum of 1988 (NAVD-88) to the nearest 0.01 foot. The survey information will be updated to summary tables and the site base map.

2.11 Slug Testing

Slug tests will be conducted on the newly installed monitoring wells in order to better estimate the range of hydrologic properties of the aquifers beneath the site and vicinity. Slug tests may be conducted by two methods, falling head or rising head tests. Falling head tests will be conducted by inserting a decontaminated, solid PVC cylinder (aka, “slug”) into the well and monitoring the water levels as they decline downward toward the static level. Rising head tests will be conducted by removing the slug from a well and monitoring the water levels as they rise up toward the static level. Falling head slug tests will not be performed in wells with partially saturated screens.

Initially, the static water level in the well will be measured and recorded. A decontaminated pressure transducer will then be lowered at least 5 feet below the static water level (or more if the slug is greater than 5-foot long) or within one foot of the bottom of the well. The static water level will again be measured and recorded and the measurement will be repeated until water level equilibrium is verified (i.e., two equal readings taken at least 5 minutes apart). The slug will then be attached to clean, new synthetic rope. The falling head test will be initiated by instantaneously lowering the cylinder into the well, which will result in an immediate water level rise. The data logger will be activated to measure the declining (falling) water levels. When the water level has returned to static conditions, the rising head slug test will be conducted. For the rising head test, the data logger will be activated as the cylinder is instantaneously removed from the well (resulting in an immediate water level decline) and the rising water levels will be measured and recorded. Water levels will be monitored until they are within 10 percent of their original static level.

Multiple tests will be conducted on each well to ensure a representative test result.

2.12 Equipment Decontamination

Single-use, factory cleaned sampling equipment will generally be used when possible. Water interface probes will be washed with a detergent (e.g. Liqui-Nox®) and rinsed with de-ionized water (DI water) between monitoring wells. Probes used for field measurements will be rinsed with DI water between each sample location. Flow-thru cells will be rinsed with DI water between sampling locations, and thoroughly washed with detergent and DI water at the end of the day. Core barrels will be decontaminated using a high-pressure hot water sprayer between each boring.

If decontamination is performed in the field, rinse water will be contained. Sampling personnel will avoid contacting bailers, pumps and lines, and core barrels with the surrounding soils or unprotected hands. All sampling equipment that have contacted any soil, unprotected hands, or anything that may contaminate the equipment will be decontaminated according to the above procedures.

2.13 IDW Management

Waste materials consisting of decontamination water, well development/purge water, and soils from drilling activities will be designated as IDW. IDW generally consists of disposable personal protective equipment (PPE), soils from drilling and sampling, groundwater from well installations and sampling, and wash/rinse waters from equipment decontamination. PPE will be disposed daily as non-hazardous solid waste in municipal trash collection containers.

Soil and groundwater IDW will be containerized in Department of Transportation (DOT) compliant 55-gallon steel drums, labeled, and temporarily staged on-site until receipt of characterization analysis. For characterization and disposal purposes, drums of IDW soil will be sampled for Toxicity Characteristic Leaching Procedure (TCLP) VOCs, TCLP SVOCs, and TCLP Priority Pollutant Metals (or analytes required by the disposal facility). Drums of IDW decontamination water will be sampled for VOCs. Drums of well development/purge water will be characterized using sampling results from the monitoring wells.

Following receipt of characterization and monitoring well sampling data, Delavan facility personnel will coordinate the profiling and disposal of the IDW materials by a licensed disposal transporter/facility.

3.0 GROUNDWATER DELINEATION REPORT

After completion of the field activities and receipt of the analytical data, a brief report will be prepared. The report will include a summary and evaluation of the current assessment activities conducted to determine the extent of PCE in in the shallow and deeper limestone aquifer units downgradient of the Delavan site. Specifically, the report will include a description of the soil boring and field screening procedures and results. The monitoring well drilling, installation and development procedures will also be presented. Soil boring and monitoring well construction details will be included in an appendix to the report along with laboratory analytical data reports.

To provide a comprehensive overview in the shallow and deeper aquifer zones in the site vicinity, groundwater elevation data from the newly installed and existing monitoring wells will be used to generate potentiometric maps of the respective aquifer units. From this information, groundwater flow lines can be inferred.

The groundwater quality data generated during the assessment activities will be validated and tabular summaries prepared for the water quality and QA/QC data. To provide an evaluation of the distribution and occurrence of PCE at the site and vicinity, the water quality data will also be posted to iso-concentration contour maps. These maps will be compiled using the data from the most recent semi-annual groundwater quality monitoring event (e.g., Spring 2016 or Fall 2016) and the newly acquired data generated during the groundwater delineation activities.

Pertinent conclusions and/or recommendations will be developed based on the evaluation of the potentiometric and groundwater quality data.

4.0 REFERENCES

AECOM, January 8, 2015, *Fall 2014 Semi-Annual Groundwater Monitoring Report*, 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 Highway301 South, Bamberg, South Carolina, VCC 12-4762-RP.

AECOM, June 30, 2016, *Spring 2016 Semi-Annual Groundwater Monitoring Report*, Delavan Spray Technologies Site, Bamberg, South Carolina.

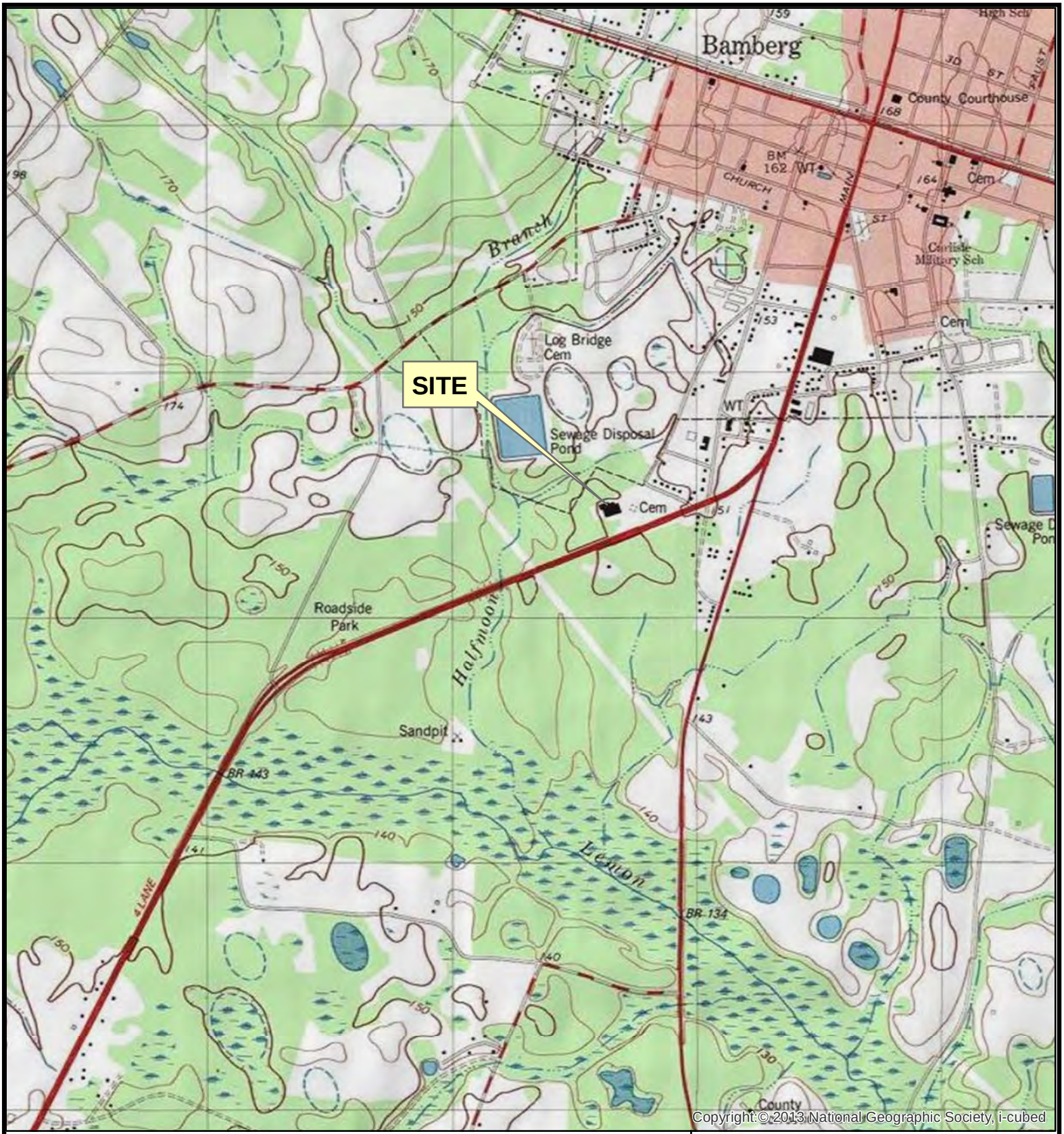
Hart & Hickman, August 1, 2013, *Remedial Investigation Work Plan*, Delavan Spray Technologies Site, Bamberg, South Carolina, VCC 12-4762-RP.

