418096

VOLUNTARY CLEANUP CONTRACT
REMEDIAL INVESTIGATION WORKPLAN
SEPTEMBER 2014

RECEIVED
SEP 26 2014
SITE ASSESSMENT,
REMEDIATION &
REVITALIZATION

WOVEN ELECTRONICS CORPORATION
1001 OLD STAGE ROAD
SIMPSONVILLE, SOUTH CAROLINA 29681

VCC #13-6203-RP
BLWM TECHNICAL FILE #418096

PREPARED FOR:

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SEPTEMBER 23, 2014

(8)

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1.0 INTRODUCTION

This Remedial Investigation (RI) Workplan was prepared by BE Aerospace, Inc. ("BEA") and CRB Geological & Environmental Services, Inc. (CRB) for the Woven Electronics Corporation (WEC) facility located at 1001 Old Stage Road, in Simpsonville, Greenville County, South Carolina (the "Site"). This Workplan was prepared in accordance with the requirements of the Voluntary Cleanup Contract (VCC), signed May 19, 2014, and specifically as required in an August 18, 2004 letter from the South Carolina Department of Health & Environmental Control (SCDHEC).

The purpose of the RI is to further delineate the nature and extent of contamination; to assess potential human health and ecological risks; and to obtain the necessary site data to evaluate remedial action alternatives in a Remedial Investigation / Feasibility Study (RI/FS) report to follow. This Workplan describes the technical approach and sampling methods that will be followed during the RI.

This Workplan has been prepared in general accordance with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and the RI will be implemented in accordance with the U.S. Environmental Protection Agency (USEPA) guidance including EPA Region 4 Sampling Methods and guidance provided under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The RI Workplan is organized into six (6) sections. Figures and tables are included after the report text. Section 1.0 is the introduction and includes the purpose and format of the report and provides a summary of previous investigations. The Conceptual Site Model (CSM) and current site conditions are summarized in Section 2.0. Section 3.0 presents the RI technical implementation; the Sampling & Analysis Plan; Data Quality Objectives (DQO) and a tentative implementation schedule. Section 4.0 describes the Field Sampling Plan and which referenced in this Workplan. The Appendix includes copies of recent regulatory documents; sampling method references and a summary of the groundwater Target Analyte Lists (TALs).

1.1 SITE INVESTIGATION HISTORY

A Phase I Environmental Site Assessment was performed at the Site in September 2010 as part of the acquisition of Woven Electronics by BEA. The Phase I identified the past use of chlorinated solvents as an environmental concern.

A soil gas survey performed in March 2011 identified relatively low concentrations of tetrachloroethene (PCE), 1,1,2-trichloroflouromethane (TCFM) and related solvents following BEA's acquisition of the business and property in September 2010. No sources of PCE or TCFM were identified at the Site at the time of the 2010 Phase I or later investigations. The soil gas concentrations were elevated beneath the building slab, and suggested a possible release area beneath the western building addition. No areas of exterior soil contamination or recent surface spill areas were identified through the soil gas survey.

A groundwater assessment performed in November 2012 identified concentrations of PCE at concentrations above the Maximum Contaminant Level (MCL) for groundwater in South Carolina. The sampling results were reported to SCDHEC in a letter report dated November 28, 2012. The primary Contaminant of Concern (COC) was identified as PCE, with concentrations up to 400 ug/L measured in

boundary well MW-6. Concentrations of 1,1-dichloroethene (11-DCE) and 1,1-dichloroethane (11-DCA) slightly exceeded the MCL in two (2) monitoring wells.

Concentrations of 1,1,2-trichloroflouromethane (TCFM, aka Freon 112) were measured in initial groundwater samples in 2012 at concentrations up to 1,100 ug/L in boundary well MW-6 and 65 ug/L in sub-slab groundwater at MW-10. USEPA has not published an MCL for TCMF. The target groundwater concentration for the June 2013 Vapor Intrusion Screening Level (VISL) was 770 ug/L for commercial scenarios.

An Initial Monitoring Report (IMR) dated January 17, 2013 was submitted to SCDHEC in which groundwater concentrations were further delineated horizontally and vertically in January. The groundwater concentrations of PCE extended southwest from an unknown source beneath the west end of the building towards a groundwater discharge zone near a perennial creek at the southwest Site property boundary. Concentrations of target compounds were delineated in the saprolitic water bearing zone, and no detectable concentrations were measured in bedrock monitoring wells.

A Conceptual Site Model (CSM) was submitted to SCDHEC in a report dated June 10, 2014 CSM. The monitoring wells were most recently sampled during May 2014 as part of the CSM submittal. As of June 2014, concentrations decreased across the Site in most monitoring wells, and groundwater elevations increased by over 10-feet in some wells as a result of higher precipitation and recharge during 2013 and 2014. The maximum PCE concentration as of June 2014 decreased from 480 ug/L to 185 ug/L in MW-6.

2.0 CONCEPTUAL SITE MODEL

The Site is located in an industrial area northwest of Simpsonville, South Carolina and the property was one parcel 16.4-acre parcel identified by the Greenville County Property Assessor as Parcel Number 0303000100300. A Site Location Map using the Mauldin, SC USGS topographic base map is included as Figure 1. The Site was developed from vacant land in 1961, and has been used for weaving and electronics manufacturing processes since that time. The area surrounding the facility is characterized by industrial or manufacturing facilities and vacant, undeveloped land as shown in Figure 2.

2.1 CURRENT USE OF THE SITE & SURROUNDING PROPERTIES

The Site is occupied by Woven Electronics Corporation, Inc., and utilized as an electronics manufacturing assembly and weaving facility. Several acres of the Site remain undeveloped as landscaped areas in the northeastern side of the Site.

The site was developed circa 1963 from vacant land. The main development of the site is a 100,000-square foot brick and slab manufacturing building with administrative offices, and work areas for assembly, machining, weaving, and testing. The building has undergone additions and expansion of the interior space since the 1980s. The property boundary includes a narrow strip to the southwest which was formerly used as an easement for the wastewater discharge pipe for the original wastewater drainage system. A Site Map showing sampling locations and the property boundary is included as Figure 3.

The Site was bordered to the north and west by a 22-acre undeveloped, wooded parcel which was listed as being owned by Cooper Old Stage LLC. Warehouses and office buildings were present beyond Old Stage Road along the northern and eastern border of the Site in an upgradient direction. The Cryovac/Sealed Air Corporation manufacturing facility was located south and east of the Site beyond several acres of undeveloped, wooded land. Sandlapper Concrete Products was present beyond the wooded area northwest of the Site. Further to the west and adjacent to the Site's sewer easement terminus, was the Kemet Corporation manufacturing plant.

2.2 HYDROGEOLOGY

Figure 1 is based on the 7.5-minute "Mauldin, SC" United States Geological Survey (USGS) topographic map of the Site and surrounding area. As depicted on the topographic map, the Site slopes predominantly to the southwest. The ground surface slopes to the northwest along the northern property boundary. The watershed drainage is generally to the southwest towards the headwater tributaries of Rocky Creek. The elevation of the Site is approximately 900 feet above sea level sloping southwest to an elevation of 820-feet along the creek.

Regional geology and hydrogeology was determined from maps and publications produced by the South Carolina Geologic Survey (SCGS) and the USGS. Site-specific hydrogeology was determined through monitoring well installation observations, groundwater elevation measurements and aquifer test data collected during the site investigation.

2.2.1 Regional Geology

The Site lies within the Paris Mountain thrust sheet (Horton and McConnell, 1991) of the Inner Piedmont belt of the Piedmont Physiographic Province of South Carolina which is characterized by surficial topography of rolling hills from 400 to 1,000 feet above mean sea level (msl). The geology in the vicinity of the site was comprised of residuum, saprolite, transition zone, gneiss and schist. Based on a review of the Mauldin, SC Quadrangle Geologic Map, the uppermost rock unit is a weathered metamorphic biotite gneiss which undulates with an underlying sillimanite schist through Greenville County.

Geology at the Site is comprised of surficial fill material underlain by native saprolite and partially weathered bedrock in a thin transition zone, and competent gneissic bedrock. Fill material covers most of the Site to a depth of 2 to 3 feet below land surface (bls) and was characterized as sandy clay loam. Surficial soils near the site are clay rich silty saprolite & residuum of weathered gneiss or schist bedrock with low to moderate permeability. The slope of surface soils follows erosion channels to nearby creeks or drainage basins. The soil is normally red to brown iron rich sandy to clayey silt below a thin organic surface.

Up to 60-feet of native saprolite was measured in the monitoring wells followed by a weathered bedrock transition zone above competent bedrock. Competent bedrock was encountered at depths near 60-feet in monitoring wells near the western building wall. Regionally, the saprolitic soil typically extends to a depth of up to 100-feet to contact with the underlying fractured metamorphic bedrock. An undulating bedrock surface in the vicinity of the Site was evident from surface observations and drilling observations.

Regional faults and structure were evaluated based on public geological maps published by the South Carolina Department of Natural Resources (SCDNR) and the SCGS. The Site was situated north of the Six-Mile thrust plate which extends from the northeast to southwest across Greenville County and the upstate region of South Carolina. No mapped faults or shear zones were identified near the Site.

2.2.2 Hydrogeology

Regional hydrogeology is part of the Piedmont and Mountains Groundwater System, comprised of the Piedmont Plateau and the Appalachian Mountains. The regolith, or unconsolidated rock layer stores groundwater in a water table aquifer that discharges to regional streams. The Piedmont Groundwater System is characterized by a shallow water table and low hydraulic conductivity. The direction of groundwater flow is variable depending primarily on the topography of the specific area. Regional groundwater flow in the vicinity of the Site trends to the southwest in the watershed drainage of Rocky Creek and the Saluda River.

The shallow groundwater table was identified in saprolitic layers above metamorphic bedrock. Saprolite is derived from physical and chemical weathering of the underlying parent bedrock. The predominant parent rock types are granitic gneiss and mica schist. Saprolite has a variable thickness across the Site. Saprolite is generally friable and grades at depth into bedrock across an area referred to as the transition zone. In general, surficial saprolitic soils are clay-rich due to greater weathering and become coarser grained and more permeable with depth.

The groundwater at the Site is found in an upper water bearing zone in the saprolite, and a deep water bearing zone in the fractured bedrock. Groundwater depths from the surface ranged from 10 to 22 feet

bls and were consistent with a recharge area northeast of the building, and a groundwater discharge to surface water west of the building along the southern property boundary near the creek. A diagram of groundwater elevation contours and a groundwater flow diagram is presented in Figure 4.

2.2.3 Aquifer Properties

Aquifer properties were evaluated as party of the CSM and hydraulic conductivity in the saprolite ranges from 0.1 to 10 ft/day. Hydraulic conductivity was measured at 4.8 to 5.2 ft/day in the lower saprolite intersected by MW-2 and MW-3, and was estimated to be less than 0.1 ft/day in the upper bedrock beneath the building near MW-1. Porosity was estimated based on typical conditions for silty, sandy saprolite to be between 20-30%.

The horizontal hydraulic gradient varied across the Site. From the upgradient well MW-12 southwest over a distance of 1,035 feet to the creek discharge well MW-9, the observed gradient in 2014 and 2013 was 0.027 and 0.020, respectively. Based on an average gradient of 0.025, and an estimated range of hydraulic conductivity from 1 to 5 ft per day, the calculated linear groundwater flow velocity across the Site ranged from 126 to 150 feet per year. Discrete areas of lower and higher groundwater flow are expected based on variability in the saprolite permeability.

2.3 CONTAMINATION ASSESSMENT

Contamination from an unknown release of PCE was discovered during sub-slab soil vapor sampling during March 2011. A subsequent groundwater assessment was performed from November 2012 through January 2013 which included the installation of fifteen (15) monitoring wells at the Site.

2.4 SOIL GAS ASSESSMENT

Soil gas was assessed across the Site using passive soil gas sampling devices and through direct measurements of soil vapor using field instruments. The soil gas analytical results identified relatively low concentrations of PCE and TCFM in an isolated area near the western end of the building.

2.5 GROUNDWATER ASSESSMENT

Fifteen (15) groundwater monitoring wells were installed at the Site during November 2012 and January 2013 and were sampled for volatile organic compounds (VOCs) by EPA Method 8260. The total depths of the well screens were selected to encounter shallow groundwater above the bedrock surface which ranged from thirty-one (31) feet to seventy (70) feet below ground.

2.5.1 Groundwater Flow

Prior to each sampling event, groundwater elevation surveys were performed using an electronic water level indicator. A survey of well casing elevations was performed relative to an arbitrary on-site benchmark in order to determine relative groundwater elevation across the Site. The surface water stage elevation of the creek stage was estimated based on survey measurements and the Greenville County topographic map data. The groundwater surface slopes southwest from an upgradient recharge zone which begins northeast of Old Stage Road. The slope of the groundwater surface reflects the general topography of the Site. The groundwater elevation is nearly 30-feet higher along Old Stage Road compared to the elevation of the creek and in downgradient well MW-15. From the western end of the

building the direction of groundwater flow turns more southerly towards the creek headwaters along the southern property boundary.

No significant fractures were encountered in the upper ten feet of bedrock and upward vertical gradient was measured between shallow/bedrock pair MW-4 and MW-11D during 2013 and 2014. The absence of bedrock contamination was consistent with the low bedrock few fractures, and the measured upward hydraulic gradient which recharges groundwater from the bedrock into the overlying saprolite.

A horizontal hydraulic gradient of 0.27 was measured across the length of the Site from upgradient well MW-12 to creek discharge well MW-9. A higher localized gradient up to 0.10 was measured in the area west of the building between wells MW-4 and MW-6. Average linear groundwater flow velocity across the site was estimated between a low range of 30 feet per year in the deep saprolite and over 200 feet per year in localized zones west of the building.

2.5.2 Groundwater Concentrations

Groundwater analytical results identified concentrations of PCE from below detectable levels (BDL) to a maximum of 480 ug/L measured in MW-6 during January 2013. PCE was identified as the primary Constituent of Concern (COC) for the Site. A diagram of PCE concentrations in groundwater is shown as Figure 5.

As of May 2014, the PCE concentration in MW-6 decreased to 185 ug/L, and PCE concentrations decreased in most wells from 2013 through 2014. The concentration of PCE increased in MW-10 from 120 ug/L in November 2012 to 172 ug/L in May 2014. The significant decrease in downgradient well concentrations are probably attributed to dilution and source material resaturation, respectively. The dilution and resaturation effects are consistent with higher groundwater elevations as a result of abundant regional precipitation during 2013.

Relatively low concentrations of cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethane (11-DCA) were measured in two (2) monitoring wells. No other chlorinated ethenes were detected, including trichloroethene and vinyl chloride. Concentrations of TCFM were reported in boundary well MW-6 at 1,100 ug/L, and 64 ug/L in the sub-slab well MW-10.

