PREDESIGN INVESTIGATION WORK PLAN

CABOT CARBON SUPERFUND SITE

Site Identification Number FLD980709356

Prepared for

U.S. Environmental Protection Agency
Region 4
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PREDESIGN INVESTIGATION WORK PLAN

Cabot Carbon Superfund Site
US EPA ID No. FLD980709356
Gainesville, Florida

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ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
ASTM	American Society for Testing and Materials
bgs	below ground surface
cm/sec	centimeters per second
DNAPL	dense non-aqueous phase liquid
EDD	electronic data deliverable
ft	foot/feet
FFS	focused feasibility study
gmp	gallons per minute
HSA	hollow-stem auger
HASP	Health and Safety Plan
HG	Hawthorn Group
ID	identification
IDW	investigation-derived waste
LHG	Lower Hawthorn Group
PDI	predesign investigation
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
RD	remedial design
SOG	standard operating guideline
SPD	stormwater pond design (boring)
SPLP	synthetic precipitation leaching procedure
SPT	Standard Penetration Test
SRI	supplemental remedial investigation
THA	task hazard analysis
UFA	Upper Floridan Aquifer
UHG	Upper Hawthorn Group
US EPA	United States Environmental Protection Agency
VBW	vertical barrier wall (boring)
VOC	volatile organic compound

1. INTRODUCTION

1.1 Overview

This Predesign Investigation (PDI) Work Plan, prepared by Geosyntec Consultants (Geosyntec) on behalf of Cabot Carbon Corporation (Cabot), addresses PDI activities that will be performed for the Cabot portion of the Cabot Carbon/Koppers Superfund Site located in Gainesville, Alachua County, Florida (Site). This document establishes the scope of work and protocol to be used for the PDI activities and includes procedural guidance documents and addenda to existing documents (e.g., addenda to the quality assurance project plan [QAPP], health and safety plan [HASP]). Existing documents, such as the QAPP and HASP, are not included with this PDI Work Plan; only the applicable addenda are included. This PDI Work Plan was prepared in accordance with the Remedial Design (RD) Work Plan (Geosyntec 2017). PDI activities will be undertaken to provide information for developing the RD of the Hawthorn Remedy described in the RD Work Plan.

1.2 Purpose and Objective

The purpose of the PDI activities is to obtain additional data necessary to develop and design the Hawthorn Remedy in accordance with the RD Work Plan. This PDI Work Plan describes the scope of work for field investigations, sampling, analysis, and mix design procedures that will be performed as part of the PDI activities.

The Hawthorn Remedy is the remedial action that will be designed and implemented to address soil and groundwater contamination in the Hawthorn Group (HG) formation. Additional details regarding the remedy components are provided in Section 2.2.

1.3 PDI Work Plan Organization

The remainder of this PDI Work Plan is organized as follows:

- **Section 2** provides a brief Site description and a summary of the Hawthorn Remedy.
- **Section 3** provides a description of the various PDI activities and their objectives, procedures, sampling and testing requirements, and data analysis and management requirements.
- **Section 4** describes the deliverables.
- **Section 5** presents the proposed PDI schedule.

1.4 Predesign Investigation Team

The PDI team comprises of those organizations who will carry out the activities described in this plan. A brief description of each team member is provided below.

- Cabot will retain consultants to perform the PDI activities for the Hawthorn Remedy. Cabot will coordinate with the RD consultant to ensure the activities are completed.

- Gradient Corporation (Gradient) is a consultant to Cabot and will continue to serve as Cabot's supervising contractor. Gradient will provide technical input on the PDI activities, as needed.
- Geosyntec is contracted by Cabot as the RD consultant and design engineer and will be responsible for carrying out the scope of work in this PDI Work Plan. Geosyntec will coordinate or perform the activities described in this plan and disseminate pertinent information to Cabot and Gradient during the PDI. Geosyntec will be responsible for coordinating the drilling contractor and the geotechnical and mix design laboratory.
- Contactors:
  - Environmental Drilling Services, Inc. is expected to be the drilling contractor retained by Geosyntec to perform the drilling activities described in the scope of work. Contact information: Carl Leonhardt, 407-295-3532, carl@edsenvironmental.com
  - Excel Geotechnical Testing Inc. will be retained by Geosyntec as the geotechnical and mix design laboratory to conduct the geotechnical, soil, and mix design testing described in the scope of work. Contact information: Nader Rad, 770-910-7537, nrad@excelgeotesting.com
  - Test America laboratory will be retained by Geosyntec as the environmental laboratory to conduct environmental laboratory analyses. Contact information: Charles Newton (850-474-1001), Charles.Newton@testamericainc.com
  - Southeastern Surveying will be retained by Geosyntec to conduct field surveying. Contact information: Ryan Johnson, 407-292-8580 x 2244, rjohnson@southeasternsurveying.com
  - Clark Environmental will be retained by Geosyntec to provide transportation and disposal of investigation derived waste from the investigation, if needed. Contact information: Steve Hall, 863-425-4884, shall@clarkenvironmental.com

1.5 Hawthorn Group Investigations and Historical Data Summary

A review of historical Site investigations and investigation results can be found in the *Supplemental Remedial Investigation and Focused Feasibility Study Report* (SRI/FFS Report; Gradient 2017).

2. SITE DESCRIPTION AND PROPOSED REMEDY

2.1 Site Description

The Site comprises approximately 34 acres, located in the northern section of Gainesville, Florida (Figure 1). The Site is relatively flat with topographic elevations ranging from approximately 170 to 190 feet (ft) above mean sea level. Surface water drainage is controlled by the stormwater pond located in the northwestern portion of the former Cabot Carbon property, a stormwater pond north of NE 28th Place, and a concrete-lined drainage ditch that runs along North Main Street. Typical stratigraphy encountered at the Site is shown in cross section in Figure 2. Stratigraphy generally consists of the following units (from top to bottom):

- Surficial Aquifer: approximately 1 to 2 ft of topsoil or fill materials and approximately 25 to 30 ft of silty to clayey sand, beginning at ground surface.
- The Hawthorn Group (HG) formation:
  - Upper Clay Unit - approximately 3 to 6 ft of a stiff plastic clay, beginning approximately 25 to 30 ft below ground surface (bgs)
  - Upper Hawthorn Group (UHG) - approximately 25 to 30 ft of consolidated sand to silty to clayey sand, beginning approximately 28 to 36 ft bgs
  - Middle Clay Unit - approximately 10 to 20 ft of a stiff clay, beginning approximately 60 to 65 ft bgs
  - Lower Hawthorn Group (LHG) – approximately 20 to 30 ft of semi-consolidated to consolidated silty to clayey sand with phosphate grains and indurated clasts cemented with dolomite
  - Lower Clay Unit - approximately 28 to 30 ft of clay
- Upper Floridan Aquifer (UFA): consists of a water-bearing zone of friable, weathered dolomite limestone formation.

The PDI activities will occur along the north side of the former Cabot Carbon property around the three former lagoons, also known as the Former Cabot Carbon Lagoon Area. The SRI/FFS Report presents a conceptual site model describing the contaminants of concern, their overall impact on the Site, their migration, and their attenuation. Residual pine tar is present in the unsaturated zone soils (within approximately 10 ft bgs) and in localized areas in saturated soils within the Former Lagoon Area. Pine tar is a dense non-aqueous phase liquid (DNAPL) containing various contaminants of concern. Groundwater concentrations indicate the potential presence of residual pine tar in the UHG. Chemical characterization of groundwater and soil is summarized in the SRI/FFS Report (Gradient 2017).

2.2 Proposed (Hawthorn) Remedy

The Hawthorn Remedy comprises two components, Part I and Part II, as described below and in the Remedial Design Work Plan. The conceptual layout of the proposed remedy components is provided on Figure 3.

Part I: Containment

The Hawthorn Remedy includes physical containment of the source area and concentrated portions of the related groundwater plume, and will be achieved using a low-permeability vertical barrier wall and a low-permeability cap. The vertical barrier wall will mitigate lateral migration of upgradient groundwater into the surficial aquifer and UHG below the former lagoons and concentrated portions of the groundwater plume, and aid in the capture of groundwater from these impacted areas of the surficial aquifer and UHG. A low-permeability cap will be installed over the footprint encompassed by the vertical barrier wall to reduce infiltration of precipitation into the containment zone. The surface of the cap will be graded to promote surface runoff and drainage. The existing storm water pond will be relocated.

The vertical barrier wall will key into the middle clay unit, approximately 65-ft below ground surface. Any excavated soil will likely be reused for construction of the vertical barrier wall and any excess soil will be placed under the containment cap. It is anticipated that construction of the vertical barrier wall will be performed using traditional barrier wall construction methods (i.e., excavation, slurry installation, backfill installation) or using a one-pass trenching system (e.g., using technology developed by the slurry wall contractor DeWind).

Part II: Groundwater Extraction

The groundwater extraction portion of the Hawthorn Remedy consists of groundwater extraction within the containment system (i.e., vertical barrier wall), and groundwater extraction downgradient and outside of the containment system. Extraction within the containment system will mitigate the vertical migration from the UHG into underlying aquifers, and allow for dissolved mass removal within the containment zone. Extraction downgradient and outside of a containment system will facilitate targeted contaminant mass removal from the UHG downgradient of the source area.

Pumping wells (i.e., a well-point system) will be utilized within the containment area and downgradient of the containment area. Extracted groundwater will be sent to the Gainesville Regional Utility (GRU)-operated Publicly Owned Treatment Works (POTW) for treatment.

3. PREDESIGN INVESTIGATION

3.1 Predesign Investigation Activities

The objectives, description of laboratory and field work, standard operating guidelines (SOGs), methods of documentation, and task hazard analyses (THAs) are described for each PDI activity in the sections below. The PDI activities include the following:

- PDI-1—Geotechnical borings and soil sampling that has three components:
  - Borings and soil sampling for VBW design
  - Borings and soil sampling for low-permeability cap design
  - Borings and soil sampling for stormwater pond relocation design
- PDI-2—Aquifer hydraulic testing for groundwater extraction system design
- PDI-3—Laboratory mix design for the VBW

Adjustments may be made to the PDI activities, field testing and analysis, as warranted by the field engineer/geologist and Cabot team, to accommodate conditions encountered in during the work.

Figure 4 is a Site map with proposed sampling and testing locations.

3.2 Health and Safety

The Site HASP is included in Appendix A. It will be the governing health and safety document used during PDI activities. The HASP includes a general health and safety risk analysis, a description of field monitoring and personal protective equipment (PPE), medical monitoring, and provisions for Site control. The HASP will be supplemented with Task Hazard Analyses (THAs) to cover the specific scopes of work under this PDI Work Plan. THAs are appended to the HASP. A THA is available for each PDI activity described below and will be finalized based on United States Environmental Protection Agency (US EPA) and stakeholder comments prior to field mobilization.

Site personnel (Geosyntec field engineers/geologists, subcontractors, visitors, etc.) will review the Site HASP and the applicable THAs and will sign each document prior to initiating field work.

3.3 PDI-1: Geotechnical Borings and Soil Sampling

3.3.1 Borings for Vertical Barrier Wall Design

The objective of this PDI activity is to perform geotechnical borings to define the alignment and depth of the VBW (particularly the west portion of the Site), in and around the former western lagoon based on visual evidence of mobile DNAPL (i.e., pine tar) if any, soil descriptions and lithology, and geotechnical properties for soils along the potential VBW alignment. Samples will also be collected for mix design testing as part of this PDI.

The scope of work for this PDI includes performing geotechnical borings every 150 ft along the perimeter of the proposed VBW alignment. The proposed boring locations are shown on Figure 4.

Borings will be performed to allow evaluation of a potential vertical barrier alignment that surrounds the westernmost lagoon as well as a potential alignment that passes through the westernmost lagoon.

The scope of work is as follows:

- At each location, the driller under Geosyntec oversight will advance the boring 2 to 4 ft into the middle clay unit, located approximately 60 to 65 ft bgs, using 4.25-inch hollow-stem augers (HSAs) in accordance with SOG-001 – *Soil and Rock Boring* (Appendix B).
    - At every odd-numbered location (VBW-01, VBW-03, VBW-05, etc.), the driller will conduct continuous standard penetration tests (SPTs) and record SPT blow counts, soil descriptions and classifications, and the presence of water in accordance with SOG-006 – *Visual-Manual Soil Classification (Field)* (Appendix B).
    - At every even-numbered location (VBW-02, VBW-04, VBW-06, etc.), the driller will conduct SPTs at 5-ft intervals beginning at the ground surface and will record SPT blow counts, soil descriptions and classifications, and the presence of water in accordance with SOG-006 (Appendix B).
    - The Geosyntec field engineer/geologist will visually inspect soil cuttings for mobile DNAPL (pooled pine tar), as drilling occurs in the surficial aquifer, according to SOG-010 – *Visual Identification of Mobile DNAPL (Pine Tar)*. The goal is to place the vertical barrier wall such that it encircles all areas of pooled pine tar, to the extent practicable in the field.
        - Pooled pine tar will be identified by visually examining soil and split spoon samplers, for flowing mobile DNAPL, as they are retrieved from the borehole in accordance with SOG-010. To-date, pooled pine tar has only been observed in a few locations at the Site; in the upper portions of the surficial aquifer in borings SB-1 through SB-4A, SB-6, SB-7, SB-9A, SB-10, SB-11, and SB-14, and at the base of the surficial aquifer in SB-10A. No pine tar has been observed in the UHG formation to-date at the Site.
        - If no evidence of pooled pine tar is observed, drilling will continue to the target depth (i.e., 2 to 4 ft into the middle-clay unit).
        - If evidence of pooled pine tar is observed, the boring will be abandoned where such tar is observed, the boring will be grouted and another boring (i.e., step-out) will be performed approximately 25 ft outward from the initial boring.
        - Step-out borings will not be performed on the north and east edges of the proposed VBW alignment (i.e., for approximately VBW-05 through VBW-10) because roadways prohibit installing a VBW beyond the footprint shown on Figure 4. If pine tar is observed at borings on these edges of the proposed VBW alignment, then borings will be advanced 2 to 4 ft into the

middle clay unit (as described above) and then the boring will be immediately grouted upon completion of sample collection.

  - Step-out borings will be labeled as the original boring location name with a letter designation after the boring number (e.g., original location is VBW-01, step-out location is VBW-01A).
  - If pine tar is observed in the step-out boring, follow the same step-out procedure described above. Step-out borings shall not extend beyond the "area for potential step-out borings" identified on Figure 4.

- At each VBW boring location the following tasks will be completed:
  - The Geosyntec field engineer/geologist will collect soil samples from every split spoon sample by placing soil from each split spoon (i.e., discrete samples) into a 1-gallon resealable bag.
  - The driller will place drill cuttings obtained from the HSAs onto plywood overlain by plastic sheeting (or similar). After all cuttings for a given location are on plywood, the following steps will be taken:
    - The driller will mix all drill cuttings (i.e., all subsurface layers) from one boring to make a uniform composite of the soil for the location.
    - The field engineer/geologist will collect a composite soil sample into a 1-gallon resealable bag.
    - The field engineer/geologist will fill two 5-gallon buckets with the remaining composite soil.
  - The field engineer/geologist will label bags and buckets according to the SOG-009 – *Sample Management and Documentation*.
- After samples have been collected, the driller will backfill and seal all boreholes using cement-bentonite grout in accordance with SOG-002 – *Tremie Grouting*.
- The driller will containerize, label, and manage excess soil from drill cuttings and split spoons (if any) as described in Section 3.7.

Samples collected during the field boring program will undergo laboratory analysis as follows:

- The field engineer/geologist will select one boring location from each side of the VBW alignment from which one discrete soil sample from each stratum (the surficial aquifer, upper clay unit, UHG, and middle clay unit) will be taken for testing. It is possible that the upper clay unit may not be represented in a sample due to the small thickness of the layer in some areas. If a representative sample of the upper clay unit cannot be obtained at a location, no sample will be collected from this strata at this location. Therefore, up to 16 discrete samples (i.e., 4 strata at 4 locations) will be obtained, however the final number of samples selected may be adjusted at the discretion of the Cabot project team.

- The field engineer/geologist will complete a chain-of-custody form for each selected discrete sample and will specify that the following laboratory tests be conducted for discrete samples:
  - American Society for Testing and Materials (ASTM D422 – *Standard Test Method for Particle Size Analysis of Soils (Sieve Analysis only)*
  - ASTM D2216 – *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*
  - ASTM D4318 – *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)*
- The field engineer/geologist will complete a chain-of-custody form for each 1-gallon-sized composite sample at each boring location, and will specify that the following laboratory tests be conducted for each 1-gallon-sized composite sample (i.e., 14 composite samples):
  - ASTM D422 (Sieve Analysis only)
  - ASTM D2216 (Moisture Content)
  - ASTM D2487 – *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*
- For locations where continuous SPTs were conducted (i.e., every odd-numbered location), the laboratory will conduct the following additional tests on the 1-gallon composite samples (i.e., seven of the composite samples):
  - ASTM D4318 (Atterberg Limits)
  - ASTM D2974 – *Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils*
  - ASTM D4972 – *Standard Test Method for pH of Soils*

- Five-gallon bucket samples and the remaining 1-gallon discrete soil samples will be saved for additional testing and for mix design testing as discussed in Section 3.5. The laboratory tests as described in PDI-3 will be the determining factor regarding which of these samples are carried forward for additional testing. Unused samples shall be stored in their sealed container and may be placed in a drum and sealed or labeled as "Not Waste, Additional Samples" and stored on-Site until the PDI lab testing programs are complete.

3.3.2 Borings for Low-Permeability Cap Design

The objective of this PDI activity is to collect samples of lagoon-bottom soils to assess potential settlement under the load of a cap. The scope of work for this PDI is to perform two geotechnical borings at locations within the Former Lagoon Area to obtain soil samples for laboratory testing. Boring locations are shown on Figure 4. The following steps will be followed at each boring location:

- The driller will advance a borehole into the surficial aquifer using 4.25-inch HSAs to a depth of approximately 25 ft bgs in accordance with SOG-001 (Appendix B).
  - During advancement, continuous SPTs will be conducted and the field engineer/geologist will record SPT blow counts, soil descriptions and classifications, and the presence of water in accordance with SOG-006 (Appendix B).
- The field engineer/geologist will visually inspect drill cuttings and split spoon samples for sediments associated with the bottom of the former lagoons and will record observations on the field forms.
- At each boring location, the field engineer/geologist will complete the following:
  - Collect soil samples from every split spoon sample by placing soil from each split spoon into a 1-gallon resealable bag (i.e., discrete samples).
  - Collect one Shelby tube sample of the former lagoon bottom sediments for each boring location.
  - For the Shelby tube sample, use a flat-edged spatula or equivalent to create a smooth, competent face on the bottom of the sample, conduct three field torvane tests on this face, and record the results of the torvane test on the field forms.
  - After conducting the field torvane test, remove approximately 0.25 to 0.5 inches of soil from the bottom of the sample using the flat-edged spatula; seal the top and bottom of the sample using a melted mixture of 50% petroleum jelly and 50% paraffin wax approximately 0.25 to 0.5 inches thick (one side at a time); and when the wax mixture has cooled and hardened, place plastic wrap over the end of the tube, cover it with a plastic tube cap, and secure the cap with duct tape (repeat these steps for each end of the tube).
  - Label bags and Shelby tube samples according to the SOG-009.
- After samples have been collected, the driller will backfill and seal all boreholes using cement-bentonite grout in accordance with SOG-002.
- The field team will dispose of excess soil from drill cuttings and split spoons (if any) as described in Section 3.7.
- The field engineer/geologist will ship Shelby tube samples to the geotechnical and mix design laboratory for analysis. Shelby Tube samples shall be stored vertically in the orientation that the sample was *in-situ* until delivered to the laboratory for testing.
  - The field engineer/geologist will complete a chain-of-custody form for each Shelby tube sample.
  - The geotechnical and mix design laboratory will conduct the following tests on samples from each Shelby tube:
    - ASTM D2435 – *Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading*

        - ASTM D422 (Sieve Analysis)
        - ASTM D2216 (Moisture Content)
        - ASTM D4318 (Atterberg Limits)

3.3.3 Borings for Stormwater Design

The objective of this PDI activity is to assess subsurface conditions above the water table in the proposed location for the relocated stormwater pond. The scope of work for this PDI is to perform four geotechnical borings south of the former lagoons within the proposed footprint of the relocated stormwater pond. The boring locations are shown on Figure 4.

At each location, the following will be performed:

- The driller will advance a boring into the surficial aquifer using 4.25-inch HSAs to a depth of approximately 25 ft bgs in accordance with SOG-001 (Appendix B).
    - During advancement, the driller will conduct continuous SPTs and the field engineer/geologist will record SPT blow counts, soil descriptions and classifications, and presence of water in accordance with SOG-006 (Appendix B).
- The field engineer/geologist will visually inspect drill cuttings and split spoon samples for visible pine tar according to SOP-010 and record observations on the field forms.
- At each stormwater pond boring location, the following will occur:
    - The field engineer/geologist will composite soil samples from all split spoon samples at a given location by placing the soil onto plastic sheeting, a plywood board, or in a bucket, and then mixing the soil into a single composite sample for each borehole.
    - The composite sample will then be placed into a 1-gallon resealable bag and labeled according to the SOG-009.
- After composite samples have been collected, the driller will backfill and seal all boreholes using cement-bentonite grout in accordance with SOG-002.
- The field team will dispose of excess soil from drillings and split spoons in accordance with Section 3.7.
- The field engineer/geologist will complete chain-of-custody forms and ship composite samples to the geotechnical and mix design laboratory for analysis.
    - The laboratory will conduct the following tests on the composite samples:
        - ASTM D422 (Sieve Analysis)
        - ASTM D2216 (Moisture Content)
        - ASTM D2487 (USCS Soil Classification)

At the conclusion of PDI-1, the field engineer/geologist will record the locations of all borings using a hand-held GPS so that the locations can be shown on Site figures and design drawings as necessary.

3.4 PDI-2: Aquifer Hydraulic Testing

The objective of this PDI activity is to collect hydraulic data for the surficial aquifer and UHG. This data will be used to design the groundwater extraction system to be installed within the VBW as well as the groundwater extraction system to be installed downgradient of the VBW. To accomplish these objectives, step-drawdown testing will be conducted at one surficial aquifer well and one UHG well to provide estimates of specific yield and well efficiency.

The scope of work for PDI-2 is to conduct step-drawdown testing at two existing monitoring wells. Step-drawdown testing will be conducted by a Geosyntec field engineer/geologist, as follows:

- Testing will be conducted at SA-29 (a well screened in the surficial aquifer) and HG-28S (a well screened in the UHG). Well ITW-8 will be the back-up test well for surficial aquifer. These wells were selected because they are screened in the appropriate lithologic units and are proximal to the anticipated location of future groundwater extraction wells.
- The field engineer/geologist will develop selected test wells in accordance with SOG-003-*Monitoring Well Development*, to remove potential sediment that may have accumulated in the wells.
- At the conclusion of well development at HG-28S, the field engineer will collect samples of groundwater from the well for laboratory analysis of VOCs, SVOCs and metals by EPA methods 624, 625 and 300.0, respectively. Samples shall be collected using methods to minimize head-space in the sample containers. These samples will be analyzed on a 24-hour turn-around time. Results for the analyses will be provided to GRU in a letter requesting approval to discharge water generated during the step test at HG-28S into a lift station for the surficial aquifer treatment system[1].
- After the wells are developed, they will be left undisturbed for a minimum of 48 hours to allow water levels to stabilize prior to the start of aquifer testing.
- The field engineer/geologist will conduct step-drawdown (pumping) tests in accordance with SOG-005-*General Step-Drawdown Test*, at the two selected monitoring wells using three different flowrates at each well. During testing, the field engineer/geologist will complete the following:
  - Obtain the static water level measurement in accordance with SOG-004-*Water Level Measurements* prior to initiating step-drawdown testing at each selected well.
  - Install a data-logging transducer and an appropriately sized downhole pump into the well and conduct step-drawdown pump test at the first selected flow rate. Flow rates are expected to be between 0.5 gallons per minute (gpm) and 4 gpm (e.g., 0.5, 1.5 and 3 gpm) but may be adjusted based on field observations.

[1] As an alternative, historic groundwater data from HG-28S can be provided to GRU in a request for approval to discharge. If this is done, then the VOC, SVOC and metals samples will not be collected.

  - Measure water levels by hand periodically and record these measurements along with pumping flow rates on field forms in accordance with the applicable SOGs.
  - Once water level in the well reaches a relatively steady-level at a given pumping rate, the pumping rate will be increased to the next flow rate (i.e., "step") and the hydraulic heads and flow rates will be recorded. This sequence will be repeated for three steps (i.e., three separate flow rates).
  - At the end of the third step, pumping will be terminated but heads in the well will continue to be recorded to monitor well recovery.
  - When the test is complete, equipment will be decontaminated in accordance with SOG-007-*Decontamination*.
- A Geosyntec hydrogeologist will analyze step-drawdown test data using AQTESOLV™ software other solutions, at the discretion of the hydrogeologist, depending on characteristics of the data. Test data will be used to calculate specific yield, hydraulic conductivity/transmissivity, and well efficiency estimates for each of the selected monitoring wells.

3.5 PDI-3: Mix Design Study

The objectives of the mix design study are:

- Identify an appropriate trench slurry mix (i.e., combination groundwater and/or hydrant water and bentonite)[2].
- Identify the percent bentonite, when mixed with native soils, required to achieve a backfill mix design with a hydraulic conductivity of 1 x 10^{-7} centimeters per second (cm/sec) or less.
- Evaluate long-term compatibility of the proposed backfill mix with Site groundwater using a maximum of 2 pore volumes of groundwater or 60 days of permeation, whichever occurs first, and assess hydraulic conductivity and contaminant leaching from the soil-bentonite mixture.

The PDI-3 laboratory program will consist of four phases.

Phase 1 – Composite Soil Sample Property Testing

A Geosyntec engineer will review the particle size analysis results from samples collected during PDI-1 (i.e., from the 1-gallon composite soil samples described in Section 3.3.1) and select two composite soil samples for mix design testing. One sample will be selected from boring locations VBW-03 through VBW-11 (i.e., within the approximate groundwater plume footprint) and the other sample will be selected from boring locations VBW-01, VBW-02, and VBW-12 through VBW-14 (upgradient of the lagoons). Samples selected for PDI-3 testing will be those deemed a worst-case soil for construction of a VBW, such as soils with low fines content and low plasticity

[2] A feasibility/constructability evaluation will be conducted after the field investigation to assess whether a one-pass trenching construction method or traditional construction methods (i.e., trenching and backfill) will be used to build the VBW. The mix design described in PDI-3 encompasses information necessary for installation using either approach.

fines. Selecting this soil for testing will ensure that the VBW will meet or exceed performance specification along its entire reach. Selecting samples from upgradient and downgradient of the Former Lagoon Area will account for potential impacts on hydraulic conductivity from groundwater contamination.

After locations have been selected, the following will occur:

- Geosyntec will ship the 5-gallon composite samples for each selected test location to the geotechnical and mix design testing laboratory, who is the selected subcontractor for geotechnical testing and the mix design experiments. Samples will be shipped under chain-of-custody protocols. The geotechnical and mix design laboratory will conduct the following index tests and issue the results to the Geosyntec engineer:
    - ASTM D422 (Sieve Analysis)
    - ASTM D2216 (Moisture Content)
    - ASTM D4318 (Atterberg Limits)
    - ASTM D2487 (USCS Soil Classification)

During PDI-2, the field engineer/geologist will collect Site groundwater and municipal water for use in slurry design, backfill mix design, and the long-term compatibility testing. Municipal water will be obtained from a public distribution system (i.e., the nearby publicly available spigot or hydrant). The intent is to use hydrant water for bentonite hydration since this is common construction practice when preparing slurry for VBW construction. Impacted Site groundwater will be used as mix water and permeant water to evaluate the worst-case compatibility scenario of the contaminant water with the bentonite slurry and the soil-bentonite mix. Water for PDI-3 will be collected as follows:

- 10 gallons of groundwater from well HG-28S will be collected during PDI-2 or using a bailer. This water will be shipped to the geotechnical and mix design laboratory.
- Water shall be containerized in glass jars with the head space in the jar minimized. Jars shall be kept sealed until use and handled to minimize potential changes in water chemistry and pH.
- 10 gallons of water from the nearby spigot or fire hydrant will be collected and shipped to the geotechnical and mix design laboratory.
- All water samples will be clearly marked and shipped in sealed containers (i.e., buckets).

<u>Phase 2-Slurry Evaluation</u>

The geotechnical and mix design laboratory will prepare three bentonite slurry mixtures using Site groundwater and three bentonite slurry mixtures using municipal water. These mixtures represent the water-bentonite slurry that will support the trench during soil excavation and prior to backfilling. Test results will be used to select a bentonite content for the slurry and to determine the design trench slurry unit weight; slurry unit weight is a key parameter for field monitoring during VBW construction. The geotechnical and mix design laboratory will perform the following tests.

- Analyze the Site groundwater and hydrant water samples for anions and cations to understand potential reactions between the water and bentonite.
- Prepare a bentonite slurry in glass columns using Site groundwater with 4%, 6%, and 8% bentonite[3].
- Prepare a bentonite slurry using municipal water with 4%, 6%, and 8% bentonite.
- After preparation of each slurry, the geotechnical and mix design laboratory will perform the following tests.
  - Measure the viscosity, unit weight, filtrate loss, pH and sand content as described in the American Petroleum Institute (API) test standard API-13B-1 or the comparable ASTM specifications if published.
  - Observe mixes for visual flocculation or other issues that may indicate potential problems with field application.
  - Repeat viscosity, unit weight, filtrate loss, pH, and sand content tests on the samples one day and seven days after preparing the slurry mixture.

<u>Phase 3-Backfill Mix Design:</u>

The laboratory will prepare soil-bentonite mixes using the trench slurry developed in Phase 2 and the selected soil samples tested in Phase 1. These mixtures will represent the backfill to be placed into the VBW that creates the containment system. Testing will be conducted by the geotechnical and mix design laboratory and will consist of the following steps:

- Analyze each composite soil sample for anions and cations.
- Prepare three soil-bentonite backfill mixtures for each composite soil sample. These will
  - use the 4%, 6%, and 8% slurries from Phase 2; and
  - target a bentonite content between 2% and 6% for the backfill mix.
- Perform slump tests on each backfill mix. Acceptable slump shall be between 4 and 6 inches.
- Perform hydraulic conductivity testing using Site groundwater as the permeant on the backfill mixes in accordance with ASTM D5084 – *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

[3] Bentonite used in preparing the bentonite-water slurry and for the soil-bentonite mixture shall be premium Wyoming grade sodium bentonite meeting the requirements of American Petroleum Institute (API) Specification 13A Section 9 (e.g., CETCO Premium Gel and Wyo-Ben Hydrogel), or equivalent as approved by the Geosyntec engineer.

