REMEDIAL INVESTIGATION
Georgia-Pacific West Site
Bellingham, Washington

Prepared for: Port of Bellingham

Appendices A through H

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Prepared in association with

ANCHOR QEA

Aspect CONSULTING

earth + water

APPENDIX A

Field Methods and Exploration Logs for RI

Field Methods and Boring Logs for RI

This appendix provides the data, methods, and procedures for the GP West Site (Site) RI/FS field data collection program. The program was executed pursuant to the RI/FS Work Plan for the Site (Work Plan; Aspect, 2009a) and the Addendum to RI/FS Work Plan (Aspect, 2010a). Following Ecology approval of the Work Plan, Aspect Consulting (Aspect) conducted an extensive soil, groundwater, and air (soil vapor) sampling and analysis program to supplement the existing Site data. The purpose of the field program was to evaluate environmental conditions within each subarea where data gaps were identified in the RI/FS Work Plan. Further hydrogeologic data were collected to refine our understanding of hydrogeologic groundwater flow conditions across the Site as they pertain to protection of the Whatcom Waterway and Bellingham Bay. In addition, supplemental data collected in specific Site subareas das part of pre-design and design efforts for the interim action, and these data are incorporated into the RI.

This appendix presents field methods for the following RI/FS field data collection program tasks:

- Direct Push Soil Borings;
- Hand Auger Soil Borings;
- Air-Knifed Soil Boring;
- Soil Classification and Sampling;
- Soil Vapor Sampling;
- Ambient Air Sampling;
- Monitoring Well Installation (both Fill Unit and Lower Sand);
- Dewatering Test Well Installation;
- Monitoring Well Development;
- Groundwater Level Measurements;
- Groundwater Sampling;
- Slug Testing;
- Tidal Studies;
- Sample Handling for Analytical Testing;
- Exploration Surveying; and
- Equipment Decontamination and Disposal of Investigation Derived Waste.

The boring logs and well construction logs for the soil borings and monitoring wells installed during the RI are included at the end of this appendix.

Aspect conducted the initial RI data collection program between September 2009 and May 2010 in two major phases. The first, and largest, data collection effort occurred in August through October 2009, representing dry season conditions. The first phase was conducted in accordance with the Ecology-approved RI/FS Work Plan for the Site (Aspect, 2009a). The second phase, which occurred in March through May 2010, representing wet season conditions, addressed remaining data gaps, based on the information collected during the previous phase. The second phase was conducted in accordance with the Ecology-approved Addendum to the RI/FS Work Plan (Aspect, 2010a), and in accordance with a supplemental memorandum to Ecology regarding installation of well CP-MW12 (Aspect, 2010b).

Supplemental data collection was done to support scoping, cost estimating, and design of early interim actions that would address areas of known contamination on the Site. In addition to further informing the Site RI/FS, the investigation findings were used to evaluate the practicality and timing for conducting one or more interim actions. The scope for a first phase of pre-design data collection was outlined in Addendum 2 to the RI/FS Work Plan (Addendum 2; Aspect, 2010c) submitted to Ecology. A second phase of pre-design data collection was outlined in a follow-up memorandum to Ecology (Aspect, 2011a). A scope for additional investigation supporting interim action remedial design was outlined in a memorandum to Ecology (2011c). Finally, supplemental soil vapor sampling was conducted beneath the Mercury Cell Building, as outlined in a memorandum to Ecology (Aspect, 2011e). Ecology approved each proposed phase of investigation prior to the Port undertaking them.

The drilling and well construction activities were performed in accordance with Chapter 18.104 Revised Code of Washington (RCW), *Water Well Construction*, and Chapter 173-160 of the Washington Administrative Code (WAC), *Minimum Standards for Construction and Maintenance of Wells*.

Direct Push Soil Borings

Between September 14 and 22, 2009, Pacific Northwest Probe of Milton, Washington, a Washington State-licensed driller, under subcontract to and direct supervision of Aspect, installed fifty-five direct-push (“Geoprobe”) borings. Twenty-three were completed as monitoring wells, eight were temporary shallow vapor sampling points, and 24 were soil borings. Between March 24 and 29, 2010, Pacific Northwest Probe installed five more soil borings and eight more monitoring wells. Between late December 2010 and early February 2011, Cascade Drilling of Woodinville, Washington, drilled 62 soil borings, 11 of which were completed as monitoring wells and 14 of which were completed as soil vapor probes. In early June 2011, Cascade drilled eight additional soil borings to sample soils within the planned Caustic Plume interim action area for waste designation purposes. In late October 2011, Cascade drilled four soil borings for completion of soil vapor sampling probes.

Soil borings were advanced using a direct push rig and were sampled on a nearly continuous basis. Each boring was advanced to collect samples at depth intervals specified in the RI/FS Work Plan or as determined by field screening. Samples were collected in disposable 1.5-inch-diameter plastic liners (4-foot lengths) or 2-inch-diameter plastic liners (5-foot lengths). The liners were opened by a stainless steel blade to access the sample.

A geologist from Aspect oversaw the drilling activities and preparation of geologic logs for each of the explorations completed. The field representative visually classified the soils in accordance with ASTM Method D 2488 and recorded soil descriptions, field screening results, and other relevant details (e.g., staining, debris, odors, etc.) on the boring log form.

In addition to field observations, the field representative screened each soil sample using a photoionization detector (PID) equipped with a 10.6 eV lamp to monitor the presence of volatile organic compounds (VOCs). Soil samples submitted for VOC analyses were collected in accordance with EPA Method 5035A.

Each soil boring not completed as a monitoring well was decommissioned with hydrated granular bentonite.

Hand-Augered Soil Borings

Aspect personnel conducted shallow soil sampling in six hand-augered locations (SW-HA01 through SW-HA06) around the perimeter of the topographic stormwater swale to better define the lateral extent of soil mercury in the area. Aspect personnel conducted the hand-augered borings on March 23 and 24, 2010. Two-inch-diameter auger holes were completed to depths of about 1 foot. Two soil samples were collected from each of these six locations, at depths of 0 to 0.5 and 0.5 to 1 foot, for consistency with the majority of the existing soil sample data in the subarea.

Air-Knifed Soil Boring

On April 13, 2010, Cascade Drilling of Woodinville, Washington, a Washington State-licensed driller, under subcontract to and direct supervision of Aspect, drilled and installed one soil monitoring well CP-MW12 immediately adjacent to a stormdrain line beneath Cornwall Avenue, using the air knifing methodology. This method was used to address concerns for proximity of the borehole location to a natural gas pipeline and other nearby utilities. The air knife approach involves vacuuming soil from the borehole, which allowed careful observation for the storm drain line and other utilities (not observed).

Soil Classification and Sampling

Soils were classified in general accordance with the ASTM D 2488, “Standard Practice for Description and Identification of Soils (Visual and Manual Procedure).” Soil samples were collected directly using decontaminated, stainless-steel spoons and homogenized in a stainless-steel bowl by mixing thoroughly before being placed into sample containers.

The soil aliquot for VOC analysis was collected from the undisturbed soil sample core using a laboratory-supplied modified disposable plastic syringe as required by the 5035A method, and placed in pre-weighed laboratory-supplied vials.

For other analyses, the soil samples were removed from the sampler using a stainless-steel spoon and placed in a stainless-steel bowl for homogenization with the stainless-steel spoon. Gravel-sized material greater than approximately 0.5 inch was removed from the sample during mixing. A representative aliquot of the homogenized soil was placed into certified-clean jars supplied by the analytical laboratory.

Pre-cleaned, stainless-steel sampling equipment was brought to the Site for use. We collected equipment rinsate blanks to determine the potential of cross-contamination introduced by sampling equipment between samples. Deionized water was used to rinse through the cleaned soil sampling equipment and collected into appropriate sample containers. The blanks were then processed, analyzed, and reported as regular field samples. Equipment rinsate blanks were collected for reusable soil sampling equipment only; dedicated or disposable equipment was not monitored with equipment rinsate blanks.

Soil Vapor Sampling

Mercury Vapor Sampling

Soil vapor from selected boring locations were analyzed for both elemental and total mercury, using similar sampling methods to those employed during the RI Addendum (Anchor Environmental, 2003b) but with improved analytical methods. Frontier Geosciences Inc., of Seattle, Washington, conducted the mercury vapor sampling and analyses, collecting the samples from gas probes installed by a licensed resource protection well driller. The temporary soil vapor probes were generally installed to a depth of 3 feet, adjusted as needed based on depth to water observed during drilling. The soil vapor probes were 3/4-inch-diameter, threaded Schedule 40 PVC slotted screen and blank casing. Gas intake screens were 0.020-inch slot (20-slot) and generally 1.5 feet in length. Screens were pre-packed with 10/20 silica sand and an annular seal consisting of bentonite chips was placed above the filter pack. The surface penetration was sealed with hydrated bentonite slurry to limit intrusion of atmospheric air into the soil gas sample. During the February 2001 vapor sampling event, a valid soil vapor sample could not be collected from vapor probe CP-VP06, located on the west side of the Cell Building, because water from the very shallow water table was drawn into the sample trap over the course of the day-long sampling. For the October 2011 vapor probes installed beneath the Cell Building slab (CP-VP11 and CP-VP12) included a temporary outer casing (4-inch PVC) to seal off the sub-slab void space. The outer casing was cut to length to extend from the sub-slab soil surface to above the floor slab. The probe was completed inside the casing, and the annular seal between the probe and outer casing will be sealed with hydrated bentonite. During this sampling event, drilling hit refusal on thick subsurface concrete at one location (CP-VP13) so a vapor probe could not be completed.