2.6 SOURCE EVALUATION

The concentrations of PCE in groundwater at the Site were attributed to an unknown past release, and the distribution of groundwater concentrations within the plume is consistent with a limited release which occurred prior to 1997 based on the groundwater plume geometry and distribution characteristics. PCE has not been used since BEA's acquisition of the Site, and no evidence of PCE use or PCE containing waste was evident since the time of the property acquisition in 2010. The relatively low concentrations of PCE in groundwater do not appear to constitute an immediate health-risk to on-site workers.

A potential source area for PCE was identified near MW-10 within the building footprint as suggested by soil gas and groundwater concentration delineation. The area near MW-10 corresponded to the original western building entrance and loading dock. The maximum PCE concentration this area was measured at 172 ug/L in MW-10 during May 2014. PCE concentrations extended from beneath the building to the southwest in the direction of groundwater flow. Near the building, the groundwater

plume was defined by BDL concentrations to the north and south in MW-1 and MW-3, and no significant soil vapor concentrations were measured beyond the building footprint.

The presence of PCE in MW-6 downgradient and at concentrations higher than the suspected source area was indicative of a one-time release and resulting migration over several years. The travel time required to distribute low PCE concentrations to MW-15 more than 800-feet from the building is consistent with a release outside of the former exterior building wall prior to 1997, which is when the area near MW-10 was covered during an expansion of the facility.

2.6.1 Groundwater Plume Delineation

Concentrations of PCE extended southwest from MW-10 approximately 900-feet where groundwater was expected to discharge to surface water as baseflow into a perennial creek along the southern property boundary. The downgradient PCE concentration of 11.6 ug/L was measured in MW-9 and 7.7 ug/L in MW-15.

The PCE plume was defined horizontally by MW-12 in the upgradient direction; by MW-3 and MW-8 to the south; MW-1 to the north; MW-13 and MW-15 to the west. The southwest boundary of the plume was defined generally by the creek and by MW-8, MW-9 and MW-15. The plume was defined vertically by deep saprolite well MW-1 and bedrock well MW-11D, which is consistent with the upward hydraulic gradient measured between MW-4 and MW-11D.

Groundwater parameters measured during purging documented generally aerobic conditions which was consistent with the absence of significant degradation compounds such as trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride.

2.7 EXPOSURE PATHWAY EVALUATION

The evaluation of potential exposure pathways considered for on-site and off-site locations and included soil vapor intrusion associated with the groundwater plume, downgradient water supply wells, and surface water bodies within one-half (½) mile of the Site. No public or private drinking water supplies were identified within 1,500-feet of the Site.

2.7.1 Migration Pathways

No shallow natural or manmade migration pathways were identified during the site assessment. A utility drainage survey and review of groundwater flow patterns at the Site were conducted to evaluate potential migration pathways. No stormwater conduit or catch basin structures were identified in the western area of the Site which would be expected to act as a migration pathway.

2.7.2 Direct Exposure

Direct exposure to PCE concentrations in soil or groundwater was not identified as a complete exposure pathway. The results of the soil gas assessment did not indicate shallow soil contamination beyond the building perimeter, and no obvious soil contamination was observed during the installation of fifteen (15) monitoring wells at the Site. The groundwater analytical results were consistent with a potential source area located under the western building slab, in which case exposure to contaminated soil is unlikely. Consideration should be given to the subsurface construction scenario in order to manage possible contaminated soil.

2.7.3 Water Supply Evaluation

A public water supply connection was confirmed at the Site, and no on-site water supply wells were identified in any historic records or site inspections. Groundwater did not flow towards any developed area or known groundwater supply wells. A review of nearby registered water supply wells was conducted through a review of public database records, aerial photography and area reconnaissance. Several residential buildings were identified northwest of the Site in a cross-gradient groundwater flow direction, however, no obvious or registered water wells were identified within a ½-mile radius of the Site, and public water supply was available in the area of the Site.

2.7.4 Surface Water Evaluation

Site-specific potentiometric measurements and general drainage basin conditions are consistent with shallow groundwater discharged to an unnamed tributary to Rocky Creek along the southwestern property boundary. Based on low groundwater concentrations measured in downgradient monitoring wells, minimal concentrations of PCE, if any, were expected in surface water. The surface water flows through an undeveloped and remote vacant land area with no indication of regular contact with Site or neighboring property personnel. Rocky Creek drains a commercial area and eventually flows into the Reedy River approximately 3-miles south of the Site.

2.7.5 Soil Vapor Evaluation

Soil vapor intrusion was identified as an exposure pathway and volatilization of PCE from groundwater or source material into soil gas was measured during soil gas assessment performed in 2011. The potential for significant concentrations in excess of industrial risk-based concentrations was not identified as a significant risk based on low groundwater concentrations relatively low soil gas concentrations. Additional evaluation of the soil vapor exposure pathway will be completed as part of the RI.

3.0 REMEDIAL INVESTIGATION

The RI is intended to obtain data to evaluate remedial options for the Site in accordance with the additional sampling requirements identified by SCDHEC. The technical approach to collect samples of soil vapor, surface water, and groundwater is presented in the following sections.

The technical approach to the RI consists of a Sampling & Analysis Plan (SAP) and a Quality Assurance Plan (QAP). The SAP is comprised of the methods described below and provides specific data collection methods and the QAP outlines the protocol to ensure data quality. A QAP will be submitted to SCDHEC as a separate report prior to sampling.

3.1 NEIGHBORING PROPERTY ACCESS

Elements of the RI will require short-term and limited access to two (2) neighboring properties west and south of the Site in order to install monitoring wells and to collect surface water measurements. Accordingly, the implementation of portions of the RI are contingent upon obtaining off-site access agreements.

Surface water sampling will require foot access to the property south of the Site, while the installation of two (2) additional monitoring wells will require access for a track-mounted drill-rig to install shallow monitoring wells on the properties west and south of the Site. Prior to accessing the neighboring properties, BEA will contact the property owners in order to provide information regarding the scope of work and to request written permission for the RI assessment activities.

3.2 REPORT SUBMITTAL

Following RI investigation, a Remedial Investigation and Feasibility Study (RI/FS) Report will be prepared and submitted to SCDHEC. The RI/FS will document the results of the RI and detail the risk assessment and feasible remedial technologies. Data collected in the RI will be presented in tables and figures and discussed in the text of the report.

3.3 IMPLEMENATION SCHEDULE

Following approval of the RI Workplan, some on-site elements of the Workplan will be implemented per the schedule shown in Table 1. The starting point of the schedule is based on the approval of the RI Workplan within three (3) weeks by SCDHEC. Field work notification will be provided to SCDHEC 5-days prior to sampling events. Off-site access requests will be delivered to the neighboring property owners after SCDHEC approval, followed by some on-site sampling. The additional monitoring well installations will be deferred until off-site access agreements are completed and drilling can be completed during a single mobilization.

3.4 SAMPLING & ANALYSIS PLAN

The SAP consists of the methods described in the following sections and a sampling summary is provided in Table 2.

3.5 SOIL VAPOR SAMPLING

The initial soil vapor sampling was performed using high-sensitivity passive sampling capsules in order to locate any source material at the Site. No significant detections of PCE or TCFM were measured outside the perimeter of the building and no other target compounds were identified. The RI exposure assessment for vapor intrusion requires resampling areas of VOC detections using concentration-based soil gas analytical techniques for comparison with Applicable or Relevant and Appropriate Requirements (ARARs) including USEPA Vapor Intrusion Screening Levels (VISLs).

In order to quantify PCE and TCFM concentrations, four (4) sub-slab soil gas samples will be collected from the locations shown in Figure 6, and then submitted for laboratory analysis of VOCs. The soil vapor samples will be collected by penetrating the building slab and then using a hand operated soil-gas sampling apparatus to collect the samples for laboratory analysis. One ambient air sample will be collected outside the building for quality assurance and background concentration comparison. Each soil vapor sampling location will be collected using the post-run methodology described below.

3.5.1 Post-Run Soil Gas Sampling Method

The concrete slab will be penetrated using a 1-inch masonry bit and a hand-held rotary hammer drill. Samples will be collected in vacuum cylinders through disposable tubing connected to a stainless steel probe.

Sample Containers: Summa™ canisters used for this survey will be lab-evacuated, pre-cleaned, coated stainless-steel spheres. Samples of soil gas will be collected into the 1-Liter Summa™ canisters by connecting the canisters to a pre-purged probe placed three to four (3-4) feet below grade in the shallow vadose zone soil and releasing the vacuum from the Summa™ canister to capture the gas.

Post-Run Method: Sample collection will involve advancing a disposable 7/8-inch diameter screened sampling probe to a depth of four (4) feet using a 7/8-inch diameter probe stem. After reaching the target depth, the probe rod will be retracted to expose a six (6) inch soil interval for sampling. The probe will be advanced using a manual slide hammer tool. Prior to sampling, a plug of modeling clay or hydrated bentonite will be set to fill any annular void around the probe stem to seal out ambient air. The sampling tip will be connected to disposable nylon tubing to the surface. The total void space from the sample interval and 6-feet of nylon sample tubing will be approximately 92-mL.

Purging: The top of the probe tubing will be fitted with a gas tight connection three-way valve with one side of the valve attached to an acrylic hand pump for purging and the other side of the valve attached to the Summa™ canister. A pressurized helium gas bladder will be placed at the floor and sample stem interface during purging and sampling in order to trace ambient air leaks at the slab penetration.

A volume of 275-mL will be purged from the sample probe using the hand pump over a five-minute period. Following purging, the three-way valve will be positioned to allow a vapor sample to enter the Summa canister once the vacuum valve is opened until the vacuum is equalized. The vapor sample will be collected over a minimum of five-minutes using a preset-gas regulator and then the sampling valve will be closed.

The Summa™ canisters will then be delivered under Chain-of-Custody to a SCDHEC-certified laboratory for analysis via EPA Method TO-15 and helium tracer. The TO-15 analysis will be performed to identify target volatile chlorinated organic compounds comparable to the 8260B list of compounds, and the helium tracer analysis will be used to evaluate atmospheric cross-contamination.

3.6 SURFACE WATER SAMPLING

Surface water sampling is included in the RI in order to evaluate the potential groundwater plume discharge as baseflow into the creek south of the Site. Surface water sampling will consist of field parameter measurements followed by laboratory analysis from sampling locations which will be determined based on field parameter measurements. The surface water sampling follows the methods prescribed in the guidance document *SCDHEC 2001, Methods to Evaluate Groundwater Discharge to Surface Water* (see Appendix II).

All of the surface water sampling methods described below will be performed during equalized flow conditions at least 48-hours after any significant precipitation event. A record of weather conditions prior to the time of sampling will be included in the data evaluation report.

3.6.1 Field Parameter Sampling

In order to locate the most likely areas of groundwater baseflow, field parameters will be measured along the creek from the upstream emanation from the ground to the downstream confluence into Rocky Creek. Visual indications of bedrock outcrops, transition zone gravel banks or mineral staining will be noted as potential areas of groundwater discharge. The measurements and locations will be logged and located using a GPS receiver and marked using temporary creek bank flags.

A thermal imaging camera will be used to walk along the length of the creek in order to identify zones of surface water temperature contrast. Groundwater baseflow can be recognized based on the contrast of stable groundwater temperature to ambient surface water temperatures. Measurements of conductivity and temperature will also be collected using a portable meter from along the base of the creek. The meter survey will proceed from downstream to upstream to avoid sampling in areas of sediment disturbance.

The results of the parameter measurements will be incorporated into a data table and evaluated to determine the most likely or most prominent areas of groundwater baseflow along the creek. The discharge zones will be targeted for the elevation and laboratory analytical sampling locations described below.

3.6.2 Surface Water Elevations

Surface water elevation measurements will be collected using staff gauges in order to measure groundwater discharge into the creek bed and to confirm overall groundwater flow patterns at the Site. Three temporary gauging stations will be installed as piezometers along the creek generally from locations shown in Figure 6 as SW-1 (upstream), SW-2 (discharge zone) and SW-3 (downstream).

The gauging stations will be installed by hand into the sandy base of the creek bed in order to measure and compare the potentiometric surface of the groundwater and the free surface of the creek stage. Groundwater discharge locations will be identified where streambed potentiometric surface is higher than the prevailing creek stage elevation.

The measurements will be collected using an electric water interface probe or staff gauge from a common reference point. The creek stage elevations will be incorporated into the site hydrogeological map by performing an elevation survey to tie the gauging station elevations into the existing monitoring well network. If the elevation survey using gauging stations is inconclusive for determining zone of baseflow discharge, seepage meters may be used for additional evaluation.

3.6.3 Analytical Sampling

Three surface water sampling locations are proposed in order to evaluate the groundwater discharge zone into the creek in hydraulically downgradient from the contaminant plume. The upstream sampling location (SW-1) is intended as a background sampling location to establish prevailing water quality. The creek emanates from the land surface south of the Site and the headwaters are expected to be visible as a spring seepage with erosion and soil moisture.

The discharge zone sampling location (SW-2) is intended to measure the concentrations of dissolved phase groundwater contaminants entering the creek immediately downgradient from the plume area. Based on monitoring well measurements, the location of SW-2 is expected to be near MW-9, but will be adjusted based on the surface water parameter and elevation results. Downstream sampling location (SW-3) is intended to measure ambient surface water concentrations in the mixed stream flow downstream of the groundwater discharge zone.

Two sets of surface water samples will be collected at each gauging station as stream flow samples and creek bed baseflow samples. The stream flow samples will be collected using unpreserved 40-mL vials which will be submerged, opened, filled and recapped beneath the water surface. The baseflow samples will be collected by allowing the gauging station piezometer to overflow and then collecting a water sample from within the piezometer. If required, baseflow samples may also be collected using streambed diffusion bag samplers and then transferring the water sample to 40-mL sampling vials.

The surface water samples will be preserved and submitted to an SCDHEC certified analytical laboratory under Chain of Custody for analysis of target VOCs by EPA Method 8260B.

3.7 GROUND WATER SAMPLING

Groundwater sampling is included in the RI in order to further delineate groundwater concentrations at the Site. Groundwater sampling results from the RI will be compared to previous sampling results in order to evaluate trends and to confirm the plume geometry in preparation of a remedial Feasibility Study. Groundwater sampling will involve resampling existing wells and sampling additional wells to be installed as part of this RI.

3.7.1 Monitoring Well Installation

Three (3) additional monitoring wells are proposed in response to SCDHECs August 2014 review of the CSM. The additional monitoring well locations are shown in Figure 6 and the associated rationale are proposed:

- MW-16 will be located approximately 200-feet west of MW-6 and downgradient from MW-14 in order to confirm the western plume boundary on the neighboring undeveloped parcel. Shallow groundwater

is expected to be encountered at a depth of 20-feet bls. MW-16 will be installed to a depth of 40-feet in order to maintain consistent measurements with nearby wells MW-14 and MW-6.

