COKE OVEN AREA
INTERIM MEASURES
PILOT TEST RESULTS AND
PROTOTYPE SYSTEMS PLAN

Prepared for:

Severstal-Sparrows Point, LLC
Sparrows Point, Maryland

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1.0 INTRODUCTION

1.1 BACKGROUND

In their letter dated February 19, 2009 the Environmental Protection Agency (EPA) Region 3 requested that Severstal submit an Interim Measures (IM) work plan to recover hydrocarbons from groundwater at the Coke Oven Area (COA), under the authority of Section V.A.4 of the applicable Consent Decree (CD) for this facility. Section V.A.4 of the CD allows for collection of additional site information to help with the evaluation of potential IMs. Accordingly, Severstal submitted to EPA on July 17, 2009 a work plan to conduct pilot testing of soil vapor extraction (SVE), air sparging (AS), and groundwater pumping. EPA approved this work plan in their letter dated August 24, 2009.

This report presents the results of IM pilot testing conducted at the COA at Severstal-Sparrows Point, LLC’s (Severstal) Sparrows Point facility during October/November, 2009 and outlines proposed IMs including:

- Prototype AS/SVE Systems
- Enhanced in-situ Anaerobic Biological Remediation (AB) systems
- Light (i.e., floating on water) non-aqueous phase liquid (LNAPL) recovery

1.2 OBJECTIVES

The proposed designs of the IMs are intended to achieve the objectives outlined in the EPA approval letter dated August 24, 2009, including description of the IM technology, intended area of influence and/or systems due to the size of the remediation area, description of LNAPL recovery components, and description of how the IMs will reduce off-site migration of the groundwater plume.

As discussed in the July 17, 2009 IM pilot test work plan, the COA pilot testing objectives were to:

- Evaluate the potential effectiveness of Dual-Phase technologies (i.e., treatment of both groundwater and vapors) for removing and destroying benzene and naphthalene mass from the unsaturated zone and shallow groundwater,
- Conduct groundwater pumping to test the effects that groundwater extraction has on: a) optimizing heavy fraction hydrocarbon removal, b) mitigating groundwater elevation increases at the SVE extraction well to optimize extraction well efficiency (e.g., maintain/increase the vadose zone thickness to enhance vapor recovery), and c) lowering the groundwater table elevation at the pilot test area, thus influencing shallow groundwater migration,
- Develop criteria for expanded-scale IM application of the technology(ies) that demonstrate the most potential effectiveness,
- Evaluate other potential IM technologies (including screening and assessment), such as groundwater pumping to influence groundwater migration, LNAPL skimming, surfactant

enhanced product recovery, co-solvent enhanced recovery, aerobic and anaerobic bioremediation, etc.

1.3 SUMMARY OF COA SITE CONDITIONS

The COA is made land comprised of slag fill placed over natural sediments comprised of: 1) recent fluvial sediments deposited by the Patapsco River, and 2) the underlying Talbot Formation. The slag fill contains the uppermost hydrostratigraphic unit (Slag Fill Unit) at the COA. This unit is characterized by unconfined groundwater that occurs approximately 10 feet below ground surface (bgs). Shallow groundwater movement at the COA generally is radial toward surrounding surface water bodies.

Throughout much of the COA, the Slag-Fill unit is underlain by finer-grained silts and clays that comprise upper layers of the Talbot Formation and restrict downward migration of groundwater. In these areas, groundwater flow in the Slag-Fill Unit is separated from groundwater flow in any underlying coarse-grained beds or lenses. In some COA areas, the Slag-Fill Unit is directly underlain by and connected to the coarser grained sand lenses within the Talbot Formation. In these areas, the Slag-Fill and Upper Talbot Units form a single groundwater flow system.

COA groundwater analytical results indicate that VOCs and SVOCs (predominately benzene and naphthalene) have impacted groundwater. The areal extent of the VOCs and SVOC is confined to the southwestern fill portion of the Sparrows Point peninsula and has not migrated to the area north of the COA. The maximum VOC concentrations (predominately benzene) are located at the northwest portion of the COA. Groundwater with elevated VOCs has migrated toward the southwest and northwest of the COA.

SVOC concentrations (predominately naphthalene) are more evenly distributed, and the maximum concentrations are located on the eastern half of the COA. VOC and SVOC concentrations generally decrease to below their respective reporting limits or exhibit a significant decreasing trend toward the laboratory reporting limits in all samples collected from the lower groundwater zone piezometers. LNAPL is also present at the COA and is a contributing source of dissolved groundwater contamination.

2.0 DUAL-PHASE PILOT TEST SCOPE AND PROCEDURES

2.1 TEST WELL INSTALLATION

A total of fourteen (14) pilot test groundwater wells were installed using hollow-stem auger drilling techniques between mid-October and early November, 2009. Seven (7) test wells were installed in each of the former Benzol Processing Area and the Coal Tar Storage Area as shown on **Figure 2-1**. In each area, three types of wells were constructed: one air sparge (AS) well, one extraction well (EXT), and five observation wells (OBS). **Figure 2-2** illustrates the design features for these three types of wells and **Appendix A** presents the as-built boring logs and well construction diagrams.

The pilot test wells were installed to provide bottom depths coincident with the interface between slag and the underlying natural deposits, typically 20 to 25 ft bgs. The wells were screened as follows:

- 2-inch diameter AS wells were installed with 2-foot screened intervals coincident with the bottom of the slag which typically occurred at a depth of 20-25 ft bgs. These short, deep AS screens were designed to introduce air into the bottom of the saturated portion of the slag fill.
- 4-inch diameter EXT wells were installed with long screened intervals that extended across the entire saturated portion of the slag and 5-feet upward into the overlying unsaturated slag. The saturated screen interval allows for groundwater extraction by pumping while simultaneous extracting soil vapors from the unsaturated zone.
- OBS wells were constructed as described for the EXT wells. The OBS wells facilitated monitoring of groundwater levels and soil gas pressure.

The wells were installed in the general spatial configuration presented in the July 17, 2009 IM work plan; although some well locations were adjusted (i.e., offset) because of drilling difficulties and other site constraints. All wells were developed by pumping and resulting development water was contained in 55-gallon drums for subsequent chemical characterization and offsite treatment and disposal.

2.2 PILOT TEST PROCEDURES

Equipment was mobilized to the Site beginning on October 19, 2009 and included the following:

- Trailer-mounted internal combustion engine (ICE) remediation unit as described in **Appendix B**,
- Towable diesel-powered air compressor to supply sparge air,
- Four portable fractionation (“Frac”) tanks (21,000 gallon capacity each) for containing groundwater recovered during the pilot tests,
- 500-gallon propane tank for ICE supplemental fuel, and
- Various ancillary equipment necessary to support the pilot tests, including soil gas sampling equipment, double-diaphragm pump/hoses/valves/flow meters for pumping

groundwater, field instruments (PID, FID, water level meter, etc.), PPE necessary for compliance with project health and safety plan requirements, and other miscellaneous equipment.

Former Benzol Processing Area

Pilot testing was performed at the Former Benzol Processing Area from October 22 through October 28, 2009. In general, procedures described in the April 2009 IM work plan (URS, April 2009) were followed, including:

- Reviewing the project health and safety plan elements and discussing the testing procedure at a tailgate meeting,
- Measuring depth to groundwater water in each area well,
- Connecting the ICE vacuum hose assembly to well EXT-1. This assembly including a soil gas flow element, vacuum gauge, VOC sample collection port, polyurethane foam (PUF) cartridge holder for collecting SVOC constituents in the soil gas flow, and temperature gauge,
- Installing a suction tube into well EXT-1 (approximately 0.5 ft below the static water level) and pneumatic double-diaphragm (D-D) pump to withdraw groundwater from well EXT-1 and control the water level during SVE operation,
- Installing a groundwater discharge hose from the D-D pump to one of the 21,000-gallon “frac” tanks,
- Connecting the compressed air hose, equipped with a flow/pressure regulator and flow meter, to the air sparge well AS-1,
- Collecting a pre-test groundwater sample from well EXT-1 on the discharge side of the D-D pump. This sample was not intended to represent a compliance sample, but rather a pre-test “process design” sample for comparison to a similar sample collected from well EXT-1 after the pilot testing was completed,
- Performing groundwater profiling at several depths in the water column of each well for various parameters (temperature, specific conductivity, pH, oxidation-reduction potential, and dissolved oxygen, both before and after SVE/AS testing) using a YSI 556 MPS water quality meter, and
- Checking the equipment for proper operation before starting the SVE/AS pilot testing.

SVE operations were performed on well EXT-1 in three different modes:

1. SVE with no groundwater pumping,
2. SVE with groundwater pumping to maintain the static water level in well EXT-1 at or approximately 0.5 ft below the static water level, and
3. SVE with groundwater pumping as in No. 2 above plus air sparging at well AS-1.

In addition, based on field observations during air sparging at well AS-1, four other wells (EXT-1, OBS-1, OBS-2, and OBS-3) were connected simultaneously to the ICE unit because aggressive bubbling was observed (as a result of the air sparging) in each of the observation wells. As discussed in Section 3.1, this modification increased benzene mass recovery by the ICE, as compared to SVE from a single well (i.e., EXT-1).

During each operational mode described above, various data were periodically collected, including:

- Vacuum pressure in well EXT-1 well casing,
- Vacuum pressure, soil gas temperature, and differential pressure across the soil gas flow element in order to compute soil gas flow rate,
- Vacuum pressure responses in the observation wells (OBS-1 through OBS-5, BP-MW-02S, BP-MW-02D, and well CO18-PZM006),
- Compressed air pressure and flow rate at well AS-1 (during AS operations only),
- Various ICE control panel readings (as displayed and recorded by the ICE control module), including propane fuel usage, well gas BTU values and various other ICE operational data,
- Groundwater pumping rates (during pumping cycles), and
- Water levels in some observation wells.

Various samples were collected during each operational mode as follows:

- Soil gas samples for VOC analysis were collected in Tedlar® bags from the ICE vacuum hose assembly via a small laboratory vacuum pump. The Tedlar® bags were shipped via Federal Express to TestAmerica Laboratories' Knoxville, Tennessee facility for analysis by EPA Method TO-15.
- Samples for SVOC analysis were collected using laboratory prepared PUF cartridges that were also shipped via Federal Express to TestAmerica Laboratories' Knoxville, Tennessee facility for analysis by EPA Method TO-13.
- Field analyses of soil gas samples for Total VOCs were also performed periodically using a photoionization detector (PID) instrument, flame ionization detector (FID) instrument, and a Horiba auto emissions analyzer.

Field and laboratory data collected for the Former Benzol Processing Area pilot tests are summarized in **Appendix C**.

Former Coal Tar Storage Area

Between November 3 and 6, 2009, pilot testing was performed at the Former Coal Tar Storage Area. Generally the procedures described in the April 2009 IM work plan (URS, April 2009) were followed. Specific procedures essentially identical to those described above for the Former Benzol Processing Area pilot tests were also followed.

Field and laboratory data collected for the Former Coal Tar Storage Area pilot tests are summarized in **Appendix C.**

Aquifer Pump Testing

Two short-term (3 hour) aquifer-pumping tests, one at Former Benzol Area well EXT-1 and the second at the Former Coal Tar Storage Area well EXT-2, were performed to assess the water table aquifer hydraulic properties. These tests were conducted on November 5 and 6, 2009, respectively. Details of the pumping tests are presented in **Appendix D**.

Potential Fouling

Fouling produced by inorganic precipitates and microbial mass may impact the efficiency and maintenance requirements of groundwater treatment systems. Existing COA data describing Eh, pH, and metals concentrations throughout the COA were reviewed to assess the potential for fouling resulting from precipitation of inorganic associated with in-situ groundwater treatment that changes prevailing Eh, pH, and oxygen conditions (see discussion in Section 3.4.2).

3.0 PILOT TEST RESULTS

This section summarizes the pilot test results. Presented results focus on those parameters important to design and operation of full-scale IM remediation systems for the COA. Accordingly, the results include unsaturated slag zone formation responses to SVE and saturated slag zone responses to both air sparging and groundwater pumping. Estimated benzene and naphthalene mass removal rates are also summarized.

3.1 FORMER BENZOL PROCESSING AREA PILOT TEST

3.1.1 Formation Responses

Several important parameters resulting from the SVE pilot tests include:

- Effective radius of influence (ROI),
- Unsaturated zone intrinsic permeability, and
- Contaminant mass removal rate.

Effective SVE ROI is generally considered to be the distance from an extraction well from which contaminant vapors can be removed from the unsaturated zone formation via induced soil gas flow. There are numerous interpretations and methods used to evaluate SVE ROI; some more rigorously analytical than others. However, there are also relatively simple graphical methods, as used herein, to evaluate the ROI based on vacuum pressure responses in observation wells. It must be emphasized that the ROI parameter, regardless how it is derived, is only an approximation of what may be expected under prototype or full-scale SVE implementation.

Vacuum pressure responses in the observation wells measured and recorded during the "SVE with groundwater pumping mode" were used to evaluate a SVE ROI in the unsaturated slag zone. These data were used to evaluate the SVE ROI because the maximum SVE effectiveness should be achieved when the water level in the extraction well (EXT-1) is controlled at or below the original static water level.

As shown by the October 22, 2009 data in **Appendix C**, no vacuum pressure responses were measured in any of the observation wells surrounding SVE well EXT-1 (including well OBS-4, located approximately 15.5 ft from well EXT-1), even with groundwater pumping to control the water level at or near the original static level. Based on these results, an effective ROI for well EXT-1 could not be evaluated, but is less than 15.5 ft. *This suggests that the unsaturated slag zone material surrounding well EXT-1 is relatively "tight" and not permeable to soil gas flow*.

The unsaturated zone permeability of the Former Benzol Processing Area was estimated using the vacuum pressure-soil gas flow relationship at well EXT-1, based on methods described by Johnson, et.al. (1990). From **Appendix E**, an intrinsic permeability of 36 Darcy (equivalent to a saturated hydraulic conductivity of approximately 3.5 x 10^{-2} centimeters per second [cm/sec]) is indicated. Saturated hydraulic conductivity is presented as a relative comparison for purposes of identifying intrinsic formation permeability and for comparison to the saturated slag zone hydraulic conductivity, as discussed below.

Air Sparging responses are typically described in terms of three-dimensional air flow distribution or "zone of air flow", which are typically irregular in shape, as determined by preferential air pathways that are established under sparging conditions in the saturated zone. Continuously sparged air typically establishes preferential pathways in the saturated zone that may or may not intercept zones of groundwater VOC contaminants and thereby achieve the desired level of contaminant removal effectiveness.

When air sparging is combined with SVE, VOC contaminant mass removal rates can be increased (compared to removal rates by SVE alone) because of "in-situ air stripping" of VOCs from the groundwater. The sparged air tends to accumulate VOC vapors that partition into the vapor phase and are subsequently extracted and treated by the SVE system. Pulsed air sparging (intermittent doses of air) tends to reduce development of unwanted preferential air pathways while still providing a level of "in-situ VOC air stripping" while supplying oxygen to subsurface water, which can enhance aerobic microbial respiration of the VOCs and SVOCs present at the Former Benzol Processing Area.

During air sparging at well AS-1 at a compressed air flow rate of 30 standard cubic feet per minute (SCFM) at a pressure (gauge) of 10.5 pounds per square inch (psig), varying degrees of "bubbling", ranging from none up to "violent bubbling", were recorded in the test wells surrounding well AS-1. Only two wells (OBS-5 located 20 ft southeast from well AS-1 and pre-existing well BP-MW-02D, also located 20 ft north from well AS-1) showed no indication of bubbling. However, other wells located farther from well AS-1 (i.e., well CO18-ZM006 at over 29 ft to the northeast) experienced significant bubbling of sparged air. These results indicate the zone of air flow around well AS-1 was irregular in shape with a maximum observed impact at approximately 30 ft (see **Figure 2-1** for test well locations).

During the EXT-1 pumping test, a groundwater pumping rate of 23.9 gallons per minute (gpm) was maintained based on the pump test data for well EXT-1 in the Former Benzol Processing Area (**Appendix D**). Analysis of the pump test data indicate the average hydraulic conductivity of the saturated slag zone in the Former Benzol Processing Area was 1,005 ft/day or 3.5×10^{-1} cm/sec. This data indicates that the saturated zone is approximately 1 order of magnitude more permeable than the unsaturated zone based on the 3.5×10^{-2} cm/sec SVE-evaluated intrinsic permeability of the unsaturated slag zone. While this analysis is based on limited data, these data suggest the unsaturated zone is less permeable than the saturated zone.

3.1.2 Contaminant Removal Responses

Table 3-1 summarizes important data from the Former Benzol Processing Area pilot test used to estimate benzene and naphthalene removal rates. Results are discussed below.

As described in Section 3.2, numerous samples of soil gas were collected for analysis during the pilot test. Soil gas analytical results (**Appendix F**) were utilized, along with soil gas flow rates to compute benzene and naphthalene mass removal rates in the soil gas under varying SVE and AS/SVE conditions.

3.1.2.1 Benzene

Calculation sheets used to compute benzene mass removal rates in the soil gas (expressed in pounds of benzene removed per hour) are presented in **Appendix G** and summarized as follows:

- SVE only (extraction from well EXT-1 with no air sparging): 0.20 pounds/hour,
- SVE (extraction from well EXT-1) with air sparging: 2.58 pounds/hour, and
- SVE (simultaneous extraction from 4 wells) with air sparging: 6.95 pounds/hour

These results indicate that significant increases in benzene mass recovery are caused by air sparging; particularly when multiple wells (i.e., EXT-1, OBS-1, OBS-2, and OBS-3) were used for extraction of soil gas (including sparged air). The effect of "in-situ air stripping" of benzene via air sparging and recovery of the sparged air appears beneficial for enhancing benzene mass recovery from the saturated zone via SVE.

Groundwater samples were collected from the D-D pump discharge from well EXT-1 (Section 3.2) prior to the start of SVE operations and after completion of the AS/SVE portion of the pilot testing. A significant decrease in benzene concentration (**Table 3-2**) was observed after completion of the pilot testing, as follows:

- Pre-test benzene concentration in well EXT-1: 790 mg/L
- Post-test benzene concentration in well EXT-1: 430 mg/L

While the decrease in benzene concentration resulting from the short-term combination of AS/SVE in well EXT-1 is likely temporary because of "rebound" from surrounding groundwater benzene concentrations, the potential for the combined technologies to reduce groundwater benzene concentrations is illustrated.

3.1.2.2 Naphthalene

From the PUF analytical data of **Appendix F**, no significant naphthalene mass was recovered via the soil gas during the short-term SVE pilot tests. Air sparging did not enhance naphthalene mass recovery.

3.2 FORMER COAL TAR STORAGE AREA PILOT TEST

3.2.1 Formation Responses

As shown in the data of November 4, 2009 in **Appendix C**, no vacuum pressure responses were measured during SVE in any of the observation wells surrounding EXT-2 in the Former Coal Tar Storage Area (including well OBS-10, located approximately 15.5 ft from well EXT-2), even with groundwater pumping to control the water level at or near the original static level. Based on these results, an effective ROI for well EXT-2 could not be evaluated, but is less than 15.5 ft. This suggests the unsaturated slag zone material surrounding well EXT-2 is also not permeable to soil gas flow. This is similar to the condition observed at well EXT-1 in the Former Benzol Processing Area.

The unsaturated slag zone permeability of the Former Coal Tar Storage Area was estimated using the vacuum pressure-soil gas flow relationship at well EXT-2, as described above for well EXT-1. From **Appendix E**, an intrinsic permeability of 5.7 Darcy (equivalent to a saturated hydraulic conductivity of approximately 5.5×10^{-3} cm/sec) is indicated. Saturated hydraulic conductivity is presented for comparison to the saturated slag zone hydraulic conductivity, as derived from the pump test and discussed below.

During air sparging at well AS-2 at a compressed air flow rate of 50 SCFM and pressure of 13 psig, “bubbling” was observed in only two test wells surrounding well AS-2. Well OBS-9, located approximately 7 ft from well AS-2, exhibited “vigorous bubbling” while well OBS-7, located approximately 15 ft from well AS-2, exhibited only slight bubbling. All other wells around well AS-2 exhibited no bubbling of sparged air. These results suggest the zone of air flow in the saturated slag zone around well AS-2 was irregular in shape with maximum observed impact at less than 15 f t (see **Figure 2-1** for test well locations)

During the EXT-2 pumping test a pumping rate of only 9.9 gpm resulted in significant pumping well drawdown, contrasted with EXT-1 (Benzol Area) where a pumping rate of 24 gpm resulted in much less drawdown. Also, the observation well associated with EXT-2 showed very minor drawdown. These factors suggest that the hydraulic conductivity at EXT-2 was less than at EXT-1. However, the curve-matching results discussed in **Appendix D** reveal similar calculated hydraulic conductivities (0.4 cm/s at EXT-1 versus 1.2 cm/s at EXT-2). This similarity likely is an artifact of the very minor drawdown at the EXT-2 observation well and the resultant uncertainties with the associated curve-matching.

3.2.2 Contaminant Removal Responses

Table 3-3 summarizes important data from the Former Coal Tar Storage Area pilot tests, used to estimate benzene and naphthalene removal rates. Results are discussed below.

3.2.2.1 Benzene

Soil gas analytical results (**Appendix F**) were utilized, along with soil gas flow rates to compute benzene and naphthalene mass removal rates under varying SVE and AS/SVE conditions. A calculation sheet used to compute benzene mass removal rates (expressed in pounds of benzene removed per hour) under AS/SVE conditions is presented in **Appendix G** and summarized as follows:

- SVE (extraction from well EXT-2) with air sparging: 0.002 pounds/hour

These results indicate no significant benzene mass recovery by SVE combined with air sparging. The effect of “in-situ air stripping” of benzene via air sparging and recovery of the sparged air does not appear to be practicable for enhancing benzene mass recovery from the saturated zone at the Former Coal Tar Storage Area.

Groundwater samples were collected from the D-D pump discharge from well EXT-2 (Section 3.2) prior to the start of SVE operations and after completion of the AS/SVE portion of the pilot testing. Slight increases in both benzene and naphthalene concentrations (**Table 3-2**) were observed after completion of the pilot testing, as follows:

- Pre-test benzene concentration in well EXT-2: 0.9 mg/L
- Post-test benzene concentration in well EXT-2: 1.2 mg/L
- Pre-test naphthalene concentration in well EXT-2: 5.5 mg/L

- Post-test naphthalene concentration in well EXT-2: 15 mg/L

These groundwater results indicate the combined AS/SVE technologies are not effective for reducing groundwater benzene or naphthalene concentrations in the Former Coal Tar Storage Area. Groundwater analytical data are presented in **Appendix F**.

3.2.2.2 Naphthalene

Similar to results from the Former Benzol Processing Area, the PUF analytical data of **Appendix F**, show no significant naphthalene mass was recovered via the soil gas during the short-term SVE pilot tests. Air sparging did not enhance naphthalene mass recovery.

3.3 SHORT-TERM AQUIFER PUMP TEST

At EXT-1 a groundwater pumping rate of 23.9 gallons per minute (gpm) was maintained. The pump test data analysis (Appendix D), indicate a slag zone hydraulic conductivity of 0.4 cm/sec.

At EXT-2 a groundwater pumping rate of only 9.9 gallons per minute (gpm) could be maintained, indicating a lower permeability at EXT-2. However, the pump test data analysis (Appendix D) calculated an EXT-2 hydraulic conductivity of 1.2 cm/sec, which is higher than observed at EXT-1. The observation well associated with EXT-2 showed very minor drawdown. Therefore, there is significant uncertainty associated with the curve matching results used to estimate the EXT-2 hydraulic conductivity.

The pump test results, while short-term in nature, reveal that the saturated slag zone is very productive and that potential groundwater treatment systems that involve groundwater pumping may be impractical at the COA.

3.4 POTENTIAL FOULING

3.4.1 Biological Fouling

Optimization of growth conditions for microorganisms can result in biological fouling of treatment systems. Water samples from EXT-1 and EXT-2 were analyzed for Biochemical Oxygen Demand (BOD). BOD is a chemical procedure for determining the uptake rate of dissolved oxygen by biological organisms in the water sample being tested. If the water sample contains contaminants that microorganisms can utilize and the water chemistry is not otherwise toxic to the microorganism, then they will metabolize the contaminant and utilize oxygen in the process.

BOD results for EXT-1 and EXT-2 were 1,100 and 140 mg/l, respectively (Appendix F). The higher value for EXT-1 likely relates to the fact that benzene, which was present in a high concentration in the sample, is relatively more readily biodegradable than naphthalene which was the dominant carbon source in EXT-2.

The implication is that the groundwater constituents support microbial activity and, if conditions are optimized, biological growth, increased metabolism of water carbon sources (i.e. benzene and naphthalene), and potential bio-fouling may occur. The rates of growth/fouling, however, can be mitigated by monitoring and controlling the parameters that control biological growth.

'Bio-fouling' can also be leveraged to remove groundwater constituents such as benzene and naphthalene.

3.4.2 Chemical Fouling

Review of field parameter results (URS, 2005) for numerous wells throughout the COA shows dissolved oxygen concentrations typically below 1 mg/l, eH values are correspondingly negative, pH usually is elevated, and iron concentrations are elevated. The low oxygen and eH likely are influenced by in-situ microbial activity, motivated by the abundant food/carbon sources (benzene and naphthalene. Groundwater treatment that changes eH/pH conditions, such as introducing oxygen and increasing eH can cause metals to precipitate from solution and encourage chemical fouling. This potential exists at the COA and, therefore, potential groundwater treatment systems must be designed with this possibility in mind. Any treatment approach that minimizes introduction of oxygen (i.e. in-situ anaerobic bio-treatment) is advantageous from a chemical fouling perspective.

3.5 FINDINGS SUMMARY

Results of the IM pilot tests indicate:

- AS/SVE, applied at multiple locations simultaneously, significantly enhances benzene removal from the saturated slag zone groundwater at the Former Benzol Processing Area, but not at the Former Coal Tar Storage Area.
- SVE alone (without AS) is not effective for reducing benzene concentrations in the unsaturated slag zone in either the Former Benzol Processing Area or the Former Coal Tar Storage Area.
- The unsaturated slag zone is less permeable than the saturated slag zone in each area. This observation suggests that sparged air is restricted from migrating to the surface and can potentially be directed to engineered collection points within (or slightly above) the saturated-unsaturated zone interface.
- It is likely that localized aerobic conditions could develop around AS wells, could be enhanced, and would encourage aerobic biodegradation of benzene and naphthalene. Beyond the zone of AS well influence, anaerobic conditions probably would prevail.
- Anaerobic bioremediation (likely an ongoing COA process, as discussed in Section 4) probably would persist in areas beyond the influence of AS wells due to the COA's prevailing highly anaerobic groundwater conditions. Anaerobic bioremediation in these areas could be enhanced to accelerate reduction of groundwater benzene and naphthalene concentrations.
- Biological and chemical fouling can occur at the COA and influence the operation of any treatment system. Negative influences can be managed by proper treatment system design.

4.0 ASSESSMENT OF ADDITIONAL IM TECHNOLOGIES

The presence of LNAPL at the COA and the limited effectiveness of AS/SVE at the Former Coal Tar Storage Area motivate consideration of additional IM technologies. **Table 4-1** identifies thirteen additional IM technologies that have been screened for their interim applicability. It summarizes the following information for each technology:

- Process/Description
- Advantages (Technical Effectiveness)
- Disadvantages
- Assessment Status (Retained/Rejected)

The technologies that passed the screening process, supplemental to AS/SVE at the Former Benzol Processing Area, are:

- LNAPL product skimming, and
- Enhanced In-situ Anaerobic Bioremediation at the Former Benzol Processing Area

These two additional technologies are described below in sections 4.1 and 4.2. Section 5.0 presents proposed details for the implementation of AS/SVE, LNAPL product skimming, and enhanced anaerobic bioremediation.

4.1 LNAPL PRODUCT SKIMMING

EA (2009) recently described the occurrence of LNAPL at the COA. The thickness of the LNAPL measured in monitoring wells ranges up to about 4 feet, representing significant recoverable product. LNAPL product skimming consists of using an automatic oil skimming/collection system to remove LNAPL from the well(s) in which it accumulates. Additional recovery wells/skimmers can be considered if, during skimming, changes in recovery rates indicate that zones of influence do not cover the entire area of LNAPL occurrence.

4.2 ENHANCED *IN-SITU* BIOREMEDIATION OF BENZENE AND NAPHTHALENE

The following observations suggest that benzene and naphthalene can be removed via enhanced in-situ bioremediation, in conjunction with or as an alternative to AS/SVE which is best-suited for the Former Benzol Processing Area.

Site data indicate that groundwater sulfate-reducing conditions are prevalent at the Former Coal Tar Storage Area, based on reported dissolved oxygen concentrations, oxidation-reduction potentials (ORP), and concentrations of total nitrogen, nitrate, sulfate, sulfide, total iron, and methane. It should be considered that aerobic, nitrate-reducing, and iron-reducing processes would have depleted aerobic terminal electron acceptors (TEA) long ago. Site sulfate concentrations are likely supporting sulfate-reducing microbial populations capable of biodegrading naphthalene, indicated by measured ORP, sulfate, and sulfide levels. This probability is increased due to the high solubility of both contaminants in water and their somewhat easy chemical structure to metabolize by bacteria. Methane does not appear to be readily produced and thus methanogenic microbial populations are not likely significant in size in comparison to those that undergo sulfate-reduction.

Further detailed discussion of the in-situ biodegradation process applicable to naphthalene and benzene at the Former Coal Tar Storage Area is provided in Appendix I.

4.2.1 Naphthalene Biodegradation

In-situ naphthalene degradation under the anaerobic conditions prevalent at the Former Coal Tar Storage Area is likely occurring, considering the long time period for indigenous microorganism to adapt to the site conditions and the low oxygen conditions present throughout the COA. Anaerobic naphthalene degradation is known to occur under nitrate-, iron-, and sulfate-reducing conditions as well as more extremely reduced methanogenic conditions.

Naphthalene bioremediation is well established and accepted, as indicated by a number of API and US.EPA guidelines concerning groundwater and the vadose zone. A brief investigation into reported degradation rates provides the following examples of naphthalene biodegradation rates:

- Aerobic (vadose zone) degradation: 700 µg/L/d
- Anaerobic groundwater degradation: 2.24 µg/L/d

4.2.2 Benzene Biodegradation

In-situ benzene degradation under aerobic and anaerobic (nitrate-, iron-, and sulfate-reducing conditions as well as methanogenic conditions) has been well established for decades. Thousands of reports are available in the peer-reviewed scientific and technical literature. Benzene has been successfully remediated when partnered with other BTEX compounds, more complex hydrocarbons, metals, and chlorinated contaminants. Remediation has occurred in both the vadose zone and in groundwater. Aerobic, *in-situ* biodegradation occurs so readily that it is not considered to be a challenge and thus is no longer reported in the technical literature as an interesting occurrence.

A brief investigation into reported degradation rates provides the following examples of benzene degradation rates:

- Aerobic (vadose zone) degradation: 1,200 µg/L/d
- Anaerobic groundwater degradation: 6.14 µg/L/d

Further detailed discussion of the in-situ biodegradation process applicable to naphthalene and benzene at the Former Coal Tar Storage Area is provided in **Appendix I**.

5.0 PROPOSED INTERIM MEASURES

Based on the pilot test findings and inferences concerning the applicability of LNAPL recovery and in-situ anaerobic bioremediation of benzene and naphthalene, Severstal proposes to implement the following COA Interim Measures;

- Construct, as IM Phase 1, a prototype AS/SVE system at the Former Benzol Processing Area to evaluate the proposed technology performance at operational prototype scale. Operate this Former Benzol Processing Area prototype system for a 6-month to 1-year period to collect operational data. Pending satisfactory performance of the system (as defined by benzene recovery/destruction efficiencies and groundwater benzene concentration decreases), construct and operate, as IM Phase 2, additional AS/SVE systems located at the Former Coal Storage Area and Cove Area, , as described in the following paragraphs. Satisfactory operation of the proposed AS/SVE technology concept will be confirmed at operational prototype scale in the Former Benzol Processing Area before deploying the technology to other areas.
- Construct a prototype enhanced AB naphthalene and benzene groundwater treatment system at the Former Coal Tar Storage Area, consisting of Phase 1 (Proof of Concept) and Phase 2 (Build-out). Phase II would be scoped based on the Phase I findings, and
- LNAPL recovery at the central portion of the LNAPL area defined by the recent EA study (2009).

5.1 PROTOTYPE AS/SVE AND ENHANCED IN-SITU ANAEROBIC BIODEGRADATION SYSTEMS

Locations and design details for these systems are described below.

5.1.1 Locations

Severstal proposes to ultimately implement AS/SVE systems in three areas at the Former Benzol Processing Area (‘yellow’ systems in **Figure 5-1**) and two enhanced in-situ AB systems at two areas at the Former Coal Tar Storage Area (‘red’ systems in **Figure 5-1**). All prototype systems, as shown on **Figure 5-1** along with the benzene concentration in the shallow aquifer, are intended address benzene and naphthalene contamination in the saturated slag zone. The proposed footprints for the **Figure 5-1** systems may be adjusted slightly from those shown, depending on surface features and subsurface utilities yet to be identified. **Figure 5-2** is a close-up of the proposed AS/SVE systems.

A prototype AS/SVE system at the Former Benzol Processing Area will be constructed and operated first to evaluate the proposed technology performance at operational prototype scale. This Former Benzol Processing Area prototype system will be operated for a 6-month to 1-year period to collect operational data. Pending satisfactory performance of the system (as defined by benzene recovery/destruction efficiencies and groundwater benzene concentration decreases), additional AS/SVE systems will be constructed and operated at the Former Coal Storage Area and Cove Area, as IM Phase 2. The Former Coal Storage Area AS/SVE system (**Figure 5-2**) proposed at the northwest corner of the former COA is also intended to address benzene contamination in the intermediate groundwater formation which underlies the shallow slag groundwater zone. At this location, elevated benzene concentrations are present below the shallow slag groundwater formation.

The AS/SVE systems are intended to mitigate the groundwater plume in locations around the former COA where the existing data indicate the greatest potential for offsite migration of benzene and naphthalene in the groundwater. The systems employ the AS/SVE technology combination that was demonstrated effective during the pilot tests described herein. Complimentary aerobic and anaerobic bioremediation processes will also be evaluated simultaneously in conjunction with operation of the AS/SVE technologies. The prototype In-situ AB System proposed for the Former Coal Tar Storage Area is coincident with the area of highest groundwater naphthalene concentrations and where DNAPL has been observed in shallow monitoring well CO13-PZM0008 (**Figure 5-6**).

5.1.2 Prototype System Design Details

Design details are discussed below for 1) AS/SVE Systems, and 2) In-Situ AB Systems.

5.1.2.1 AS/SVE System Design Details

The AS/SVE system will utilize a combination of saturated slag zone (shallow aquifer) and deeper (intermediate aquifer) air sparge wells coupled with vapor collection trenches in the unsaturated/saturated slag zone and possibly vapor recovery wells in the intermediate aquifer. All vapor recovery systems will be connected to a dedicated internal combustion engine (ICE) that will provide the vapor extraction vacuum and vapor destruction capacity necessary to destroy the recovered benzene vapors.