For all vapor probes, the seal was checked again for integrity prior to vapor sample collection. After collection of the soil vapor samples, the probes were removed and the holes backfilled to ground surface with bentonite chips.

Vapors were pulled from the soil probe by a low-flow vacuum pump through dedicated Teflon tubing to mercury collectors, over a period of approximately 20 to 24 hours. Elemental mercury concentrations were measured in the field using the Lumex RA-915+ field analyzer. The results of the elemental mercury field analysis were used to identify the appropriate run times and flow rates for total mercury soil-vapor sampling. Total mercury was sampled using a modification of EPA Method 30B, which involves pumping soil vapor through a chemically impregnated carbon sorbent trap for up to 16 hours (overnight) and analyzing the sorbent trap in the laboratory using EPA Method 1631. Frontier Geosciences' reports of the vapor sampling and analysis are included in Appendix E of this report.

Petroleum Hydrocarbon Vapor Sampling

As part of the interim pre-design data collection, soil vapor sampling for petroleum hydrocarbons was conducted in the Million Gallon Tanks and Bunker C subareas.

Four soil vapor probes were installed and sampled in each subarea to provide for empirical assessment of vapor intrusion risk and thereby help establish appropriate soil and groundwater cleanup levels/remediation levels for the subarea. The vapor probes were installed based on soil and groundwater quality data to target locations with elevated petroleum concentrations. The probes were installed using the same methodology as for the mercury vapor sampling (described above), but samples were collected using Summa canisters provided by Air Toxics laboratory in California. The soil vapor samples were analyzed for petroleum fractions (aliphatics C5-C6, C6-C8, C8-C10, C10-12; aromatics C8-10, C10-C12) and naphthalene using Air Toxics laboratory's Method TO15-APH.

Ambient Air Sampling

In February 2011, a sample of ambient indoor air was collected to document mercury air concentrations within the Mercury Cell Building (CP-AA01). For reference, an area background sample of ambient outdoor air (BG-AA01) was also collected. The area background air sample was collected within the Bellingham Shipping Terminal southwest of the former Chlor-Alkali Plant, at a location determined to be generally upwind of the Cell Building at the time of sampling.

Monitoring Well Installation and Development

Monitoring Well Installation

Selected direct-push soil borings (described above) were constructed as Fill Unit monitoring wells in accordance with requirements for resource protection wells under Chapter 173-160 WAC. The Fill Unit monitoring wells were drilled and constructed by a licensed resource protection well driller. An Aspect field geologist oversaw and documented installation of each monitoring well. Well construction logs are provided at the end of this appendix.

New Fill Unit monitoring wells were constructed with 2-inch-diameter or 3/4-inch-diameter, threaded Schedule 40 PVC slotted screen and blank casing. Well screens were 0.020-inch slot (20-slot) and 5 feet in length. Screens were pre-packed with 10/20 silica sand and an annular seal consisting of bentonite chips was placed above the filter pack. Wells in which slug testing was conducted were completed as 2-inch-diameter wells, while 3/4-inch-diameter wells were installed elsewhere on the Site.

Two new Lower Sand Unit monitoring wells were installed by Cascade Drilling, Inc., a licensed resource protection well driller in Woodinville, Washington, on September 9 through 10, 2009, using combined hollow-stem auger and rotosonic drilling methods. The wells were completed in accordance with state well construction regulations (Chapter 173-160 WAC). The wells were completed in the Lower Sand Unit, beneath the Tidal Flat Aquitard separating that aquifer from a presumed-contaminated Fill Unit aquifer. To limit the chance for contaminant carry down from the Fill Unit, Cascade Drilling constructed the two wells using a permanent steel conductor casing advanced through the Fill Unit and sealed into the Tidal Flat Aquitard, prior to advancing the borehole through the Aquitard into the Lower Sand Unit.

The general steps used in drilling the Lower Sand Unit soil borings for monitoring wells were as follows:

- Mobilized a hollow-stem auger drill rig and advance a 10.25-inch inside diameter (ID) hollow-stem auger into a competent portion of the Tidal Flat Aquitard (approximately 20-foot depth);
- While advancing the auger, collected soil samples at 2.5-foot-depth intervals using the Standard Penetration Test (ASTM D 1586 84);
- Placed an 8-inch steel casing within the auger to the boring depth (conductor casing);
- Pumped a cement-bentonite seal around the 8-inch conductor casing, as the auger was withdrawn, and allowed the seal to cure over the weekend;

- Poured an approximately 3-foot layer of bentonite slurry in the bottom of conductor casing, prior to advancing the lower portion of the borehole;
- Mobilized a rotosonic (sonic) drill rig to advance a 6-inch borehole through the conductor casing to a depth of 40 feet;
- Below the conductor casing, collected soil samples at defined intervals from the continuous core produced by sonic drilling;
- Once at the 40-foot depth, the drill casing was kept in the ground while lab results for total mercury from a pair of soil samples just above and at the borehole bottom were received. Based on the low soil mercury concentrations at the bottom of the borehole in both borings, Aspect decided to not continue drilling deeper, and completed the wells at the 40-foot depth, in accordance with the decision process outlined in the RI/FS Work Plan.

The Lower Sand Unit monitoring wells were constructed with 2-inch-diameter, threaded Schedule 40 PVC slotted screen and blank casing. Well screens were 0.020-inch slot (20-slot) and 10 feet in length. An artificial filter pack consisting of 10/20 silica sand was placed around the well screen, and an annular seal consisting of bentonite chips was placed above the filter pack, within the conductor casing.

A concrete surface seal was set at grade for each new monitoring well. The finished monitoring wells were protected with a steel flush-mount monument embedded in cement.

Well screen depths were determined based on the field conditions, although wells to be completed in the Fill Unit were less than 20 feet deep and wells completed in the Lower Sand Unit were 40 feet deep. Wells intended to identify impacts from petroleum releases (e.g., at the Million Gallon Tanks and Bunker C Tanks subareas) were screened across the water table.

Dewatering Test Well Installation

To support interim action design, a pair of dewatering test wells were drilled by Holt Services using cable tool methods.

In the Bunker C Tank subarea, total depth of the test well borehole (BC-DW1) was 51.5 feet below ground surface (bgs). The well was installed to a depth of 26 feet, and constructed with 6-inch-diameter PVC casing with a 6-inch-diameter, 30-slot stainless steel wire-wrapped screen extending from 16 to 26 feet bgs. The well is screened in the upper sand unit (fill over potential native sand), which is underlain by an aquitard (presumed glaciomarine drift) extending to the 51-foot depth of exploration.

In the Caustic Plume subarea, a test well (CP-DW1) was drilled to a depth of 50.5 feet bgs and completed into the Lower Sand. The well is screened in the Lower Sand below the Tidal Flat Aquitard. The well was constructed with 6-inch-diameter PVC casing and 6-inch-diameter, 30-slot stainless steel wire-wrapped screen extending from 28 to 48 feet bgs. To limit the potential for contaminant carry-down from the Fill Unit to the Lower Sand, the 6-inch test well was drilled using a dual casing technique. A nominal 18-inch-diameter steel conductor casing was initially advanced to a depth of 19 feet below grade, terminating in the Tidal Flat Aquitard. The bottom 3 feet of the conductor casing was sealed with a grout plug. A nominal 12-inch drill casing was then telescoped within the conductor casing, through the grout plug, to the bottom of the 18-inch borehole. Drilling of the 12-inch borehole then continued through the remaining Aquitard thickness and into the underlying Lower Sand. Once the 12-inch borehole was advanced to total depth, construction of the permanent 6-inch well began. With the conductor casing remaining in place, the 12-inch casing was gradually withdrawn as the bentonite annular seal (around the 6-inch casing) was incrementally placed from the bottom of the borehole, always maintaining the bentonite level above the bottom of the 12-inch casing. Once the annular seal reached the bottom of the conductor casing (depth of 19 feet), the 12-inch casing was withdrawn completely, so the annular seal filled the larger-diameter conductor casing (thicker annular seal above 19 feet). The conductor casing was withdrawn only after full placement of the annular seal, and placement of the surface seal started.

Intertidal Wellpoint Installation and Sampling, Law-1 Area

As part of the interim pre-design investigation, three wellpoints (L1-WP1, L1-WP2, and L1-WP3) were installed in the intertidal shoreline downgradient (north) of Law-1 to monitor groundwater quality closer to its discharge to surface water. The intertidal wellpoints consisted of 3-foot-long stainless steel screens with drive point tips, threaded to black iron riser pipe, and were driven manually screened from a depth of approximately 1.5 to 4.5 feet below the beach grade at each location. The wellpoints are located at or above the upper edge of the thin layer capping area of the current Log Pond sediment cap; therefore, the wellpoints are screened into the underlying contaminated sediment. Groundwater samples were collected from the wellpoints at low tides, consistent with groundwater sampling procedures for monitoring wells (describe below).

Monitoring Well Development

Following installation, each new monitoring well was developed to remove fine-grained material from inside the well casing and filter pack, and to improve hydraulic communication between the well screen and the surrounding water-bearing formation. Wells were developed using a combination of pumping methods. The 2-inch wells were developed using a submersible 12-volt electrical pump gently surged along the entire length of the well screen. The 3/4-inch wells were developed using a peristaltic pump and downhole 1/4-inch tubing surged gently along the length of the well screen.