- MW-17 will be located downgradient from MW-9 in order to delineate the downgradient groundwater between the property boundary and the creek. The location will be adjusted on the basis of the surface water baseflow survey proposed above. The depth to water in this area is expected to be less than 10-feet. MW-17 may require installation using hand equipment as this area is inaccessible to vehicles.

- MW-18 will be located within the building approximately 70-feet east of MW-10 in line with MW-12. This location is intended to confirm MW-10 as the upgradient and easternmost extent of the PCE concentrations.

Each of the monitoring wells will be constructed using 1-inch diameter PVC wellscreen and risers. Monitoring wells MW-16 and MW-17 will be completed with 2-foot surface stickups and locking caps to ensure being able to locate the wells in the woods. MW-18 will be completed with a flush-mounted locking manhole within the building and flush with the slab of the manufacturing floor.

Each of the wells requires limited access drilling. Monitoring well MW-17 will be drilled using a two-man auger drill. Monitoring wells MW-16 and MW-18 will be installed using a hollow-stem auger capable track-mounted drill rig. Initially, a 3-inch diameter direct-push borehole will be opened and the gravel pack will be installed through the direct push surface casing. If necessary, the augers will be used to construct the well in the borehole.

Ten (10) feet of wellscreen and eleven feet of gravel sandpack will be installed to the bottom of the boreholes. The annular space will be filled to the surface using hydrated bentonite and grout pursuant to SCDHEC well construction regulations. Following installation, the wells will be developed using bailers and either submersible pumps or peristaltic pumps and sample tubing until drilling sediment has been removed and clarified.

3.7.2 Monitoring Well Network Permit

Approval of the monitoring well network is requested from SCDHEC for the three (3) monitoring wells MW-16, MW-17, and MW-18. Upon completion, well completion logs from a SCDHEC licensed well driller will be submitted to SCDHEC.

3.7.3 Groundwater Sampling & Analysis

Groundwater samples will be collected from the existing and additional monitoring wells using submersible centrifugal or bladder pumps and low-flow sampling techniques. Prior to sampling, the monitoring wells will be opened and allowed to equalize with the atmosphere. Depth to water and total well depth measurements will be collected using an electronic water-interface probe. Three to five well volumes will be purged from the wells to purge stagnant groundwater from the well casings. Geochemical parameters will be measured and recorded for each well volume to ensure that equalized groundwater conditions are reached for temperature, turbidity, oxidation-reduction potential (ORP), dissolved oxygen (DO), conductivity, and pH.

Downhole sampling equipment and meters will be decontaminated prior to each sampling station. Disposable tubing and disposable PPE will be used pursuant to EPA standard sampling protocol in order to prevent cross-contamination between sampling locations. Field equipment blanks will be collected from each daily sampling event. Trip blanks analyzed for each sample shipment and daily sample duplicates will be collected pursuant to the QAP. Groundwater samples will be collected directly from virgin disposable polyethylene tubing connected to the submersible pump. Laboratory pre-cleaned bottles will be filled and labeled pursuant to analytical parameters.

The samples will be preserved, placed on ice and delivered to an SCDHEC certified analytical laboratory for analysis of EPA Target Analyte List/Target Compound List (TAL/TCLs) included in Appendix III for the following parameters:

- VOCs by EPA Method 8260,
- Semi-Volatile Organic Compounds (SVOCS) by EPA Method 8270, and
- Dissolved metals by EPA Method 6020.
- In order to evaluate interference from turbidity or particulate matter in the groundwater samples, duplicate standby samples will be collected for lab-filtration and re-analysis if necessary.

With SCDHEC approval, it is proposed that TAL/TCL SVOCs and TAL/TCL Metals be analyzed initially from the core plume monitoring wells MW-2, MW-4, MW-6, MW-10, and MW-11D. If SVOCs or metals are detected in these wells, it is understood that analysis from additional Site monitoring wells may be required.

Following analysis and quality control review, the groundwater analytical results will be incorporated into the existing groundwater data tables for evaluation and reporting as the basis of the RI/FS. The results and evaluation from the previous sections will be submitted to SCDHEC as required using hardcopy and electronic submittal formats.

3.8 QUALITY ASSURANCE/QUALITY CONTROL

Data Quality Objectives (DQOs) for data collection and quality assurance/quality control (QA/QC) controls samples that will be collected during the RI are described below. Details regarding additional quality procedures are provided in the QAP and SAP.

The DQOs are intended to ensure that the laboratory analytical data are accurate and reliable for the RI evaluation. EPA Contract Laboratory Program reporting packages will be performed to achieve DQO Level II as standard documentation to support the remedial investigation conclusions and risk assessment with. Laboratory performance will include the ability to produce additional documentation for Level III and Level IV reporting if required.

In order to evaluate interference from turbidity or particulate matter in the groundwater samples, duplicate standby samples will be collected for lab-filtration and re-analysis if necessary. In order to evaluate potential atmospheric background cross-contamination in the soil gas sampling, the soil gas analysis will include analysis of a laboratory provided helium tracer gas. The seal penetrations through the slab will be sampled through a pressurized bladder filled with the helium-tracer gas.

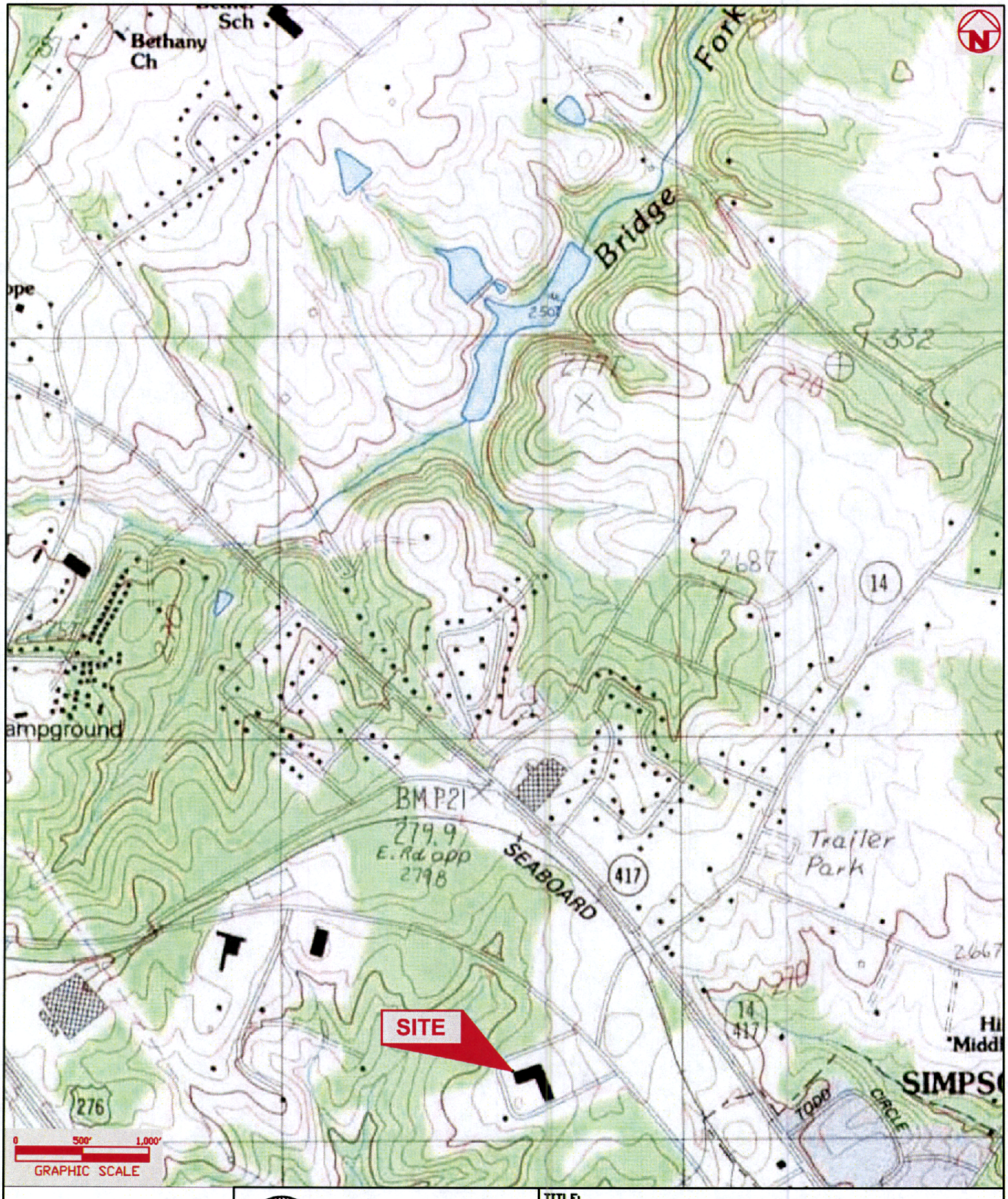
Quality Assurance sampling will include analysis of blanks for target VOC compounds. Field duplicate samples will be collected at a frequency of 10% of all environmental samples during the RI and submitted to the laboratory as blind duplicates. Additionally, trip blanks will be submitted and analyzed at a frequency of one per cooler. Equipment rinse blanks will be collected on a daily basis and submitted for analysis of target compounds.

FIGURES

Figure 1 - Site Location Map
Figure 2 - Site and Surrounding Area Map
Figure 3 - Site Map with Sampling Locations
Figure 4 – Groundwater Flow Diagram
Figure 5 – PCE in Groundwater
Figure 6 – Proposed RI Sampling Locations

TABLES

Table 1 – Proposed RI Implementation Schedule
Table 2 – Proposed Sampling Summary



CRB

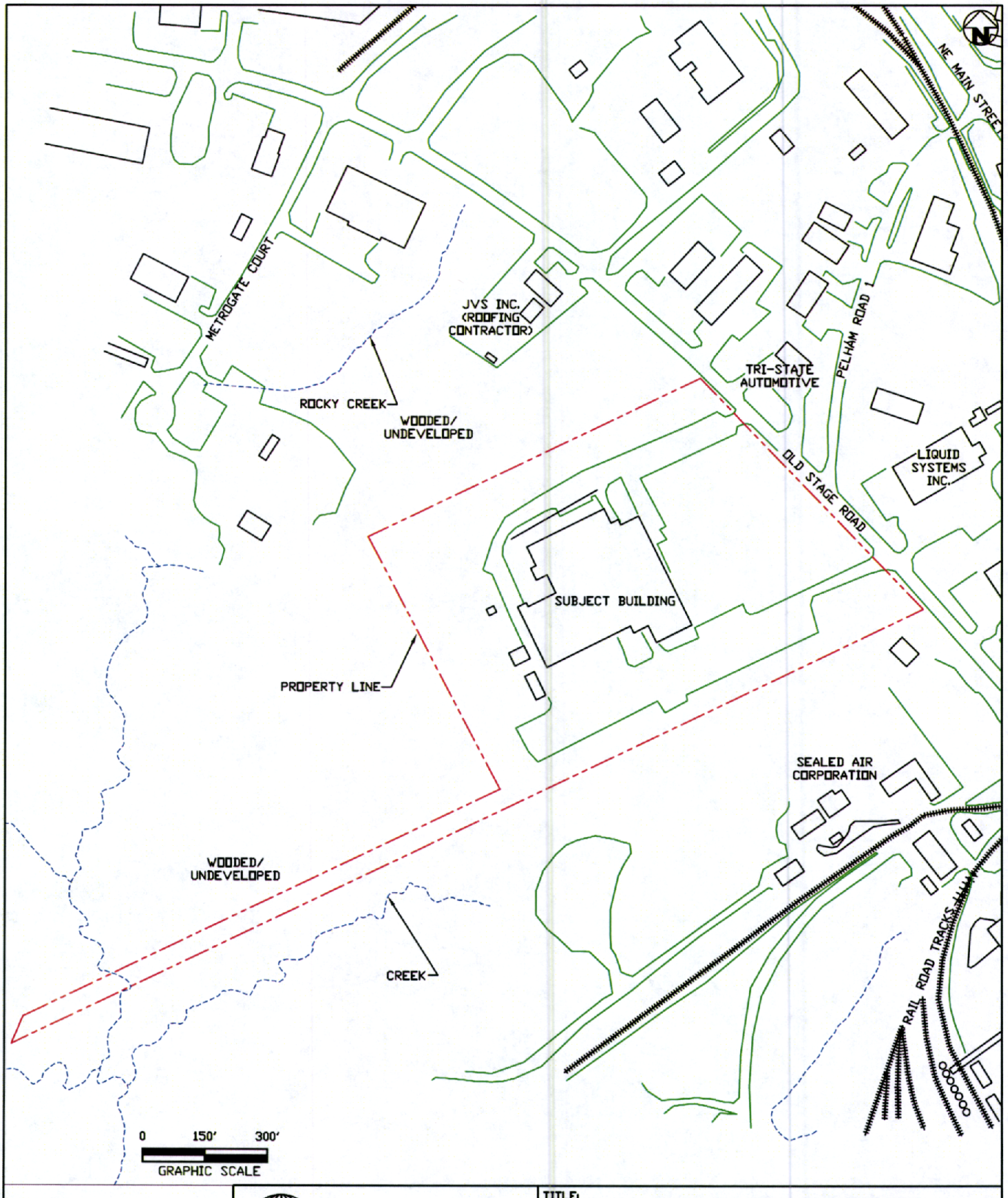
Geological & Environmental Services, Inc.
8744 SW 133rd Street
Miami, Florida 33176
Tel: (305) 447-9777
Fax: (305) 567-2853

TITLE:
SITE LOCATION MAP
WOVEN ELECTRONICS
1001 OLD STAGE ROAD
SIMPSONVILLE, SOUTH SAROLINA

REV'D DATE:	JUN 12, 2014	PROJECT NO.	BEA 414-26
DRAWN DATE:	SEP 20, 2010	SCALE:	AS NOTED
DRAWN BY:	L. AYALA	APPROVED BY:	RW