It is expected the air sparge systems in both groundwater aquifers will be pulsed in order to maximize benzene vapor recovery rates and not develop air preferential pathways. The combination of AS wells to be used and frequency of cycling will be developed during startup and shakedown of each individual system. The ICE unit will be equipped with an integral air compressor to provide the sparge air. In this way, the ICE unit provides both SVE and AS functions while providing a failsafe condition in that if the ICE shuts down, the AS component also automatically shuts down. In the event that the proposed slag zone vapor collection trench does not function properly, the backup concept is to provide a network of SVE collection wells, similar in construction to those installed for the AS/SVE pilot tests described herein.

The vapor collection design (trenches) for this system mitigates potential fouling issues by not relying on individual wells intended to facilitate both distribution and recovery of sparge air (i.e., dual purpose wells). The extremely large sparge air recovery zone presented by the recovery trenches and their distance from the injection locations, results in reduction of the oxygen content and associated fouling potential of sparge air before it reaches the recovery trench. If excessive injection well fouling occurs, replacement injection wells can be considered.

The prototype system proposed for the Benzol Area (**Figure 5-3)** is configured as a "double-wide" footprint in order to address a larger impacted area. It is positioned between the Former Benzol Processing Area pilot test location (near well CO18-PZM006) and the LNAPL recovery well MW-BP-05 in order to maximize potential benzene mass recovery. As described above, this prototype system will be constructed and operated first to establish operational and performance parameters.

Figure 5-4 shows a schematic diagram of plan and section views of the proposed system for the northwest corner (Former Coal Storage Area) of the former COA. This system, to be constructed after confirmation of the operational prototype AS/SVE system at the Former Benzol Processing Area, will utilize a combination of saturated slag zone (shallow aquifer) and deeper (intermediate aquifer) air sparge wells coupled with vapor collection trenches in the unsaturated/saturated slag zone and vapor recovery wells in the intermediate aquifer. All vapor recovery systems will be connected to a dedicated internal combustion engine (ICE) that will provide the vapor extraction vacuum and vapor destruction capacity necessary to destroy the recovered benzene vapors. **Figure 5-5** shows a schematic diagram of plan and section views of the proposed system for the Cove Area near well CO30-PZM060 (**Figure 5-5**).

5.1.2.2 In-Situ Bio System Design Details

Before construction of the In-situ AB system, additional site monitoring is planned to:

- Prove that indigenous micro-organisms are present
- Prove that the indigenous micro-organisms are actively degrading benzene and naphthalene under the prevailing anaerobic site conditions
- Identify the nutrient requirements to optimize microbe performance
- Establish baseline geochemical and biological conditions
- Design nutrient injection requirements (amounts and frequency)

This 'proof of concept' step will substantially utilize 'bio-trap' analyses. Bio-Trap analyses will be performed for both benzene and naphthalene (see **Appendix J** for a detailed description of Bio-traps). Both isotopically-labeled benzene and naphthalene are commercially available. Each hydrocarbon will have its own Bio-Trap, and one of each Bio-Trap can be deployed at the same time in the same monitoring well. Bio-Trap assemblies, containing one of each type of Bio-Trap will be placed in multiple, strategically located monitoring wells in order to gain the most valuable information possible regarding how to fine-tune bioremediation plans in order to increase bioremediation efficiency and effectiveness.

After inception of the bioremediation system, Bio-Traps will once again be deployed to monitor changes in the degrading community, the level of bioremediation success, and to determine if any further modifications need to be made to the remediation system.

Implementation of the Prototype In-Situ AB system at the Former Coal Tar Storage Area will focus on the shallow aquifer where naphthalene concentrations are greater than 10,000 ug/L and is considered to be an area with residual DNAPL that feeds the dissolved phase groundwater plume. **Figure 5-6** illustrates the planned treatment area. The proposed bioremediation for the naphthalene contamination is intended to remove naphthalene and provide operational information for expansion to other COA areas (Phase II).

The planned implementation sequence generally is: 1) deployment of bio-traps, 2) construction of the groundwater circulations cells, 3) amend groundwater with biological essential nutrients indicated by the bio-traps, 4) circulate groundwater to distribute the amendments, 5) again utilize bio-traps and groundwater chemistry analysis to monitor system performance and amendment attenuation, 6) repeat amendments as indicated.

Figure 5-7 illustrates the planned groundwater circulation cells. Three circulation cell configurations (A, B, and C) are planned. Associated with each circulation cell is a nutrient injection well and a groundwater extraction well. Extracted groundwater will be re-injected into the injection well, with the intent of dispersing nutrients. A monitoring well will be located mid-way between the injection well and the extraction well to assess nutrient dispersion. The planned distances between these three wells (extraction, monitoring, and injection) is 10 feet, 20 feet, and 50 feet, respectively, for configurations A, B, and C.

These three wells will be oriented perpendicular to the inferred shallow groundwater flow direction. Thus, after nutrient dispersion by pumping/injection, the natural shallow groundwater seepage will effect additional down-gradient dispersion, increasing the size of the treatment area. To assess down-gradient dispersion and contaminant attenuation, each configuration will include four additional closely-spaced monitoring wells, as illustrated in **Figure 5-7**.

The wells will be installed to the base of the slag which is typically between 20 and 25 feet below the ground surface. Injection wells will have a 15-foot screen and will typically be screened from a few feet above the water table to the base of the slag. Based on the results of the bio-trap testing, a nutrient mixture will be delivered into the subsurface in order to enhance biodegradation of the dissolved naphthalene concentrations. The nutrient mixture will be mixed and delivered to the subsurface using either large above-ground tanks or by extracting groundwater and adding amendments and re-injecting it. The tanks can be filled either by pumping groundwater into the tank or by using the potable water, if available. Nutrients will be added to the water and either pumped down the wells or gravity fed into the wells. The exact volume of nutrient to be delivered will be determined after the bio-trap testing discussed above.

5.2 LNAPL SYSTEM

LNAPL recovery from the COA is planned at existing well BP-MW-05 (**Figure 5-1**), where approximately 3 feet of LNAPL is present. This well also was determined to be the most efficient producer of LNAPL (*EA Engineering Science and Technology* 2009). The LNAPL from BP-MW-05 will be recovered using an automatic pumping system. Performance of the system will be monitored and the recovery network may be expanded to other existing wells and potentially new wells where LNAPL is present.

5.3 PROTOTYPE SYSTEM INSTALLATION/OPERATION SCHEDULE

Pending EPA approval of this IM Work Plan, Severstal plans to install the proposed IM Phase I operational prototypes for the Former Benzol Processing Area and Coal Tar Area AB systems about 120 days after EPA's approval, assuming no extreme site conditions are encountered during construction and associated regulatory permits are obtained for installation and operation of remedial processes. Pending satisfactory performance of the IM Phase I prototype systems (as defined by satisfactory benzene/naphthalene mass removal rates and decreases in groundwater benzene/naphthalene concentrations after a 6-month to 1-year operational period), Severstal plans to implement IM Phase 2 consisting of: 1) design, construct, and operate the operational IM systems for the Cove Area and Former Coal Storage Area, and 2) implement expanded Coal Tar Area AB systems.

6.0 REFERENCES

EA Engineering, Science, and Technology, Inc. “Site Assessment for the Proposed Coke Point Dredged Material Containment Facility at Sparrows Point”. November, 2009.

Johnson, P.C., et.al. “A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil-Venting Systems. GWMR. Spring 1990.

URS, “Site Wide Investigation, Report of Nature and Extent of Releases to Groundwater from the Special Study Areas”, January, 2005.

USEPA. “Soil Vapor Extraction Technology Reference Handbook”. EPA/540/2-91/003. Washington, DC. February 1991.

Tables

Table 3-1
Pilot Test Summary
Former Benzol Processing Area
Severstal Sparrows Point, LLC

Parameter	Value	Units	Notes
Air Sparge Zone of Air Flow	30	feet	irregular shape zone of air flow
SVE ROI in Unsaturated Slag Zone	< 15.5	feet	estimated value because no measured vacuum responses in observation wells
Saturated Zone Permeability	$3.5x10^{-1}$	cm/sec	based on pump test at well EXT-1
Unsaturated Slag Zone Permeability	$3.5x10^{-2}$	cm/sec	based on SVE data at well EXT-1 with groundwater level control
Benzene Mass Removal Rate (Sparge)	2.6	lbs/hr	SVE from well EXT-1 only with sparging
Benzene Mass Removal Rate (4 well Sparge)	7.0	lbs/hr	SVE from four wells (EXT-1, OBS-1, OBS-2, OBS-3, and OBS-4 simultaneously with sparging
Benzene Mass Removal Rate (No Sparge)	0.2	lbs/hr	SVE from well EXT-1 only with no sparging

Table 3-2

Benzene and Naphthalene Concentrations in EXT-1 and EXT-2

Parameter	Water Units	EXT-1	EXT-1-PS	EXT-2	EXT-2-PS
		10/26/2009	10/27/2009	11/3/2009	11/4/2009
Benzene	ug/l	790,000	430,000	900	1,200
Naphthalene	ug/l	270	320	5,500	15,000

Note: Samples EXT-1 and EXT-2 samples were collected at the beginning of the pilot test and EXTT-1-PS and EXT-2-PS were collected at the end ('**P**ost-**S**parging). EXT-1 is located at the benzol area. EXT-2 is located at the coal tar area.

Table 3-3
Pilot Test Summary
Former Coal Tar Storage Area
Severstal Sparrows Point, LLC

Parameter	Value	Units	Notes
Air Sparge Zone of Air Flow	15	feet	irregular shape zone of air flow
SVE ROI in Unsaturated Slag Zone	< 15.5	feet	estimated value because no measured vacuum responses in observation wells
Saturated Zone Permeability	1.2	cm/sec	based on pump test at well EXT-2 (a)
Unsaturated Slag Zone Permeability	$5.5x10^{-3}$	cm/sec	based on SVE data at well EXT-2 with groundwater level control
Benzene Mass Removal Rate (Sparge)	$2.4x10^{-3}$	lbs/hr	SVE from well EXT-2 only with sparging
Benzene Mass Removal Rate (No Sparge)	0.0	lbs/hr	SVE from well EXT-2 only with no sparging

(a) Minor observation well drawdown imparts greater uncertainty to the permeability estimatd from drawdown curve matching.

Table 4-1
IM Technology Assessment
Severstal Sparrows Point, LLC

Technology	Process	Description	Advantage / Technical Effectiveness	Disadvantage	Assessment Status
Free-Phase Product Recovery	Product Skimming	Install active or passive NAPL removal systems in selected wells and remove product to the intent practicable	Effectively removes free-phase product	Can be a slow process	RETAINED
	Multiphase Extraction	Uses high vacuum to remove various combinations of impacted groundwater, separate-phase petroleum product and hydrocarbon vapor from the subsurface.	Accelerates contaminant removal relative to traditional product recovery (e.g. product skimming)	Requires energy and separation/treatment of extracted waste streams	Rejected
Enhanced Product Recovery	Surfactant Enhanced Product Recovery	Facilitates NAPL and groundwater cleanup through the addition and recovery of non-toxic food-grade surfactants to NAPL-impacted regions of the subsurface.	Increases the mobility and/or solubility of organic constituents in the NAPL, groundwater and sorbed phases in the treatment zone. Surfactants would facilitate the entrainment of hydrophobic compounds to effectively remove multiphase organic materials.	Limitations related to its implementability in the field and residual impacts.	Rejected
	Co-Solvent Enhanced Recovery	Co-Solvents (e.g. primary alcohols) are used in place of (or in conjunction with) surfactants.	The co-solvent is used to enhance the solubility of the organic compounds, thus quickening the pace of mass recovery in a dissolved form in recovered groundwater.	Slow and costly. The reliance on NAPL solubilization may exacerbate groundwater impacts if the co-solvent injection and recovery treatment cell is not hydraulically contained.	Rejected
Groundwater Containment	Slurry Wall Containment	This containment typically consists of a vertically excavated trench filled with a semi-liquid mixture of soil, bentonite and water.	The slurry hydraulically shores the trench to prevent collapse and forms a low permeability zone to reduce groundwater flow across the trench.	Construction defects and post construction property changes lead to the greater probability for system failure.	Rejected
	Soil Vapor Extraction/Air Sparging	Air is injected into the subsurface (in the zone of saturation) to encourage transfer of volatile organic contaminants from the aqueous phase to the vapor phase. SVE is used in conjunction with air sparging to remove VOCs from soils in the unsaturated zone.	On-site pilot tests have shown technologies to be effective for benzene reduction in groundwater	Requires energy and separation/treatment of extracted waste streams	RETAINED
	Pump and Treat	Extraction and ex-situ treatment of impacted groundwater.	Groundwater would be extracted from recovery wells installed within or at the perimeters of groundwater plumes at rates high enough to prevent water from migrating from the site. Extracted water would require treatment for removal of the constituents of concern prior to return to the subsurface or before discharge. Water treatment for volatile organics could include air stripping, thermal oxidation or granular activated carbon.	Anticipated flow volume is very high which would require a large treatment system; Timeframe required to treat groundwater using this technology is excessively long.	Rejected

Table 4-1
IM Technology Assessment
Severstal Sparrows Point, LLC

Technology	Process	Description	Advantage / Technical Effectiveness	Disadvantage	Assessment Status
Enhanced Bioremediation	Aerobic Bioremediation	Adds oxygen into groundwater to stimulate degradation of organic constituents such as the types of aromatic hydrocarbons found at the site.	The organic constituents observed in groundwater at the site readily biodegrade given sufficient dissolved oxygen as an electron acceptor in biodegradation reactions.	Low oxygen levels within slag layer.	RETAINED
	Anaerobic Bioremediation	Addition of microorganisms that use inorganic oxygen-bearing compounds to stimulate hydrocarbon degradation.	Anaerobic bacteria use nitrate, sulfate, iron, manganese and carbon dioxide as their electron acceptors to break down organic chemicals into smaller compounds such as carbon dioxide and methane.	In-situ bioremediation may not be effective where free-phase product is present because constituent concentrations are too high for microbial degradation.	RETAINED
Capping	DMCF Capping	Placement of low permeability dredged material over the existing surface onshore. The onshore slag material would be capped by the designed thickness of approximately 25 to 30 feet of low permeability dredged material that would be placed over time as the DMCF was filled with dredged material.	The DMCF capping process would adequately protect against further environmental impacts to groundwater from onshore fill material, and it could be implemented seamlessly with the construction of the DMCF.	Increased dead load could "squeeze" contaminant-laden groundwater out of existing saturated slag zone.	Rejected
	Engineered Capping	Placement of low permeability geotextile, liners or clay material that would be brought onto the site and placed over the existing land surface.	Similar to DMCF capping, the purpose of the engineered cap would be to reduce infiltration and potential leaching of source material to groundwater. This technology would require long-term maintenance to be effective.	The engineered cap is an implementable remedy and would not be necessarily be compatible with future use of the Peninsula as a DMCF.	Rejected
Thermal Treatment	Electrical Resistance Heating	Install electrically heated thermal/SVE wells in the impacted zones and apply electric current to heat the soil to approximately 100 degrees Celsius while applying vacuum to extract NAPL constituent vapors. The heat extracted vapor stream by condensation/thermal oxidizer/granular activated carbon (GAC) treatment.	Water and organic constituents released by vaporization during heating will migrate to relatively conductive subsurface regions, where they will be recovered via wells by vacuum extraction. The heat created by the process forces trapped liquids to vaporize and move to the stream zone for removal via the extraction wells	Cost prohibitive based on the size of impact.	Rejected
	Ex-Situ Thermo Desorption	Process that involves excavation of impacted material followed by treatment through heating to volatilize organic constituents.	Successfully used to remediate soils containing coking operations wastes, including MAHs and PAHs.	Not implementable due to the volume of material to be treated, the need to control/treat off-gases and the energy intensive nature of operations.	Rejected
Stabilization	In-Situ Stabilization/Solidification	Constituents are physically bound or enclosed with a stabilized mass (solidification) or chemical reactions are induced between the stabilizing agent and constituents to reduce their mobility.	Reduces contaminant migration potential	Not generally effective on dissolved hydrocarbon constituents and considered implementable over the area of concern.	Rejected

Figures

N

Legend

- 1st System Focused on the Benzol Pilot Test Area
- 2nd System Focused on the Coal Tar Storage Pilot Test Area

GIS: AER
CHECKED: BE
SENIOR: BE

URS
200 Orchard Ridge Drive
Gaithersburg, MD 20878

Figure 2-1

AS/SVE Pilot Test Locations
Sparrows Point
Former Coke Oven Area

G:\Projects\SparrowsPoint\Projects\2009\2-1CokeOven-and-CokePoint-PilotTestAreas-Jan11.mxd 01/11/10 aer

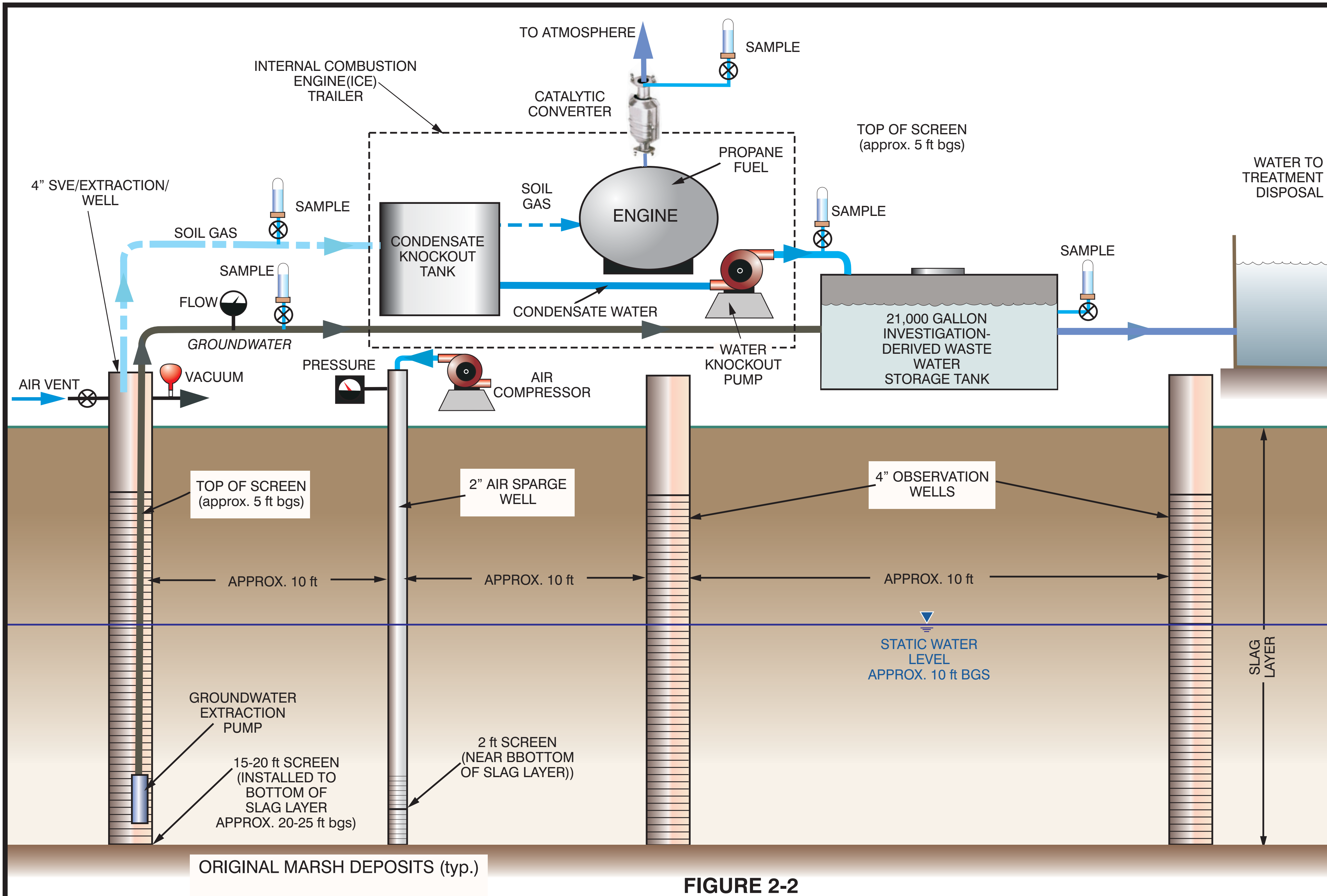


FIGURE 2-2
SEVERSTAL-SPARROWS POINT
DUAL-PHASE SOIL VAPOR AND GROUNDWATER EXTRACTION PILOT TEST SYSTEM

URS

SW13-PZM003

CLIENT: Sparrows Point	LOCATION: Baltimore, MD
DATE: 01/11/10	FILE: G:\Projects\SparrowsPoint\Projects\2009\6-1CokeOven-and-CokePoint-Prototype focusareas-BenzAndNaph-Jan11.mxd

GIS: AER
CHECKED: RL
SENIOR: BE

URS
200 Orchard Ridge Drive
Gaithersburg, MD 20878

Figure 5-1

In-situ AS/SVE and Anaerobic Bio-Treatment Areas, and Shallow Wells

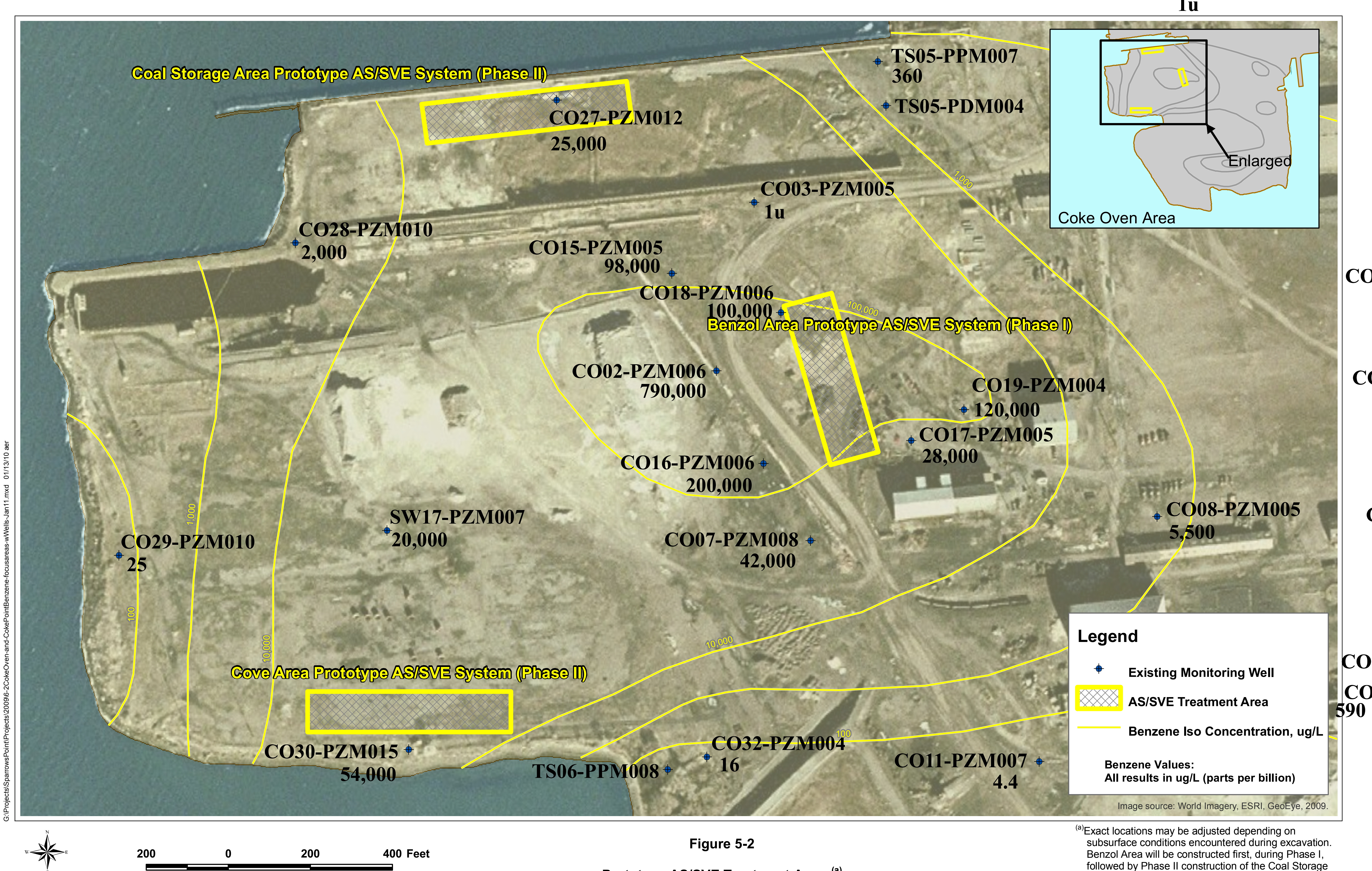
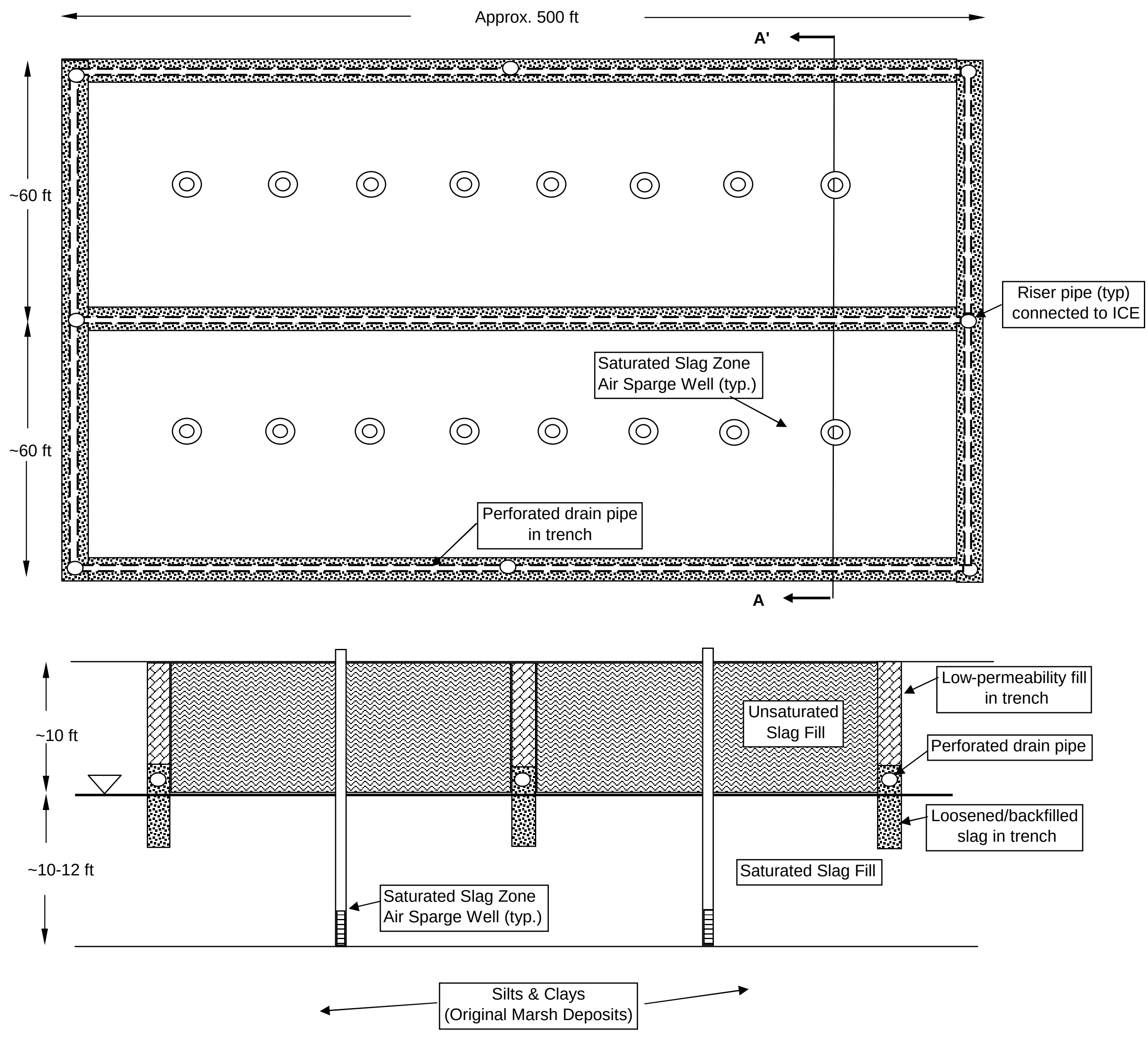


Figure 5-2

Prototype AS/SVE Treatment Areas[a]

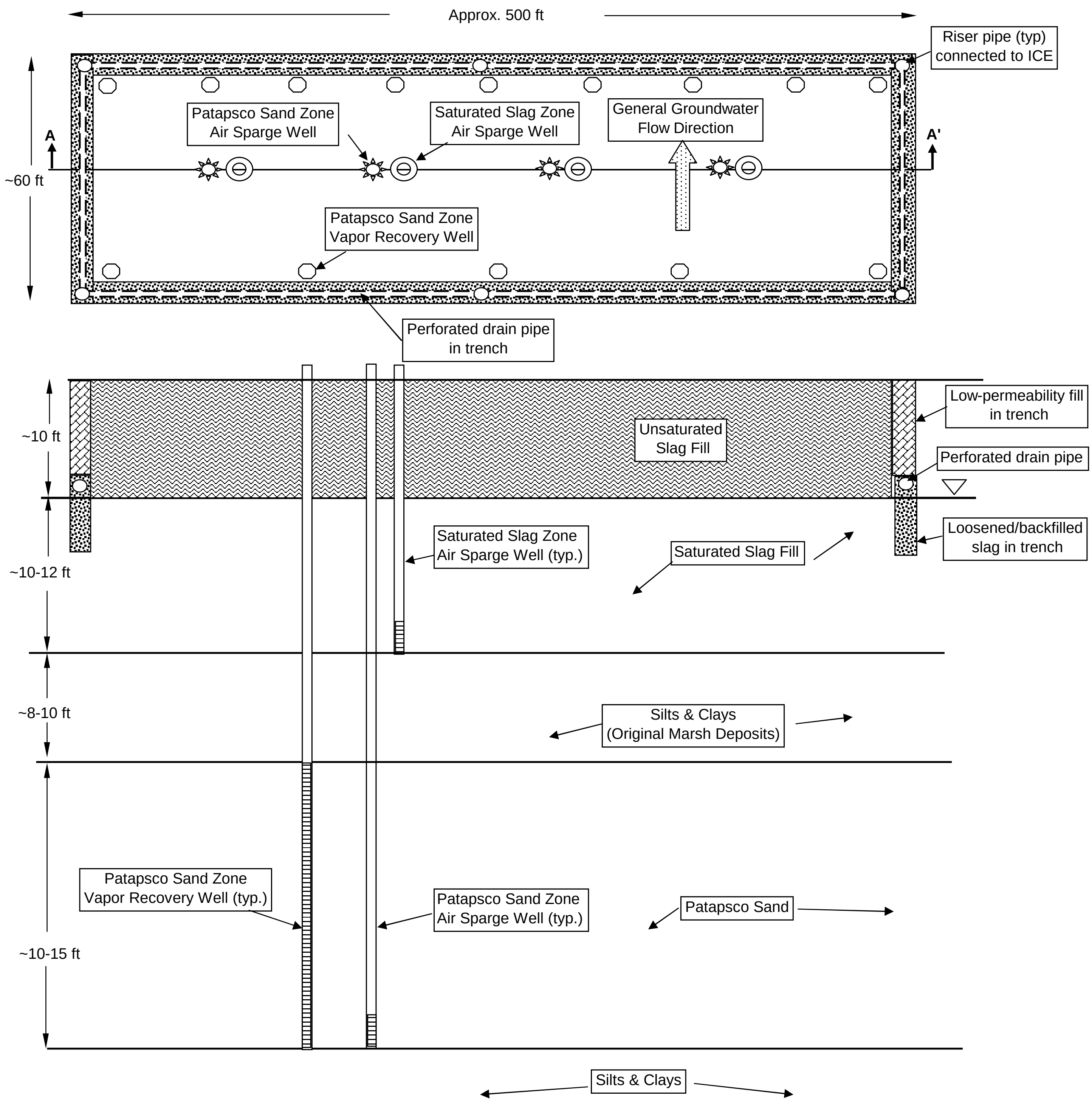
[a]Exact locations may be adjusted depending on subsurface conditions encountered during excavation. Benzol Area will be constructed first, during Phase I, followed by Phase II construction of the Coal Storage and Cove Area systems.

Figure 5-3
Schematic Diagram - Prototype AS/SVE System
Benzol Area
Severstal Sparrows Point, LLC.



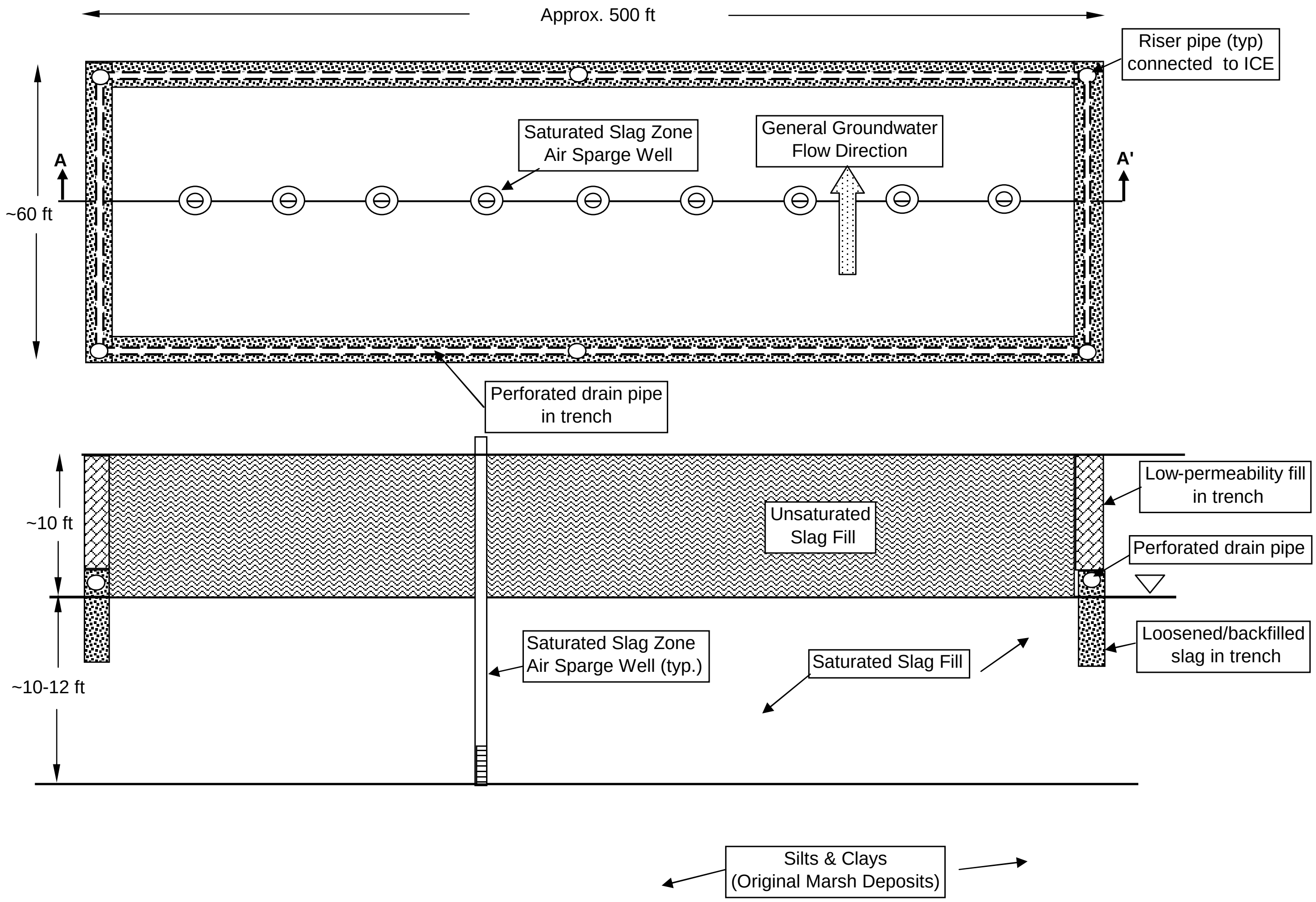
Section A-A' (not to scale)

Figure 5-4
Schematic Diagram - Prototype AS/SVE System
Former Coal Storage Area
Severstal Sparrows Point, LLC.