SCDHEC, July 12, 2016, Comments to the Post Remedial Investigation Report, dated May 27, 2016 and requesting a work plan for delineation of the shallow and deep groundwater plumes.

USEPA, 1996, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (EPA/540/S-95/504 dated April 1996.

USEPA, 2013, *Region 4 SESD Groundwater Level and Well Depth Measurement Operating Procedure* (January 2013).

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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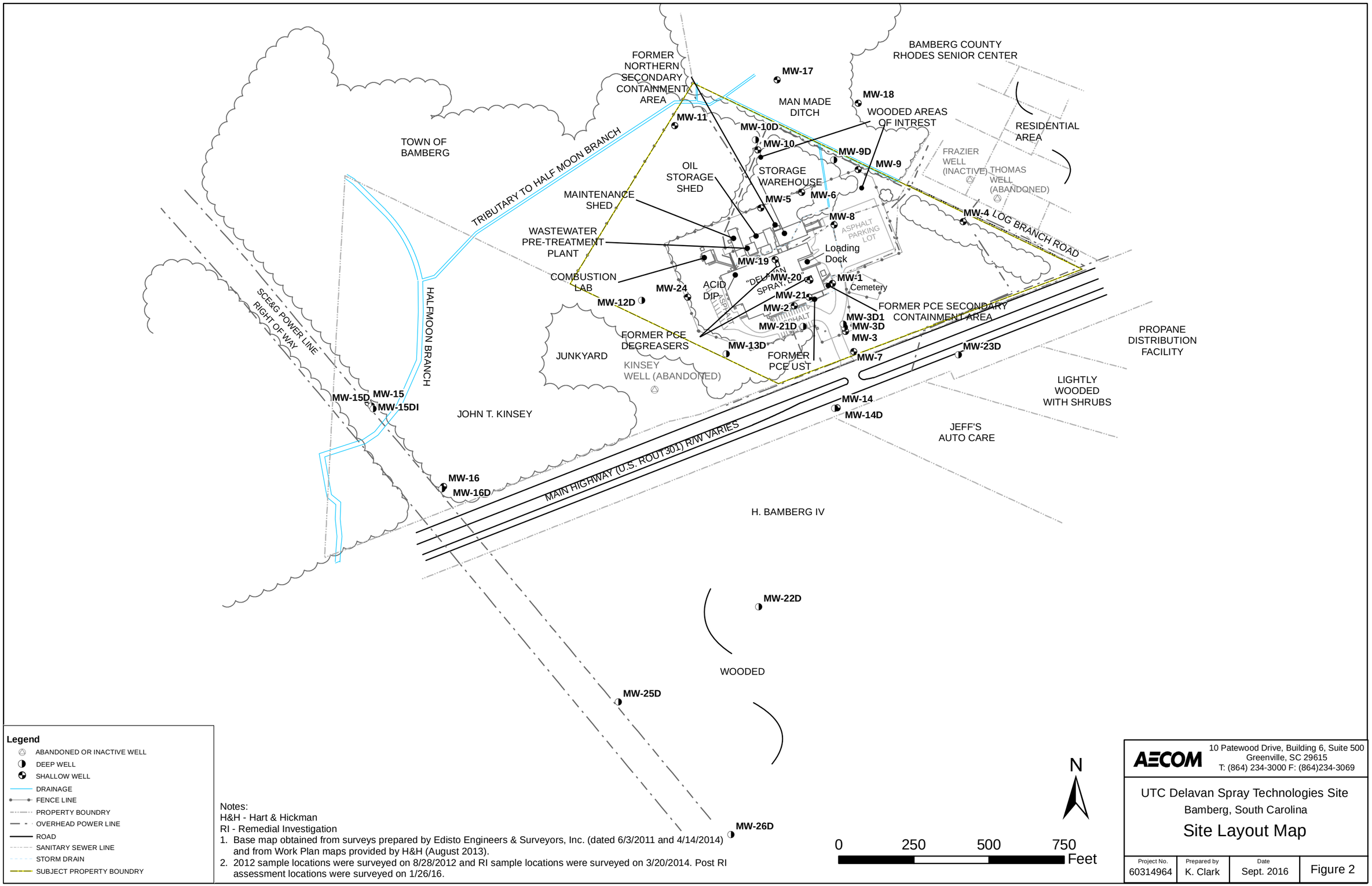
UTC Delavan Spray Technologies Site
Bamberg, South Carolina

Site Location Map

Project No.	Prepared by	Date	
60314964	K. Clark	Sept 2016	Figure 1

Path: L:\Projects\60314964\900-CAD-GIS\920 GIS-Graphics\Maps\Maps for May 2016\Figure 1 Site Location Map.mxd



Legend

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

Notes:
H&H - Hart & Hickman
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 1/26/16.

N

0 250 500 750 Feet

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Site Layout Map

Project No.	Prepared by	Date	
60314964	K. Clark	Sept. 2016	Figure 2

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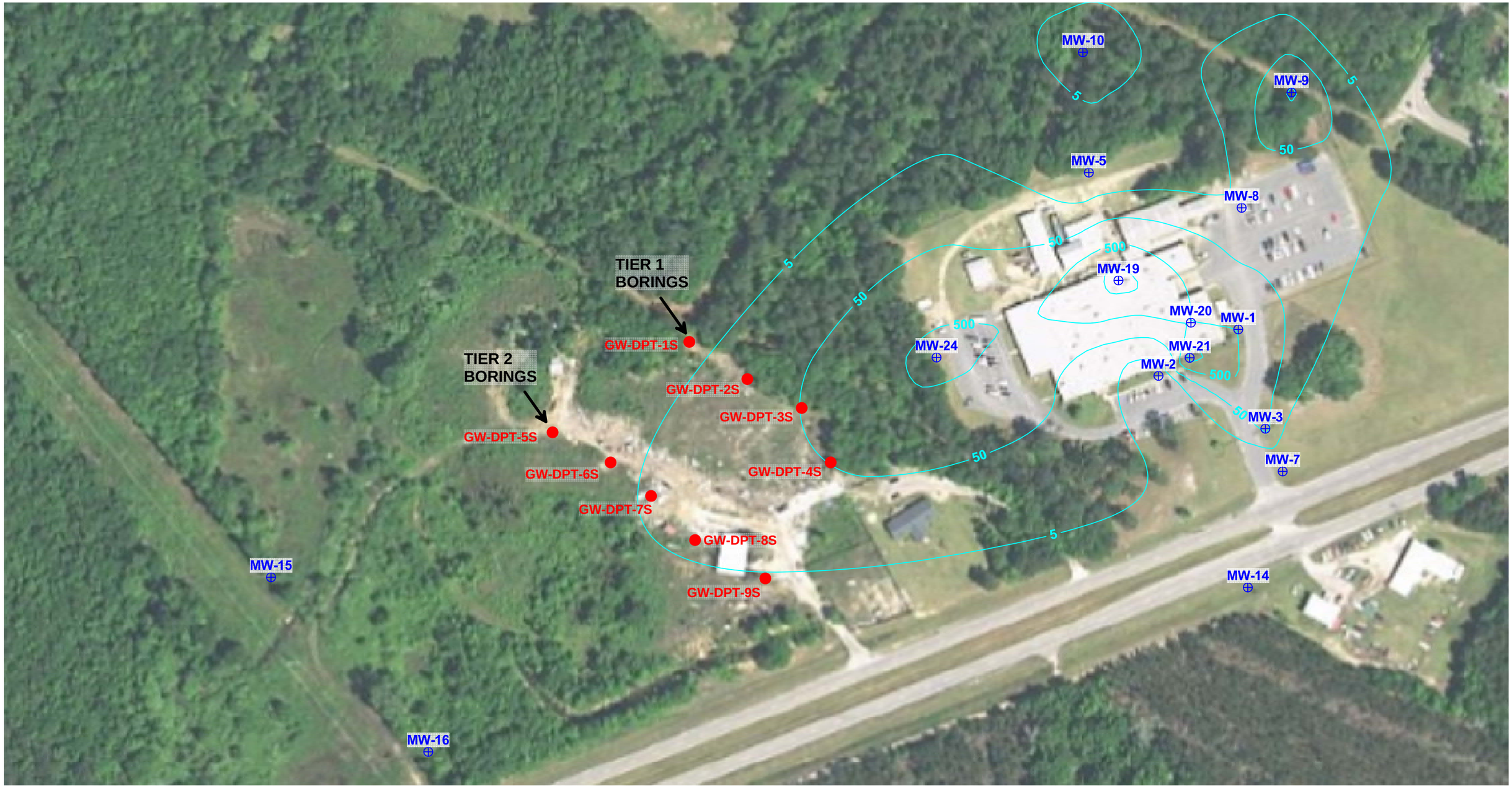