- Identify the optimum mixture to provide the required hydraulic conductivity. This identification of the optimum mixture will be a collaboration between Geosyntec engineer and the laboratory and will be based on initial hydraulic conductivity results. Soil-bentonite mixes may be revised by adding free (dry) bentonite as necessary to achieve the target hydraulic conductivity.

Phase 4-Long-Term Compatibility Testing and Synthetic Precipitation Leaching Procedure (SPLP) Testing:

Following the Phase 3 testing, the geotechnical and mix design laboratory and Geosyntec engineer will select a soil-bentonite mixture to use for long-term compatibility testing as described below. The selected sample will be the mixture which attains a hydraulic conductivity of 1.0 x 10^{-7} cm/sec (or lower) and has the least bentonite. The testing below will be performed on the selected sample.

- The geotechnical and mix design laboratory will perform hydraulic conductivity testing on the selected soil-bentonite sample mixture by
  - using Site groundwater for the pore fluid;
  - conducting long-term compatibility testing in general accordance with ASTM D5084 or another applicable standard; and
  - running the test for 60 days or until 2 pore volumes pass through the sample, whichever occurs first.
- Hydraulic conductivity will be evaluated at the end of the long-term testing.
  - If the hydraulic conductivity is $1x10^{-7}$ cm/sec or less, then the mixture will be deemed acceptable and carried forward in design.
  - If the hydraulic conductivity is greater than $1x10^{-7}$ cm/sec, then a revision to the mix design work plan will be discussed, including potential alternative mix design designs with additional additives and testing performed using the revised mixture.

Leachability testing will be conducted on the acceptable soil-bentonite mixture selected from the long-term testing. Potential leaching of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) from the soil-bentonite mixture will be assessed by having the geotechnical and mix design laboratory collecting a soil sample from the soil-bentonite mixture selected during the aforementioned testing (i.e., a sample that has been permeated by Site groundwater). This sample will be submitted under chain-of-custody procedures to the environmental laboratory. This sample will undergo SPLP testing for VOCs and SVOCs according to the US EPA method SW-846. Results for this testing will provide a worst-case estimate of VOC leaching from the soil-bentonite mixture because of the following:

- The sample will be permeated by multiple pore volumes of the impacted Site groundwater from HG-28S. Full permeation of groundwater through the VBW material may not occur in the field since pumping will occur within the VBW limits.

- The SPLP testing potentially induces greater leaching than may occur under field conditions because there will be more water-soil contact in the SPLP test than in the field.
- The SPLP test assumes no groundwater migration/flushing. In the field, desorption/leaching from the soil-bentonite mixture, if it occurs, will be very slow and the resulting groundwater concentrations will be a function of the desorption/leaching rate relative to the groundwater flux (i.e., flow through the wall). SPLP tests do not account for the slowness of desorption/leaching or dynamic groundwater flow.

Revisions to the Mix Design Work Plan:

The testing program described above is tailored to a VBW constructed using traditional means (i.e., a slurry wall excavated using a backhoe and backfilled with a soil-bentonite mixture). If the results from PDI-1 and conversations with contractors determine that a continuous one-pass trencher can be used for installing the VBW, then the mix design program may be modified, if necessary, to address installation by one-pass trenching.

3.6 Standard Operating Guidelines

The SOGs (Appendix B) describe the methods that will generally be used to execute the work. The SOGs provided in Appendix B represent addenda to various project plans (e.g., the field sampling and analysis plan). The following are SOGs that will be followed for PDI-1 activities:

- SOG-001 – Soil and Rock Boring
- SOG-002 – Tremie Grouting
- SOG-006 – Visual-Manual Soil Classification (Field)
- SOG-007 – Decontamination
- SOG-008 – Investigation Derived Waste (IDW) Management
- SOG-009 – Sample Management and Documentation
- SOG-010 – Visual Identification of Pine Tar

The following SOGs will be followed for the PDI-2 activities:

- SOG-003 – Monitoring Well Development
- SOG-004 – Water Level Measurements
- SOG-005 – General Step-Drawdown Test
- SOG-007 – Decontamination
- SOG-008 – IDW Management

All manufacturer user guides for the equipment used to perform any portion of the PDI activities will serve as a supplemental SOG. Manufacturer user guides will be used for actions such as equipment calibration and troubleshooting.

3.7 Investigation Derived Waste Management

The IDW generated during the PDI activities might include the following:

- Spent PPE
- Disposable sampling equipment
- Decontamination and purging liquids
- Excess soils from drilling
- Water from developing and testing wells

In general, solid and liquid IDW will be contained in 55-gallon drums, moved to a centralized waste storage area at the Site, and tested prior to determining where the IDW will be disposed of in accordance with SOG-008– *Investigation Derived Waste Management* (Appendix B). These wastes will be managed to limit exposure of Site personnel to potentially hazardous materials and to prevent contaminated materials from being introduced to uncontaminated environmental media at the Site. SOG-008 provides details on the handling, testing and disposal of anticipated wastes generated during the PDIs. Section 1.5 identifies the expected waste transported and disposal subcontractor.

3.8 Documentation

Hawthorn Remedy PDI activities and testing will be documented as described below. Documentation methods for this PDI have been tailored for the specific activities under this PDI Work Plan.

3.8.1 Field Documentation

All field work and sample collection programs will be documented using a combination of daily field reports and/or specific field log forms. All sample information to be included in field logs, on sample labels, custody seals, and chain-of-custody forms is described below.

Field Activity Log

Daily field reports will be used to document field activities. Field reports will be supplemented by loose-leaf drilling and/or testing logs and field data entry records (e.g., field forms and possibly personal data assistants or tablet computers) as necessary. This project will have dedicated forms and databases that will not be used for other projects. To the extent possible, field data will be recorded on field forms or electronic data entry records and on the daily field report.

The following information, as appropriate, will be provided in the daily field reports:

- Project name/number
- On-Site personnel
- Documentation of daily safety meeting

- Date and weather information
- Relevant personnel leaving or arriving on Site (e.g., drilling crew)
- Time and description of task activities
- Notes on calibration of instruments or devices as necessary
- Description of drilling, sampling, testing, and shipping activities for the day including the following:
  - Sampling personnel
  - Date and time of collection
  - Location of sampling
  - Method of sampling (e.g., split spoon)
  - Type of sample (e.g., composite or discrete)
  - Notable observations during sampling
- Description of drilling and sampling progress for the day
- Relevant communications
- Any additional notes on events or problems

Field notes will be supplemented with photographs at the discretion of the field engineer/geologist. Photographs will be saved to the project file for later reference or use in reports as needed.

Sample Management and Documentation

Samples obtained during field activities will be sent to the geotechnical and mix design laboratory or to the environmental laboratory for analysis. Sample management activities will include the following:

- Containerizing samples
- Sample preservation and storage
- Shipping

In addition to a record of samples in the daily field report, sample documentation will include the following:

- Boring logs
- Sample labeling
- Chains-of-custody

In general, each sample selected for testing will have a unique sample ID, will be stored to prevent sample volume loss, and will be shipped with a chain-of-custody form. Samples retained for future potential testing will be stored until the results of the laboratory analyses (including mix design) have been evaluated. Field personnel will follow the management and documentation procedures described in SOG-009 – *Sample Management and Documentation*, provided in Appendix B.

Photographic Documentation

The field engineer/geologist will take photographs that are representative of field sampling activities and locations. Digital images will be retained electronically with the project files.

Documentation of Field Variances

During field work, site conditions and information collected during field activities may indicate that a proposed procedure or method should be altered to meet the data quality requirements in the QAPP. Documentation of any changes will include the following:

- The change from the planned method or procedure
- The rationale for the change including adverse field conditions responsible for the modification, field screening data/observations that led to the decision, and any other reason for the modification
- A description of the revised procedure or method and a description of the data that will be collected
- A description of how, if at all, the modification will affect or modify future data collection during the PDI.

Documentation of variances will be submitted to the project manager for review and filing.

3.8.2 Laboratory Documentation

The geotechnical and mix design laboratory will generate reports releasing the results of the requested testing. Laboratory reports will be issued to and reviewed by Geosyntec. Geosyntec will retain electronic copies of the laboratory reports. Laboratory documentation will generally be in the format preferred by the laboratory. Geosyntec will coordinate with the laboratory to make sure the following project information, at a minimum, is included on laboratory-issued documents:

- Project name
- Sample ID (as shown on the chain-of-custody)
- Date sample was received
- Date sample was tested
- Name of laboratory technician reviewing test results
- Tests performed and results

The laboratory procedures for data reporting (i.e., laboratory data package deliverables) are provided in Section A.9 of the QAPP (Gradient 2015). These procedures will be adhered to, in general, but may be altered given the different nature of geotechnical and treatability study reporting compared to environmental testing. Geosyntec personnel will be responsible for reviewing and summarizing laboratory data.

The environmental testing laboratory will provide a level 2 laboratory report and electronic data deliverable (EDD). Geosyntec staff will review the laboratory report for quality assurance and control (e.g., hold times). Data from the EDD will be entered into a project database, and reports will be provided, as needed, with a PDI report.

3.8.3 Electronic Data

Following each stage of field activities, Geosyntec personnel will enter field data, as appropriate, into the project database. Field forms will be scanned and saved in the project folder on Geosyntec's server. Analytical laboratory data will be provided as EDDs and hard copy reports in accordance with the QAPP. Geotechnical laboratory data will be provided, at a minimum, as electronic report documents (e.g., PDF).

4. DELIVERABLE

Data from the PDI investigations will be analyzed as part of the 50% RD and integrated into the design. For example, field notes from PID-1 will be used to create boring logs and stratigraphic profiles along the VBW alignment; yield for extraction wells will be determined from PDI-2 and used to select pumping wells for groundwater extraction; and the recommended slurry and backfill mixture will be determined from PDI-3. Such design information will be shared with US EPA and other stakeholders either in a report, as one or more technical memoranda, and/or in a technical workshop that would be held in Gainesville, FL so that US EPA and local Stakeholders can comment on the work and participate in the remedial design. Geosyntec will provide information (e.g., field and laboratory data, preliminary design concepts based on the data, etc.) to US EPA where such data are relevant to the basis of design. Other field data may be provided at US EPA's request. The current schedule has PDI field work being performed from October 2017 through late January 2018. If we can adhere to this schedule, we anticipate providing EPA with preliminary design information and other information in March 2018. The 50% Design Report would be provided to EPA in June 2018 under the current schedule.

5. PREDESIGN INVESTIGATION SCHEDULE

Hawthorn Remedy PDI field activities will be performed based on the schedule provided in the RD Work Plan (Geosyntec 2017). The actual start and end dates for PDI activities is contingent upon US EPA approval of this work plan and other factors such as access and contractor availability; as such, scheduled dates are subject to change. The anticipated durations for each PDI activity in this work plan are provided in Table 1.

6. REFERENCES

Geosyntec. 2017. *Remedial Design Work Plan*. Cabot Carbon Superfund Site, Gainesville, Florida. August.

Gradient. 2015. *Quality Assurance Project Plan*. Cabot Portion of Cabot Carbon/Koppers Site Gainesville, Florida. March.

Gradient. 2017. *Supplemental Remedial Investigation and Focused Feasibility Study Report*. Cabot Carbon/Koppers Superfund Site Gainesville, Florida. January.

United States District Court. 1991. *Consent Decree: Civil Action No.: 91-10130. United States of America v. Cabot Corporation*. United States District Court for the Northern District of Florida Gainesville Division. 12 September.

TABLE

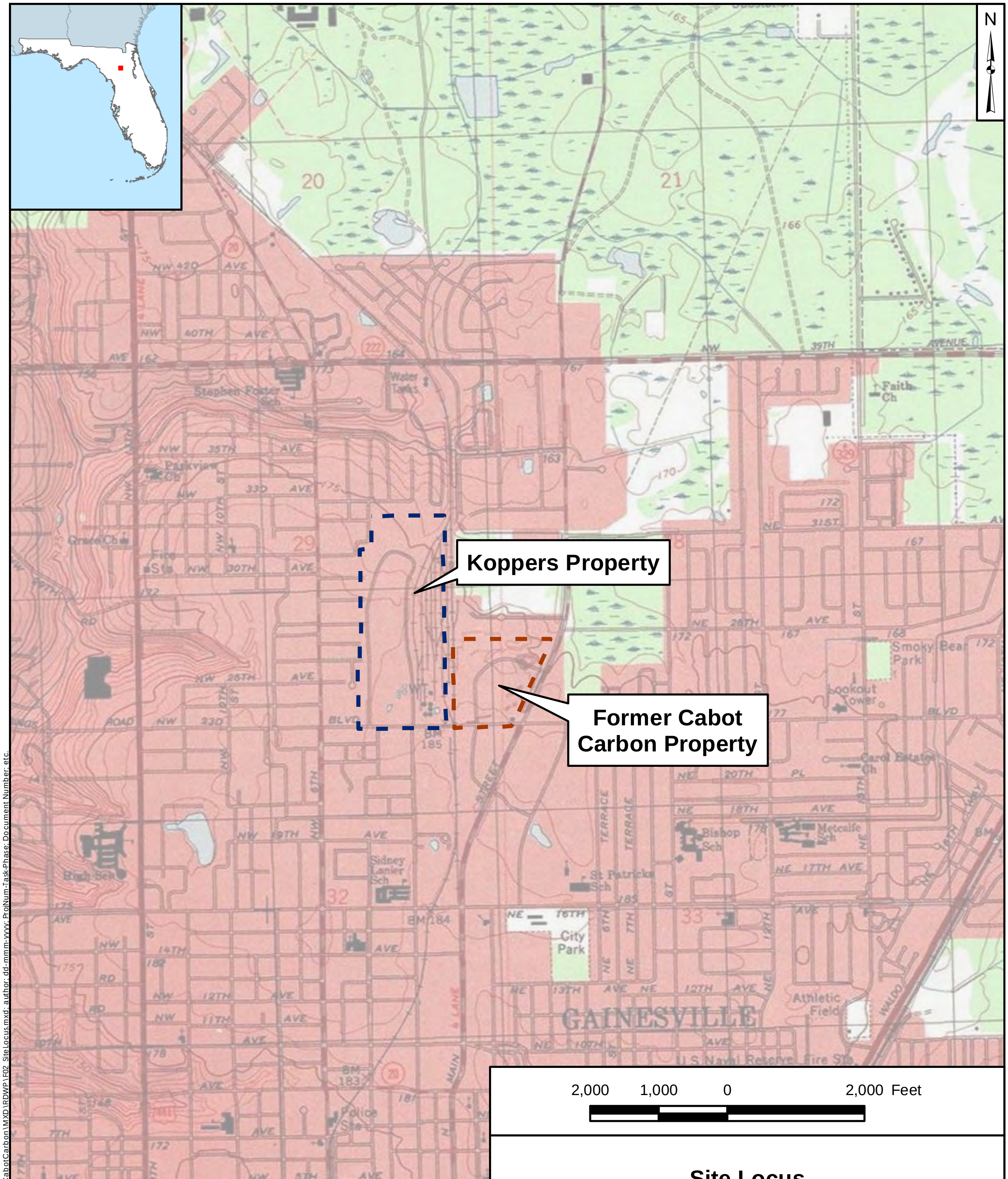
TABLE 1
PDI ACTIVITY DURATIONS
HAWTHORN REMEDY
CABOT CARBON SUPERFUND SITE

PDI Activity	Approx. Duration
Geotechnical Borings and Soil Sampling	
Borings for Vertical Barrier Wall Design	2 weeks
Borings for Low Permeability Cap Design	1 week
Borings for Stormwater Design	1 week
Aquifer Hydraulic Testing	1 - 2 weeks
Mix Design Testing	
Initial geotechnical characterization testing	1 week
Soil mixtures prepareation and geotechnical characteristic testing	1 week
Initial slurry properties testing	1 week
Hydraulic conductivity and slump testing	2 weeks
Hydraulic conductivity and SPLP testing[1]	4 - 16 weeks

Notes:

1. The length of the hydraulic conductivity tests are subject to the time required for three pore volumes of water to pass through the vertical barrier wall. Due to this limitation, the hydraulic conductivity and contaminant compatibility testing portion of the study may require from 4 weeks to 16 weeks to complete.

FIGURES



2,000 1,000 0 2,000 Feet

Site Locus

Cabot Carbon Superfund Site
Gainesville, Florida

Geosyntec consultants

Acton, MA | August 2017

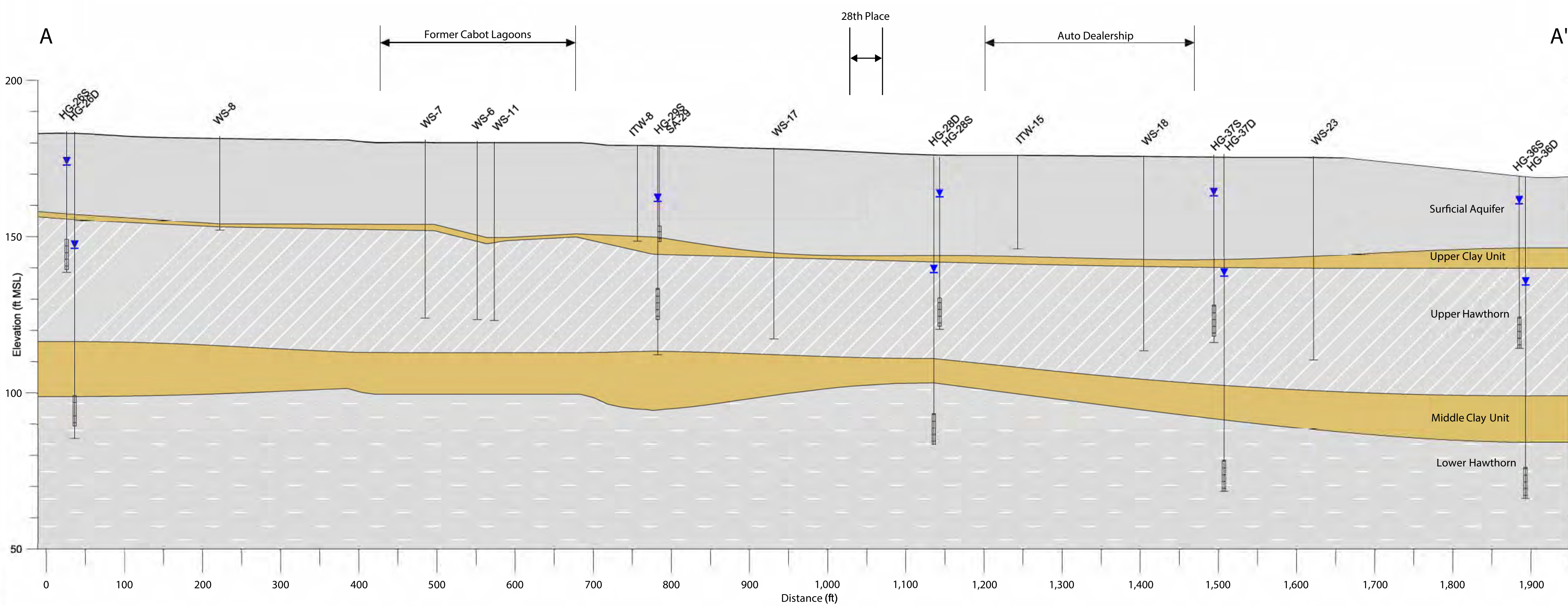
Figure 1

Legend

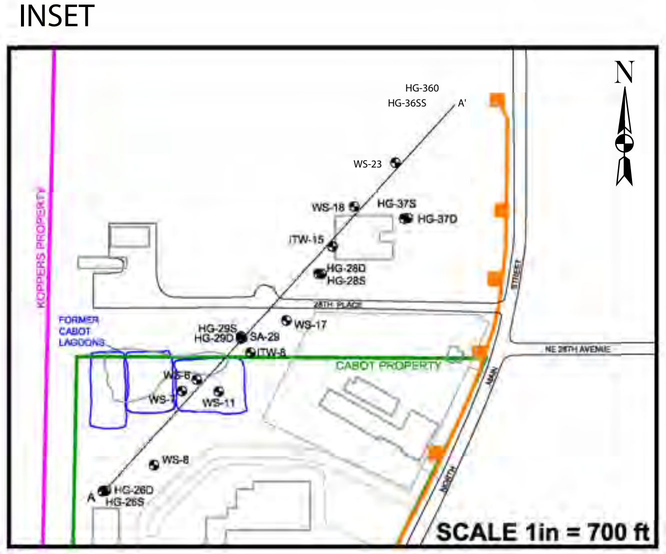
- Former Cabot Carbon Property
- Koppers Property

Source: USGS Gainesville East 7.5-Minute Quadrangle

(Q:\ = \\boston-01\GIS$\) Q:\GSProjects\BR0227_CabotCarbon\MXD\RDWP\F02_SiteLocus.mxd; author; dd-mmm-yyyy; ProjNum-Task-Phase; Document Number; etc.



INSET



LEGEND

Sample Location

Ground Surface

Water Level Measurement

Well Screen

Bottom of Boring

NOTES:
1) All of the borings/monitoring wells are projected onto the cross-section.
2) Vertical Exaggeration = 4x.
3) Vertical datum is NGVD29.
4) Stratigraphic contacts are interpolated from site wide information and refined locally based on known data.
5) All site features and locations are approximate.

Note:
1. This figure was obtained from Figure 3.1 presented in the Supplemental Remedial Investigation and Focused Feasibility Study Report, dated January 2017 and prepared by Gradient Corporation.

Geologic Cross Section A-A'
Cabot Carbon Superfund Site

Geosyntec consultants

FIGURE 2

ACTON, MASSACHUSETTS | AUGUST 2017

File Path: G:\Projects\204079\Graphics\CADGIS\211\204079_211_01_ALLGw_CrossSections.dwg

N

Legend

- Existing Well or Piezometer
- Floridan Monitoring Well
- Extraction Wells - Conceptual Location
- Soil Boring/Sample
- Groundwater Sample
- Groundwater and Soil Sample
- Cross Section A-A'
- Anticipated Vertical Barrier Wall Alignment
- Stormwater Pond
- Former Lagoon Area
- Former Cabot Carbon Property

Notes:
1) Locations obtained from Figure 2.1 titled "Recent Soil and Groundwater Sample Locations" produced 11 May 2016 by Gradient.
2) 2015 aerial obtained from USDA National Agriculture Imagery Program (NAIP).
3) Reference Figure 2 for stratigraphy along cross section A-A'.
4) The final extraction well locations within and downgradient of the vertical barrier wall will be dependent on the predesign investigation data and testing results. Locations shown are conceptual.

160 80 0 160 Feet

Hawthorn Remedy Component Concept Locations

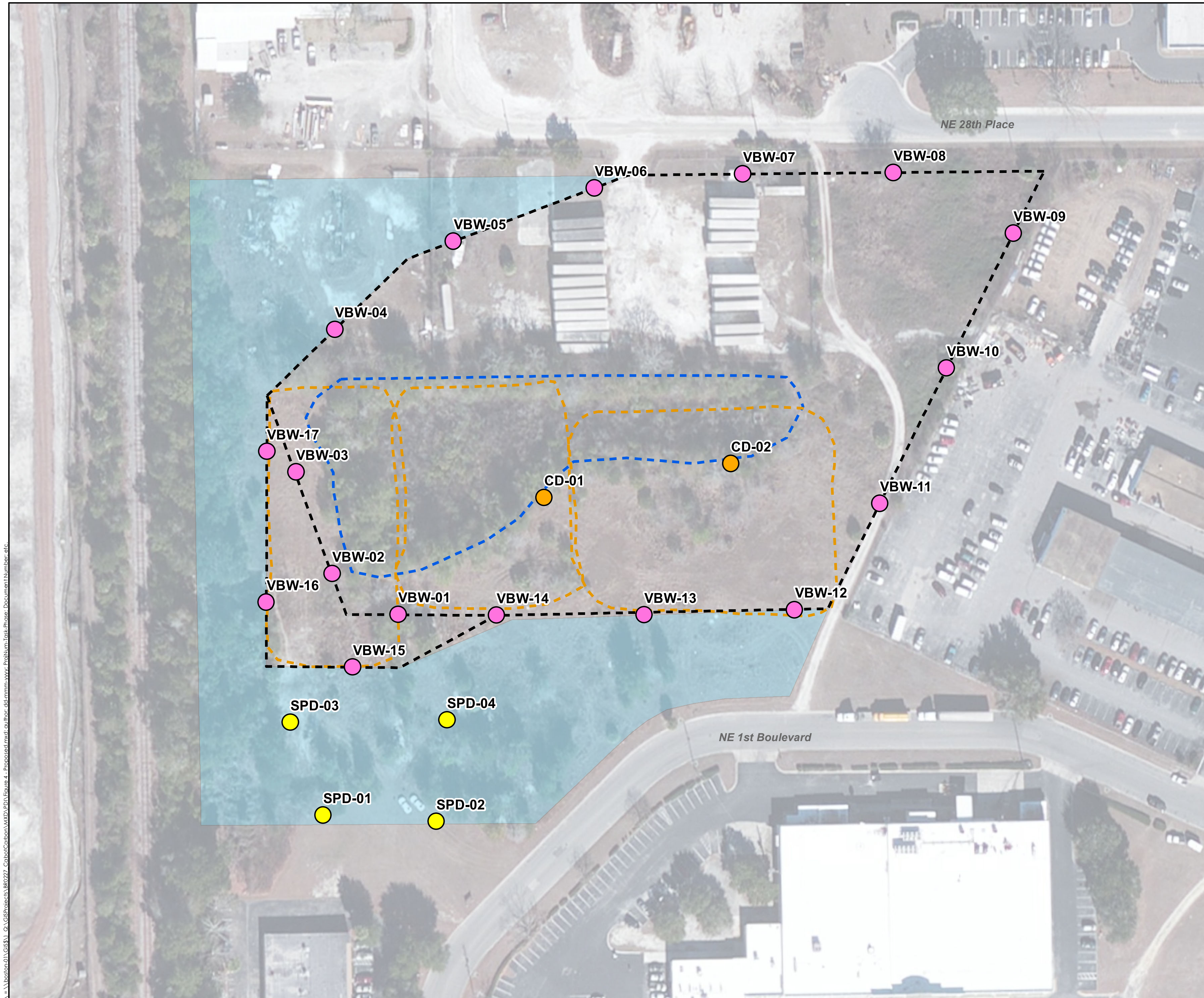
Cabot Carbon Superfund Site
Gainesville, Florida

Geosyntec consultants

Figure 3

Acton, MA

September 2017



Legend

Proposed Geotechnical Boring Locations

- Vertical Barrier Wall Delineation
- Stormwater Pond Design
- Cap Design
- Potential Vertical Barrier Wall Alignment(s) (Note 3).
- Stormwater Pond
- Former Lagoon
- Area for Potential Vertical Barrier Wall Step-out Borings

Notes:
1) 2015 aerial obtained from USDA National Agriculture Imagery Program (NAIP).
2) Vertical Barrier Wall step-out borings will be performed as necessary within the potential vertical barrier wall step-out boring area. Step-out borings shall be located 25 ft offset outside the current VBW boring location. Potential stepout borings shall not be performed outside of the zone shown.
3) The final vertical barrier wall alignment along the southwest portion of the Former Lagoon Area will be dependent on DNAPL field observations and investigation results.

100 50 0 100 Feet

Proposed Locations

Cabot Carbon Superfund Site
Gainesville, Florida

Geosyntec consultants

Figure 4

Acton, MA | September 2017

APPENDIX A

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

CABOT CARBON SUPERFUND SITE

Site Identification Number FLD980709356

Submitted to:

U.S. Environmental Protection Agency

Region 4

Atlanta Federal Center

61 Forsyth Street S.W.

Atlanta, Georgia 30303-8960

On Behalf of:

Cabot Corporation

Two Seaport Lane

Suite 1300

Boston, MA 02210

Prepared by:

Geosyntec consultants

engineers | scientists | innovators

Geosyntec Consultants, Inc.
289 Great Road, Suite 202
Acton, Massachusetts 01720

September 2017

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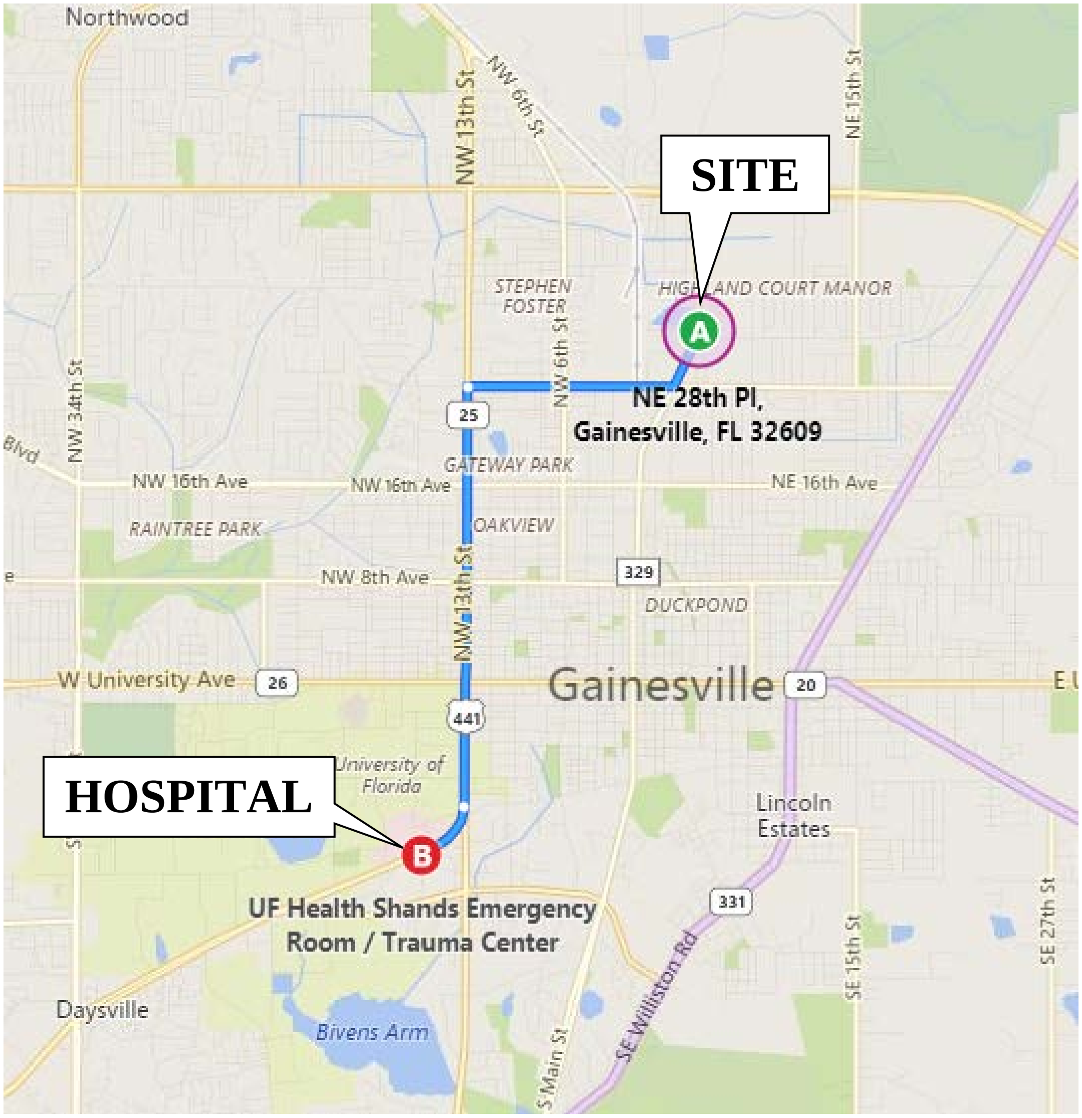
FIGURES

LIST OF ATTACHMENTS

ROUTE TO HOSPITAL



UFHealth Shands Emergency Room / Trauma Center
(352) 733-0111
1515 SW Archer Rd, Gainesville, FL 32608

Written Directions to Hospital from Site:

1. Depart N Main St / CR-329 toward NE 28th Ave
2. Turn right onto SR-120
3. Turn left onto US-441 / SR-25 / NW 13th St
4. Bear right onto SR-24 W
5. Turn back on SR-24 E

Distance: 3.9 miles Time: 11 minutes

1. INTRODUCTION

This site-specific Health and Safety Plan (HASP) was prepared by Geosyntec Consultants for the Cabot Carbon Superfund Site (site) remedial design (RD) and remedial actions (RA) associated with the Hawthorn Remedy. The purpose of this document is to provide the Geosyntec field team the health and safety requirements and mitigation procedures for hazards known or suspected to be present during activities on Site. This HASP will be used by visitors and serves a guidance for Geosyntec's subcontractors.