Section A-A' (not to scale)

Figure 5-5
Schematic Diagram - Prototype AS/SVE System
"Cove" Area (CO30-PZM015 Area)
Severstal Sparrows Point, LLC



Section A-A' (not to scale)

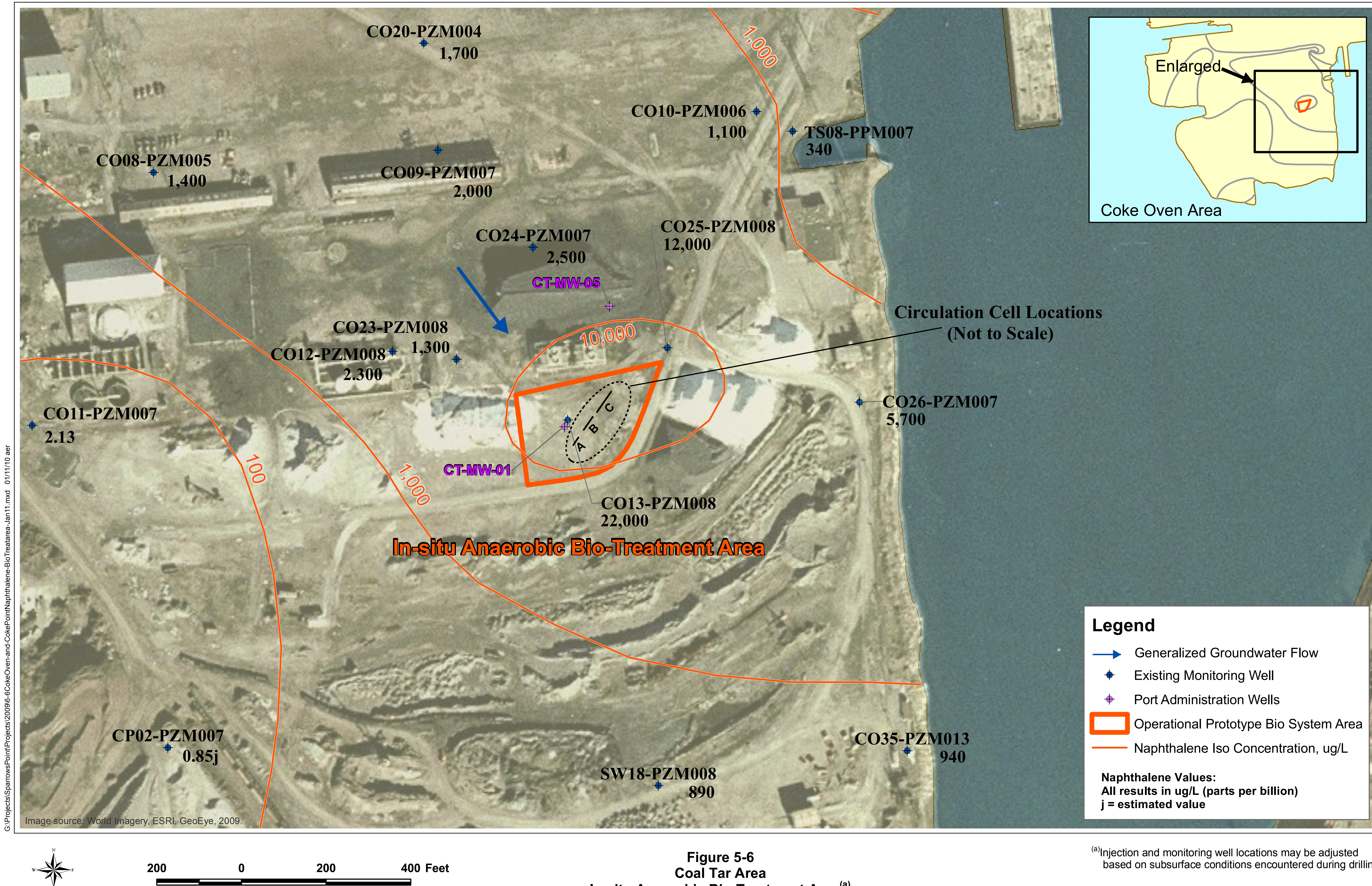


Figure 5-6
Coal Tar Area
In-situ Anaerobic Bio-Treatment Area[(a)]

[(a)]Injection and monitoring well locations may be adjusted based on subsurface conditions encountered during drilling.

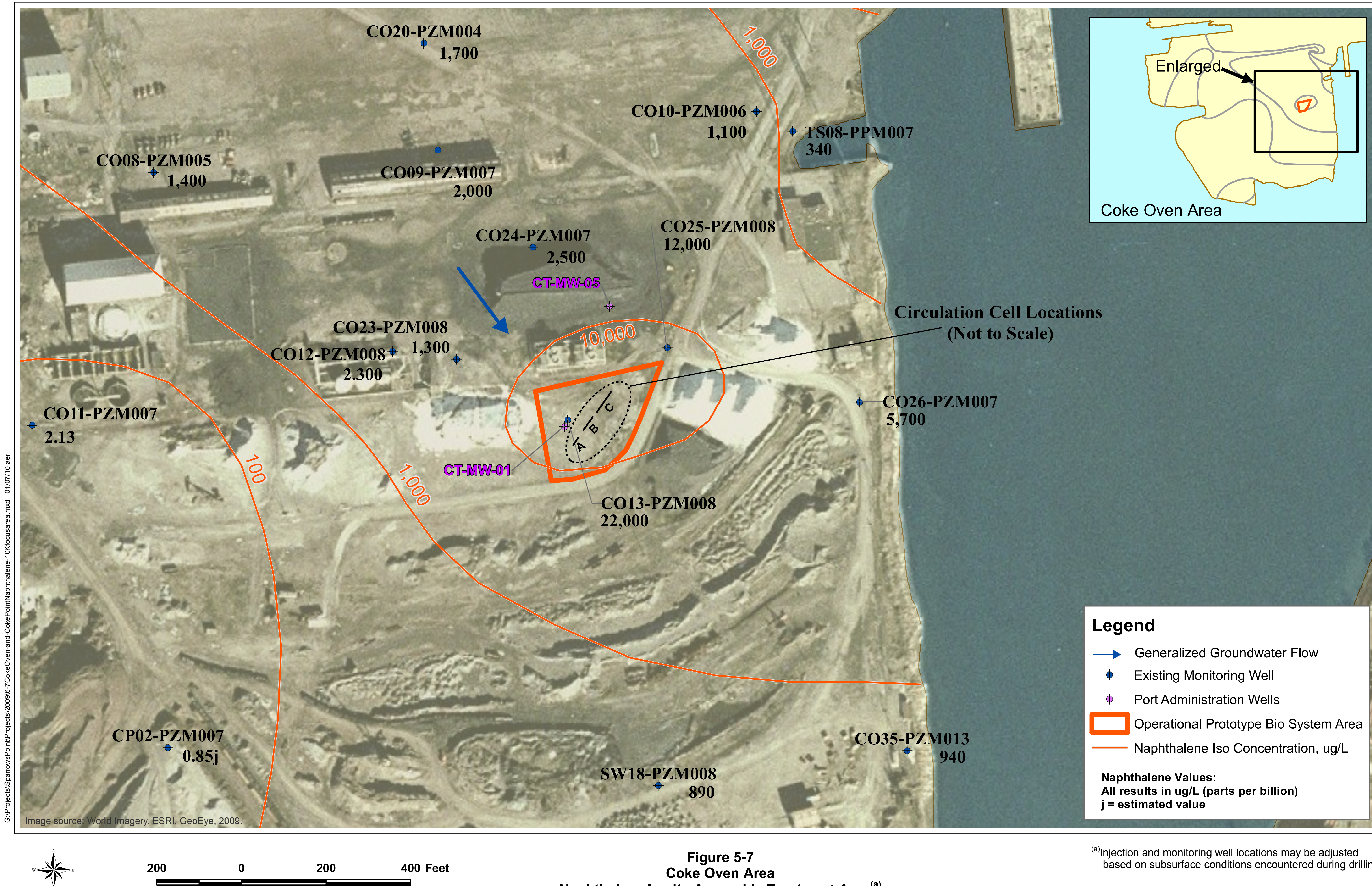


Figure 5-7
Coke Oven Area
Naphthalene In-situ Anaerobic Treatment Area[a]

[a]Injection and monitoring well locations may be adjusted based on subsurface conditions encountered during drilling.

APPENDIX A

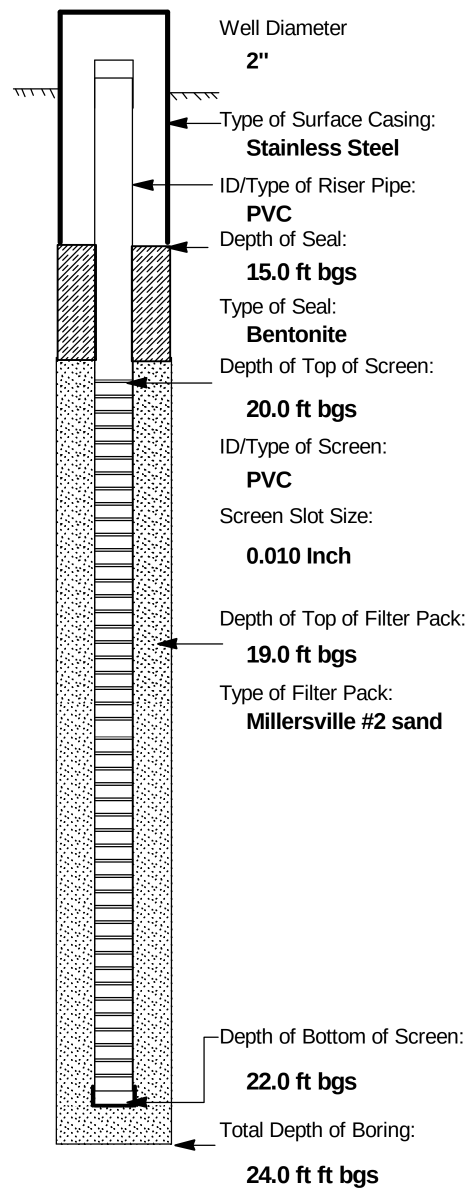
Pilot Test Well Logs

Project: Severstal-Sparrows Point **Project Location:** Sparrows Point, MD **Project Number:** 15302058	**Benzene Area Boring AS-1** Sheet 1 of 1

Date(s) Drilled	**10/13/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Benzene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	Sample ID	PID (ppm)	Blow Count	Graphic Log	MATERIAL DESCRIPTION
0	AS-1 (0-2)	0	8-16-24-25		SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
	AS-1 (2-4)	0	13-37-50/3		
5	AS-1 (4-6)	6.4	35-50/4		Broken glass and broken rock
	AS-1 (6-8)	152	15-18-20-20		
	AS-1 (8-10)	57	16-19-20-24		
10	AS-1 (10-12)	84	18-20-24-23		
	AS-1 (12-14)	58	6-3-6-2		Loosely packed
15	AS-1 (14-16)	230	- -		
	--	- -	- -		
	AS-1 (18-20)	330	5-2-2-3		
20	AS-1 (20-22)	73	3-2-2-4		
	AS-1 (22-24)	247	- -		
					CLAY (CL) Dark gray, wet, clay with some silt. Strong contamination odor.

WELL CONSTRUCTION



URS

Project: Severstal-Sparrows Point
Project Location: Sparrows Point, MD
Project Number: 15302058

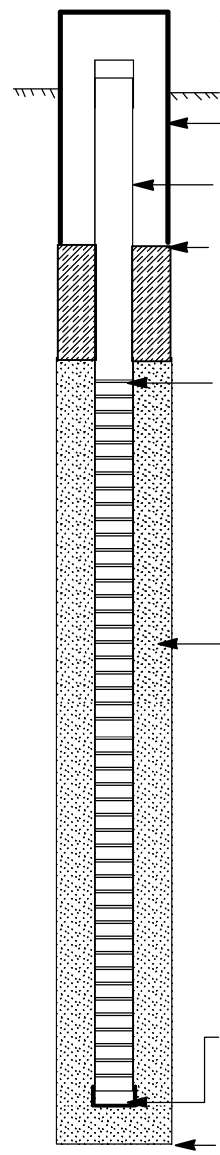
Napthalene Area Boring AS-2

Sheet 1 of 1

Date(s) Drilled	**10/29/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Napthalene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	Sample ID (SAMPLES)	PID (ppm) (SAMPLES)	Blow Count (SAMPLES)	Graphic Log	MATERIAL DESCRIPTION
0	- -	- -	- -		SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
	- -	0	50/3		
5	AS-2 (4-6)	1.1	50/2		
	AS-2 (6-8)	21.2	14-17-50/5		
	- -	- -	- -		3" to 4" rock pieces
10	- -	- -	- -		
	AS-2 (12-14)	3.2	9-17-21-31		
15	AS-2 (14-16)	2.8	23-29-50/5		
	AS-2 (16-18)	4.8	23-29-50/5		
	AS-2(18-19.5)	- -	- -		SAND (SP) Fine compact well sorted sand.

WELL CONSTRUCTION



Well Diameter
2"

Type of Surface Casing:
Stainless Steel

ID/Type of Riser Pipe:
PVC

Depth of Seal:
13.0 ft bgs

Type of Seal:
Bentonite

Depth of Top of Screen:
17.3 ft bgs

ID/Type of Screen:
PVC

Screen Slot Size:
0.010 Inch

Depth of Top of Filter Pack:
15.0 ft bgs

Type of Filter Pack:
Millersville #2 sand

Depth of Bottom of Screen:
19.3 ft bgs

Total Depth of Boring:
19.5 ft ft bgs

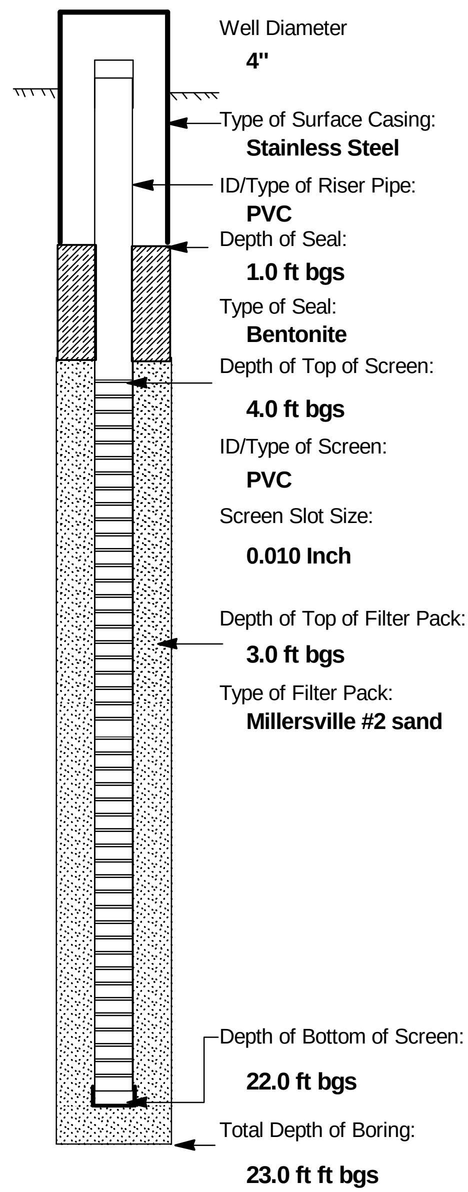
URS

Project: Severstal-Sparrows Point	Benzene Area Boring EXT-1
Project Location: Sparrows Point, MD	Sheet 1 of 1
Project Number: 15302058	

Date(s) Drilled	**10/20/09**	Logged By	**T. Fox**	Client	**Severstal Sparrows Point**
Location	**Benzene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	SAMPLES: Sample ID	SAMPLES: PID (ppm)	SAMPLES: Blow Count	Graphic Log	MATERIAL DESCRIPTION
0–21.5					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
20–22	--	35.6	12-18-11-9		
21.5–22					CLAY (CL) Dark gray, wet, clay with some silt. Strong contamination odor.

WELL CONSTRUCTION



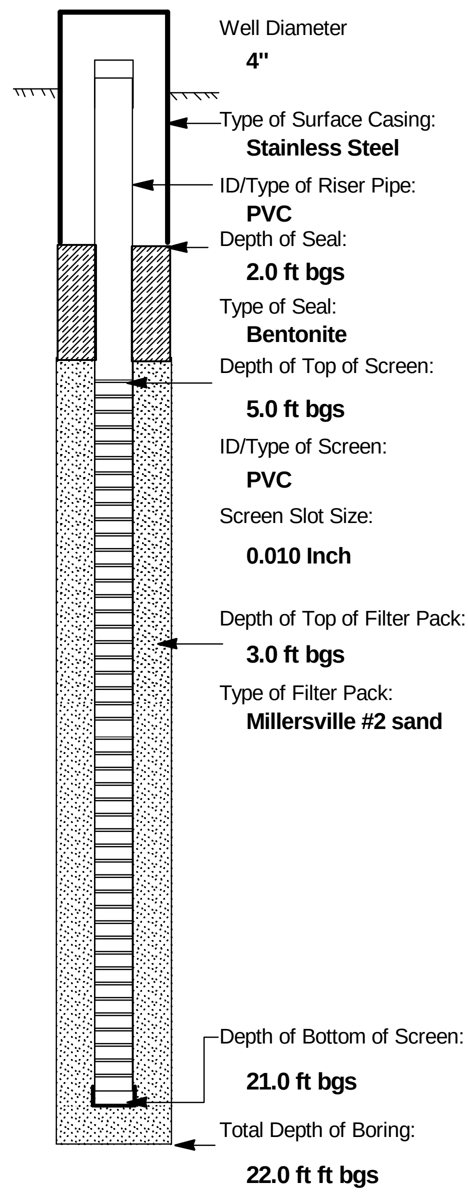
URS

Project: Severstal-Sparrows Point	Napthalene Area Boring EXT-2
Project Location: Sparrows Point, MD	Sheet 1 of 1
Project Number: 15302058	

Date(s) Drilled	10/23/09	Logged By	C. Matherly	Client	Severstal Sparrows Point
Location	Napthalene Area	Sampler Type	2 in. OD split spoon sampler	Drilling Contractor	Summit Site Services

Depth (ft)	Sample ID	PID (ppm)	Blow Count	MATERIAL DESCRIPTION
0–21				SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
20–22	--	8.2	46-21-11-12	CLAY (CL) Dark gray, wet, clay with some silt. Strong contamination odor.
				SAND (SP) Fine well sorted sand.

WELL CONSTRUCTION



URS

Project: Severstal-Sparrows Point
Project Location: Sparrows Point, MD
Project Number: 15302058

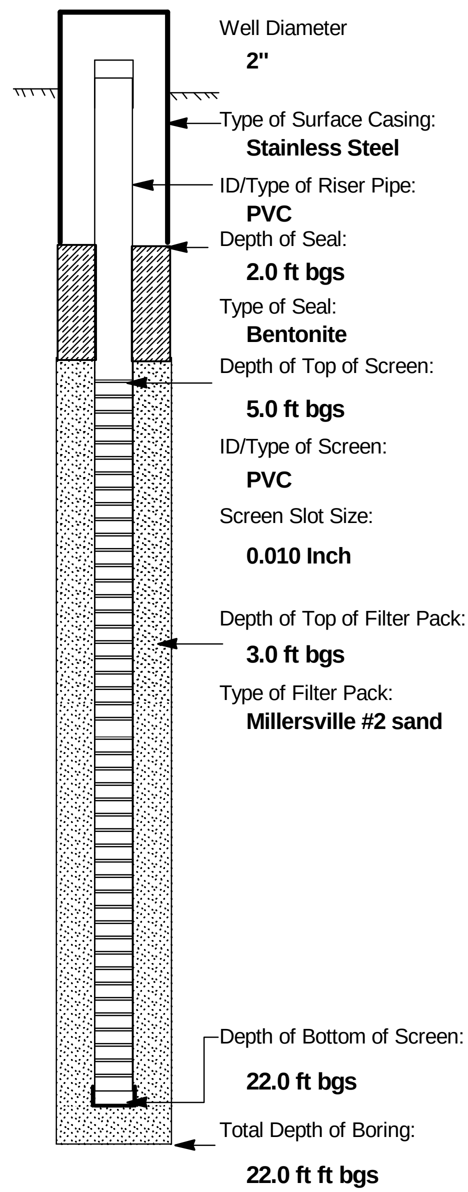
Benzene Area Boring OBS-1

Date(s) Drilled	**10/14/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Benzene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

SAMPLES

Depth (ft)	Sample ID	PID (ppm)	Blow Count	Graphic Log	MATERIAL DESCRIPTION
0					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
5					
10					
15					
20	--	648	15-15-14-3		
	--	133	9-3-3-2		
					CLAY (CL) Dark gray, wet, clay with some silt. Strong contamination odor.

WELL CONSTRUCTION



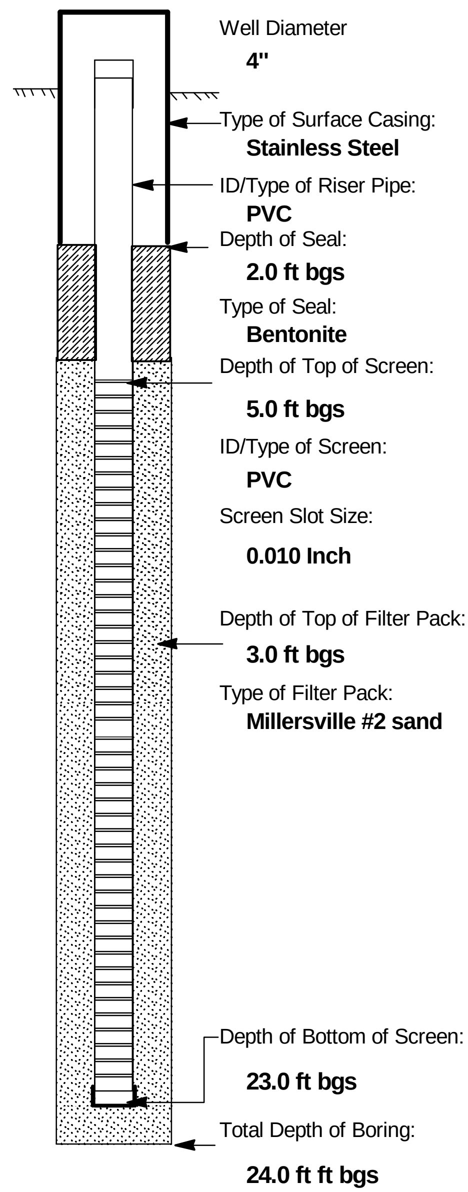
URS

Project: Severstal-Sparrows Point	Napthalene Area Boring OBS-10
Project Location: Sparrows Point, MD	Sheet 1 of 1
Project Number: 15302058	

Date(s) Drilled	**10/29/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Napthalene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	SAMPLES: Sample ID	PID (ppm)	Blow Count	Graphic Log	MATERIAL DESCRIPTION
0					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
5					
10					
15					
20	--	30.4	29-24-20-15		
	--	5.8	3-5-6-7		SAND (SP) Fine to medium sand with sheen.

WELL CONSTRUCTION



URS

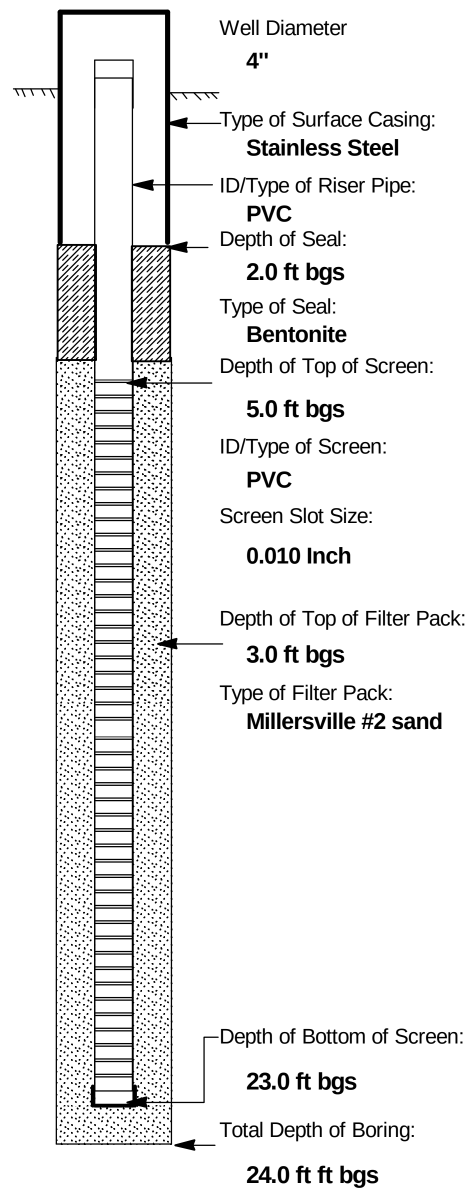
Project:	**Severstal-Sparrows Point**
Project Location:	**Sparrows Point, MD**
Project Number:	**15302058**

Benzene Area Boring OBS-2

Date(s) Drilled	**10/14/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Benzene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	Sample ID	PID (ppm)	Blow Count	Graphic Log	MATERIAL DESCRIPTION
0					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
5					
10					
15					
20	--	103	6-12-8-5		
	--	112	7-5-3-3		CLAY (CL) Dark gray, wet, clay with some silt. Strong contamination odor.

WELL CONSTRUCTION



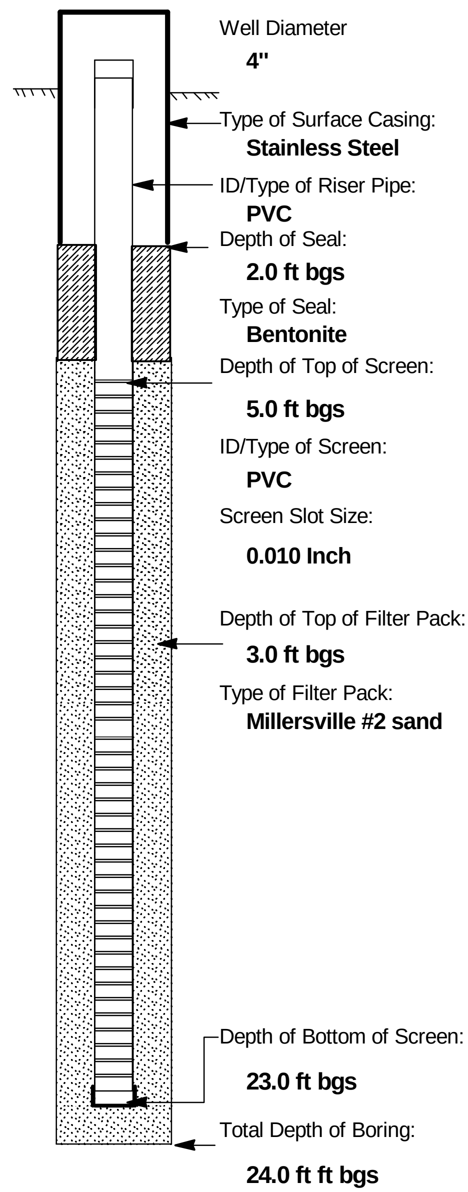
URS

Project: Severstal-Sparrows Point **Project Location:** Sparrows Point, MD **Project Number:** 15302058	**Benzene Area Boring OBS-3** Sheet 1 of 1

Date(s) Drilled	**10/12/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Benzene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	Sample ID	PID (ppm)	Blow Count	Graphic Log	MATERIAL DESCRIPTION
0					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
5					
10					
	--	301	3-8-7-8		
15	--	53	9-9-13-12		Wood pieces
	--	179	7-6-7-6		
	--	57	--		
20	--	--	10-7-5-5		
	--	--	4-2		
	--	--	3-3		CLAY (CL) Dark gray, wet, clay with some silt. Strong contamination odor.

WELL CONSTRUCTION



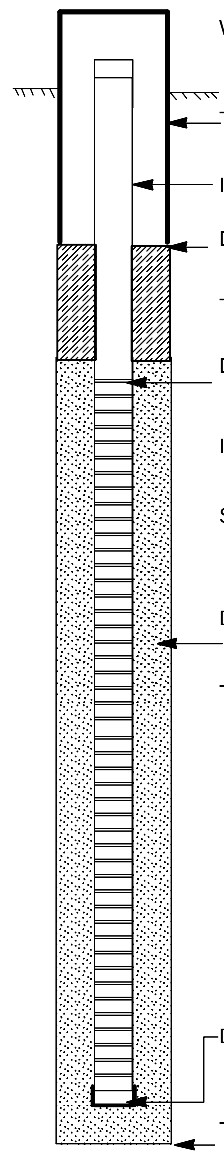
URS

Project: Severstal-Sparrows Point **Project Location:** Sparrows Point, MD **Project Number:** 15302058	**Benzene Area Boring OBS-4** Sheet 1 of 1

Date(s) Drilled	**10/15/09**	Logged By	**T. Fox**	Client	**Severstal Sparrows Point**
Location	**Benzene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	SAMPLES: Sample ID	SAMPLES: PID (ppm)	SAMPLES: Blow Count	Graphic Log	MATERIAL DESCRIPTION
0					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
5					
10					
15					
20	--	42	14-11-10-6		
	--	19	7-9-7-6		CLAY (CL) Dark gray, wet, clay with some silt. Strong contamination odor.

WELL CONSTRUCTION

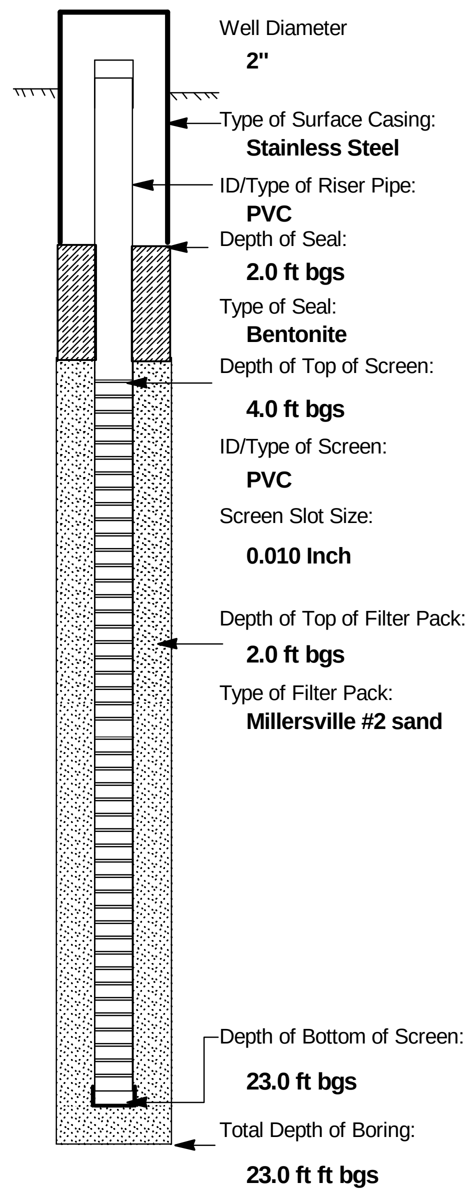


Project: Severstal-Sparrows Point	**Benzene Area Boring OBS-5**
Project Location: Sparrows Point, MD	Sheet 1 of 1
Project Number: 15302058	

Date(s) Drilled	**10/19/09**	Logged By	**T. Fox**	Client	**Severstal Sparrows Point**
Location	**Benzene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	SAMPLES: Sample ID	PID (ppm)	Blow Count	Graphic Log	MATERIAL DESCRIPTION
0					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
5					
10					
15					
20					
	--	94.6	3-12-37-35		CLAY (CL) Dark gray, wet, clay with some silt. Strong contamination odor.

WELL CONSTRUCTION



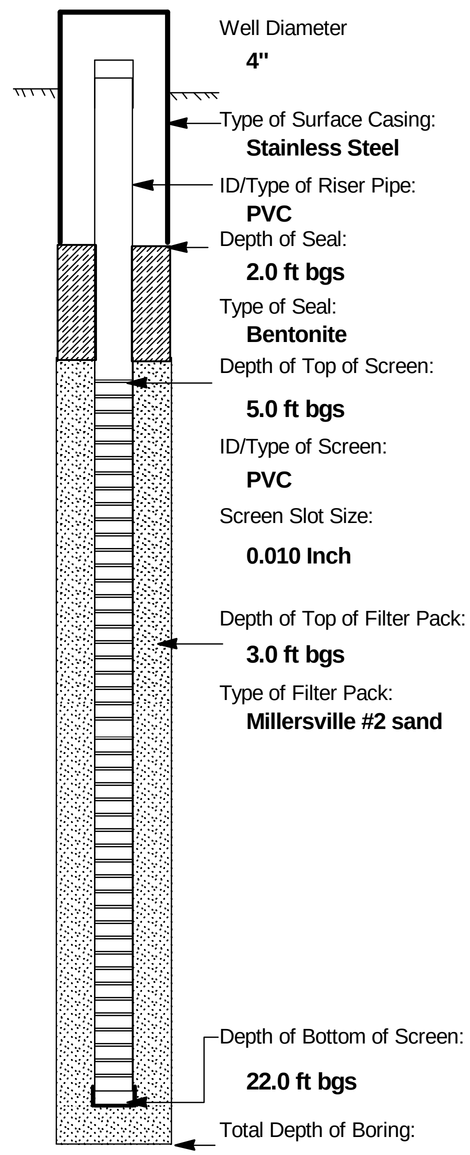
Project:	**Severstal-Sparrows Point**
Project Location:	**Sparrows Point, MD**
Project Number:	**15302058**

Napthalene Area Boring OBS-6

Date(s) Drilled	**10/22/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Napthalene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	SAMPLES: Sample ID	SAMPLES: PID (ppm)	SAMPLES: Blow Count	Graphic Log	MATERIAL DESCRIPTION
0–21.8					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
20–22	--	23.8	44-16-10-8		
21.8–24					SAND (SP) Fine well sorted sand.