Aspect monitored the volume of development water and field water quality indicators including color and visual estimate of turbidity throughout development. Wells were pumped until visual turbidity was reduced to minimal levels or until a maximum of 10 casing volumes of water had been removed. Between 2 and 20 gallons were purged from each well.

Prior to RI exploration activities, on August 25 and 26, 2009, Aspect personnel conducted redevelopment of accessible existing monitoring wells. Well redevelopment was performed using the same procedures and criteria as for the new monitoring wells. Since some of the wells had not been accessed for a decade or more, the purpose of redevelopment was to remove fine-grained material or scale accumulation within the well casing and to improve hydraulic communication between the well screen and water-bearing formation. Redevelopment also included sounding well depths, checking for obstructions in well casings, and identifying existing damage to wells to evaluate their reliability for groundwater level monitoring and sampling. In addition, the condition of the protective monuments for the existing monitoring wells was evaluated by Aspect staff. Damaged monuments were replaced by a licensed driller with Pacific Northwest Probe, during its mobilizations to conduct new explorations.

Groundwater Level Measurements

Two rounds of concurrent groundwater level measurements were made from accessible Site monitoring wells site-wide, once during the dry season sampling event and again during the wet season event: September 28, 2009, and March 30, 2010, respectively. Depth-to-groundwater measurements were made in the wells using an electric well sounder, graduated to 0.01 foot. To collect concurrent water level data across the Site, thus minimizing tidal influences, three to four field personnel measured water levels over a time period of approximately two to three hours. An oil-water interface probe was available to measure water levels and evaluate the presence of floating free-phase product (light non-aqueous phase liquid [LNAPL]) in wells in the Million Gallon Tanks and Bunker C Tank subareas. A very thin accumulation of LNAPL was observed in well BC-MW01 within the Bunker C Tank subarea during dry season and wet season monitoring events. No LNAPL was observed in wells within the Million Gallons Tanks subarea, including at downgradient wells within the Confined Nearshore Fill/Chemfix subarea.

As part of the interim action pre-design investigation, water level measurements were also collected from twelve Fill-Unit monitoring wells and three intertidal well points in the Law-1 area on February 3, 2011, using the same general methods described above. Table A-1 provides the RI water level measurements,

Groundwater Sampling

Site-wide groundwater samples were collected during the wet season monitoring event between September 28 and October 2, 2009. Dry season groundwater well samples were collected between March 29 and April 6, 2010. Groundwater samples were subsequently collected from selected wells and intertidal wellpoints as part of the interim action pre-design investigation in late 2010 and early 2011. The groundwater samples were collected by Aspect personnel in accordance with the sampling quality assurance and quality control mechanisms, as outlined in detail in the SAP (Appendix C of the RI/FS Work Plan).

Groundwater samples were collected with a peristaltic pump and pre-cleaned, dedicated downhole fluoropolymer (Teflon) tubing attached to a length of pre-cleaned styrene/ethylene/butylenes silicone (SEBS) tubing, following low-flow sampling techniques to minimize suspended solids in the samples. This tubing was required for sample collection for the low-level mercury analysis (EPA Method 1669). Columbia Analytical Services, Inc. provided lengths of acid-washed tubing. After sampling, the tubing was carefully removed from the well and placed in labeled double plastic zip-top bags for later reuse. Groundwater samples from wells not analyzed for mercury by EPA Method 1669 were collected using peristaltic pump and new dedicated downhole polyethylene (PE) tubing.

The wells were purged at flow rates less than 0.5 liter per minute, and the field parameters: temperature, pH, electrical conductance, dissolved oxygen, and oxidation-reduction potential (ORP) were monitored using a YSI 556 multi-parameter meter and flow-through cell. These field parameters were recorded at 2- to 4-minute intervals throughout well purging until they stabilized. Stabilization is defined as three successive readings where the parameter values vary by less than 10percent (or 0.5 mg/L dissolved oxygen if the readings are below 1 mg/L). However, no more than three well casing volumes were purged prior to groundwater sample collection.

ORP was measured in the field using a silver:silver chloride reference electrode in an airtight low-flow system. For reporting and modeling purposed, we converted the ORP to standard hydrogen electrode (SHE) Eh by adding 200 mVolts to the field measured value (Nordstrom and Wilde, 2005). The purpose of this conversion was to estimate the actual groundwater Eh, assuming equilibrium, to use in PhreeqC groundwater model calculations. As a final note on ORP, a single redox potential cannot necessarily be assigned to a system that is in disequilibrium, nor can it be assigned to a water sample without specifying the particular redox species to which it refers. Different redox elements (iron, manganese, sulfur, arsenic) tend not to reach overall equilibrium in most natural water systems; therefore, a single Eh measurement generally does not represent the entire system (Nordstrom and Wilde, 2005). Thus, the reported values are best estimates of the actual groundwater Eh.

Once purging was complete, the groundwater samples were collected using the same low flow rate. Samples were collected by directly filling laboratory-supplied pre-cleaned containers from the pump discharge tubing. Samples for dissolved metals analyses were filtered using a Whatman Polycap™ GW Capsule in-line 0.45 μm filter; at least 1 liter of water was purged through the filter prior to sample collection. To reduce the likelihood of trace metals cross-contamination, sample collection methods for samples to be analyzed for trace metals generally followed the protocol established in EPA Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. In addition to the procedures described above, clean nitrile disposable gloves were used to handle the sampling apparatus, samples, and blanks for samples collected for trace metals analyses. During the Spring 2010 sampling event, conditions required that three of the wells (EMW-6S, CP-MWB3, and LP-MW01) be resampled due to sample bottle(s) being reported as broken by the laboratory upon receipt.

In addition to the groundwater samples from monitoring wells, six grab groundwater samples were collected from the Lignin Plant LP-MW01 area. A peristaltic pump was used to evacuate groundwater from the soil borings when collecting the grab groundwater samples. A temporary PVC screen was installed and water was pumped through dedicated polyethylene tubing until water turbidity was less than about 50 NTU. Samples were collected directly from the tubing in laboratory-prepared, hydrochloric acid-preserved, 40 mL glass VOA bottles.

Porewater Sampling within Shallow Intertidal Sediment, Million Gallon Tanks Subarea

Sampling of porewater sampling within the surficial intertidal sediment was conducted in November 2012 to measure TPH concentrations at two locations downgradient of the Million Gallon Tanks Subarea and as close as practical to the point of groundwater discharge to surface water. The samples were collected from the uppermost 6 to 8 inches of sediment on the exposed intertidal beach during a falling tide, after the tide had receded below the sample location.

The porewater samples were collected using a temporary stainless steel shielded drive point piezometer (Solinst Model 615S) with a 12 cm-long screen, threaded to black iron riser pipe. The drive point piezometer was manually driven until the drive point tip was fully inserted below the mudline and the filter screen fully submerged. Once installed, the drive point was withdrawn, leaving the shield in place, to expose the screen. Then, dedicated LDPE sample tubing was inserted into the piezometer, and porewater was extracted using a peristaltic pump. Consistent with the RI groundwater sampling procedures, the drive points were purged at flow rates less than 0.25 liter per minute, and the field parameters temperature, pH, electrical conductance, dissolved oxygen, and oxidation-reduction potential (ORP) were continuously monitored until field parameters stabilized, after which the sample was collected at the same low flow rate. Following sample collection, the drive point was withdrawn and the protective shield dug up and removed for future samplings, following decontamination.

Because the iron riser pipe had cutting oil on it when purchased, it was scrubbed with hot water and detergent prior to sampling. In the field, prior to sample collection, a rinse blank was collected by inserting the drive point screen into a jug of deionized water and withdrawing a sample of the deionized water using peristaltic pump (same procedure as subsequent sample collection). The rinse blank sample was submitted for TPH analysis with the porewater samples.

Slug Testing

Slug tests were performed on select wells to estimate the hydraulic conductivity (K) of aquifer materials during the Fall 2009 field effort. The test method involved quickly displacing a volume of water within the well and measuring water level recovery rate. Analytical methods were used to estimate hydraulic conductivity of the aquifer immediately outside the well from the recorded water level data.

A slug test can consist of a “slug-in” or falling head test, where the water level in the well is rapidly raised, or a “slug-out” or rising head test, where the water level in the well is rapidly lowered. A minimum of two slug tests was performed at each well tested. An electric well sounder was used to determine the depth from the top of the casing to the water table. The depth-to-water measurements were compared to the well construction log to determine the well screen was fully saturated. Rising and falling head tests were performed in wells where the screen section was fully saturated. Only rising head tests were conducted in wells with partially saturated screens.

Slug tests in Fill Unit wells were performed using a solid PVC slug rod to create the initial water level displacement. Slug tests in Lower Sand Unit wells were performed using a pneumatic device, sealed on the well top of casing, to create the initial water level displacement. Pressure transducers and data loggers were used to measure and record displacement and recovery of the monitoring well water levels. For a falling head test, the static water level was displaced upward (e.g., slug rod was rapidly lowered into the well) and the falling water levels monitored until it approached the pre-test measured water level. For a rising head test, static water level was displaced downward (e.g., slug rod was rapidly removed from the well) and the rising water level monitored until it approached the pre-test measured water level.