In case of emergencies, field personnel shall dial 911 for immediate assistance. If an injured person can be transported safely to a hostpital, the Route to Hospital Map is provided on the previous page. If the person cannot be safely transported, request an ambulance. Required emergency and non-emergency procedures for Geosyntec employees are further defined in a flow chart provided as Figure 1.

2. SIGNATURES

2.1 Preparers and Reviewers

This HASP must be maintained on-Site when field work is being performed. The Geosyntec Site Health and Safety Officer (SHSO) can change or amend this document, in agreement with the Geosyntec Health and Safety Coordinator (HSC) or Geosyntec Project Manager (PM). Changes or ammendments must be documented in Section 11 and in Attachment A. This HASP should be reviewed and amended on an annual basis for the duration of the work.

Prepared by:

Jonathan Gillen
Engineer

9/7/2017
Date

Reviewed by:

Steven Poirier, Ph.D, P.E.
Project Manager

7 September 2017
Date

Approved by:

Carl Elder
Project Director

7 Sept 2017
Date

This HASP has been given to the following H&S approved subcontractor(s).

Subcontractor	Representative	Date
Subcontractor	Representative	Date
Subcontractor	Representative	Date

2.2 Site Workers

This HASP must be reviewed by Geosyntec personnel, Geosyntec affiliates, and subcontractors retained by Geosyntec prior to performing work or visiting the site. The SHSO must brief all workers on the information covered in this HASP and relevant ammendments, including Task Hazard Analyses (THAs), prior to site entry. All site workers must sign the following acknowledgment statement once they have read the HASP, relevant THAs, and received the safety briefing.

"I have read, understand, and will perform my work in accordance with the information set forth in this HASP."

Signature	Printed Name	Date
______________________	______________________	_____________
______________________	______________________	_____________
______________________	______________________	_____________
______________________	______________________	_____________
______________________	______________________	_____________
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______________________	______________________	_____________
______________________	______________________	_____________
______________________	______________________	_____________
______________________	______________________	_____________
______________________	______________________	_____________

3. EMERGENCY CONTACT INFORMATION

Contact	Telephone Numbers	
	Office	Alternate (Type)
Fire Department - Fire Rescue Station 5	(352) 334-5078	911
Police Department	(352) 334-2400	911
Site Emergency Response (if applicable)	-	-
Hospital – UFHealth Shands Emergency Room / Trauma Center	(352) 733-0111	911
Director of H&S – Dale Prokopchak	(804) 332-6376	(804) 349-8067 (Cell)
H&S Regional Manager – Mark Malchik	(978) 206-5777	-
Project Manager – Steve Poirier	(978) 206-5785	(617) 835-5795
Site Health & Safety Officer	[TBD]	[TBD]
H&S Coordinator – Chris Martin	(978) 206-5711	-
Principal- or Associate-in-Charge – Carl Elder	(978) 206-5768	(978) 844-4172
Utility Emergencies –	811	-
Work Care –	(888) 449-7787	(714) 978-7488
Client Contact – Wayne Reiber	978-671-4096	617-306-1438
Other – Mark Taylor (Weston Solutions)	904-512-6750	904-577-8353

4. APPLICABILITY OF THIS HASP

This HASP was prepared to meet the requirements specified in Occupational Safety and Health (OSHA) Hazardous Waste Operations Emergency and Response (HAZWOPER) program, Geosyntec Consultants, Inc. (Geosyntec)'s Health and Safety (H&S) Procedure HS 301, and the H&S requirements of the client.

This HASP was prepared for use by Geosyntec project staff and subcontractors. Subcontractors, at a minimum, shall ensure that their employees, and those of its lower tier subcontractors, comply with these procedures and other health, safety and security provisions in the Subcontract. Compliance with this HASP shall represent the minimum requirements to be met by subcontractors, who shall be responsible for examining all requirements and determining whether additional or more stringent health, safety and security provisions are appropriate for their portion of the work and implementing them accordingly. Therefore, for firms executing all or any portion of the work, this document and its contents should not be used without a thorough peer review by their health and safety managers. Prior to commencing work, such firms are responsible for reviewing and supplementing the HASP to add appropriate procedures specific to their portion of the work.

5. SITE DESCRIPTION

5.1 Geographic Location

The Site comprises approximately 34 acres, located in the northern section of the City of Gainesville, and is part of a larger 170-acre Superfund area known as the Cabot/Koppers Superfund area. The Cabot/Koppers Superfund area is comprised of two properties, the former Cabot Carbon property (referred to in this document as "the site") and the Koppers property. The site is located east of the Koppers property. A mixture of commercially developed and undeveloped areas exists on and to the north of the site.

The site has been redeveloped for commercial use, consistent with land use in the area. Automobile dealerships are concentrated in this section of the city, particularly along North Main Street, which abuts the former Cabot Carbon property to the east. The site is occupied by a shopping mall (referred to as the Northside Shopping Center) with several retail box store facilities, automobile and boat dealership and service shop locations, and several smaller office buildings. The northwestern portion of the site is undeveloped; a storm water pond, associated with the shopping center, is also located in this area as shown on Figure 2.

5.2 Problem Statement

The site comprises unsaturated and saturated soils, surficial aquifer groundwater, and groundwater contained in a geologic unit, known as the surficial aquifer and Hawthorn Group (HG) formation. These soils and groundwater have been impacted by the historical operations, including a former pine tar processing facility and subsequent site development. Migration of the impacted groundwater in the surficial aquifer and the HG formation from former process lagoons is the primary ecological and human health concern.

5.3 Chemical Hazards

As noted above, groundwater at the site has been impacted byhistoric site operations. The classes of chemicals in groundwater that are known or suspected to be present that may be encountered while performing site work include the following:

- Volatile organic compounds, principally:
  - Benzene
  - Toluene,
  - Phenol
  - 3,4-methylphenol
  - Naphthalene

5.4 Physical Hazards

The site is an empty lot except where it has been developed for car dealerships of the Northside Mall so there are minimal physical hazards related to terrain, footing, etc. The site contains a stormwater pond that is owned and operated by the City of Gainesville. This is an overgrown and shallow waterbody that continuously has water in it. Care shall be exercised at the water edge.

Biological hazards such as mosquitoes, particularly in the vicinity of the stormwater pond, may exist and warrant planning.

THAs contain addition information of task-specific chemical, physical and biological hazards.

6. SCOPE OF WORK AND TASK HAZARDS

6.1 Scope of Work

Due to the nature of this project, the specific scope of work covered under this HASP will be defined by individual THAs, which will be appended to this document as new work tasks are identified. In general, work covered under this HASP and the supplemental THAs will include:

- Pre-design investigations
  - Subsurface explorations (i.e., drilling);
  - Soil sampling
  - Water (i.e., surface or groundwater) sampling

  - Other activities designated by pre-design investigations, work plans, or data collection efforts for design purposes.
- Site visits
- Construction (i.e., Remedial Action)
- Construction Quality Oversight Activities

6.2 Task Hazard Analyses

Task Hazard Analyses are required for task or action to be taken at the site. THAs will define the scope of the activity in detail, identify the potential or known hazards associated with each activity, and identify the procedural and/or engineering controls that will be used to mitigate the hazard. In general, the topics covered by the THA shall include, but not be limited to, the following as they apply to the specific task:

- A site safety plan including:
  - project information
  - summary of work steps,
  - hazards and controls,
  - H&S equipment list
  - emergency response procedures

- A Hazard Analysis for work steps including (as applicable):
  - basic hazard preparedness
  - special driving, traffic and transportation hazards
  - water hazards,
  - fall hazards,
  - powered tools, equipment, and machinery hazards,
  - drilling hazards,
  - construction, heavy equipment, and lift equipment hazards,
  - electrical hazards,
  - utility-related hazards,
  - confined space entry hazards,
  - storage of bulk materials,
  - infectious/allergenic biohazards
  - chemical hazards (commercial products used and site contaminants or wastes),
  - airborne hazards (i.e., air monitoring), and
  - radiation hazards.

THAs shall be appended to this HASP, and logged as a HASP amendement in Attachment A. A copy of completed THAs shall be included in Attachment B. THAs shall be reviewed by all site workers associated with the defined task, regardless of whether the site worker has previously read this HASP. The SHSO shall provide a safety briefing to all site workers associated with a THA task(s).

7. KEY PERSONNEL AND HEALTH AND SAFETY RESPONSIBILITIES

Project personnel and their responsibilities in regard to health and safety concerns on this project are as follows:

Project Manager (PM): **Steve Poirier**

- Approve this HASP and amendments, if any;
- Monitor the field logbooks for health and safety work practices employed;
- Coordinate with SHSO so that emergency response procedures are implemented;
- Check that corrective actions are implemented;
- Check and document that qualified personnel receive this plan and are aware of its provisions and potential hazards associated with site operations, and that they are instructed in safe work practices and familiar with emergency response procedures; and
- Provide for appropriate monitoring, PPE, and decontamination materials.

Site Health and Safety Officer (SHSO): **[to be determined]**

- Prepare and implement project HASP and amendments, if any, and report to the PM for action if deviations from the anticipated conditions exist and authorize the cessation of work if necessary;
- Check that site personnel meet the training and medical requirements;
- Conduct pre-entry briefing and daily tailgate safety meetings;
- Check that monitoring equipment and PPE are operating correctly according to manufacturer's instructions and such equipment is utilized by on-site personnel. Calibrate or check calibration of monitoring equipment and record results;
- Check that decontamination procedures are being implemented;
- Implement site emergency response and follow-up procedures;
- Notify the HSC in the event an emergency occurs; and
- Perform and document weekly inspections.

Health and Safety Coordinator: **Mark Malchik**

- Review and audit HASP and amendments;
- Notify Director of H&S when an emergency occurs;
- Assist with the implementation of the corporate health and safety program; and
- Consult with staff on health and safety issues.

Site Workers:

- Provide verification of required health and safety training and medical surveillance prior to arriving at the site;
- Notify supervisors of workplace accomodation requirements as the result of physical limitations or medical conditions;
- Attend pre-entry briefings and daily tailgate safety meetings;
- Immediately report accidents and/or unsafe conditions to the SHSO;
- Be familiar with and abide by the HASP; and
- Be ultimately responsible for his or her own safety.

8. WORKER TRAINING AND MEDICAL SURVEILLANCE

Personnel involved in field activities subject to OSHA HAZWOPER 29 Code of Federal Regulations (CFR) 1910.120 will be required to participate in both a health and safety training program that complies with criteria primarily set forth by the OSHA HAZWOPER in 29 CFR 1910.120(e) and a medical surveillance program covered under 29 CFR 1910.120(f), or equivalent regulations based on the jurisdiction in which the project is performed.

8.1 Pre-Assignment and Annual Refresher Training

Prior to arrival on-site, the Geosyntec PM will be responsible for monitoring that their staff meet the requirements of pre-assignment training (40/24 hours per Procedure HS 301). In addition, personnel must be able to document dates of attendance at an annual 8-hour refresher and three days of fieldwork under a qualified supervisor. Failure to provide this documentation will prohibit entry to the active work area(s) (i.e., Exclusion Zone).

8.2 Site Supervisor Training

Consistent with OSHA 29 CFR 1910.120 (e)(4), prior to arrival on-site, individuals designated as site supervisors require an additional eight hours of specialized training.

8.3 Initial Site Safety Orientation and HASP Review

In addition to complying with 29 CFR 1910(e), site personnel will attend an initial safety orientation during which the HASP and applicable THAs will be reviewed prior to initiating field activities. This review will include the following:

- Understanding the lines of authority regarding health and safety and site personnel roles and responsibilities;

- Information of specific hazard agents related to the site and site operations will be discussed, such as health hazards of site chemicals and specific safety hazards of processes, tools, and equipment;
- Training in the proper use, maintenance, and decon protocol of PPE and Level(s) of Protection;
- Appropriate work practices and engineering controls to reduce/eliminate exposures to site hazards will be reviewed;
- Personnel will be informed of means for normal site and emergency communication(s);
- Air monitoring strategies will be discussed to include the frequency/types, action levels, sampling techniques, pre/post calibration techniques;
- Unique/site specific medical surveillance requirements that need to be considered based on site contaminants;
- Understanding site control measures, work zones, and proper decontamination procedures for personnel/tools/vehicles, etc. to reduce the potential for both on-/off-site contamination;
- Personnel will be trained to respond quickly and properly in the event of an emergency; and
- Personnel involved in specific hazardous activities, such as confined space entry, drum handling, sampling unknowns, etc. will receive specialized training in the appropriate techniques to employ prior to commencing these operations.

8.4 Baseline Medical Surveillance Exam

The baseline medical examination is used to identify physical capabilities and certain medical limitations that may have an impact on the candidate's ability to perform in the position and/or job activity for which he/she is being considered, as well as to establish certain baseline medical parameters. The initial test results can then be compared against future periodic or project-specific monitoring results.

8.5 Periodic/Annual/Biennial Medical Exam

The periodic medical examination is used to evaluate an employee's continued fitness for duty and to assess possible impact(s) occupational exposures may have had on their health status. The periodic examination includes an update to the medical and work history, results of previous occupational exposure assessments, and a detailed medical exam tailored to the job description.

The Medical Director from WorkCare determines the frequency of the periodic medical exams based on regulatory requirements, the position/work activities of the employee, and the level of exposure to physical, chemical, and biological agents.

8.6 Exposure/Activity/Project-Specific Medical Testing

Exposure-specific medical tests and/or evaluation of biological indices may be conducted to establish a baseline for certain project-specific parameters, to monitor the effectiveness of hazard controls, and/or to assess the impact of occupational exposures associated with a particular work activity or project. The Medical Director, in coordination with the H&S Department, will require or recommend an exposure-specific exam when deemed appropriate based on knowledge of project hazards, occurance of employee health symptoms, or an unexpected exposure event. Requests for exposure-specific examinations will be forwarded to the H&S Department, who will process the requests in collaboration with the Medical Director. The Medical Director will determine the type and frequency of the exposure-specific medical exams for employees designated to participate based on sound medical practice, latest toxicology information, and current regulatory requirements.

8.7 Exit Exam

An exit medical examination is offered when an employee leaves the medical surveillance program, either because of termination of employment with Geosyntec or because of reassignment to a position not designated or identified to participate in the medical surveillance program. This optional exit examination may be used to assess potential changes in medical status that have occurred during the course of employees' previous work activities, and to establish a medical baseline at the time of departure.

8.8 Exit/Termination

An exit medical examination is offered when an employee leaves the medical surveillance program, either because of termination of employment with Geosyntec or because of reassignment to a position not designated or identified to participate in the medical surveillance program. This optional exit examination assesses potential adverse impacts occupational exposures may have contributed to the employee's health status.

9. GENERAL HEALTH AND SAFETY PRACTICES AND PROCEDURES

9.1 Routes to Hospital and Urgent Care Facility

A hospital and an urgent care facility near the site have been identified. Maps to the hospital and urgent care are included after the Table of Contents of this HASP. The figure also includes the facility name and phone number.

9.2 Site Map

Figure 2 is a Site Map. It shows the site, the location of the former Cabot Carbon Property and the adjacent Koppers Property. The site map can be used as a reference when establishing work zones and to delineate evacuation routes. The site map shall be updated as necessary to reflect any changes to site conditions.

9.3 Buddy System

The buddy system is required when work is performed in hazardous areas. The buddy system includes maintaining regular contact with one or more onsite Geosyntec personnel, clients, and/or contractors to periodically check on the condition of site workers such that each employee in the work group is observed by (or in verbal contact with) at least one other employee in the work group. For field visits with only one employee onsite, the buddy system shall be implemented via periodic telephone contact with offsite Geosyntec personnel. The purpose of the buddy system is to provide rapid assistance to employees in the event of an emergency.

9.4 Controlled Work Zones

Controlled work zones shall be utilized as necessary when performing site work, including an Exclusion Zone, a Contaminant Reduction Zone (CRZ), and a Support Zone. The Exclusion Zone is defined as the area on site where contamination is suspected and tasks are to be performed. The CRZ is defined as the area where equipment and workers are to be decontaminated as they leave the Exclusion Zone. The Support Zone is defined as the command area and may serve as a staging and storage area for supplies. The location and extent of the work zones may be modified as necessary as site investigation information becomes available. For activities that do not require the three controlled work zones, the area(s) where work is to be performed shall be called the Work Zone.

Visitors to the site may need to be continually escorted for safety purposes. Visitors under Geosyntec's direction need to check in with the SHSO upon visiting the site.

For the tasks identified above, the boundaries of the Exclusion Zone, CRZ, and Support Zone, or the Work Zone, shall be marked using appropriate methods, including but not limited to warning tape, signs, traffic cones, fencing, or other appropriate means.

9.5 Site Access

Site access may change as needed depending on the scope of work. Access from the south via NE 1st Blvd, and access from the north via NE 28th Pl. may be used if available. The SHSO shall disseminate site access requirements as necessary to the site workers. Site access will be reviewed at a minimum, during the initial Site safety orientation meeting, and during tailgate meetings as necessary.

9.6 Inspections

Health and Safety inspections may be performed by Geosyntec at any time as deemened necessary. These inspections will be announced in advance of the date of inspection during the daily tailgate meetings. Additional inspections may be performed by other regulatory agencies, as required by law. To the extent possible additional inspections will be announced however, the may be unannounced. The events, discussions, and outcomes of inspections will be recorded by the SHSO, who will accompany any inspectors during the inspection.

9.7 Tailgate Meetings

Tailgate meetings must be held daily prior to starting work to discuss important health and safety issues concerning tasks to be performed during that shift. Non-Geosyntec site workers should also communicate health and safety concerns associated with the tasks they will be performing. Topics discussed in the tailgate meetings must be documented.

9.8 Stop Work Authority

All site visitors and site workers have the authority and responsibility to issue a Stop Work Order if unsafe actions and/or conditions are identified. The Stop Work Authority (SWA) process involves a stop of the activities, notify, correct, and resume approach for resolving observed unsafe work actions or conditions. The person issuing the work stoppage will first notify workers engaged in or affected by the unsafe activity or condition and require that associated work be stopped. After this Stop Work Order is issued, the Geosyntec project manager and the supervisors for affected or concerned contractors will also be notified. The Geosyntec project manager will document the issuance of the Stop Work Order on the form provided in Procedure HS 203. Work will not resume until the issues and concerns of the Stop Work Order have been adequately addressed.

10. EMERGENCY RESPONSE

This section discusses emergency response procedures and response equipment to be maintained on-site. A table presenting a list of contacts and telephone numbers for the applicable local and off-site emergency responders is provided in section3 of this HASP.

10.1 Injury and Emergency Response Procedures

In the event of an **injury** to an employee, the instructions for injury response given in Figure 2, shall be implemented immediately. In the event that an **emergency** develops, the following procedures are to be implemented:

- The SHSO, or designated alternate, should be immediately notified via the on-site communication system. The SHSO assumes control of the emergency response.
- If applicable, the SHSO must immediately notify off-site emergency responders (e.g., fire department, hospital, police department, etc.) and must inform the response team of the nature and location of the emergency on-site.
- If applicable, the SHSO may call for evacuation of the site. Site workers should move to their respective refuge stations using the evacuation routes provided on the Site Map.
- For small fires, flames should be extinguished using the appropriate type of fire extinguisher. Large fires should be handled by the local fire department.
- If a worker is injured, the procedures presented in "Instructions for Injury Response," included as Figure 2 must be implemented immediately.
- After an incident has stabilized, the procedures presented in "Instructions for Incident Reporting" shown on Figure 2 must be followed.

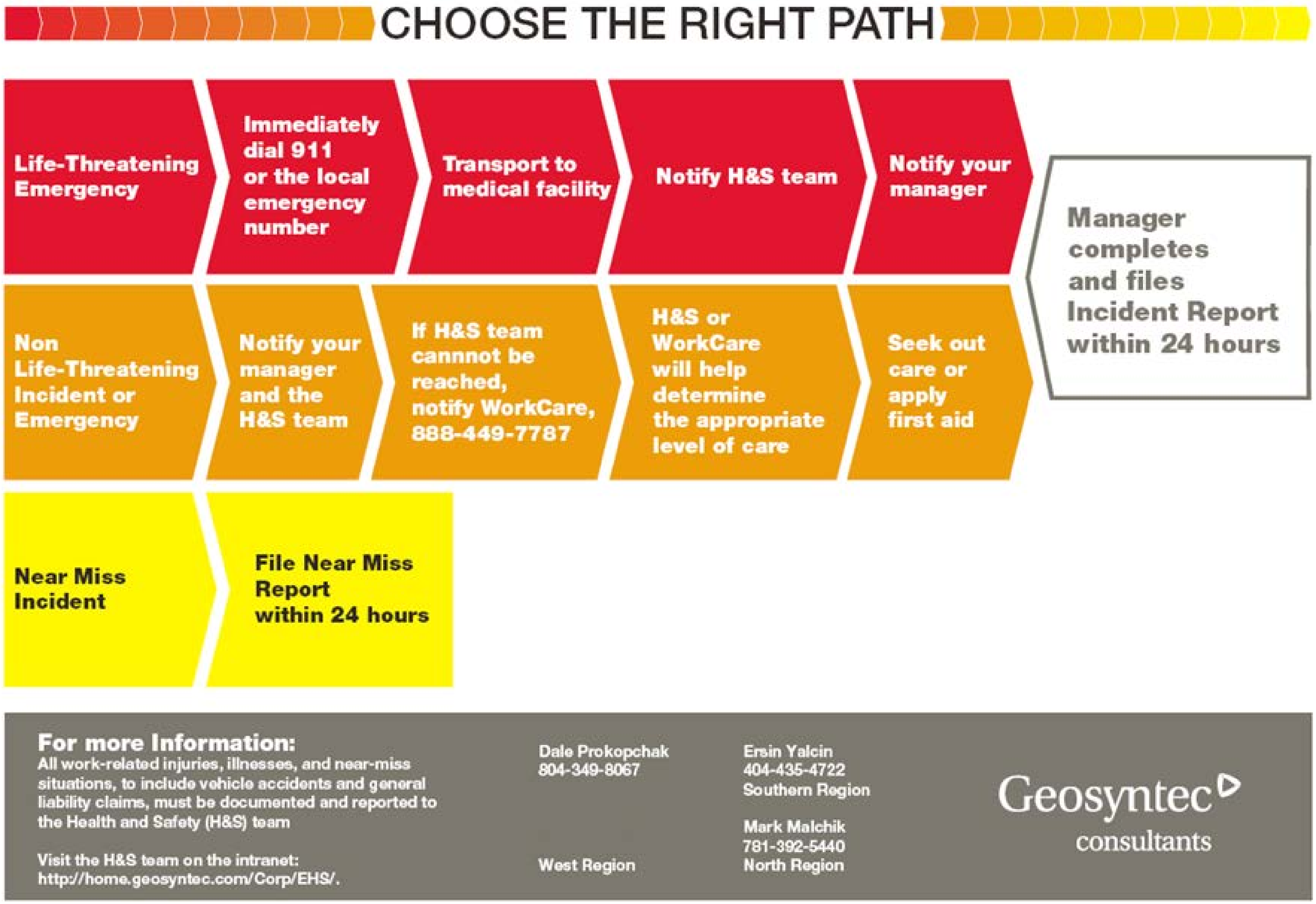
10.2 Emergency Response Equipment

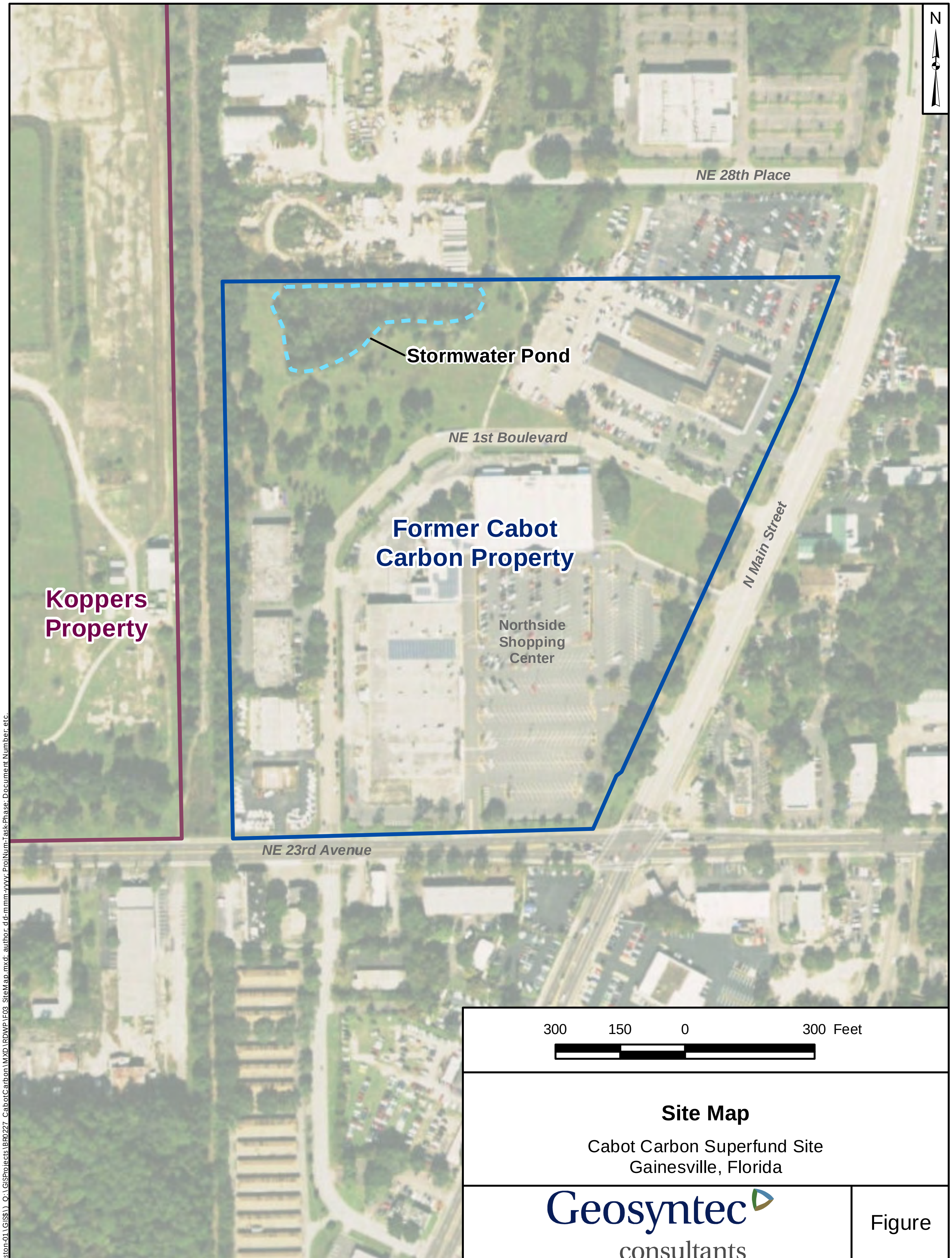
Emergency response equipment identified in THAs will be maintained in the work area as necessary for this project. Examples of emergency response equipment include first aid kits, fire extinguishers (Type ABC), and eyewash bottles.

11. HASP AMENDMENTS

Over the course of this project, it is possible that the project-specific hazards and working conditions will change. This HASP and/or THAs may be reviewed and amended as necessary to effectively describe the changing working conditions and measures to mitigate the potential health and safety issues that may arise during the project. Amendments to the HASP should be briefly described in Attachment A and/or additional THAs should be added to Attachment B.

FIGURE 1: H&S INCIDENT RESPONSE PRODECURES





Site Map

Cabot Carbon Superfund Site
Gainesville, Florida

Geosyntec consultants

Figure 2

2015 aerial obtained from USDA National Agriculture Imagery Program (NAIP).