WELL CONSTRUCTION

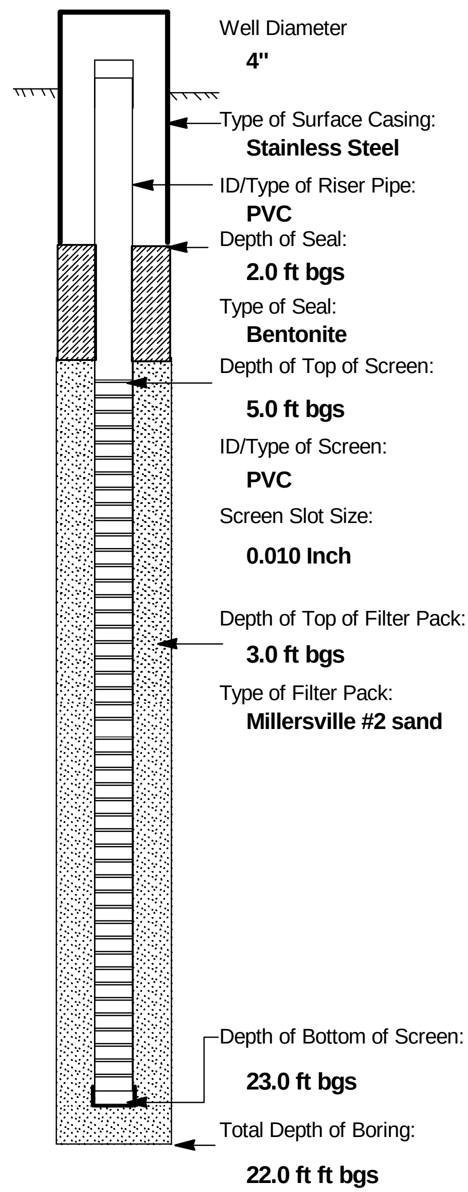


URS

Project: Severstal-Sparrows Point Project Location: Sparrows Point, MD Project Number: 15302058	**Napthalene Area Boring OBS-7** Sheet 1 of 1

Date(s) Drilled	**10/27/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Napthalene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	SAMPLES: Sample ID	SAMPLES: PID (ppm)	SAMPLES: Blow Count	Graphic Log	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.	
5						
10						
15						
20						



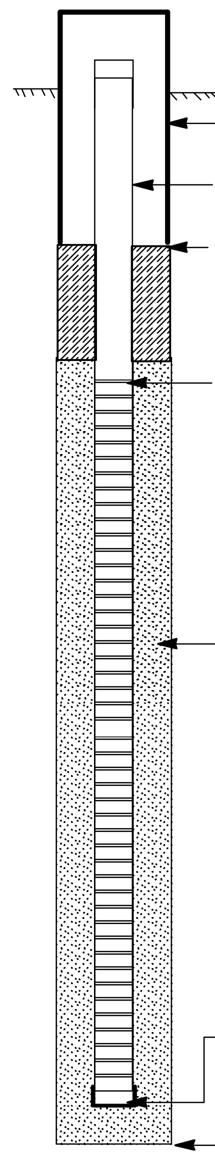
URS

Project: Severstal-Sparrows Point Project Location: Sparrows Point, MD Project Number: 15302058	**Napthalene Area Boring OBS-8** Sheet 1 of 1

Date(s) Drilled	**10/30/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Napthalene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	SAMPLES: Sample ID	SAMPLES: PID (ppm)	SAMPLES: Blow Count	Graphic Log	MATERIAL DESCRIPTION
0					SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
5					
10					
15					
20	--	16.9	--		SAND (SP) Fine dense well sorted sand

WELL CONSTRUCTION



Well Diameter
4"

Type of Surface Casing:
Stainless Steel

ID/Type of Riser Pipe:
PVC

Depth of Seal:
2.0 ft bgs

Type of Seal:
Bentonite

Depth of Top of Screen:
5.0 ft bgs

ID/Type of Screen:
PVC

Screen Slot Size:
0.010 Inch

Depth of Top of Filter Pack:
3.0 ft bgs

Type of Filter Pack:
Millersville #2 sand

Depth of Bottom of Screen:
21.0 ft bgs

Total Depth of Boring:
22.0 ft ft bgs

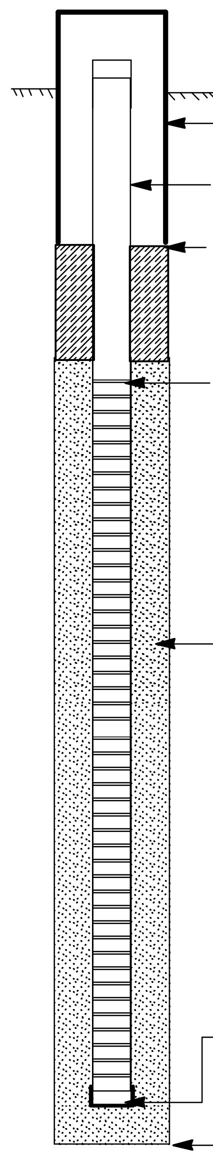
URS

Project: Severstal-Sparrows Point	**Napthalene Area Boring OBS-9**
Project Location: Sparrows Point, MD	Sheet 1 of 1
Project Number: 15302058	

Date(s) Drilled	**10/26/09**	Logged By	**C. Matherly**	Client	**Severstal Sparrows Point**
Location	**Napthalene Area**	Sampler Type	**2 in. OD split spoon sampler**	Drilling Contractor	**Summit Site Services**

Depth (ft)	SAMPLES: Sample ID	SAMPLES: PID (ppm)	SAMPLES: Blow Count	MATERIAL DESCRIPTION
0				SLAG. Dense black fine to coarse slag with occasional glass, metal, and rock fragments. Strong contamination odor throughout.
5				
10				
15				
20				
20–22	--	1.9	46-35-29-21	
22–24	--	1.8	25-17-14-12	
24				SAND (SP) Fine dense well sorted sand

WELL CONSTRUCTION



Well Diameter
4"

Type of Surface Casing:
Stainless Steel

ID/Type of Riser Pipe:
PVC

Depth of Seal:
2.0 ft bgs

Type of Seal:
Bentonite

Depth of Top of Screen:
5.0 ft bgs

ID/Type of Screen:
PVC

Screen Slot Size:
0.010 Inch

Depth of Top of Filter Pack:
3.0 ft bgs

Type of Filter Pack:
Millersville #2 sand

Depth of Bottom of Screen:
23.0 ft bgs

Total Depth of Boring:
24.0 ft ft bgs

URS

APPENDIX B

ICE Technical Specifications

Unit ID:	0	"										
Controller S/N:	285	"										
Software version:	841	"										
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"								
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P
10/18/2009 11:33	0	0	14.3	0	27	Snapshot	Auto	1793	96	74	0	0
10/18/2009 11:54	0	0	14.3	0	27	Valve	Auto	1777	16	272	146	0
10/18/2009 11:58	0	0	13.72	0	27	Shutdown	Auto	1799	80	76	0	0
10/19/2009 12:52	0	0	13.95	0	27	Snapshot	Auto	1803	88	72	0	0
10/19/2009 13:22	0	0	13.83	0	27	O2 Mode	Auto	1801	198	158	388	0
10/19/2009 14:52	0	0	13.6	0	27	O2 Mode	Auto	1782	206	164	384	0
10/19/2009 15:22	0	0	14.07	0	27	O2 Mode	Auto	1811	202	160	352	0
10/19/2009 15:52	0	0	13.89	0	27	O2 Mode	Auto	1799	206	168	346	0
10/19/2009 16:22	0	0	13.83	0	27	O2 Mode	Auto	1798	200	164	346	0
10/22/2009 13:18	0	0	13.66	0	27	Snapshot	Auto	1793	96	70	0	0
10/22/2009 13:48	0	0	13.83	0	27	O2 Mode	Auto	1798	200	152	206	0
10/22/2009 14:18	0	0	13.72	0	27	O2 Mode	Auto	1811	194	140	170	0
10/22/2009 14:48	0	0	13.42	0	27	O2 Mode	Auto	1780	200	142	178	0
10/22/2009 15:18	0	0	13.48	0	27	O2 Mode	Auto	1818	198	148	180	0
10/22/2009 15:48	0	0	13.6	0	27	O2 Mode	Auto	1777	200	154	198	0
10/22/2009 16:18	0	0	13.54	0	27	O2 Mode	Auto	1789	198	152	206	0
10/22/2009 16:48	0	0	13.78	0	27	O2 Mode	Auto	1785	204	158	218	0
10/22/2009 17:15	0	0	13.6	0	27	Shutdown	Auto	1935	102	86	0	0
10/26/2009 11:55	0	0	13.83	0	27	Snapshot	Auto	1788	92	76	0	0
10/26/2009 12:25	0	0	13.42	0	27	O2 Mode	Auto	1798	196	156	166	0
10/26/2009 12:55	0	0	13.42	0	27	O2 Mode	Auto	1807	204	164	174	0
10/26/2009 13:25	0	0	13.25	0	27	O2 Mode	Auto	1793	202	164	178	0
10/26/2009 13:55	0	0	13.31	0	27	O2 Mode	Auto	1802	200	170	188	0
10/26/2009 14:25	0	0	13.66	0	27	O2 Mode	Auto	1805	200	164	188	0
10/26/2009 14:55	0	0	13.66	0	27	O2 Mode	Auto	1798	198	168	198	0
10/26/2009 15:25	0	0	13.95	0	27	O2 Mode	Auto	1793	198	160	366	0

Unit ID:	0	"										
Controller S/N:	285	"										
Software version:	841	"										
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"								
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P
10/26/2009 15:34	0	0	14.01	0	27	Valve	Auto	1781	220	168	364	0
10/26/2009 15:56	0	0	13.54	0	27	Snapshot	Auto	1806	80	78	0	0
10/26/2009 16:26	22400	20900	14.01	0	27	O2 Mode	Auto	1784	142	122	426	0
10/26/2009 16:56	20800	27700	13.48	0	27	O2 Mode	Auto	1793	140	118	238	0
10/26/2009 17:26	17600	12300	13.54	0	27	O2 Mode	Auto	1794	134	120	238	0
10/26/2009 17:56	17600	11700	13.6	0	27	O2 Mode	Auto	1792	134	120	238	0
10/27/2009 9:41	0	0	13.89	0	27	Snapshot	Auto	1819	96	70	0	0
10/27/2009 10:11	0	0	13.48	0	27	O2 Mode	Auto	1805	200	146	158	0
10/27/2009 10:41	0	0	13.42	0	27	O2 Mode	Auto	1831	196	142	158	0
10/27/2009 10:45	0	0	13.48	0	27	Shutdown	Auto	1974	104	86	0	0
10/27/2009 10:57	0	0	14.01	0	27	Snapshot	Auto	1796	80	82	0	0
10/27/2009 11:27	8000	10500	13.78	0	27	O2 Mode	Auto	1802	152	130	430	0
10/27/2009 11:57	4800	700	13.95	0	27	O2 Mode	Auto	1804	88	84	238	0
10/27/2009 12:27	3200	300	14.3	0	27	O2 Mode	Auto	1802	66	68	238	0
10/27/2009 12:57	1600	200	14.01	0	27	O2 Mode	Auto	1808	54	60	238	0
10/27/2009 13:27	1600	200	13.42	0	27	O2 Mode	Auto	1791	50	60	238	0
10/27/2009 13:32	0	0	13.48	0	27	Shutdown	Auto	1743	78	80	0	0
10/27/2009 13:44	0	0	14.19	0	27	Snapshot	Auto	1801	82	82	0	0
10/27/2009 14:14	0	0	14.24	0	27	O2 Mode	Auto	1792	204	158	308	0
10/27/2009 14:44	0	0	14.24	0	27	O2 Mode	Auto	1774	204	158	294	0
10/27/2009 15:14	0	0	14.3	0	27	O2 Mode	Auto	1796	198	156	242	0
10/27/2009 15:44	0	0	14.3	0	27	O2 Mode	Auto	1779	204	160	362	0
10/27/2009 16:05	0	0	14.24	0	27	Shutdown	Auto	1942	98	92	0	0
10/28/2009 10:13	0	0	14.24	0	27	Snapshot	Auto	1822	96	74	0	0
10/28/2009 10:43	0	0	14.24	0	27	O2 Mode	Auto	1818	170	136	432	0
10/28/2009 11:12	0	0	14.24	0	27	O2 Mode	Auto	1795	178	142	238	0

Unit ID:	0	"										
Controller S/N:	285	"										
Software version:	841	"										
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"								
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P
10/28/2009 11:42	0	0	14.42	0	27	O2 Mode	Auto	1791	182	142	238	0
10/28/2009 12:01	0	0	14.36	0	27	Shutdown	Auto	1894	94	88	0	0
10/28/2009 12:11	0	0	14.36	0	27	Snapshot	Auto	1797	82	86	0	0
10/28/2009 12:41	44800	5500	14.24	0	27	O2 Mode	Auto	1812	68	80	432	0
10/28/2009 13:11	73600	8900	14.36	0	27	O2 Mode	Auto	1793	86	92	238	0
10/28/2009 13:41	33600	3500	14.42	0	27	O2 Mode	Auto	1819	58	76	238	0
11/3/2009 11:02	0	0	14.13	0	27	Snapshot	Auto	1800	92	72	0	0
11/3/2009 11:20	0	0	14.24	0	27	Valve	Auto	1784	216	264	182	0
11/3/2009 11:24	0	0	14.24	0	27	Snapshot	Auto	1795	82	76	0	0
11/3/2009 11:28	0	400	14.19	0	27	Valve	Auto	1176	234	388	32	0
11/4/2009 11:41	0	0	14.24	0	27	Snapshot	Auto	1796	94	72	0	0
11/4/2009 12:11	0	0	14.3	0	27	O2 Mode	Auto	1789	42	74	430	0
11/4/2009 12:40	3200	300	14.36	0	27	O2 Mode	Auto	1815	48	76	238	0
11/4/2009 13:10	4800	400	14.42	0	27	O2 Mode	Auto	1793	46	80	238	0
11/4/2009 13:40	4800	500	14.42	0	27	O2 Mode	Auto	1782	48	82	238	0
11/4/2009 14:10	0	0	14.36	0	27	O2 Mode	Auto	1811	66	80	368	0
11/4/2009 14:40	0	100	14.3	0	27	O2 Mode	Auto	1804	72	80	60	0
11/4/2009 15:03	0	0	14.42	0	27	Shutdown	Auto	1782	80	78	0	0
11/4/2009 16:18	0	0	14.42	0	27	Snapshot	Auto	1809	82	74	0	0
11/4/2009 16:47	0	0	14.36	0	27	O2 Mode	Auto	1795	60	76	52	0
11/4/2009 17:17	0	0	14.42	0	27	O2 Mode	Auto	1812	62	80	54	0
11/4/2009 17:47	0	0	14.3	0	27	O2 Mode	Auto	1804	62	78	52	0
11/4/2009 18:17	0	0	14.48	0	27	O2 Mode	Auto	1796	64	82	50	0
11/4/2009 18:27	0	0	14.42	0	27	Shutdown	Auto	1696	76	80	0	0
11/5/2009 15:30	0	0	14.13	0	27	Snapshot	Auto	1825	92	78	0	0
11/5/2009 16:00	0	0	14.48	0	27	O2 Mode	Auto	1813	62	76	48	0

Unit ID:	0	"										
Controller S/N:	285	"										
Software version:	841	"										
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"								
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P
11/5/2009 16:20	0	0	14.24	0	27	Shutdown	Auto	1701	76	78	0	0
Fast Buffer 1"												
	0	0	0	0	0	Initial	Auto	0	0	0	0	0
Fast Buffer 2"												
	0	0	0	0	0	Initial	Auto	0	0	0	0	0
SetPoint Menu			"									
Parameter	Value	Units	"									
Running RPM	1800	RPM	"									
Max Engine Well Vacuum	20	in H2O	"									
Max CatOx Well Vacuum	20	in H2O	"									
Data Save Interval	30	minutes	"									
Control Menu			"									

Unit ID:	0	"											
Controller S/N:	285	"											
Software version:	841	"											
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"									
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P	
Parameter	Value	Units	"										
Selected Data Set	3		"										
Idle RPM	1800	RPM	"										
Air Initial Position	90	steps	"										
Fuel Initial Position	85	steps	"										
Min Tank Vacuum	23	in Hg	"										
Target O2	1800		"										
KFRRun O2	35		"										
Number of Restart Attempts	3		"										
Remote Start Enable(1)/Disable(0)	0		"										
Fuel Ratio (0=Demod 1=O2 @ Temp)	1		"										
Fuel Type (0=Propane 1=Natural Gas)	0		"										
Modem Speed (0=2400 1=4800 2=9600)	2		"										
Number of Cylinders (4 6 8)	8		"										
Emergency Phone #1 Area Code	0		"										

Unit ID:	0	"										
Controller S/N:	285	"										
Software version:	841	"										
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"								
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P
Emergency Phone #1 Prefix	0		"									
Emergency Phone #1 4 Digits	0		"									
Emergency Phone #2 Area Code	0		"									
Emergency Phone #2 Prefix	0		"									
Emergency Phone #2 4 Digits	0		"									
System Access Code	XXXX		"									
Control Menu Access Code	XXXX		"									
RSI Menu			"									
Parameter	Value	Units	"									
RSI System ID	0		"									
Maintenance Hour Count	2325	hours	"									
KdTBS	6670		"									
Water Cycle Count	0		"									
Aux Cycle Count	27		"									

Unit ID:	0	"										
Controller S/N:	285	"										
Software version:	841	"										
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"								
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P
Well Valve Increment	20	steps	"									
Minumum Manifold Vacuum	12	in Hg	"									
Engine Cat Temp for well Dec	1150		"									
Min Valve Position	5	steps	"									
Max Air Position	200	steps	"									
Max Fuel Position	200	steps	"									
Max Well Position	750	steps	"									
Max Tank Position	0	steps	"									
Max RPM Shutdown	2400	RPM	"									
Delta RPM Limit for Well Dec	100	RPM	"									
Max DRPM Limit for Well Dec	600		"									
KTankVac	10		"									
CatOx Inlet Temp Setpoint	630	deg F	"									
CatOx Outlet Temp Setpoint	1100	deg F	"									
Min CatOx Outlet Temp	575	deg F	"									
LEL% for Well Kickback	45	%	"									
Pager Delay Time	20	sec	"									

Unit ID:	0	"										
Controller S/N:	285	"										
Software version:	841	"										
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"								
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P
KCell	2334		"									
Emergency Phone #3 Area Code	800		"									
Emergency Phone #3 Prefix	867		"									
Emergency Phone #3 4 Digits	8503		"									
Breathing Coefficient #1	5636		"									
Breathing Coefficient #1	606		"									
Breathing Coefficient #1	5776		"									
BTU Coefficient #1	4690		"									
BTU Coefficient #1	5903		"									
BTU Coefficient #1	5185		"									
KMagic ppmV	338		"									
Operational Hours to New Snapshot	999		"									
Mike Joy Menu			"									
Parameter	Value	Units	"									
KRPM	150		"									

Unit ID:	0	"											
Controller S/N:	285	"											
Software version:	841	"											
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"									
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P	
KDRPM	75		"										
KGAugment	125		"										
KFRRun	75		"										
Demodulator Amplitude	2		"										
Kmagic for Air Valve	480		"										
Kmagic for Propane Valve	350		"										
Kmagic for Natural Gas Valve	550		"										
Kmagic for Well Valve	775		"										
KCatAir	1		"										
KCatWell	2		"										
KCatBlower	3		"										
KCatHExchg	2		"										
K dT/dt	4		"										
LEL Kickback steps	5		"										
Fuel Flow Meter Gain	256		"										
Calibration Data			"										
Parameter	Value	Units	"										

Unit ID:	0	"											
Controller S/N:	285	"											
Software version:	841	"											
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"									
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P	
Controller Serial Number	285	data	"										
Software Revision	841	data	"										
Manifold Vac Gain	1252	cal	"										
Manifold Vac Offset	3430	cal	"										
Tank Vac Gain	1152	cal	"										
Tank Vac Offset	3271	cal	"										
Well Vac Gain (Engine)	1204	cal	"										
Well Vac Offset (Engine)	3289	cal	"										
Well Vac Gain (CatOx)	0	cal	"										
Well Vac Offset (CatOx)	0	cal	"										
Engine Thermocouple Offset + 100	17586	cal	"										
Engine Thermocouple Gain	417	cal	"										
CatOx Thermocouple Offset + 100	0	cal	"										
CatOx Thermocouple Gain	0	cal	"										

Unit ID:	0	"										
Controller S/N:	285	"										
Software version:	841	"										
Installed Flow Boxes:	Box1 - N	Box2 - N	Box3 - N	"								
Time Stamp	BTU/Hr	ppmV	Vbatt	Vaux	Aux count	Murphy Status	Op Status	RPM	Air P	Fuel P	Well P	Tank P
# of Start Attempts after Stall	0	data	"									
Air Valve Volume (x100) - HW	1	data	"									
Air Valve Volume (x100) - LW	53207	data	"									
Fuel Valve Volume (x100) - HW	4	data	"									
Fuel Valve Volume (x100) - LW	36420	data	"									
Well Valve Volume (x100) - HW	0	data	"									
Well Valve Volume (x100) - LW	32917	data	"									
Spare	0		"									
Spare	0		"									
Spare	0		"									
Spare	0		"									
Spare	0		"									

Unit ID:												
Controller S/N:												
Software version:												
Installed Flow Boxes:												
Time Stamp	Air Flow	Fuel Flow	Well Flow	Man Vac	Well Vac	Oil Pres	Eng Temp	PreCat T	PostCat T	O2	LEL	Maint ET
10/18/2009 11:33	53	1.6	0	20.12	0	72	115	744	800	1808	66	6632
10/18/2009 11:54	6	6.467	36	20.43	0	72	150	744	816	240	65.5	6633
10/18/2009 11:58	45	0.267	0	20.59	0	63	150	696	872	1776	66	6633
10/19/2009 12:52	48	1.667	0	20.12	0	72	130	712	800	1776	66	6633
10/19/2009 13:22	90	3.133	0	15.52	21.51	72	155	1024	1032	1776	65.5	6633
10/19/2009 14:52	89	3.2	0	15.36	21.51	72	155	1032	1072	1808	65.5	6634
10/19/2009 15:22	88	3.2	0	15.05	21.51	72	155	1064	1080	1744	64.5	6634
10/19/2009 15:52	90	3.2	0	15.05	19.36	72	155	1056	1088	1808	65	6635
10/19/2009 16:22	89	3.2	0	15.21	19.36	72	155	1040	1080	1760	65	6635
10/22/2009 13:18	51	1.533	0	19.64	0	72	135	728	784	1776	65.5	6636
10/22/2009 13:48	88	3	0	15.21	4.3	66	155	1032	1080	1776	65.5	6636
10/22/2009 14:18	89	2.8	0	15.21	2.15	66	155	1000	1024	1792	65	6637
10/22/2009 14:48	89	2.867	0	15.05	4.3	66	155	984	1016	1808	65	6637
10/22/2009 15:18	89	2.867	0	15.05	4.3	66	155	968	992	1760	64.5	6638
10/22/2009 15:48	88	2.933	0	15.05	6.45	66	160	1016	1056	1776	64.5	6638
10/22/2009 16:18	88	2.933	0	14.89	6.45	66	160	1024	1064	1760	65	6639
10/22/2009 16:48	90	3	0	15.05	8.6	66	160	1032	1072	1808	64.5	6639
10/22/2009 17:15	53	1.867	0	19.17	0	66	160	968	1048	1248	64.5	6640
10/26/2009 11:55	50	1.667	0	19.96	0	72	125	720	792	1824	66	6640
10/26/2009 12:25	90	3.2	0	15.68	0	72	155	1032	1032	1760	65.5	6640
10/26/2009 12:55	90	3.267	0	15.36	0	69	155	1048	1056	1808	65	6641
10/26/2009 13:25	89	3.2	0	15.36	0	69	155	1064	1040	1792	65	6641
10/26/2009 13:55	89	3.334	0	15.21	0	69	155	1024	1048	1776	65	6642
10/26/2009 14:25	89	3.267	0	15.21	0	66	155	1024	1040	1776	65	6642
10/26/2009 14:55	90	3.334	0	15.21	0	66	155	1024	1056	1792	65	6643
10/26/2009 15:25	87	3.133	0	14.89	4.3	66	155	1072	1096	1776	65	6643

Unit ID:												
Controller S/N:												
Software version:												
Installed Flow Boxes:												
Time Stamp	Air Flow	Fuel Flow	Well Flow	Man Vac	Well Vac	Oil Pres	Eng Temp	PreCat T	PostCat T	O2	LEL	Maint ET
10/26/2009 15:34	95	3.334	0	14.89	4.3	66	155	1056	1096	1936	65.5	6643
10/26/2009 15:56	43	1.667	0	19.8	0	66	155	696	848	1776	65.5	6644
10/26/2009 16:26	68	2.333	0	16.16	47.33	66	155	1032	1048	1792	65	6644
10/26/2009 16:56	66	2.4	3	16	47.33	66	155	1040	1048	1776	65	6645
10/26/2009 17:26	63	2.4	5	16.16	51.63	66	150	1040	1064	1776	65	6645
10/26/2009 17:56	64	2.4	3	16.32	51.63	66	150	1032	1056	1776	65	6646
10/27/2009 9:41	52	1.6	0	19.96	0	72	125	752	816	1776	66	6646
10/27/2009 10:11	92	2.933	0	15.84	0	66	150	1056	1040	1776	65.5	6646
10/27/2009 10:41	90	2.933	0	15.68	0	69	150	1056	1048	1776	65.5	6647
10/27/2009 10:45	55	1.933	0	19.48	0	69	150	1024	1040	1200	65.5	6647
10/27/2009 10:57	42	0.067	0	19.96	0	66	150	736	872	1776	65.5	6647
10/27/2009 11:27	72	0.067	0	15.84	38.72	66	150	1040	1032	1776	65.5	6647
10/27/2009 11:57	43	0.067	23	17.11	79.59	66	150	1032	992	1776	65	6648
10/27/2009 12:27	32	0.067	29	17.9	103.26	66	150	976	968	1776	65.5	6648
10/27/2009 12:57	28	0.067	32	18.22	116.16	66	155	936	944	1776	65.5	6649
10/27/2009 13:27	25	0.067	33	18.53	122.62	66	155	904	928	1792	65	6649
10/27/2009 13:32	43	0.067	0	19.96	27.97	66	155	864	936	1824	65	6649
10/27/2009 13:44	44	1.733	0	19.8	0	66	155	704	856	1776	65.5	6649
10/27/2009 14:14	90	3.067	0	15.05	4.3	66	155	1072	1080	1776	65.5	6650
10/27/2009 14:44	88	3	0	15.05	8.6	66	155	1040	1056	1760	65	6650
10/27/2009 15:14	91	3.067	0	15.21	6.45	66	150	1040	1048	1792	65.5	6651
10/27/2009 15:44	90	3.2	0	15.21	17.21	66	155	1048	1056	1792	65	6651
10/27/2009 16:05	52	2	0	19.17	0	66	155	1000	1024	1312	65	6652
10/28/2009 10:13	52	1.667	0	19.48	0	72	130	752	816	1760	65.5	6652
10/28/2009 10:43	82	2.8	0	15.52	30.12	69	155	1016	1040	1760	65	6652
10/28/2009 11:12	83	2.8	0	15.36	32.27	69	155	1016	1032	1776	65	6653

Unit ID:												
Controller S/N:												
Software version:												
Installed Flow Boxes:												
Time Stamp	Air Flow	Fuel Flow	Well Flow	Man Vac	Well Vac	Oil Pres	Eng Temp	PreCat T	PostCat T	O2	LEL	Maint ET
10/28/2009 11:42	83	2.733	0	15.05	30.12	66	155	1024	1072	1760	65	6653
10/28/2009 12:01	49	1.933	0	19.01	0	66	155	968	1048	1440	65	6654
10/28/2009 12:11	44	1.8	0	19.32	0	66	150	712	888	1792	65	6654
10/28/2009 12:41	35	1.733	23	18.37	129.07	66	155	864	928	1776	65	6654
10/28/2009 13:11	43	1.8	20	17.11	96.8	66	155	968	984	1776	65	6655
10/28/2009 13:41	30	1.733	26	18.69	144.13	66	155	808	904	1776	65	6655
11/3/2009 11:02	51	1.6	0	19.96	0	72	130	728	832	1760	66	6656
11/3/2009 11:20	96	5.267	0	15.52	6.45	72	155	1000	1040	336	65.5	6656
11/3/2009 11:24	44	1.733	0	20.12	0	66	150	664	824	1792	65.5	6656
11/3/2009 11:28	85	6.734	0	12.04	0	63	155	832	816	96	65.5	6656
11/4/2009 11:41	52	1.6	0	19.8	0	72	110	768	824	1776	66.5	6656
11/4/2009 12:11	22	1.733	30	19.48	150.58	66	150	808	888	1760	65	6657
11/4/2009 12:40	25	1.733	29	19.17	146.28	66	150	840	912	1776	65	6657
11/4/2009 13:10	25	1.733	29	19.17	141.98	66	150	848	912	1792	65	6658
11/4/2009 13:40	24	1.733	30	19.17	141.98	66	150	840	904	1792	65	6658
11/4/2009 14:10	34	1.733	17	19.64	161.34	66	150	784	904	1776	65	6659
11/4/2009 14:40	39	1.733	13	19.48	49.48	66	150	792	888	1776	65.5	6659
11/4/2009 15:03	44	1.733	0	20.12	36.57	66	150	776	872	1936	65.5	6660
11/4/2009 16:18	46	1.667	0	20.59	0	72	145	696	856	1776	66	6660
11/4/2009 16:47	32	1.8	14	20.59	19.36	66	150	752	936	1776	65.5	6660
11/4/2009 17:17	32	1.867	16	20.43	19.36	66	150	752	896	1776	66	6661
11/4/2009 17:47	34	1.8	13	20.43	21.51	66	150	760	912	1792	66	6661
11/4/2009 18:17	35	1.867	12	20.43	19.36	66	150	768	928	1808	66	6662
11/4/2009 18:27	43	1.667	0	20.59	10.76	66	150	760	912	2224	66	6662
11/5/2009 15:30	49	1.733	0	19.96	0	72	125	736	816	1744	66.5	6662
11/5/2009 16:00	35	1.8	14	20.28	21.51	66	150	736	880	1776	66	6662

Unit ID:												
Controller S/N:												
Software version:												
Installed Flow Boxes:												
Time Stamp	Air Flow	Fuel Flow	Well Flow	Man Vac	Well Vac	Oil Pres	Eng Temp	PreCat T	PostCat T	O2	LEL	Maint ET
11/5/2009 16:20	43	1.667	0	20.43	10.76	66	150	736	888	2144	66	6663
Fast Buffer 1"												
	0	0	0	0	0	0	0	0	0	0	0	0
Fast Buffer 2"												
	0	0	0	0	0	0	0	0	0	0	0	0
SetPoint Menu												
Parameter												
Running RPM												
Max Engine Well Vacuum												
Max CatOx Well Vacuum												
Data Save Interval												
Control Menu												

APPENDIX C

Field and Analytical Data Summaries

Analytical Data

Sample ID	EXT-1 Exhaust	BA-RAW	RAW-4 WELLS	RAW-SPARGE-4 WELLS	RAW-SPARGE-4 WELLS-PUF	RAW-EXT-1-NO SPARGE-PUF	RAW-EXT-1-NO SPARGE	RAW-EXT-1-SPARGE	EXT-2 RAW
Sample Date	10/26/2009	10/26/2009	10/26/2009	10/27/2009	10/27/2009	10/28/2009	10/28/2009	10/28/2009	11/4/2009
Sample Time	16:30	16:35	17:53	13:20	13:34	12:00	12:00	14:05	13:30
Analysis	TO-15	TO-15	TO-13 MOD	TO-15	TO-13 MOD	TO-13 MOD	TO-15	TO-15	TO-15
Chemical Name / Units	ppb	ppb	µg	ppb	µg	µg	ppb	ppb	ppb
Acenaphthylene	NA	NA	< 2,000 U	NA	< 1,500 U	< 1,000 U	NA	NA	NA
Acetone	21	NA	NA	< 2,500,000 U	NA	NA	< 270,000 U	< 1,700,000 U	< 730 U
Benzene	78	370,000	NA	30,000,000	NA	NA	1,100,000	16,000,000	2,500
Ethylbenzene	< 0.80 U	< 1,300 U	NA	< 100,000 U	NA	NA	< 11,000 U	< 68,000 U	57
Dibenzofuran	NA	NA	< 2,000 U	NA	< 1,500 U	< 1,000 U	NA	NA	NA
Fluorene	NA	NA	< 2,000 U	NA	< 1,500 U	1,000	NA	NA	NA
2-Methylnaphthalene	NA	NA	5,100	NA	4,500	3,400	NA	NA	NA
Naphthalene	NA	NA	69,000	NA	43,000	38,000	NA	NA	NA
Phenol	NA	NA	< 4,000 U	NA	< 3,000 U	2,300	NA	NA	NA
Toluene	< 0.80 U	< 1,300 U	NA	2,500,000	NA	NA	22,000	1,200,000	1,500
m,p-xylenes	< 0.80 U	< 1,300 U	NA	< 100,000 U	NA	NA	< 11,000 U	< 68,000 U	640
o-xylenes	< 0.80 U	< 1,300 U	NA	< 100,000 U	NA	NA	< 11,000 U	< 68,000 U	180
Methane	< 0.19 %	NA	NA	NA	NA	NA	NA	NA	NA
Total VOC	99	370,000	74,100	32,500,000	47,500	44,700	1,122,000	17,200,000	4,877