LEGEND

- PROPOSED SHALLOW AQUIFER BORING LOCATION
- EXISTING SHALLOW AQUIFER MONITORING WELL
- PCE ISOCONCENTRATION CONTOUR (µg/L) - APRIL 2016

N

0 150 300

FEET

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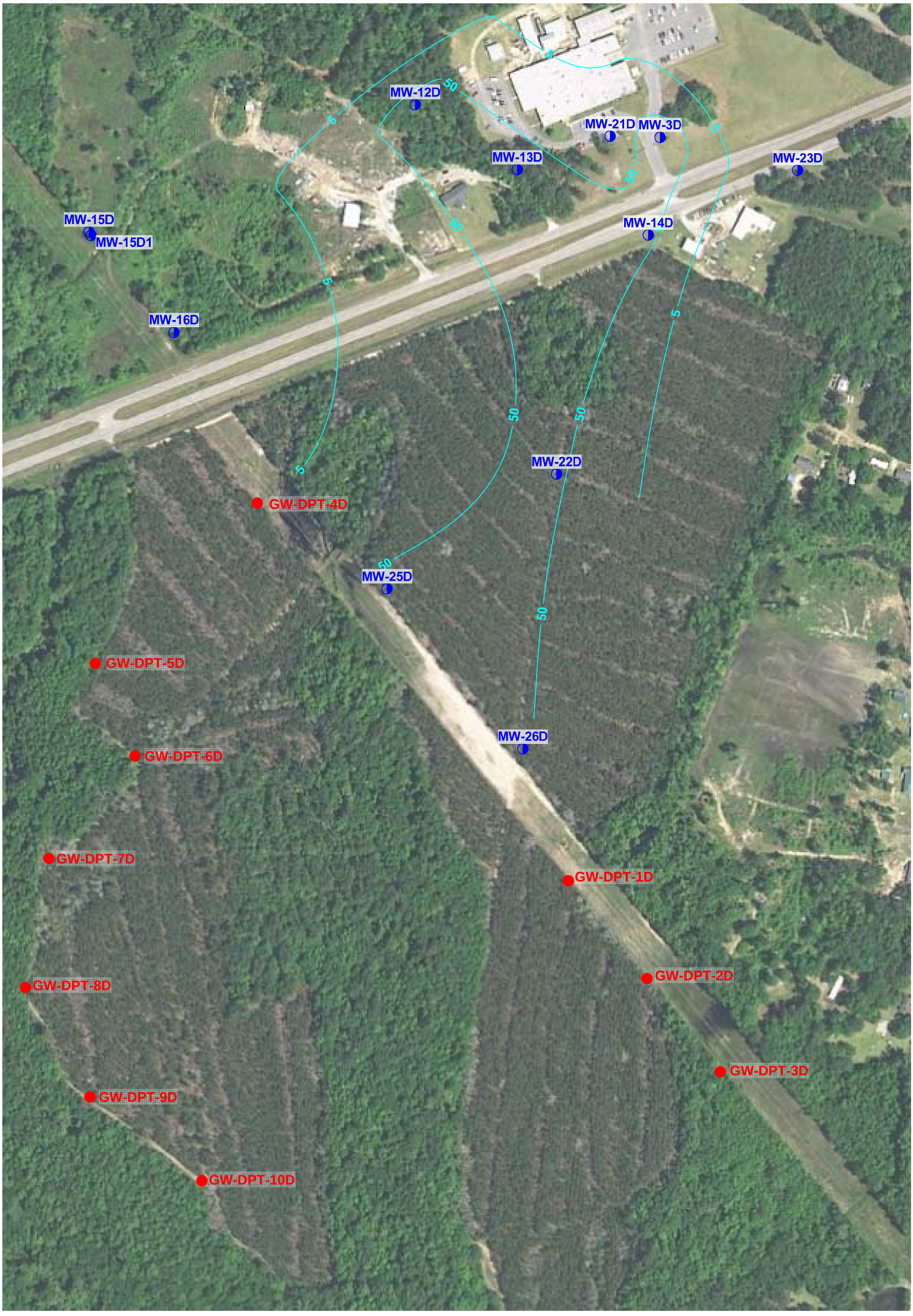
UTC Delavan Spray Technologies Site
Bamberg, South Carolina

PROPOSED SHALLOW AQUIFER SAMPLE LOCATIONS

PROJECT NO.	PREPARED BY:	DATE:	
60314964	LJA	September 2016	**Figure 3**

L:/Projects/60314964/400-Technical/406 Surfer/For 2016 GW Delineation WP/F3 Proposed Shallow MW Locations.srf



LEGEND

- PROPOSED DEEPER AQUIFER BORING LOCATION
- EXISTING DEEPER AQUIFER MONITORING WELL
- PCE ISOCONCENTRATION CONTOUR (µg/L) - APRIL 2016

0 250 500
FEET

N

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UTC Delavan Spray Technologies Site
Bamberg, South Carolina

PROPOSED DEEPER AQUIFER SAMPLE LOCATIONS

PROJECT NO.	PREPARED BY:	DATE:	
60314964	LJA	September 2016	**Figure 4**

L:/Projects/60314964/400-Technical/406 Surfer/For 2016 GW Delineation WP/F3 Proposed Deep MW Locations.srf

TABLES

Table 1
Proposed Borings for Groundwater Screening
Delavan Spray Technology Site
Bamberg, South Carolina

Area	Boring Location[1]	Boring Target Depth (feet bls)	Aquifer Unit	Sampling Methodology
Tier 1 Borings	GW-DPT-1S	20	Shallow Undifferentiated Sand/Clay Unit	Each boring will be screened for VOCs using a PID. 1 to 2 groundwater samples will be collected from each boring at the depth interval(s) with the highest PID reading(s). Groundwater samples will be analyzed by a local laboratory for PCE by USEPA Method 8260B.
	GW-DPT-2S	20	Shallow Undifferentiated Sand/Clay Unit	
	GW-DPT-3S	20	Shallow Undifferentiated Sand/Clay Unit	
	GW-DPT-4S	20	Shallow Undifferentiated Sand/Clay Unit	
Tier 2 Borings	GW-DPT-5S*	20	Shallow Undifferentiated Sand/Clay Unit	
	GW-DPT-6S*	20	Shallow Undifferentiated Sand/Clay Unit	
	GW-DPT-7S*	20	Shallow Undifferentiated Sand/Clay Unit	
	GW-DPT-8S*	20	Shallow Undifferentiated Sand/Clay Unit	
	GW-DPT-9S*	20	Shallow Undifferentiated Sand/Clay Unit	
Adjacent to Powerline ROW	GW-DPT-1D	50	Deeper Limestone Unit	Each boring will be screened for VOCs using a PID. 1 to 2 groundwater samples will be collected from each boring at the depth interval(s) with the highest PID reading(s). Groundwater samples will be analyzed by a local laboratory for PCE by USEPA Method 8260B.
	GW-DPT-2D	50	Deeper Limestone Unit	
	GW-DPT-3D	50	Deeper Limestone Unit	
	GW-DPT-4D	50	Deeper Limestone Unit	
Logging Road	GW-DPT-5D	50	Deeper Limestone Unit	
	GW-DPT-6D	50	Deeper Limestone Unit	
	GW-DPT-7D	50	Deeper Limestone Unit	
	GW-DPT-8D	50	Deeper Limestone Unit	
	GW-DPT-9D	50	Deeper Limestone Unit	
	GW-DPT-10D	50	Deeper Limestone Unit	

Notes:

* - Boring will be installed if needed pending the results of the initial Tier 1 screening samples.