FIGURE 1

BEA 414_\26_\Reports\2014 CSA\CAD\F2- Site Location Map



CRB

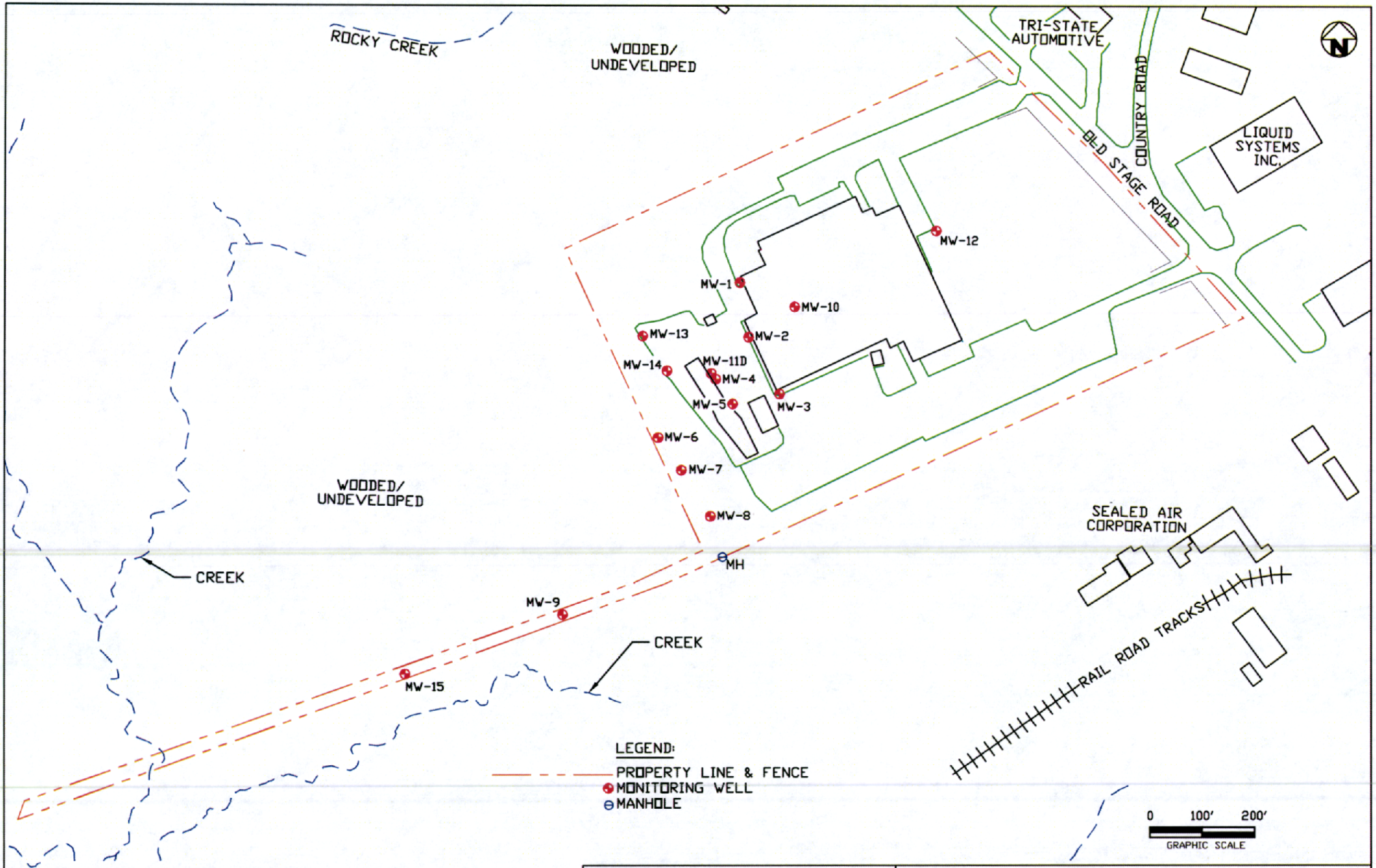
Geological & Environmental Services, Inc.
8744 SW 133rd Street
Miami, Florida 33176
Tel: (305) 447-9777
Fax: (305) 567-2853

TITLE: SITE MAP WITH SURROUNDING PROPERTIES
WOVEN ELECTRONICS
1001 OLD STAGE ROAD
SIMPSONVILLE, SOUTH CAROLINA

REV'D DATE:	JUN 12, 2014	PROJECT NO.	BEA 414-26
DRAWN DATE:	SEP 20, 2010	SCALE:	AS NOTED
DRAWN BY:	L. AYALA	APPROVED BY:	RW

FIGURE 2

BEA 414-\26-\Reports\2014 CSA\CAD\F2- Site Map with Surrounding Properties



SURVEY SOURCE: FREELAND & ASSOCIATES AND
GREENVILLE COUNTY PROPERTY ASSESSOR

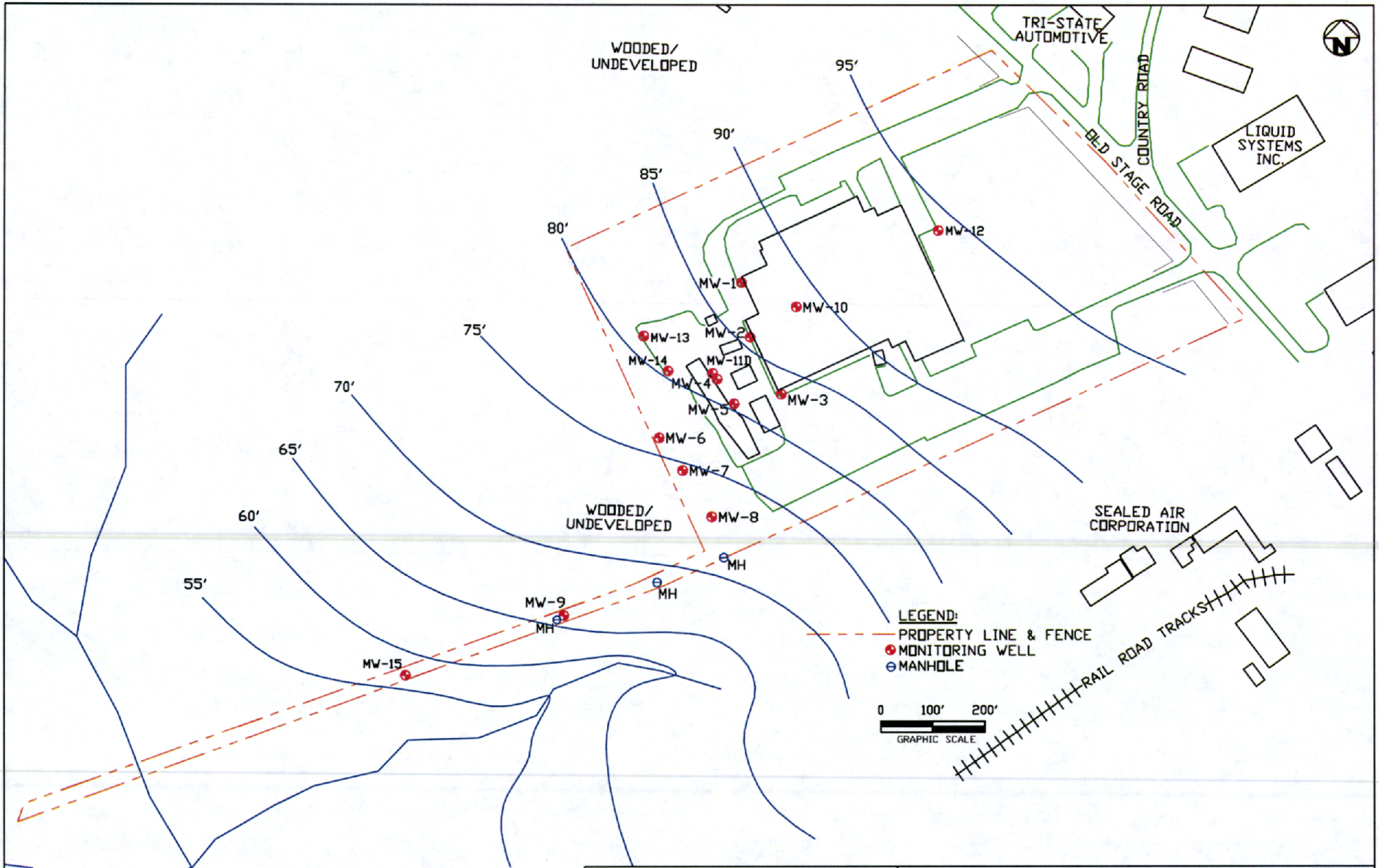
CRB
Geological & Environmental Services, Inc.
8744 SW 133rd Street
Miami, Florida 33176
Tel: (305) 447-9777
Fax: (305) 567-2853

TITLE:
SITE MAP WITH MONITORING WELL LOCATIONS
WOVEN ELECTRONICS
1001 OLD STAGE ROAD
SIMPSONVILLE, SOUTH CAROLINA

REV'D DATE:	JUN 12, 2014	PROJECT NO.	BEA 414-26
DRAWN DATE:	SEP 20, 2012	SCALE:	AS NOTED
DRAWN BY:	L. AYALA	APPROVED BY:	RW

FIGURE 3

BEA 414...\26...\Reports\2014 CSA\CAD\F3- Site Map with MW Locations

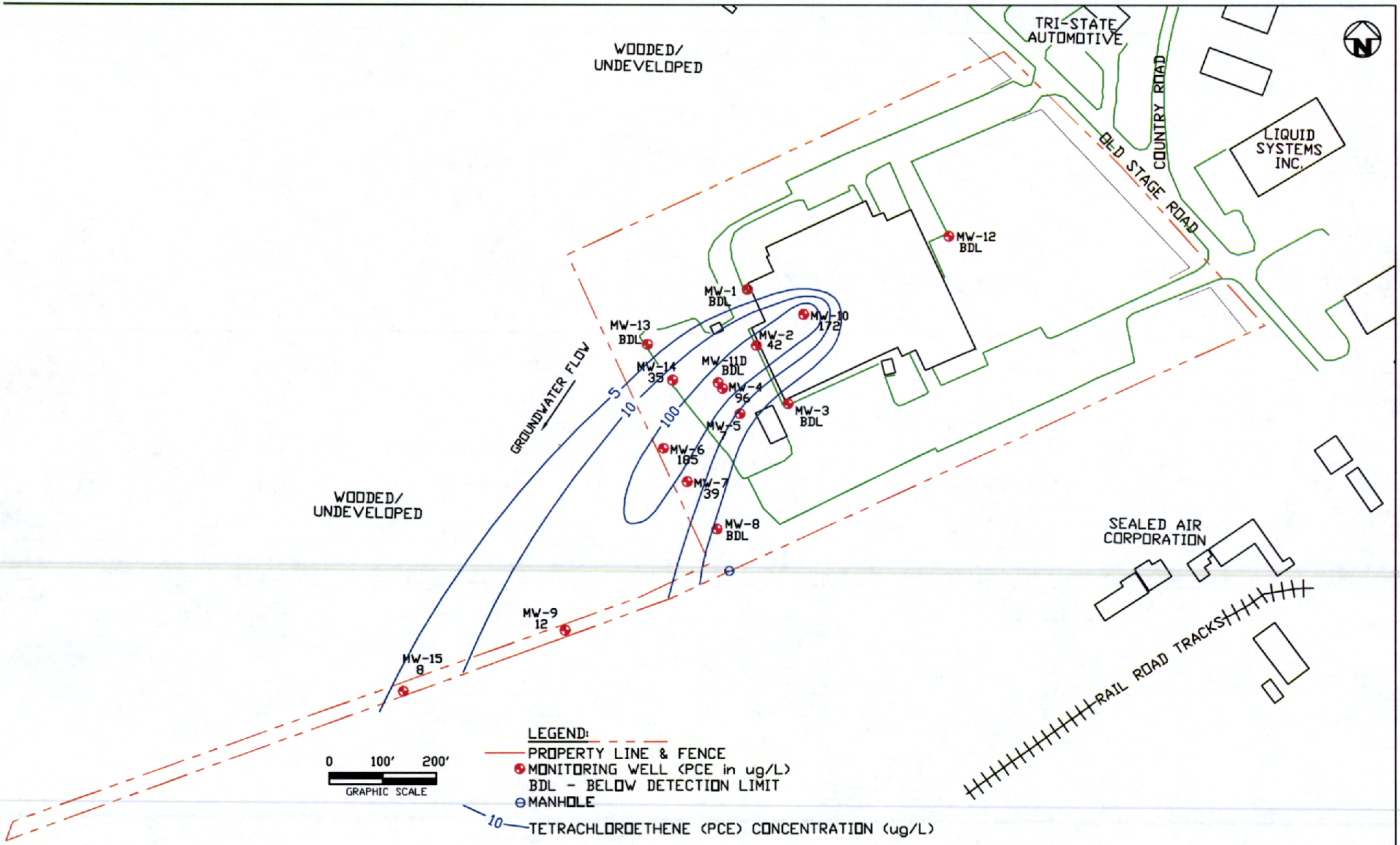


CRB
Geological & Environmental Services, Inc.
8744 SW 133rd Street
Miami, Florida 33176
Tel: (305) 447-9777
Fax: (305) 567-2853

TITLE:
GROUNDWATER FLOW DIAGRAM - 5/29/2014
WOVEN ELECTRONICS
1001 OLD STAGE ROAD
SIMPSONVILLE, SOUTH CAROLINA

REV'D DATE:	JUN 10, 2014	PROJECT NO.	BEA 414-26
DRAWN DATE:	NOV 11, 2012	SCALE:	AS NOTED
DRAWN BY:	L. AYALA	APPROVED BY:	RW