Sample ID	EXT-2 EXHAUST	EXT-2 SPARGE	EXT-2 RAW PUF	EXT-2 PUF SPARGE
Sample Date	11/4/2009	11/4/2009	11/4/2009	11/4/2009
Sample Time	13:50	15:00	14:05	17:30
Analysis	TO-15	TO-15	TO-13 MOD	TO-13 MOD
Chemical Name Units	ppb	ppb	µg	µg
Acenaphthylene	NA	NA	7,200	< 5,000 U
Acetone	< 50 U	< 13,000 U	NA	NA
Benzene	4.7	34,000	NA	NA
Ethylbenzene	< 2.0 U	1,200	NA	NA
Dibenzofuran	NA	NA	2,800	< 5,000 U
Fluorene	NA	NA	< 2,500 U	< 5,000 U
2-Methylnaphthalene	NA	NA	24,000	17,000
Naphthalene	NA	NA	210,000 D	290,000 D
Phenol	NA	NA	< 5,000 U	< 10,000 U
Toluene	< 2.0 U	43,000	NA	NA
m,p-xylenes	< 2.0 U	18,000	NA	NA
o-xylenes	< 2.0 U	3,800	NA	NA
Methane	NA	NA	NA	NA
Total VOC	5	100,000	244,000	307,000

Benzene Area

Chemical Name	RAW-4 WELLS 10/26/2009 17:53 TO-13 MOD µg
Acenaphthylene	< 2,000 U
Acetone	NA
Benzene	NA
Ethylbenzene	NA
Dibenzofuran	< 2,000 U
Fluorene	< 2,000 U
2-Methylnaphthalene	5,100
Naphthalene	69,000
Phenol	< 4,000 U
Toluene	NA
m,p-xylenes	NA
o-xylenes	NA
Total VOCs (µg)	74,100
Elasped Time (min)	120

START **15:53**
FINISH **17:53**

	16:07	16:50	17:45
T (deg F)	71	75	60
ΔP (in.WC)	0.045	0.025	0.1
combined (in.WC)	2.45	2.5	2.5
Static (in.Hg)	2.4	3.4	2.5
Static (in.WC)	32.64	46.24	34
Q (SCFM)	11.17	8.14	16.79

mass removal rate (µg/min)
617.5

Chemical Name	RAW-SPARGE-4 WELLS-PUF 10/27/2009 13:34 TO-13 MOD µg
Acenaphthylene	< 1,500 U
Acetone	NA
Benzene	NA
Ethylbenzene	NA
Dibenzofuran	< 1,500 U
Fluorene	< 1,500 U
2-Methylnaphthalene	4,500
Naphthalene	43,000
Phenol	< 3,000 U
Toluene	NA
m,p-xylenes	NA
o-xylenes	NA
Total VOCs (µg)	47,500
Elapsed Time (min)	219

START **9:55**
FINISH **13:34**

	10:30	12:00	12:15	12:40	13:21	13:29
T (deg F)	58	60	60	60	60	60
ΔP (in.WC)	0.08	0.125	0.14	0.16	0.16	0.145
combined (in.WC)	2.5	5.5	7.5	6.75	5	6
Static (in.Hg)	3	5.75	7.25	7.75	8.75	8
Static (in.WC)	40.8	78.2	98.6	105.4	119	108.8
Q (SCFM)	14.91	17.63	18.07	19.10	18.67	18.08

mass removal rate (µg/min)
216.9

Chemical Name	RAW-EXT-1-NO SPARGE-PUF 10/28/2009 12:00 TO-13 MOD µg
Acenaphthylene	< 1,000 U
Acetone	NA
Benzene	NA
Ethylbenzene	NA
Dibenzofuran	< 1,000 U
Fluorene	1,000
2-Methylnaphthalene	3,400
Naphthalene	38,000
Phenol	2,300
Toluene	NA
m,p-xylenes	NA
o-xylenes	NA
Total VOCs (µg)	44,700
Elasped Time (min)	105

START 10:15
FINISH 12:00

	10:20	10:45	11:10	11:45	12:00
T (deg F)	60	61	62	64	64
∆P (in.WC)	0.06	0.08	0.08	0.065	0.065
EXT-1 (in.WC)	5	9	9	9	8.5
Static (in.Hg)	1	2.5	2.4	2.5	2.5
Static (in.WC)	13.6	34	32.64	34	34
Q (SCFM)	13.36	15.01	15.02	13.49	13.49

mass removal rate (µg/min) 425.7

Naphthalene Area

Chemical Name	EXT-2 RAW PUF 11/4/2009 14:05 TO-13 MOD µg
Acenaphthylene	7,200
Acetone	NA
Benzene	NA
Ethylbenzene	NA
Dibenzofuran	2,800
Fluorene	< 2,500 U
2-Methylnaphthalene	24,000
Naphthalene	210,000 D
Phenol	< 5,000 U
Toluene	NA
m,p-xylenes	NA
o-xylenes	NA
Total SVOCs (µg)	244,000
Elasped Time (min)	197

START 10:48
FINISH 14:05

	11:26	12:18	13:45
T (deg F)	53	53	55
∆P (in.WC)	0.05	0.07	0.005
EXT-2 (in.WC)	36.72	34	24.2
Static (in.Hg)	10.7	10	3.6
Static (in.WC)	145.52	136	48.96
Q (SCFM)	10.01	12.06	3.70

mass removal rate
(µg/min) 1,238.6
(lb/hr) 1.6368881E-07

Chemical Name	EXT-2 PUF SPARGE 11/4/2009 17:30 TO-13 MOD µg
Acenaphthylene	< 5,000 U
Acetone	NA
Benzene	NA
Ethylbenzene	NA
Dibenzofuran	< 5,000 U
Fluorene	< 5,000 U
2-Methylnaphthalene	17,000
Naphthalene	290,000 D
Phenol	< 10,000 U
Toluene	NA
m,p-xylenes	NA
o-xylenes	NA
Total SVOCs (µg)	307,000
Elasped Time (min)	165

START 14:45
FINISH 17:30

	15:57	**16:50**
T (deg F)	53	52
ΔP (in.WC)	0.01	0.01
EXT-2 (in.WC)	21.5	21
Static (in.Hg)	1.6	1.6
Static (in.WC)	21.76	21.76
Q (SCFM)	5.43	5.44

mass removal rate (µg/min)
1,860.6

Benzene Area

Sample ID	EXT-1 Exhaust	BA-RAW
Sample Date	10/26/2009	10/26/2009
Sample Time	16:30	16:35
Analysis	TO-15	TO-15
Chemical Name Units	ppb	ppb
Acenaphthylene	NA	NA
Acetone	21	NA
Benzene	78	370,000
Ethylbenzene	< 0.80 U	< 1,300 U
Dibenzofuran	NA	NA
Fluorene	NA	NA
2-Methylnaphthalene	NA	NA
Naphthalene	NA	NA
Phenol	NA	NA
Toluene	< 0.80 U	< 1,300 U
m,p-xylenes	< 0.80 U	< 1,300 U
o-xylenes	< 0.80 U	< 1,300 U
Total VOC	99	370,000

START	15:53
FINISH	17:53
Run time	2:00
Benzene removed (lb)	0.2
Benzene rate (lb/hr)	0.06

	16:07	16:50	17:45
T (deg F)	71	75	60
∆P (in.WC)	0.045	0.025	0.1
combined (in.WC)	2.45	2.5	2.5
Static (in.Hg)	2.4	3.4	2.5
Static (in.WC)	32.64	46.24	34
Q (SCFM)	11.17	8.14	16.79
average Q	12.03		

Sample ID	RAW-SPARGE-4 WELLS
Sample Date	10/27/2009
Sample Time	13:20
Analysis	TO-15
Chemical Name Units	ppb
Acenaphthylene	NA
Acetone	< 2,500,000 U
Benzene	30,000,000
Ethylbenzene	< 100,000 U
Dibenzofuran	NA
Fluorene	NA
2-Methylnaphthalene	NA
Naphthalene	NA
Phenol	NA
Toluene	2,500,000
m,p-xylenes	< 100,000 U
o-xylenes	< 100,000 U
Total VOC	32,500,000

START	9:55
FINISH	13:34
Run time	3:39
Benzene removed (lb)	25.4
Benzene rate (lb/hr)	6.95

		10:30	12:00	12:15	12:40	13:20	13:29
	T (deg F)	58	60	60	60	60	60
	∆P (in.WC)	0.08	0.125	0.14	0.16	0.16	0.145
	combined (in.WC)	2.5	5.5	7.5	6.75	5	6
	Static (in.Hg)	3	5.75	7.25	7.75	8.75	8
	Static (in.WC)	40.8	78.2	98.6	105.4	119	108.8
	Q (SCFM)	14.91	17.63	18.07	19.1	18.67	18.08
	average Q	17.74					
Air Sparge	Pressure (PSI)	12	10	10	10	9	9
	Q (SCFM)	30	40	50	50	50	50

Soil Gas Data

Sample ID	RAW-EXT-1-NO SPARGE	RAW-EXT-1-SPARGE
Sample Date	10/28/2009	10/28/2009
Sample Time	12:00	14:05
Analysis	TO-15	TO-15
Chemical Name Units	ppb	ppb
Acenaphthylene	NA	NA
Acetone	< 270,000 U	< 1,700,000 U
Benzene	1,100,000	16,000,000
Ethylbenzene	< 11,000 U	< 68,000 U
Dibenzofuran	NA	NA
Fluorene	NA	NA
2-Methylnaphthalene	NA	NA
Naphthalene	NA	NA
Phenol	NA	NA
Toluene	22,000	1,200,000
m,p-xylenes	< 11,000 U	< 68,000 U
o-xylenes	< 11,000 U	< 68,000 U
Total VOC	1,122,000	17,200,000

START	**10:15**
FINISH	**12:00**
Run time	1:45
Benzene removed (lb)	0.35
Benzene rate (lb/hr)	0.20

	10:20	10:21	10:45	11:10	11:45	12:00
T (deg F)	60	GW Pumping	61	62	64	64
ΔP (in.WC)	0.06		0.08	0.08	0.065	0.065
EXT-1 (in.WC)	5		9	9	9	8.5
Static (in.Hg)	1		2.5	2.4	2.5	2.5
Static (in.WC)	13.6		34	32.64	34	34
Q (SCFM)	13.36		15.01	15.02	13.49	13.49
average Q	14.07					
Water Rate (gpm)		4.3				

START	**12:20**
FINISH	**14:08**
Run time	1:48
Benzene removed (lb)	4.52
Benzene rate (lb/hr)	2.58

		12:30	12:52	14:02
	T (deg F)	65	63	64
	ΔP (in.WC)	0.04	0.06	0.1
	EXT-1 (in.WC)	8	9.75	16
	Static (in.Hg)	3.1	6	9.5
	Static (in.WC)	42.16	81.6	129.2
	Q (SCFM)	10.45	12.12	14.44
	average Q	12.34		
Air Sparge	Pressure (PSI)	18	4.8	9
	Q (SCFM)	50	14	30

Naphthalene Area

Sample ID	EXT-2 RAW	EXT-2 EXHAUST
Sample Date	11/4/2009	11/4/2009
Sample Time	13:30	13:50
Analysis	TO-15	TO-15
Chemical Name Units	ppb	ppb
Acenaphthylene	NA	NA
Acetone	< 730 U	< 50 U
Benzene	2,500	4.7
Ethylbenzene	57	< 2.0 U
Dibenzofuran	NA	NA
Fluorene	NA	NA
2-Methylnaphthalene	NA	NA
Naphthalene	NA	NA
Phenol	NA	NA
Toluene	1,500	< 2.0 U
m,p-xylenes	640	< 2.0 U
o-xylenes	180	< 2.0 U
Total VOC	4,877	5

START	**10:48**
FINISH	**14:05**
Run time	3:17

	11:26	11:30	12:18	13:45
T (deg F)	53	GW Pumping	53	55
ΔP (in.WC)	0.05		0.07	0.005
EXT-2 (in.WC)	36.72		34	24.2
Static (in.Hg)	10.7		10	3.6
Static (in.WC)	145.52		136	48.96
Q (SCFM)	10.01		12.06	3.70
average Q	8.59			
Water Rate (gpm)		10		

Soil Gas Data

Sample ID	EXT-2 SPARGE
Sample Date	11/4/2009
Sample Time	15:00
Analysis	TO-15
Chemical Name Units	ppb
Acenaphthylene	NA
Acetone	< 13,000 U
Benzene	34,000
Ethylbenzene	1,200
Dibenzofuran	NA
Fluorene	NA
2-Methylnaphthalene	NA
Naphthalene	NA
Phenol	NA
Toluene	43,000
m,p-xylenes	18,000
o-xylenes	3,800
Total VOC	100,000

			15:25	15:57	16:50
START 14:45					
FINISH 17:30		T (deg F)	GW Pumping	53	52
Run time 2:45		ΔP (in.WC)		0.01	0.01
		EXT-2 (in.WC)		21.5	21
		Static (in.Hg)		1.6	1.6
		Static (in.WC)		21.76	21.76
		Q (SCFM)		5.43	5.44
		average Q	5.44		
		Water Rate (gpm)	6		
	Air Sparge	Pressure (PSI)	17	14.5	16
		Q (SCFM)	29	27	31

Benzene Area

		OBS-4 Pre			OBS-4 Post			Δ15	Δ18	Δ21
Depth	(feet)	15	18	21	15	18	21			
Temp	(℃)	17.65	17.67	17.64	18.16	18.14	18.11	0.51	0.47	0.47
SC	(mS/cm)	1.64	1.648	1.66	1.622	1.618	1.665	-0.018	-0.03	0.005
DO	(g/mL)	0.18	0.15	0.12	0.45	0.31	0.29	0.27	0.16	0.17
pH	(std. units)	8.29	8.3	8.32	8.29	8.32	8.34	0	0.02	0.02
ORP	(mV)	-202.5	-231.7	-259.9	-74.6	-117.6	-145.5	127.9	114.1	114.4

		OBS-5 Pre		OBS-5 Post		Δ15	Δ18
Depth	(feet)	15	18	15	18		
Temp	(℃)	20.46	20.53	20.32	20.4	-0.14	-0.13
SC	(mS/cm)	0.79	0.874	0.876	0.903	0.086	0.029
DO	(g/mL)	0.32	0.23	0.55	0.34	0.23	0.11
pH	(std. units)	8.04	7.6	7.62	7.45	-0.42	-0.15
ORP	(mV)	-55	-145	-109.7	-147.6	-54.7	-2.6

Naphthalene Area

		OBS-6 Pre		OBS-6 Post			
Depth	(feet)	15	18	15	18	**Δ15**	**Δ18**
Temp	(℃)	19.33	18.82	19.3	18.77	-0.03	-0.05
SC	(mS/cm)	2.975	3.041	2.993	3.024	0.018	-0.017
DO	(g/mL)	0.39	0.25	0.33	0.2	-0.06	-0.05
pH	(std. units)	12.04	12.1	12.03	12.05	-0.01	-0.05
ORP	(mV)	-264	-288	-172.4	-197.8	91.6	90.2

		OBS-7 Pre		OBS-7 Post			
Depth	(feet)	15	18	15	18	**Δ15**	**Δ18**
Temp	(℃)	18.7	18.98	18.53	18.55	-0.17	-0.43
SC	(mS/cm)	2.658	2.63	3.289	3.313	0.631	0.683
DO	(g/mL)	0.31	0.15	0.26	0.18	-0.05	0.03
pH	(std. units)	11.83	11.84	11.36	11.34	-0.47	-0.5
ORP	(mV)	-217.5	-269.3	-158.4	-172.4	59.1	96.9

Well Profiling

		OBS-8 Pre		OBS-8 Post			
Depth	(feet)	15	18	15	18	**Δ15**	**Δ18**
Temp	(℃)	19.17	18.95	19.26	18.95	0.09	0
SC	(mS/cm)	2.749	2.699	2.83	2.774	0.081	0.075
DO	(g/mL)	0.29	0.14	0.32	0.2	0.03	0.06
pH	(std. units)	12.06	12.01	12.04	12.04	-0.02	0.03
ORP	(mV)	-219.4	-289.7	-190.9	-204	28.5	85.7

		OBS-9 Pre		OBS-9 Post			
Depth	(feet)	15	18	15	18	**Δ15**	**Δ18**
Temp	(℃)	18.67	18.88	18.64	18.7	-0.03	-0.18
SC	(mS/cm)	2.317	2.245	2.939	2.925	0.622	0.68
DO	(g/mL)	0.26	0.2	0.89	0.81	0.63	0.61
pH	(std. units)	11.65	11.61	11.01	11.01	-0.64	-0.6
ORP	(mV)	-252.2	-294.6	-122.8	-133.4	129.4	161.2

Overall Data

10/22/2009 Benene Area

		10:00	10:25	13:05	13:05	14:10	15:10	15:25	15:50	15:53	15:54	16:30	16:30	16:35	16:37	16:40	16:50	16:55	17:15	17:20	17:21	17:35	17:40
	Event			Start SVE/ GW Pumping					Finish SVE/ GW Pumping			Start SVE/Air Sparge								Finish SVE			Finish Air Sparge
SVE	**T (deg F)**					73		74											70				
	ΔP (in.WC)					0.08		0.07											0.08				
	EXT-1 (in.WC)														10.6	10.4							
	Static (in.Hg)					0.51	0.44	0.46											0.74				
	Static (in.WC)					7	6	6.2											10				
	Q (SCFM)					15.36	14 (est.)	14.37											15.35				
GW Pumping	**Rate (gpm)**				5.0	7.5	7.5	7.5															
Air Sparge	**Pressure (PSI)**												4.0	7.0	7.5	6.0						6.0	
	Q (SCFM)													6	10	13						13.50	
Vac Response	**OBS-1 (in.WC)**						0.00																
	OBS-2 (in.WC)						0.00																
	OBS-3 (in.WC)						0.00																
	OBS-4 (in.WC)						0.00																
	OBS-5 (in.WC)						0.00																
Water Levels	**EXT-1 (ft)**	12.16	14.10		14.60		14.25			13.48	12.75		13.40	13.15		13.14							
	AS-1 (ft)	12.06																					
	OBS-1 (ft)	12.11											12.14			12.00							
	OBS-2 (ft)	12.03											12.07			10.65							
	OBS-3 (ft)	11.70											11.75			9.35							
	OBS-4 (ft)	12.05											12.06			11.87							
	OBS-5 (ft)	11.73											11.77			11.70							
PID	**EXT-1 (ppm)**	1,185	(wellhead)																2,800		2,905	1,485	
	AS-1 (ppm)	86																					
	OBS-1 (ppm)	2,180																	114				
	OBS-2 (ppm)	1,485																	2,700			1,387	
	OBS-3 (ppm)	2,905															2,300	1,400	1,700				
	OBS-4 (ppm)																		1,100				
	OBS-5 (ppm)	2,020																	110				

10/26/2009 Benzene Area

		11:15	11:53	14:10	15:05	15:15	15:35	15:37	15:53	16:07	16:30	16:35	16:50	17:45	17:53
	Event		Start SVE		Start GW Pumping to take sample	Collect GW Sample (EXT-1)	Finish GW Pumping	Finish SVE (Cat-Ox reached max temp [1,200°F])	Start SVE		Collected Summa Sample EXT-1 [ICE] EXHAUST	Collected Tedlar Sample BA-RAW			Finish SVE
SVE	**T (deg F)**									71			75	60	
	ΔP (in.WC)									0.045			0.025	0.1	
	EXT-1 (in.WC)			3.5						2.25			2.65	2.5	
	OBS-1 (in.WC)			3.6						2.15			2.65		
	OBS-2 (in.WC)			3.7						2.3			2.5		
	OBS-3 (in.WC)			3.5						2.32			2.65		
	Comb.(in.WC)									2.45			2.5		
	Static (in.Hg)									2.4			3.4	2.5	
	Static (in.WC)									32.64			46.24	34	
	Q (SCFM)									11.17			8.14	16.79	
GW Pumping	**Rate (gpm)**														
Air Sparge	**Pressure (PSI)**														
	Q (SCFM)														
Vac Response	**MW-02S (in.WC)**													0.01	
	CO18 (in.WC)													0.01	
	OBS-4 (in.WC)													0.00	
	OBS-5 (in.WC)													0.01	
Water Levels	**MW-02D (ft)**			11.73											
	MW-02S (ft)			12.40											
	CO18 (ft)			11.66											
PID	**MW-02D (ppm)**			998											
	MW-02S (ppm)			1,185											
	CO18 (ppm)			2,905											
	OBS-1 (ppm)	1,185													
	OBS-2 (ppm)	1,485													
	OBS-3 (ppm)	2,180													
	OBS-4 (ppm)	339													
	OBS-5 (ppm)	1,178													

10/27/2009 Benzene Area

		8:00	8:25	8:45	8:55	9:35	9:47	9:55	10:20	10:30	12:00	12:15	12:40	13:20	13:20	13:29	13:30	13:34	13:34	14:00	14:15	14:45	15:15	15:45	16:07	16:15	16:30	16:33	16:40
SVE	T (deg F)		Profile Benzene Area Wells	Start SVE	56	58	Finish SVE	Start SVE	Start Air Sparge	58	60	60	60	60	Collected Tedlar RAW-SPARGE-4-WELLS	60	Finish Air Sparge	Collected PUF RAW-SPARGE-4-WELLS-PUF	Finish SVE	Start SVE	60	60	60	60	Finish SVE	Start GW Pumping for GW Sample	Collected GW Sample (EXT-1-PS)	Finish GW Pumping	Profile Benzene Area Wells
	ΔP (in.WC)				0.08	0.09				0.08	0.125	0.14	0.16	0.16		0.145					0.165	0.12	0.1	0.1					
	combined (in.WC)				2.45	2.5				2.5	5.5	7.5	6.75	5		6					5.5	3.75	3.4	3					
	Static (in.Hg)									3	5.75	7.25	7.75	8.75		8					0.1	0.5	0.1	0.1					
	Static (in.WC)									40.8	78.2	98.6	105.4	119		108.8					1.36	6.8	1.36	1.36					
	Q (SCFM)									14.91	17.63	18.07	19.10	18.67		18.08					22.49	19.05	17.51	17.51					
GW Pumping	Rate (gpm)																												
Air Sparge	Pressure (PSI)									12	10	10	10	9		9													
	Q (SCFM)									30	40	50	50	50		50													
Vac Response	MW-02S (in.WC)																					0.00		0.03					
	CO18 (in.WC)																					0.01		0.02					
	OBS-4 (in.WC)																					0.00		0.00					
	OBS-5 (in.WC)																					0.01		0.01					
Water Levels	OBS-4 (ft)	11.97																											
	OBS-5 (ft)	11.66																											
PID	RAW (ppm)				2,100	2,000																							

10/28/2009 Benzene Area

		10:15	10:20	12:21	10:45	11:10	11:45	12:00	12:00	12:00	12:20	12:25	12:30	12:52	14:02	14:05	14:08
SVE	T (deg F)	Start SVE	60	Start GW Pumping	61	62	64	64	Finish SVE/GW Pumping	Collected Tedlar RAW-EXT-1-NO SPARGE	Start SVE SVE	Start Air Sparge	65	63	64	Collected PUF RAW-EXT-1-SPARGE	Finish SVE/Air Sparge
	ΔP (in.WC)		0.06		0.08	0.08	0.065	0.065					0.04	0.06	0.1		
	EXT-1 (in.WC)		5		9	9	9	8.5					8	9.75	16		
	Static (in.Hg)		1.0		2.5	2.4	2.5	2.5					3.1	6.0	9.5		
	Static (in.WC)		13.6		34	32.64	34	34					42.16	81.6	129.2		
	Q (SCFM)		13.36		15.01	15.02	13.49	13.49					10.45	12.12	14.45		
GW Pumping	Rate (gpm)		4.3		4.3	4.3	4.3	4.3									
Air Sparge	Pressure (PSI)												18	4.8	9		
	Q (SCFM)												50	14	30		
Vac Response	MW-02D (in.WC)													None	Slight		
	MW-02S (in.WC)				0.00		0.00							Some	Some		
	CO18 (in.WC)				0.00		0.00							Good	Good		
	OBS-1 (in.WC)				0.00		0.00							Foamy	Good		
	OBS-2 (in.WC)				0.00		0.00							Violent	Violent		
	OBS-3 (in.WC)				0.00		0.00							Violent	Violent		
	OBS-4 (in.WC)				0.00		0.00							Violent	Violent		
	OBS-5 (in.WC)				0.01		0.00							None	None		

11/3/2009 Benzene Area/ Naphthalene Area

		9:10	10:00	10:15	10:22	10:55	11:40	14:40	16:00	16:12	16:15	16:30	16:35
SVE	T (deg F)												
	ΔP (in.WC)												
	EXT-1 (in.WC)			10									
	Static (in.Hg)												
	Static (in.WC)												
	Q (SCFM)												
GW Pumping	Rate (gpm)												
Air Sparge	Pressure (PSI)												
	Q (SCFM)												
Vac Response	MW-02D (in.WC)												
	MW-02S (in.WC)												
	CO18 (in.WC)												
	OBS-1 (in.WC)												
	OBS-2 (in.WC)												
	OBS-3 (in.WC)												
	OBS-4 (in.WC)												
	OBS-5 (in.WC)												
Water Levels	EXT-2 (ft)							13.37		15.59	15.57		
	AS-2 (ft)							13.14					
	OBS-6 (ft)							12.6					
	OBS-7 (ft)							13.09					
	OBS-8 (ft)							13.12					
	OBS-9 (ft)							13.62					
PID	EXT-1 (ppm)	2,547											
	OBS-1 (ppm)	3,051											
	OBS-2 (ppm)	3,941											
	OBS-3 (ppm)	4,317											
	OBS-4 (ppm)	463											
	OBS-5 (ppm)	799											
	EXT-2 (ppm)							69					
	AS-2 (ppm)							253					
	OBS-6 (ppm)							77					
	OBS-7 (ppm)							18					
	OBS-8 (ppm)							4					
	OBS-9 (ppm)							9					
Event			Start SVE		Finish SVE (shut down unexpectedly)	Used Vac Pump to get Tedlar Sample w/ GAC (PID=2,136ppm)	Moved to Naphthalene Area		Start GW Pumping			Collect GW Sample (EXT-2)	Finish GW Pumping

11/4/2009 Naphthalene Area

		9:15	10:48	10:48	11:26	12:18	13:20	13:30	13:45	13:50	14:05	14:05	14:45	15:00	15:00
SVE	T (deg F)				53	53			55						
	ΔP (in.WC)				0.05	0.07			0.005						
	EXT-2 (in.WC)				36.72	34	20.8		24.2						
	Static (in.Hg)				10.7	10	1.5		3.6						
	Static (in.WC)				145.52	136			48.96						
	Q (SCFM)				10.01	12.06			3.7						
GW Pumping	Rate (gpm)				10	11	11		11						
Air Sparge	Pressure (PSI)													15	
	Q (SCFM)													11	
Vac Response	OBS-6 (in.WC)					0.00	P		0.00						
	OBS-7 (in.WC)					0.00	P		0.00						
	OBS-8 (in.WC)					0.00	P		P						
	OBS-9 (in.WC)					0.00	P		P						
	OBS-10 (in.WC)					0.00	P								
Water Levels	EXT-2 (ft)				11.00										
PID	EXT-2 (ppm)								126						
Event		Profile Naphthalene Area Wells	Start SVE	Start GW Pumping				Collected Tedlar EXT-2 RAW		Collected Summary EXT-2 EXHAUST	Finish SVE	Collected PUF EXT-2 RAW PUF	Start Air Sparge		Collected Tedlar EXT-2 SPARGE

		15:05	15:07	15:09	15:10	15:13	15:15	15:18	15:25	15:57	16:12	16:40	16:50	17:30	17:30
SVE	T (deg F)									53			52		
	ΔP (in.WC)								0	0.01			0.01		
	EXT-2 (in.WC)								21.5	21.5			21		
	Static (in.Hg)									1.6			1.6		
	Static (in.WC)									21.76			21.76		
	Q (SCFM)									5.43			5.44		
GW Pumping	Rate (gpm)							6	6	6	6	6	6		
Air Sparge	Pressure (PSI)	16	14	16	19	19		18	17	14.5	16	16	16		
	Q (SCFM)	14	16	20	24	30		28	29	27	31	50	31		
Vac Response	OBS-6 (in.WC)							None			0.00		None		
	OBS-7 (in.WC)							None			0.15		Slight		
	OBS-8 (in.WC)							None			0.07		None		
	OBS-9 (in.WC)							None			0.13		Violent		
	OBS-10 (in.WC)							None			0.11		None		
Water Levels	EXT-2 (ft)											14.45			
PID	EXT-2 (ppm)										96				
Event							Start SVE/GW Pumping							Finish SVE/Air Sparge/GW Pumping	Collected PUF EXT-2 PUF SPARGE

11/5/2009 Naphthalene Area

		14:15	14:25	14:40	15:10	15:15	15:22	17:45
SVE	T (deg F)		Start SVE	Start GW Pumping		Collect GW Sample - EXT-2-PS	Finish SVE/GW Pumping	Profile Naphthalene Area Wells
	∆P (in.WC)							
	EXT-2 (in.WC)							
	Static (in.Hg)							
	Static (in.WC)							
	Q (SCFM)							
GW Pumping	Rate (gpm)				9			
Air Sparge	Pressure (PSI)							
	Q (SCFM)							
Vac Response	OBS-6 (in.WC)							
	OBS-7 (in.WC)							
	OBS-8 (in.WC)							
	OBS-9 (in.WC)							
	OBS-10 (in.WC)							
Water Levels	EXT-2 (ft)	11.91						
PID	EXT-2 (ppm)				294			

11/6/2009 Naphthalene Area - Pumping Tests

		10:40	11:30	14:10
Water Levels	EXT-2 (ft)	13.50		
	OBS-6 (ft)	12.70		
	OBS-7 (ft)	13.20		
	OBS-9 (ft)	13.74		
	BA Frac (ft)		6.7	
	NA Frac (ft)			7.96

APPENDIX D

Pumping Test Results

PUMPING TEST

Two short-term (3 hour) aquifer pumping tests were performed during conduct of the SVE pilot test for the purpose of assessing the water table aquifer hydraulic properties. The first test was conducted at the Benzene Area (pumping well EXT-1) and the second at the Naphthalene Area (pumping wells EXT-2). These tests were conducted on November 5 and 6, 2009, respectively.

PUMPING TEST SETUP

Based on the results of well development, a 3-inch diameter submersible pump capable of pumping up to 30 gallons per minute (gpm) was selected as being appropriate for both test areas. The pump was wired to a gasoline-powered portable generator. The pump was supported by 1-inch-diameter black polyethylene tubing. The discharge rate was controlled using a ball valve. Flow rates were measured using a turbine style flow meter and rates were verified using a 5-gallon bucket and stopwatch. The water during both tests was directed to temporary 21,000 gallon storage tanks located adjacent to the test areas.

Following the installation of the submersible pump, pressure transducers were installed in a total of three observation wells per test. The pressure transducers were the Mini-Troll 700 manufactured by InSitu Inc. These units were programmed using InSitu's Windows-based Software Win-Situ, a communication package, and a handheld computer via a serial communication cable. Additionally, manually recorded water levels were measured manually in the pumping wells. Water levels were very difficult to measure in pumping well EXT-2 at the Naphthalene Area because of DNAPL which repeatedly coated the interface probe rendering it ineffective.

PUMPING TEST TIMING

A summary of the two pumping tests is provided below including start and stop times, total gallons pumped, average pumping rate, and a list of pumping and observation wells. Both tests ran for three hours or 180 minutes. The recovery phase was monitored for 1 to 2 hours following cessation of pumping.

Test Area	Time On	Time Off	Gallons Pumped	Rate (gpm)	Pumping (P) & Observation (O)
Benzene	11-5-09 13:45	11-5-09 16:45	4,307	23.9	EXT-1, OBS-2, OBS-4, and OBS-5.
Naphthalene	11-6-09 11:05	11-6-09 14:05	1,786	9.9	EXT-2, OBS-6, OBS-7, and OBS-9.

PUMPING TEST RESULTS

The constant rate test data were interpreted using ISOAQX version 7.0 computer software developed for aquifer test analysis by Hydrologic Analytical Software, Inc.

(Hydrologic, Inc., 1998). ISOAQX is a graphics-oriented, menu-driven, multi-model pumped aquifer analysis and prediction package with advanced analytical, data manipulation, error checking, test documentation, and archiving capabilities. Table 1 shows the relative distances of observation wells from pumping wells, the well screen positions, and the measured drawdowns in wells after 3 hours.

TABLE 1
Summary of Pumping Test Data

Well ID	Drawdown after 3 Hours (ft)	Screened Interval (ft, bgs)	Distance to Pumped Well (ft)
Benzene Area			
EXT-1	5.5	4 to 22	0
OBS-2	0.30	5 to 23	16.0
OBS-4	0.19	3.5 to 21.5	15.6
OBS-5	0.12	5 to 23	20.5
Naphthalene Area			
EXT-2	~5	5 to 17	0
OBS-6	0.019	5 to 17	22.6
OBS-7	0.019	5 to 22	22.2
OBS-9	0.016	5 to 23	16.3

Aquifer properties derived from these pumping tests are presented in Table 2. Time-drawdown curves for the observation wells from the Benzene Area test (OBS-2, OBS-4, and OBS-5) and the Naphthalene Area test (OBS-7, OBS-7, and OBS-9) are presented in Attachment 1. Time-drawdown curves were analyzed using the Theis Method as it applies to unconfined aquifers. Data collected during these tests assisted in the determination of the aquifer coefficients of hydraulic conductivity, transmissivity, and specific yield. The estimated average hydraulic conductivity and specific yield from the test are presented in Table 2.