Pumping Tests in Dewatering Test Wells

As part of interim action design, pumping tests were conducted in the two dewatering test wells (Fill Unit well BC-DW1 in Bunker C Tank subarea, and Lower Sand well CP-DW1 in Caustic Plume subarea) during July 2011. For both wells, a short-term (roughly 4 hours) step-rate test and a 24-hour constant-rate test were conducted. Water levels were monitored continuously using data loggers at nearby monitoring wells throughout the testing, including during post-pumping water level recovery.

Pumping tests were performed using an electric submersible pump fitted with a shroud and intake screen. The pump was set near the bottom of the well to maximize available drawdown during testing. The short-term step-rate test was performed to assess the sustainable pumping rate for the 24-hour constant rate test of each well.

Water from the dewatering test wells was initially tested, with test data submitted to Ecology NPDES staff to satisfy condition S6.A for non-routine and unanticipated discharges of water to the Port's ASB under their NPDES permit for the facility (letter to Mark Henderson, Ecology, from Steve Germiat, Aspect, dated July 15, 2011). The pumping test water was pumped into an on-site Baker tank (one per well) to provide settling of suspended solids. Following Ecology approval for discharge to the ASB (letter from Mark Henderson, Ecology, to Brian Gouran, Port, dated August 4, 2011), the pumping test water (approximately 35,000 gallons) was pumped from the Baker tanks to the Port's ASB pump station.

Memoranda detailing the testing of each well are provided at the end of Appendix B.

Tidal Studies

A 96-hour tidal study was conducted on ten wells screened in Fill Unit aquifer from October, 19 to 22, 2009, a period of high tidal fluctuations in Bellingham Bay. The results of the study indicated that nearshore wells (CP-MWA3, CP-MWC3, and AA-MW01) exhibited some degree of tidal influence (1.15, 2.27, and 1.51 feet of fluctuation, respectively). However, the remaining wells further inland (EMW-10S, CP-MWA1, CF-MW02, AA-MW04, CP-MWC1, and CP-MW03) showed no discernible tidal influence on groundwater levels. Well Law-1 also exhibited no obvious tidal influence, despite being located adjacent to the Log Pond on the Whatcom Waterway.

Two subsequent 72-hour tidal studies were conducted during April and May 2010. Four Fill Unit monitoring wells (CP-MW07, CP-MW08, CP-MW09, and CP-MW-12), installed in March 2010, were monitored continuously from April 17 through 19, 2010. Fill Unit wells CP-MWB1, CP-MWB2, CP-MWB3, AA-MW04, FH-MW01, AA-MW01, and CP-MW10 were monitored from May 11 through 13, 2010.

In February of 2011, during the second phase of interim action pre-design investigation, continuous water level data were collected over a period of 72 hours in wells Law-1, L1-MW02, and L1-MW06, located within the Law-1 area. The data were collected to provide refined assessment of local groundwater flow directions in the Law-1 area.

Sample Handling and Analytical Testing Points of Contact

Soil, groundwater, and soil vapor samples were collected from the Site and shipped to analytical laboratories following protocols set forth in the Quality Assurance Project Plan (QAPP), Appendix D to the RI/FS Work Plan.

The soil vapor sampling and analysis for mercury was performed by Frontier Geosciences, Inc. in Seattle, Washington, as reported in Appendix E. The laboratory project manager and the contact information are as follows:

Laboratory Project Manager – Robert Brunette
Frontier Geosciences, Inc.
414 Pontius Avenue, North
Seattle, WA 98109
Tel: (206) 957-1461
e-mail: BobB@frontiergeosciences.com

The chemical analyses of soil and groundwater samples were performed by ALS Environmental, formerly Columbia Analytical Services, Inc. (CAS), in Kelso, Washington; and dioxins/furans analyses were performed by ALS (formerly CAS) in

Houston, Texas. While the CAS/ALS laboratory PM has changed over the course of the RI data collection, the current contact information is as follows:

Laboratory Project Manager - Lisa Domenighini
ALS Environmental
1317 South 13th Avenue
Kelso, Washington 98626
Tel: (360) 577-7222
e-mail: ldomenighini@caslab.com

Petrographic analysis including SEM, XRD, and thin-section optical analysis was conducted by MWH Americas in Fort Collins, Colorado, as described in Appendix D. The contact information is as follows:

Kenneth Esposito
MWH Americas
3665 John F Kennedy PKWY, STE 206
Fort Collins, CO 80525-3152
Tel: (970)212-2753
e-mail: Ken.Esposito@us.mwhglobal.com

Groundwater samples were analyzed for biomarker assay by Manchester Environmental Laboratory in Port Orchard, Washington, as described in Appendix G. The laboratory PM and contact information are as follows:

Laboratory Project Manager – Bob Carrel
Washington State Department of Ecology
Manchester Environmental Laboratory
7411 Beach Drive East
Port Orchard, WA 98366
Tel: 360-871-8800
Fax: 360-871-8850

Soil samples were collected for rush-turnaround soil mercury analyses during drilling of the two new Lower Sand Unit monitoring wells to confirm the soil mercury concentrations were below screening levels. Because of the rapid 24-hour turnaround time required for this analysis, samples were submitted to Avocet Environmental Testing located in Bellingham, Washington. The laboratory PM and contact information are as follows:

Laboratory Project Manager – Mark Lorenz
Avocet Environmental Testing
1500 North State Street, Suite 200
Bellingham, WA 98225
Tel: 360-743-9033
e-mail: lab@avocetlab.com

Air Toxics' laboratory project manager for the petroleum hydrocarbon soil vapor analyses (Appendix E) was:

Kelly Buettner

Air Toxics Ltd.
180 Blue Ravine Rd. Ste. B
Folsom, CA 95630
Tel: 916-605-3378
Email: kbuettner@airtoxics.com

Exploration Surveying

Following each round of well installation, new monitoring well locations were surveyed by a licensed surveyor with Wilson Engineering, LLC, of Bellingham, Washington. Wells were surveyed relative to a common horizontal and vertical datum being used for the Whatcom Waterway cleanup work. The vertical coordinates reference the Mean Lower Low Water Datum (MLLW 1983-2001) in feet. Horizontal coordinates are referenced to NAD83/98 Washington State Plane Coordinates (North Zone) in US Survey Feet. Monitoring well top-of-casing elevations were surveyed to the nearest 0.01 foot, and horizontal coordinates to the nearest 0.1 foot, or better. Measurements were taken at the “notched” or “marked” spot at the top edge of the open PVC casing. Other pertinent Site features surveyed by Wilson Engineering included pre-existing usable monitoring wells, as well as pipe invert locations and elevations for accessible manholes along City of Bellingham’s storm drain lines along Laurel Street and Cornwall Avenue.

Other Site sampling locations including direct-push soil borings, hand auger soil borings and soil vapor sampling locations were located in the field by Aspect using a hand-held Global Positioning System (GPS) with sub-meter scale accuracy.

Decontamination and Disposal of Investigation Derived Waste (IDW)

Decontamination was performed on non-dedicated sampling equipment that may have contacted potentially contaminated water or soil. This includes hand augers, water level indicators, oil-water interface probes, and stainless-steel bowls and spoons. The non-disposable, non-dedicated sampling equipment was decontaminated before collection of each sample. The decontamination sequence consists of a scrub with a detergent (Alconox) solution, followed by tap water (potable) rinse, and finished with thorough spraying with deionized or distilled water. Clean nitrile gloves were worn during decontamination. Decontamination water was collected in 5-gallon buckets and transferred to the on-Site stormwater pump station, which conveys water to the Port’s ASB for treatment and permitted discharge under a NPDES permit, in accordance with the SAP.

Soil cuttings from borings and disposable personal protective equipment (PPE) were placed in labeled 55-gallon drums pending the analytical results from each boring to determine appropriate disposal. The drums were temporarily consolidated in the on-Site cell building, profiled based on available analytical data, and, in June 2010, disposed of appropriately at Allied Waste's Roosevelt Regional Subtitle D Landfill in Roosevelt, Washington. Aspect maintains records for the proper disposal of the IDW drums.

Water generated during decontamination and monitoring well development and sampling was containerized at the wellhead and transferred to the on-Site stormwater pump station, which conveys water to the Port's ASB, in accordance with the SAP.

References for Appendix A

Nordstrom, D.K., Wilde F.D., 2005, Reduction-Oxidation Potential (Electrode Method) (Version 1.2): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chapter A6, Section 6.5, September, accessed May 17, 2010 from http://pubs.water.usgs.gov/twri9A6/.