FIGURE
4

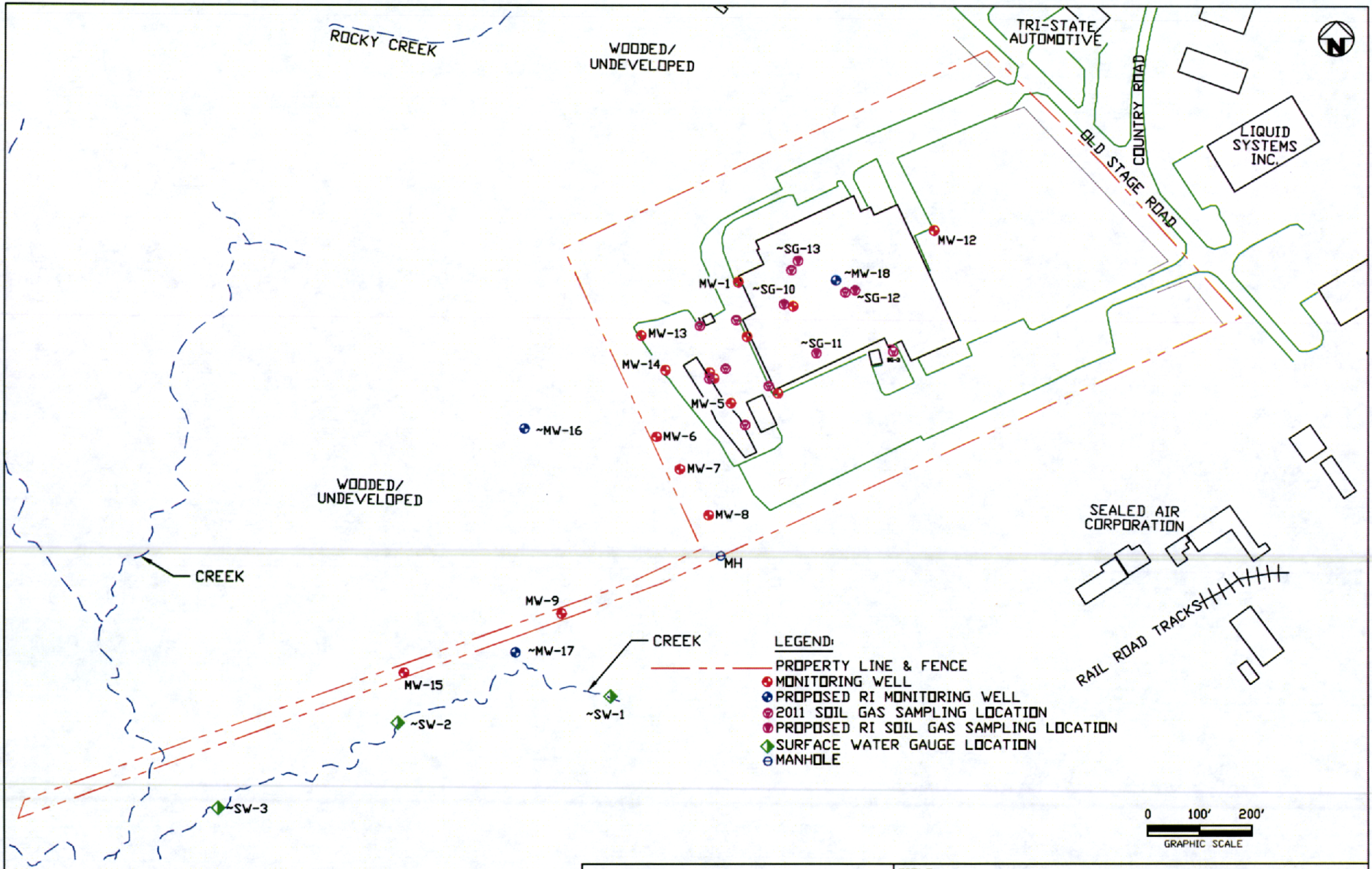


CRB
Geological & Environmental Services, Inc.
8744 SW 133rd Street
Miami, Florida 33176
Tel: (305) 447-9777
Fax: (305) 567-2853

TITLE:
PCE IN GROUNDWATER - 5/29/14
WOVEN ELECTRONICS
1001 OLD STAGE ROAD
SIMPSONVILLE, SOUTH CAROLINA

REV'D DATE:	JUN 6, 2014	PROJECT NO.	BEA 414-26
DRAWN DATE:	JAN 10, 2013	SCALE:	AS NOTED
DRAWN BY:	L. AYALA	APPROVED BY:	RW

FIGURE
5



SURVEY SOURCE: FREELAND & ASSOCIATES AND
GREENVILLE COUNTY PROPERTY ASSESSOR

CRB
Geological & Environmental Services, Inc.
8744 SW 133rd Street
Miami, Florida 33176
Tel: (305) 447-9777
Fax: (305) 567-2853

TITLE: PROPOSED REMEDIAL INVESTIG. SAMPLE LOCATIONS
WOVEN ELECTRONICS
1001 OLD STAGE ROAD
SIMPSONVILLE, SOUTH CAROLINA

REV'D DATE:	SEP 8, 2014	PROJECT NO.	BEA 414-26
DRAWN DATE:	SEP 20, 2012	SCALE:	AS NOTED
DRAWN BY:	L. AYALA	APPROVED BY:	RW

FIGURE 6

BEA 414..\26..\Reports\2014 RIWP\CAD\F6 RI Locations

Table 1 - RI Implementation Schedule
Woven Electronics Corporation
1001 Old Stage Road, Simpsonville SC

RI Task	September 2014	October 2014	November 2014	December 2014
RI Workplan Submittal				
SCDHEC RI Review				
Indoor Air/Soil Vapor Sampling				
Groundwater Resampling				
Request/Arrange Off-Site Access				
Underground Clearance				
Stream Sampling				
Monitoring Well Installations				
Groundwater Sampling				
RI Data Review & Report Preparation				
RI Report Submittal				

Table 2 - RI Sampling Summary
Woven Electronics Corporation
1001 Old Stage Road, Simpsonville SC

Sampled Medium	Parameter	Sample Quantity	Objective	Analytical Method	QA/QC
Surface Water	Temperature	30-40	Identify groundwater baseflow zones as temperature contrast.	Field Aerial Thermograph	Calibrate to known temperature and duplicate samples
	Conductivity (S/m)	30-40	Identify groundwater baseflow zones as conductivity contrast.	Field Instrument	Calibrate to standard and duplicate samples
	Elevation (ft - msl)	3	Incorporate water surface elevation to groundwater flow diagram.	Relative height using a surveyed staff gauge elevation	Duplicate measurements
	VOCs (ug/L)	3	Compare concentrations to ARARs and incorporate into groundwater plume diagram.	EPA Method 8260B / MS	10% Field duplicate samples DQO Level II
Soil Gas	VOCs (ug/L)	4	Compare concentrations to ARARs and evaluate for indoor air vapor intrusion.	EPA Method TO-15 / MS	Ambient background sample DQO Level II
Ground Water	Temperature Conductivity Dissolved O_2 ORP	18	Measure stabilized groundwater purging & evaluate geochemistry	Field instruments	Calibrate to standards
	Elevation (ft - msl)	18	Incorporate depth to water measurements to groundwater flow diagram.	Relative height using a surveyed well casing elevation	Duplicate measurements
	TAL VOCs (ug/L)	18	Compare concentrations to ARARs and incorporate into groundwater plume diagram.	EPA Method 8260B / MS	10% Field duplicate samples DQO Level II
	TAL SVOCs (ug/L)	6 core plume wells		EPA Method 8270D / MS	
	TAL Metals (ug/L)	6 core plume wells		EPA Method 6020A / MS	

TAL - USEPA Superfund Sites Target Analyte List
MS - Mass Spectrometry
DQO - Data Quality Objectives
QA/QC - Quality Assurance / Quality Control

APPENDIX

Appendix I – Regulatory Correspondence
Appendix III – SCDHEC 2001, Methods to Evaluate Groundwater Discharge to Surface Water
Appendix III – USEPA Target Analyte Lists

APPENDIX I

REGULATORY CORRESPONDENCE

D H E C

PROMOTE PROTECT PROSPER

Catherine B. Templeton, Director

Promoting and protecting the health of the public and the environment

August 18, 2014

Mr. Brian Hackler
Vice President and General Manger
Woven Electronics, LLC
1001 Old Stage Road
Simpsonville, SC 29681

Re: Woven Electronics
Conceptual Site Model; June 2014, B/E Aerospace
& CRB Geological and Environmental Services
Technical File #418096 PCAS #6203
Greenville County

Dear Mr. Hackler:

The South Carolina Department of Health and Environmental Control (the Department) has reviewed the referenced report. The Department accepts the information; however, a Remedial Investigation (RI) Work Plan should be prepared to address the following comments:

1-Soil Gas Assessment: The passive soil gas results were mass-based and were not directly comparable to regulatory compliance standards. Therefore, an indoor air quality assessment should be conducted.

2-Additional assessment to determine the full extent of the plume is warranted. Assessment should include the area under the building between MW-10 and MW-12; the area between MW-13 and MW-15; and the area between MW-15, MW-9, MW-8 and the creek.

3-The plume discharge point to the creek needs to be determined. Please reference the enclosed *Methods to Evaluate Contaminated Groundwater Discharges to Surface Water* when preparing the RI Work Plan. In addition, please propose to install several staff gauges in the creek and incorporate the measured water levels into the potentiometric data map.

4-Groundwater monitoring wells samples shall be collected and analyzed for United States Environmental Protection Agency's (EPA's) Target Analyte List (TAL) metals and Target Compound List (TCL) Volatile Organic Compounds and Semi-Volatile Organic Compounds.

Please submit the requested RI Work Plan (one hard copy and one Portable Document Format (PDF) version to my attention on or before September 18, 2014. Please reference LWM

Technical File #418096 on all correspondence. If you have any questions, please e-mail me at trentje@dhec.sc.gov or contact me at (803) 898-0723.

Sincerely,

Jan Trent

Jan Trent, Hydrogeologist
State Remediation Section
Site Assessment, Remediation & Revitalization Division
Bureau of Land and Waste Management

Enc: *Methods to Evaluate Contaminated Groundwater Discharges to Surface Water*

cc:

Natalie Kirkpatrick, Area Director, Upstate EQC, Greenville (w/o enc.)
Robert Workman, CRB; 5000 Old Buncombe Rd., Suite 21 Greenville, SC 29617 (w/Enc.)
Technical File #418096 (w/o Enc.)
Gary Stewart; BLWM (w/o Enc.)

APPENDIX II

SCDHEC 2001, METHODS TO EVALUATE CONTAMINATED GROUNDWATER DISCHARGES TO SURFACE WATER

METHODS TO EVALUATE CONTAMINATED GROUNDWATER DISCHARGES TO SURFACE WATER SOUTH CAROLINA DHEC OCTOBER, 2001

Introduction

This document describes methods for selecting sampling locations for the purpose of assessing impacts of contaminated groundwater discharges to surface water. A proper assessment of contaminated discharges to surface water is key to effective monitoring and design of site remediation systems. A number of reconnaissance techniques have been developed to identify areas of contaminated groundwater discharge to surface water. These methods may be used to help identify appropriate locations for additional surface-water or pore-water sampling.

Surface water samples should be collected at locations where higher rates of discharge of contaminated groundwater have been identified or are suspected based on the reconnaissance techniques described in this document. The use of reconnaissance techniques should minimize the number of surface water samples that are needed to complete an adequate assessment of a site and will increase confidence that potential areas of concern have been evaluated. Specific recommendations for use of reconnaissance techniques and selection of locations for surface water sampling are based on the following conceptual model:

South Carolina Conceptual Model for Groundwater to Surface Water Discharge

In South Carolina, the majority of streams, rivers, and natural lakes derive much of their stream flow from groundwater discharge to surface water. There are two ways in which groundwater may discharge to surface water: as diffuse insterstitial flow in unconsolidated material or through preferential discharge pathways. Groundwater discharging to surface water in South Carolina flows through aquifer material that is usually not continuous, well-sorted, or homogeneous, and therefore, it is expected that preferential discharge occurs to most surface water in South Carolina. Preferential discharge occurs in the Piedmont through fractures in bedrock and through relic fractures in saprolite. In the Coastal Plain and the Piedmont, preferential discharges may also occur through zones of higher permeability associated with minor changes in grain size or lithology.

Discharge of contaminated groundwater to surface water may occur near the shoreline or at some distance from the shoreline depending on the size of the surface water body , topographic relief, the

elevation of the top of the aquifer, and the depth of the contaminant plume as it approaches the shoreline (Figure 1).

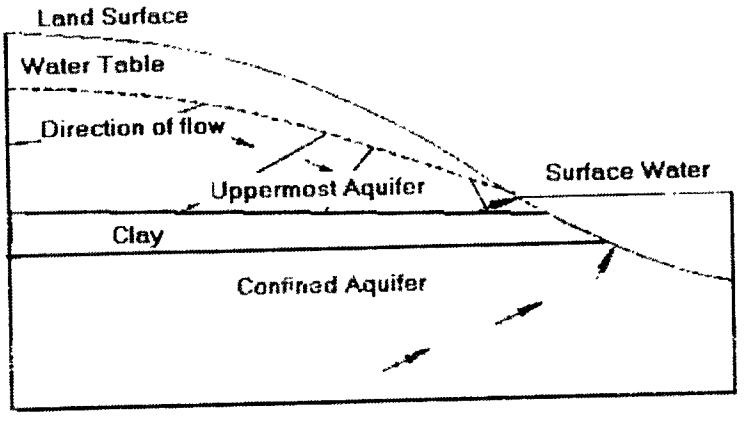


Figure 1. Illustration of groundwater to surface water discharge including uppermost and confined aquifers.

The area beneath and adjacent to the surface-water body where groundwater encounters and mixes with surface water is known as the hyporheic and/or transition zone. Water flow directions within this zone may differ significantly from those of the adjacent aquifer (Figure 2).

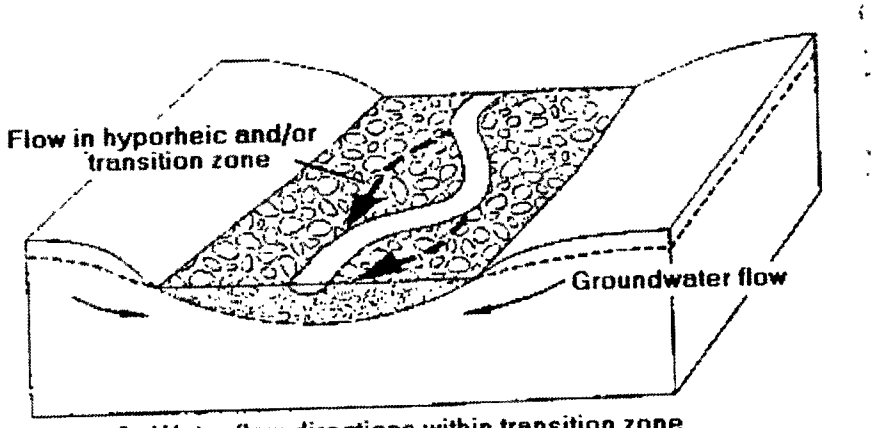


Figure 2. Water flow directions within transition zone. Modified after Winter and others (1998)

This is because flow at the edge of the aquifer interacts with surface water flow and may also be influenced by tidal fluctuations or flooding events. Water quality within the hyporheic/transition zone

is a result of the mixing of groundwater with the adjacent surface water body. As elevated organic matter may be present in a portion of the hyporheic/transition zone, contaminants in groundwater will tend to react with organic matter in this zone resulting in sorption or degradation.

The hyporheic zone may be sampled to evaluate whether contaminated groundwater is reaching and causing adverse ecological impacts at the groundwater- surface water interface. The potential for biochemical degradation within the hyporheic zone may also be evaluated. Because the hyporheic zone is often an area of biological activity that contains burrowing organisms, assessment of water quality within the hyporheic zone may help determine whether there is a risk to lower trophic organisms. However, sampling of the hyporheic zone may not conclusively indicate where contamination is discharging to surface water.