TABLE 2
Aquifer Parameters Determined from Pumping Test Analysis

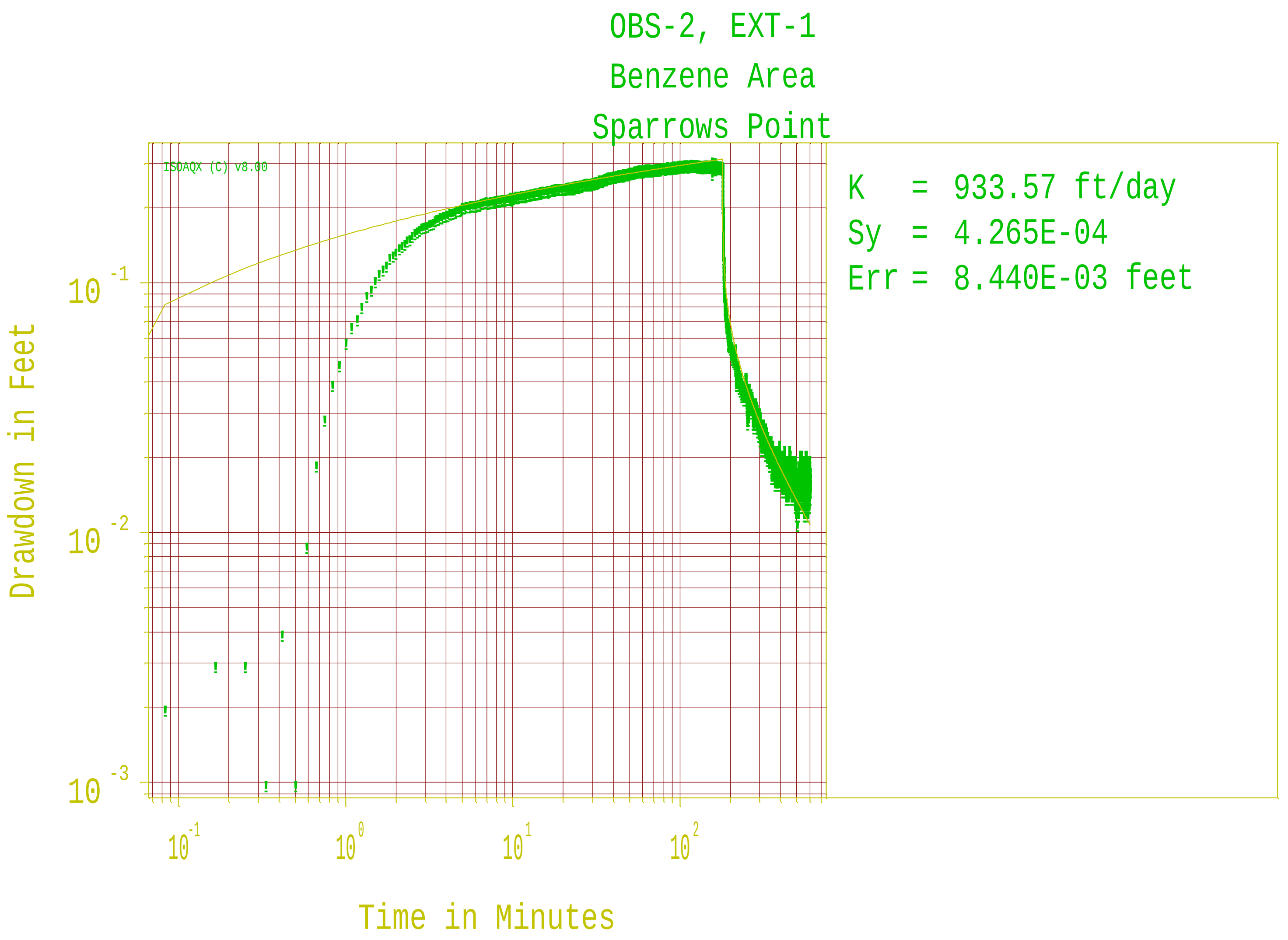
Theis Curve Unconfined Model – Drawdown Analysis				
Well ID	**K_h (ft/day)**	**b (ft)**	**T (ft^2/day)**	**S_y**
Benzene Area				
OBS-2	933.57	13	12,136.41	4.3E-4
OBS-4	982.34	13	12,770.42	2.2E-2
OBS-5	1,098.40	13	14,279.20	1.2E-1
Average	**1,004.77**	**13**	**13,062.01**	**4.7E-2**

Naphthalene Area				
OBS-6	2,903.91	12	34,846.92	4.7E-1
OBS-7	4,087.10	12	49,045.20	1.2E-1
OBS-9	3,470.59	12	41,647.08	7.6E-1
Average	**3,487.20**	**12**	**41,846.40**	**4.5E-1**

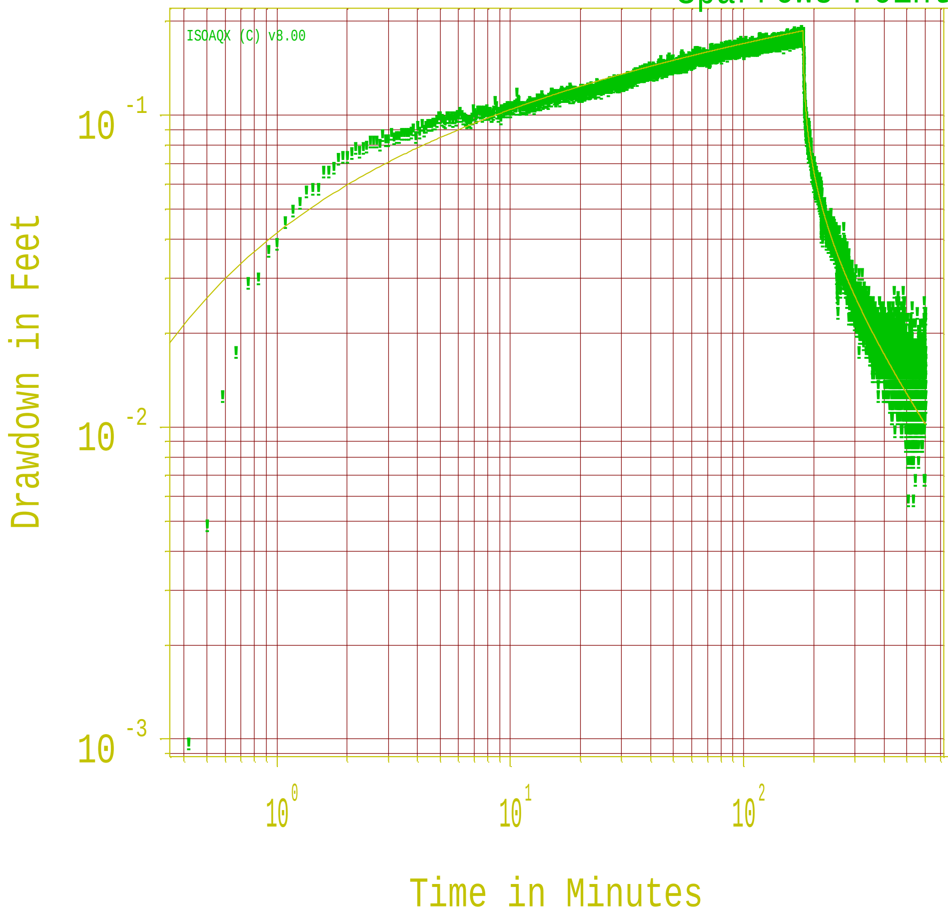
K_h = Horizontal Hydraulic Conductivity
K_z = Vertical Hydraulic Conductivity
T = Transmissivity
b = Aquifer thickness
S_y = Specific Yield

The average hydraulic conductivity for the Benzene Area was 1,004.77 ft/day or 3.5E-1 cm/sec. and the average hydraulic conductivity for the Naphthalene Area was 3,478.2 ft/day or 1.2 cm/sec. The amount of drawdown measured in observation wells during the Benzene Area test was sufficient to allow curve matching for both the drawdown and recovery phases which provides some assurance that the matches are valid. In addition, the type curve and the measured curves overlapped substantially adding to the comfort level. In the case of the Naphthalene Area, much less drawdown was measured in the observation wells where the maximum drawdown was 0.019 feet or 0.23 inches. Minor background water table fluctuations at the Naphthalene Area (noted before, during, and after the pumping test) likely masked the pumping effects to some extent. For this reason the pump test results from the Benzene Area may be more representative of flow conditions in the slag.

BENZENE AREA


OBS-2, EXT-1
Benzene Area
Sparrows Point
ISOAQX (C) v8.00
K = 933.57 ft/day
Sy = 4.265E-04
Err = 8.440E-03 feet
Drawdown in Feet
10^{-1}
10^{-2}
10^{-3}
10^{-1}
10^{0}
10^{1}
10^{2}
Time in Minutes

OBS-4, EXT-1
Benzene Area
Sparrows Point

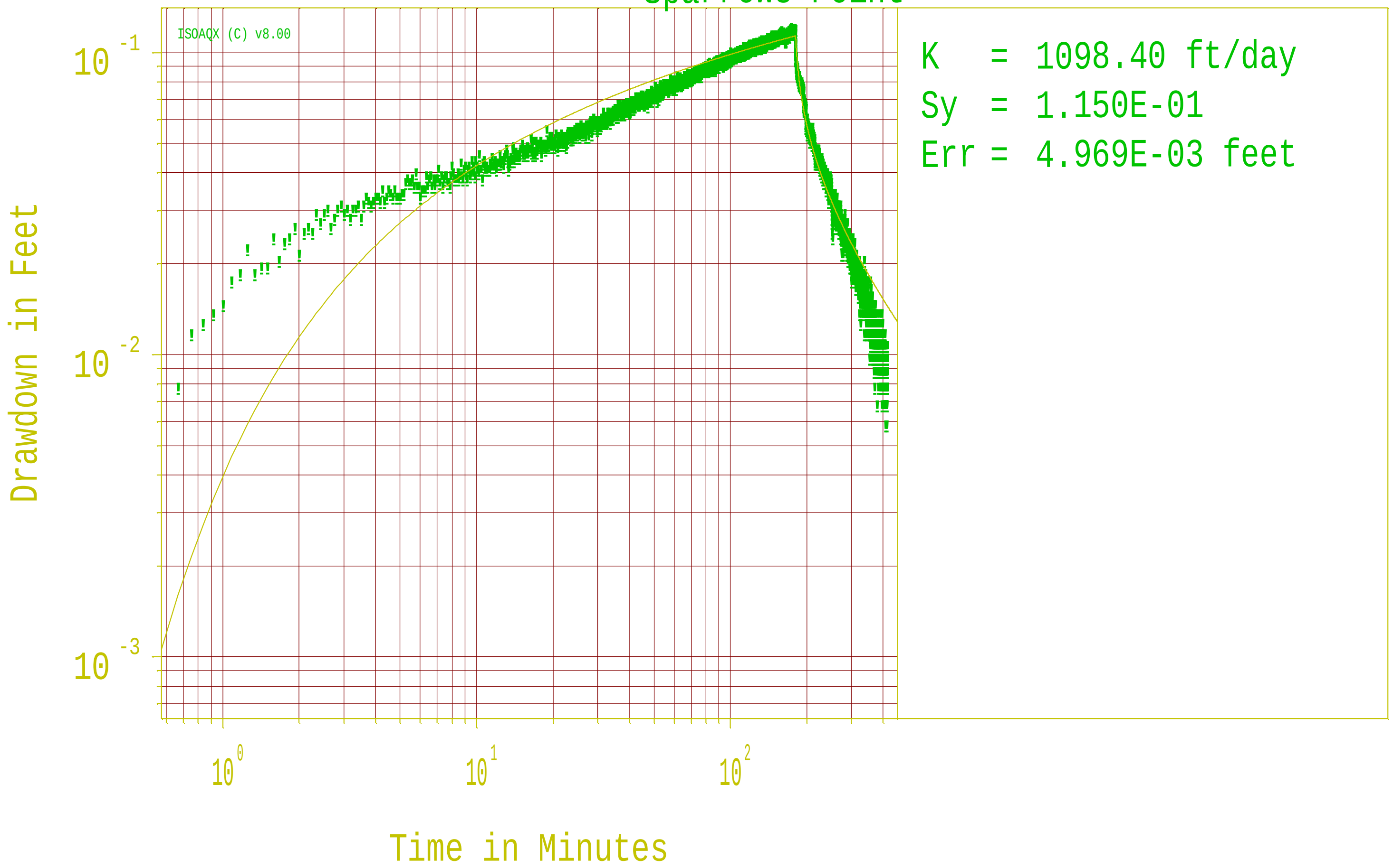


K = 982.34 ft/day
Sy = 2.191E-02
Err = 3.734E-03 feet

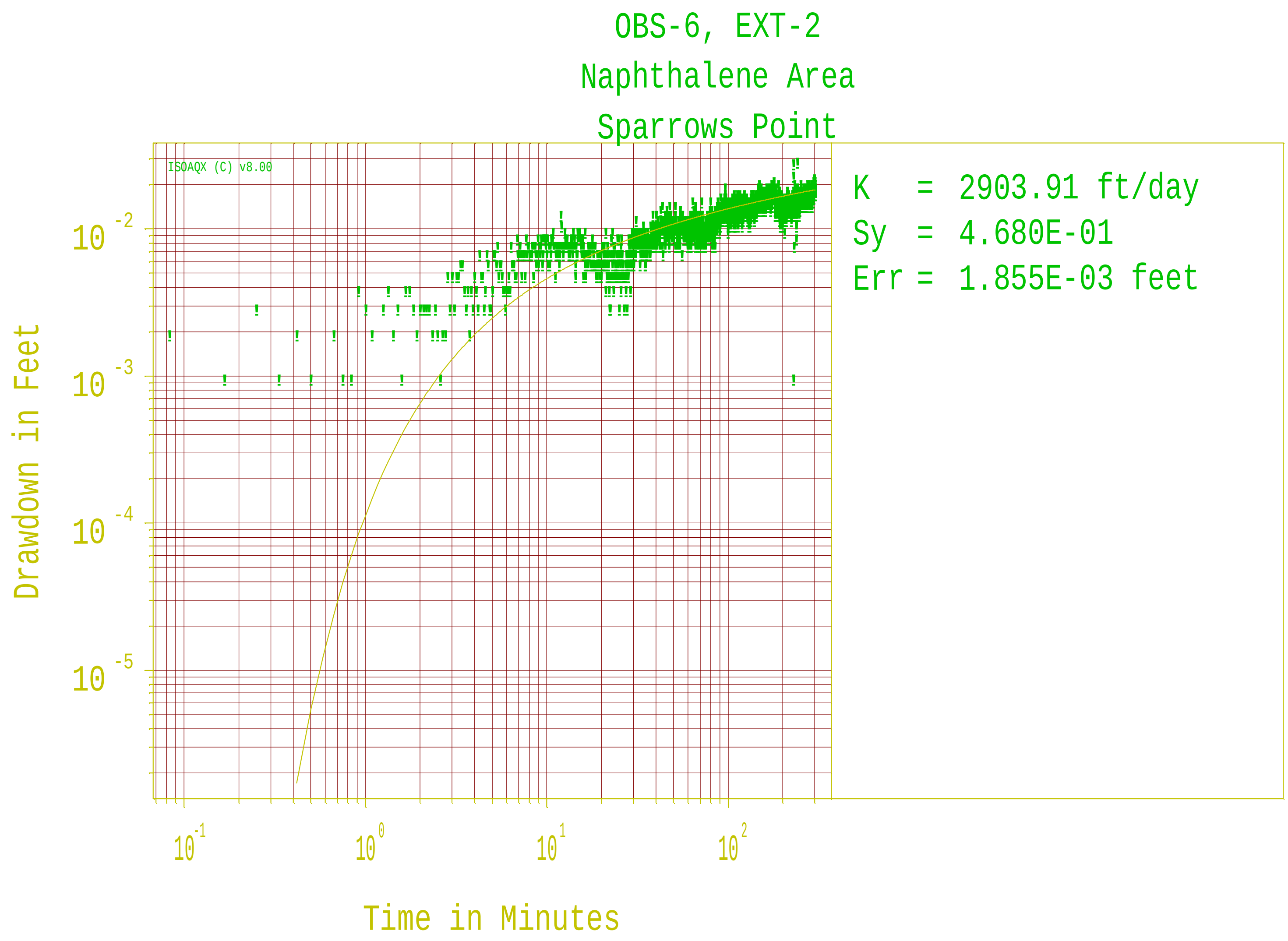
OBS-5, EXT-1

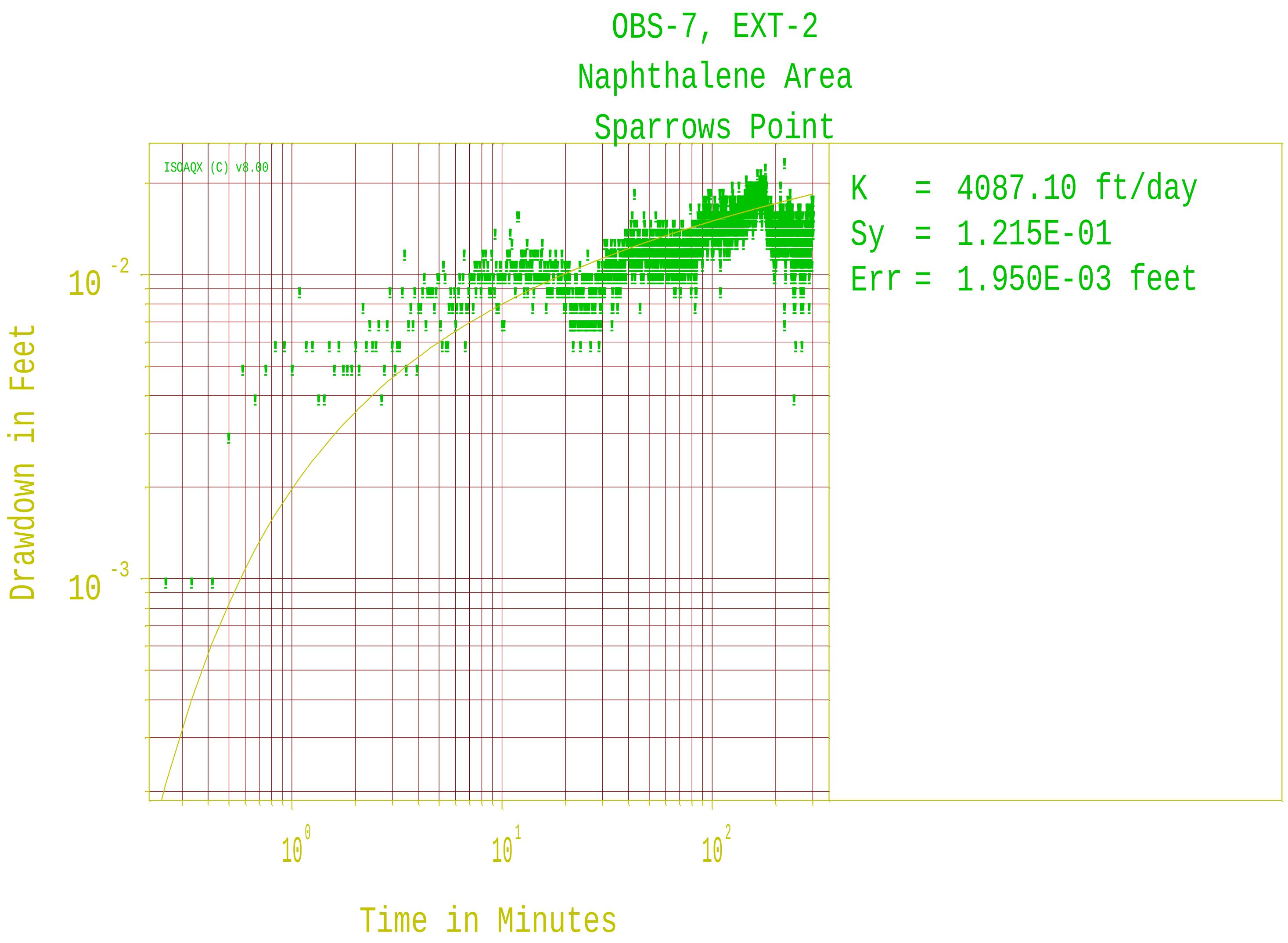
Benzene Area

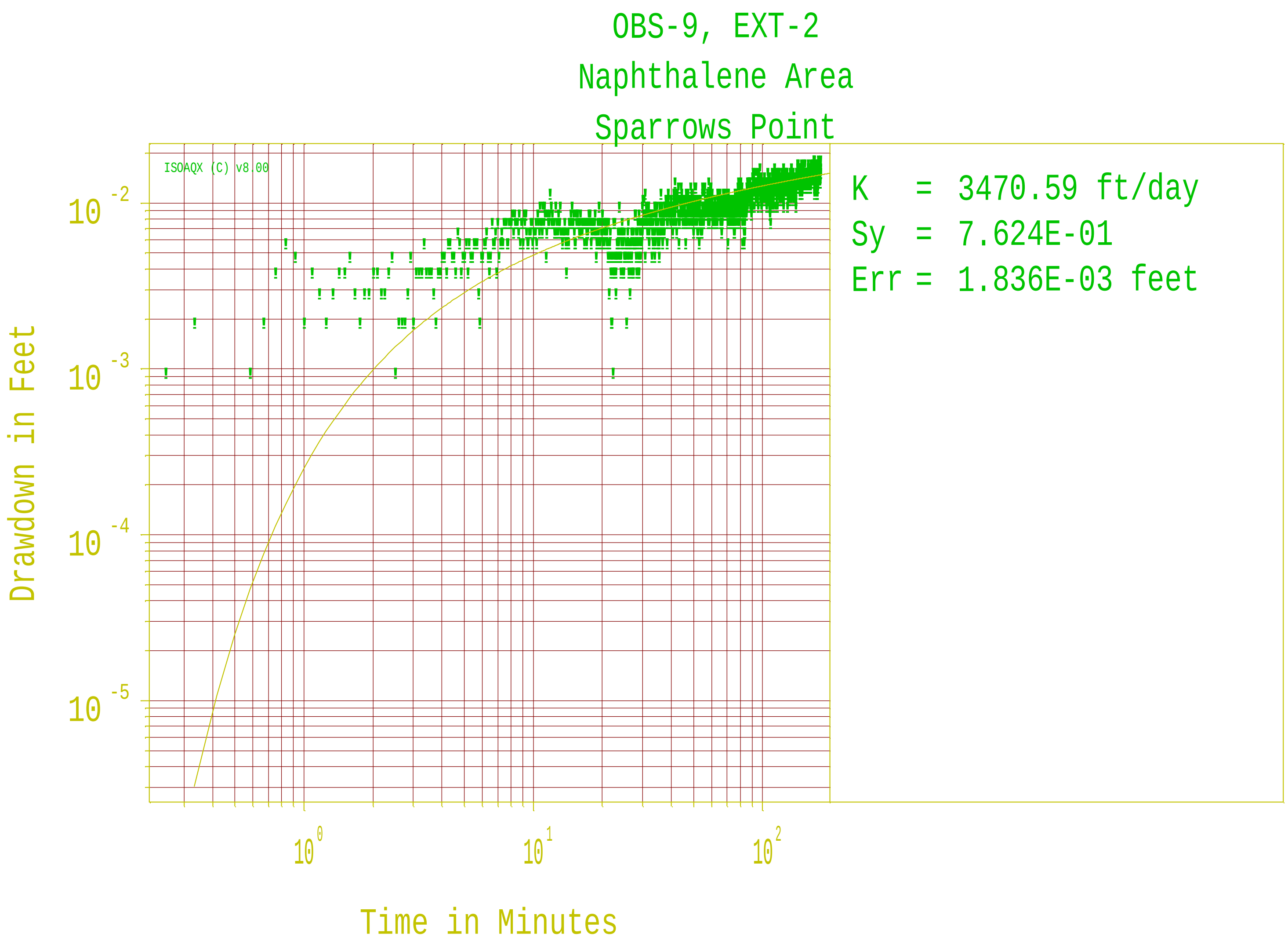
Sparrows Point



NAPHTHALENE AREA


OBS-6, EXT-2
Naphthalene Area
Sparrows Point
ISOAQX (C) v8.00
K = 2903.91 ft/day
Sy = 4.680E-01
Err = 1.855E-03 feet
Drawdown in Feet
Time in Minutes


OBS-7, EXT-2
Naphthalene Area
Sparrows Point
ISOAQX (C) v8.00
K = 4087.10 ft/day
Sy = 1.215E-01
Err = 1.950E-03 feet
Drawdown in Feet
10 -2
10 -3
Time in Minutes
10 0
10 1
10 2



OBS-9, EXT-2
Naphthalene Area
Sparrows Point
ISOAQX (C) v8.00
K = 3470.59 ft/day
Sy = 7.624E-01
Err = 1.836E-03 feet
Drawdown in Feet
Time in Minutes
10^-2
10^-3
10^-4
10^-5
10^0
10^1
10^2

APPENDIX E

Intrinsic Permeability Calculations

Flow-Vacuum Evaluation Sheet
Well EXT-1
Former Benzol Processing Area

	PARAMETERS:							
	K (Hydraulic Conductivity)	**0.035**	**cm/sec**					
	P (Hydraulic Permeability)		gal/day ft2					
	(k) Soil Permeability	*3.62319E-07*	*cm2*					
	Darcy	36.23						
	Screen Length	**5**	**feet**					
	Well Diameter	**4**	**inches**	*5.08*	*cm (Rw)*			
	Assumed Rad. of Influence	**12**	**feet**	*365.76*	*cm (Ri)*			
Total								
Well Flow	**Q*/H**	Q/H	Q/H	**Pw**	Pw	Pw	*Pw*	Pw
(SCFM)	**(SCFM/Ft. screen)**	(ACFM/Ft. screen)	(Acm3/S/cm screen)	**(" Hg Vac.)**	(atm.)	(Torr)	*(g/cm-s2)*	("WC vac)
5.92	1.183217983	1.190499444	18.43360277	**0.183**	0.99	755.35161	*1009786*	2.51
8.07	1.614602632	1.6282073	25.21103789	**0.25**	0.99	753.64974	*1007511*	3.42
14.16	2.832640003	2.874918194	44.51501449	**0.44**	0.99	748.82353	*1001059*	6.02
16.08	3.215657672	3.270308527	50.63720832	**0.5**	0.98	747.29947	*999021*	6.85
18.94	3.788721036	3.864934622	59.8443535	**0.59**	0.98	745.01338	*995965*	8.08
26.86	5.371351352	5.52650724	85.57201745	**0.84**	0.97	738.66311	*987476*	11.5
34.70	6.940434076	7.202836778	111.5281764	**1.09**	0.96	732.31285	*978987*	14.9
50.19	10.03795675	10.6013293	164.1501759	**1.59**	0.95	719.61232	*962008*	21.8
65.41	13.08128906	14.06367792	217.7609184	**2.09**	0.93	706.91179	*945029*	28.6
77.68	15.5363847	16.95290345	262.4974667	**2.5**	0.92	696.49735	*931107*	34.2
80.35	16.070431	17.59338736	272.4146708	**2.59**	0.91	694.21126	*928051*	35.5
95.03	19.00538258	21.19422361	328.1697452	**3.09**	0.90	681.51073	*911072*	42.3

Flow-Vacuum Evaluation Sheet
Well EXT-2
Former Coal Tar Storage Area

	PARAMETERS:							
	K (Hydraulic Conductivity)	**0.0055**	**cm/sec**					
	P (Hydraulic Permeability)		gal/day ft2					
	(k) Soil Permeability	*5.69358E-08*	*cm2*					
	Darcy	5.69						
	Screen Length	**5**	**feet**					
	Well Diameter	**4**	**inches**	*5.08*	*cm (Rw)*			
	Assumed Rad. of Influence	**12**	**feet**	*365.76*	*cm (Ri)*			
Total Well Flow (SCFM)	**Q*/H (SCFM/Ft. screen)**	Q/H (ACFM/Ft. screen)	Q/H (Acm3/S/cm screen)	**Pw (" Hg Vac.)**	Pw (atm.)	Pw (Torr)	*Pw (g/cm-s2)*	Pw ("WC vac)
0.93	0.185934254	0.187078484	2.896709006	**0.183**	0.99	755.35161	*1009786*	2.51
1.27	0.253723271	0.255861147	3.961734526	**0.25**	0.99	753.64974	*1007511*	3.42
2.23	0.445129143	0.451772859	6.995216563	**0.44**	0.99	748.82353	*1001059*	6.02
2.53	0.505317634	0.513905626	7.957275593	**0.5**	0.98	747.29947	*999021*	6.85
2.98	0.595370449	0.607346869	9.404112694	**0.59**	0.98	745.01338	*995965*	8.08
4.22	0.844069498	0.868451138	13.44703131	**0.84**	0.97	738.66311	*987476*	11.5
5.45	1.090639641	1.131874351	17.5258563	**1.09**	0.96	732.31285	*978987*	14.9
7.89	1.577393204	1.665923175	25.79502764	**1.59**	0.95	719.61232	*962008*	21.8
10.28	2.055631138	2.21000653	34.21957289	**2.09**	0.93	706.91179	*945029*	28.6
12.21	2.441431881	2.664027685	41.2496019	**2.5**	0.92	696.49735	*931107*	34.2
12.63	2.525353443	2.764675157	42.8080197	**2.59**	0.91	694.21126	*928051*	35.5
14.93	2.986560119	3.330520853	51.56953139	**3.09**	0.90	681.51073	*911072*	42.3
17.20	3.439251166	3.908180367	60.51396734	**3.59**	0.88	668.8102	*894094*	49.1
19.42	3.883426584	4.498339751	69.65195032	**4.09**	0.86	656.10967	*877115*	56.0
19.46	3.892223233	4.510275425	69.83676138	**4.1**	0.86	655.85566	*876775*	56.1
20.73	4.145844333	4.858740839	75.23237332	4.39	0.85	648.48935	*866928*	60.1
21.60	4.319086374	5.101739226	78.99494185	**4.59**	0.85	643.40914	*860136*	62.8
23.73	4.746230534	5.719178635	88.55532666	**5.09**	0.83	630.70861	*843158*	69.7
25.82	5.164859065	6.351523572	98.34650754	**5.59**	0.81	618.00808	*826179*	76.5
27.87	5.574971968	6.999712278	108.3830121	**6.09**	0.80	605.30755	*809201*	83.4
29.88	5.976569241	7.664763427	118.6806135	**6.59**	0.78	592.60702	*792222*	90.2
31.85	6.369650885	8.34778493	129.2564665	**7.09**	0.76	579.90649	*775243*	97.1
33.77	6.754216901	9.049983932	140.1292624	**7.59**	0.75	567.20596	*758265*	104

APPENDIX F

Analytical Laboratory packages

Microbac Laboratories, Inc.
Baltimore Division
2101 Van Deman Street • Baltimore, MD 21224

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COVER LETTER

Bill Eaton
URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

November 25, 2009
Report No.: 09K0225

RE: Sparrows Point

The report of analyses contains test results for samples received at Microbac Laboratories, Inc., Baltimore Division on 11/05/2009 11:46.

The enclosed results were obtained from and applicable to the sample(s) as received at the laboratory. All sample results are reported on an "as received" basis unless otherwise noted.

All data included in this report has been reviewed and meet the applicable project and certification specific requirements, unless otherwise noted.

This report has been paginated in its entirety and shall not be reproduced except in full, without the written approval of Microbac Laboratories, Inc.

We appreciate the opportunity to service your analytical needs. If you have any questions, please feel free to contact us.

This Data Package contains the following:

- This Cover Page
- Sample Summary
- Test Results
- Notes and Definitions
- Cooler Receipt Log
- Chain of Custody

Final report reviewed by: Melanie C. Duszynski/Project Manager — 11/25/2009 Report issue date

All samples received in proper condition and results conform to ISO 17025 standards unless otherwise noted.

If we have not met or exceeded your expectations, please contact the Director or Trevor Boyce, President at tboyce@microbac.com or Robert Morgan, Chief Operation Officer, at rmorgan@microbac.com.