Acton, MA | September 2017

ATTACHMENT A

HASP AMENDMENTS SUMMARY

FIGURE 1: H&S Incident Response Prodecures

ATTACHMENT A

AMENDMENT 1:

Date: ___________ Project Manager: _________________ HSC: _______________

Brief Description of Amendment:

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AMENDMENT 2:

Date: ___________ Project Manager: _________________ HSC: _______________

Brief Description of Amendment:

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AMENDMENT 3:

Date: ___________ Project Manager: _________________ HSC: _______________

Brief Description of Amendment:

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FIGURE 1: H&S Incident Response Prodecures

ATTACHMENT B

TASK HAZARD ANALYSES

FIGURE 1: H&S Incident Response Prodecures

ATTACHMENT B

SUMMARY OF THAs

Date	THA Description	Project Number
2017 08 24	Hawthorn Remedy - Geotechnical Drilling and Soil Sampling	BR0227 Phase 52
2017 08 24	Hawthorn Remedy – Aquifer Hydraulic Testing	BR0227 Phase 52

FIGURE 1: H&S Incident Response Prodecures

PART 1 – SITE SAFETY PLAN

A. PROJECT/TASK INFORMATION

TASK:	Geotechnical Drilling and Soil Sampling		
Project Name:	Cabot Carbon Superfund Site – Hawthorn Remedy PDI	**Project Number/Org:**	BR0227/1932
Project Address:	2810 NE 28th Pl, Gainesville, FL		
Description of Task & Worksite:	Geotechnical borings, Standard Penetration Testing (SPT), and soil sampling will be performed where contaminants, including pine tar, from former industrial activities and site development are present. Drilling will occur around the soil and groundwater contaminant source are (i.e., the Former Lagoon Area). Tasks described in the Pre-Design Investigation (PDI) Work Plan that are covered by this THA include: 1. Geotechnical Borings for Vertical Barrier Wall 2. Borings for Low-Permeability Cap 3. Borings for Stormwater Pond.		

Geosyntec Personnel	Name	Office Phone	Cell Phone
Site Lead/HS Officer	[TBD]		
Project Manager	Steven Poirier	978-206-5785	617-835-5795
Project Director	Carl Elder	978-206-5768	978-844-4172
HS Coordinator	Chris Martin	978-506-5711	314-307-1694
Regional HS Mngr.	Mark P. Malchik	978-206-5777	781-392-5440
Corp. HS Director	Dale Prokopchak	804-332-6376	804-349-8067
Client Contact(s):	Wayne Reiber (Project Manager)	978-671-4096	617-306-1438
Subcontractor(s):	☐ Not Applicable ☒ Applicable, provide contact information below:		
	Drilling subcontractor: Environmental Drilling Services Inc. (expected)		

B. SUMMARY OF WORK STEPS, HAZARDS, CONTROLS Based on PART 2, "HAZARD ANALYSIS," and on worksite/client/project factors.

Abstract of work steps/hazards/controls, with references to applicable Sections in Part 2 for greater detail:

Site personnel (i.e., Geosyntec PDI field crew) will mobilize to the site, and mark boring locations. Several locations will be adjacent to existing roadways. Drilling and sampling will be performed outdoors. If pine-tar is observed in borings, step-out borings may be located and performed; however step-out borings will not be located in adjacent roadways or sidewalks. Site personnel will observe and record results of SPT testing. Site personel will collect discrete soil samples from split spoon samplers, and obtain drill cuttings from Hollow Stem Augers to create composite soil samples. Samples will be containerized and select samples shipped to the Geotechnical Testing Laboratory.

WORK STEPS	HAZARDS	CONTROLS
1. Mobilization	*Driving/traffic/pedestrians, heavy lifting (supplies), slips/trips/falls (potential winter conditions), weather-related stress, working in Urban/suburban setting.*	*Pay close attention to driving and avoid distractions, plan travel ahead and obey traffic signs and posted speed limits, follow safe lifting procedures for heavy supplies, be aware of your surroundings, dress for weather.*
2. Geotechnical drilling (observing), SPTs, and Soil Sampling	*Heavy lifting (supplies and soil samples), weather-related stress, stinging insects, loud noises, pinch points, heavy equipment/drill rig, potential contaminants of concern.*	*Wear prescribed PPE, dress for weather (i.e., additional safe clothing if necessary), insect repellent, observe surroundings, follow safe lifting procedures for heavy supplies/samples, setup exclusion zone with cones around the work area, perform breathing zone air monitoring, maintain safe working distances from heavy equipment, communicate with drillers.*

C. H&S EQUIPMENT LIST List HS equipment needed at the worksite to control/manage hazards identified in PART 2, "HAZARD ANALYSIS."

EXPLANATORY NOTES, CLARIFICATIONS:

Site personnel will be required to utilitze the basic PPE described below. Note, nitrile gloves will be required for all drilling and sampling tasks.

☒	**BASIC PPE AND SAFETY GEAR**	☒ Standard work clothes & footwear, appropriate for task ☒ Hard-toed boots/shoes ☒ Hardhat ☒ Safety glasses	☒ Work gloves appropriate for task ☒ Noise/hearing protection ☒ High-visibility/reflective vest ☒ First aid kit
		☐ Basic PPE for limited protection from chemical contact & low-hazard dust inhalation – nitrile gloves, Tyvek suit, dust mask, boot covers.	
☐	**OTHER H&S EQUIPMENT/GEAR**	☐ Fire extinguisher ☐ Traffic control warning devices ☐	☐ Vehicle emergency kit (flares, lights, reflective device) ☐ ☐

		☐ Other:		
☒	**ADDITIONAL PERSONAL PROTECTIVE EQUIPMENT (PPE)**	Eye/face protection ☐ Goggles ☐ Face shield Chemical protective clothing ☒ Gloves, type: nitrile ☐ Coveralls, type: ☐ Outer boots, boot covers	Respiratory Protection ☐ Disposable n-95 face mask ☐ Half-face air-purifying respirator ☐ Full-face air-purifying respirator ☐ Respirator cartridge, type: ☐	☐ Personal flotation device ☐ Personal fall apparatus ☐ Fire retardant clothing ☐ Arc Flash Protection ☐ Electrical-Hazard-rated boots, gloves ☐
		☐ Other:		
☐	**SPECIAL HAZARD CONTROLS**	☐ Portable GFCI ☐	☐ Lockout/tagout equipment ☐	☐ Ventilation equipment (fan, blower) ☐
☐	**DECON, PPE DISPOSAL**	☒ Waste receptacle for disposable PPE	☐ Hand washing provisions	☒ Decon solution, misc. supplies
		☐ Additional information:		
☒	**AIR MONITORING EQUIPMENT**	PID 11.7 eV lamp		

D. EMERGENCY RESPONSE

Based on **PART 2, "HAZARD ANALYSIS,"** and on worksite factors, client requirements.

SUMMARY of Recognized Emergency Risk Factors & Response Procedures *(fire/explosion, medical , chemicals/spills, security, site conditions/topography, prevailing weather, other concerns)*:

To Summon Police, Fire, Ambulance in an Emergency	☒ DIAL 911 ☐ use alternate procedure:	
Nearest Emergency Medical Services	Hospital Name: UF Health Shands Emergency Room / Trauma Center	
	Address: 1515 SW Archer RD, Gainesville, FL 32608	
	Phone #: (352) 733-0111	☒ See Attached Directions
For **Non-Emergency Urgent Care**:	Contact WorkCare, 24/7 at: 800-455-6155, menu option "3"	
Other Emergency Contacts, as needed *(such as security, spill responder, utility)*:		
Job-site **Evacuation** Procedure, Rally Point, Place of refuge:	Rally point at the designated parking area.	
Means of alerting on-site personnel in case of emergency:	☒ Verbal ☐ Radio ☒ Cell Phone ☐ Other:	
Special Equipment, as applicable (such as PPE, first aid, eyewash):		

IMPORTANT: After initial emergency response actions and incident stabilization, contact appropriate project personnel (see Part 1.A.).

PART 2 – HAZARD ANALYSIS

*Complete Section A. Then complete Sections B thru O, as applicable to your project. Provide comments in each section under "Explanatory Notes, Clarifications" to sufficiently describe **site-specific** hazards and safety measures.*

A. BASIC HAZARD PREPAREDNESS This section required for all Tasks.

Explanatory Notes, Clarifications:

Basic hazards present at the site generally include those relating to (i) work outdoors (i.e. insects); (ii) work in urban/sub-urban locations; (iii) travel to/from job sites; and (iv) manual work with tools and sampling equipment. The following basic protections and precautions should be recognized for all aspects of this task.

Basic Personal Protection

☒ **Overhead Hazards** - Wear hardhat or "bump cap" as appropriate for hazard.
☒ **Hand injury hazards** - Wear protective work gloves appropriate for the hazard and work tasks.
☒ **Eye injury hazards** - Wear safety glasses (with side shield or wrap around, either clear or shaded for sun protection).
☒ **Foot hazards, rough terrain** - Wear work boots/shoes with hard toes, ankle support, puncture resistance, traction, as appropriate for conditions.
☒ **Noise** – use hearing protection, (earplugs, earmuffs, or both) as appropriate for conditions, at a minimum where noise levels exceed 85dBA.
☒ **Chemical/biological agents, low hazard and/or "passive" exposure** - use appropriate PPE and precautions; describe above.
☐ **Chemical/biological agents, elevated hazard and/or "active use" exposure** – see Part 2, Section(s) M, N, O, as applicable.

Geosyntec Procedures: *HS-109-Hearing Conservation, HS-113-Personal Protective Equipment, HS-210-Walking and Working Surfaces*

General Safety Precautions

☒ **General premises** hazards - housekeeping, rough terrain, trip hazards, steep slope, remote location; describe specific hazards and controls above.
☒ **Weather/climate-related hazards** - heat cold protection, fluids, breaks, shade, sun screen, multiple layers, discontinue use of aerial lift/ladder in high wind, "30/30 rule" for lightning safety, protection from hail, seek place of refuge for extreme weather
☒ **Plant/Insect/Animal Hazards** - Precautions: poison ivy wash; insect repellant; check for ticks; hornet nest spray; animal precautions.
☒ **Traffic** – Implement measures to protect personnel (high visibility/reflective clothing, on-person lighting, traffic control measures).
☐ **Illumination hazards/night work** - Illuminate work areas and/or access routes, use reflective/hi-visibility clothing or on-person lighting, as appropriate.
☒ **Manual hand tools** - proper tool for the job, maintain in good condition, use vice/clamp to hold work piece, proper follow thru
☒ **Machinery hazards, passive exposure** – keep safe distance, heed warning signs, use appropriate PPE (such as eye/hearing protection), secure long hair, loose

clothing, jewelry near moving parts. For active use of equipment machinery as part of the work, see Part 2, Section E "Powered Tools, Equipment, Machinery"

☒ **Lifting, manual material handling** – use proper lifting procedures, seek help for >50 lbs.

Geosyntec Procedures: *HS-127-Ticks, HS-124-Heat Stress, HS-125-Cold Stress, HS-210-Walking and Working Surfaces, HS-208-Housekeeping, HS-401-Back Injury Prevention, HS-502-Manual Hand Tool, HS 517 Traffic Safety*

Security

☐ **High crime, urban** – Use appropriate measures for personal security (such as buddy system, security service, work scheduling, other measures)

☐ **Working alone** - Establish "check in" procedure with supervisor/project manager.

Geosyntec Procedures: *HS-207-Working Alone*

Driving Hazards

☒ **Routine work travel** - Use routine safe/defensive driving practices (seat belts, safe speeds, eyes ahead, no tailgating, limit distractions, safe cell phone use, no texting, clear windows, account for weather/road conditions, adequate sleep, other measures as appropriate).

☒ **Unfamiliar location** - Plan travel route before driving (assemble maps, enter destination in GPS).

☐ **Long Distance or During Sleep Hours** – Minimize fatigue: rest breaks, light snacks (avoid heavy meals), stay hydrated, fresh air, no loud music, clean windshield.

☒ **Unfamiliar vehicle** – Become familiar with vehicle operational controls before operating vehicle.

☐ **Special hazards** - see Part2, Section B, "Special Driving/Traffic/Transportation Hazards"

Geosyntec Procedures: *HS-105-Driver and Vehicle Safety*

B. SPECIAL DRIVING/TRAFFIC/TRANSPORTATION HAZARDS ☒Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

The Site is bounded by roadways on three sides. Access to the site will be by vehicle. Vehicles will be parked in a designated parking area on the Site. Workers will walk to designated borehole locations. Drilling activities are not proposed along roadways, and step-out locations will not be permitted in roadways, however drilling adjacent to roadways may occur. The primary transportation hazard will be working near vehicle thoroughfares.

Though not anticipated, drilling crews may haul drilling equipment (i.e., drill rod trailer) in tow, attached to drill rigs or vehicles. Field personnel shall also recognize hazards associated with vehicle trailers, if necessary, and maintain safe clearance from moving trailers, rigs, or vehicles used for site investigations.

☐	**SPECIAL DRIVING HAZARDS** Off-Road Driving or use of non-typical vehicle, ATV Hazards: Worker injury due to vehicle collision, rollover	☐ For off road driving, do not exceed capability of vehicle, beware of wet conditions, speed low, avoid unsafe orientation on slopes. ☐ Follow ATV specific procedures for training, safety equipment, operation, manufacturer's instructions. ☐ Special Skills Required for Vehicle type - For vehicles requiring special skills (such as windowless van, heavy work vehicle, utility vehicle, similar) ensure operator is provided training and/or has appropriate operator skills through experience. ***Geosyntec Procedure(s):*** *HS-510-All Terrain Vehicles*
☐	**TRANSPORTING MATERIALS, TOWING/HAULING LOADS** Hazards: Vehicle accident, occupant injury from shifting load, unsafe equipment.	☐ Ensure load is firmly secured (rope, straps, load configuration) to prevent shifting during travel. ☐ Slings, chains, strap, rope and related equipment used for towing, hauling, load-securing shall be appropriate for use, and used in a manner as to prevent an unsafe condition. ☐ For trailer use, verify signal/braking lights operational, rear-view mirrors effective, hitch/safety chains secure.
☒	**WORKSITE IN/NEAR VEHICLE THOROUGHFARE** Hazards: Worker injury from being struck by vehicle traveling in thoroughfare.	☒ Wear reflective vests where exposed to traffic hazards. ☒ Where possible, park vehicles as protective shield from oncoming traffic. ☒ Configure work area and support vehicles to minimize worker exposure to traffic hazards. ☐ Use DOT signal devices to re-route vehicles around work area, site entrances/exits. ☐ Use DOT-trained flaggers or police detail where appropriate or required. ***Geosyntec Procedure(s):*** *HS-517-Traffic Safety*
☐	**RAILROAD HAZARD** Hazard: Worker injury from being struck by train in R.R. right-of-way	☐ Coordinate with rail company and implement required safety and security measures. ☐ Site workers to receive safety training for railroad work. **Geosyntec Procedure(s):** HS-305-Rail Operations
☐	**WATER TRANSPORTATION**	☐ Follow HS 312 "Water Transportation Safety," and Section C, "Water/Boating Hazards." **Geosyntec Procedure(s):** HS-312-Water Transportation Safety
☐	**AIRPORT, AIRCRAFT** Worker injury when working on/near airport runway, or use of helicopter, light aircraft	☐ Coordinate safety requirements with Airport personnel and implement required safety measures. ☐ Site workers to receive safety training for railroad/airport work. ☐ Follow HS 310 "Helicopter Safety" and/or HS 311 "General Aviation (Small Aircraft) Safety." ***Geosyntec Procedure(s):*** *HS-310-Helicopter Safety, HS 311-General Aviation (Small Aircraft) Safety*
☐	**HEAVY EQUIPMENT TRAFFIC/VEHICLE HAZARDS AT CONSTRUCTION SITE**	☐ See Section G, "Construction, Heavy Equipment, Lift Equipment"

C. WATER/BOATING HAZARDS ☐ Applicable ☒ Not Applicable, Not Anticipated

D. FALL HAZARDS ☐ Applicable ☒ Not Applicable, Not Anticipated

E. POWERED TOOLS, EQUIPMENT, MACHINERY ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS: Field Personnel will be actively working with equipment necessary to perform sampling activities (i.e., split spoon samplers, sample buckets, etc.) around drill rigs. Powered hand tools, electrical, welding, or compressed air equipment or tools are not anticipated for use. Primary hazards for this task will be proximity to the drill rig/large equipment during drilling, SPTs, and sampling; noise generated during SPT testing; potential for pinch points due to drill rig or sampling equipment, handling sampling equipment (i.e., split spoon samplers), and lifting of heavy soil samples (i.e., 5-gallon buckets).		
☐	**POWERED HAND TOOLS** ☐ Electric-powered ☐ Fuel-powered ☐ Pneumatic ☐ Powder-actuated Hazards: Eye/hand/body injury, fuel-related hazards, Inhalation hazards, noise, sparks, heat, fire hazard, electrical hazards	☐ For all power tools: • Inspect tools to ensure safe operating condition before each use. • Use tool in accordance with manufacturer's specifications. • Ensure guards are in place and no hazardous equipment modifications. • Use PPE or other safety practices, as appropriate, for eye/hearing/hand/head/body protection (such as use of Kevlar chaps and jacket for chainsaw use). • Provide training or verify operator qualification for use of power tool. • Stay clear of hazard zone, "line of fire" when working near where power tools are used. • For spark/heat generating tool, control fire hazards, segregate combustible/flammable materials. ☐ Use respirators, ventilation, wet methods, other appropriate means to control inhalation hazard. ☐ See fuel-safety practices in Part 2, Section O, "Active Use of Commercial Chemical Products." ☐ For electrical hazards, see Part 2, Section H, "Electrical Hazards". ***Geosyntec Procedure(s):*** *HS-503-Powered Hand Tools*
☒	**OPERATION OF EQUIPMENT/MACHINERY** ☒ Point-of-operation hazards ☒ Pinch points, moving parts ☒ 'Struck-by,' 'caught between' ☐ Hot surfaces, heat ☐ Extension cords, flexible wire ☒ Fuel related (gas or liquid) ☐ Hydraulic pressure ☒ Kinetic, stored energy ☒ Noise ☐ Emissions, discharge gases ☐ Working at heights, falls ☒ Lifting, repetitive motion ☐ Illumination ☐ Electrical	☒ <u>General safety requirements for equipment, machinery:</u> • Arrange worksite for safe access to equipment/machinery. • Use equipment/machinery in accordance with manufacturer's use and safety instructions. • Ensure point-of-operation, mechanical power transmission, other moving parts are guarded with protective devices; do not override interlocks, guards, protective devices. • Secure long hair/loose clothing/hanging jewelry near moving/rotating parts. • Heed warning signs/labels, keep safe distance; avoid locations of "struck by" and "caught between" hazards. • Implement lockout/tagout for repairs/adjustments/tooling changes. ☒ Use safe lifting practices for movement of heavy portable equipment ☐ Incorporate safety provisions/safe work practices for compressed air, pressurized systems (pneumatic/hydraulic), stored energy. ☐ For climbing/fall hazards associated with large equipment, See Part 2, Section D, "Fall Hazards." ☐ For electrical hazards, see Part 2, Section H, "Electrical Hazards." ☐ Operate fuel-powered equipment in well ventilated location. ☐ Use safe practices for fuels, see Part 2, Section O, "Active Use of Commercial Chemical Products."
☐	**LOCKOUT/TAGOUT OF HAZARDOUS ENERGY**	☐ Implement control-of-hazardous-energy practices (lockout/tagout), provide lockout/tagout locks and devices, training workers, designate "authorized" personnel, notify "affected" personnel. ***Geosyntec Procedure(s):*** *HS-119-Lockout Tagout*
☐	**WELDING, CUTTING, HOT WORK (GAS OR ARC)** UV/IR light-eye/skin burns, hot-work hazards, toxic welding fumes, compressed gases, electrical shock	☐ <u>General safe work practices:</u> • Hot work permit system to be implemented. • Operator properly protected (eye protection, clothing, apron, etc.). • Fire hazard controls (watcher, fire extinguisher, water, isolate combustibles). • Protect nearby personnel from hazardous UV, IR light (shielding, curtain). ☐ For gas welding/cutting, use gas cylinder safe practices (secured, upright, caps on when not in use, prevent Damage; never secure gas cylinders to metal bench used for arc welding). ☐ For arc welding, follow electrical safe work practices. See Part 2 Section H, "Electrical Hazards." ☐ See Part 2, Section M "Active Use of Commercial Chemical Products" for hazards associated with welding rods (toxic metals), welding gases. ***Geosyntec Procedure(s):*** *HS-511-Welding, Cutting and Other Hot Work*
☐	**COMPRESSED AIR, COMPRESSOR** (for compressed gases, see Section P, "Compressed Gases")	☐ Never direct nozzle toward body; do not use compressed air for cleaning clothes. ☐ If compressed air is used for cleaning, restrict pressure to 30 psi, equip nozzle with chip guard. ☐ Use eye protection. ☐ Ensure air tank, hoses, fittings are in good repair using factory fittings.
☐	**PORTABLE GENERATOR** Hazards: Electrical shock, carbon monoxide in exhaust, fuel-related fire, injury from mechanical hazards, lifting	☐ <u>Follow general safety practices for Operation of Equipment/Machinery (above), and as follows:</u> • Keep generator dry. • Never use indoors, or near windows, vents, doors due to carbon monoxide hazard. • Use power cords/extension cords specified by instructions. • Use ground-fault circuit interrupters (GFCIs) in accordance with manufacturer's instructions. • See Part 2, Section H, "Electrical Hazards." • Shut down equipment before refueling. See safe practices for flammable/combustible liquids in Part 2, Section M, "Project Use of Commercial Chemical Products." ***Geosyntec Procedures:*** *HS-121-Electrical Safety, HS-115-Hazard Communication*

☐	**PORTABLE HEATERS (electric or fuel powered)** Hazards: Electric-powered: Electrical shock, fires from hot surfaces. Fuel powered: Carbon monoxide in exhaust, fires from hot surfaces, fuel-related fires	☐ Follow general safety practices for Operation of Equipment/Machinery (above), and as follows: • Keep heater dry, and locate heater on level surface where it will not be knocked over. • Never use fuel-powered heaters indoors, or near windows, vents, doors due to carbon monoxide hazard. • Keep combustible materials at least 3 feet from hot surfaces. • Do not use an extension cord or power strip to power an electric heater. • For electric heaters, See Part 2, Section H, "Electrical Hazards." • Shut down fuel-powered equipment before refueling. See safe practices for flammable/combustible liquids and/or compressed gases in Part 2, Section M, "Project Use of Commercial Chemical Products." ***Geosyntec Procedures:*** *HS-121-Electrical Safety, HS-115-Hazard Communication*

F. DRILLING ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

Site personnel will work in proximity to a geotechnical drill rig. Hazards include those listed below, and noise from SPT testing. Site Personnel shall review emergency procedures for the drill rig with the drillers prior to initiating work. Site Personell shall maintain safe working distances from the drill rig while in operation (i.e., distance equal to 1.5 times the height of the drill rig), and communicate with the drillers on each stop and start of drilling operations.

☒	**DRILLING** Hazards: Struck-by, run-over, caught between (pinch points), manual lifting, roll over, fluid leaks, fuel hazards, suspended equipment **IMPORTANT!** Follow safe work practices per Section I, "Utility Related Hazards"	☒ Follow safe work practices, as applicable: • Non-essential personnel to stay clear of drilling work zone when drill rig in operation. • Use PPE near operating rig (eye/head/hearing/hand/foot protection, high visibility vests or equivalent). • Contractor inspects drill rig daily before use. • Drill rig to be equipped with operational emergency stop, equipment in good repair, machine guards in place, whip checks on high pressure lines. • Operators/helpers maintain safe distance from moving parts; secure loose hair, loose clothing, equipment. • Drill rigs will only be moved with masts lowered. • Max. safe slope for rig will be followed, drill rig leveled, appropriate blocking/cribbing as needed. • Use safety practices for refueling, fuel handling/storage/transport. • Spill equipment is available for fuel and hydraulic fluid leaks. • See "Mechanical Lifting, Rigging," in Part 2, Section G "Construction, Heavy Equipment, Lift Equipment." ***Geosyntec Procedure(s):*** *HS-403-Drilling*

G. CONSTRUCTION, HEAVY EQUIPMENT, LIFT EQUIPMENT ☐ Applicable ☒ Not Applicable, Not Anticipated

H. ELECTICAL HAZARDS ☐ Applicable ☒ Not Applicable, Not Anticipated

I. UTILITY RELATED HAZARDS ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

Boring locations are located adjacent to roadways and in the vicinity of commercial developments. Sample locations will be marked out and cleared with Sunshine 811 prior to drilling. Overhead power lines or underground utility hazards may be present and may conflict with some locations. Each location will be evaluated in the field prior to drilling and, if needed, be adjusted to accommodate the utilities.

☒	**OVERHEAD, ABOVE-GROUND UTILITIES**	☒ Maintain proper clearance, employ other appropriate precautions for the conditions. ***Geosyntec Procedure(s):*** *HS-304-Overhead Electrical Lines*
☒	**UNDERGROUND UTILITIES**	☒ Confirm appropriate underground utility clearance procedures have been completed prior to ground penetrations, and employ other utility clearance/locator practices, as appropriate for conditions. ☒ Hand digging within 3' of utility locations.

J. CONFINED SPACE ENTRY, HAZARDOUS ENCLOSED SPACES ☐ Applicable ☒ Not Applicable, Not Anticipated

K. STORAGE OF BULK MATERIALS ☐ Applicable ☒ Not Applicable, Not Anticipated

L. INFECTIOUS / ALLERGENIC BIOHAZARDS ☐ Applicable ☒ Not Applicable, Not Anticipated

M. PROJECT USE OF COMMERCIAL CHEMICAL PRODUCTS ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

Commercial checmical product hazards may include commercially available decontamination products (e.g., alconox). Site personnel will obtain Safety Data Sheets for any decontamination products ordered for sampling use.

☒	**PRODUCTS REGULATED BY HAZARD COMMUNICATION STANDARD**	☒ Safety Data Sheets available, either on site or readily available within same work shift, containers labelled properly, workers trained/oriented on hazards ☐ For subcontractor use of chemical products, coordinate/discuss during safety meetings.
☐	**COMPRESSED GAS (flammable or nonflammable)**	☐ Secure cylinders upright, caps on when not in use, handle with care, prevent damage. ☐ Propane cylinders not in use must be stored outdoors in cage or similar secure enclosure. ☐ Ensure acetylene cylinders NOT secured to steel arc welding bench. ☐ Store/use in a manner to prevent asphyxiation hazard. ☐ Segregate oxygen and fuel gases by distance (20') or barrier. ☐ Control ignition sources. ☐ "No smoking" signage at cylinder storage area for flammable gases. ☐ Use/store in a manner to control inhalation exposure hazards, PPE, air monitoring.
☐	**FLAMMABLE/COMBUSTIBLE LIQUIDS**	☐ Proper storage (flam. storage cabinets, other storage precautions). ☐ Use proper fuel safety can (metal fuel can preferred).

		☐ Control ignition sources. ☐ Grounding and bonding where appropriate.
☐	**ACIDS, CAUSTICS, OTHER CORROSIVES**	☐ Handle with care, use appropriate eye/face/skin protection. ☐ Eyewash, deluge shower, drench hose, hand washing (with water), as appropriate .
☐	**TOXIC**	☐ For toxic substances, use/store in a manner to control exposure hazards (inhalation, ingestion, skin contact, skin absorption); use PPE as appropriate, conduct air monitoring as appropriate.
☐	**EMISSIONS FROM FUEL COMBUSTION** ☐ Gasoline ☐ Diesel ☐ Propane/Natural Gas	☐ Position outdoor personnel upwind of exhaust source. ☐ Use blowers, fans to provide fresh air to work area and dissipate atmospheric hazards. ☐ Use respiratory protection for high levels of smoke, exhaust particulates, soot. ☐ Conduct air monitoring as appropriate (see Section O, "Air Monitoring").
☐	**OTHER HAZARDS**	☐ Describe other hazardous substances and safety measures under "Explanatory Notes, Clarifications," above.
☐	**CHEMICAL STORAGE** Check this when jobsite requirements include special provisions for chemical storage.	☐ Chemical storage cabinet, cage, storage room, or similar. ☐ Ensure incompatible chemicals are segregated. ☐ Provide secondary containment. ☐ Locate special safety equipment near chemical storage

Geosyntec Procedures: *HS-115-Hazard Communication, HS-111-Air Monitoring, HS-112-Respiratory Protection, HS-113-Personal Protective Equipment, HS-114-Safety Training Programs, Others as applicable*

N. SITE CONTAMINANTS, CHEMICAL WASTES ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

Potential contaminates of concern in soil and groundwater are 2,4-demethylphenol, 2-methynapthalene, 2-methyphenol, 3,4-methylphenol, acetophenone, carbazole, dibenzofuran, naphthalene, phenol, 1,2,4-trimethylebnzene, 2-butanone, actone, benzene, ethylbenzene, toluene, aluminum, antimony, arsenic, chromium, iron, manganese, nickel, selenium, vanadium, borneol, and camphor. Potential exposure will be through dermal contact with soil or groundwater during sampling, or inhallation. Site personnel shall use nitrile gloves while performing sampling, and execute hazard mitigation efforts as described below. A PID shall be used to monitoring for vapors.

Site personnel shall mitigate the spread of soils and groundwater by containerizing those materials when sampled. If excess soil is present after drilling, soil shall be disposed of according to the Investigation Derived Waste procedures in the PDI Work Plan. Site personnel shall ensure all sample containers are sealed prior to transportation around or off site, to prevent contaminant migration and spills.

CHECK ALL THAT APPLY. Provide explanatory notes above.

☒ Soil/groundwater contaminants (historical release)	☐ Oxygen deficiency	☐ Asbestos
☐ Recent release, known high concentrations	☐ Chlorinated volatile organic compounds (VOCs)	☐ Lead paint
☐ Former chemical disposal site, landfill	☐ BTEX, petroleum derived VOCs	☐ Pesticides, herbicides, fungicides
☐ Urban fill, residual contaminants	☐ Fuel oils, petroleum, waste oil, lubricants	☐ Sensitizers
☒ Containerized waste (drums, process equipment)	☐ Metals, metal compounds, metal dusts	☐ Radioactive contaminants
☐ Buried drums (known or potential)	☐ Elemental mercury	☐ Other:
☐ Large containers, potential for spills	☐ Polyaromatic hydrocarbons (PAHs)	
☐ Emissions from active industrial processes	☐ Polychlorinated biphenyls (PCBs)	
☐ Emissions from welding/cutting/hot work	☐ Potential for flammable vapors	
☐ Carbon monoxide (vehicle/equipment exhaust)	☐ Potential for flammable gas (methane)	
☐ Contaminated building surfaces	☐ Corrosive, acids/caustics, strong irritants	
☐ Unexploded ordnance	☐ Sulfides, hydrogen sulfide (H_2S)	
☐ Explosive dust	☐ Cyanides, hydrogen cyanide (HCN)	

☐ **FOR SITE REGULATED AS "UNCONTROLLED HAZ. WASTE SITE," e.g. REGULATED BY HAZWOPER (OSHA 29 CFR 1910.120)**

- Implement site control plan via Exclusion Zone(s), Contaminant Reduction Zone(s) and Support Zone (aka EZ, CRZ, SZ)
- Workers to be aware of and trained on hazards per OSHA Hazard Communication Standard.
- Include site map/figure depicting work locations and other relevant site-specific information.
- Site workers in EZ or CRZ to have OSHA 40-hour training, current 8-hour refresher, 3 days supervised field experience.
- Site workers in EZ or CRZ to participate in Medical Monitoring program, as applicable.
- "Peripheral" site workers, engaged on-site, with no hazardous exposure: 24 hr. training required.
- Site supervisor(s) required to have 8-hr. Supervisor training.
- Implement site-specific procedures for worker protection via engineering controls, work practices, personal protective equipment (PPE), air monitoring, decontamination procedures, spill containment, emergency preparedness and response.