From a regulatory perspective, the water table aquifer and all hydraulically connected units that discharge to surface water in South Carolina are considered the "uppermost aquifer". The discharge of contaminated groundwater in the uppermost aquifer to surface water is expected to occur on a local scale and should be looked at on a site-specific basis. Hydraulically separated deeper aquifers may also discharge contamination to rivers or lakes (Figure 1) affecting water quality on a regional scale. As a result, evaluating the impact of deeper aquifer discharge on rivers and lakes may be more difficult.

Please refer to the Selected Reference List for documents used in the development of this conceptual model.

Screening Methods for Identification of Zones of Groundwater to Surface Water Discharges

The following reconnaissance methods may be used to screen for areas of contaminated groundwater discharge to surface water. The best results can be obtained by combining two or more of these screening methods. It is recommended that every site receive a visual inspection to help refine the locations where other screening methods will be implemented.

Water Sampling and Organic Vapor Evaluations

Water Quality Indicator Parameters Contrast

Water-quality indicator parameters can be used as a screening tool to identify locations of potential groundwater discharges where there is a measurable contrast between surface water and groundwater. These parameters include, but are not limited to, pH, specific conductance (SpC), and temperature. Contrasts in temperature are likely to be most significant during the late winter and summer months. Differences in temperature may be measured using a temperature probe and may be evident using aerial digital thermography.

To screen for potential groundwater discharges to surface water, evenly spaced measurements

of temperature, pH, or SpC should be made along the length of the area being evaluated parallel to the beach or bank, generally in knee-deep water. These measurements can also be made in transects out into the surface water body at selected locations along the hypothetical axis of the plume to determine if discharges may be occurring further from shore. A temperature, pH, or SpC probe may be lowered to the bottom of the surface water column at selected locations, or water samples may be collected and screened for these parameters. As these measurements can be fast and inexpensive, spacing of ten to twenty-five feet between initial screening locations may be used. Tools pulled behind a boat that drag along the sediment/water interface are available for continuous monitoring of these parameters in deeper water (Lee and Beattie, 1991). Places where the pH, SpC, or temperature of the surface water changes noticeably and approaches that of the groundwater or an average between the groundwater and surface water may be locations of groundwater discharges. Experience has shown that SpC anomalies are often associated with regions of contamination in groundwater and contaminated groundwater discharging to surface water.

Push/Drive Point Samplers

Samplers such as mini-piezometers and the MHE PushPoint sampler (see Selected Reference List) may be used to identify potential pathways of contaminated groundwater to surface water discharge (Figures 3 and 4).

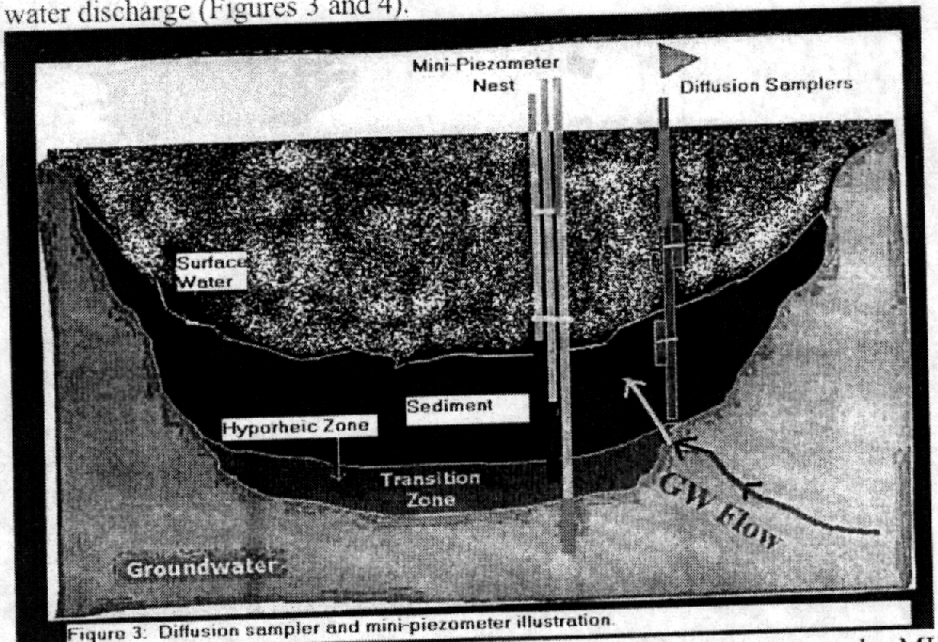


Figure 3: Diffusion sampler and mini-piezometer illustration.

Water samples can be collected from either the mini-piezometer or the MHE PushPoint Sampler to identify where groundwater contamination exists within the hyporheic/transition zone. Samples may be collected from these devices using a peristaltic pump or syringe. In addition to water-quality indicator parameters, a number of other screening analytical methods are available which can be completed quickly in the field. These methods include the colorimetric method for PCE, bioassay or immunoassay techniques, headspace

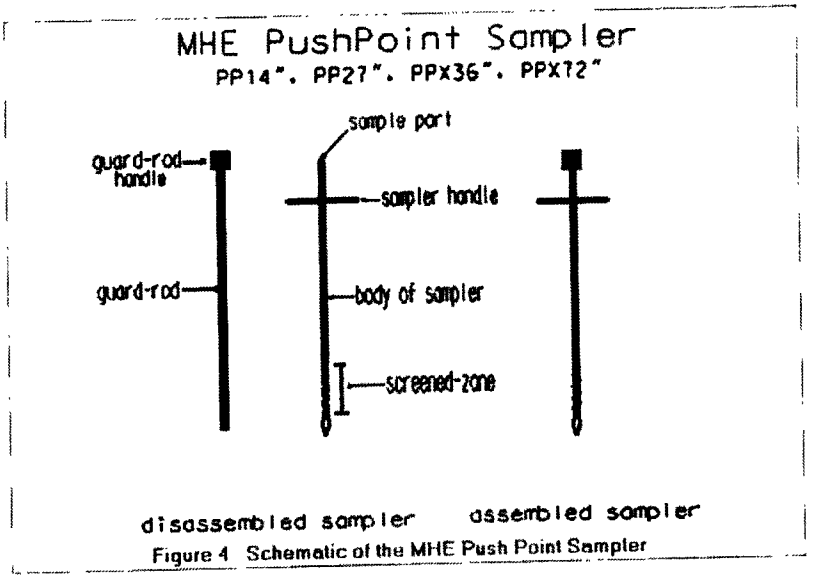


Figure 4 Schematic of the MHE Push Point Sampler

analysis using a portable gas chromatograph, or Chemetrics spectrophotometric methods. An organic vapor screening tool (portable PID or FID) may also be used to screen headspace of water samples if volatile organic chemicals are of concern. The limitations of these methods depend on the depth of the water body under investigation. These tools are easiest to employ in near shore evaluations.

Mini-piezometers and MHE samplers can be used to measure the hydraulic head differences between the surface water and groundwater. Such differential head measurements can help determine if groundwater discharge is occurring.

Vapor Diffusion Samplers/Passive Diffusion Bags

These methods can be effective for assessing whether volatile organic compounds are discharging to surface water (See Selected Reference list). There are two types of diffusion samplers, water to water and water to vapor. Water to vapor diffusion samplers, air-filled bottles with a semi-permeable membrane over the opening, allow vapors to diffuse from the water into the air, and are a variation of diffusion samplers. Vapor diffusion samplers may be buried just below the sediment/water interface to identify areas where higher levels of contamination exist at the boundary of the hyporheic zone and surface water. Passive diffusion bags filled with clean water (water to water diffusion samplers) may be buried within the upper portion of the sediment at regular intervals. Diffusion samplers may be installed in transects using ten to twenty-five foot spacings to characterize where discharges of contaminated groundwater may be occurring. The samplers should be allowed to equilibrate with the surrounding water for approximately two weeks before the samplers are removed and analyzed. Analysis of diffusion samples requires a gas chromatograph to obtain meaningful results. One advantage of the vapor diffusion samplers is that the vapor may be injected directly into the gas chromatograph which saves the time and money of sample extraction The limitation of vapor diffusion sampling is the results are considered qualitative because they

cannot be converted to exact pore water concentrations without making assumptions about equilibrium conditions.

Flux Measurements

Seepage Meters

Seepage meters may be used to estimate groundwater seepage rates in areas where the sediment consists of sand with varying amounts of clay (Lee, 1977 and 1988; Lee and Cherry, 1978) (Figure 5).

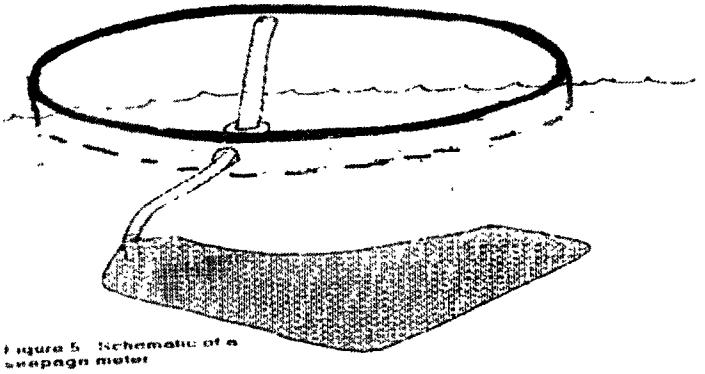


Figure 5 Schematic of a seepage meter

Seepage meters are more difficult to use in rocky areas or areas with a very thin veneer of sediments resting on bedrock. Their usefulness in streams depends on the rate of stream flow which can induce pressure and velocity gradients within the meter. They can be installed at any location that is humanly accessible. Transects of areas using seepage meters are also possible. When the area is amenable to installation of seepage meters, they should be installed at ten to twenty-five foot spacings if possible and seepage rates should be measured. Areas with the highest seepage rates are likely areas of preferential groundwater discharge to surface water.

Mini-Piezometers

Mini-piezometers can be used to estimate the relative head differences between surface water and groundwater, between two groundwater zones of different depths, the rate of groundwater discharge from a specific interval, and the flow directions within the hyporheic zone (Lee and Cherry, 1978).

Visual Observation

Water bodies that are accessible and conducive to a walking inspection should be visually inspected. In the Piedmont, the location of rock outcrops in stream beds should be noted along with any visible fractures. Springs should be noted where groundwater is visibly discharging to surface water. Areas of iron or manganese staining should be identified. Phreatophytes or stressed vegetation should be noted if present. The presence of any sheen should be described. Any other condition that may suggest an area of groundwater discharge to surface water should also be reported. This method may be effective for evaluating near shore discharges but is not effective for determination of discharges further off shore.

Very low surface water flow periods may reveal discharges from groundwater and their impacts to surface water, so site visits should be timed correctly. Similarly, periods after a storm event, which may increase groundwater discharge to surface water, may cause the discharges to be more visible and therefore allow prospective sampling locations to be selected.

Large Water Bodies

Assessment of groundwater to surface water discharge in large water bodies will require more effort than smaller water bodies. Screening should occur parallel to shore as well as in transects away from the shore until the area of potential discharge has been delineated. Most of the screening techniques mentioned above can be adapted to larger water bodies through use of boats and divers when necessary. A deep-water seepage meter has been designed and deployed by the U. S. Navy at numerous deep-water sites (see Selected Reference List). Drive points may be installed from specialized boats. Methods for the use of diffusion samplers in deep water are currently being developed and tested by the USGS. It has been found that a significant amount of discharge may occur in the nearshore portions of deep-water bodies. Whenever possible, near shore conditions should be evaluated in large water bodies.

Assessing Flow Directions Within the Hyporheic/Transition Zone

Temporary wells, piezometers, or mini-piezometers can be installed manually in nearshore investigations. The top portion of the screened zone should be at least six inches below the surface of the sediment. Clusters of mini-piezometers set at varying depths may be emplaced to determine vertical gradients. After these points are allowed to equilibrate, water level elevations may be determined relative to the elevation of the water in the surface water body. These elevations may be compared between points to estimate flow directions within the hyporheic/transition zone. This information can also be used to identify areas where surface water should be sampled.

Surface Water Sampling for Evaluation of Contaminated Groundwater Discharges

If the groundwater plume discharging to the surface-water body has been adequately characterized and sampling data indicate no constituents are present above allowable levels for surface water, sampling may not be required.

To accurately assess the potential impacts of contaminated groundwater discharges, surface wate samples should be collected near the bottom of the water column in the area where contaminate groundwater discharge has been identified. Surface water samples should be collected during ba flow conditions and not during or immediately after a period of significant rainfall. It is preferred th samples be collected during the dry season or at least a week after a rainfall event to maximize sam representativeness and quality.

Surface water samples should be collected from all areas where a potential for preferential dischar contaminated groundwater is identified. If preferential pathways are not identified, samples sho collected upgradient of the area of suspected discharges, within the area of suspected discharge

immediately downstream of the area of suspected discharge. If the plume is relatively large, more than one sample should be collected from within the area of suspected plume discharge. If a zone of elevated contamination is suspected or known to exist within the plume or in the vicinity of discharge of the plume, the surface water should be sampled in the vicinity of this zone regardless of whether preferential discharge has been identified.

Surface water sampling locations should be surveyed and marked with a permanent marker so that spatial and temporal comparisons of surface water quality can be made. This will allow comparison of plume data with surface water quality and will allow resampling of any location of interest to determine changes in water quality over time. Sub-meter GPS surveys are adequate for most purposes. If the area is subject to erosion, a permanent elevation benchmark may be established nearby so that the elevation of the sampling locations can be measured over time.

If surface water contamination is identified, samples should be collected further out into the water body and further down stream until acceptable concentrations are identified in surface water so that the size of the area of impact may be determined.

SELECTED REFERENCES

The conceptual model for South Carolina was based on the following documents:

USEPA, 2000, Proceedings of the Ground-Water/Surface-Water Interactions Workshop: EPA/542/R-00/007

Winter, T. C., and others, 1998, Ground Water and Surface Water a Single Resource: USGS Circular 1139, 79p.

Winters, S.L. and D.R. Lee, 1987, *In Situ* Retardation of Trace Organics in Ground water Discharge to a Sandy stream Bed, *Environmental Science & Technology*, v. 21, no. 12, pp.1182-1186.

Publications regarding screening methods:

Diffusion Samplers

Church, P. E., Lyford, F. P., and S. Clifford, 2000, Distribution of Selected Volatile Organic Compounds Determined with Water-to-Vapor Diffusion Samplers at the Interface Between Ground Water and Surface Water, Centredale Manor Site, North Providence, Rhode Island, September 1999, USGS Open-File Report 00-276, 9pp.

Lyford, F. P., Willey, R.E., and S. Clifford, 2000, Field Tests of Polyethylene-Membrane Diffusion Samplers for Characterizing Volatile Organic Compounds in Stream-Bottom Sediments, Nyanza Chemical Waste Dump Superfund Site, Ashland, Massachusetts, USGS Water-Resources Investigations Report 00-4108, 19pp.