[1] - Proposed boring locations are illustrated on Figures 3 and 4. These may be adjusted in the field due to access issues or the presence of utilities/infrastructure.

bls - below land surface

PID - photo ionization detector

ROW - right of way

VOCs - volatile organic compounds

Table 2
Proposed Monitoring Well Details
Delavan Spray Technologies Site
Bamberg, South Carolina

Monitoring Well Number	Location	Target Aquifer Unit[1]	Screen Length (feet)	Analytical Testing	Comments
MW-27	Kinsey Property, TBD based on field screening results	Shallow Undifferentiated Sand/Clay Unit	10	VOCs by USEPA Method 8260B Field Parameters[2]	1 or 2 wells will be installed to delineate the extent of PCE in the Shallow Sand/Clay Aquifer Unit
MW-28*	Kinsey Property, TBD based on field screening results	Shallow Undifferentiated Sand/Clay Unit	10		
MW-29D	H. Bamberg Property, TBD based on field screening results	Deeper Limestone Unit	10		2 or 3 wells will be installed to delineate the extent of PCE in the Deeper Limestone Aquifer Unit
MW-30D	H. Bamberg Property, TBD based on field screening results	Deeper Limestone Unit	10		
MW-31D*	H. Bamberg Property, TBD based on field screening results	Deeper Limestone Unit	10		

Notes:

* - well will be installed if needed to delineate the groundwater plume.

[1] - The shallow monitoring wells are typically screened between 10 and 20 feet bls and deep.
The deeper limestone aquifer unit monitoring wells are typically screened between 40 and 50 feet bls.

[2] - pH, specific conductivity, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential.

TBD - To be Determined

VOCs - volatile organic compounds

APPENDIX A

MONITORING WELL PERMIT APPLICATION AND PROPOSED CONSTRUCTION DETAILS

Monitoring Well Application

1. Proposed Location of Monitoring Well(s):

   Street Address:

   City (including Zip):

   County:

   Please attach Scaled Map or Plat

2. Well Owner's Information:

   Name (Last then First):

   Company:

   Complete Address:

   Telephone Number:

3. Property Owner's Information:

   Check if same as Well Owner

   Name (Last then First):

   Company:

   Address:

   Telephone Number:

4. Proposed Drilling Date:

5. Intended Purpose of Well(s):

   Pre-Purchase

   Investigation

   NOTE: If this request is for an existing DHEC project, please enter the Program area and ID number below.

   Program Area:
   Project or Site ID #:

6. Proposed number of monitoring wells:

7. Proposed parameters to be analyzed (check all that apply), please specify analytical method beside check box:

VOCs	8260B
BTEX	
MtBE	
Naphthalene	
PAHs	
Metals	
Nitrates	
Base, Neutral & Acid Ex.	
Pesticides/Herbicides	
Phenols	
Radionuclides	
PCBs	
Other (specify below)	

8. Proposed construction details (complete and attach proposed monitoring well schematics):

Multiple locations for Screen Point groundwater sampling (see Figures A-1 and A-2). The diagram for the screen point sampler is in Fiugre A-3. Anticipated up to 2 Type II & up to 3 Type III Monitoring Wells based on screening results. See well const Figs A-4 through A-7.

South Carolina Department of Health and Environmental Control (SCDHEC) summary of standards for monitoring well construction (per South Carolina Well Standards and Regulations R. 61-71)

Approval and License Requirements

Prior Department approval is required for the installation or abandonment of all monitoring wells including direct push, geoprobe or other temporary type monitoring wells. The attached monitoring well approval document should be completed, submitted and approved prior to construction of any monitoring well. A monitoring well is any well used to obtain water samples for water quality analyses or to measure groundwater levels. There are no fees for approvals. All monitoring wells must be drilled by a driller that is registered in South Carolina with the Board of Certification of the Environmental Systems Operators. If any of the information on the application including the proposed drilling date, well construction details or well placement changes, the Department (i.e. project manager issuing the well approval) must be notified 24 hours prior to well construction.

Location

Due to the nature and purpose of a monitoring well, the depth and location requirements in respect to surface water bodies, potential contamination sources, etc., are variable, and shall be approved on a case by case basis by the Department.

Construction and Material

Casing should be of sufficient strength to withstand normal forces encountered during and after well installation and be composed of material so as to minimally affect water quality analyses. Casing should have a sufficient diameter to allow for efficient sample collection (i.e., to provide access for sampling equipment). The diameter of the drilled hole needs to be large enough on all sides (1.5 inches of annular space) to allow forced injection of grout through a tremie pipe. All monitoring wells should have a cement pad or aggregate reinforced concrete at the ground surface which extends at least six inches beyond the bore hole diameter and six inches below ground surface to prevent infiltration between the surface casing and the bore hole. All monitoring wells should be grouted from the top of the bentonite seal to the surface with a neat cement, high solids bentonite or neat cement, bentonite mixture approved by the Department. A hydrated bentonite seal with a minimum thickness of 12 inches is to be placed above the filter pack to prevent infiltration of grout if the well has a filter pack. The monitoring well intake or screen design should minimize the amount of formational materials entering the well. The gravel
pack should be utilized opposite the well screen as appropriate so that parameters analyses will be minimally affected. All monitoring wells should have a locking cap or other security device to prevent damage and/or vandalism. Any monitoring well which is destroyed, rendered unusable or is abandoned should be reported to the Department and be properly abandoned, revitalized or replaced as appropriate or required by permit or regulation.

Development

Monitoring wells shall be properly developed. Development shall include the removal of
formation cuttings and drilling fluids from the well bore hole. Development shall be complete when the well produces water typical of the aquifer being monitored.

Reporting Requirements

A monitor well record form (1903) or equivalent to include the following should be completed and submitted to the Department within 30 days after completion of the monitoring wells:

Name and address of facility/owner;
Surveyed or global positioning system location of monitor well(s) on a scaled map or plat;
Driller and certification number;
Date drilled;
Driller's or Geologist's log;
Total depth;
Screened interval;
Diameter and construction details;
Depth to water table with date and time measured;
Surveyed elevation of measuring point with respect to established benchmark;
Monitoring well approval number issued by the Department.