Geosyntec Procedures: *HS-301-HAZWOPER, HS-108-Medical Monitoring Surveillance, HS-111-Air Monitoring, HS-112-Respiratory Protection, HS-113-Personal Protective Equipment, HS-114-Safety Training Programs, HS-115-Hazard Communication, HS-405-Drum Sampling, Others as applicable*

☒ **FOR SITE WITH CHEMICAL CONTAMINANTS OR WASTE BUT NOT REGULATED BY HAZWOPER**

- Workers to be knowledgeable/aware of chemical hazards thru safety training/orientation and availability of hazard information
- Implement controls to minimize worker exposure through engineering controls, work practices, PPE, as appropriate.
- Conduct air monitoring/sampling to monitor/evaluate worker exposure, as applicable.

		Geosyntec Procedures: *HS-111-Air Monitoring, HS-112-Respiratory Protection, HS-113-Personal Protective Equipment, HS-114-Safety Training Programs, HS-115-Hazard Communication, Others as applicable*
☒	**OFF-SITE MIGRATION OF CONTAMINANTS**	☐ Implement controls to minimize hazard migration (dust suppression, covers, foam, etc.) ☐ Community/perimeter air monitoring to be conducted per perimeter air monitoring plan.
☒	**SPILL CONTAINMENT, CONTAINERS**	☒ Describe above any site-specific procedures for spill containment, container handling, as applicable. ***Geosyntec Procedures:*** *HS-406-Unknown Hazardous Waste Drum Handling*

O. AIR MONITORING ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:
Site personnel will use personal air monitoring devices (i.e., PID) during drilling activities to scan the breathing zone for potential hazards (i.e., VOCs). Hazard mitigation shall be performed as described below.

☒	**AIR-TESTING PARAMETERS**	☒ VOCs, GASES ☒ PID, Lamp energy: 11.7 eV ☐ FID ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ Oxygen (O_2)	☐ Flammable gas (LEL) ☐ Particulate (dust) ☐ Calibration kit for each parameter ☐ Other:

☐	**ACTION LEVELS FOR O2/LEL**	☐ Oxygen	≤19.5% - ventilate to raise O_2 to acceptable levels, or use Level B. ≥23.0% - ventilate to lower O_2 to acceptable levels, or use Level B and control fire hazards & ignition sources.
		☐ LEL	Confirm at least 12% oxygen is present to ensure accuracy of LEL readings. At <10% LEL - Continue working, continue to monitor LEL levels At ≥10% LEL- Immediately withdraw from area. Resume work ONLY after LEL readings reduced to <10%.

	Parameters	**Level D, Modified D***	**Use levels C or B*, as indicated below, OR take action to reduce breathing zone level to concentration acceptable for Level D*.**
☒ **ACTION LEVELS FOR TOXICS** (sustained breathing zone concentrations)	☒ VOCs	< 2 ppm	> 2 ppm: ventilate breathing space by stepping away from borehole or sample and remain outside of breathing zone with > 2 ppm until breathing zone levels are below background reading.
	☐ Carbon Monoxide	< 35 ppm	≥35 ppm - Level B (air-supplied respirator)
	☐ Hydrogen Sulfide	< 10 ppm	≥10 ppm - Level B (air-supplied respirator)
	☐ Total Dust	< ___ mg/m^3	>___ mg/m^3 - Level C (air-purifying respirator)

*** Levels of Protection:**
Level D (standard work clothes, basic personal protective wear, no chemical protective clothing, no respiratory protection)
Modified Level D (chemical protective clothing in addition to standard work clothes, no respiratory protection)
Level C (air purifying respirator or dust mask, in addition to chemical protective clothing)
Level B or A (air supplied respirator, chemical protective suit; fully-encapsulating suit for Level A)

Geosyntec Procedures: *HS-111-Air Monitoring*

P. RADIATION HAZARDS (Other than Sunlight) ☐ Applicable ☒ Not Applicable, Not Anticipated

PART 3 – APPROVALS, ACKNOWLEDGEMENTS

A. THA PREPARATION, REVIEW/APPROVAL SIGNATURES - THA typically prepared by project staff, reviewed/approved by Project Manager, Supervisor, qualified/knowledgeable designee, with support of HS personnel as deemed appropriate for the work and associated hazards.			
THA PREPARED BY: (minimum one person)	*Printed Name*	*Signature*	*Date*
	Zachary Tanguay	Zachary B Tanguay	9/7/2017
THA REVIEWED/ APPROVED BY: (minimum one person)	*Printed Name*	*Signature*	*Date*
	Jonathan Gillen	Jonathan H. Gillen	9/7/2017
	Carl Elder	Carl R. Elder	7 Sept 2017

>>> Please See Section B, "Field Crew Acknowledgements," on Following Page <<<

B. FIELD CREW ACKNOWLEDGEMENTS

GEOSYNTEC FIELD CREW

Please sign below to acknowledge you reviewed and understand this THA, participated in project safety briefing and had an opportunity to ask questions about the information herein.

Print Name:	Signature:	Employee No.	Date:

SUBCONTRACTOR'S FIELD CREW

Please sign below to acknowledge that this THA was made available to you, and you had an opportunity to ask questions about the information herein.

Print Name:	Signature:	Company Name:	Date:

ROUTE TO HOSPITAL

UF Health Shands Emergency Room / Trauma Center
(352) 733-0111
1515 SW Archer Rd, Gainesville, FL 32608

Written Directions to Hospital from Site:

1. Depart N Main St / CR-329 toward NE 28th Ave
2. Turn right onto SR-120
3. Turn left onto US-441 / SR-25 / NW 13th St
4. Bear right onto SR-24 W
5. Turn back on SR-24 E

Distance: 3.9 miles   Time: 11 minutes

PART 1 – SITE SAFETY PLAN

A. PROJECT/TASK INFORMATION

TASK:	Aquifer Hydraulic Testing		
Project Name:	Cabot Carbon Superfund Site – Hawthorn Remedy PDI	**Project Number/Org:**	BR0227/1932
Project Address:	2810 NE 28th Pl, Gainesville, FL		
Description of Task & Worksite:	Aquifer hydraulic testing will constitue step-drawdown tests at two existing groundwater wells at at site where contaminants, including pine tar, from former industrial activities and site development are present.		

Geosyntec Personnel	Name	Office Phone	Cell Phone
Site Lead/HS Officer	[TBD]		
Project Manager	Steven Poirier	978-206-5785	617-835-5785
Project Director	Carl Elder	978-206-5768	978-844-4172
HS Coordinator	Chris Martin	978-506-5711	314-307-1694
Regional HS Mngr.	Mark P. Malchik	978-206-5777	781-392-5440
Corp. HS Director	Dale Prokopchak	804-332-6376	804-349-8067
Client Contact(s):	Wayne Reiber (Project Manager)	978-671-4096	617-306-1438
Subcontractor(s):	☐ Not Applicable ☒ Applicable, provide contact information below:		

B. SUMMARY OF WORK STEPS, HAZARDS, CONTROLS
Based on **PART 2, "HAZARD ANALYSIS,"** and on worksite/client/project factors.

Abstract of work steps/hazards/controls, with references to applicable Sections in Part 2 for greater detail:

Site personnel (i.e., Geosyntec PDI field crew) will mobilize to the site, and identify monitoring well locations to be tested. Monitoring wells may require development. Pump testing will be performed outdoors. Groundwater obtained during pump testing will be containerized and shipped to the Mix Design Laboratory.

WORK STEPS	HAZARDS	CONTROLS
1. *Mobilization*	*Driving/traffic/pedestrians, heavy lifting (supplies), slips/trips/falls (potential winter conditions), weather-related stress, working in Urban/suburban setting.*	*Pay close attention to driving and avoid distractions, plan travel ahead and obey traffic signs and posted speed limits, follow safe lifting procedures for heavy supplies, be aware of your surroundings, dress for weather.*
2. *Well development, water level measurements, Step-Drawdown (pump) testing, and groundwater sampling*	*Heavy lifting (equipment and 5-gallon bucket samples), slips/trips/falls/, weather-related stress, stinging insects, electrical pumps, contaminants of concern*	*Wear PPE during activities, use insect repellent, observe safe lifting practices, avoid electrical equipment contact with water, plan for weather conditions, and use work gloves as appropriate.*

C. H&S EQUIPMENT LIST
List HS equipment needed at the worksite to control/manage hazards identified in **PART 2, "HAZARD ANALYSIS."**

EXPLANATORY NOTES, CLARIFICATIONS:

Site personnel will be required to utilize the basic PPD described below. Note, nitrile gloves will be required for groundwater pump testing and obtaining 5-gallon bucket s of groundwater.

☒	**BASIC PPE AND SAFETY GEAR**	☒ Standard work clothes & footwear, appropriate for task ☒ Hard-toed boots/shoes ☒ Hardhat ☒ Safety glasses	☒ Work gloves appropriate for task ☐ Noise/hearing protection ☒ High-visibility/reflective vest ☒ First aid kit	
		☐ Basic PPE for limited protection from chemical contact & low-hazard dust inhalation – nitrile gloves, Tyvek suit, dust mask, boot covers.		
☐	**OTHER H&S EQUIPMENT/GEAR**	☐ Fire extinguisher ☐ Traffic control warning devices ☐	☐ Vehicle emergency kit (flares, lights, reflective device) ☐ ☐	
		☐ Other:		
☒	**ADDITIONAL PERSONAL PROTECTIVE EQUIPMENT (PPE)**	Eye/face protection ☐ Goggles ☐ Face shield Chemical protective clothing ☒ Gloves, type: nitrile ☐ Coveralls, type: ☐ Outer boots, boot covers	Respiratory Protection ☐ Disposable n-95 face mask ☐ Half-face air-purifying respirator ☐ Full-face air-purifying respirator ☐ Respirator cartridge, type: ☐	☐ Personal flotation device ☐ Personal fall apparatus ☐ Fire retardant clothing ☐ Arc Flash Protection ☐ Electrical-Hazard-rated boots, gloves ☐
		☐ Other:		

☐	**SPECIAL HAZARD CONTROLS**	☐ Portable GFCI ☐	☐ Lockout/tagout equipment ☐	☐ Ventilation equipment (fan, blower) ☐
☒	**DECON, PPE DISPOSAL**	☒ Waste receptacle for disposable PPE ☐ Additional information:	☐ Hand washing provisions	☒ Decon solution, misc. supplies
☒	**AIR MONITORING EQUIPMENT**	PID 11.7 eV lamp		

D. EMERGENCY RESPONSE Based on **PART 2, "HAZARD ANALYSIS,"** and on worksite factors, client requirements.

SUMMARY of Recognized Emergency Risk Factors & Response Procedures *(fire/explosion, medical , chemicals/spills, security, site conditions/topography, prevailing weather, other concerns)*:

To Summon Police, Fire, Ambulance in an Emergency	☒ DIAL 911 ☐ use alternate procedure:
Nearest Emergency Medical Services	Hospital Name: UF Health Shands Emergency Room / Trauma Center Address: 1515 SW Archer Rd, FL 32608 Phone #: (352) 733-0111 ☒ See Attached Directions
For **Non-Emergency Urgent Care**:	Contact WorkCare, 24/7 at: 800-455-6155, menu option "3"
Other Emergency Contacts, as needed *(such as security, spill responder, utility):*	
Job-site **Evacuation** Procedure, Rally Point, Place of refuge:	Rally point at the designated parking area.
Means of alerting on-site personnel in case of emergency:	☒ Verbal ☐ Radio ☒ Cell Phone ☐ Other:
Special Equipment, as applicable (such as PPE, first aid, eyewash):	

IMPORTANT: After initial emergency response actions and incident stabilization, contact appropriate project personnel (see Part 1.A.).

PART 2 – HAZARD ANALYSIS *Complete Section A. Then complete Sections B thru O, as applicable to your project. Provide comments in each section under "Explanatory Notes, Clarifications" to sufficiently describe **site-specific** hazards and safety measures.*

A. BASIC HAZARD PREPAREDNESS This section required for all Tasks.

Explanatory Notes, Clarifications:

Basic hazards present at the site generally include those relating to (i) work outdoors (i.e. insects); (ii) work in urban/sub-urban locations; (iii) travel to/from job sites; and (iv) manual work with tools and sampling equipment. The following basic protections and precautions should be recognized for all aspects of this task

Basic Personal Protection

☐ **Overhead Hazards** - Wear hardhat or "bump cap" as appropriate for hazard.
☒ **Hand injury hazards** - Wear protective work gloves appropriate for the hazard and work tasks.
☒ **Eye injury hazards** - Wear safety glasses (with side shield or wrap around, either clear or shaded for sun protection).
☒ **Foot hazards, rough terrain** - Wear work boots/shoes with hard toes, ankle support, puncture resistance, traction, as appropriate for conditions.
☐ **Noise** – use hearing protection, (earplugs, earmuffs, or both) as appropriate for conditions, at a minimum where noise levels exceed 85dBA.
☒ **Chemical/biological agents, low hazard and/or "passive" exposure** - use appropriate PPE and precautions; describe above.
☐ **Chemical/biological agents, elevated hazard and/or "active use" exposure** – see Part 2, Section(s) M, N, O, as applicable.

Geosyntec Procedures: *HS-109-Hearing Conservation, HS-113-Personal Protective Equipment, HS-210-Walking and Working Surfaces*

General Safety Precautions

☒ **General premises** hazards - housekeeping, rough terrain, trip hazards, steep slope, remote location; describe specific hazards and controls above.
☒ **Weather/climate-related hazards** - heat cold protection, fluids, breaks, shade, sun screen, multiple layers, discontinue use of aerial lift/ladder in high wind, "30/30 rule" for lightning safety, protection from hail, seek place of refuge for extreme weather
☒ **Plant/Insect/Animal Hazards** - Precautions: poison ivy wash; insect repellant; check for ticks; hornet nest spray; animal precautions.
☒ **Traffic** – Implement measures to protect personnel (high visibility/reflective clothing, on-person lighting, traffic control measures).
☐ **Illumination hazards/night work** - Illuminate work areas and/or access routes, use reflective/hi-visibility clothing or on-person lighting, as appropriate.
☒ **Manual hand tools** - proper tool for the job, maintain in good condition, use vice/clamp to hold work piece, proper follow thru
☐ **Machinery hazards, passive exposure** – keep safe distance, heed warning signs, use appropriate PPE (such as eye/hearing protection), secure long hair, loose clothing, jewelry near moving parts. For active use of equipment machinery as part of the work, see Part 2, Section E "Powered Tools, Equipment, Machinery"
☒ **Lifting, manual material handling** – use proper lifting procedures, seek help for >50 lbs.

Geosyntec Procedures: *HS-127-Ticks, HS-124-Heat Stress, HS-125-Cold Stress, HS-210-Walking and Working Surfaces, HS-208-Housekeeping, HS-401-Back Injury Prevention, HS-502-Manual Hand Tool, HS 517 Traffic Safety*

Security

☐ **High crime, urban** – Use appropriate measures for personal security (such as buddy system, security service, work scheduling, other measures)
☐ **Working alone** - Establish "check in" procedure with supervisor/project manager.

Geosyntec Procedures: *HS-207-Working Alone*

Driving Hazards

☒ **Routine work travel** - Use routine safe/defensive driving practices (seat belts, safe speeds, eyes ahead, no tailgating, limit distractions, safe cell phone use, no texting, clear windows, account for weather/road conditions, adequate sleep, other measures as appropriate).

☒ **Unfamiliar location** - Plan travel route before driving (assemble maps, enter destination in GPS).

☐ **Long Distance or During Sleep Hours** – Minimize fatigue: rest breaks, light snacks (avoid heavy meals), stay hydrated, fresh air, no loud music, clean windshield.

☒ **Unfamiliar vehicle** – Become familiar with vehicle operational controls before operating vehicle.

☐ **Special hazards** - see Part2, Section B, "Special Driving/Traffic/Transportation Hazards"

Geosyntec Procedures: *HS-105-Driver and Vehicle Safety*

B. SPECIAL DRIVING/TRAFFIC/TRANSPORTATION HAZARDS ☒Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

The Site is bounded by roadways on three sides. Access the site by vehicle. Vehicles will be parked in the designated parking area on the Site. Workers will walk to designated well locations (one is across a secondary roadway). The primary transportation hazard will be working near vehicle thoroughfares.

☐	**SPECIAL DRIVING HAZARDS** Off-Road Driving or use of non-typical vehicle, ATV Hazards: Worker injury due to vehicle collision, rollover	☐ For off road driving, do not exceed capability of vehicle, beware of wet conditions, speed low, avoid unsafe orientation on slopes. ☐ Follow ATV specific procedures for training, safety equipment, operation, manufacturer's instructions. ☐ Special Skills Required for Vehicle type - For vehicles requiring special skills (such as windowless van, heavy work vehicle, utility vehicle, similar) ensure operator is provided training and/or has appropriate operator skills through experience. ***Geosyntec Procedure(s):*** *HS-510-All Terrain Vehicles*
☐	**TRANSPORTING MATERIALS, TOWING/HAULING LOADS** Hazards: Vehicle accident, occupant injury from shifting load, unsafe equipment.	☐ Ensure load is firmly secured (rope, straps, load configuration) to prevent shifting during travel. ☐ Slings, chains, strap, rope and related equipment used for towing, hauling, load-securing shall be appropriate for use, and used in a manner as to prevent an unsafe condition. ☐ For trailer use, verify signal/braking lights operational, rear-view mirrors effective, hitch/safety chains secure.
☒	**WORKSITE IN/NEAR VEHICLE THOROUGHFARE** Hazards: Worker injury from being struck by vehicle traveling in thoroughfare.	☒ Wear reflective vests where exposed to traffic hazards. ☒ Where possible, park vehicles as protective shield from oncoming traffic. ☒ Configure work area and support vehicles to minimize worker exposure to traffic hazards. ☐ Use DOT signal devices to re-route vehicles around work area, site entrances/exits. ☐ Use DOT-trained flaggers or police detail where appropriate or required. ***Geosyntec Procedure(s):*** *HS-517-Traffic Safety*
☐	**RAILROAD HAZARD** Hazard: Worker injury from being struck by train in R.R. right-of-way	☐ Coordinate with rail company and implement required safety and security measures. ☐ Site workers to receive safety training for railroad work. **Geosyntec Procedure(s):** HS-305-Rail Operations
☐	**WATER TRANSPORTATION**	☐ Follow HS 312 "Water Transportation Safety," and Section C, "Water/Boating Hazards." **Geosyntec Procedure(s):** HS-312-Water Transportation Safety
☐	**AIRPORT, AIRCRAFT** Worker injury when working on/near airport runway, or use of helicopter, light aircraft	☐ Coordinate safety requirements with Airport personnel and implement required safety measures. ☐ Site workers to receive safety training for railroad/airport work. ☐ Follow HS 310 "Helicopter Safety" and/or HS 311 "General Aviation (Small Aircraft) Safety." ***Geosyntec Procedure(s):*** *HS-310-Helicopter Safety, HS 311-General Aviation (Small Aircraft) Safety*
☐	**HEAVY EQUIPMENT TRAFFIC/VEHICLE HAZARDS AT CONSTRUCTION SITE**	☐ See Section G, "Construction, Heavy Equipment, Lift Equipment"

C. WATER/BOATING HAZARDS ☐ Applicable ☒ Not Applicable, Not Anticipated

D. FALL HAZARDS ☐ Applicable ☒ Not Applicable, Not Anticipated

E. POWERED TOOLS, EQUIPMENT, MACHINERY ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

Site personnel will be utilizing pumps and other equipment to develop wells and perform testing. In addition to powered handtool hazards due to equipment, heavy objects (i.e., 5-gallon bucket sample of groundwater) will present a lifting hazard.

☒	**POWERED HAND TOOLS** ☒ Electric-powered ☐ Fuel-powered ☐ Pneumatic ☐ Powder-actuated Hazards: Eye/hand/body injury, fuel-related hazards, Inhalation hazards, noise, sparks, heat, fire hazard, electrical hazards	☒ For all power tools: • Inspect tools to ensure safe operating condition before each use. • Use tool in accordance with manufacturer's specifications. • Ensure guards are in place and no hazardous equipment modifications. • Use PPE or other safety practices, as appropriate, for eye/hearing/hand/head/body protection (such as use of Kevlar chaps and jacket for chainsaw use). • Provide training or verify operator qualification for use of power tool. • Stay clear of hazard zone, "line of fire" when working near where power tools are used. • For spark/heat generating tool, control fire hazards, segregate combustible/flammable materials. ☐ Use respirators, ventilation, wet methods, other appropriate means to control inhalation hazard. ☐ See fuel-safety practices in Part 2, Section O, "Active Use of Commercial Chemical Products." ☐ For electrical hazards, see Part 2, Section H, "Electrical Hazards". ***Geosyntec Procedure(s):*** *HS-503-Powered Hand Tools*
☐	**OPERATION OF EQUIPMENT/MACHINERY** ☐ Point-of-operation hazards ☐ Pinch points, moving parts ☐ 'Struck-by,' 'caught between' ☐ Hot surfaces, heat ☐ Extension cords, flexible wire ☐ Fuel related (gas or liquid) ☐ Hydraulic pressure ☐ Kinetic, stored energy ☐ Noise ☐ Emissions, discharge gases ☐ Working at heights, falls ☐ Lifting, repetitive motion ☐ Illumination ☐ Electrical	☐ General safety requirements for equipment, machinery: • Arrange worksite for safe access to equipment/machinery. • Use equipment/machinery in accordance with manufacturer's use and safety instructions. • Ensure point-of-operation, mechanical power transmission, other moving parts are guarded with protective devices; do not override interlocks, guards, protective devices. • Secure long hair/loose clothing/hanging jewelry near moving/rotating parts. • Heed warning signs/labels, keep safe distance; avoid locations of "struck by" and "caught between" hazards. • Implement lockout/tagout for repairs/adjustments/tooling changes. ☐ Use safe lifting practices for movement of heavy portable equipment ☐ Incorporate safety provisions/safe work practices for compressed air, pressurized systems (pneumatic/hydraulic), stored energy. ☐ For climbing/fall hazards associated with large equipment, See Part 2, Section D, "Fall Hazards." ☐ For electrical hazards, see Part 2, Section H, "Electrical Hazards." ☐ Operate fuel-powered equipment in well ventilated location. ☐ Use safe practices for fuels, see Part 2, Section O, "Active Use of Commercial Chemical Products."
☐	**LOCKOUT/TAGOUT OF HAZARDOUS ENERGY**	☐ Implement control-of-hazardous-energy practices (lockout/tagout), provide lockout/tagout locks and devices, training workers, designate "authorized" personnel, notify "affected" personnel. ***Geosyntec Procedure(s):*** *HS-119-Lockout Tagout*
☐	**WELDING, CUTTING, HOT WORK (GAS OR ARC)** UV/IR light-eye/skin burns, hot-work hazards, toxic welding fumes, compressed gases, electrical shock	☐ General safe work practices: • Hot work permit system to be implemented. • Operator properly protected (eye protection, clothing, apron, etc.). • Fire hazard controls (watcher, fire extinguisher, water, isolate combustibles). • Protect nearby personnel from hazardous UV, IR light (shielding, curtain). ☐ For gas welding/cutting, use gas cylinder safe practices (secured, upright, caps on when not in use, prevent Damage; never secure gas cylinders to metal bench used for arc welding). ☐ For arc welding, follow electrical safe work practices. See Part 2 Section H, "Electrical Hazards." ☐ See Part 2, Section M "Active Use of Commercial Chemical Products" for hazards associated with welding rods (toxic metals), welding gases. ***Geosyntec Procedure(s):*** *HS-511-Welding, Cutting and Other Hot Work*
☐	**COMPRESSED AIR, COMPRESSOR** (for compressed gases, see Section P, "Compressed Gases")	☐ Never direct nozzle toward body; do not use compressed air for cleaning clothes. ☐ If compressed air is used for cleaning, restrict pressure to 30 psi, equip nozzle with chip guard. ☐ Use eye protection. ☐ Ensure air tank, hoses, fittings are in good repair using factory fittings.
☒	**PORTABLE GENERATOR** Hazards: Electrical shock, carbon monoxide in exhaust, fuel-related fire, injury from mechanical hazards, lifting	☒ Follow general safety practices for Operation of Equipment/Machinery (above), and as follows: • Keep generator dry. • Never use indoors, or near windows, vents, doors due to carbon monoxide hazard. • Use power cords/extension cords specified by instructions. • Use ground-fault circuit interrupters (GFCIs) in accordance with manufacturer's instructions. • See Part 2, Section H, "Electrical Hazards." • Shut down equipment before refueling. See safe practices for flammable/combustible liquids in Part 2, Section M, "Project Use of Commercial Chemical Products." ***Geosyntec Procedures:*** *HS-121-Electrical Safety, HS-115-Hazard Communication*

☐	**PORTABLE HEATERS (electric or fuel powered)** Hazards: Electric-powered: Electrical shock, fires from hot surfaces. Fuel powered: Carbon monoxide in exhaust, fires from hot surfaces, fuel-related fires	☐ Follow general safety practices for Operation of Equipment/Machinery (above), and as follows: • Keep heater dry, and locate heater on level surface where it will not be knocked over. • Never use fuel-powered heaters indoors, or near windows, vents, doors due to carbon monoxide hazard. • Keep combustible materials at least 3 feet from hot surfaces. • Do not use an extension cord or power strip to power an electric heater. • For electric heaters, See Part 2, Section H, "Electrical Hazards." • Shut down fuel-powered equipment before refueling. See safe practices for flammable/combustible liquids and/or compressed gases in Part 2, Section M, "Project Use of Commercial Chemical Products." ***Geosyntec Procedures:*** *HS-121-Electrical Safety, HS-115-Hazard Communication*

F. DRILLING ☐ Applicable ☒ Not Applicable, Not Anticipated

G. CONSTRUCTION, HEAVY EQUIPMENT, LIFT EQUIPMENT ☐ Applicable ☒ Not Applicable, Not Anticipated

H. ELECTRICAL HAZARDS ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

☒	**ELECTRICAL HAZARDS (GENERAL)** Equipment/tool use/operation, use of extension cords, working near electrical equipment. Hazards: Electrical shock, secondary hazards (falls, other injuries).	☒ Follow safe work practices: • Control water-related/wet-location hazards in a manner appropriate for the job tasks/equipment/tool. • Never touch electrical equipment if you are wet, or standing in water or on wet surfaces. • Use extension cords/power cords properly, prevent damage, take out of service if damaged. • Inspect tool/equipment/extension cords/power cords/welding cables before each use; do not use if damaged. • Use GFCI-protected outlet or portable GFCI in wet locations, outdoors, basements. • Ensure live parts are guarded, enclosures secure. • Enclosures, circuits properly labeled. ***Geosyntec Procedure(s):*** *HS-121-Electrical Safety*
☐	**HANDS-ON WORK ON ELECTRICAL CIRCUITS:** ☐ Voltage < 50 v ☐ Voltage 50-600v ☐ Voltage > 600v ☐ AC ☐ DC ☐ 3-phase ☐ Battery and/or solar power ☐ Capacitor/transformer	☐ Implement electrical safe work practices pertaining to: • Worker training/qualification (Level 1, Level 2, Level 3) • General electrical safe work practices, grounding, use of GFCIs • Safe work practices during diagnostics/troubleshooting, maintenance, repair • Safe design features for electrical equipment • Arc flash protection ☐ For utility-related hazards, see Section I, "Utility Related Hazards") ***Geosyntec Procedure(s):*** *HS-121-Electrical Safety, HS-129-High Voltage Electricity Safety*
☐	**LOCKOUT/TAGOUT OF ELECTRICAL ENERGY**	☐ Implement control-of-hazardous-energy practices (lockout/tagout), provide lockout/tagout locks and devices, training workers, designate "authorized" personnel, notify "affected" personnel. ***Geosyntec Procedure(s):*** *HS-119-Lockout Tagout*

I. UTILITY RELATED HAZARDS ☐ Applicable ☒ Not Applicable, Not Anticipated

J. CONFINED SPACE ENTRY, HAZARDOUS ENCLOSED SPACES ☐ Applicable ☒ Not Applicable, Not Anticipated

K. STORAGE OF BULK MATERIALS ☐ Applicable ☒ Not Applicable, Not Anticipated

L. INFECTIOUS / ALLERGENIC BIOHAZARDS ☐ Applicable ☒ Not Applicable, Not Anticipated

M. PROJECT USE OF COMMERCIAL CHEMICAL PRODUCTS ☐ Applicable ☒ Not Applicable, Not Anticipated

N. SITE CONTAMINANTS, CHEMICAL WASTES ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:

Potential contaminates of concern in soil and groundwater are 2,4-demethylphenol, 2-methynapthalene, 2-methyphenol, 3,4-methylphenol, acetophenone, carbazole, dibenzofuran, naphthalene, phenol, 1,2,4-trimethylebnzene, 2-butanone, actone, benzene, ethylbenzene, toluene, aluminum, antimony, arsenic, chromium, iron, manganese, nickel, selenium, vanadium, borneol, and camphor. Potential exposure will be through dermal contact with soil or groundwater during sampling. Site personnel shall use nitrile gloves while performing sampling, and execute hazard mitigation efforts as described below.

Site personnel shall mitigate the spread of soils and groundwater by containerizing those materials when sampled. If excess groundwater is present after pump testing, groundwater shall be disposed of according to the Investigation Derived Waste procedures in the PDI Work Plan. Site personnel shall ensure all sample containers are sealed prior to transportation around or off site, to prevent contaminant migration and spills.