Vroblesky, D.A., Rhodes, L.C., Robertson, J. F., and J. A. Harrigan, 1996, Locating VOC

Contamination in a Fractured-Rock Aquifer at the Ground-water/Surface Water Interface using Passive Vapor Collectors: Ground Water, v. 34, no. 2, pp. 223-230.

Vroblesky, D.A., and T. Hyde, 1997, Diffusion Samplers as an Inexpensive Approach to Monitoring VOCs in Ground Water: Ground Water Monitoring Review, v. 17, no. 3, pp. 177-184.

Vroblesky, D.A., 2001, User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells, Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance: USGS Water-Resources Investigations Report 01-4060, 18 pp.

Vroblesky, D.A., ed., 2001, User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells,Part 2: Field Tests: USGS Water-Resources Investigations Report 01-4061, 99 pp.

Seepage Meters and Mini-Piezometers

Lee, D.R., 1977, A Device for Measuring Seepage Flux in Lakes and Estuaries, *Limnology & Oceanography* v. 22, no. 1, pp. 140-147.

Lee, D. R., and J. A. Cherry, 1978, A Field Exercise on Ground water Flow Using Seepage Meters and Mini-Piezometers, *J. Of Geological Education*, v. 27, pp. 6-10.

Lee, D. R., 1988, Six *In Situ* methods for Study of Ground water Discharge, *in* Proc. Of the Int. Symposium on Interaction between Ground water and Surface Water, May 30-June 3, Ystad, Sweden, pp. 556-566.

Deep Water Methods

Lee, D. R., and W. J. Beattie, 1991, Gamma Survey Probe for Use on Ocean, Lake, Estuary, and River Sediments, U.S. Patent#5,050,525.

Lee, D. R. And F.E. Harvey, 1996, Installing Piezometers in Deepwater Sediments, *Water Resources Research*, v. 32, no.4, pp. 1113-1117.

Savoie, J.G. and others, 2000, Delineation of Discharge Areas of Two Contaminant Plumes by Use of Diffusion Samplers, Johns Pond, Cape Cod, Massachusetts, 1998: USGS Water-Resources Investigations Report 00-4017, 30 pp.

Web Sites:

General Information
www.alumni.engin.umich.edu/~markhen/gsi/index.htm

www. GSIwebpage.net

www.epa.gov/tio/tsp/download/chadwick.pdf

MHE PushPoint Sampler
www. MHEproducts.com
MHE Products
371 Sherman Rd.
East Tawas, MI 48730
(989) 362-5179
sales@MHEproducts.com

Chemetrics Kits
chemetrics.com

Other Contacts:
Deep Water Seepage Meter
Bart Chadwick
U.S. Navy
Marine Environmental Quality Branch
SPAWAR Systems Center - San Diego
619-553-5333
chadwick@nosc.mil

APPENDIX III

USEPA TARGET ANALYTE LISTS

EPA United States Environmental Protection Agency

Superfund Analytical Services / Contract Laboratory Program (CLP)

SOM01.2 Semivolatile Target Compound List and Corresponding CRQLs

COMPOUND	CAS No.	SOM01.2 CONTRACT REQUIRED QUANTITATION LIMITS				
		Low Water by SIM (ug/L)	Low Water (ug/L)	Low Soil by SIM (ug/kg)	Low Soil (ug/kg)	Med. Soil (ug/kg)
Benzaldehyde	100-52-7	--	5 0	--	170	5,000
Phenol	108-95-2	--	5.0	--	170	5,000
Bis(2-chloroethyl) ether	111-44-4	--	5 0	--	170	5,000
2-Chlorophenol	95-57-8	--	5.0	--	170	5,000
2-Methylphenol	95-48-7	--	5 0	--	170	5,000
2,2'-Oxybis(1-choloropropane)	108-60-1	--	5.0	--	170	5,000
Acetophenone	98-86-2	--	5 0	--	170	5,000
4-Methylphenol	106-44-5	--	5.0	--	170	5,000
N-Nitroso-di-n propylamine	621-64-7	--	5 0	--	170	5,000
Hexachloroethane	67-72-1	--	5.0	--	170	5,000
Nitrobenzene	98-95-3	--	5 0	--	170	5,000
Isophorone	78-59-1	--	5 0	--	170	5,000
2-Nitrophenol	88-75-5	--	5.0	--	170	5,000
2,4-Dimethylphenol	105-67-9	--	5.0	--	170	5,000
Bis(2-chloroethoxy) methane	111-91-1	--	5 0	--	170	5,000
2,4-Dichlorophenol	120-83-2	--	5 0	--	170	5,000
Naphthalene	91-20-3	0 10	5 0	3.3	170	5,000
4-Chloroaniline	106-47-8	--	5 0	--	170	5,000
Hexachlorobutadiene	87-68-3	--	5.0	--	170	5,000
Caprolactam	105-60-2	--	5 0	--	170	5,000
4-Chloro-3-methylphenol	59-50-7	--	5.0	--	170	5,000
2-Methylnaphthalene	91-57-6	0 10	5.0	3 3	170	5,000
Hexachlorocyclopentadiene	77-47-4	--	5 0	--	170	5,000
2,4,6-Trichlorophenol	88-06-2	--	5.0	--	170	5,000
2,4,5-Trichlorophenol	95-95-4	--	5.0	--	170	5,000
1,1'-Biphenyl	92-52-4	--	5.0	--	170	5,000
2-Chloronaphthalene	91-58-7	--	5 0	--	170	5,000
2-Nitroaniline	88-74-4	--	10	--	330	10,000
Dimethylphthalate	131-11-3	--	5.0	--	170	5,000
2,6-Dinitrotoluene	606-20-2	--	5 0	--	170	5,000
Acenaphthylene	208-96-8	0.10	5 0	3.3	170	5,000
3-Nitroaniline	99-09-2	--	10	--	330	10,000
Acenaphthene	83-32-9	0 10	5 0	3.3	170	5,000
2,4-Dinitrophenol	51-28-5	--	10	--	330	10,000
4-Nitrophenol	100-02-7	--	10	--	330	10,000
Dibenzofuran	132-64-9	--	5.0	--	170	5,000
2,4-Dinitrotoluene	121-14-2	--	5 0	--	170	5,000
Diethylphthalate	84-66-2	--	5 0	--	170	5,000
Fluorene	86-73-7	0 10	5.0	3 3	170	5,000
4-Chlorophenyl-phenyl ether	7005-72-3	--	5 0	--	170	5,000
4-Nitroaniline	100-01-6	--	10	--	330	10,000
4,6-Dinitro-2-methylphenol	534-52-1	--	10	--	330	10,000
N-Nitrosodiphenylamine	86-30-6	--	5.0	--	170	5,000
1,2,4,5-Tetrachlorobenzene	95-94-3	--	5.0	--	170	5,000
4-Bromophenyl-phenylether	101-55-3	--	5.0	--	170	5,000
Hexachlorobenzene	118-74-1	--	5 0	--	170	5,000
Atrazine	1912-24-9	--	5 0	--	170	5,000
Pentachlorophenol	87-86-5	0.20	10	6.7	330	10,000
Phenanthrene	85-01-8	0 10	5.0	3 3	170	5,000
Anthracene	120-12-7	0.10	5 0	3.3	170	5,000
Carbazole	86-74-8	--	5.0	--	170	5,000
Di-n-butylphthalate	84-74-2	--	5 0	--	170	5,000
Fluoranthene	206-44-0	0 10	5.0	3.3	170	5,000
Pyrene	129-00-0	0 10	5.0	3 3	170	5,000
Butylbenzylphthalate	85-68-7	--	5.0	--	170	5,000
3,3'-dicholorobenzidine	91-94-1	--	5 0	--	170	5,000
Benzo(a)anthracene	56-55-3	0.10	5 0	3.3	170	5,000
Chrysene	218-01-9	0 10	5 0	3 3	170	5,000
Bis(2-ethylhexyl) phthalate	117-81-7	--	5.0	--	170	5,000
Di-n-octylphthalate	117-84-0	--	5.0	--	170	5,000

Benzo(b) fluoranthene	205-99-2	0.10	5 0	3.3	170	5,000
Benzo(k) fluoranthene	207-08-9	0.10	5.0	3 3	170	5,000
Benzo(a) pyrene	50-32-8	0.10	5 0	3 3	170	5,000
Indeno(1,2,3,-cd) pyrene	193-39-5	0.10	5 0	3 3	170	5,000
Dibenzo(a,h) anthracene	53-70-3	0.10	5.0	3.3	170	5,000
Benzo(g,h,i) perylene	191-24-2	0.10	5.0	3.3	170	5,000
2,3,4,6-Tetrachlorophenol	58-90-2	--	5.0	--	170	5,000

EPA United States Environmental Protection Agency

Superfund Analytical Services / Contract Laboratory Program (CLP)

ISM01.3 Metals and Cyanide Target Analyte List and Corresponding CRQLs

The quantitation limits detailed in the table below are provided as a summary only For full details regarding ISM01.3 target analytes and Contract Required Quantitation Limits (CRQLs), please refer to Exhibit C of the ISM01 3 Statement of Work (SOW).

ANALYTE	CAS No.	ISM01.3 CONTRACT REQUIRED QUANTITATION LIMITS					
		ICP-AES	ICP-AES	ICP-AES	ICP-AES	ICP-MS	ICP-MS
		Water (ug/L)	Soil (mg/kg)	Wipes (ug)	Filters (ug)	Water (ug/L)	Soil (mg/kg)
Aluminum	7429-90-5	200	20	20	2	20	--
Antimony	7440-36-0	60	6	6	0.6	2	1
Arsenic	7440-38-2	10	1	1	0 1	1	0.5
Barium	7440-39-3	200	20	20	2	10	5
Beryllium	7440-41-7	5	0 5	0 5	0 05	1	0.5
Cadmium	7440-43-9	5	0.5	0 5	0 05	1	0 5
Calcium	7440-70-2	5000	500	500	50	500	--
Chromium	7440-47-3	10	1	1	0 10	2	1
Cobalt	7440-48-4	50	5	5	0.5	1	0.5
Copper	7440-50-8	25	2.5	2 5	0.25	2	1
Iron	7439-89-6	100	10	10	1	200	--
Lead	7439-92-1	10	1	1	0.1	1	0 5
Magnesium	7439-95-4	5000	500	500	50	500	--
Manganese	7439-96-5	15	1.5	1 5	0.15	1	0 5
Nickel	7440-02-0	40	4	4	0.4	1	0.5
Potassium	7440-09-7	5000	500	500	50	500	--
Selenium	7782-49-2	35	3.5	3.5	0 35	5	2 5
Silver	7440-22-4	10	1	1	0.10	1	0.5
Sodium	7440-23-5	5000	500	500	50	500	--
Thallium	7440-28-0	25	2.5	2.5	0.25	1	0.5
Vanadium	7440-62-2	50	5	5	0.5	5	2.5
Zinc	7440-66-6	60	6	6	0.60	2	1

Additional Analytes	CAS No.	Water (ug/L)	Soil (mg/kg)
Mercury by Cold Vapor Atomic Absorption (CVAA)	7439-97-6	0.2	0 1
Cyanide by Spectrophotometry	57-12-5	10	0.5

EPA United States Environmental Protection Agency

Superfund Analytical Services / Contract Laboratory Program (CLP)

SOM01.2 Volatile Target Compound List and Corresponding CRQLs

COMPOUND	CAS No.	SOM01.2 CONTRACT REQUIRED QUANTITATION LIMITS				
		Trace Water by SIM (ug/L)	Trace Water (ug/L)	Low Water (ug/L)	Low Soil (ug/kg)	Med. Soil (ug/kg)
Dichlorodifluoromethane	75-71-8	--	0.50	5.0	5.0	250
Chloromethane	74-87-3	--	0.50	5.0	5.0	250
Vinyl chloride	75-01-4	--	0.50	5.0	5.0	250
Bromomethane	74-83-9	--	0.50	5.0	5.0	250
Chloroethane	75-00-3	--	0.50	5.0	5.0	250
Trichlorofluoromethane	75-69-4	--	0.50	5.0	5.0	250
1,1-Dichloroethene	75-35-4	--	0.50	5.0	5.0	250
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	--	0.50	5.0	5.0	250
Acetone	67-64-1	--	5.0	10	10	500
Carbon disulfide	75-15-0	--	0.50	5.0	5.0	250
Methyl acetate	79-20-9	--	0.50	5.0	5.0	250
Methylene chloride	75-09-2	--	0.50	5.0	5.0	250
trans-1,2-Dichloroethene	156-60-5	--	0.50	5.0	5.0	250
Methyl tert-butyl ether	1634-04-4	--	0.50	5.0	5.0	250
1,1-Dichloroethane	75-34-3	--	0.50	5.0	5.0	250
cis-1,2-Dichloroethene	156-59-2	--	0.50	5.0	5.0	250
2-Butanone	78-93-3	--	5.0	10	10	500
Bromochloromethane	74-97-5	--	0.50	5.0	5.0	250
Chloroform	67-66-3	--	0.50	5.0	5.0	250
1,1,1-Trichloroethane	71-55-6	--	0.50	5.0	5.0	250
Cyclohexane	110-82-7	--	0.50	5.0	5.0	250
Carbon tetrachloride	56-23-5	--	0.50	5.0	5.0	250
Benzene	71-43-2	--	0.50	5.0	5.0	250
1,2-Dichloroethane	107-06-2	--	0.50	5.0	5.0	250
1,4-Dioxane	123-91-1	--	--	100	100	5000
Trichloroethene	79-01-6	--	0.50	5.0	5.0	250
Methylcyclohexane	108-87-2	--	0.50	5.0	5.0	250
1,2-Dichloropropane	78-87-5	--	0.50	5.0	5.0	250
Bromodichloromethane	75-27-4	--	0.50	5.0	5.0	250
cis-1,3-Dichloropropene	10061-01-5	--	0.50	5.0	5.0	250
4-Methyl-2-pentanone	108-10-1	--	5.0	10	10	500
Toluene	108-88-3	--	0.50	5.0	5.0	250
trans-1,3-Dichloropropene	10061-02-6	--	0.50	5.0	5.0	250
1,1,2-Trichloroethane	79-00-5	--	0.50	5.0	5.0	250
Tetrachloroethene	127-18-4	--	0.50	5.0	5.0	250
2-Hexanone	591-78-6	--	5.0	10	10	500
Dibromochloromethane	124-48-1	--	0.50	5.0	5.0	250
1,2-Dibromoethane	106-93-4	0.050	0.50	5.0	5.0	250
Chlorobenzene	108-90-7	--	0.50	5.0	5.0	250
Ethylbenzene	100-41-4	--	0.50	5.0	5.0	250
o-Xylene	95-47-6	--	0.50	5.0	5.0	250
m,p-Xylene	179601-23-1	--	0.50	5.0	5.0	250
Styrene	100-42-5	--	0.50	5.0	5.0	250
Bromoform	75-25-2	--	0.50	5.0	5.0	250
Isopropylbenzene	98-82-8	--	0.50	5.0	5.0	250
1,1,2,2-Tetrachloroethane	79-34-5	--	0.50	5.0	5.0	250
1,3-Dichlorobenzene	541-73-1	--	0.50	5.0	5.0	250
1,4-Dichlorobenzene	106-46-7	--	0.50	5.0	5.0	250
1,2-Dichlorobenzene	95-50-1	--	0.50	5.0	5.0	250
1,2-Dibromo-3-chloropropane	96-12-8	0.050	0.50	5.0	5.0	250
1,2,4-Trichlorobenzene	120-82-1	--	0.50	5.0	5.0	250
1,2,3-Trichlorobenzene	87-61-6	--	0.50	5.0	5.0	250

Monitoring Well Application

1. Proposed Location of Monitoring Well(s):

   Street Address:

   City (including Zip):

   County:

   Please attach Scaled Map or Plat

2. Well Owner's Information:

   Name (Last then First):

   Company:

   Complete Address:

   Telephone Number:

3. Property Owner's Information:

   Check if same as Well Owner

   Name (Last then First):

   Company:

   Address:

   Telephone Number:

4. Proposed Drilling Date:

5. Intended Purpose of Well(s):

   Pre-Purchase

   Investigation

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

   Program Area:
   Project or Site ID #:

6. Proposed number of monitoring wells:

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

   VOCs

   BTEX

   MtBE

   Naphthalene

   PAHs

   Metals

   Nitrates

   Base, Neutral & Acid Ex.