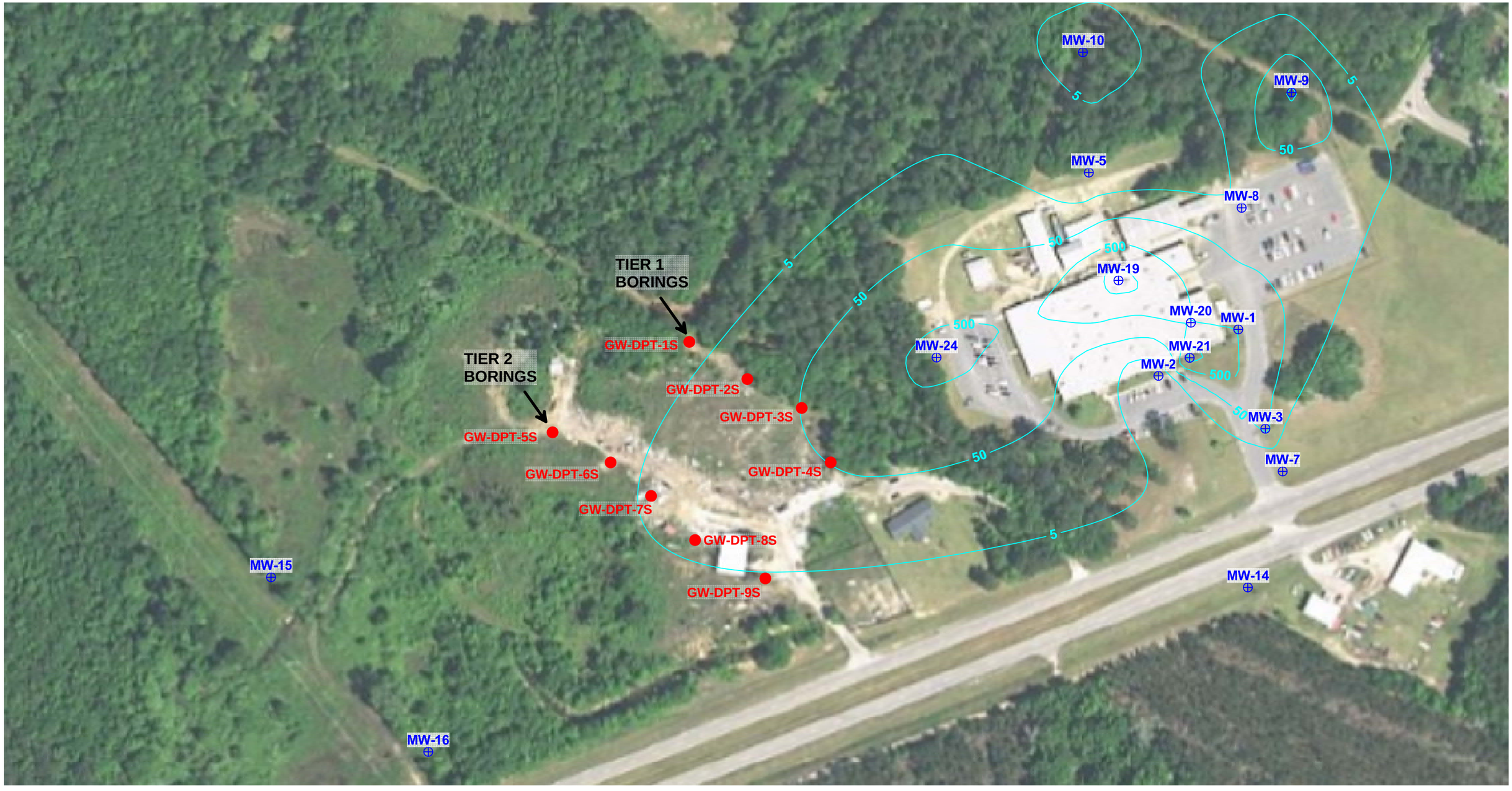
Additionally, the groundwater and soil (if taken) analytical results should be submitted to the Department within 30 days of receipt from the laboratory.

Abandonment

All monitoring wells shall be properly abandoned, when deemed appropriate by the Department. Any well that acts as a source of contamination shall be repaired or permanently abandoned immediately after receipt of notice from the Department. Abandonment shall be by forced injection of grout or pouring through a tremie pipe starting at the bottom of the well and proceeding to the surface in one continuous operation. The well shall be filled with either neat cement, bentonite-cement, or 20% high solids sodium bentonite grout, from the bottom of the well to the land surface.

* This summary of standards for monitoring well construction may not include a listing of all information necessary to obtain an approval to install monitoring wells. Final approval of monitoring well installation will be dependant upon the regulatory requirements for the Department program area for which the monitoring wells are to be installed.

* Some areas of the Department may require a detailed justification of the placement of monitoring wells and the depth of monitoring well screened zones prior to granting installation approval.



LEGEND

- PROPOSED SHALLOW AQUIFER BORING LOCATION
- EXISTING SHALLOW AQUIFER MONITORING WELL
- PCE ISOCONCENTRATION CONTOUR (µg/L) - APRIL 2016

N

0 150 300

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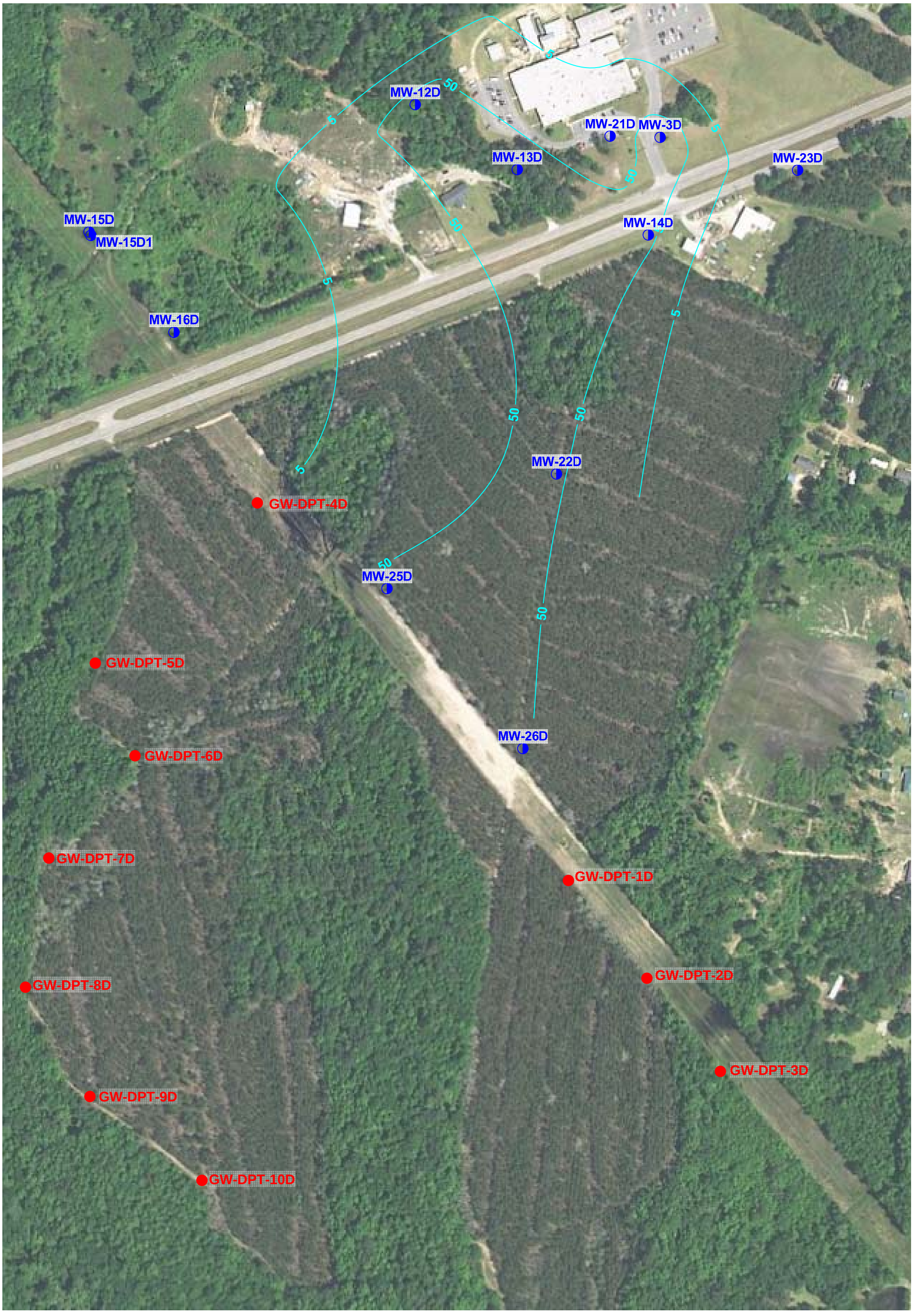
UTC Delavan Spray Technologies Site
Bamberg, South Carolina