CHECK ALL THAT APPLY. Provide explanatory notes above.

☒ Soil/groundwater contaminants (historical release)	☐ Oxygen deficiency	☐ Asbestos
☐ Recent release, known high concentrations	☐ Chlorinated volatile organic compounds (VOCs)	☐ Lead paint
☐ Former chemical disposal site, landfill	☐ BTEX, petroleum derived VOCs	☐ Pesticides, herbicides, fungicides
☐ Urban fill, residual contaminants	☐ Fuel oils, petroleum, waste oil, lubricants	☐ Sensitizers
☒ Containerized waste (drums, process equipment)	☐ Metals, metal compounds, metal dusts	☐ Radioactive contaminants
☐ Buried drums (known or potential)	☐ Elemental mercury	☐ Other:
☐ Large containers, potential for spills	☐ Polyaromatic hydrocarbons (PAHs)	
☐ Emissions from active industrial processes	☐ Polychlorinated biphenyls (PCBs)	
☐ Emissions from welding/cutting/hot work	☐ Potential for flammable vapors	

☐ Carbon monoxide (vehicle/equipment exhaust) ☐ Contaminated building surfaces ☐ Unexploded ordnance ☐ Explosive dust	☐ Potential for flammable gas (methane) ☐ Corrosive, acids/caustics, strong irritants ☐ Sulfides, hydrogen sulfide (H_2S) ☐ Cyanides, hydrogen cyanide (HCN)	

☐	**FOR SITE REGULATED AS "UNCONTROLLED HAZ. WASTE SITE," e.g. REGULATED BY HAZWOPER (OSHA 29 CFR 1910.120)** • Implement site control plan via Exclusion Zone(s), Contaminant Reduction Zone(s) and Support Zone (aka EZ, CRZ, SZ) • Workers to be aware of and trained on hazards per OSHA Hazard Communication Standard. • Include site map/figure depicting work locations and other relevant site-specific information. • Site workers in EZ or CRZ to have OSHA 40-hour training, current 8-hour refresher, 3 days supervised field experience. • Site workers in EZ or CRZ to participate in Medical Monitoring program, as applicable. • "Peripheral" site workers, engaged on-site, with no hazardous exposure: 24 hr. training required. • Site supervisor(s) required to have 8-hr. Supervisor training. • Implement site-specific procedures for worker protection via engineering controls, work practices, personal protective equipment (PPE), air monitoring, decontamination procedures, spill containment, emergency preparedness and response. ***Geosyntec Procedures:*** *HS-301-HAZWOPER, HS-108-Medical Monitoring Surveillance, HS-111-Air Monitoring, HS-112-Respiratory Protection, HS-113-Personal Protective Equipment, HS-114-Safety Training Programs, HS-115-Hazard Communication, HS-405-Drum Sampling, Others as applicable*
☒	**FOR SITE WITH CHEMICAL CONTAMINANTS OR WASTE BUT NOT REGULATED BY HAZWOPER** • Workers to be knowledgeable/aware of chemical hazards thru safety training/orientation and availability of hazard information • Implement controls to minimize worker exposure through engineering controls, work practices, PPE, as appropriate. • Conduct air monitoring/sampling to monitor/evaluate worker exposure, as applicable. ***Geosyntec Procedures:*** *HS-111-Air Monitoring, HS-112-Respiratory Protection, HS-113-Personal Protective Equipment, HS-114-Safety Training Programs, HS-115-Hazard Communication, Others as applicable*

☒	**OFF-SITE MIGRATION OF CONTAMINANTS**	☒ Implement controls to minimize hazard migration (dust suppression, covers, foam, etc.) ☐ Community/perimeter air monitoring to be conducted per perimeter air monitoring plan.
☒	**SPILL CONTAINMENT, CONTAINERS**	☒ Describe above any site-specific procedures for spill containment, container handling, as applicable. ***Geosyntec Procedures***: *HS-406-Unknown Hazardous Waste Drum Handling*

O. AIR MONITORING ☒ Applicable ☐ Not Applicable, Not Anticipated

EXPLANATORY NOTES, CLARIFICATIONS:
Site personnel will use personal air monitoring devices (i.e., PID) during pump test and groundwater sampling activities to scan the breathing zone for potential hazards (i.e., VOCs). Hazard mitigation shall be performed as described below.

☒	**AIR-TESTING PARAMETERS**	☒ VOCs, GASES ☒ PID, Lamp energy: 11.7 eV ☐ FID ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ Oxygen (O_2)	☐ Flammable gas (LEL) ☐ Particulate (dust) ☐ Calibration kit for each parameter ☐ Other:

☐	**ACTION LEVELS FOR O2/LEL**	☐ Oxygen	≤19.5% - ventilate to raise O_2 to acceptable levels, or use Level B. ≥23.0% - ventilate to lower O_2 to acceptable levels, or use Level B and control fire hazards & ignition sources.
		☐ LEL	Confirm at least 12% oxygen is present to ensure accuracy of LEL readings. At <10% LEL - Continue working, continue to monitor LEL levels At ≥10% LEL- Immediately withdraw from area. Resume work ONLY after LEL readings reduced to <10%.

☒	**ACTION LEVELS FOR TOXICS** (sustained breathing zone concentrations)	**Parameters**	**Level D, Modified D***	**Use levels C or B*, as indicated below, OR take action to reduce breathing zone level to concentration acceptable for Level D*.**
		☐ VOCs	< 2 ppm	> 2 ppm: ventilate breathing space by stepping away from borehole or sample and remain outside of breathing zone with > 2 ppm until breathing zone levels are below background reading.
		☐ Carbon Monoxide	< 35 ppm	≥35 ppm - Level B (air-supplied respirator)
		☐ Hydrogen Sulfide	< 10 ppm	≥10 ppm - Level B (air-supplied respirator)
		☐ Total Dust	< __ mg/m^3	>__ mg/m^3 - Level C (air-purifying respirator)

*** Levels of Protection:** **Level D** (standard work clothes, basic personal protective wear, no chemical protective clothing, no respiratory protection)
Modified Level D (chemical protective clothing in addition to standard work clothes, no respiratory protection)
Level C (air purifying respirator or dust mask, in addition to chemical protective clothing)
Level B or A (air supplied respirator, chemical protective suit; fully-encapsulating suit for Level A)

Geosyntec Procedures: *HS-111-Air Monitoring*

P. RADIATION HAZARDS (Other than Sunlight) ☐ Applicable ☒ Not Applicable, Not Anticipated

PART 3 – APPROVALS, ACKNOWLEDGEMENTS

A. THA PREPARATION, REVIEW/APPROVAL SIGNATURES - THA typically prepared by project staff, reviewed/approved by Project Manager, Supervisor, qualified/knowledgeable designee, with support of HS personnel as deemed appropriate for the work and associated hazards.			
THA PREPARED BY: (minimum one person)	*Printed Name*	*Signature*	*Date*
	Zachary Tanguay		9/7/2017
THA REVIEWED/ APPROVED BY: (minimum one person)	*Printed Name*	*Signature*	*Date*
	Jonathan Gillen		9/7/2017
	Carl Elder		7 Sept 2017

>>> Please See Section B, "Field Crew Acknowledgements," on Following Page <<<

B. FIELD CREW ACKNOWLEDGEMENTS

GEOSYNTEC FIELD CREW

Please sign below to acknowledge you reviewed and understand this THA, participated in project safety briefing and had an opportunity to ask questions about the information herein.

Print Name:	Signature:	Employee No.	Date:

SUBCONTRACTOR'S FIELD CREW

Please sign below to acknowledge that this THA was made available to you, and you had an opportunity to ask questions about the information herein.

Print Name:	Signature:	Company Name:	Date:

ROUTE TO HOSPITAL

UF Health Shands Emergency Room / Trauma Center
(352) 733-0111
1515 SW Archer Rd, Gainesville, FL 32608

Written Directions to Hospital from Site:

1. Depart N Main St / CR-329 toward NE 28th Ave
2. Turn right onto SR-120
3. Turn left onto US-441 / SR-25 / NW 13th St
4. Bear right onto SR-24 W
5. Turn back on SR-24 E

Distance: 3.9 miles   Time: 11 minutes

APPENDIX B

STANDARD OPERATING GUIDELINES

Standard Operating Guidelines:

B1. SOG-001 – *Soil and Rock Boring*
B2. SOG-002 – *Tremie Grouting*
B3. SOG-003 – *Monitoring Well Development*
B4. SOG-004 – *Water Level Measurements*
B5. SOG-005 – *General Step-Drawdown Test*
B6. SOG-006 – *Visual-Manual Soil Classification (Field)*
B7. SOG-007 – *Decontamination*
B8. SOG-008 – *Investigation-Derived Waste Management*
B9. SOG-009 – *Sample Management and Documentation*
B10. SOG-010 – Visual Identification of Pine Tar

STANDARD OPERATING GUIDELINE NO. 001

SOIL AND ROCK BORING

1. INTRODUCTION

This Standard Operating Guideline (SOG) was prepared to direct field personnel in the methods for advancing borings to characterize subsurface conditions during site hydrogeological and geotechnical investigations. The SOG conforms to "A Compendium of Superfund Field Operations Methods (EPA/540/P-87/001)," and other pertinent technical publications. The lithologic log field form to be used during soil and rock boring activities is provided with this SOG.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and
- Field Sampling and Analysis Plan (FSAP), which provides details for field sampling locations and procedures and which will be most frequently used by field staff on-site.

1.1 Objective

The objective of soil and rock borings is to obtain samples for description, to characterize subsurface conditions, and obtain samples for geotechnical or chemical analyses. This objective requires the use of consistent procedures for documenting observations and collecting samples.

2. PROCEDURES

2.1 Predrilling Requirements

When conducting borings in an industrial facility, the project or field engineer/geologist must contact all utilities or industrial facility personnel necessary to receive clearance to drill at specified locations. The names of the personnel authorizing clearance will be documented. The exact location of each boring shall also be reviewed by responsible facility personnel to ensure that the area is free of the facility-owned buried utilities. Geophysical testing may be conducted on the ground surface to identify the locations of subsurface facility-specific structures (e.g., drain lines, septic tanks, etc.)

Dig-Safe, or an equivalent service, must be contacted prior to drilling in public areas. Drilling locations shall be no closer than 25 feet to overhead utilities. The appropriate utility companies shall be contacted to provide insulation of utility lines prior to commencement of drilling activities.

The supervising geologist/engineer shall record the name of the drilling firm and the names of the driller and his assistant(s). The date, project location, project number, and daily weather conditions shall be recorded as well.

An accurate time log of drilling activities shall be kept. This log shall be kept in the field logbook and shall include at a minimum, the following:

- Time driller and rig arrive on site
- Time drilling begins
- Any delays in the drilling activities and the cause of such delays
- Time drillers go off site
- Down time (those periods when drilling activities cease due to equipment malfunctions, weather, and ordered stoppages)

Soil or rock boring logs will be used to document detailed drilling observations.

2.2 Test Boring Methods

Test borings can be advanced by a variety of drilling methods. The quality of the information obtained from the various boring methods varies with the character of the subsurface geologic conditions, and careful consideration should be given in selecting the desired method. It may be necessary to employ more than one boring method to advance a particular borehole. Five common drilling techniques are: auger boring, wash boring, rotary drilling, percussion drilling, and direct push (displacement/continuous) sampling. The drilling techniques used on any particular project will be selected by the project manager and/or project geologist.

Each drilling technique is described in the following subsections:

2.2.1 Auger Borings

This method involves advancing helical solid-flight or hollow-stem augers, with large mobile equipment. This is a fast method for advancing the borehole, without the use of drilling fluid, and particularly effective for boring through partially saturated or unsaturated material above the groundwater table. Conventional sampling procedures are employed (split-spoon sampler).

Some disturbance of the natural soil is caused by the advancing augers. Auger borings are primarily used for environmental investigations because they are cost-effective and do not involve the introduction of drilling fluids and muds to the subsurface environment.

Auger borings are difficult to advance below the groundwater table in granular soils because the soils can liquefy and move up the auger stem and/or collapse against the auger flights and cause excessive friction. This condition is commonly referred to as "running sands" or "blowing sands" in the drilling industry. Running sands can be counteracted with limited success by maintaining a constant hydraulic head in hollow-stem augers during the sampling operations. However, the constant head technique is not very effective when drilling more than approximately ten ft below the water table in granular soils.

Augers are difficult, and sometimes impossible, to advance to depths of greater than thirty ft in dense tills or coarse granular deposits (such as gravel).

Solid stem augers are not recommended for environmental investigations because soil samples cannot be obtained from discrete depth intervals. Soil samples from solid stem auger borings are typically collected from the surface of the auger flights as the cuttings are brought to the ground surface.

Slotted, hollow-stem augers are commonly used in environmental investigations when vertical profiling of a water-bearing unit is desired. The slotted lead auger is advanced to a pre-determined depth below the groundwater table, and water within the auger is purged with a pump to draw "undisturbed" formation water into the auger. A sample of the groundwater is obtained for analysis and the auger is advanced to the next groundwater-sampling interval.

2.2.2 Wash Boring

This method involves advancing casing, as required, and washing-out the soil to the bottom of the casing with a chopping bit to the desired sampling depth. The casing can be advanced by either spinning or hammering (pounding) the casing with a 300-pound hammer. The borehole may be stabilized with the casing, water, or drilling mud, and open samplers, such as the split-or solid-spoon type are driven into the undisturbed soil at the bottom of the borehole.

This method is most commonly used in soils which do not contain large cobbles and boulders, or cemented horizons. The wash boring method involves the introduction of drilling water and/or drilling mud to the borehole. The use of these materials and this method should be avoided whenever possible in conducting environmental investigations. The introduction of drilling fluids can alter the chemical composition of the groundwater adjacent to the borehole, and may have an adverse effect on groundwater quality analyses on groundwater samples from monitoring wells installed in the completed borehole.

If it is necessary to use this technique to advance a borehole, the field geologist should determine the source and quality of the drilling water to be used in the boring process. The field geologist should not authorize the use of on-site or nearby groundwater or surface water bodies as the source of the drilling water, unless the proposed source has been sampled and analyzed for the full suite of contaminants considered likely to be present in the groundwater beneath the site. In all cases where drilling water or drilling mud are used to advance a borehole, the field geologist should consider obtaining a sample of the drilling fluid for potential analysis, at the discretion of the project manager and quality assurance/quality control (QA/QC) officer.

2.2.3 Rotary Drilling

This method is a variation of the wash boring technique, utilizing a rotary drill bit, rather than a chopping bit. It is employed primarily in advancing and cleaning the borehole to the required sampling depth, and is used in conjunction with air, water, or mud to bring the cuttings to the ground surface. This is the method generally preferred for exploratory test borings in the geo-technical consulting industry. This method is commonly used in environmental investigations when test borings are expected to encounter dense tills and coarse granular deposits (such as gravels), or are expected to terminate at depths exceeding 30 ft below the ground surface.

The primary disadvantage of this technique for environmental investigations is the introduction of drilling water or drilling mud. The use of air rotary drilling rigs is usually not appropriate for environmental investigations unless filters are used because the cuttings brought to the ground surface are ejected into the air adjacent to the drilling rig. Airborne contaminated soil could pose a health risk to workers at the site and nearby residents.

2.2.4 Sonic Borings

The sonic drilling system employs simultaneous high-frequency vibrational and low speed rotational motion coupled with down-pressure to advance the cutting edge of a circular drill string. This action produces a uniform borehole while providing relatively continuous undisturbed core samples of both overburden and most bedrock formations. This technique can be used to obtain large diameter (4”-12”) continuous, relatively undisturbed and very accurate core samples of almost any overburden formation. Advantages in environmental investigations include minimization of IDW, ability to penetrate dense till and debris, uniformity of borehole. Disadvantages are higher cost and potential access difficulties on irregular terrain.

2.2.5 Direct-Push Drilling

Direct-Push drilling technique consist of a hydraulic ram unit, usually mounted on a small vehicle (ATV, cargo van, or pick-up truck) that advances small diameter drill rods to obtain overburden soil or groundwater samples or install piezometers. Advantages in environmental investigations include low cost, maneuverability and access to irregular terrain, minimization of IDW. Disadvantages include depth limitations and small sample volumes.

The direct push device may employ either dual tube methodology which allows the collection of subsurface soil samples through an outer casing that is set to maintain the integrity of the boring or single-rod method that collects soil into a sleeve liner (e.g., macrocore) within the lead rod.

In the dual-tube method borings are advanced by simultaneously driving an outer stainless steel casing and inner Lexan® into the ground. Upon reaching the desired penetration depth, the inner Lexan® tube is extracted to collect the discrete subsurface soil samples, leaving the outer casing in place. To sample the next interval of soil, a new length of Lexan® tubing is then inserted into the outer casing (already in the ground) attached to a length of drive pipe, and another length of outer casing is attached to the top of the outer casing that is already in the ground.

In the single-rod method, ¾-inch diameter rods are advanced in 4-foot sections. The lead section is fitted with an inner polyethylene sleeve. When the top of the desired sampling interval is reached, a tool is used to unlock the drive point and the rod is driven ahead to obtain the soil sample. The entire drill rod is retrieved and the liner removed for characterization. The process is then repeated to collect the next desired sample.

2.3 BOREHOLE STABILIZATION

2.3.1 Hollow-Stem Augers

Hollow-stem augers are advanced hydraulically into the overburden to the required sampling depth. The auger acts as a casing during the advancement of the borehole. A removable center plug allows passage of the sampling equipment (typically a split-spoon sampler or Shelby tube) to the required depth. Augers are usually in five-ft sections. Some disturbances of the sampling zone may be created during the augering operation.

Drillers commonly dislike using the center plug and often attempt to complete the boring without using one. However, the center plug should always be used to prevent soil from entering the auger. If a center plug is not used, the split-spoon sampler may not be located at the desired sampling depth due to the presence of soil inside the auger.

2.3.2 Casing

Driving steel pipe or casing provided the most reliable and practical method of advancing a borehole to the required depth. Table 1 summarizes the numerous sizes and types of casing available. The borehole is advanced by constant blows of a drive hammer (typically 300 pounds, falling over a distance of 24 inches) upon a drive head, which is attached to the casing. As the blows to drive the casing are constant, supplementary information may be obtained in the soil resistance by counting the casing blows and the resulting penetration. Casing blows are typically recorded for each ft of penetration of the casing. The casing can also be spun and pushed to the desired depth.

The casing is driven/spun in five-ft increments, with representative soil samples being obtained on a continuous basis or at the completion of each five-ft drive (depending upon the project specifications). After the casing is seated at the required depth, the borehole must be cleaned-out prior to obtaining a soil sample. In soft or loose soils, stability of the borehole is increased by keeping the casing filled with water or drilling fluids.

2.3.3 Drilling Mud

Drilling mud is a fluid employed to stabilize an encased borehole, or to improve sample quality and minimize soil disturbance in cased holes. Drilling mud may be prepared from commercially available products. Employing mud in a boring makes identification of the cuttings more difficult and hinders groundwater level observations.

The use of drilling mud is typically avoided when conducting environmental investigations. The use of drilling mud can reduce the permeability of the walls of the borehole, and therefore, lead to erroneous water level measurements. Additionally, the use of drilling mud introduces foreign material to the subsurface environment, which is not completely removed upon completion of the boring. The results of chemical analyses conducted on soil samples from boreholes advanced with drilling mud may not be representative of the natural (undisturbed) formation. Water samples obtained from wells installed in these boreholes may contain contaminants or parameters, which were not originally present in the groundwater prior to the use of the drilling mud.

Under no circumstances, should drilling mud be prepared with local or on-site clays. If the use of drilling mud is required to advance the boring, the mud should be prepared with commercially available clays, and samples of the mud mixture should be collected for potential analysis, if needed.

The basic mud mixture employed in the drilling industry is bentonite and fresh water (approximately 6 percent bentonite by weight: 50 pounds of bentonite per 100 gallons of water). Attapulgite clay is commonly used and will mix with salt water to prevent flocculation. Weight additives such as pulverized barite, hematite, galena, or other heavy minerals may be added to the mixture to increase the specific gravity in troublesome soils or under artesian conditions. The precise ingredients and their proportions in the mixture must be recorded for future reference, particularly when groundwater from wells installed in their borings is to be tested for dissolved metals and pH. Attention must be given to the particular group of contaminants exceed to be present in the groundwater beneath the site.

2.4 BOREHOLE CLEANING AND SOIL SAMPLING

Thorough and careful cleaning of the borehole is mandatory for obtaining representative, undisturbed samples. Borehole cleaning is also performed as necessary prior to disturbed sampling to remove any excess drill cuttings that may have fallen to the bottom of the borehole during drilling. Borehole cleaning is typically performed using wash water. Careful measurement of tool length is required. The washing operation should not usually extend below the bottom of the casing (cohesive soils would be an exception). Special bits that deflect the wash water outward or upward should be employed, and only enough wash water should be pumped down the hole to bring the cuttings to the surface. Special shielded auger cleanouts should be employed in cohesive soils prior to obtaining undisturbed piston samples.

2.4.1 Standard Penetration Testing and Disturbed Sampling

Where details of subsurface conditions are necessary in situ soil testing and soil sampling shall be performed. To obtain soil samples for soil descriptions, classifications, and laboratory testing, soil sampling shall be conducted using a split-barrel (commonly called a split-spoon sampler) sampler and the Standard Penetration Test (SPT), according to ASTM D1586 – *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. Soil samples obtained from this method are considered disturbed samples. In general, this technique is conducted by the driller, and verified by the field engineer/geologist, and is performed with the following equipment and general procedure:

1. The split-spoon sampler (spoon) consists of a 2-inch (outside diameter) by1-3/8 inch (inside diameter), 18-inch to 24-inch length, heat-treated, case-hardened steel head, split-spoon, and shoe assembly. Split-spoon or split-tube samplers are the most generally accepted method for obtaining representative soil samples; however, from a geotechnical perspective, the samples obtained using a split-spoon are disturbed and unsatisfactory for some analyses. The head is vented to prevent pressure buildup during sampling and must

be kept clean. A steel ball check valve is in the head to prevent downward water pressure from acting on the sample. Removal of the check frequently causes sample loss.

2. The drive rods, which connect the spoon to the drive head, should have stiffness equal to or greater than that of the A-rod. To maintain only minimal rod deflection, on exceptionally deep holes, it may be preferable to use N-rods. The size of the drive rods must be kept constant throughout a specific exploration program, as the energy absorbed by the rods will vary with the size and weight of the rod employed. This is most important in geotechnical investigation
3. The drive head consists of a guide rod to give the drop hammer (140 pounds) free fall in order to strike the anvil attached to the lower end of the assembly. The guide rod must be at least 3.5 ft in length to insure the correct hammer drop.
4. The drop hammer used in determining SPT resistance must weigh 140 pounds and have a 2.5-inch diameter hole through the center, for passage of the drive head guide rod.
5. The hammer is raised with a rope activated by the drill rig cathead; no more than two turns of the rope should be allowed on the cathead. A 30-inch hammer drop is mandatory for proper SPT determination. Extreme care must be exercised to produce consistent results. Automatic trip hammers are commercially available which insure the 30-inch free-fall drop. When presentation of the soil structure is critical (such as in liquefaction studies), the automatic trip hammer should be employed.
6. Attach the split-spoon sampler to the drill rods and lower the assembly to the bottom of the borehole. Measure the drill rod stickup to determine if heave or blow-up of the stratum has occurred. Note any penetration of the sampler into the stratum under the weight of the rods. The 140-pound hammer is raised 30 inches above the drive-head anvil and then allowed to free fall and strike the anvil. This procedure is repeated until the sampler has penetrated the full length of the sampler (18 to 24 inches depending on the sampler) into the stratum at the bottom of the borehole.
7. The number of blows of the hammer required for each 6-inch penetration is counted and recorded on the test boring log. A penetration rate of 100 blows per ft is normally considered refusal; however, this criterion may be varied depending upon the desired information. The penetration resistance (N) is determined by adding the second and third 6-inch resistance blow counts together. When other sizes and types of sampling and drive equipment are employed, ASTM reference tables may be used in converting the obtained blow count to the accepted SPT value.
8. The sampler is then withdrawn from the borehole, preferably by pulling on the rope. If the sampler is difficult to remove from the stratum, it may be necessary to remove it by hitting the drive head upward with short, light hammer strokes. Remove the sampler from the bottom of the borehole slowly to minimize disturbance. Keep the casing full of water during the removal operation.

9. Careful measurement of all drilling tools, samplers, and casing must be exercised during all phases of the test boring operations, to insure maximum quality and recovery of the sample.
10. The split-spoon is opened and carefully examined, noting all soil characteristics, color seam, disturbance, etc. A representative sample is selected and preserved in a screw-top, glass jar and properly labeled. If more than one soil type is encountered in the split-spoon, each soil type should be preserved in a separate jar.
11. The supervising geologist/engineer shall record, at a minimum, the weight of the hammer, the length of the split spoon sampler, and the number of hammer blows on the spoon per 6 inches of penetration. Upon removal of the sampler, the earth materials shall be logged in accordance with SOG-006 – Visual-Manual Soil Classification (USCS). When the number of blow counts exceeds 50 per 6 inches, the split spoon sampling shall be terminated and the number of blow per tenths of ft (for the last one-half ft) shall be recorded and noted as sampler refusal.
12. If a sample is to be retained, a pre-cleaned stainless steel or Teflon coated spoon will be used to take the soil sample and fill the sample containers.
13. After the samples have been collected and if a well is not being installed in the boring, the backfill the borehole with a cement/bentonite grout, the approximate location of the boring will be marked with an oak stake colored with highly visible spray paint. The boring number will also be written on the stake to identify the sample location for surveying purposes.

2.4.2 Undisturbed Sampling

Undisturbed soil sampling typically involves Shelby Tubes or thin-walled Shelby Tubes, which are steel tubes pushed into the soil at the bottom of a borehole using a piston mechanism on the drill rig. Prior to undisturbed sampling, boreholes shall be cleaned carefully. The driller shall perform the sampling to minimize disturbance of the rig and Shelby Tube. The field engineer/geologist shall monitor Shelby Tube sampling, and upon receipt of the tube from the driller, label and package the sample to prevent moisture loss and disturbance. Typically, Shelby Tubes come with plastic end caps which are either sealed with duct tape or wax, which is applied when the cap is placed on either end.

3. BEDROCK CORES

Rock coring is a method to obtain bedrock samples for geologic classification, facilitate their performance of permeability tests, and install groundwater monitoring wells within bedrock formations.

3.1 Drilling Rock Cores

The supervising geologist/engineer on a drilling program is responsible for logging and recording geologic and geotechnical information from rock cores.

There is no universal core barrel or drilling equipment for rock coring. The geologic and topographic conditions, in addition to the requirements of the project will dictate the type of equipment to be employed on any specific project. The following factors lead to good production:

1. Insure a level and stable drilling platform before commencing boring.
2. Insure that the drill stem remains as nearly vertical as possible. On deep core holes, true alignment of the casing is critical. The driller may elect to use a heavy drilling mud instead of casing to support the borehole walls; this procedure is not acceptable for environmental investigations.
3. Upon encountering boring refusal at the soil/bedrock interface, the casing should be firmly seated on the rock and thoroughly washed out before inserting the diamond-bit core barrel.
4. Inspect the selected core barrel and bit for wear, general cleanliness, and free movement of all parts. Reject any core barrel or bit that appears unsatisfactory. Upon selecting a satisfactory core barrel and bit, mount the core barrel and bit assembly on the drilling rods and lower it into the borehole until the bit touches the bedrock surface.
5. Pump drill fluid down the drill rods and observe a return flow before commencing drilling operations.
6. Carefully measure all length of rods, core barrel, and stick-up through all phases of the drilling to insure accurate depth determination.
7. The diamond-bit core barrel should be started in the hole and the rock drilled in continuous five-ft length intervals (runs) until the required depth is reached.
8. Drill with minimal vertical pressure and rotation. Most rigs are equipped with a selection of gear ratios and a variable hydraulically-controlled feed mechanism. Driller expertise in selecting the correct combination of speed and feed rate is invaluable.
9. Water return should be no more than what is just sufficient to bring the borehole cuttings to the surface.
10. Record the drilling time per ft, type of bit, estimate of bit wear, drill rig rpm, and feed pressure.
11. Upon completing each 5 ft core run, the core barrel is spun and lifted to break the core at the bottom of the run. After the core is broken off it should be withdrawn, labeled, and stored in an approved core box. Cores should be carefully handled to ensure their proper identification and placement in correct order. Care should be taken to recover as large a percentage of unbroken core as possible.
12. Carefully place the rock core in the core box with wooden partitions so that the cores from each boring will be kept separate. The core should always be placed in the core box in book fashion with the top of the run at the upper left corner and the remaining core placed sequentially from left to right and from the top left corner to the lower right corner. Place a wooden partition at the beginning and end of each core run. The core

should fit snugly in the box so that it will not roll or slide and suffer additional breakage. The wooden blocks should be labeled with the Run Number and depths of the beginning and end if each run.

13. Each core box should only contain cores from a single boring. Never place the core from more than one test boring in a core box. In addition, wherever core is lost due to the presence of a cavity or large discontinuity (open or filled), a spacer should be placed in the proper position in the core box. The spacer should be labeled with the depth range and thickness of the missing core, and the reason for the missing core (e.g., cavity, large joint, etc.).
14. Carefully examine and classify the rock, and measure the recovery and RQD in percent. Record all information on the core boring report.
15. If 100% recovery was not obtained, sound the borehole to determine if the missing core still remains in the bottom of the borehole.
16. Always terminate each boring with 100% recovery, in order to insure that appropriate knowledge is available of their materials.
17. The core box should be marked on the top and two ends with the client's name, site identification, boring number, depth range, and box number.
18. The core barrel and drilling tools must be steam-cleaned or washed upon completion of the borehole to preclude cross contamination between successive boreholes.
19. Wash water used during the core drilling should not be re-circulated to the borehole, if possible.

3.1.1 Wireline Drilling

The procedures for wireline drilling are also the same as for conventional rock coring, with the exception that the core barrel is designed so that the inner core barrel can be raised in a wireline without removing the entire drill string, outer core barrel, and bit. The drilling rig must be equipped with a wireline hoist.

3.1.2 Oriented Core

If precise spatial orientation of rock bedding, foliation, and discontinuities are required, it is recommended that the Christensen Diamond Products Series D-3, NWD-3 core barrel, or equivalent, be employed.