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0225 Reported: 11/25/2009 09:18

SAMPLE SUMMARY

Sample ID	Laboratory ID	Matrix	Type	Date Sampled	Date Received
EXT-2-PS	09K0225-01	Ground Water	Not Specified	11/04/2009 17:30	11/05/2009 11:46

Microbac Laboratories, Inc., Baltimore Division

Melanie C. Duszynski, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0225 Reported: 11/25/2009 09:18

EXT-2-PS

09K0225-01 (Ground Water) Sampled: 11/04/2009 17:30; Type: Not Specified

Microbac Laboratories, Inc., Baltimore Division

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Wet Chemistry								
BOD	**140**	10	mg/L	110509 1858	111009 1857	LCR	SM (20) 5210B	
COD, Total	**1100**	100	mg/L	110909 1328	111009 1034	LCR	EPA410.4/HACH8000	D
Nitrite as N	ND	0.0050	mg/L	110909 0716	110909 0716	VAS	EPA 353.2	H1
Nitrate as N	ND	0.05	mg/L	111009 1702	111009 1702	VAS	EPA 353.2	
Nitrate/Nitrite as N	ND	0.05	mg/L	111009 1702	111009 1702	VAS	EPA 353.2	
Orthophosphate as P	**0.064**	0.010	mg/L	110909 0844	110909 0844	VAS	EPA 365.1	H1
Mercury, Dissolved by EPA 200/7000 Series Methods								
Mercury	ND	0.00020	mg/L	110609 1343	111109 2113	APS	EPA 245.1	
Metals, Dissolved by EPA 200 Series Methods								
Silver	ND	0.0040	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Arsenic	ND	0.0050	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Boron	**0.41**	0.020	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Beryllium	ND	0.0010	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Cadmium	**0.0035**	0.00050	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Cobalt	ND	0.0050	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Chromium	ND	0.0010	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Copper	**0.029**	0.0010	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Nickel	ND	0.010	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Lead	ND	0.040	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Antimony	ND	0.0050	mg/L	110609 1132	111909 1551	PRM	EPA 200.8/6020	
Selenium	ND	0.010	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Titanium	ND	0.020	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Thallium	ND	0.020	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Vanadium	**1.7**	0.0050	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	
Zinc	ND	0.0050	mg/L	110609 1132	111009 1158	APS	EPA 200.7/6010B	

Microbac Laboratories, Inc., Baltimore Division

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Melanie C. Duszynski

Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

Project: Sparrows Point
Project Number: Sparrows Point
Project Manager: Bill Eaton

Report: 09K0225
Reported: 11/25/2009 09:18

EXT-2-PS

09K0225-01 (Ground Water) Sampled: 11/04/2009 17:30; Type: Not Specified

Microbac Laboratories, Inc., Baltimore Division

Volatile Organic Compounds by EPA Method 8260B

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
1,1,1,2-Tetrachloroethane	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
1,1,1-Trichloroethane	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
1,1,2,2-Tetrachloroethane	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
1,1,2-Trichloroethane	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
1,1-Dichloroethane	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
1,1-Dichloroethene	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
1,2-Dichloroethane	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
1,2-Dichloropropane	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Methyl Ethyl Ketone (2-Butanone)	ND	2500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Methyl Butyl Ketone (2-Hexanone)	ND	2500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Acetone	ND	2500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Benzene	**1200**	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	D
Bromoform	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Carbon disulfide	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Carbon Tetrachloride	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Chlorobenzene	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Chloroethane	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Chloroform	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
cis-1,3-Dichloropropene	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Ethylbenzene	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Methylene Chloride	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Tetrachloroethene	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Toluene	**2000**	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	D
trans-1,2-Dichloroethene	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
trans-1,3-Dichloropropene	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Trichloroethene	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Vinyl chloride	ND	500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	U, D
Total Xylenes	**2200**	1500	ug/L	111609 1351	111609 1351	EMG	EPA 8260B	D
Surrogate: Dibromofluoromethane		*85.2%*	*80-120*	*111609 1351*	*111609 1351*		*EPA 8260B*	
Surrogate: 1,2-Dichloroethane-d4		*85.3%*	*80-120*	*111609 1351*	*111609 1351*		*EPA 8260B*	

Microbac Laboratories, Inc., Baltimore Division

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Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0225 Reported: 11/25/2009 09:18

EXT-2-PS

09K0225-01 (Ground Water) Sampled: 11/04/2009 17:30; Type: Not Specified

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Microbac Laboratories, Inc., Baltimore Division								
Volatile Organic Compounds by EPA Method 8260B								
Surrogate: Toluene-d8		*97.2%*	*75-120*	*111609 1351*	*111609 1351*		*EPA 8260B*	
Surrogate: 4-Bromofluorobenzene		*98.4%*	*60-149*	*111609 1351*	*111609 1351*		*EPA 8260B*	
Acid and Base/Neutral Extractables by EPA Method 8270C								
1,2,4-Trichlorobenzene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
1,2-Dichlorobenzene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
1,3-Dichlorobenzene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
1,4-Dichlorobenzene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
2,4,5-Trichlorophenol	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
2,4,6-Trichlorophenol	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
2,4-Dichlorophenol	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
2,4-Dimethylphenol	**100**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	E
2,4-Dinitrophenol	ND	10	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	V6, U
2,4-Dinitrotoluene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
2,6-Dinitrotoluene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
2-Chloronaphthalene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
2-Chlorophenol	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
2-Methylnaphthalene	**920**	500	ug/L	110509 1330	111309 0245	RIS	EPA 8270C	D
2-Methylphenol	**31**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	
2-Nitrophenol	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
3,3´-Dichlorobenzidine	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
3,3'-Dimethylbenzidine	**0.0**		ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
4-Methylphenol, 3-Methylphenol	**47**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	
4,6-Dinitro-2-methylphenol	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	L3, U
4-Bromophenyl-phenylether	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
4-Chloro-3-methylphenol	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
4-Chlorophenyl-phenylether	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
4-Nitrophenol	ND	10	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Acenaphthene	**32**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	

Microbac Laboratories, Inc., Baltimore Division

Melanie C Duszynski

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0225 Reported: 11/25/2009 09:18

EXT-2-PS

09K0225-01 (Ground Water) Sampled: 11/04/2009 17:30; Type: Not Specified

Microbac Laboratories, Inc., Baltimore Division

Acid and Base/Neutral Extractables by EPA Method 8270C

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Acenaphthylene	**840**	500	ug/L	110509 1330	111309 0245	RIS	EPA 8270C	D
Anthracene	**140**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	E
Benz(a)anthracene	**140**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	
Benzo[a]pyrene	**110**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	E
Benzo[b]fluoranthene	ND	500	ug/L	110509 1330	111309 0245	RIS	EPA 8270C	U, D
Benzo[g,h,i]perylene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Benzo[k]fluoranthene	**110**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	E
bis(2-Chloroethoxy)methane	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Bis(2-Chloroethyl)ether	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Bis(2-chloroisopropyl)ether	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Bis(2-Ethylhexyl)phthalate	**16**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	
Butylbenzylphthalate	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Chrysene	**120**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	E
Dibenz[a,h]anthracene	**22**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	
Dibenzofuran	ND	500	ug/L	110509 1330	111309 0245	RIS	EPA 8270C	U, D
Diethylphthalate	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Dimethylphthalate	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Di-n-butylphthalate	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Di-n-octylphthalate	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Fluoranthene	ND	500	ug/L	110509 1330	111309 0245	RIS	EPA 8270C	U, D
Fluorene	ND	500	ug/L	110509 1330	111309 0245	RIS	EPA 8270C	U, D
Hexachlorobenzene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Hexachlorobutadiene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Hexachlorocyclopentadiene	ND	10	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	V6, U
Hexachloroethane	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Indeno[1,2,3-cd]pyrene	**66**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	
Isophorone	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Naphthalene	**15000**	1000	ug/L	110509 1330	111309 1947	RIS	EPA 8270C	D
Nitrobenzene	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U

Microbac Laboratories, Inc., Baltimore Division

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Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg	Project: Sparrows Point	Report: 09K0225
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported: 11/25/2009 09:18
Gaithersburg, MD 20878	Project Manager: Bill Eaton	

EXT-2-PS

09K0225-01 (Ground Water) Sampled: 11/04/2009 17:30; Type: Not Specified

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes

Microbac Laboratories, Inc., Baltimore Division

Acid and Base/Neutral Extractables by EPA Method 8270C

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Pentachloroethane	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Pentachlorophenol	ND	10	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	V6, U
Phenanthrene	**700**	500	ug/L	110509 1330	111309 0245	RIS	EPA 8270C	D
Phenol	ND	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	U
Pyrene	ND	500	ug/L	110509 1330	111309 0245	RIS	EPA 8270C	U, D
Pyridine	**64**	5.0	ug/L	110509 1330	111109 0326	RIS	EPA 8270C	
Surrogate: 2,4,6-Tribromophenol		*70.0%*	*12.5-139*	*110509 1330*	*111109 0326*		*EPA 8270C*	
Surrogate: 2-Fluorobiphenyl		*59.4%*	*3.75-142*	*110509 1330*	*111109 0326*		*EPA 8270C*	
Surrogate: 2-Fluorophenol		*31.7%*	*0.974-78.2*	*110509 1330*	*111109 0326*		*EPA 8270C*	
Surrogate: Nitrobenzene-d5		*113%*	*15.3-131*	*110509 1330*	*111109 0326*		*EPA 8270C*	
Surrogate: Phenol-d5		*16.7%*	*-0.12-57.5*	*110509 1330*	*111109 0326*		*EPA 8270C*	
Surrogate: Terphenyl-d14		*226%*	*16.6-136*	*110509 1330*	*111109 0326*		*EPA 8270C*	*S2*

Microbac Laboratories, Inc-Camp Hill Division

Wet Chemistry

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Sulfate as SO4	**720**	10	mg/L		111709 0000	AKK	EPA 300.0	

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg	Project: Sparrows Point	Report: 09K0225
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported: 11/25/2009 09:18
Gaithersburg, MD 20878	Project Manager: Bill Eaton	

Notes and Definitions

V6	CCV recovery was below acceptance limits. The reported result is estimated.
U	Sample concentration is less than the MDL.
S2	Surrogate recovery was above laboratory acceptance limits. Reported data is estimated.
L3	The LCS recovery was below the laboratory acceptance limits. The reported result is estimated.
H1	Sample analyzed past maximum recommended holding time.
E	Concentration estimated due to target analyte exceeding linear range.
D	Sample Diluted
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Certifications

Below is a list of certifications maintained by Microbac Laboratories, Inc. All data included in this report has been reviewed for and meets all project specific and quality control requirements of the applicable accreditation, unless otherwise noted. A complete list of individual analytes pursuant to each certification below is available upon request.

- A2LA (Microbiology): 410.02
- A2LA (Environmental): 410.01
- A2LA (ELLAP): 410.01
- CPSC: 1115
- Maryland: 109
- Pennsylvania (NELAC): 68-00339
- USDA: S-53726
- Virginia: 00152

Cooler Receipt Log

Cooler ID: Default Cooler

Cooler Temp: 4.60 °C

Custody Seals Intact:	Yes	COC/Containers Agree:	Yes
Containers Intact:	Yes	Correct Preservation:	Yes
Received On Ice:	Yes	Correct Number of Containers Received:	Yes
Radiation Scan Acceptable:	Yes	Sufficient Sample Volume for Testing:	Yes
COC Present:	Yes	Samples Received in Proper Condition:	Yes

Comments:

Microbac Laboratories, Inc.

Baltimore Division

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COVER LETTER

Bill Eaton
URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

November 25, 2009
Report No.: 09J1132

RE: Sparrows Point

The report of analyses contains test results for samples received at Microbac Laboratories, Inc., Baltimore Division on 10/26/2009 16:15.

The enclosed results were obtained from and applicable to the sample(s) as received at the laboratory. All sample results are reported on an "as received" basis unless otherwise noted.

All data included in this report has been reviewed and meet the applicable project and certification specific requirements, unless otherwise noted.

This report has been paginated in its entirety and shall not be reproduced except in full, without the written approval of Microbac Laboratories, Inc.

We appreciate the opportunity to service your analytical needs. If you have any questions, please feel free to contact us.

This Data Package contains the following:

- This Cover Page
- Sample Summary
- Test Results
- Notes and Definitions
- Cooler Receipt Log
- Chain of Custody

Final report reviewed by: Melanie C. Duszynski/Project Manager

11/25/2009
Report issue date

All samples received in proper condition and results conform to ISO 17025 standards unless otherwise noted.

If we have not met or exceeded your expectations, please contact the Director or Trevor Boyce, President at tboyce@microbac.com or Robert Morgan, Chief Operation Officer, at rmorgan@microbac.com.

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Baltimore Division
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CERTIFICATE OF ANALYSIS

URS-Gaithersburg	Project: Sparrows Point	Report: 09J1132
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported: 11/25/2009 09:20
Gaithersburg, MD 20878	Project Manager: Bill Eaton	

SAMPLE SUMMARY

Sample ID	Laboratory ID	Matrix	Type	Date Sampled	Date Received
EXT-1	09J1132-01	Water	Grab	10/26/2009 15:15	10/26/2009 16:15

Microbac Laboratories, Inc., Baltimore Division

Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09J1132 Reported: 11/25/2009 09:20

EXT-1

09J1132-01 (Water) Sampled: 10/26/2009 15:15; Type: Grab

Microbac Laboratories, Inc., Baltimore Division

Volatile Organic Compounds by EPA Method 8260B

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
1,1,1,2-Tetrachloroethane	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
1,1,1-Trichloroethane	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
1,1,2,2-Tetrachloroethane	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
1,1,2-Trichloroethane	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
1,1-Dichloroethane	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
1,1-Dichloroethene	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
1,2-Dichloroethane	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
1,2-Dichloropropane	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Methyl Ethyl Ketone (2-Butanone)	ND	25000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Methyl Butyl Ketone (2-Hexanone)	ND	25000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Acetone	ND	25000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Benzene	**790000**	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	D
Bromoform	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Carbon disulfide	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Carbon Tetrachloride	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Chlorobenzene	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Chloroethane	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Chloroform	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
cis-1,3-Dichloropropene	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Ethylbenzene	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Methylene Chloride	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Tetrachloroethene	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Toluene	**60000**	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	D
trans-1,2-Dichloroethene	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
trans-1,3-Dichloropropene	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Trichloroethene	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Vinyl chloride	ND	5000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Total Xylenes	ND	15000	ug/L	103009 1230	103009 1230	EMG	EPA 8260B	U, D
Surrogate: Dibromofluoromethane		*91.7%*	*80-120*	*103009 1230*	*103009 1230*		*EPA 8260B*	
Surrogate: 1,2-Dichloroethane-d4		*89.8%*	*80-120*	*103009 1230*	*103009 1230*		*EPA 8260B*	

Microbac Laboratories, Inc., Baltimore Division

Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09J1132 Reported: 11/25/2009 09:20

EXT-1

09J1132-01 (Water) Sampled: 10/26/2009 15:15; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Microbac Laboratories, Inc., Baltimore Division								
Volatile Organic Compounds by EPA Method 8260B								
Surrogate: Toluene-d8		*99.0%*	*75-120*	*103009 1230*	*103009 1230*		*EPA 8260B*	
Surrogate: 4-Bromofluorobenzene		*97.3%*	*60-149*	*103009 1230*	*103009 1230*		*EPA 8260B*	
Acid and Base/Neutral Extractables by EPA Method 8270C								
1,2,4-Trichlorobenzene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
1,2-Dichlorobenzene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
1,3-Dichlorobenzene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
1,4-Dichlorobenzene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2,4,5-Trichlorophenol	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2,4,6-Trichlorophenol	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2,4-Dichlorophenol	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2,4-Dimethylphenol	**37**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
2,4-Dinitrophenol	ND	10	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2,4-Dinitrotoluene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2,6-Dinitrotoluene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2-Chloronaphthalene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2-Chlorophenol	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
2-Methylnaphthalene	**12**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
2-Methylphenol	**44**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
2-Nitrophenol	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
3,3´-Dichlorobenzidine	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
3,3'-Dimethylbenzidine	**0.0**		ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
4-Methylphenol, 3-Methylphenol	**52**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
4,6-Dinitro-2-methylphenol	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
4-Bromophenyl-phenylether	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
4-Chloro-3-methylphenol	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
4-Chlorophenyl-phenylether	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
4-Nitrophenol	ND	10	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Acenaphthene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Acenaphthylene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U

Microbac Laboratories, Inc., Baltimore Division

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Melanie C. Duszynski

Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09J1132 Reported: 11/25/2009 09:20

EXT-1

09J1132-01 (Water) Sampled: 10/26/2009 15:15; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
			Microbac Laboratories, Inc., Baltimore Division					
Acid and Base/Neutral Extractables by EPA Method 8270C								
Anthracene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Benz(a)anthracene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Benzo[a]pyrene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Benzo[b]fluoranthene	**5.5**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
Benzo[g,h,i]perylene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Benzo[k]fluoranthene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
bis(2-Chloroethoxy)methane	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Bis(2-Chloroethyl)ether	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Bis(2-chloroisopropyl)ether	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Bis(2-Ethylhexyl)phthalate	**150**	25	ug/L	102809 1600	110509 1421	RIS	EPA 8270C	D
Butylbenzylphthalate	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Chrysene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Dibenz[a,h]anthracene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Dibenzofuran	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Diethylphthalate	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Dimethylphthalate	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Di-n-butylphthalate	**8.6**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
Di-n-octylphthalate	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Fluoranthene	**11**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
Fluorene	**16**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
Hexachlorobenzene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Hexachlorobutadiene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Hexachlorocyclopentadiene	ND	10	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Hexachloroethane	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Indeno[1,2,3-cd]pyrene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Isophorone	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Naphthalene	**270**	25	ug/L	102809 1600	110509 1421	RIS	EPA 8270C	D
Nitrobenzene	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Pentachloroethane	ND	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U
Pentachlorophenol	ND	10	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	U

Microbac Laboratories, Inc., Baltimore Division

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg	Project: Sparrows Point	Report: 09J1132
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported: 11/25/2009 09:20
Gaithersburg, MD 20878	Project Manager: Bill Eaton	

EXT-1

09J1132-01 (Water) Sampled: 10/26/2009 15:15; Type: Grab

Microbac Laboratories, Inc., Baltimore Division

Acid and Base/Neutral Extractables by EPA Method 8270C

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Phenanthrene	**14**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
Phenol	**93**	25	ug/L	102809 1600	110509 1421	RIS	EPA 8270C	D
Pyrene	**7.3**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
Pyridine	**76**	5.0	ug/L	102809 1600	110509 0207	RIS	EPA 8270C	
Surrogate: 2,4,6-Tribromophenol		*69.9%*	*12.5-139*	*102809 1600*	*110509 0207*		*EPA 8270C*	
Surrogate: 2-Fluorobiphenyl		*55.8%*	*3.75-142*	*102809 1600*	*110509 0207*		*EPA 8270C*	
Surrogate: 2-Fluorophenol		*25.8%*	*0.974-78.2*	*102809 1600*	*110509 0207*		*EPA 8270C*	
Surrogate: Nitrobenzene-d5		*49.8%*	*15.3-131*	*102809 1600*	*110509 0207*		*EPA 8270C*	
Surrogate: Phenol-d5		*20.9%*	*-0.12-57.5*	*102809 1600*	*110509 0207*		*EPA 8270C*	
Surrogate: Terphenyl-d14		*66.0%*	*16.6-136*	*102809 1600*	*110509 0207*		*EPA 8270C*	

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg	Project: Sparrows Point	Report:	09J1132
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported:	11/25/2009 09:20
Gaithersburg, MD 20878	Project Manager: Bill Eaton		

Notes and Definitions

U	Sample concentration is less than the MDL.
D	Sample Diluted
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Certifications

Below is a list of certifications maintained by Microbac Laboratories, Inc. All data included in this report has been reviewed for and meets all project specific and quality control requirements of the applicable accreditation, unless otherwise noted. A complete list of individual analytes pursuant to each certification below is available upon request.

- A2LA (Microbiology): 410.02
- A2LA (Environmental): 410.01
- A2LA (ELLAP): 410.01
- CPSC: 1115
- Maryland: 109
- Pennsylvania (NELAC): 68-00339
- USDA: S-53726
- Virginia: 00152

Cooler Receipt Log

Cooler ID: Default Cooler

Cooler Temp: 4.10 °C

Custody Seals Intact:	Yes	COC/Containers Agree:	Yes
Containers Intact:	Yes	Correct Preservation:	Yes
Received On Ice:	Yes	Correct Number of Containers Received:	Yes
Radiation Scan Acceptable:	Yes	Sufficient Sample Volume for Testing:	Yes
COC Present:	Yes	Samples Received in Proper Condition:	Yes

Comments:

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COVER LETTER

Bill Eaton
URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

November 25, 2009
Report No.: 09K0039

RE: Sparrows Point

The report of analyses contains test results for samples received at Microbac Laboratories, Inc., Baltimore Division on 10/30/2009 15:20.

The enclosed results were obtained from and applicable to the sample(s) as received at the laboratory. All sample results are reported on an "as received" basis unless otherwise noted.

All data included in this report has been reviewed and meet the applicable project and certification specific requirements, unless otherwise noted.

This report has been paginated in its entirety and shall not be reproduced except in full, without the written approval of Microbac Laboratories, Inc.

We appreciate the opportunity to service your analytical needs. If you have any questions, please feel free to contact us.

This Data Package contains the following:

- This Cover Page
- Sample Summary
- Test Results
- Notes and Definitions
- Cooler Receipt Log
- Chain of Custody

Final report reviewed by: Melanie C. Duszynski/Project Manager

11/25/2009
Report issue date

All samples received in proper condition and results conform to ISO 17025 standards unless otherwise noted.

If we have not met or exceeded your expectations, please contact the Director or Trevor Boyce, President at tboyce@microbac.com or Robert Morgan, Chief Operation Officer, at rmorgan@microbac.com.

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

Project: Sparrows Point
Project Number: Sparrows Point
Project Manager: Bill Eaton

Report: 09K0039
Reported: 11/25/2009 09:19

SAMPLE SUMMARY

Sample ID	Laboratory ID	Matrix	Type	Date Sampled	Date Received
AS-2 (4-6)	09K0039-01	Solid	Grab	10/29/2009 14:43	10/30/2009 15:20
AS-2 (6-8)	09K0039-02	Solid	Grab	10/29/2009 15:05	10/30/2009 15:20
AS-2 (12-14)	09K0039-03	Solid	Grab	10/30/2009 09:15	10/30/2009 15:20
AS-2 (14-16)	09K0039-04	Solid	Grab	10/30/2009 09:22	10/30/2009 15:20
AS-2 (16-18)	09K0039-05	Solid	Grab	10/30/2009 09:35	10/30/2009 15:20
AS-2 (18-19.5)	09K0039-06	Solid	Grab	10/30/2009 09:55	10/30/2009 15:20

Microbac Laboratories, Inc., Baltimore Division

Melanie C. Duszynski

Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0039 Reported: 11/25/2009 09:19

AS-2 (4-6)

09K0039-01 (Solid) Sampled: 10/29/2009 14:43; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes

Microbac Laboratories, Inc., Baltimore Division

Wet Chemistry

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
% Solids	**83.98**	0.05	% by Weight	110509 1045	110609 0905	LCR	SM (20) 2540G	

DNAPL Qualitative Determination

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Odor	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Sheen	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Visible Product	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	

Microbac Laboratories, Inc., Baltimore Division

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0039 Reported: 11/25/2009 09:19

AS-2 (6-8)

09K0039-02 (Solid) Sampled: 10/29/2009 15:05; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
				Microbac Laboratories, Inc., Baltimore Division				
Wet Chemistry								
% Solids	**90.76**	0.05	% by Weight	110509 1045	110609 0905	LCR	SM (20) 2540G	
DNAPL Qualitative Determination								
Odor	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Sheen	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Visible Product	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Acid and Base/Neutral Extractables by EPA Method 8270C								
Naphthalene	**4600**	940	ug/kg dry	110909 1300	111309 0322	RIS	EPA 8270C	D, B

Microbac Laboratories, Inc., Baltimore Division

Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0039 Reported: 11/25/2009 09:19

AS-2 (12-14)

09K0039-03 (Solid) Sampled: 10/30/2009 09:15; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
			Microbac Laboratories, Inc., Baltimore Division					
Wet Chemistry								
% Solids	**83.24**	0.05	% by Weight	110509 1045	110609 0906	LCR	SM (20) 2540G	
DNAPL Qualitative Determination								
Odor	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Sheen	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Visible Product	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Acid and Base/Neutral Extractables by EPA Method 8270C								
Naphthalene	**28000**	4100	ug/kg dry	110909 1300	111309 2024	RIS	EPA 8270C	D, B

Microbac Laboratories, Inc., Baltimore Division

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Melanie C. Duszynski

Melanie C. Duszynski, Project Manager

CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0039 Reported: 11/25/2009 09:19

AS-2 (14-16)

09K0039-04 (Solid) Sampled: 10/30/2009 09:22; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Microbac Laboratories, Inc., Baltimore Division								
Wet Chemistry								
% Solids	**85.58**	0.05	% by Weight	110509 1045	110609 0906	LCR	SM (20) 2540G	
DNAPL Qualitative Determination								
Odor	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Sheen	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Visible Product	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0039 Reported: 11/25/2009 09:19

AS-2 (16-18)

09K0039-05 (Solid) Sampled: 10/30/2009 09:35; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Microbac Laboratories, Inc., Baltimore Division								
Wet Chemistry								
% Solids	**75.40**	0.05	% by Weight	110509 1045	110609 0906	LCR	SM (20) 2540G	
DNAPL Qualitative Determination								
Odor	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Sheen	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Visible Product	**No**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	

Microbac Laboratories, Inc., Baltimore Division

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0039 Reported: 11/25/2009 09:19

AS-2 (18-19.5)

09K0039-06 (Solid) Sampled: 10/30/2009 09:55; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Microbac Laboratories, Inc., Baltimore Division								
Wet Chemistry								
% Solids	**86.65**	0.05	% by Weight	110509 1045	110609 0906	LCR	SM (20) 2540G	
DNAPL Qualitative Determination								
Odor	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Sheen	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Visible Product	**Yes**		N/A	111709 1600	111709 1726	RIS	ASTM D 3987 Modified	
Acid and Base/Neutral Extractables by EPA Method 8270C								
Naphthalene	**770000**	98000	ug/kg dry	110909 1300	111309 2102	RIS	EPA 8270C	D, B

Microbac Laboratories, Inc., Baltimore Division

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Melanie C. Duszynski, Project Manager

Microbac Laboratories, Inc.
Baltimore Division
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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0039 Reported: 11/25/2009 09:19

Notes and Definitions

Z5a	Yes
Z5	No
D	Sample Diluted
B	Analyte is found in method blank.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Certifications

Below is a list of certifications maintained by Microbac Laboratories, Inc. All data included in this report has been reviewed for and meets all project specific and quality control requirements of the applicable accreditation, unless otherwise noted. A complete list of individual analytes pursuant to each certification below is available upon request.

- A2LA (Microbiology): 410.02
- A2LA (Environmental): 410.01
- A2LA (ELLAP): 410.01
- CPSC: 1115
- Maryland: 109
- Pennsylvania (NELAC): 68-00339
- USDA: S-53726
- Virginia: 00152

Cooler Receipt Log

Cooler ID: Default Cooler

Cooler Temp: 5.10 °C

Custody Seals Intact:	Yes	COC/Containers Agree:	Yes
Containers Intact:	Yes	Correct Preservation:	Yes
Received On Ice:	Yes	Correct Number of Containers Received:	Yes
Radiation Scan Acceptable:	Yes	Sufficient Sample Volume for Testing:	Yes
COC Present:	Yes	Samples Received in Proper Condition:	Yes

Comments:

Microbac Laboratories, Inc.

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COVER LETTER

Bill Eaton
URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

November 25, 2009
Report No.: 09K0152

RE: Sparrows Point

The report of analyses contains test results for samples received at Microbac Laboratories, Inc., Baltimore Division on 11/04/2009 11:30.

The enclosed results were obtained from and applicable to the sample(s) as received at the laboratory. All sample results are reported on an "as received" basis unless otherwise noted.

All data included in this report has been reviewed and meet the applicable project and certification specific requirements, unless otherwise noted.

This report has been paginated in its entirety and shall not be reproduced except in full, without the written approval of Microbac Laboratories, Inc.

We appreciate the opportunity to service your analytical needs. If you have any questions, please feel free to contact us.

This Data Package contains the following:

- This Cover Page
- Sample Summary
- Test Results
- Notes and Definitions
- Cooler Receipt Log
- Chain of Custody

Final report reviewed by: Melanie C. Duszynski/Project Manager — 11/25/2009 (Report issue date)

All samples received in proper condition and results conform to ISO 17025 standards unless otherwise noted.

If we have not met or exceeded your expectations, please contact the Director or Trevor Boyce, President at tboyce@microbac.com or Robert Morgan, Chief Operation Officer, at rmorgan@microbac.com.

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0152 Reported: 11/25/2009 09:18

SAMPLE SUMMARY

Sample ID	Laboratory ID	Matrix	Type	Date Sampled	Date Received
EXT-2	09K0152-01	Water	Grab	11/03/2009 16:30	11/04/2009 11:30

Microbac Laboratories, Inc., Baltimore Division

Melanie C. Duszynski, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0152 Reported: 11/25/2009 09:18

EXT-2

09K0152-01 (Water) Sampled: 11/03/2009 16:30; Type: Grab

Microbac Laboratories, Inc., Baltimore Division

Volatile Organic Compounds by EPA Method 8260B

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
1,1,1,2-Tetrachloroethane	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
1,1,1-Trichloroethane	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
1,1,2,2-Tetrachloroethane	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
1,1,2-Trichloroethane	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
1,1-Dichloroethane	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
1,1-Dichloroethene	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
1,2-Dichloroethane	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
1,2-Dichloropropane	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Methyl Ethyl Ketone (2-Butanone)	ND	250	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Methyl Butyl Ketone (2-Hexanone)	ND	250	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Acetone	ND	250	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Benzene	**900**	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	D
Bromoform	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Carbon disulfide	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Carbon Tetrachloride	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Chlorobenzene	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Chloroethane	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Chloroform	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
cis-1,3-Dichloropropene	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Ethylbenzene	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Methylene Chloride	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Tetrachloroethene	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Toluene	**720**	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	D
trans-1,2-Dichloroethene	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
trans-1,3-Dichloropropene	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Trichloroethene	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Vinyl chloride	ND	50	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	U, D
Total Xylenes	**770**	150	ug/L	111109 1643	111109 1643	EMG	EPA 8260B	D
Surrogate: Dibromofluoromethane		*84.9%*	*80-120*	*111109 1643*	*111109 1643*		*EPA 8260B*	
Surrogate: 1,2-Dichloroethane-d4		*84.3%*	*80-120*	*111109 1643*	*111109 1643*		*EPA 8260B*	

Microbac Laboratories, Inc., Baltimore Division

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Melanie C. Duszynski

Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09K0152 Reported: 11/25/2009 09:18

EXT-2

09K0152-01 (Water) Sampled: 11/03/2009 16:30; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes

Microbac Laboratories, Inc., Baltimore Division

Volatile Organic Compounds by EPA Method 8260B

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Surrogate: Toluene-d8		*88.3%*	*75-120*	*111109 1643*	*111109 1643*		*EPA 8260B*	
Surrogate: 4-Bromofluorobenzene		*86.6%*	*60-149*	*111109 1643*	*111109 1643*		*EPA 8260B*	

Acid and Base/Neutral Extractables by EPA Method 8270C

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
1,2,4-Trichlorobenzene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
1,2-Dichlorobenzene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
1,3-Dichlorobenzene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
1,4-Dichlorobenzene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
2,4,5-Trichlorophenol	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
2,4,6-Trichlorophenol	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
2,4-Dichlorophenol	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
2,4-Dimethylphenol	**82**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	E
2,4-Dinitrophenol	ND	10	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	V6, U
2,4-Dinitrotoluene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
2,6-Dinitrotoluene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
2-Chloronaphthalene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
2-Chlorophenol	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
2-Methylnaphthalene	ND	250	ug/L	110509 1330	111309 0208	RIS	EPA 8270C	U, D
2-Methylphenol	**43**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
2-Nitrophenol	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
3,3´-Dichlorobenzidine	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
3,3'-Dimethylbenzidine	**0.0**		ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
4-Methylphenol, 3-Methylphenol	**63**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
4,6-Dinitro-2-methylphenol	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	L3, U
4-Bromophenyl-phenylether	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
4-Chloro-3-methylphenol	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
4-Chlorophenyl-phenylether	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
4-Nitrophenol	ND	10	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Acenaphthene	**7.9**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Acenaphthylene	ND	250	ug/L	110509 1330	111309 0208	RIS	EPA 8270C	U, D

Microbac Laboratories, Inc., Baltimore Division

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Melanie C. Duszynski, Project Manager

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Microbac Laboratories, Inc.

Baltimore Division

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg	Project: Sparrows Point	Report: 09K0152
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported: 11/25/2009 09:18
Gaithersburg, MD 20878	Project Manager: Bill Eaton	

EXT-2

09K0152-01 (Water) Sampled: 11/03/2009 16:30; Type: Grab

Microbac Laboratories, Inc., Baltimore Division

Acid and Base/Neutral Extractables by EPA Method 8270C

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Anthracene	**12**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Benz(a)anthracene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Benzo[a]pyrene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Benzo[b]fluoranthene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Benzo[g,h,i]perylene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Benzo[k]fluoranthene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
bis(2-Chloroethoxy)methane	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Bis(2-Chloroethyl)ether	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Bis(2-chloroisopropyl)ether	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Bis(2-Ethylhexyl)phthalate	**20**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Butylbenzylphthalate	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Chrysene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Dibenz[a,h]anthracene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Dibenzofuran	**49**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Diethylphthalate	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Dimethylphthalate	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Di-n-butylphthalate	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Di-n-octylphthalate	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Fluoranthene	**6.8**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Fluorene	**48**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Hexachlorobenzene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Hexachlorobutadiene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Hexachlorocyclopentadiene	ND	10	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	V6, U
Hexachloroethane	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Indeno[1,2,3-cd]pyrene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Isophorone	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Naphthalene	**5500**	500	ug/L	110509 1330	111309 1910	RIS	EPA 8270C	D
Nitrobenzene	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Pentachloroethane	ND	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	U
Pentachlorophenol	ND	10	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	V6, U

Microbac Laboratories, Inc., Baltimore Division

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Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg	Project: Sparrows Point	Report: 09K0152
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported: 11/25/2009 09:18
Gaithersburg, MD 20878	Project Manager: Bill Eaton	

EXT-2

09K0152-01 (Water) Sampled: 11/03/2009 16:30; Type: Grab

Microbac Laboratories, Inc., Baltimore Division

Acid and Base/Neutral Extractables by EPA Method 8270C

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Phenanthrene	**48**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Phenol	**44**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Pyrene	**11**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Pyridine	**45**	5.0	ug/L	110509 1330	111109 0135	RIS	EPA 8270C	
Surrogate: 2,4,6-Tribromophenol		*91.2%*	*12.5-139*	*110509 1330*	*111109 0135*		*EPA 8270C*	
Surrogate: 2-Fluorobiphenyl		*67.9%*	*3.75-142*	*110509 1330*	*111109 0135*		*EPA 8270C*	
Surrogate: 2-Fluorophenol		*33.4%*	*0.974-78.2*	*110509 1330*	*111109 0135*		*EPA 8270C*	
Surrogate: Nitrobenzene-d5		*118%*	*15.3-131*	*110509 1330*	*111109 0135*		*EPA 8270C*	
Surrogate: Phenol-d5		*24.8%*	*-0.12-57.5*	*110509 1330*	*111109 0135*		*EPA 8270C*	
Surrogate: Terphenyl-d14		*211%*	*16.6-136*	*110509 1330*	*111109 0135*		*EPA 8270C*	*S2*

Microbac Laboratories, Inc., Baltimore Division

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Melanie C. Duszynski, Project Manager

Microbac Laboratories, Inc.
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CERTIFICATE OF ANALYSIS

URS-Gaithersburg	Project: Sparrows Point	Report: 09K0152
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported: 11/25/2009 09:18
Gaithersburg, MD 20878	Project Manager: Bill Eaton	

Notes and Definitions

V6	CCV recovery was below acceptance limits. The reported result is estimated.
U	Sample concentration is less than the MDL.
S2	Surrogate recovery was above laboratory acceptance limits. Reported data is estimated.
L3	The LCS recovery was below the laboratory acceptance limits. The reported result is estimated.
E	Concentration estimated due to target analyte exceeding linear range.
D	Sample Diluted
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Certifications

Below is a list of certifications maintained by Microbac Laboratories, Inc. All data included in this report has been reviewed for and meets all project specific and quality control requirements of the applicable accreditation, unless otherwise noted. A complete list of individual analytes pursuant to each certification below is available upon request.

- A2LA (Microbiology): 410.02
- A2LA (Environmental): 410.01
- A2LA (ELLAP): 410.01
- CPSC: 1115
- Maryland: 109
- Pennsylvania (NELAC): 68-00339
- USDA: S-53726
- Virginia: 00152

Cooler Receipt Log

Cooler ID: Default Cooler

Cooler Temp: 3.60 °C

Custody Seals Intact:	Yes	COC/Containers Agree:	Yes
Containers Intact:	Yes	Correct Preservation:	Yes
Received On Ice:	Yes	Correct Number of Containers Received:	Yes
Radiation Scan Acceptable:	Yes	Sufficient Sample Volume for Testing:	Yes
COC Present:	Yes	Samples Received in Proper Condition:	Yes

Comments:

Microbac Laboratories, Inc.

Baltimore Division

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COVER LETTER

Bill Eaton
URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

November 25, 2009
Report No.: 09J1153

RE: Sparrows Point

The report of analyses contains test results for samples received at Microbac Laboratories, Inc., Baltimore Division on 10/28/2009 10:40.

The enclosed results were obtained from and applicable to the sample(s) as received at the laboratory. All sample results are reported on an "as received" basis unless otherwise noted.

All data included in this report has been reviewed and meet the applicable project and certification specific requirements, unless otherwise noted.

This report has been paginated in its entirety and shall not be reproduced except in full, without the written approval of Microbac Laboratories, Inc.

We appreciate the opportunity to service your analytical needs. If you have any questions, please feel free to contact us.

This Data Package contains the following:

- This Cover Page
- Sample Summary
- Test Results
- Notes and Definitions
- Cooler Receipt Log
- Chain of Custody

11/25/2009

Final report reviewed by: Melanie C. Duszynski/Project Manager — Report issue date

All samples received in proper condition and results conform to ISO 17025 standards unless otherwise noted.

If we have not met or exceeded your expectations, please contact the Director or Trevor Boyce, President at tboyce@microbac.com or Robert Morgan, Chief Operation Officer, at rmorgan@microbac.com.