PROPOSED SHALLOW AQUIFER SAMPLE LOCATIONS

PROJECT NO.	PREPARED BY:	DATE:	
60314964	LJA	September 2016	**Figure A-1**

L:/Projects/60314964/400-Technical/406 Surfer/For 2016 GW Delineation WP/F3 Proposed Shallow MW Locations.srf



LEGEND

- PROPOSED DEEPER AQUIFER BORING LOCATION
- EXISTING DEEPER AQUIFER MONITORING WELL
- PCE ISOCONCENTRATION CONTOUR (µg/L) - APRIL 2016

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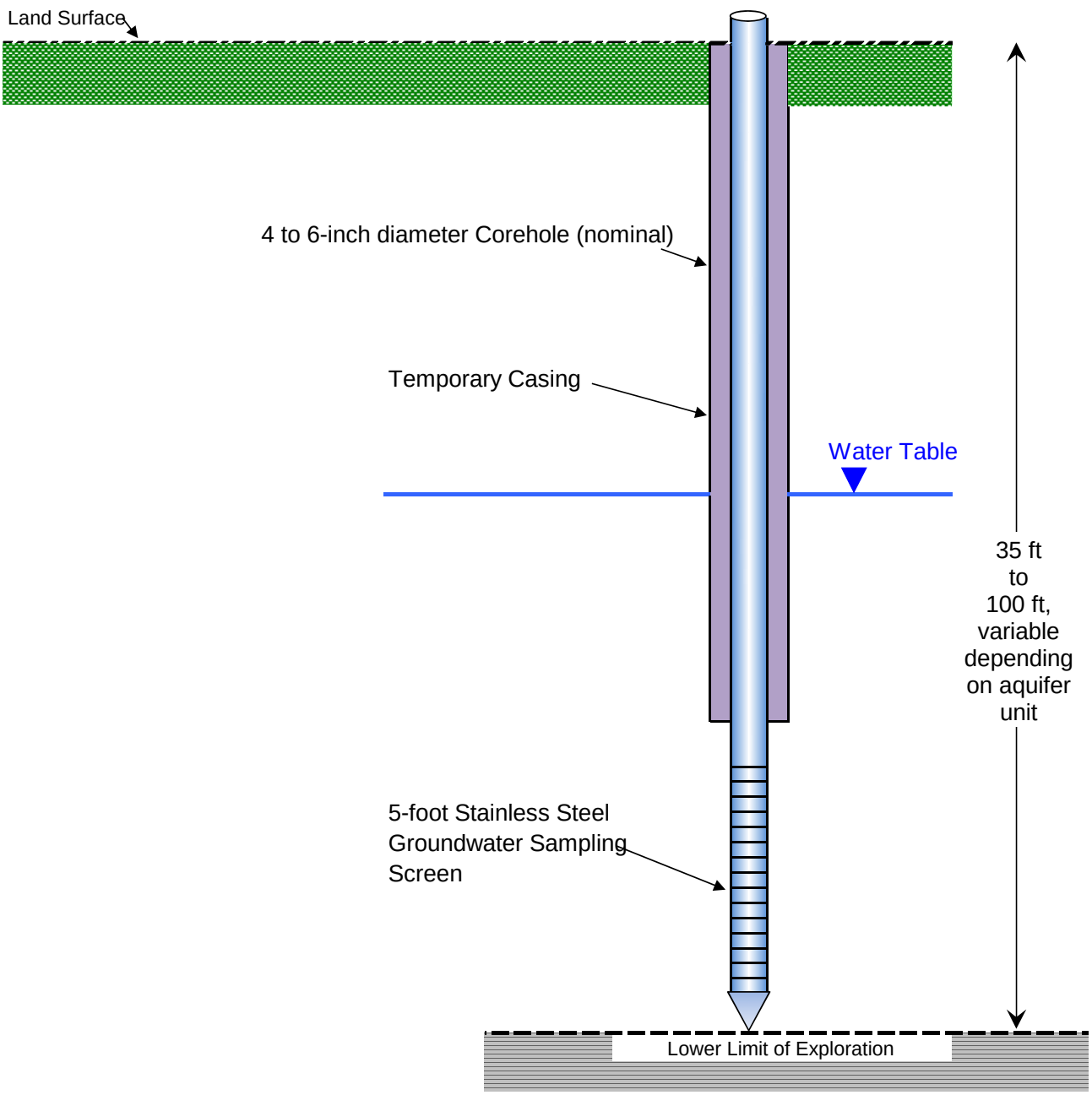
PROPOSED DEEPER AQUIFER SAMPLE LOCATIONS

PROJECT NO.	PREPARED BY:	DATE:	
60314964	LJA	September 2016	**Figure A-2**

L:/Projects/60314964/400-Technical/406 Surfer/For 2016 GW Delineation WP/F3 Proposed Deep MW Locations.srf

Project Name:	Delavan Spray Technologies	**Drilling Co.**		**Well Number:**	
Location:	Bamburg, South Carolina	**Driller:**		**Job Number:**	
Client:	United Technology Corporation	**Drilling Method:**		**Date Completed:**	
Geologist:		**Static WL:**		**Survey Datum:**	



Notes:
Drawing not to scale.

Sampling tools to be withdrawn from the boring after sample collection.

Boring to be abandoned by grouting with a neat Portland cement mixture.

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FIGURE A-3

SCHEMATIC DIAGRAM OF A DIRECT PUSH GROUNDWATER SAMLER

DELAVAN SPRAY TECHNOLOGIES

BAMBURG, SOUTH CAROLINA

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FIGURE A-4

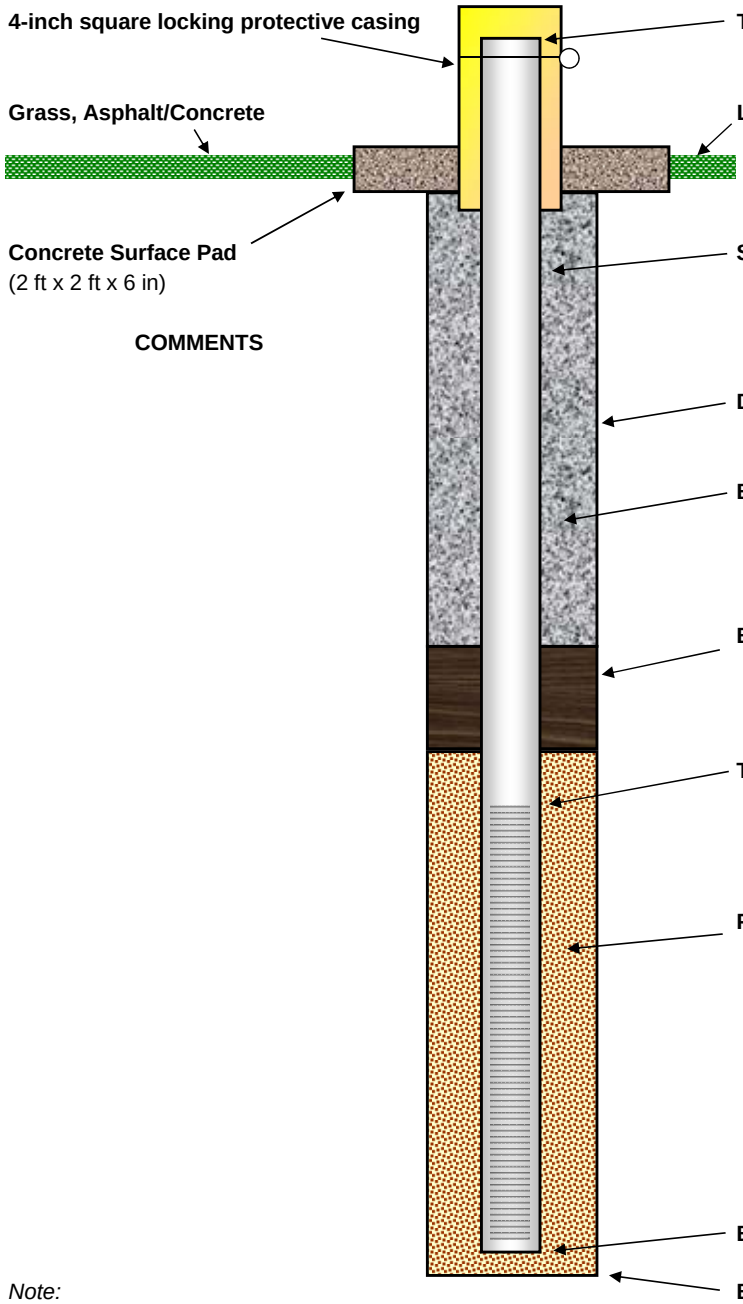
TYPE II GROUNDWATER MONITORING WELL INSTALLATION DETAIL

Project Name: Delavan Spray Technologies **Drilling Co:** _____ **Well Number:** _____