3.1.3 Shotcore Drilling

Shotcore drilling is usually employed to produce large-diameter rock core (2 to 6 ft and larger). The core is cut by the abrasive action of chilled steel shot fed to a rotating steel bit. Shotcoring procedures are as follows:

1. Lower the assembled shotcore barrel to the bedrock surface.
2. Drop one or two handfuls of chilled shot down the center rod. Connect the bit to the drilling spindle and slowly turn by hand with a pipe wrench. A gritty feeling indicates that the shot is beneath the bit.

3. Lift the bit off the bottom and introduce the fresh water supply. When water return appears at the surface, lower the bit to the bedrock surface.
4. Drill feed must be manual with only enough downward pressure to follow the bit. This is an abrasive action and too much shot will wear the core barrel and too little will not core the rock. Driller expertise and careful attention are absolutely critical in successful shotcore drilling.
5. Regulate water flow so that it just allows the cuttings and slivers of steel to be carried over the top of the casing. Add additional shot as required.
6. A good flow of muddy slurry to the surface indicates that the rock is being drilled.
7. If water return is clear, but contains fine particles of steel, this is an indication that an excess of shot has been used. Flush the hole and start again.
8. Record the drilling rate and reface the bit shoe after every withdrawal by squaring up the face with a hammer.
9. To recover the core, a hard, uniformly-graded pea gravel is fed into the center rod as it is slowly rotated so the gravel is grouted between the core and the core barrel, and the entire unit is pulled to the surface. On occasion, it may be necessary to remove the core barrel and drill a small diameter hole in the center of the core while it is still in the hole, and then drive a casing retriever into the core before retrieval is possible.

3.2 Preservation of Bedrock Cores

The following information shall be included in a rock core run log:

- The depth and length of the core run.
- The coring rate, down pressure, and torque and rotation speed. This information can be obtained from the driller.
- The color of the core wash water. Any changes, loss of return water, or gain of return water will be noted.
- The recovery of the core run recorded as length of rock recovered over the length of the core run.
- The Rock Quality Designation (RQD) of the run. RQD is reported as the sum of inches of all naturally fractured rock core pieces larger than four inches over the total number of inches in the run. The length of the piece will be determined by the distance between naturally occurring fractures.
- The rock type(s) and their location in the core run, rotating color, mineralogy, texture, fossil content, effervescence in hydrochloric acid (HCL), and any other data of geologic significance.
- Any structure in the core, including fractures, clay seams, vugs, bedding, fissility, and any other data of geologic or geotechnical significance.

Rock cores shall be stored in a core box in the exact sequence in which they were removed from the ground. Core runs will be separated by wooden blocks clearly marked with the depth of the run. The top of the core box shall be marked with the project name, location, project number, boring number, and the depths of the core runs in that box. The front and one end of the core box shall be marked with project name, boring number, and depths of the core runs in that box. All core pieces shall be oriented in the box as they fit together. A black and white stripe shall be drawn down the length of the core, so that core orientation can easily be determined.

3.3 Logging Bedrock Cores

If soil samples are to be documented with photographs, the photographs should be taken while the soil samples are still in the split spoon. If smearing of the sample has occurred, a fresh exposure can be made by scraping with a pen knife or other similar object. The spoon and sample should be placed in a good light, preferably against a solid colored background. A ruler for scale and a tag identifying the sample should be placed in the picture. The identifier tag must have the sample number, depth and project name or number written so as to be legible in the photograph. Any photographs taken should be recorded in the field log book.

Rock core samples are photographed in the wooden core box. The rock should be wetted to enhance the color and textural changes in the rock. Due to the relatively large size of most core boxes, the photographer (when possible) should stand up on a chair, tail gate, car bumper or other perch in order to photograph the box from directly above, and get the entire box in the camera's field of view. The photograph should include a ruler for scale and an identifier tag indicating the project name and number, the boring number, the date, and the depths of the various core runs.

STANDARD OPERATING GUIDELINE NO. 002

TREMIE PIPE GROUTING

1. INTRODUCTION

This standard operating procedure provides instructions for grouting during drilling. This procedure is used for bedrock wells and wells that will require telescoping of casing. In both cases, a separate bore hole will be drilled through the unconsolidated deposits and flush joint casing will be installed through the unconsolidated deposits to the top of bedrock. The casing will be seated into the top of bedrock and grouted in place. The grouting of casing in place will require the use of a tremie pipe installation method as specified below.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and
- Field Sampling and Analysis Plan (FSAP), which provides details for field sampling locations and procedures and which will be most frequently used by field staff on-site.

1.1 Objective

The objective of tremie pipe grouting is to safely abandon a boring or monitoring well location after sampling activities or useful life is complete.

1.2 Equipment

Most equipment will be provided by the drilling contractor (e.g., grout, pumps, mixers and tremie pipe). The field engineer/geologist should have field data sheet or a notebook and calculator.

2. PROCEDURES

2.1 <u>Grouting</u>

Grouting of boreholes and monitoring wells shall be performed by the driller and observed by the field engineer/geologist. A record shall be made in the field logbook and/or daily field report regarding materials used and successful completion.

1. The diameter of the drilled hole shall be large enough to allow for a minimum of 1.5 inches of annular space on all sides of the casing for forced injection of grout through the a tremie pipe.
2. Grout is to be composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.
3. Neat cement grout shall be composed of Class A, Type I Portland Cement mixed with not more than seven gallons of clean water per bag (one cubic foot or 94 pounds) of cement with a density of 15 to 16 pounds per gallon, or to manufacturer's specifications.
4. Bentonite-cement grout shall be composed of powdered bentonite (less than 5% by weight) mixed at not more than 8 gallons of water to the bag, with a density of 14 to 15 pounds per gallon, or to manufacturer's specifications.
5. High solids sodium bentonite grout shall have a minimum of 20% solids and be mixed per manufacturer's specifications with water and/or other required additives.
6. All grouting shall be accomplished using forced injection to emplace the grout. When emplacing the grouting material, the tremie pipe shall be lowered to the bottom of the zone to be grouted. The tremie pipe shall be kept full continuously from start to finish of the grouting procedure, with the discharge end of the tremie pipe being continuously submerged in the grout until the zone to be grouted is filled.
7. Wells shall be grouted in-place within five (5) days after borehole completion.
8. The drilling inspector will calculate the volume of grout necessary to fill the casing annulus based on the borehole, casing and well diameter, and compare this volume to the amount of grout used. Additionally, the inspector will verify the amount of grout used and that it is compliant with the mixture specifications presented above. Upon completion of grout emplacement, the inspector will make a separate determination of the level to which the bore hole has been grouted. Grouted wells will be allowed to stand for a minimum of 24 hours prior to advancement of the borehole.

STANDARD OPERATING GUIDELINE NO. 003

MONITORING WELL DEVELOPMENT

1. INTRODUCTION

This standard operating guideline describes the protocol to be followed during the development of monitoring wells. As the work progresses and if warranted, appropriate revisions to this standard operating procedure may be made by the project manager. Detailed procedures in this guideline may be superseded by applicable regulatory requirements.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and
- Field Sampling and Analysis Plan (FSAP), which provides details for field sampling locations and procedures and which will be most frequently used by field staff on-site.

1.1 Objectives

The objectives of monitoring well development are to:

- Remove sediment accumulated in bottom of well during or since installation or last use;
- Consolidate the filter pack around the well screen; and
- Enhance the hydraulic connection between the target zone and the well.

These objectives serve to facilitate the gathering of adequate water quality water level data.

1.2 Equipment

The following equipment may be used during well development. Site-specific conditions may warrant addition or deletion of items from this list.

- Submersible pump, peristaltic pump, and bailer;
- Surge block;
- De-ionized water for decontamination;
- Container for purge water (drums or fractionation tank);
- Container with known volume (e.g., 5-gallon bucket) for flow estimation;
- Water level indicator;
- Stopwatch or timer;
- Clear glass jars (at least 2);
- Well Development Record form; and

- Field notebook and Pen

2. PROCEDURES

2.1 General

1. For new wells, monitoring well development shall be performed as soon as practical after well installation but not sooner than 48 hours following placement of the grout seal. Weather conditions may increase grout set time and, consequently, further delay development.
2. Development of wells shall be accomplished with a submersible pump, peristaltic pump, and/or bailer that shall preferably remain solely dedicated to that well. Bailers shall be used to develop wells only where the volume of water is so small that other development methods are clearly inappropriate. Pumps used for well development shall be periodically raised and allowed to drain back into the hole to induce flow out through the well screen.
3. A surge block may be used to flush the filter pack of fine sediment in instances where field personnel expect that development may be improved by surging. Surging will be conducted slowly to reduce disruption to the filter pack and screen. Following surging, the well will be pumped or bailed again to remove sediment drawn in by the surging process until suspended sediment is reduced to acceptable levels (see below). Water shall not be added to the well to aid in development.
4. Small-diameter wells shall be developed with an inertial pump to remove silt and fine sand that enter through screen slots immediately following well installation. Pumping shall continue from the screened interval until a volume of water equal to or greater than three saturated well volumes has been purged.
5. A well is considered fully developed when all the following criteria are met:
    a. the well water is clear to the unaided eye (based on observations of water clarity through a clear glass jar);
    b. the sediment thickness remaining in the well is less than one percent of the screen length; and
    c. the total volume of water removed from the well equals five times the standing water volume in the well (including the well screen and casing plus saturated annulus, assuming 30 percent porosity) plus the volume of drilling fluid lost.
6. These criteria may be modified with approval by the field manager. Should the recharge to the well be so slow that the required volume cannot be removed in 2 to 3 consecutive hours, if the water remains discolored, or excess sediment remains after the five-volume removal, the project team shall terminate purging and/or discuss other options for improving water quality. Limited development may be specified when gross contamination is observed (e.g., the presence of NAPL).

7. The cap and all internal components of the well casing above the water table shall be rinsed with deionized water to remove all traces of soil, sediment, and cuttings. This washing shall be conducted before and/or during development.
8. Non-dedicated pumps shall be decontaminated prior to use in the next well and dedicated tubing and/or bailers shall be used during subsequent sample collection from the well. Development fluids (i.e., investigation derived waste, or IDW) shall be handled as described in the PDI Work Plan.

2.2 Documentation

The following data shall be recorded for development:

- well designation;
- date of well installation;
- date of development;
- static water level before and after development;
- quantity of drilling fluid lost during drilling;
- quantity of standing water in well and annulus (30-percent porosity of saturated annulus assumed for calculation) prior to development;
- depth from top of well casing to bottom of well;
- screen length;
- depth from top of well casing to top of sediment inside well, before and after development;
- physical character of removed water, including changes during development in clarity, color, particulates, and odor;
- type and size/capacity of pump and/or bailer used;
- height of well casing above/below ground surface;
- typical pumping rate;
- estimate of recharge rate; and
- quantity of water removed and time for removal.

This information shall be documented on a Well Development Record.

STANDARD OPERATING GUIDELINE NO. 004

WATER LEVEL MEASUREMENTS

1. INTRODUCTION

This standard operating guideline was prepared to direct field personnel in the methods for conducting water level measurements in monitoring wells during field investigations at hazardous and non-hazardous waste sites.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and
- Field Sampling and Analysis Plan (FSAP), which provides details for field sampling locations and procedures and which will be most frequently used by field staff on-site.

1.1 <u>Objectives</u>

The objective of water level measurements is to record accurate measurements (to within 0.01 ft precision) of the depth of ground water for use during well installation, in the recording of data for the preparation of ground water elevation contour maps, purge volume calculations during ground water sampling, slug tests, packer tests, or pump tests.

1.2 <u>Equipment</u>

The following equipment may be used during water level measurements. Site-specific conditions may warrant addition or deletion of items from this list.

- Electronic water level indicators – graduated;
- Tap Water;
- Alconox, liquinox or other non-phosphate concentrated laboratory grade soap;
- Deionized Water;
- Pump Sprayer;
- Pint Squeeze bottles;
- Required PPE;
- Air Monitoring instruments as required (PID or FID as specified in HASP);
- Field logbook and pen;
- Well keys;
- Previous measurement data (if available);

- Oil/water interface probe (if necessary);
- Engineers Rule; and
- Plumb bob on tape

2. PROCEDURES

2.1 General

The following procedures shall be followed to obtain water level measurements; however procedures may vary depending on the equipment used and contaminants present at the site.

Site specific conditions may warrant the use of stringent air monitoring and potentially more significant decontamination scenarios.

1. Record the condition of the well (protective casing, concrete collar, lock in place etc.).
2. Check that the water level tape has no obvious kinks or damage.
3. Put on latex or other sterile gloves. Stand upwind of the well; unlock and open the well. If a vented cap is present, conduct well mouth air monitoring from the vent. If a non-vented well cap is present, remove the cap and monitor the well mouth immediately. Record all pertinent air monitoring results (sustained, dissipating, background, odor).
4. Identify the previous measuring point marking or notch on the riser or casing (if present). Record this location in the field logbook or on the water level monitoring form.
5. Using a previously decontaminated water level indicator, turn on the meter, check the audible indicator, reel the electronic probe into the well riser (with the increments visible) slowly until the meter sounds, grasp the tape with hand, withdraw the tape and lower it again slowly until the sound is again audible. Check the depth to water on the tape and make a mental note of the depth to within .01 feet. Lower the probe again slowly and repeat the measurement for accuracy. A one-foot error is the most common measurement type during water level measurements. Be sure to read the depth correctly on the tape.
6. Record the depth to water from the measuring point in the field logbook or on the water level monitoring form.
7. Procedures utilized during water level measurements where free phase petroleum products are floating on the water table should be modified to include the use of the oil/water interface probe. The procedures during the use of this probe should be implemented similarly and by manufacturers' specifications. Through the use of this probe, product thickness can be determined.
8. Decontaminate the probe and any obviously soiled tape.

STANDARD OPERATING GUIDELINE NO. 005

GENERAL STEP-DRAWDOWN TEST PROCEDURES

1. INTRODUCTION

This standard operating guideline was prepared to direct field personnel in the methods and general procedures for conducting step-drawdown pumping tests (step-drawdown test) in monitoring wells.

A step-drawdown test is comparable to a constant-rate test except that the pumping rate is systematically increased in a series of several steps of approximately equal duration. The basic requirement is to maintain constant-discharge during each step and obtaining frequent water-level measurements in the pumping well and observation wells (if applicable). Although a step test is often used to determine well yield, a step test may be used to determine the hydraulic conductivity of an aquifer as an alternative to slug testing. A step test may be performed as a series of steps (i.e., incrementally increasing pumping rates) or be performed using only a single step (i.e., a constant pumping rate). A step test performed using a single well can be used to determine hydraulic conductivity using time-drawdown or recovery data [i.e. method of Jacob (Cooper and Jacob, 1946)], which are not affected by well-losses.

Generally, step-drawdown tests are conducted during a single day with each pumping step consisting of a 1-hour to 2-hour period. Consistent time intervals permit easy comparison of the drawdown data. It is desirable, but not critical, that the water level in the pumping well be allowed to recover to its static condition after the last step to collect additional data.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and

1.1 Objectives

The objectives of step-tests include identifying aquifer properties of recharge, drawdown, storage, transmissivity/hydraulic conductivity, specific and sustained yield, and aquifer boundaries.

1.2 Equipment

The following equipment may be used during water level measurements. Site-specific conditions may warrant addition or deletion of items from this list.

- Field logbook or pump test log and pen
- Water level indicators
- Pressure transducer(s)

- Data logging equipment
- Field printer
- Lap-top computer
- Duct tape and zip ties
- Alconox, liquinox, or other non-phosphate concentrated laboratory grade soap;
- Deionized Water;
- Submersible pump with flow regulator and foot valve, and tubing
- Generator
- Heavy duty extension cords
- Polyethylene sheeting
- Large capacity barrels (alternately holding tanks);
- Required PPE;
- Portable radios or mobile phone (for health and safety)
- Well completion logs
- Well keys
- Flow meter/graduated bucket
- Stopwatch

2. PROCEDURES

2.1 General

The following general procedures should be used for conducting step-tests. Alterations of these general procedures may be necessary to accommodate site-specific conditions and data requirements. For example, site-specific conditions may warrant the use of air monitoring and potentially more significant decontamination scenarios. Such modifications are not expected for the Cabot site.

1. Determine the appropriate lengths of transducer cables based the well diameter and depth. Determine the appropriate pressure-rated transducer based on water depth and the number of logging channels needed. Determine the required pump hosing length, pump capacity and type, minimum and maximum anticipated pumping rates. Identify the test control location and create a pre-test schematic of where the wells are, depth of transducer and pump settings, where the water will be discharged or containerized, and how the test can be implemented efficiently before going into the field.
2. Conduct decontamination of all downhole step-test equipment.
3. Following any required air/explosion monitoring at the well head, open the well and measure water levels in all the wells to be monitored during the test. Record the water

levels in the logbook or on the pump test log. If possible, it is recommended that the water levels be monitored for a period prior to the test, for instance by installing a transducer in well a day or more prior to initiating the test, to identify any trends of rising or falling water levels due to nearby supply wells, tidal influence or surface water bodies.

4. Collect manual measurements of the water level (i.e., using water level indicator) in the test well before and after setting the transducer. These data will be used to corroborate transducer data.

5. Set and secure the pump in the pumping well at the planned depth and allow for stabilization of the displaced water level caused by its insertion. The generator, if used to power the pump, should be filled with gasoline at a remote down-wind location and extension cord run to this location. Record the pump depth in the logbook or on the pump test log. Monitor the water level in the pumping well to ensure that static levels are attained.

6. Secure the transducers with zip-ties and/or tape in the desired wells at the planned depths as identified in the pre-test schematic. Set all transducers in the wells for a minimum of two hours to allow for adaptation to ground water temperature and cable stretch. The transducer in the pumping well should be set above the pump. Run all the transducer cables to the test control location and connect them to the data logger in the desired channel(s), or for logging transducers establish convenient access to the cable connection. Record the transducer depths in the logbook or on the pump test log.

7. While the transducers are becoming stable, programming of the data logger for each channel should be completed with the specific parameters for each transducer. Scale factors, linearity, offset, well ID, reference level, and type of reading (surface or top of casing) should be selected. These parameters are specific to each transducer and data logger and are usually clearly identified on the wheel and cable for each transducer.

8. The data logger should be programmed to collect readings at the desired interval(s) for the entire duration of the test including recovery. The test should be programmed to allow for logging of water levels during the drawdown and recovery stages using the logarithmic option recommended with most data loggers. The actual log scale can also be modified to suit the needs of the test if desired. The data logger should be programmed to start prior to initiation of pumping the well. Record the programmed duration in the logbook or on the pump test log.

9. Once the test equipment is ready, the entries, well IDs, and parameters for each channel should then be double checked for accuracy. The connections to all channels should be checked by communication with each individual transducer.

10. The startup of the pump should be synchronized with the logging of water level data. The rate of pumping should be set at the desired rate. The rate should be stabilized as quickly as possible to promote accurate data analysis. Direct the discharge to the appropriate containers, if required, or to a location outside of the anticipated cone of influence for the well. The pumping rate should be measured and recorded routinely during initial pumping to confirm that the rate is stable. All adjustments to the rate

should be recorded. Record the actual start time and pumping rate of the test in the logbook or on the pump test log.

11. Monitor the channels of the data logger to read the transducers. Look for drawdown in the pumping well to confirm operation. Monitor the transducers in the observation wells to confirm their operation. Manual measurement of the water levels should be performed periodically to confirm the accuracy of the transducer data.
12. Step-testing will yield quick drawdown in the pumping well followed by asymptotic drawdown as the head in the well stabilized to the pumping increment. It is desirable to continue each step of the test until near stable head is observed in the pumping well. As mentioned earlier, this is typically 1 to 2 hours per step, but discretion should be used in the field to determine when a given step has completed. At the completion of a step, the pumping rate should be increased to the next step. If possible, logging of heads on a logarithmic interval should be repeated at the start of each step. Repeat steps 10 through 12 for all steps of the test.
13. After the last step, shut down the pump while continuing to record the time and water level in the pumping well to gather data during well recovery. If time permits, collecting data until there is recovery to 90 percent of the initial static levels is desired. If logging transducers are used, these can be left in wells overnight (or longer if needed) to collect the recovery data.
14. Once the test is completed, remove, and decontaminate all downhole equipment.

This SOG does not address data analysis. However, data analysis performed by a hydrogeologists is recommended and frequently performed using once of several data analysis programs such as AQTESOLV.

STANDARD OPERATING GUIDELINE NO. 006

VISUAL-MANUAL SOIL CLASSIFICATION (FIELD)

1. INTRODUCTION

This Standard Operating Guideline was prepared to direct field personnel in the method for describing soil samples in test pits, soil borings, and soil grab samples. This SOG conforms to ASTM D2488-09a – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)* and other pertinent technical publications.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and
- Field Sampling and Analysis Plan (FSAP), which provides details for field sampling locations and procedures and which will be most frequently used by field staff on-site.

1.1 Objectives

The objective of soil sample description is to provide consistent geological information useful for hydrogeological or geotechnical evaluation of a site. The Visual-Manual Procedure generally utilizes the Unified Soil Classification System (USCS) method of classification.

1.2 Equipment

The following equipment may be used during water level measurements. Site-specific conditions may warrant addition or deletion of items from this list.

- Soil classification/sand grading chart;
- Field logbook and/or field data sheet, relevant boring log forms, pen;
- Pocket knife, spoon, or spatula;
- Folding ruler, yardstick, or tape measure;
- Portable table;
- Polyethylene sheeting or plywood board;
- Magnifying glass;
- De-ionized water in a squeeze bottle;
- Required PPE;
- Duct tape; and
- Nitrile gloves

2. PROCEDURES

2.1 General

The general description of a soil sample should be in the following order:

1. color;
2. density;
3. moisture content;
4. geologic modifiers or classifications;
5. major constituent – capitalized;
6. minor constituent(s); and
7. geologic description (in parentheses).

Example: Tan, loose, wet, stratified, medium SAND, little fine sand, trace coarse sand, trace silt (Till).

Before beginning, ensure that PPE has been donned and air monitoring is being performed per the HASP. When logging a soil sample collected from a split spoon where more than one soil type is present, describe each one separately, using additional line(s) on the boring log form. Start the description from the top of the split spoon, and log each change in stratigraphy in sequence to the bottom of the spoon. Provide an interval or length (i.e., 0- 0.5 ft.:) at the beginning of each separate sequence description, followed by a colon. Draw a line below the bottom of the complete sample description.

2.2 Color

The main color value should be stated, along with an appropriate modifier. Examples include: light brown, dark brown, reddish brown, and brown. The presence of mottling should be included in the description, where present.

Example: Gray, slightly mottled, dense, damp, poorly sorted angular fine to medium SAND, some silt, trace angular coarse sand, trace clay (lodgement glacial till).

2.3 Density

In borings, density should be based on the sum of the middle two 6-inch blow counts of a two-ft split spoon or the last two 6-inch blow counts of an 18-inch split spoon. Professional judgement should be used when applying the density modifier. If high blow counts are due to the presence of a cobble, boulder or large piece of gravel that impedes forward progress of the split spoon, density should be based upon the character of the material in the split spoon, if any, or omitted from the description. A notation should be made in the sample description when this situation occurs. Appropriate modifiers are described in the following table.

Granular Soils		Cohesive Soils	
Blows/ft	**Density**	**Blows/ft**	**Density**
0-4	Very Loose	< 2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Medium Stiff
30-50	Dense	8-15	Stiff
> 50	Very Dense	15-30	Very Stiff
-	-	> 30	Hard

In test pits, density is subjective and should be based upon the ease of excavation. The above adjectives for granular and cohesive soils should be used in the description.

2.4 Moisture Content

Moisture content should be described using the following modifiers:

- dry - no moisture;
- damp- very slight moisture content, no visible water droplets;
- moist - very slight moisture content, soils will not stick together;
- wet - enough moisture for soils to stick together; or
- saturated - water dripping from sample; soils below the water table.

2.5 Geologic Modifiers

Sedimentological descriptions aid in the geologic classification of a soil material. Only insert geologic modifiers when present.

Stratification: Note the presence and thickness of alternating layers of non-cohesive materials of different grain sizes and/or color with layers at least 6 mm thick.

Lamination or Varves: Note the presence and thickness of alternating very thin layers of fine materials or color, such as silt and clay, with layers less than 6 mm thick.

Sorting: A geological term used to describe how close in size the grains in a sample are to each other. For example, a well sorted (i.e., poorly graded) sample contains grains of similar size; a poorly sorted (i.e., well graded) sample contains grains of many sizes.

Angularity or Rounding: Geological terms that are used to describe the general appearance of visible grains in the soil sample. Useful in determining the origin and depositional environment of a material. Water transported materials may be rounded. Glacial tills will be more angular. The following terms describe differing degrees of angularity:

- angular – particles have sharp edges and relatively plane sides with unpolished surfaces;

- subangular – particles are similar to angular description but have rounded edges;
- subrounded – particles have nearly plane sides but have well-rounded corners and edges; and
- rounded – particles have smoothly curved sides and no edges.

Shape: A term used to describe the shape of gravel, cobbles, and boulders. Terms are as follows where the particle shape shall be described where the length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle:

- flat – particles with width/thickness > 3;
- elongated – particles with length/width > 3; or
- flat and elongated – particles meet criteria for both flat and elongated.

Odor: Describe the odor if organic or unusual. Soils containing a significant amount of organic material have a distinct odor of decaying vegetation. Always utilize appropriate breathing zone air monitoring equipment as specified in the site-specific HASP.

Cementation: Describe the cementation of intact coarse-grained soils as follows:

- weak – crumbles or breaks with handling or little finger pressure;
- moderate – crumbles or breaks with considerable finger pressure; or
- strong – will not crumble or break with finger pressure.

Identification of Peat: A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor. When present the sample shall be designated as highly organic soil.

2.6 Major/ Minor Constituents

Grain-size Scales: Grain size classification should be based on an accepted classification system, such as the Unified System. The predominate grain size should be listed in the soil description in all capital letters, selected from the following:

- boulder: 300 mm ~ 12 inches;
- cobble: 75 - 300 mm ~3-12 inches;
- coarse gravel: 19 - 75 mm ~¾ to 3 inches;
- fine gravel: 4.75 - 19 mm ~¼ to ¾ inch;
- coarse sand: 2.0 - 4.75 mm ~0.01 to ¼ inch;
- medium sand: 0.425 - 2.0 mm ~0.01 to 0.1 inch;
- fine sand: 0.075 - 0.425 mm ~0.003 to 0.01 inch;
- silt: 0.002 - 0.075 mm ~0.0001 to 0.003 inch; or
- clay: <0.002 mm ~<0.0001 inch.

Proportions: For geologic description, proportions of grain sizes will be based upon the following nomenclature:

- trace: 0-10%;
- little: 10-20%;
- some: 20-35%; or
- and: 35-50%.

The major soil sample constituent is always capitalized and listed first. Minor constituents also include ancillary materials, such as mica flakes, dark minerals, or naturally occurring organic matter, such as humus, peat, or other vegetative material.

Geologic Description: Where possible based on existing site data, local research, or geologic understanding of the local region, include a geologic description of the sample. Examples include till, fluvial, glaciofluvial, fill material, or Lowell Formation. Do not utilize geologic description if not certain.

FIELD REFERENCE SOIL CLASSIFICATION

GRADATION	DESCRIPTION	EXAMPLES
Well-graded	Full range and even distribution of grain sizes present	Silty, sandy GRAVEL
Poorly-graded	Narrow range of grain sizes present	Fine to medium SAND, trace of silt
Uniformly -graded	Consists predominantly of one grain size	Fine SAND
Gap-graded	Within the range of grain sizes present, one or more sizes are missing	Silty, medium to coarse SAND

CLASSIFICATION OF ICE IN FROZEN SOIL

VISIBLE / NON-VISIBLE	NATURE OF ICE		CLASSIFICATION
Segregated Ice is Not Visible by Eye	Friable, poorly-bonded material is easily broken up		Nf
	Well-bonded, soil particles strongly held together by ice	Excess ice	Nbe
		No excess ice	Nbn
Segregated Ice is Visible by Eye	Individual ice crystals (record size)		Vx
	Ice coatings on soil particles		Vc
	Stratified or distinctly oriented ice formations (determine thickness and orientation)		Vs
	Random or irregularly oriented ice formations (determine size and shape)		Vr

Dual Symbols

(symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND) are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbols

(symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND) indicate that the soil may fall into one of two possible basic groups.

ASTM D 2488 TABLES

TABLE 8 Criteria for Describing Dry Strength

DESCRIPTION	CRITERIA
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

TABLE 9 Criteria for Describing Dilatancy

DESCRIPTION	CRITERIA
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

TABLE 10 Criteria for Describing Toughness

DESCRIPTION	CRITERIA
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

TABLE 11 Criteria for Describing Plasticity

DESCRIPTION	CRITERIA
Nonplastic	A 1/8-in. (3mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

TABLE 2 Criteria for Describing Particle Shape

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

DESCRIPTION	CRITERIA
Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and Elongated	Particles meet criteria for both flat and elongated

TABLE 4 Criteria for Describing the Reaction with HCl

DESCRIPTION	CRITERIA
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

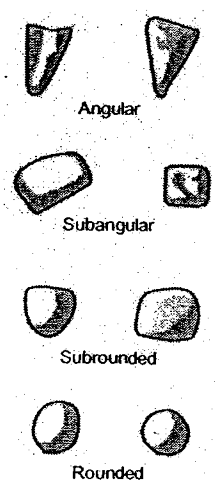
TABLE 6 Criteria for Describing Cementation

DESCRIPTION	CRITERIA
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

SOIL SYMBOL	DRY STRENGTH	DILATANCY	TOUGHNESS
ML	None to Low	Slow to Rapid	Low or Thread Cannot be Formed
CL	Medium to High	None to Slow	Medium
MH	Low to Medium	None to Slow	Low to Medium
CH	High to Very High	None	High

GRAIN SHAPE



SPT SPECS (From ASTM D 1586-84)

140-lb hammer, 30-inch freefall

Cathead: 6 to 10-inch diameter, 2-1/4 rope turns, ≥ 100 rpm, mechanical OK

Sampler: 24-inch long, shoe ID = 1.375 inches, barrel ID = 1.5 inches, OD = 2.0 inches

Count blows for each of four 6-inch increments
Refusal: 100 blows for 6 inches or less, 75 blows for <1 inches

Standard Penetration Resistance = "N-Value" = blows for middle 12 inches

FIELD REFERENCE SOIL CLASSIFICATION

ORDER OF CLASSIFICATION TERMS

Relative density or consistency,
color,
slightly (5 to 12%),
minor constituents (12 to 50%),
MAJOR constituent (>50%),
trace constituents (0 to 5%),
moisture content,
structure, plasticity, gradation, grain shape, min., cementation, organics, odor, other,
(Geologic Name: Fill, Till, Alluvium, etc.)
USCS group symbol.