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

Project: Sparrows Point
Project Number: Sparrows Point
Project Manager: Bill Eaton

Report: 09J1153
Reported: 11/25/2009 09:19

SAMPLE SUMMARY

Sample ID	Laboratory ID	Matrix	Type	Date Sampled	Date Received
EXT-1-PS	09J1153-01	Water	Grab	10/27/2009 16:30	10/28/2009 10:40

Microbac Laboratories, Inc., Baltimore Division

Melanie C. Duszynski, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg
200 Orchard Ridge Dr.
Gaithersburg, MD 20878

Project: Sparrows Point
Project Number: Sparrows Point
Project Manager: Bill Eaton

Report: 09J1153
Reported: 11/25/2009 09:19

EXT-1-PS

09J1153-01 (Water) Sampled: 10/27/2009 16:30; Type: Grab

Microbac Laboratories, Inc., Baltimore Division

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Wet Chemistry								
BOD	**1100**	300	mg/L	102809 1520	110209 1400	LCR	SM (20) 5210B	
COD, Total	**710**	100	mg/L	110309 1352	110409 1134	LCR	EPA410.4/HACH8000	D
Nitrite as N	**0.11**	0.0050	mg/L	102909 0837	102909 0837	VAS	EPA 353.2	
Nitrate as N	ND	0.05	mg/L	110209 1150	110209 1150	VAS	EPA 353.2	
Nitrate/Nitrite as N	ND	0.05	mg/L	110209 1150	110209 1150	VAS	EPA 353.2	
Orthophosphate as P	**0.21**	0.010	mg/L	102909 0719	102909 0719	VAS	EPA 365.1	
Mercury, Dissolved by EPA 200/7000 Series Methods								
Mercury	**0.00029**	0.00020	mg/L	110409 1143	110509 1542	APS	EPA 245.1	
Metals, Dissolved by EPA 200 Series Methods								
Silver	ND	0.0040	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Arsenic	ND	0.020	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Boron	**0.34**	0.020	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Beryllium	ND	0.0010	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Cadmium	**0.0022**	0.00050	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Cobalt	ND	0.0050	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Chromium	ND	0.0010	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Copper	**0.0077**	0.0050	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Nickel	ND	0.010	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Lead	ND	0.040	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Antimony	ND	0.040	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Selenium	ND	0.040	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Titanium	ND	0.020	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Thallium	**0.026**	0.020	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Vanadium	**0.013**	0.0050	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	
Zinc	ND	0.020	mg/L	103009 1322	110309 2023	APS	EPA 200.7/6010B	

Microbac Laboratories, Inc., Baltimore Division

Melanie C. Duszynski, Project Manager

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09J1153 Reported: 11/25/2009 09:19

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09J1153-01 (Water) Sampled: 10/27/2009 16:30; Type: Grab

Microbac Laboratories, Inc., Baltimore Division

Volatile Organic Compounds by EPA Method 8260B

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
1,1,1,2-Tetrachloroethane	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
1,1,1-Trichloroethane	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
1,1,2,2-Tetrachloroethane	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
1,1,2-Trichloroethane	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
1,1-Dichloroethane	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
1,1-Dichloroethene	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
1,2-Dichloroethane	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
1,2-Dichloropropane	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Methyl Ethyl Ketone (2-Butanone)	ND	25000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Methyl Butyl Ketone (2-Hexanone)	ND	25000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Acetone	ND	25000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Benzene	**430000**	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	D
Bromoform	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Carbon disulfide	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Carbon Tetrachloride	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Chlorobenzene	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Chloroethane	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Chloroform	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
cis-1,3-Dichloropropene	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Ethylbenzene	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Methylene Chloride	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Tetrachloroethene	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Toluene	**47000**	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	D
trans-1,2-Dichloroethene	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
trans-1,3-Dichloropropene	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Trichloroethene	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Vinyl chloride	ND	5000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Total Xylenes	ND	15000	ug/L	103009 1307	103009 1307	EMG	EPA 8260B	U, D
Surrogate: Dibromofluoromethane		*92.3%*	*80-120*	*103009 1307*	*103009 1307*		*EPA 8260B*	
Surrogate: 1,2-Dichloroethane-d4		*90.8%*	*80-120*	*103009 1307*	*103009 1307*		*EPA 8260B*	

Microbac Laboratories, Inc., Baltimore Division

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CERTIFICATE OF ANALYSIS

URS-Gaithersburg 200 Orchard Ridge Dr. Gaithersburg, MD 20878	Project: Sparrows Point Project Number: Sparrows Point Project Manager: Bill Eaton	Report: 09J1153 Reported: 11/25/2009 09:19

EXT-1-PS

09J1153-01 (Water) Sampled: 10/27/2009 16:30; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Microbac Laboratories, Inc., Baltimore Division								
Volatile Organic Compounds by EPA Method 8260B								
Surrogate: Toluene-d8		*100%*	*75-120*	*103009 1307*	*103009 1307*		*EPA 8260B*	
Surrogate: 4-Bromofluorobenzene		*97.8%*	*60-149*	*103009 1307*	*103009 1307*		*EPA 8260B*	
Acid and Base/Neutral Extractables by EPA Method 8270C								
1,2,4-Trichlorobenzene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
1,2-Dichlorobenzene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
1,3-Dichlorobenzene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
1,4-Dichlorobenzene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2,4,5-Trichlorophenol	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2,4,6-Trichlorophenol	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2,4-Dichlorophenol	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2,4-Dimethylphenol	**20**	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	
2,4-Dinitrophenol	ND	10	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2,4-Dinitrotoluene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2,6-Dinitrotoluene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2-Chloronaphthalene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2-Chlorophenol	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
2-Methylnaphthalene	**11**	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	
2-Methylphenol	**28**	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	
2-Nitrophenol	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
3,3´-Dichlorobenzidine	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
3,3'-Dimethylbenzidine	**0.0**		ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
4-Methylphenol, 3-Methylphenol	**28**	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	
4,6-Dinitro-2-methylphenol	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
4-Bromophenyl-phenylether	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
4-Chloro-3-methylphenol	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
4-Chlorophenyl-phenylether	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
4-Nitrophenol	ND	10	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Acenaphthene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Acenaphthylene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U

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EXT-1-PS

09J1153-01 (Water) Sampled: 10/27/2009 16:30; Type: Grab

Microbac Laboratories, Inc., Baltimore Division

Acid and Base/Neutral Extractables by EPA Method 8270C

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
Anthracene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Benz(a)anthracene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Benzo[a]pyrene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Benzo[b]fluoranthene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Benzo[g,h,i]perylene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Benzo[k]fluoranthene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
bis(2-Chloroethoxy)methane	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Bis(2-Chloroethyl)ether	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Bis(2-chloroisopropyl)ether	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Bis(2-Ethylhexyl)phthalate	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Butylbenzylphthalate	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Chrysene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Dibenz[a,h]anthracene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Dibenzofuran	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Diethylphthalate	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Dimethylphthalate	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Di-n-butylphthalate	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Di-n-octylphthalate	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Fluoranthene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Fluorene	**7.5**	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	
Hexachlorobenzene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Hexachlorobutadiene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Hexachlorocyclopentadiene	ND	10	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Hexachloroethane	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Indeno[1,2,3-cd]pyrene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Isophorone	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Naphthalene	**320**	25	ug/L	102809 1600	110509 1458	RIS	EPA 8270C	D
Nitrobenzene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Pentachloroethane	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Pentachlorophenol	ND	10	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U

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200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported: 11/25/2009 09:19
Gaithersburg, MD 20878	Project Manager: Bill Eaton	

EXT-1-PS

09J1153-01 (Water) Sampled: 10/27/2009 16:30; Type: Grab

Analyte	Result	Reporting Limit	Units	Prepared	Analyzed	Analyst	Method	Notes
			Microbac Laboratories, Inc., Baltimore Division					
Acid and Base/Neutral Extractables by EPA Method 8270C								
Phenanthrene	**6.0**	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	
Phenol	**83**	25	ug/L	102809 1600	110509 1458	RIS	EPA 8270C	D
Pyrene	ND	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	U
Pyridine	**30**	5.0	ug/L	102809 1600	110509 0243	RIS	EPA 8270C	
Surrogate: 2,4,6-Tribromophenol		*72.9%*	*12.5-139*	*102809 1600*	*110509 0243*		*EPA 8270C*	
Surrogate: 2-Fluorobiphenyl		*52.0%*	*3.75-142*	*102809 1600*	*110509 0243*		*EPA 8270C*	
Surrogate: 2-Fluorophenol		*24.6%*	*0.974-78.2*	*102809 1600*	*110509 0243*		*EPA 8270C*	
Surrogate: Nitrobenzene-d5		*47.6%*	*15.3-131*	*102809 1600*	*110509 0243*		*EPA 8270C*	
Surrogate: Phenol-d5		*19.5%*	*-0.12-57.5*	*102809 1600*	*110509 0243*		*EPA 8270C*	
Surrogate: Terphenyl-d14		*68.3%*	*16.6-136*	*102809 1600*	*110509 0243*		*EPA 8270C*	
			Microbac Laboratories, Inc-Camp Hill Division					
Subcontracted Analyses								
Sulfate as SO4	**220**	10	mg/L		110609 0000	AKK	EPA 300.0	

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URS-Gaithersburg	Project: Sparrows Point	Report:	09J1153
200 Orchard Ridge Dr.	Project Number: Sparrows Point	Reported:	11/25/2009 09:19
Gaithersburg, MD 20878	Project Manager: Bill Eaton		

Notes and Definitions

U	Sample concentration is less than the MDL.
D	Sample Diluted
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Certifications

Below is a list of certifications maintained by Microbac Laboratories, Inc. All data included in this report has been reviewed for and meets all project specific and quality control requirements of the applicable accreditation, unless otherwise noted. A complete list of individual analytes pursuant to each certification below is available upon request.

- A2LA (Microbiology): 410.02
- A2LA (Environmental): 410.01
- A2LA (ELLAP): 410.01
- CPSC: 1115
- Maryland: 109
- Pennsylvania (NELAC): 68-00339
- USDA: S-53726
- Virginia: 00152

Cooler Receipt Log

Cooler ID: Default Cooler

Cooler Temp: 8.90 °C

Custody Seals Intact:	Yes	COC/Containers Agree:	Yes
Containers Intact:	Yes	Correct Preservation:	Yes
Received On Ice:	Yes	Correct Number of Containers Received:	Yes
Radiation Scan Acceptable:	Yes	Sufficient Sample Volume for Testing:	Yes
COC Present:	Yes	Samples Received in Proper Condition:	Yes

Comments:

APPENDIX G

Benzene Mass Removal Calculations

Organic Compound Mass Recovery Rates
SVE Pilot Test
Former Benzol Processing Area
Severstal Sparrows Point, LLC

Compounds	Molecular Weight [g/g-mole]	Vapor Pressure [mm Hg @ deg. C]	Boiling Point [°C]	Vapor Phase Concentration [ppbv][1]	Mass Recovery Rate[2] [lbs/hour]
Volatile Organics					
Benzene	78.12	75.2 @ 20	80.09	1,100,000	0.20
Ethylbenzene	106	7.08 @ 20	136.2	0	0.00
Toluene	92.1	21.8 @ 20	110.4	22,000	0.005
Xylenes (total)	106	6.72 @ 21	138.5	0	0.00
TOTAL BTEX				**1,122,000**	**0.21**
Total C5-C10[3]	100			0	0
Other Hydrocarbons					
Methane[4]	16.04	gas		0	0.0
TOTAL Hydrocarbons[5]				**0**	**0.00**

Notes:
1. Soil gas sample (RAW EXT-1 No Sparge) collected before ICE at 12:00 on 10/28/09.
2. Based on 1 hour of continuous operation at a flowrate of **14.07** SCFM.
3. Molecular weight for C5-C10 hydrocarbons estimated at 100.
4. Methane was likely present in the extracted gas stream but could not be accurately measured with the FID instrument.
5. Total hydrocarbons were taken as the C5-C10 measurement in the gas stream and should include the BTEX itemized above.

Organic Compound Mass Recovery Rates
SVE Pilot Test
Former Coal Tar Storage Area
Severstal Sparrows Point, LLC

Compounds	Molecular Weight [g/g-mole]	Vapor Pressure [mm Hg @ deg. C]	Boiling Point [°C]	Vapor Phase Concentration [ppbv][1]	Mass Recovery Rate[2] [lbs/hour]
Volatile Organics					
Benzene	78.12	75.2 @ 20	80.09	34,000	0.0024
Ethylbenzene	106	7.08 @ 20	136.2	1,200	0.00
Toluene	92.1	21.8 @ 20	110.4	43,000	0.0036
Xylenes (total)	106	6.72 @ 21	138.5	21,800	0.0021
TOTAL BTEX				**100,000**	**0.008**
Total C5-C10[3]	100			0	0
Other Hydrocarbons					
Methane[4]	16.04	gas		0	0.0
TOTAL Hydrocarbons[5]				**0**	**0**

Notes:
1. Soil gas sample (EXT-2 Sparge) collected before ICE at 15:00 on 11/4/09.
2. Based on 1 hour of continuous operation at a flowrate of **5.4** SCFM.
3. Molecular weight for C5-C10 hydrocarbons estimated at 100.
4. Methane was likely present in the extracted gas stream but could not be accurately measured with the FID instrument.
5. Total hydrocarbons were taken as the C5-C10 measurement in the gas stream and should include the BTEX itemized above.

Organic Compound Mass Recovery Rates
SVE Pilot Test
Former Benzol Processing Area
Severstal Sparrows Point, LLC

Compounds	Molecular Weight [g/g-mole]	Vapor Pressure [mm Hg @ deg. C]	Boiling Point [°C]	Vapor Phase Concentration [ppbv][1]	Mass Recovery Rate[2] [lbs/hour]
Volatile Organics					
Benzene	78.12	75.2 @ 20	80.09	16,000,000	2.58
Ethylbenzene	106	7.08 @ 20	136.2	0	0.00
Toluene	92.1	21.8 @ 20	110.4	1,200,000	0.23
Xylenes (total)	106	6.72 @ 21	138.5	0	0.00
TOTAL BTEX				**17,200,000**	**2.81**
Total C5-C10[3]	100			0	0
Other Hydrocarbons					
Methane[4]	16.04	gas		0	0.0
TOTAL Hydrocarbons[5]				**0**	**0**

Notes:
1. Soil gas sample (RAW EXT-1 Sparge) collected before ICE at 14:05 on 10/28/09.
2. Based on 1 hour of continuous operation at a flowrate of **12.34** SCFM.
3. Molecular weight for C5-C10 hydrocarbons estimated at 100.
4. Methane was likely present in the extracted gas stream but could not be accurately measured with the FID instrument.
5. Total hydrocarbons were taken as the C5-C10 measurement in the gas stream and should include the BTEX itemized above.

Organic Compound Mass Recovery Rates
SVE Pilot Test
Former Benzol Processing Area
Severstal Sparrows Point, LLC.

Compounds	Molecular Weight [g/g-mole]	Vapor Pressure [mm Hg @ deg. C]	Boiling Point [^{o}C]	Vapor Phase Concentration [ppbv][1]	Mass Recovery Rate[2] [lbs/hour]
Volatile Organics					
Benzene	78.12	75.2 @ 20	80.09	30,000,000	6.95
Ethylbenzene	106	7.08 @ 20	136.2	0	0.00
Toluene	92.1	21.8 @ 20	110.4	2,500,000	0.68
Xylenes (total)	106	6.72 @ 21	138.5	0	0.00
TOTAL BTEX				**32,500,000**	**7.63**
Total C5-C10[3]	100			0	0
Other Hydrocarbons					
Methane[4]	16.04	gas		0	0.0
TOTAL Hydrocarbons[5]				**0**	**0**

Notes:
1. Soil gas sample (RAW Sparge-4 Wells) collected before ICE at 13:20 on 10/27/09.
2. Based on 1 hour of continuous operation at a flowrate of **17.74** SCFM.
3. Molecular weight for C5-C10 hydrocarbons estimated at 100.
4. Methane was likely present in the extracted gas stream but could not be accurately measured with the FID instrument.
5. Total hydrocarbons were taken as the C5-C10 measurement in the gas stream and should include the BTEX itemized above.

APPENDIX H

Enhanced Biological Remediation

Appendix H
Enhanced Biological Remediation

H.1 Introduction

A wide variety of organisms can degrade the types of hydrocarbons present at the COA, including bacteria, fungi, and plants. The following discussion will focus on bacterial degradation; however, many of the principles detailed below also apply to fungal and botanical degradation. The process of biological remediation, or bioremediation, of hydrocarbons is rooted in the fact that an organism will consume a compound to extract energy and/or nutrition. This energy and nutrition is used to fuel biomass repair, growth, and reproduction.

Metabolism is a combination of two processes: catabolism (breaking down larger molecules into smaller ones) and anabolism (building smaller molecules into larger ones).

In order for a bacterium to utilize a complex compound such as a hydrocarbon, the compound must be broken into smaller, more manageable units. The resulting, smaller, and more readily manipulated molecules are then funneled into pre-existing metabolic pathways to be further broken down. The products of these reactions are then either excreted as a waste product or are used to form more complex but intentional molecules such as nucleic acids, lipids, or proteins. This process of metabolism explains how the carbon atoms within a petroleum hydrocarbon can be used as a nutrient source for a degrading bacterium.

Bacteria, like all organisms, require not only nutrients but also energy for survival. Energy is actually produced as a by-product of catabolism. As larger molecules are broken into smaller ones, electrons are released. These electrons are passed from one carrier molecule to another in what is called the electron transport chain. The final molecule at the end of this chain is called the terminal electron acceptor (TEA). In aerobic organisms, or aerobes, the TEA is oxygen. In anaerobic organisms, or anaerobes, the TEA can be a wide variety of molecules other than oxygen. In both aerobic and anaerobic processes, the addition of an electron will transform the oxidized, TEA substrate into its reduced form.

	Oxidized TEA	Reduced Product	Energy Produced
Aerobic	Oxygen	Water	More
Anaerobic	Nitrate	Nitrite	
	Ferric Iron	Ferrous Iron	
	Sulfate	Sulfide	
	Carbon Dioxide	Methane	Less

Aerobic bacteria can grow faster than anaerobic ones for the simple reason that aerobic metabolism produces more energy per unit of nutrient than anaerobic forms of metabolism. Increased energy production per unit of nutrient translates into more energy available for biomass production and reproduction. In other words, aerobic and anaerobic chemical reactions occur at a similar rate. However, the higher amount of energy produced by aerobes after consuming a given amount of a nutrient will result in more energy being available for creating more bacteria through reproduction. This is why aerobic bacterial growth is faster than anaerobic bacterial growth.

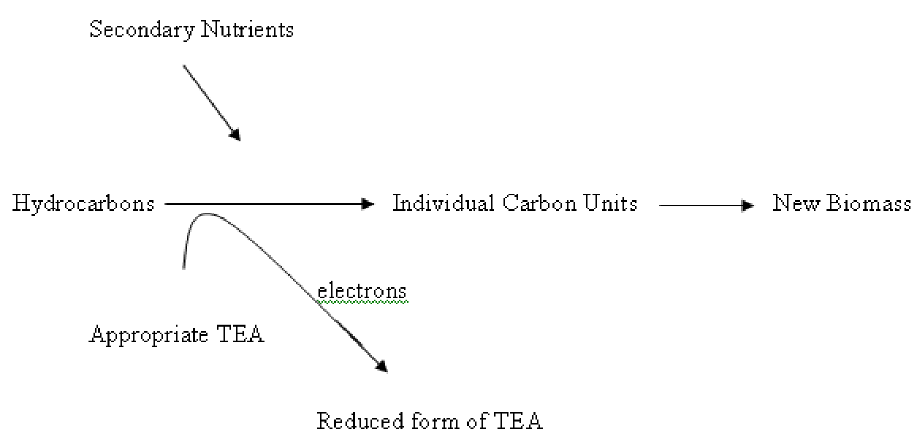
Faster growth means that over a given time, an aerobic population will contain more members than an anaerobic one. The substantially larger aerobic population will simply have more biomass to feed on a contaminant. Thus, it will demonstrate a higher net consumption of a compound, such as a hydrocarbon, during a given time period than will the smaller, anaerobic population. In other words, an individual aerobic bacterium will consume a hydrocarbon molecule at a similar rate as an individual anaerobic bacterium. There will just be more aerobes present to do the consuming, and thus total hydrocarbon loss will be greater in an aerobic environment than in an anaerobic one.

Bacterial populations will always exploit the most energy-yielding pathways available. Therefore, if oxygen is present in sufficient concentrations, aerobic metabolism will dominate a system. However, if oxygen tensions become limited, nitrate-reducing populations will start to take over because nitrate is the next-highest energy yielding TEA to utilize. This transition from one population to the next as TEAs are consumed (and it is assumed, not replenished) will continue to occur until a microbial community is established that is in a biogeochemical equilibrium with the environment – in other words, TEA consumption is matched by environmental replenishment. This is why a newly contaminated site will demonstrate a predictable, sequential transition from one TEA-utilizing population to another while well-established contaminated sites will demonstrate stable TEA consumption over time.

It should be noted that when bacteria consume a hydrocarbon, the primary nutrient derived is carbon. However, carbon alone can not sustain microbial growth. Other required nutrients that are needed in significant quantities include nitrogen (for the production of DNA, RNA, and proteins), phosphorous (cell membranes, DNA, and RNA), and sulfur (proteins). A wide variety of additional compounds, called micronutrients, are required at smaller concentrations. In addition, all bacteria require a sustained source of an appropriate TEA – aerobes require a source of oxygen, sulfate-reducers require a source of sulfate, etc.

H.2 Bioremediation Process

When bacteria metabolize hydrocarbons, they are using the compound as a growth substrate to produce carbon (for biomass production) and energy. Bioremediation takes advantage of this naturally occurring process and manipulates it for the purpose of removing an undesired contaminant from an area. Bioremediation processes are typically divided into two major categories: 1) monitored natural attenuation (MNA), and 2) enhanced bioremediation. MNA typically involves simply following the progress of non-stimulated bioremediation. Enhanced bioremediation, however, involves active intervention to increase bioremediation efficiency and effectiveness:



Enhancement measures for bioremediation can be as easy to perform as amending the contaminated soil or groundwater with required nutrients that are determined to be in low concentration at the site. The goal of such amendments is to encourage the biological use of the hydrocarbon as a carbon source while supplying enough support nutrients to prevent these necessary, secondary compounds from becoming limited (a situation that is unfavorable because it could result in a decrease in hydrocarbon degradation).

Amended compounds can also include an appropriate TEA. If the TEA concentration becomes depleted, there is no molecule available to capture the electrons produced during metabolism. This will cause metabolic reactions to systematically shut down, resulting in a cessation of hydrocarbon degradation until a new microbial population can be established that can survive off of another TEA. For example, if benzene remediation is occurring under iron-reducing conditions, and ferric iron concentrations become depleted, then the degrading population will eventually die. Small numbers of sulfate-reducing bacteria, present in micro-environments interspersed within the larger area, will begin to take over as long as a constant supply of their required nutrients and TEA (sulfate) are present. Because sulfate-reducers do not reduce contaminant concentrations as rapidly as iron-reducing populations, this transition from one population to another would be unfavorable for a remediation site.

Hydrocarbon bioremediation can occur in groundwater, soils, and sediments. A number of factors can contribute to the speed of hydrocarbon bioremediation, including:

- The indigenous microbial population and their dominant TEA
- Availability of secondary nutrients
- The chemical structure of the target hydrocarbon
- The length of time that indigenous site microbes have been exposed to the target hydrocarbon

Hydrocarbons can take on a number of forms, ranging from simple aliphatic chains to complex, poly-aromatic ring structures. Shorter aliphatic chains will be degraded more readily than longer ones. Cyclic aliphatics will typically be degraded slower than straight chains due to the need to break open the ring structure. Single aromatic ring hydrocarbons, such as benzene, will be degraded faster than structures with multiple aromatic rings, such as naphthalene. This is because there are fewer double bonds to sever and fewer rings to open up in order for metabolic attack to occur.

The structure of each hydrocarbon also imparts secondary characteristics that can impact compound metabolism. More soluble hydrocarbons will be more readily degraded because of the increased contact that bacteria will have to the compound. Bacteria require water for survival and motility. Bacteria also need direct contact with any hydrocarbon that it will metabolize. If a hydrocarbon is particularly hydrophobic, there is a decreased likelihood of contact with between the degrading bacteria and the target compound. This slows net metabolism.

Finally, the length of exposure time to a contaminant can determine how quickly a bacterial community can degrade it. Each time a bacterial population encounters a new compound, there is an initial period of adjustment to the new nutrient. If a population has previously been exposed to this particular compound, however, then this lag time is reduced if not eliminated.

H.3 Bioremediation Site Assessment

It is essential to understand what is currently available at the site, from a biological and geochemical standpoint, before the details of a bioremediation plan are set. The importance of recording baseline site information is that it enables one to quantitatively discern whether the site is inherently supportive of bioremediation and how to best increase remediation efficiency and effectiveness. Furthermore, baseline data provide a mechanism to measure this efficiency and effectiveness as the bioremediation process proceeds.

Once baseline measurements have been made, the bioremediation plan can be implemented. Bioremediation effectiveness and efficiency typically are regularly monitored to determine necessary adjustments to optimize the system.

Geochemical Baseline

Gathering baseline site geochemical data analyses includes two major tasks: examining useful data already obtained during previous monitoring events (i.e., see what we already have) and obtain any necessary, new site data. Previous site analyses should be taken advantage of in order to eliminate redundant measurements. The process of mining existing data can occur concurrently with the initial biological assessments, to maximize time efficiency. Once an assessment of the available data has been made, missing data should be obtained.

Data that should be obtained include:

- Contaminant data
  - Understand levels and distribution of contaminants
  - Will establish baseline values to compare remediation progress to
- Bioremediation parameters
  - Understand levels and distribution of bioremediation parameters
  - Will help monitor biological activity levels
  - Will determine if site amendments are necessary, and if so, at what levels and frequency
  - Involves standard groundwater field and laboratory parameters
    - DO, ORP, pH
    - Nitrate, total nitrogen, ferrous iron, total iron, sulfate, sulfide, methane

Baseline data will be established. Parameters should be regularly monitored, possibly quarterly, to determine remediation progress and any shifts in biological activity.

<u>Biological Baseline</u>

Bioremediation requires assessment and confirmation of indigenous microbial populations capable of utilizing site contaminants under the prevailing site conditions. This biological baseline provides information about the members and size of the microbial population as well as indications how to enhance the activity of the population.

Direct assessment of the degrading bacterial population is possible utilizing commercially available samplers called Bio-Traps which are comprised of Bio-Sep ® beads (**Figure 5-1**). Bio-Traps are a product of Microbial Insights, Inc. located in Rockford, TN. A typical, individual Bio-Trap is a six-inch length of PVC tubing that is perforated. This tube is filled with hundred of Bio-Sep ® beads, composed of powdered activated carbon (PAC) and Nomex and characterized as having a very high level of porosity and thus internal surface area. Using benzene as an example, pre-prepared, isotopically-labeled benzene is vaporized and sorbed onto the PAC component of sterilized beads. The beads are then placed into the PVC housing, and both ends of the PVC tube are sealed. The constructed Bio-Trap is express-mailed to the deployment site where, at the time of deployment, a sturdy nylon-rope is tied to one end. The Bio-Trap is then lowered into a chosen monitoring well and tied off such that the Bio-Trap remains submerged under water for the duration of its six-week, in-situ incubation period.

During incubation in the monitoring well, groundwater flows through the perforations of the PVC housing, exposing indigenous bacteria to the Bio-Sep ® beads. These bacteria are enticed to take up residence in the pores of these beads as a result of the high level of internal surface area and the presence of a nutrient source – the sorbed benzene. However, only those indigenous bacteria capable of degrading the benzene will be capable of metabolizing the compound. As the degrading bacteria metabolize the isotopically-tagged benzene, the isotopic tag will become incorporated into the degrader's biomass. Specifically, this tag will become incorporated into the phospholipid fatty acid (PLFA) molecules that compose the cellular membrane that encapsulates the bacterium. These molecules have a very short half-life during the lifespan of a cell, and thus any isotopic tag found in a PLFA molecule represents biomass created from tagged compounds recently degraded.

After the incubation period, the Bio-Traps are retrieved and returned to Microbial Insights for analysis. The following parameters are quantified:

- Total biomass
- Community structure (percent metal oxidizers, percent anaerobes, etc.)
- Which community members were responsible for the degradation and to what degree, as measured by the incorporation of the isotopic tag into biomass
- Total amount of isotopic tag incorporated into biomass
- The amount of labeled benzene lost during incubation
- The rate of labeled benzene loss
- The isotopic shift reported by the remaining benzene (a geochemical signal of biological degradation)
- The amount of isotopically-labeled benzene mineralized to carbon dioxide

- The response of the degrading population to any environmental stresses such as a lack of nutrients or the presence of a toxic compound, as measured by the conversion of cis-PLFA forms to trans-PLFA forms

APPENDIX I

Bio Trap Samplers

BIO-TRAP®

ADVANCED DIAGNOSTIC SAMPLERS

Catch Remediation in the Act… **Trap It!**

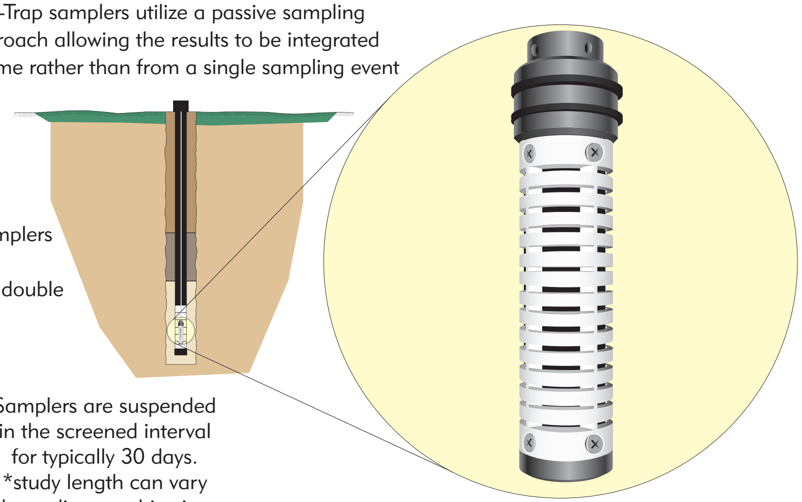
What are Bio-Trap® Samplers?

Bio-Trap® Samplers are passive sampling tools that collect microbes over time for the purpose of better understanding biodegradation potential. The key to the Bio-Trap® approach is a unique sampling matrix, Bio-Sep® beads. The beads are 2–3 mm in diameter and are engineered from a composite of Nomex® and powdered activated carbon (PAC). When a Bio-Trap® Sampler is deployed in a monitoring well, the Bio-Sep® beads adsorb contaminants and nutrients present in the aquifer essentially becoming an *in situ* microcosm with an incredibly large surface area (~600 m^2/g) which is colonized by subsurface microorganisms. Once recovered from a monitoring well (30-60 days after deployment), DNA, RNA, or PLFA can be extracted from the beads for CENSUS® or PLFA assays to evaluate the microbial community.

A modern approach to microbial sampling

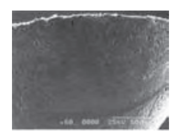
Bio-Trap samplers utilize a passive sampling approach allowing the results to be integrated over time rather than from a single sampling event

Multiple Bio-Trap samplers can be isolated from one another using a double seal cap assembly



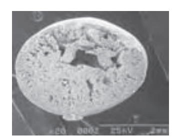
Samplers are suspended in the screened interval for typically 30 days.
*study length can vary depending on objectives

Sampling Matrix: Bio-Sep® Beads



Exterior of Bio-Sep bead

A key to this sampling approach is the use of Bio-Sep® beads as the sampling matrix. The unique properties of these beads allow them to mimic environmental conditions very well.



Interior of Bio-Sep bead

Bio-Sep® beads provide a large surface area within the bead for microbial attachment. Most microbes prefer to be attached to a surface rather than be free floating.

Lactate amended Bio-Sep® bead

Fishin' for microbes! "Baited" Bio-Trap® samplers can be used to evaluate the microbial response to a wide range of amendments (electron donors and acceptors, etc.).

*see reverse for more details

Samplers can be analyzed using a wide variety of analyses including:

Molecular Biological Tools
- CENSUS® (qPCR)
- PLFA
- DGGE
- SIP

Chemical Analysis
Geochemical Parameters
And more!

microbialinsights
www.microbe.com

BIO-TRAP®
ADVANCED DIAGNOSTIC SAMPLERS

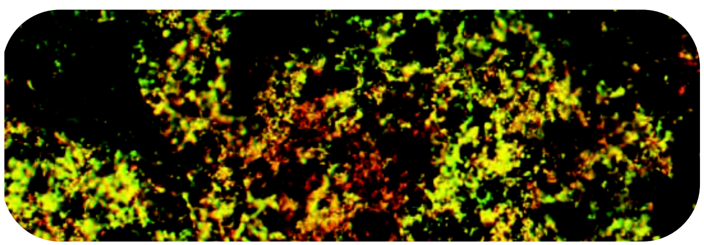
What types of samplers are available?

Bio-Trap samplers are available in a wide variety of configurations that can be tailored to answer your site-specific questions.

Standard: Basic Bio-Trap® Samplers in the simplest terms are a replacement for collecting groundwater samples using a conventional approach. Most microbes prefer to be attached to a surface rather than free floating and this passive sampler provides a large surface area for the microbes to colonize. Results generated using this approach have been shown to minimize the variability associated with traditional sampling approaches. Bio-Traps biofilms have also been shown to directly reflect spatial and temporal changes in aquifer microbial community structure plume which could not be determined from groundwater analysis. Standard Bio-Trap® Samplers are primarily used during site characterization and routine monitoring activities to:

- Quantify specific microbes or contaminant degrading bacteria (e.g. *Dehalococcoides* spp.)
- Evaluate monitored natural attenuation (MNA)
- Compare microbial populations from different sampling points
- Monitor shifts within microbial communities following biostimulation

Standard Bio-Trap® Samplers are designed for microbial analyses using a variety of molecular biological tools but can also be configured for some chemical and geochemical analyses.



microbialinsights
www.microbe.com
2340 Stock Creek Blvd.
Rockford, TN 37853-3044
Phone: 865.573.8188

Baited: As the name suggests, Bio-Trap® Samplers can be "baited" with various amendments or compounds to answer site-specific questions. In the past, project managers have been forced to turn to laboratory microcosms or small-scale pilot studies to evaluate bioremediation as a treatment alternative. While microcosm experiments with native site materials can show biodegradation in the laboratory, duplication of *in situ* conditions is difficult and the results may not extrapolate to the field. Pilot studies are performed on site but are often prohibitively expensive as an investigative tool. Baited Bio-Trap® Samplers are designed to create discrete in situ microcosms that can be used to:

- Evaluate monitored natural attenuation versus enhanced bioremediation
- Compare effectiveness of different amendments (e.g. HRC®, EOS®, sodium lactate, molasses, etc.) designed to stimulate bioremediation
- Prove that biodegradation is occurring (^{13}C-labeled compounds - Stable Isotope Probing)
- Estimate relative rates of degradation for a specific contaminant (i.e. MTBE, TBA etc.)
- Address specific questions such as:
  - Is benzene being degraded at my site?
  - Will sulfate amendments stimulate bioremediation?
  - Will sodium lactate increase the concentration of known dechlorinating bacteria?

Baited Bio-Trap® Samplers can be amended with a number of compounds including:

- Sodium acetate
- Sodium lactate
- Potassium lactate
- HRC®
- Molasses
- Vegetable oil
- EOS®
- Sodium phosphate
- Sulfate
- Nitrate
- Ammonium chloride
- Elemental sulfur
- Calcium carbonate
- Iron (III)
- ^{13}C-labeled contaminants
  - Benzene
  - Toluene
  - Xylene
  - MTBE
  - TBA
  - Chlorobenzene
  - TCE
  - DCE
  - VC
- Fluorinated surrogates for tracing chlorinated compounds
  - TCE
  - DCE
- And more!