Table A-1 - Well Construction and Waste Level Data

GP West RI/FS 070188

Well construction data						Water level data					
						9/28/09		3/30/10		2/3/11	
Well ID	**Well TOC Elevation (MLLW)**	**Depth to top of screeened interval (BGS)**	**Depth to bottom of screened interval (BGS)**	**Elevation of top of screened interval**	**Elevation of bottom of screened interval**	**DTW**	**Groundwater Elevation (MLLW)**	**DTW**	**Groundwater Elevation (MLLW)**	**DTW**	**Groundwater Elevation (MLLW)**
AA-MW01	15.75	11	16	5.05	0.05	9.46	6.29	7.89	7.86		
AA-MW02	16.24	11	16	5.54	0.54	7.85	8.39	6.09	10.15		
AA-MW03	15.43	7	12	8.73	3.73	7.69	7.74	6.30	9.13		
AA-MW04	17.25	8	13	9.55	4.55	8.19	9.06	5.95	11.30		
AMW-01	14.81	10	15	5.11	0.11	8.71	6.10	7.48	7.33	7.72	7.09
AMW-02	14.16	10	15	4.46	-0.54	5.51	8.65	4.20	9.96		
AMW-03	14.36	10	15	4.66	-0.34	3.79	10.57	2.02	12.34		
BC-MW01	14.42	5	15	9.72	-0.28	7.82	6.60	6.18	8.24		
BC-MW02	14.79	7	17	8.09	-1.91	11.00	3.79	9.47	5.32		
BC-MW03	12.72	7	12	6.02	1.02	7.42	5.30	5.74	6.98		
CF-MW01	12.21	12	17	0.51	-4.49	1.78	10.43	2.18	10.03		
CF-MW02	14.73	10	15	5.03	0.03	2.13	12.60	1.70	13.03		
CP-MW01	14.42	10	15	4.72	-0.28	6.09	8.33	5.05	9.37		
CP-MW02	12.37	10	15	2.67	-2.33	5.46	6.91	4.79	7.58	4.66	7.71
CP-MW03	14.85	11	16	4.15	-0.85	3.21	11.64	1.39	13.46	1.74	13.11
CP-MW04	14.92	30	40	-14.78	-24.78	8.48	6.44	7.50	7.42		
CP-MW05	14.97	29.7	39.7	-14.43	-24.43	9.12	5.85	7.60	7.37		
CP-MW06	15.39	12	17	3.69	-1.31	3.93	11.46	2.70	12.69		
CP-MW07	12.98	12	17	1.28	-3.72			6.25	6.73		
CP-MW08	13.11	10	15	3.41	-1.59			4.40	8.71		
CP-MW09	15.17	11	16	4.47	-0.53			5.77	9.40		
CP-MW10	12.85	7	12	6.15	1.15			2.69	10.16	3.29	9.56
CP-MW11	15.25	10	15	5.55	0.55			4.15	11.10		
CP-MW12	12.78	6	11	7.08	2.08			5.10	7.68		
CP-MW13	14.32	11	16	3.62	-1.38						
CP-MWA1	14.16	11	16	3.46	-1.54	5.56	8.60	4.14	10.02	4.14	10.02
CP-MWA2	13.36	11	16	2.66	-2.34	6.03	7.33	5.12	8.24	5.12	8.24
CP-MWA3	12.17	9	14	3.47	-1.53	6.42	5.75	4.78	7.39	4.78	7.39
CP-MWB1	14.71	11	16	4.01	-0.99	6.99	7.72	6.23	8.48	6.23	8.48
CP-MWB2	13.49	10	15	3.79	-1.21	6.51	6.98	5.40	8.09	5.40	8.09
CP-MWB3	12.55	11	16	1.85	-3.15	6.90	5.65	5.01	7.54	5.01	7.54
CP-MWC1	13.74	9	14	5.04	0.04	5.40	8.34	4.17	9.57	4.17	9.57
CP-MWC2	13.79	11	16	3.09	-1.91	7.03	6.76	6.17	7.62	6.17	7.62
CP-MWC3	14.77	9.9	14.9	5.17	0.17	9.15	5.62	8.03	6.74	8.03	6.74
CW-MW01	22.88	8	18	15.18	5.18	13.77	9.11	10.79	12.09		
EMW-01S	14.62	5	10	9.92	4.92	1.73	12.89	0.88	13.74		
EMW-02S	14.82	8	18	7.12	-2.88	4.63	10.19	3.09	11.73		
EMW-04S	14.71	8	18	7.01	-2.99	3.30	11.41	1.51	13.20		
EMW-05S	14.52	8	18	6.82	-3.18	3.35	11.17	1.97	12.55		
EMW-06S	14.44	6	16	8.74	-1.26	3.18	11.26	1.15	13.29		
EMW-07S	12.34	7	22	5.64	-9.36			2.09	10.25		
EMW-08S	13.82	5	20	9.12	-5.88	5.66	8.16	5.87	7.95		
EMW-10S	16.57	3	18	13.87	-1.13	6.80	9.77	6.26	10.31		
EMW-11S	14.79	4	9	11.09	6.09	5.73	9.06	3.90	10.89		
EMW-12S	14.58	6	16	8.88	-1.12	5.01	9.57	3.39	11.19		
EMW-13S	14.88	7.5	17.5	7.68	-2.32	6.12	8.76	4.33	10.55		
EMW-14S	15.82	4	14	12.12	2.12	4.12	11.70	2.38	13.44		
EMW-16S	14.77	5	15	10.07	0.07	6.33	8.44	4.37	10.40		
EMW-18S	16.02	5	15	11.32	1.32	6.34	9.68	4.81	11.21		
EMW-19S	14.83	5	15	10.13	0.13	3.34	11.49	2.21	12.62		
EMW-20S	16.25	5	15	11.55	1.55	3.24	13.01	3.03	13.22		
EMW-28D	14.42	30	40	-15.28	-25.28	7.62	6.80	6.79	7.63		
EMW-29D	14.02	30	40	-15.68	-25.68	8.52	5.50	6.96	7.06		
FH-MW01	15.26	5	15	10.56	0.56	7.53	7.73	5.76	9.50		
GF-MW01	15.13	5	15	10.43	0.43	10.08	5.05	8.45	6.68		
L1-MW01	13.20	8.5	13.5	5.00	0.00					4.92	8.28
L1-MW02	13.60	10	15	3.90	-1.10					4.31	9.29
L1-MW03	13.30	14	19	-0.40	-5.40					6.04	7.26
L1-MW04	14.32	11	16	3.62	-1.38					1.25	13.07
L1-MW05	14.36	5.25	10.25	9.41	4.41					1.26	13.10
L1-MW06	14.00	11	16	3.30	-1.70					6.40	7.60
L1-WP-1	8.12	1.6	4.6	6.82	3.82					2.12	6.00
L1-WP-2	6.41	1.6	4.6	5.11	2.11					1.16	5.25
L1-WP-3	6.74	1.6	4.6	5.44	2.44					1.20	5.54
LAW-1	14.89	5	14.5	10.19	0.69	7.00	7.89	5.50	9.39	6.47	8.42
LAW-3	15.35	5	14.5	10.65	1.15	5.30	10.05	4.35	11.00		
LAW-5	15.74	3	12.5	13.04	3.54	7.43	8.31	4.65	11.09		
LAW-6	14.39	3	12.5	11.69	2.19	1.35	13.04	0.24	14.15		
LAW-8	13.94	3	12.5	11.24	1.74	5.04	8.90	3.89	10.05	3.94	10.00
LB-MW01	14.54	2.5	12.5	12.34	2.34	5.14	9.40	3.13	11.41		
LP-MW01	14.33	3	13	11.63	1.63	4.15	10.18	1.74	12.59		
LW-MW01	15.64	3	13	12.94	2.94	5.27	10.37	3.85	11.79		
MG-MW01	14.47	3	13	11.77	1.77	3.67	10.80	2.00	12.47		
MG-MW02	14.43	7	12	7.73	2.73			1.17	13.26		
MG-MW03	14.80	13	18	2.10	-2.90			4.31	10.49		
PR-MW01	15.23	8	13	7.53	2.53	5.26	9.97	3.92	11.31	3.92	11.31
PR-MW02	14.32	10	15	4.62	-0.38	4.39	9.93	3.02	11.30	3.02	11.30
PR-MW03	15.34	12	17	3.64	-1.36			4.10	11.24	4.10	11.24
SC-MW01	15.76	3	13	13.06	3.06	11.76	4.00				
SC-MW02	14.50	3	13	11.80	1.80			2.52	11.98		
TS-MW01	12.44	5	15	7.74	-2.26	5.05	7.39	3.52	8.92		

TOC: Top of well casing (measuring point). DTW: Depth to water below top of casing. BGS: Below ground surface
Horizontal Coordinates are NAD83/98 WSPN (ft). Vertical datum is MLLW 1983-2001
All depths and elevations are in feet.
Blank cells indicate no measurement

RI Boring/Monitoring Well Logs

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	AA-MW01	1 of 1

Project Name: Georgia Pacific West Site
Location: Acid Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 16.05
Top of Casing Elev.: 15.75
Depth to Water (ft BGS): 7.89 - 3/30/2010
Start/Finish Date: 9/17/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–1		8" flush mount monument set in concrete	Continuous Core					Concrete	
1–5	15	3/4" sch 40 PVC riser	Continuous Core					Moist, brown, slightly silty SAND (SP-SM); trace organics, trace wood, trace iron oxide staining, fine to medium sand	
5–9.5	10	3/8" bentonite chips; 3/30/2010 (static water level); water level (ATD); 9/28/2009 (static water level)	Continuous Core					Moist, dark brown, slightly silty SAND (SP-SM); scattered wood, trace seashells, trace thin silt beds, fine to medium sand Becomes wet.	5
9.5–16	5	10-20 silica sand; Prepacked screen, 0.020" slot, 3/4"	Continuous Core; No Recovery (15–16)					Medium stiff, wet, gray, sandy SILTY (ML); scattered wood, scattered seashells, trace fine gravel, predominantly fine to medium sand Very thinly bedded, coarse, slightly silty sand Wood	10, 15
16	0	Threaded cap						Bottom of boring @16'	