Location: Bamburg, South Carolina **Driller:** _____ **Job Number:** _____

Client: United Technology Corporation **Drilling Method:** Sonic **Date Completed:** _____

Geologist: _____ **Static Water Level** _____ **b.TOC** **Survey Datum:** _____



4-inch square locking protective casing

Grass, Asphalt/Concrete

Concrete Surface Pad
(2 ft x 2 ft x 6 in)

COMMENTS

Top Of Casing Elevation _____ ft _____ ft Stickup

Land Surface Elevation _____ ft

Surface Casing From _____ ft to _____ ft

Casing Type: **PVC**
Inside Diameter: **2**

Diameter of Borehole (nominal)
6 in

Bentonite/Cement Grout
From _____ ft to _____ ft

Bentonite Pellet Seal
Type: _____
From _____ ft to _____ ft

Top of Screen Depth _____ ft
Screen Type: **SCH-40 PVC**
Screen Slot Size: **0.010-in** ID **2** in
Screen Length: **10** ft

Filter Sand for Screen
Sand Type: _____
From _____ ft to _____ ft

Bottom of Well Depth _____ ft

Bottom of Boring (estimated) Depth **30 - 60** ft

Total Depth of Well, b. Top of Casing Depth _____ ft

Note:
Drawing Not to Scale
All Depths are Referenced to Ground Surface

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FIGURE A-5

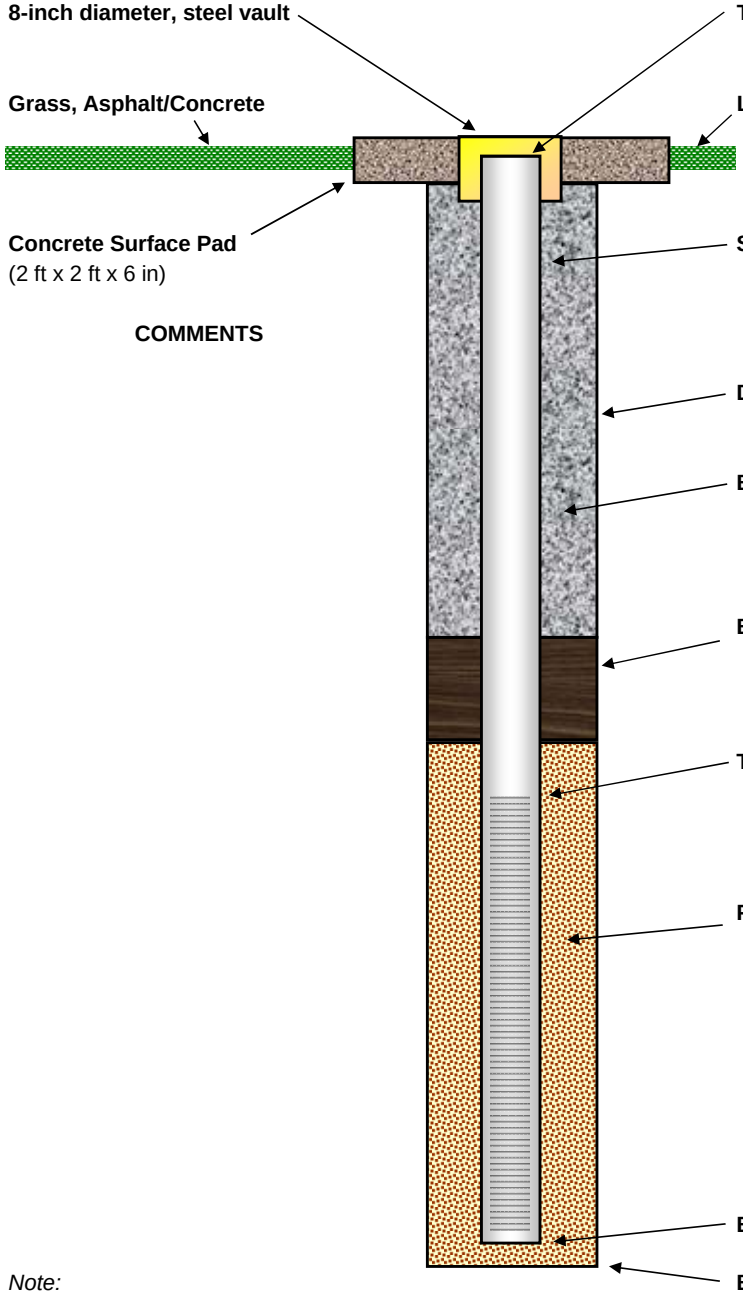
TYPE II GROUNDWATER MONITORING WELL INSTALLATION DETAIL

Project Name: Delavan Spray Technologies **Drilling Co:** _____ **Well Number:** _____

Location: Bamburg, South Carolina **Driller:** _____ **Job Number:** _____

Client: United Technology Corporation **Drilling Method:** Sonic **Date Completed:** _____

Geologist: _____ **Static Water Level** _____ **b.TOC** **Survey Datum:** _____



8-inch diameter, steel vault

Grass, Asphalt/Concrete

Concrete Surface Pad
(2 ft x 2 ft x 6 in)

COMMENTS

Top Of Casing Elevation _____ ft _____ ft Stickup

Land Surface Elevation _____ ft

Surface Casing From _____ ft to _____ ft

Casing Type: **PVC**
Inside Diameter: **2**

Diameter of Borehole (nominal)
6 in

Bentonite/Cement Grout
From _____ ft to _____ ft

Bentonite Pellet Seal
Type: _____
From _____ ft to _____ ft

Top of Screen Depth _____ ft
Screen Type: **SCH-40 PVC**
Screen Slot Size: **0.010-in** ID **2** in
Screen Length: **10** ft