EXAMPLES

Very dense, light brown, slightly silty, sandy fine GRAVEL, trace of cobbles; moist; scattered roots; (Weathered Till) GP-GM.

Medium stiff, dark gray, silty CLAY, trace of fine sand; moist; laminated (< 2mm) with light gray silt, occasional slickensides; (Glaciolacustrine) CL.

Medium dense, dark brown, sandy SILT, trace of clay; wet; numerous organics and strong organic odor; (Marsh Deposits) ML.

Loose and soft, mottled black and green, silty SAND and clayey SILT; moist; hydrocarbon sheen and faint hydrocarbon odor; (Fill) SM/ML.

TERM	GRAIN SIZE	EXAMPLES
Boulders	> 12"	> Basketball
Cobbles	3" to 12"	Fist to basketball
Gravel-coarse	3/4" to 3"	Thumb to fist
Gravel-fine	#4 to 3/4"	Pea to thumb
Sand-coarse	#10 to #4 (5 mm)	Rock salt to peat
Sand-medium	#40 to #10 (2 mm)	Sugar to rock salt
Sand-fine	#200 to #40 (0.4 mm)	Flour to sugar
Fines	< #200 (0.08 mm)	Grains not visible

MOISTURE CONTENT

Dry	Dusty, dry to the touch
Moist	Damp but no visible water near optimum
Wet	Visible free water, saturated, over optimum

RELATIVE DENSITY OF COARSE-GRAINED (COHESIONLESS) SOILS
(Cohesionless Silt, Sand, and Gravel)

N. SPT, BLOWS/FT	RELATIVE DENSITY	FIELD TEST FOR RELATIVE DENSITY OF SAND
0 to 4	Very loose	Easily penetrated with 1/2" reinforcing rod pushed by hand
4 to 10	Loose	Easily penetrated with 1/2" reinforcing rod pushed by hand
10 to 30	Medium dense	Penetrated one foot with 1/2" reinforcing rod driven with 5-lb hammer
30 to 50	Dense	Penetrated one foot with 1/2" reinforcing rod driven with 5-lb hammer
Over 50	Very dense	Penetrated only a few inches with 1/2" reinf. rod driven with 5-lb hammer

RELATIVE CONSISTENCY OF FINE-GRAINED (COHESIVE) SOILS
(Cohesive Silt, Clayey Silt, and Clay)

N. SPT, BLOWS/FT	RELATIVE CONSISTENCY	TORVANE, tsf SHEAR STR.	POC. PEN., tsf UNCONF. STR.	MANUAL PENETRATION TEST
< 2	Very soft	< 0.13	< 0.25	Easy several inches by fist
2 to 4	Soft	0.13 to 0.25	0.25 to 0.5	Easy several inches by thumb
4 to 8	Medium stiff	0.25 to 0.5	0.5 to 1	Moderate several inches by thumb
8 to15	Stiff	0.5 to 1	1 to 2	Readily indented by thumb
15 to 30	Very stiff	1 to 2	2 to 4	Readily indented by thumbnail
Over 30	Hard	> 2	> 4	Difficulty by thumbnail

STRUCTURE

TERM	THICKNESS
Parting	0 to 1/16"
Seam	1/16 to 1/2"
Layer	> 1/2"
Lamination	< 6 mm, < 1/4"
Pocket	Irregular, < 1 foot
Varved	Alternating seams or lam.
Occasional	< 1 per foot
Frequent	≥ 1 per foot

DESCRIPTION	CRITERIA, LIST THICKNESS
Stratified	Alternating layers
Interbedded	Alternating layers > 1/2"
Laminated	Alt. layers < 6 mm thick
Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, striated fractured planes
Blocky, Diced	Easily breaks into small angular lumps
Lensed	Small pockets of diff. soils
Homogenous	Same color and appearance throughout
Sheared	Disturbed texture, mix of strengths

ORGANIC CONTENT

ADJECTIVE	PERCENT BY VOLUME
Occasional	0 to 1
Scattered	1 to 10
Numerous	10 to 30
Organic	30 to 50, minor constituent
PEAT	50 to 100, MAJOR const.

Describe type and size of organic debris.

UNIFIED SOIL CLASSIFICATION SYSTEM
(From ASTM D-2488 & 2487-90)

MAJOR DIVISIONS			GROUP SYMBOL	TYPICAL DESCRIPTION
Coarse-Grained Soils (more than 50% retained on No. 200 sieve) [Use Dual Symbols for 5 to 12% Fines (i.e. GP-GM)]	Gravels (more than 50% of coarse fraction retained on No.4 sieve)	Clean Gravels (less than 5% fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures
		Gravels with Fines (more than 12% fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sands (50% or more of coarse fraction passes the No. 4 sieve)	Clean Sands (less than 5% fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		Sands with Fines (more than 12% fines)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
Fine-Grained Soils (50% or more passes the No. 200 sieve)	Silts and Clays (liquid limit less than 50)	Inorganic	ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		Organic	OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays (liquid limit 50 or more)	Inorganic	CH	Inorganic Clays of Medium to High Plasticity, Sandy Fat Clay, Gravelly Fat Clay
			MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sands or Silty Soils, Elastic Silt
		Organic	OH	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		PT	Peat, Humus, Swamp Soils with High Organic Content (See D 4427-92)

File: J:\Support library\Field and Lab Forms\Rock Log Keys and Field Reference\SOIL FIELD REFERENCE (2 pgs).dwg Date: 06-13-2006 Author: SAC

STANDARD OPERATING GUIDELINE NO. 007

DECONTAMINATION

1. INTRODUCTION

This Standard Operating Guideline was prepared to direct field personnel and/or subcontractors on the methods for decontamination of field equipment at sites with hazardous and potentially hazardous waste. Subcontractors are responsible for decontamination of their own equipment. This SOG is specific to a site impacted by volatile and semi-volatile organic compounds.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and

1.1 <u>Objectives</u>

The objective of equipment decontamination is to remove potential contaminants from a sampling device or item of field equipment prior to, between, and/or after collection of samples for laboratory analysis or after field testing. These procedures limit personnel exposure to residual contamination that may be present on field equipment and avoids cross-contamination that among other things can cause erroneous sample results.

1.2 <u>Equipment</u>

The following equipment may be utilized when decontaminating equipment. Site-specific conditions may warrant the use or deletion of items from this list. Subcontractors (i.e., drillers) are responsible for their own decontamination equipment, unless otherwise directed by the Project Manager.

- Alconox, liquinox or other non-phosphate concentrated laboratory grade soap;
- Deionized water and/or tap water;
- Pump sprayer;
- Paper towel
- Two scrub brush (coarse or wire);
- Aluminum foil and/or paper towels;
- Polyethylene sheeting;
- Minimum of four 5-gallon plastic buckets with lids
- Required PPE;
- Extra quantities of above listed liquids.

Because of the size and nature of drilling equipment, drillers may opt to decontaminate equipment using power washers and/or steam cleaners. This equipment is acceptable and use of them follows similar guidelines as provided herein for decontamination by hand.

2. PROCEDURES

2.1 General

The following procedures should be used for decontaminating field equipment. Procedures will vary with equipment used and potential contaminants present at the site.

Field personnel (i.e., field engineer/geologist) shall not perform decontamination on subcontractor equipment. Field personnel shall coordinate with the subcontractor regarding decontamination expectations, monitor subcontractor decontamination activities, and record the successful completion or any notable deficiencies in the field logbook.

2.2 Procedure for Soil Sampling and Pumping Equipment

Reusable equipment (e.g., pumps, split spoon samplers, spoons, etc.) that comes in direct contact with the sample will be decontaminated according to the procedures below. The field engineer/geologist must use the following procedure prior to collecting the first sample, between samples, and after the final sample.

1. Set up a decontamination area. The decontamination area should progress from “dirty” to “clean”, with an area for drying decontaminated equipment if needed. The decontamination line should be set up on polyethylene sheeting or a similar barrier.
2. Wash the item thoroughly in a bucket of soapy water (tap water). Use a stiff-bristle brush to dislodge any clinging dirt. Disassemble any items that might trap contaminants internally before washing. Do not reassemble until decontamination is complete.
3. Rinse the item in a bucket containing tap water. Rinse water should be replaced as needed.
4. Wash the equipment/pump with a solution of Alconox and potable water. Do not use the same bush between the first and second wash of equipment.
5. Flush and rinse equipment with tap water.
6. Document that decontamination was performed in the appropriate logbook or sample sheet.

Decontamination water will be managed in accordance with the investigation derived waste (IDW) plan in the PDI Work Plan.

2.3 Procedure for Oversized Equipment

Oversized equipment, such as augers, shovels, etc. will be cleaned, by the drilling subcontractor, using the following procedure.

1. The drilling contractor will construct a decontamination area, if required, at a designated area on site of 6-mil polyethylene, large enough to capture decontamination fluids. Decontamination of drilling equipment will be performed over the decontamination pad,

or depending on site contaminants, equipment may be decontaminated at each exploration location and decontamination fluids allowed to infiltrate back into the ground.

2. Drill rigs and tools will be cleaned between each location and prior to the initiation of any sampling.
3. Remove larger chunks/clods of dirt from the equipment using a shove, brush or paper towels.
4. Spray all sides/surfaces of the tooling with a high-pressure sprayer (i.e., power washer) to remove all dirt and staining. If necessary, a small amount of soap can be added; if soap is used, tooling will need to undergo a rinse spray to remove the soap.
5. Document that decontamination was performed by the driller in the appropriate log book or sample sheet. For augers and other down-hole tooling, confirm that all parts are disassembled during cleaning and that there is no residual dirt or staining on the equipment after decontamination.
6. For equipment decontamination (e.g., drill rig or backhoe), spray areas (rear of rig or backhoe) exposed to contaminated soils using high pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.

STANDARD OPERATING GUIDELINE NO. 008

INVESTIGATION DERIVED WASTE MANAGEMENT

1. INTRODUCTION

This Standard Operating Guideline (SOG) was prepared to direct field personnel on the methods for removing and disposing investigation derived waste (IDW) generated during the PDI activities. IDW generated may include:

- Soils;
- Groundwater;
- Sediments;
- Debris;
- Other materials:
  - Used personal protective equipment (PPE);
  - Disposable sampling equipment; and
  - Plastic sheeting, containers, etc.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and

1.1 Objectives

The objective of IDW management is to limit the exposure of field personnel (i.e., field crews, subcontrators, etc.) to potentially hazardous materials from the investigation, and to prevent the introduction of contaminated materials to uncontaminated environmental media on or off the Site.

This SOG does not apply to laboratory samples. Laboratories who handle samples for testing shall manage spent or unused samples in accordance with their laboratory-established procedures.

1.2 Equipment

Equipment for IDW management may include steel drums and plastic trash bags. In some cases, IDW management may use roll-off containers for soils or fractionation tanks for water. Other equipment related to IDW management is discussed in the decontamination SOG.

2. PROCEDURES

2.1 General

All IDW identified as potentially contaminated with hazardous materials will be stored in a designated and clearly marked IDW management area. The location of the IDW management area will be selected by the field engineer in consultation with contractors, the client and other project personnel. The IDW management, if possible, should be in a location that is conveniently near the work location (but not in the way) and away from areas potentially accessible to the public (e.g., not adjacent to sidewalks). It is strongly recommended that the IDW management area be accessible to trucks to allow for future pick-up of wastes.

All IDW containers (e.g., drums of trash bags) will also be clearly labeled to indicate the source of the IDW. The IDW storage area will be inspected daily to ensure that storage procedures are being followed. Any violations of these procedures will be documented and remedied as quickly as possible. Potentially contaminated IDW will be identified based on its origin, olfactory and visual evidence, and field screening results. Laboratory testing may be required to determine the proper disposition of these IDW.

Procedures will vary with equipment used and potential contaminants present at the site. The field engineer/geologist shall record information related to packaging the IDW, and disposal of IDW in the field logbook.

2.2 Soil

Waste soils will be generated as drill cuttings, test pit spoils, and excess sample material. The required testing and handling of these IDWs will depend on their origin and characteristics.

Drill cuttings from borings will be placed into a drum or on polyethylene sheeting near the boring location. After drilling is completed, cuttings will be transferred into drums (or a roll-off if the volume is appropriate) and moved to the IDW staging area **daily**. At a later time and after characteristics of the IDW are known, IDW soils will then be shipped off site by a licensed waste hauler to an approved disposal facility. In some cases, IDW may remain on-site to be placed within a containment cell and/or beneath the cap.

Soil IDW will be staged in the site in the IDW management area until the conclusion of the investigation program.

2.3 Groundwater

Groundwater will be generated during drilling, well development, pumping tests, and well purging and sampling. Groundwater will be contained in drums and/or tanks. Groundwater, except for purge water generated during sampling, will be containerized into 55-gallon drums. Drums will be labeled when first used and moved to the IDW storage area **daily**. IDW water will be sampled and tested, as needed, prior to disposal as described in section 3.

For off-site disposal, testing will be for site contaminants of concern unless otherwise instructed by the disposal facility.

2.4 Debris

Debris from PDI activities is not anticipated; however, if encountered the debris will be assessed by the field engineer/geologist and Project Manager to determine the appropriate disposal method. Debris is likely to remain on-site (stick, logs, brush) or be discarded as general refuse (i.e., trash).

2.5 Other Materials

Personal protective equipment will be placed into plastic bags and discarded as refuse/trash.

Disposables such plastic sheeting, caution tape, sampling containers, and other disposable equipment will also be placed into plastic bags for disposal as trash unless contamination is extensive (e.g., NAPL staining). If contamination is extensive on these items, then these items will be decontaminated according to SOG-007 and then discarded as trash.

Trash will be discarded accordingly such as into an on-site dumpster.

3. DISPOSAL

IDW soil and groundwater will be staged in the IDW management area until the conclusion of the investigation. The exception is IDW water that, in some cases, may be discharged directly into the on-site surficial aquifer treatment works.

3.1 Soil

Soils will be disposed of at Clark Environmental (Clark) for thermal treatment and recycling unless specified differently by Cabot. At the conclusion of the investigation program, soil IDW will tested for waste characterization according to Clark's requirements. Waste characterization samples will be collected by Geosyntec at a frequency of one sample per 500 cubic yards of material unless specified otherwise by Clark. Drums to sample will be selected with a bias toward drums with higher contaminant concentrations.

Clark will be provided with waste characterization results, and will then prepare manifests for the soil IDW. Clark, or their subcontracted waste hauler, will pick-up drummed soil IDW at the site under supervision of a Geosyntec field engineer/geologist. Waste manifests will either be signed in advance by an authorized Cabot representative or by Geosyntec as an Agent for Cabot.

3.2 Groundwater and Rinse Water

Groundwater IDW will be disposed of according to different protocols depending on its origin.

- Water from well development will be placed into drums and moved to the IDW management area. Drums will then be tested and then shipped off-site for disposal.
- Groundwater from the surficial aquifer (e.g., from the step test) will be discharged either directly or in batches into them lift station of the surficial aquifer remedy.
- Groundwater from the Hawthorn aquifer (i.e., from step testing at HG-28D) will be discharged either directly or in batches into them lift station of the surficial aquifer remedy **if approved by GRU based on results of VOC and SVOC analysis.** If GRU will not accept water from the Hawthorn aquifer, then Hawthorn Group water will containerized for off-site disposal by Clark.

- Rinse water from decontamination will be containerized, staged in the IDW management area, tested and transported off-site for disposal.

Water to be transported off-site for disposal shall be sampled at a frequency of 1 sample per 1000 gallons of water. Samples will be analyzed for VOCs and SVOCs by methods 624 and 625, and metals by method 300. More frequent sampling and/or analysis of other parameters will be performed if requested by the waste disposal facility. **Clark should be contacted prior to IDW sampling to discuss disposal and sampling needs.**

Clark will be provided with waste characterization results, and will then prepare manifests for the IDW. Clark, or their subcontracted waste hauler, will pick-up IDW at the site under supervision of a Geosyntec field engineer/geologist. Waste manifests will either be signed in advance by an authorized Cabot representative or by Geosyntec as an Agent for Cabot.

NON-CLASSIFIED WASTE MATERIAL

LABORATORY ANALYSIS IN PROGRESS

CAUTION: THE CONTENTS OF THIS CONTAINER HAVE NOT BEEN CLASSIFIED AND MUST BE MANAGED WITH CAUTION UNTIL CLASSIFIED AND THEN MANAGED ACCORDINGLY. DO NOT OPEN OR MOVE WITHOUT PRIOR APPROVAL FROM GENERATOR/CONTRACTOR. CONTENTS MAY BE HARMFUL TO HUMAN HEALTH OR THE ENVIRONMENT.

MATERIAL: ______________________________

SITE ADDRESS: ______________________________

____

____

ACCUMULATION DATE: ______________________________

GENERATOR: ______________________________

GENERATOR CONTACT & PHONE: ______________________________

CONTRACTOR CONTACT & PHONE: ______________________________

____

____

NOTE: THIS CONTAINER CANNOT BE SHIPPED UNTIL CLASSIFICATION IS COMPLETE AND CONTAINER IS APPROPRIATELY MARKED AND LABELED

STANDARD OPERATING GUIDELINE NO. 009

SAMPLE MANAGEMENT AND DOCUMENTATION

1. INTRODUCTION

This Standard Operating Guideline (SOG) was prepared to direct field personnel on the methods for preparing samples for shipping and any required documentation/labeing required for transfer of custody and shipping:

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and

1.1 Objectives

The objective of sample management and documentation is to provide consistent sample nomenclature and procedures for labeling, sample storage and preservation, shipping, and chain-of-custody forms.

1.2 Equipment

The following equipment is needed for containerizing samples of soil and groundwater. Site-specific conditions may warrant the use or deletion of items from this list.

- 1-gallon resealable bags;
- 5-gallon plastic buckets with re-sealable lids;
- Analytical Laboratory sample jars/containers;
- Stainless-steel or plastic spoons/scoops;
- Nitrile gloves;
- "Sharpie"-style pen;
- Field logbook or field data sheets and pen;
- Laboratory chain(s) of custody forms.

2. PROCEDURES

2.1 General

Containers can be obtained from a local supply store by the field engineer/geologist. Sample containers for environmental analysis (i.e., soil and groundwater analyses at Test America) shall be obtained from the laboratory. Sample tools shall be used to collect soil samples from split spoons; these can be reusable such as stainless-steel spoons or disposable such as plastic spoons.

Samples shall be placed in containers in accordance with the PDI Work Plan. In general, each split spoon sample is placed in an individual 1-gallon resealable bag and sealed. Composite samples will be placed in either 1-gallon resealable bags or in 5-gallon plastic buckets after the soil composite is made. Each sample will be labeled and either stored or shipped to a testing laboratory.

Environmental samples shall be collected directly into a sample container (for water) or placed into a container (for soil). Procedures will vary with equipment used and potential contaminants present at the site. Sample collection approaches will be at the discretion of the field engineer/geologist.

2.2 Sample Nomenclature and Labeling

The field engineer/geologist shall label all sample containers (i.e., 5-gallon buckets, Shelby Tubes, resealable bags, etc.) with the following information:

- Sample Location;
- Sample Date;
- Sample Depth interval (for discrete, split spoon samples);
- Composite sample indicator (e.g., "C" for "composite sample")
- Field engineer/geologist initials;
- Project title and/or project number.

A convenient way to include this information on each soil sample label is to use the following sample nomenclature:

Sample Name = "Boring Location ID" – "Date" – "depth interval" or "composite sample"

Example 1: "VBW-01-10-20-2017-0-2" represents a discrete soil sample taken at boring location VBW-01, on 10/20/2017, at a depth interval of 0-2 ft bgs.

Example 2: "SPD-01-11-02-2017-C" represents a composite soil sample "C", taken at boring location SPD-01, on 11/2/2017.

Groundwater samples do not require the use of a depth interval or composite sample indicator in the sample name, however groundwater samples should be labeled in numerical sequential order. Thus, a sample from a well may have an identification such as HG-28S-11-02-2017-## (where ## = 01, 02, 03,…,##).

2.3 Sample Storage and Preservation

The field engineer/geologist shall seal the soil or groundwater samples in resealable containers that prevent loss of moisture or sample volume. For environmental soil and groundwater samples, samples will be sealed into laboratory-provided containers. The field engineer/geologist shall ensure all containers are properly sealed before storage and shipping.

The field engineer/geologist will seal soil samples obtained, but not sent for laboratory testing, until the completion of the proposed laboratory testing and evaluation of laboratory results. These samples can be stored on-site in a secure location to be determined.

2.4 Shipping and Chain of Custody Forms

The field engineer/geologist shall prepare samples for shipping as necessary to preserve the integrity of the sample during transportation. Disturbed samples shall be sealed, labeled, and if needed, placed in a shipping container (i.e., box, cooler, bucket) to prevent damage. Undisturbed samples (i.e., Shelby Tubes) shall be sealed and packaged in a box or rack with bubble-wrap or other protective packaging material, and stored vertically (i.e., tube in the orientation it was removed from the borehole). Sample labels should be checked for clarity, and re-labeled if needed. Sample identification/names shall match those on Chains of Custody.

A chain of custody shall accompany each shipment of samples. For guidance on filling out a chain of custody for analytical laboratories, reference the QAPP. Minimum information recorded on the chain-of-custody record will include:

- client/project name;
- project location;
- airbill number as applicable;
- sample identification number/name;
- sampling date and time;
- type of sample (discrete or composite);
- identification of sample collector and his/her affiliation;
- sample container number, size, and material;
- sample description (matrix);
- analyses to be performed (e.g., the ASTM standard or EPA method number):
  - This must include any specific testing parameters required for the testing. For example, for consolidation testing, the load-increment and or time-increment may be specified.
- The date which the field engineer/geologist relinquished the samples and chain of custody to:
  - the shipping company or courier; or
  - the laboratory staff receiving the sample.

The chain of custody shall be signed by the individual relinquishing the samples, and the individual receiving the samples, for all transactions (including the shipping company, and laboratory). The field engineer/geologist shall maintain a copy for the project records. A template chain of custody is attached for analytical laboratory testing, and for geotechnical laboratory testing.

SOIL CHAIN OF CUSTODY AND TEST REQUEST

CLIENT NAME:	Geosyntec Consultants
PROJECT NO:	BR0227, Phase 52
PROJECT MANAGER:	Steve Poirier
DATE:	
PROJECT OR SITE NAME:	Cabot Corporation Site - Gainesville, FL
FIELD ENGINEER/GEOLOGIST:	
SEND RESULTS TO:	
Jonathan Gillen	jgillen@geosyntec.com
Steven Poirier	spoirier@geosyntec.com

CLIENT ADDRESS:	289 Great Road, Suite 202
CITY, STATE, ZIP:	Acton, MA 01720
PROJECT MANAGER CONTACT:	978-263-9588
TESTING LABORATORY:	
WORK ORDER/PO NUMBER:	
REQUESTED TURNAROUND:	3 to 5 days

Geosyntec consultants

SOIL			Particle Size Analysis[1]: ASTM D 422	Atterberg Limits: ASTM D4318	USCS Classification: ASTM D2487	Density: ASTM D 2937 - Drive Cylinder	Unit Weight: ASTM D 7263	Moisture Content: ASTM D2216	Organic Content: ASTM D2974	pH: ASTM D4972	Standard Proctor: ASTM D698	Modified Proctor: ASTM D1557	California Bearing Ratio: ASTM D1883	Direct Shear[2]: ASTM D3080	Triaxial Shear UU[2] - ASTM D 2850	Triaxial Shear CU[2] - ASTM D4767	Triaxial Shear CD[2] - ASTM D7181	Incremental Consolidation[2]: ASTM D2435	Permeability Flexible Wall - ASTM D5084	Permeability Fixed Wall - ASTM D2434
Sample ID	**Location ID**	**Depth**																		

Notes: 1. Specify if only sieve, or sieve and hydrometer tests are to be performed.
2. Specify load conditions (i.e., consolidation stresses), strain rates (if applicable), permeant liquid, or other relevant test conditions for Triaxial and Direct Shear testing.
3. Specify load increments and load increment durations for Incremental Consolidation Testing.

Test Conditions:

Test Requested By:

SIGNATURE: ______________________ **PRINT NAME:** ______________________ **DATE:** __________

Signatures

		SAMPLE CONDITION NOTES:
Relinquished by: ____________	**Received by:** ____________	
Date: ____________	**Date:** ____________	
Time: ____________	**Time:** ____________	
Relinquished by: ____________	**Received by:** ____________	
Date: ____________	**Date:** ____________	
Time: ____________	**Time:** ____________	
Relinquished by: ____________	**Received by:** ____________	
Date: ____________	**Date:** ____________	
Time: ____________	**Time:** ____________	

Page: ________________ of ________________
Project #: _____BR0227 | PHASE 52_____
Quote #: ______________________________
COC Number [1]: ______________________
PO Number:

Chain of Custody and Analytical Request

Geosyntec consultants

Client Name: Geosyntec Consultants Phone #: 978 263 9588

Project/Site Name: Cabot Corporation Site - Gainesville, FL Fax #:978 263 9594

Address: 289 Great Road, Suite 202, Acton, MA 01720

Collected by: Send Results To:

Sample Analysis Requested [5] (Fill in the number of containers for each test)

Sample ID	Date Collected **(mm-dd-yy)**	Time Collected **(Military) (hhmm)**	QC Code [2]	Field Filtered [3]	Sample Matrix [4]	Should this sample be considered: Radioactive	Should this sample be considered: TSCA Regulated	Total number of containers											<-- Preservative Type (6) / **Comments** Note: extra sample is required for sample specific QC

TAT Requested: Normal: ______ Rush: ______ Specify: ______ (Subject to Surcharge) Fax Results: Yes / No Circle Deliverable: C of A / QC Summary / Level 1 / Level 2 / Level 3 / Level 4

Remarks: *Are there any known hazards applicable to these samples? If so, please list the hazards*

Chain of Custody Signatures		**Sample Shipping and Delivery Details**	
Relinquished By (Signed) Date Time	Received by (signed) Date Time	GEL PM:	
1	1	Method of Shipment:	Date Shipped:
2	2	Airbill #:	
3	3	Airbill #:	

1.) Chain of Custody Number = Client Determined
2.) QC Codes: **N** = Normal Sample, **TB** = Trip Blank, **FD** = Field Duplicate, **EB** = Equipment Blank, **MS** = Matrix Spike Sample, M**SD** = Matrix Spike Duplicate Sample, **G** = Grab, **C** = Composite
3.) Field Filtered: For liquid matrices, indicate with a **- Y -** for yes the sample was field filtered or **- N -** for sample was not field filtered.
4.) Matrix Codes: **DW** = Drinking Water, **GW** = Groundwater, **SW** = Surface Water, **WW** = Waste Water, **W** = Water, **SO** = Soil, **SD** = Sediment, **SL** = Sludge, **SS** = Solid Waste, **O** = Oil, **F** = Filter, **P** = Wipe, **U** = Urine, **F** = Fecal, **N** = Nasa
5.) Sample Analysis Requested: Analytical method requested (i.e. **8260B**, **6010B/7470A**) and number of containers provided for each (i.e. *8260B* - **3**, *6010B/7470A* - **1**).
6.) Preservative Type: **HA** = Hydrochloric Acid, **NI** = Nitric Acid, **SH** = Sodium Hydroxide, **SA** = Sulfuric Acid, **AA** = Ascorbic Acid, **HX** = Hexane, **ST** = Sodium Thiosulfate, If **no preservative** is added = leave field blank

For Lab Receiving Use Only
Custody Seal Intact?
YES NO
Cooler Temp:
________ *C*

WHITE = LABORATORY **YELLOW = FILE** **PINK = CLIENT**

STANDARD OPERATING GUIDELINE NO. 010

VISUAL IDENTIFICATION OF MOBILE DNAPL (PINE TAR)

1. INTRODUCTION

This Standard Operating Guideline (SOG) was prepared to direct field personnel on the methods for visual identification of pooled pine tar (i.e., mobile DNAPL), and accordingly determine if it is prudent to advance the soil boring deeper or relocate the boring to a "step-out" location. Pooled pine tar can be mobilized in the subsurface by stresses, such as a steep hydraulic gradient, and can also serve as an ongoing source of dissolved phase groundwater contamination. Consequently, the goal is to place the vertical barrier wall such that it encircles areas of mobile DNAPL, to the extent practicable in the field.

This SOG will be implemented in accordance with the following governing documents:

- PDI Work Plan, which provides an overview of the site background and conceptual model and describes the overall goals and scope of work;
- Health and Safety Plan (HASP) and relevant Task Hazard Analyses (THAs), which identify physical, chemical, and biological hazards relevant to each field task and provides hazard mitigation techniques to address these hazards; and

1.1 Objectives

The objective of visual identification of pine tar is to understand whether or not the proposed alignment of the vertical barrier wall is likely to encircle or intercept pine tar-saturated soils. The decision to advance the borings into the Upper Hawthorn Group (UHG) formation may be contingent on the absence of evidence of pooled pine tar within the surficial aquifer.

1.2 Equipment

The following equipment is needed for containerizing samples of soil and groundwater. Site-specific conditions may warrant the use or deletion of items from this list.

- nitrile gloves;
- aluminum foil or plastic sheeting
- camera;
- field logbook or field data sheets and pen;

2. PROCEDURES

2.1 General

The field engineer/geologist will assess the presence of pooled pine tar at a boring location by evaluating split spoon soil samples and auger cuttings using visual inspection of soil. Note, to-date such conditions have only been observed at a few locations at the Site. No pooled pine tar has been observed in the Upper Hawthorn to-date at the Site.

2.2 Visual Inspection of Soils

The field engineer/geologist will ensure each split spoon and all soil cuttings retrieved from the subsurface during drilling are inspected for visual evidence of pine tar. When mobile DNAPL is present in the subsurface, the DNAPL can saturate between 30 to 80% of pore space in soils (Kueper and Davies, 2009). Therefore, when a split spoon that has penetrated an area of pooled pine tar is retrieved, pooled pine tar may be seen flowing from the spoon. In addition, when the split spoon sampler is opened, any mobile DNAPL will typically flow since it is filling a significant portion of the sample's pore space. Consequently, pooled pine tar will be confirmed if: a) mobile DNAPL is observed flowing from the split spoon upon retrieval; or b) mobile DNAPL is observed to be flowing out of pore spaces when the split spoon sampler is opened. Pine tar is a dark colored and highly viscous material with characteristic pine oil odors, and the native soils range in color from beige to brown (surficial aquifer) to grey (UHG formation); therefore, the pine tar is expected to be identifiable in split spoon samples and auger cuttings.