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 2

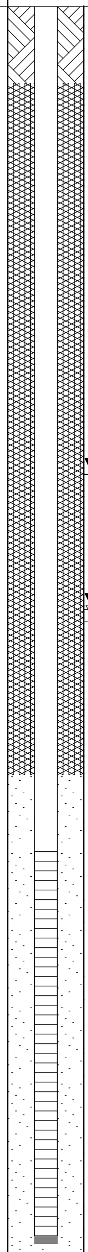
Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	AA-MW02	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	16.54
Location:	Acid Area / Bellingham, Washington	Top of Casing Elev.	16.24
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	6.09 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/17/2009

Columns: Depth / Elevation (feet) | Borehole Completion | Sample Type/ID | Tests | PID (ppm) | Soil pH | Material Type | Description | Depth (ft)



Depth (ft)	Elevation (ft)	Description
0		Concrete
1	15	Slightly moist, brown, slightly gravelly SAND (SW); trace silt, scattered organics, fine to coarse gravel, fine to coarse sand, predominantly fine
5		
6	10	
7.5		Wood; becomes silty
8		Wet, dark gray, silty SAND (SM); trace wood, abundant seashells, fine to medium sand
10		
11	5	
12		Trace to slight coarse sand
13		Thin silt bed
15		
16	0	Bottom of boring @16'

Sampler Type:
- ○ No Recovery
- ▮ Continuous Core

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 3

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	AA-MW03	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.73
Location:	Acid Area / Bellingham, Washington	Top of Casing Elev.	15.43
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	6.3 - 3/30/2010
Sampling Method:	2.25" core	Start/Finish Date	9/15/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 15	5" flush mount monument set in concrete						Asphalt and gravel	
1	3/4" sch 40 PVC riser						Moist, brown SAND (SP); trace silt, fine sand	
2							Very thin silt bed	
3	3/8" bentonite chips							
4							Light iron oxide staining	
5 / 10							Heavy iron oxide staining	5
6	3/30/2010 10-20 silica sand						Fine to medium sand	
7	9/28/2009							
8							Wet, dark gray SAND (SW); trace silt, fine to coarse sand, predominantly fine	
9	Prepacked screen, 0.020" slot, 3/4"							
10 / 5								10
12	Threaded cap						Bottom of boring @ 12'	
15 / 0								15

Sampler Type:
- No Recovery
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 4

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	AA-MW04	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	17.55
Location:	Acid Area / Bellingham, Washington	Top of Casing Elev.	17.25
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	5.95 - 3/30/2010
Sampling Method:	2.25" core	Start/Finish Date	9/15/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–2		5" flush mount monument set in concrete						Moist, brown, silty SAND (SM); scattered thin silt beds, scattered organics, iron oxide staining, fine to coarse sand	
1–2			AA-MW04-1-2	As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, pH					
	15	3/4" sch 40 PVC riser							
4–5			AA-MW04-4-5	As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, pH				Moist, gray, slightly silty SAND (SP-SM); scattered organics, scattered iron oxide staining, trace coarse sand, trace gravel, fine to medium sand	
5		3/8" bentonite chips							5
		3/30/2010							
7								Dry, gray, sandy GRAVEL (GP); crushed rock	
7.5	10	10-20 silica sand						Wood, trace fine to medium sand. Wet.	
		9/28/2009							
8.5–9.5			AA-MW04-8.5-9.5	As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, pH				Wet, dark gray, silty SAND (SM); scattered wood, fine to coarse sand	
10		Prepacked screen, 0.020" slot, 3/4"							10
11–12			AA-MW04-11-12	As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, pH				Very silty	
								Slightly silty to silty, trace gravel, scattered wood	
	5	Threaded cap							
13								Bottom of boring @ 13'	
15									15
	0								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 5

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-DW1	1 of 2

Project Name: Georgia Pacific West Site

Location: Bellingham, Washington

Driller/Method: Holt Drilling / Cable tool

Sampling Method: 2" ID X 2.5" OD split spoon / Hammer Weight: 300 lb jars / Hammer Drop: 30"; sand in

Ground Surface Elev: 15.0

Top of Casing Elev.: 14.68

Depth to Water (ft BGS): 8.8

Start/Finish Date: 6/27/2011-6/29/2011

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	15	Flush-mount monument; Concrete seal 0'-1'						Asphalt.	
								Moist, gravelly, silty SAND (SM) with cobbles and crushed concrete; rounded to angular gravel; no petroleum odor.	
		Bentonite grout seal 1'-13'							
5	10	6" I.D. schedule 40 PVC riser pipe, threaded connection 0'-16'						Very dense, wet, dark gray, slightly silty, slightly gravelly SAND (SW-SM); fine to coarse sand; no petroleum odor.	5
								Very dense, wet, lightly brown, slightly gravelly SAND (SW); trace silt, fine to coarse sand; no petroleum odor.	
10	5							Medium dense, wet, light brown, slightly silty SAND (SP-SM); trace gravel; medium to coarse sand; abundant seashell fragments; no petroleum odor.	10
								Medium dense, wet, dark gray, silty SAND (SM); fine sand; no petroleum odor.	
		Bentonite chip seal 13'-14'						Gravelly; fine to medium sand; scattered seashell fragments.	
15	0	10/20 Sand filterpack 14'-27'						Fine to coarse sand; abundant seashell fragments.	15
								Very silty; fine to medium sand.	
20	-5							Wet, dark gray SAND (SW); fine to coarse sand; trace silt; no petroleum odor.	20
		6" ID stainless steel .030" slot wire-wrapped screen, 16'-26'						Abundant seashell fragments; scattered woody debris.	
								Wet, dark gray, silty SAND (SM); fine sand; scattered seashell fragments; no petroleum odor.	
25	-10	Centralizers							25
								Very stiff, wet, gray CLAY (CH); high plasticity; high toughness, no dilatancy; no petroleum odor.	
								Dark gray; medium to high plasticity. Slightly gravelly.	
		Bentonite chips 27'-32'						Slightly sandy, no gravel.	

Sampler Type:
- No Recovery
- Split Spoon Sampler

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 6

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-DW1	2 of 2

Project Name: Georgia Pacific West Site
Location: Bellingham, Washington
Driller/Method: Holt Drilling / Cable tool
Sampling Method: 2" ID X 2.5" OD split spoon / Hammer Weight: 300 lb jars / Hammer Drop: 36", sand line

Ground Surface Elev: 15.0
Top of Casing Elev.: 14.68
Depth to Water (ft BGS): 8.8
Start/Finish Date: 6/27/2011-6/29/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Sandy.	
							Medium dense, wet, dark gray, slightly silty SAND (SP-SM); fine to medium sand; no petroleum odor.	
35 -20	Pea gravel 32'-51.5'						Medium dense, wet, dark gray, silty SAND (SM); fine to medium sand; no petroleum odor.	35
							Stiff, wet, dark gray CLAY (CH); high plascticity; high strength; no dilatancy; no petroleum odor.	
40 -25							Stiff, wet, dark gray SILT (ML); trace coarse sand; no petroleum odor.	40
							Stiff, wet, dark gray CLAY (CH); trace coarse sand; no petroleum odor.	
45 -30							High plasticity; high strength; no dilatancy; no petroleum odor.	45
50 -35								50
							Bottom of boring at 51.5 feet.	
							* "N" values are not equivalent to SPT values.	
55 -40								55

Sampler Type:
No Recovery
Split Spoon Sampler

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MvdA
Approved by: SJG
Figure No. A- 6

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-MW02	1 of 2

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.09
Location:	Bunker C Area / Bellingham, Washington	Top of Casing Elev.	14.79
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	9.47 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/22/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	15	5" flush mount monument set in concrete						Slightly moist, brown, silty, very gravelly SAND (SM); abundant organics, fine to coarse sand	
1	14								1
2	13	3/4" Sch 40 PVC riser							2
3	12		BC-MW02-2-4	NWTPH-Dx, PAHs					3
4	11	3/8" bentonite chips							4
5	10							Wet, dark brown, slightly gravelly, very silty SAND (SM); fine to medium sand	5
6	9	10-20 silica sand							6
7	8								7
7.6								Iron oxide staining	
8	7								8
9	6		BC-MW02-8-10	NWTPH-Dx, PAHs					9
9.47		3/30/2010							
10	5							Wet, dark gray, sandy, very silty GRAVEL (GM); fine to medium sand, fine to coarse gravel	10
11	4	9/28/2009							11
12	3	Prepacked screen, 0.020" slot, 3/4" diam.							12
13	2		BC-MW02-12-14	NWTPH-Dx, PAHs					13
14	1								14

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 7

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-MW02	2 of 2

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.09
Location:	Bunker C Area / Bellingham, Washington	Top of Casing Elev.	14.79
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	9.47 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/22/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	0							Wet, dark gray, very silty SAND (SM); slight sheen, fine to coarse sand	
16	-1								16
17	-2	Threaded cap							17
18	-3		BC-MW02-17-19	NWTPH-Dx, PAHs				Abundant wood	18
19	-4							Abundant seashells	19
20	-5							Wet, dark gray, very sandy SILT (ML); abundant seashells	20
21	-6		BC-MW02-21-22	NWTPH-Dx, PAHs					21
22	-7								22
23	-8							Abundant wood	23
24	-9							Bottom of boring at 25'	24
25	-10								25
26	-11								26
27	-12								27
28	-13								28
29	-14								29