   Pesticides/Herbicides

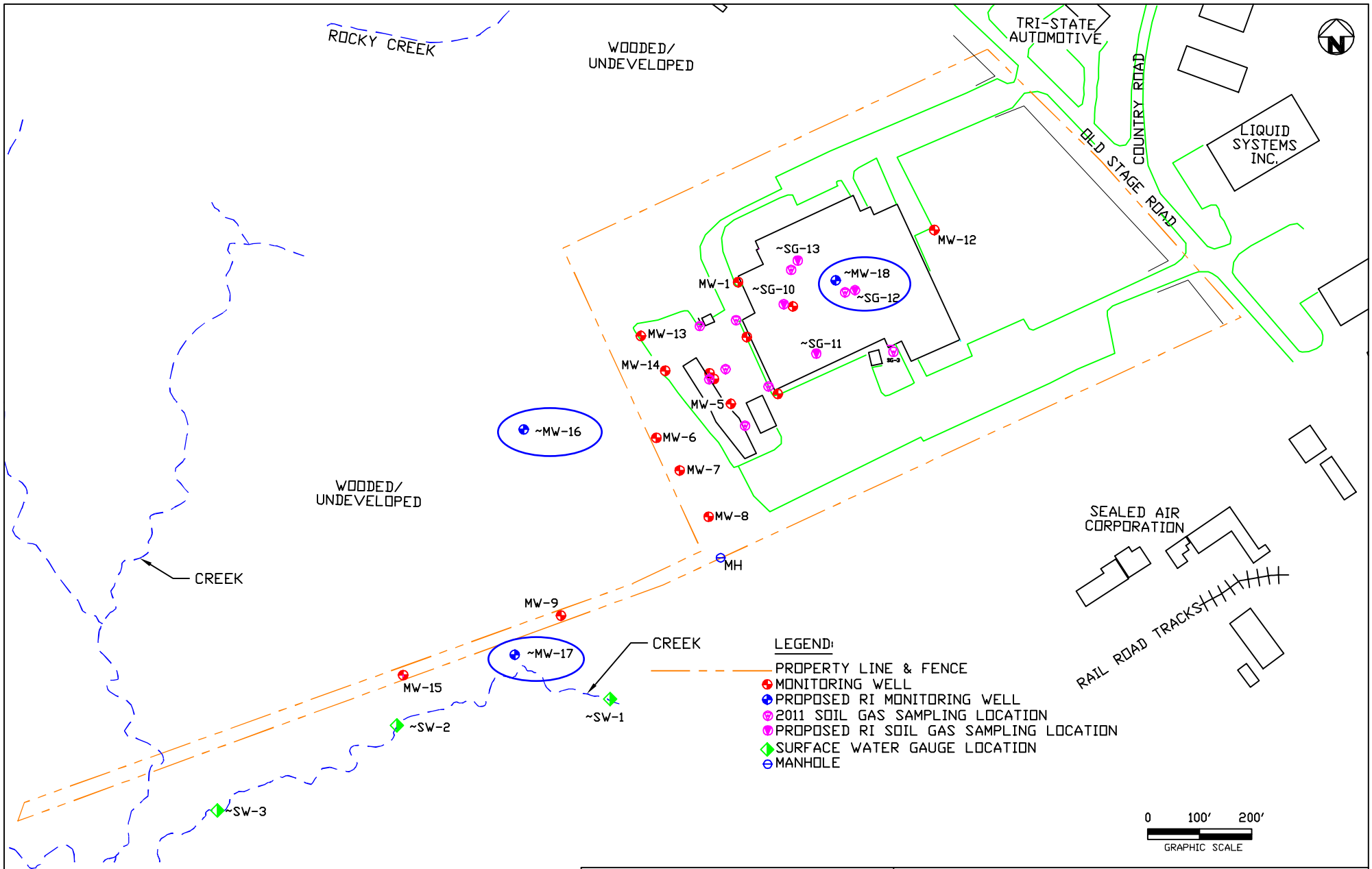
   Phenols

   Radionuclides

   PCBs

   Other (specify below)

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



SURVEY SOURCE: FREELAND & ASSOCIATES AND
GREENVILLE COUNTY PROPERTY ASSESSOR

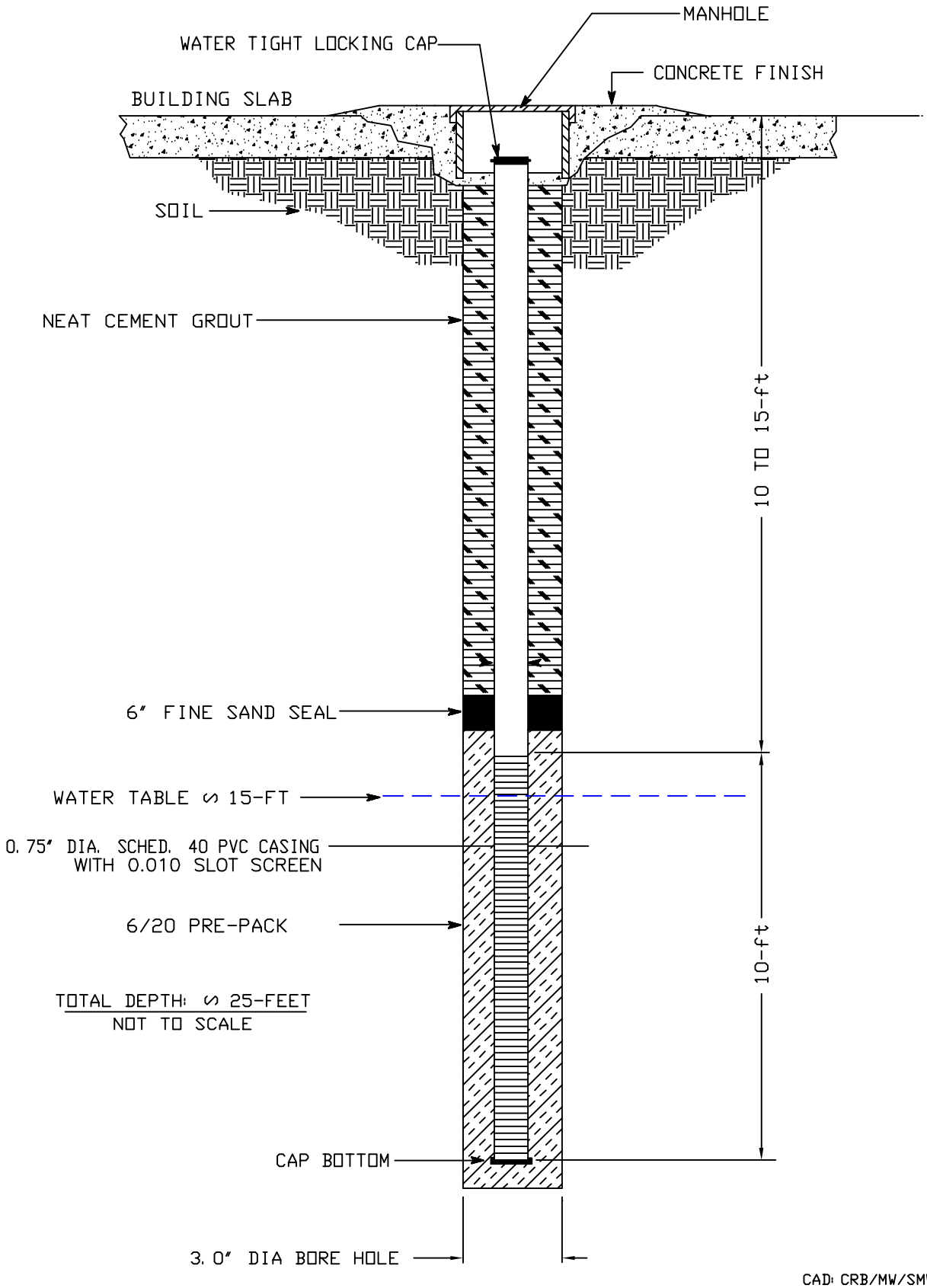
CRB
Geological & Environmental Services, Inc.
8744 SW 133rd Street
Miami, Florida 33176
Tel: (305) 447-9777
Fax: (305) 567-2853

TITLE: PROPOSED REMEDIAL INVESTIG. SAMPLE LOCATIONS
WOVEN ELECTRONICS
1001 OLD STAGE ROAD
SIMPSONVILLE, SOUTH CAROLINA

REV'D DATE:	SEP 8, 2014	PROJECT NO.	BEA 414-26
DRAWN DATE:	SEP 20, 2012	SCALE:	AS NOTED
DRAWN BY:	L. AYALA	APPROVED BY:	RW

FIGURE 6

BEA 414...\26...\Reports\2014 RIWP\CAD\F6 RI Locations

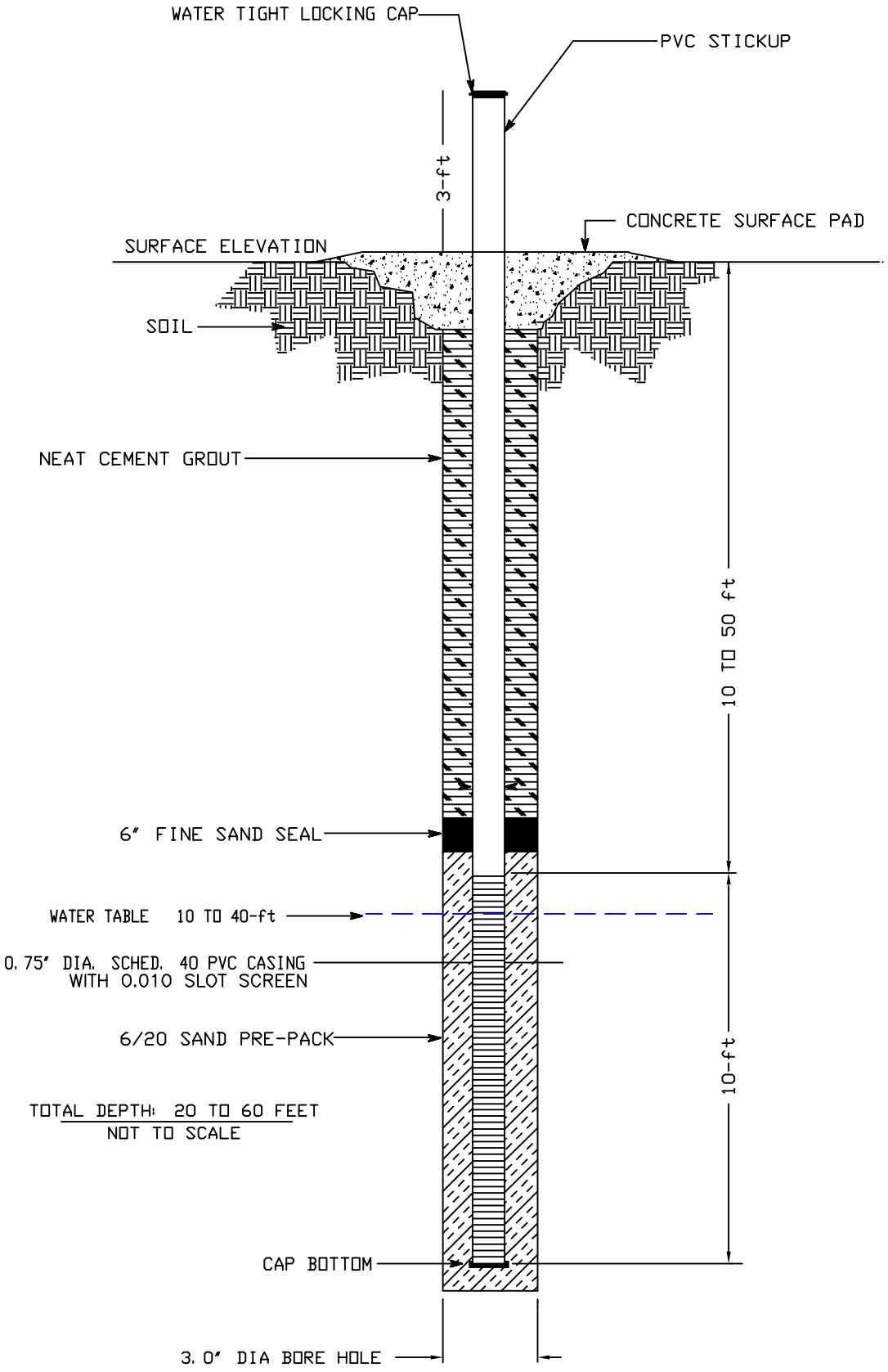


CAD: CRB/MW/SMWMH.DWG

FIGURE 1

SHALLOW MONITORING WELL ASSEMBLY
WITH MANHOLE IN SLAB
CONSTRUCTION DIAGRAM

CRB



CAD: CRB/MW/SMWMH.DWG

FIGURE 2

SHALLOW MONITORING WELL ASSEMBLY LIMITED ACCESS STICKUP CONSTRUCTION DIAGRAM

CRB