Filter Sand for Screen
Sand Type: _____
From _____ ft to _____ ft

Bottom of Well Depth _____ ft

Bottom of Boring (estimated) Depth **30 - 60** ft

Total Depth of Well, b. Top of Casing Depth _____ ft

Note:
Drawing Not to Scale
All Depths are Referenced to Ground Surface

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FIGURE A-6

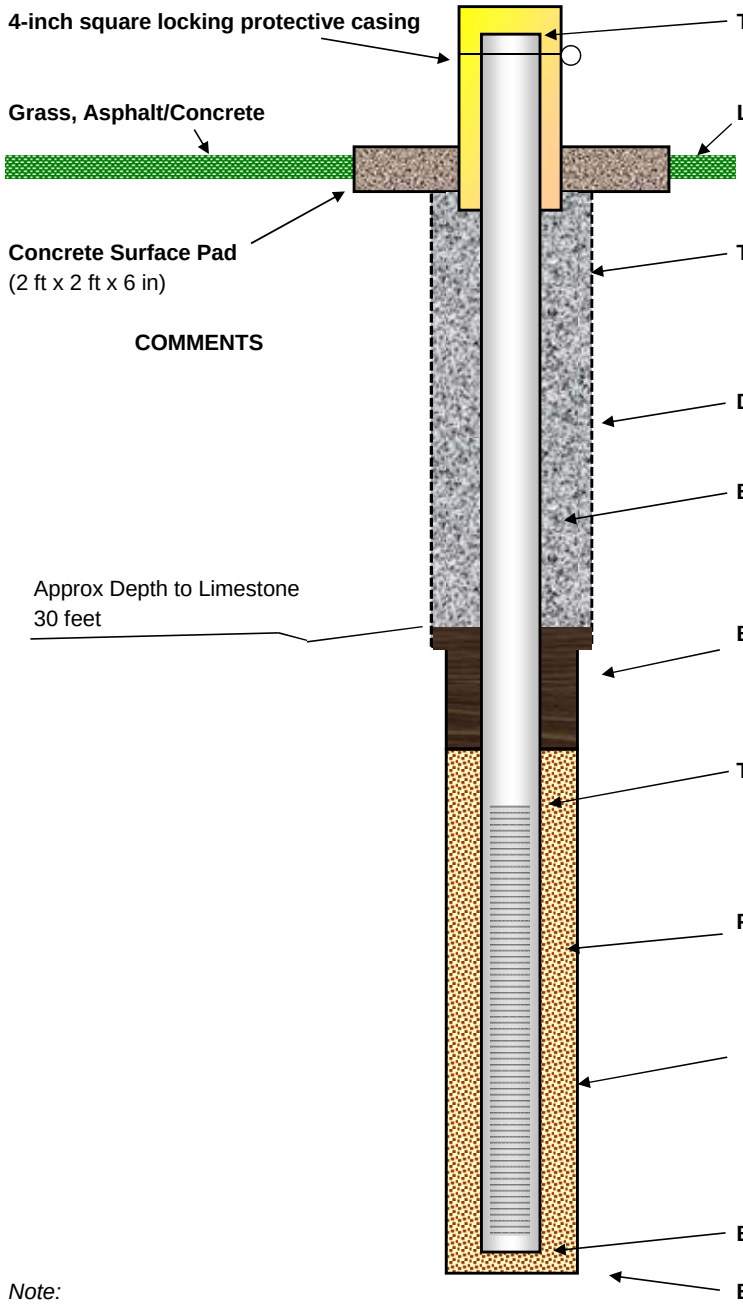
TYPE III GROUNDWATER MONITORING WELL INSTALLATION DETAIL

Project Name: Delavan Spray Technologies **Drilling Co:** _____ **Well Number:** _____

Location: Bamberg, South Carolina **Driller:** _____ **Job Number:** _____

Client: United Technology Corporation **Drilling Method:** Sonic **Date Completed:** _____

Geologist: _____ **Static Water Level** _____ **b.TOC** **Survey Datum:** _____



4-inch square locking protective casing

Grass, Asphalt/Concrete

Concrete Surface Pad
(2 ft x 2 ft x 6 in)

COMMENTS

Approx Depth to Limestone
30 feet

Top Of Casing Elevation _____ ft _____ ft Stickup

Land Surface Elevation _____ ft

Temp Surf Casing From _____ ft to _____ ft

Casing Type: **Temporary Steel**
Inside Diameter: **6** in

Diameter of Borehole (nominal)
6 in

Bentonite/Cement Grout
From _____ ft to _____ ft

Bentonite Pellet Seal
Type: _____
From _____ ft to _____ ft

Top of Screen Depth _____ ft
Screen Type: **SCH-40 PVC**
Screen Slot Size: **0.010-in** ID **2** in
Screen Length: **10** ft

Filter Sand for Screen
Sand Type: _____
From _____ ft to _____ ft

Diameter of Borehole (nominal)
4 in

Bottom of Well Depth _____ ft

Bottom of Boring (estimated) Depth **80 - 100** ft

Total Depth of Well, b. Top of Casing Depth _____ ft

Note:
Drawing Not to Scale
All Depths are Referenced to Ground Surface

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FIGURE A-7

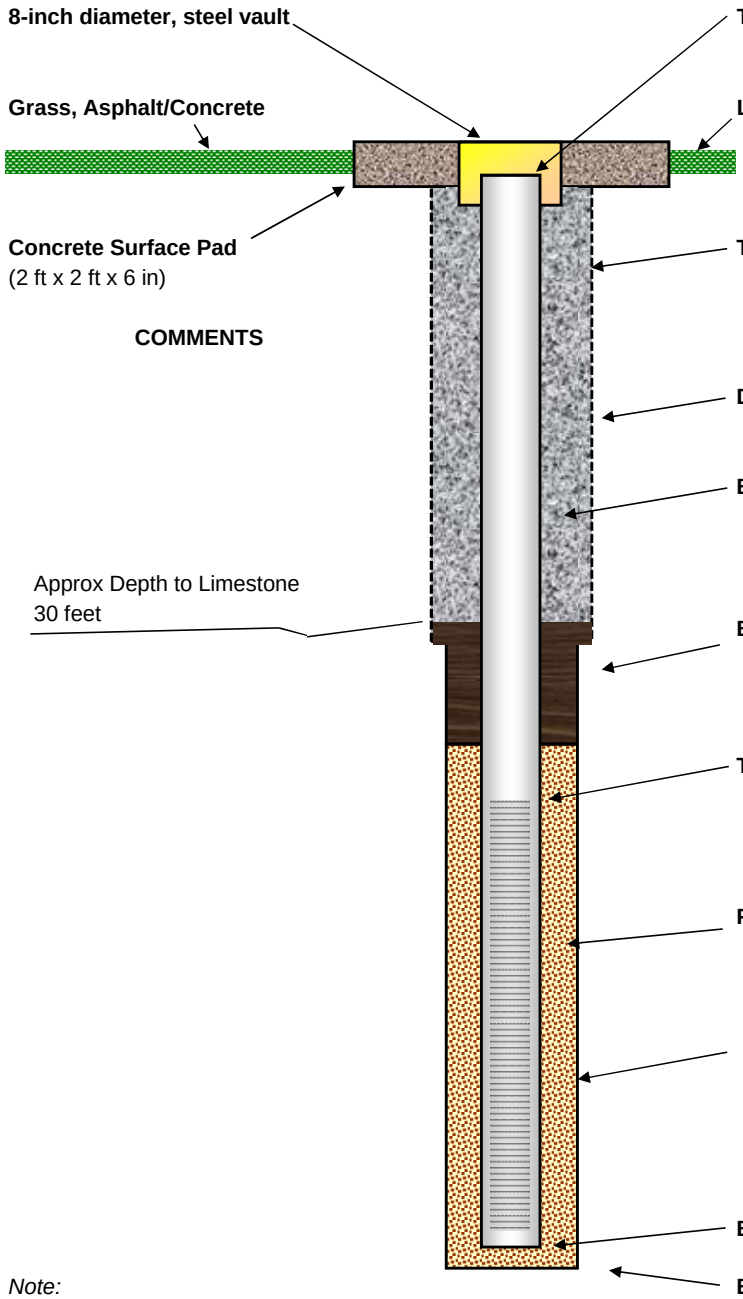
TYPE III GROUNDWATER MONITORING WELL INSTALLATION DETAIL

Project Name: Delavan Spray Technologies **Drilling Co:** _____ **Well Number:** _____

Location: Bamberg, South Carolina **Driller:** _____ **Job Number:** _____

Client: United Technology Corporation **Drilling Method:** Sonic **Date Completed:** _____

Geologist: _____ **Static Water Level** _____ **b.TOC** **Survey Datum:** _____



Top Of Casing Elevation _____ ft _____ ft Stickup

Land Surface Elevation _____ ft

Temp Surf Casing From _____ ft to _____ ft

Casing Type: **Temporary Steel**

Inside Diameter: **6** in

Diameter of Borehole (nominal)

6 in

Bentonite/Cement Grout

From _____ ft to _____ ft

Bentonite Pellet Seal

Type: _____

From _____ ft to _____ ft

Top of Screen Depth _____ ft

Screen Type: **SCH-40 PVC**

Screen Slot Size: **0.010-in** ID **2** in

Screen Length: **10** ft

Filter Sand for Screen

Sand Type: _____

From _____ ft to _____ ft

Diameter of Borehole (nominal)

4 in

Bottom of Well Depth _____ ft

Bottom of Boring (estimated) Depth **80 - 100** ft

Total Depth of Well, b. Top of Casing Depth _____ ft

Note:
Drawing Not to Scale
All Depths are Referenced to Ground Surface