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 7

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-MW03	1 of 2

Project Name:	Georgia Pacific West Site	Ground Surface Elev	13.02
Location:	Bunker C Area / Bellingham, Washington	Top of Casing Elev.	12.72
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	5.74 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/22/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0		5" flush mount monument set in concrete					Slightly moist, dark brown, sandy, very silty GRAVEL (GM); abundant organics and seashells	
1	12							1
2	11	3/4" Sch 40 PVC riser						2
3	10						Medium stiff, moist, dark gray, slightly sandy SILT (ML)	3
4	9	3/8" bentonite chips	BC-MW03-4-5	NWTPH-Dx, PAHs			Moist, dark gray, slightly sandy, very silty GRAVEL (GM)	4
5	8							5
		3/30/2010						
6	7	10-20 silica sand						6
7	6	9/28/2009						7
8	5		BC-MW03-7.5-9.5	NWTPH-Dx, PAHs				8
9	4	Prepacked screen, 0.020" slot, 3/4" dia.						9
10	3							10
11	2							11
12	1	Threaded cap						12
13	0							13
14	-1		BC-MW03-13-15	NWTPH-Dx, PAHs			Wet, dark gray, silty, gravelly SAND (SM); scattered seashells, fine to coarse sand	14

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 8

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-MW03	2 of 2

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 13.02
Top of Casing Elev.: 12.72
Depth to Water (ft BGS): 5.74 - 3/30/2010
Start/Finish Date: 9/22/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
16	-3	3/8" bentonite chips							16
17	-4								17
18	-5								18
19	-6		BC-MW03-18.5-19.5	NWTPH-Dx, PAHs				Hard, wet, dark olive gray, slightly sandy SILT (ML); trace organics	19
20	-7							Bottom of boring 20'	20
21	-8								21
22	-9								22
23	-10								23
24	-11								24
25	-12								25
26	-13								26
27	-14								27
28	-15								28
29	-16								29

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 8

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	BC-MW04	1 of 2

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev. 17.22
Depth to Water (ft BGS) 9.5 ATD
Start/Finish Date 12/17/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	5" flush mount monument set in concrete						Moist, gray, gravelly, silty SAND (SW); fine to coarse sand, gravel to 1.5" diameter, scattered concrete fragments	
1								1
2								2
3		BC-MW04-3-4	NWTPH-Dx					3
4	3/4" Sch 40 PVC riser						Perched water 4'-7'	4
5								5
6		BC-MW04-6-7	NWTPH-Dx, PAH				6" bed crushed asphalt	6
7	3/8" bentonite chips							7
8								8
9		BC-MW04-9-10	NWTPH-Dx				Becomes wet	9
10								10
11	10-20 silica sand	BC-MW04-11-12	NWTPH-Dx, TOC					11
12								12
13							Wet, silty, GRAVEL (GM)	13
14	Prepacked screen, 0.020" slot, 3/4" dia.							14

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 9

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-MW04	2 of 2

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 17.22
Depth to Water (ft BGS): 9.5 ATD
Start/Finish Date: 12/17/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
		BC-MW04-15-16	NWTPH-Dx, PAH				Woody debris	
16							Moist, gray to brown, silty, SAND (SM); abundant woody debris, trace fine gravel	16
17	Threaded cap							17
18								18
	Slough	BC-MW04-18-19	NWTPH-Dx					
19								19
20							Bottom of boring at 20'	20
21								21
22								22
23								23
24								24
25								25
26								26
27								27
28								28
29								29

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 9

_GP_MONITORING WELL GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-MW05	1 of 2

Project Name:	Georgia Pacific West Site	Ground Surface Elev	
Location:	Bunker C Area / Bellingham, Washington	Top of Casing Elev.	15.98
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	13.5 ATD
Sampling Method:	1.5" core	Start/Finish Date	12/17/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	5" flush mount monument set in concrete						Concrete	
1							Moist, brown, slightly silty, gravelly SAND (SP); medium to coarse sand	1
2								2
3		BC-MW05-3-4	NWTPH-Dx					3
4							Becomes black; scattered red brick fragments	4
5	3/4" Sch 40 PVC riser							5
6							Whitish building material fragments	6
7		BC-MW05-7-8	NWTPH-Dx, PAH				Moist to wet, brown, silty, gravelly SAND (SM)	7
8								8
9		BC-MW05-9-10	NWTPH-Dx					9
10	3/8" bentonite chips							10
11								11
12		BC-MW05-12-13	NWTPH-Dx				Whitish building material fragments	12
13							Becomes wet, becomes black	13
14	10-20 silica sand							14

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 10

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-MW05	2 of 2

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 15.98
Depth to Water (ft BGS): 13.5 ATD
Start/Finish Date: 12/17/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
		BC-MW05-15-16	NWTPH-Dx, PAH					
16								16
							Petroleum-like odor, slight sheen	
17	Prepacked screen, 0.020" slot, 3/4" dia.						Woody debris	17
18							Trace gravel 18'-20'	18
		BC-MW05-18-19	NWTPH-Dx					
19								19
20	Threaded cap						Bottom of boring at 20'	20
21								21
22								22
23								23
24								24
25								25
26								26
27								27
28								28
29								29

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 10

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	BC-SB03	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core
Ground Surface Elev: 14.9
Depth to Water (ft BGS):
Start/Finish Date: 9/22/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0–0.5		Hole abandoned with 3/8" bentonite chips (0–15 ft)	Continuous Core				Asphalt cover
0.5–2.5			Continuous Core				Slightly moist, brown, slightly silty SAND (SW), fine to coarse sand Abundant wood
2.5–5			No Recovery (3–4); Soil sample BC-SB03-4-5 (4–5)				Moist, dark brown, silty, gravelly SAND (SP-SM); occasional wood debris, occasional asphalt debris, fine to coarse sand Thick bed very moist, dark gray silt
5–9	10		Continuous Core; Soil sample BC-SB03-8.5-9.5 (8.5–9.5)				Moist, brown SAND (SP); trace silt, fine to medium sand Very thinly bedded coarse sand, trace gravel
9–15	5	Water Level (ATD) at approx. 9 ft	No Recovery (9.5–10); Continuous Core; Soil sample BC-SB03-11.5-12.5; Soil sample BC-SB03-14-15				Stiff, wet, dark gray, slightly sandy SILT (ML). Very silty sand medium bedded Becomes dark olive gray with trace coarse sand, gravel, wood, and shell fragments at 14' to 15'.
15	0						Bottom of boring at 15'
20	-5						
25	-10						

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 11

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB04	1 of 1

Project Name: Georgia Pacific West Site — Ground Surface Elev: 14.6

Location: Bunker C Area / Bellingham, Washington

Driller/Method: Northwest Probe / Direct push soil probe — Depth to Water (ft BGS):

Sampling Method: 3.25" core — Start/Finish Date: 9/22/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0		Hole abandoned with 3/8" bentonite chips					Asphalt
			BC-SB04-1-2				Slightly moist, gray, silty, very gravelly SAND (SW), fine to coarse sand
	10						Slightly moist, brown, slightly silty SAND (SP), trace gravel, fine to medium sand
5							Slightly moist to wet, gray, silty SAND (SM)
			BC-SB04-7.5-8.5				
10	5		BC-SB04-10.5-11.5				
							Medium stiff, wet, dark olive gray, slightly sandy SILT (ML). Occasional seashell fragments, scattered wood debris
	0		BC-SB04-14-15				
15							Bottom of boring at 15 feet, backfilled with bentonite chips.
20	-5						
	-10						

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 12

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	BC-SB05	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 14.5
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 3.25" core
Start/Finish Date: 9/22/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14.5	Hole abandoned with 3/8" bentonite chips						Asphalt	
		BC-SB05-0.5-1.5					Slightly moist, dark brown, slightly silty, gravelly SAND (SM)	
							Abundant brick and concrete debris	
							Moist to wet, brown, slightly silty to silty SAND (SW-SM); trace gravel, fine to coarse sand	
5 / 10								5
		BC-SB05-7.5-8.5					Becomes dark brown	
10 / 5								10
		BC-SB05-10.5-11.5					Wet, dark gray SAND (SP); trace silt, fine sand	
							Wet, dark gray, silty SAND (SM); coarse sand	
							Wet, dark gray, silty SAND to sandy SILT (SM-ML)	
							Trace gravel	
		BC-SB05-14-15					Trace wood	
15 / 0							Bottom of boring at 15'	15
20 / -5								20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 13

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB06	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core
Ground Surface Elev: 15.9
Depth to Water (ft BGS):
Start/Finish Date: 9/22/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0–1	15		Continuous Core				Concrete
1–5			No Recovery; Soil sample BC-SB06-4-5				Slightly moist, brown, gravelly, very silty SAND (SM); fine to coarse sand Medium bedded silt
5–10	10	Hole abandoned with 3/8" bentonite chips; Water Level (ATD)	Continuous Core; No Recovery; Soil sample BC-SB06-9-10				Slightly moist, dark brown, slightly sandy, very silty GRAVEL (GM); abundant wood and organics Abundant brick debris
10–15	5		Continuous Core; No Recovery; Soil sample BC-SB06-12-14				Wet, dark brown to gray, very silty, very gravelly SAND (SM); abundant wood Becomes dark gray
15–17	0		Continuous Core				Soft, wet, gray, slightly sandy SILT (ML); abundant wood and organics
17–17.5							Wood
17.5–19			Soil sample BC-SB06-17.5-18.5				Wet, dark gray, very silty, very gravelly SAND (SM-SW); fine to coarse sand Slight sheen Abundant wood, very sandy
19–20			Soil sample BC-SB06-19-20				Medium stiff, wet, dark olive gray, sandy SILT (ML); trace gravel, scattered wood & seashell fragments Bottom of boring at 20'
	-5						

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 14

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	BC-SB07	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 13.2
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 3.25" core
Start/Finish Date: 9/22/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Topsoil	
							Moist, dark brown, sandy, silty GRAVEL (GM), numerous organics	
10								
		BC-SB07-4-5					Soft, very moist, dark gray, slightly sandy, slightly gravelly SILT (ML), numerous organics, occasional wood debris	
5	Hole abandoned with 3/8" bentonite chips							5
5		BC-SB07-7.5-9.5					Brick debris	
							Grades to slightly sandy silt, scattered wood	
10								10
0		BC-SB07-13-14					Scattered seashell fragments	
15								15
		BC-SB07-16-17						
-5							Trace gravel	
20							Bottom of boring at 20'	20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 15

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB08	1 of 1

Project Name: Georgia Pacific West Site

Location: Bunker C Area / Bellingham, Washington

Driller/Method: Northwest Probe / Direct push soil probe

Sampling Method: 3.25" core

Ground Surface Elev: 15.9

Depth to Water (ft BGS):

Start/Finish Date: 9/22/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 15	Hole abandoned with 3/8" bentonite chips						Slightly moist, brown, very silty, very gravelly SAND (SM)	
		BC-SB08-4-5					Very thin bed of silt	
5 / 10							Moist, dark brown, very silty, very gravelly SAND (SM); fine to coarse sand	5
		BC-SB08-9-10					Brick	
10 / 5							Wet, brown, silty, very gravelly SAND (SM); fine to coarse sand, predominantly coarse	10
		BC-SB08-13-14						
15 / 0		BC-SB08-15.5-16.5					Becomes dark gray	15
							18" layer of wood	
		BC-SB08-18-19						
20 / -5							Bottom of boring at 20'	20

Sampler Type:

- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 16

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB09	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 12.2
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 1.5" core
Start/Finish Date: 3/25/2010

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0–1							Asphalt	
1–2			BC-SB09-1-2				Gravel	
2	10						Slightly moist, brown SAND (SP); medium sand	
3–4			BC-SB09-3-4					
5		Hole abandoned with 3/8" bentonite chips	BC-SB08-5-6					5
6							Moist, gray, silty, sandy GRAVEL (GW)	
7	5		BC-SB09-7-8				Wet, gray, silty SAND (SW); trace gravel, trace seashell fragments, fine to coarse sand	
9–10			BC-SB08-9-10					10
11							Layers of silt	
12	0							
13–15			BC-SB09-13-15					
15							Grades to very silty	15
17	-5							
18			BC-SB09-18-20				SILT and SAND (SM-ML); fine sand	
20							Bottom of boring at 20'	20
22	-10							

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 17

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB10	1 of 1

Project Name: Georgia Pacific West Site

Location: Bunker C Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev: 16.1

Depth to Water (ft BGS):

Start/Finish Date: 3/25/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0							Concrete	
15 (elev.)								
1.5							Moist, brown to gray SAND (SP); scattered seashell fragments	
5	Hole abandoned with 3/8" bentonite chips	BC-SB10-5-6						5
10 (elev.)								
~8							Wood	
9		BC-SB10-9-10					Moist to very moist, sandy SILT (ML); trace fine gravel, frequent wood fragments, coarse sand	
10								10
5 (elev.)								
13		BC-SB10-13-14					Oily sheen	
15		BC-SB10-15-16					Clayey	15
0 (elev.)		BC-SB10-16-17						
17							Wet, gray, silty, slightly gravelly SAND (SM); seashell fragments	
18		BC-SB10-18-19						
20							Bottom of boring at 20'	20
-5 (elev.)								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 18

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB11	1 of 1

Project Name: Georgia Pacific West Site

Location: Bunker C Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0–0.5						Asphalt	
0.5–3						Slightly moist, brown, silty, slightly gravelly, SAND (SM); fine to medium sand, fine angular gravel, trace rootlets	
3–6		BC-SB11-3-4				Moist, gray SAND (SW); fine to coarse sand, trace gravel, scattered building debris	
5	Hole backfilled with 3/8" bentonite chips						5
6–10.5		BC-SB11-6-7; BC-SB11-9-10				Wet, gray SILT (ML); trace coarse sand, trace fine gravel	10
10.5–12						Wet, gray SAND (SW); fine to coarse sand, abundant seashell fragments, trace silt	
12–13		BC-SB11-12-13				SILT (ML)	
13–20		BC-SB11-15-16; BC-SB11-18-19				Wet, gray, silty SAND (SM), fine sand, abundant seashell fragments, trace fine gravel	15
~18						Thin bed gravelly sand	
20						Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 19

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	BC-SB12	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Cascade/Pacific NW Probe & Drill / Air knife-vac/Direct push soil probe
Depth to Water (ft BGS)
Sampling Method: 1.5" core
Start/Finish Date 12/21/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0							Asphalt	
							Excavated by air knife to 7'.	
							Slightly moist, brown SAND (SW); fine to coarse sand, trace gravel	
		BC-SB12-3-4					Top of fiberglas pipe encountered. Boring abondoned, backfilled, moved ~3' to NE, and resumed.	
5	Hole backfilled with 3/8" bentonite chips							5
	▽	BC-SB12-6-7					Becomes wet	
							Wet, gray, slightly sandy, silty GRAVEL (GM)	
							Angular red brick debris	
		BC-SB12-9-10					Wet, gray, silty, gravelly SAND (SM) to silty, sandy GRAVEL (GM)	
10							Slight petroleum-like odor, slight sheen	10
		BC-SB12-12-13						
15								15
		BC-SB12-16-17						
							Bottom of boring at 17'	
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 20

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB13	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev

Location: Bunker C Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS)

Sampling Method: 1.5" core
Start/Finish Date 12/21/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							Excavation with air knife to 7'	
							Moist, brown SAND (SW); fine to coarse sand, trace gravel	
		BC-SB13-3-4						
5	Hole backfilled with 3/8" bentonite chips							5
		BC-SB13-6-7						
							Wood	
							Grades to gray	
		BC-SB13-9-10						
10								10
							Wet, gray, slightly sandy SILT (ML); trace organics	
		BC-SB13-12-13						
							Wet, very silty SAND (SM)	
		BC-SB13-14-15						
15								15
		BC-SB12-16-17					Abundant seashell fragments	
							Bottom of boring at 17'	
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 21

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB14	1 of 1

Project Name: Georgia Pacific West Site

Location: Bunker C Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 12/23/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Slightly moist to moist, silty, sandy GRAVEL (GW-GM); fine to coarse subangular gravel	
		BC-SB14-2-3						
5	Hole backfilled with 3/8" bentonite chips							5
		BC-SB14-6.5-7.5					Free, heavy petroleum-like product and sheen 6.5'-9'	
							Wet, gray, SILT (ML); interbedded with SAND (SP)	
		BC-SB14-8-9						
		BC-SB14-9-10					Wet, gray SAND (SP/SW); fine sand interbedded with poorly graded fine to coarse sand, scattered seashell fragments, scattered woody debris	
10								10
		BC-SB14-12-13					Petroleum-like odor and sheen 12'-16'	
15		BC-SB14-15-16						15
		BC-SB14-18-19						
20							Bottom of boring at 20'	20

Sampler Type:

- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 22

_GP_ENV BORING LOG GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	BC-SB15	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/23/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0							Asphalt	
							Gray, GRAVEL (GW); medium to coarse, angular gravel	
							Slightly moist, brown, SAND (SW); fine to coarse, subrounded to subangular sand, trace fine to medium gravel, scattered shell fragments	
		BC-SB15-2-3						
5	Hole backfilled with 3/8" bentonite chips							5
		BC-SB15-6.5-7.5						
							Wet, gray, SILT (ML)	
		BC-SB15-9-10						
10								10
							Wet, gray, silty SAND (SP-SM); fine sand to silty fine sand	
		BC-SB15-12-13						
							Wet, gray, silty SAND (SW-SM); fine to coarse sand	
							Wet, gray, silty, SAND (SP-SM); fine sand to silty fine sand, scattered shell fragments and woody debris	
15		BC-SB15-15-16						15
							Grades to wet, gray, silty SAND (SW-SM); fine to coarse sand	
		BC-SB15-18-19						
20							Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 23

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB16	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev

Location: Bunker C Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS)

Sampling Method: 1.5" core
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Building material debris	
							Moist, dark brown to dark gray, gravelly SAND (SW); fine to coarse sand	
		BC-SB16-3-4					Slightly moist, brown SAND (SP); poorly sorted fine to medium sand, trace gravel	
5	Hole backfilled with 3/8" bentonite chips						Slightly moist, dark brown to dark gray, silty SAND (SW); well-sorted fine to coarse sand, trace gravel	5
		BC-SB16-6-7					6" bed of silt	
							Slightly moist, gray, sandy SILT (ML); scattered seashell fragments	
		BC-SB16-9-10						
10		BC-SB16-10-11					Wet, brown to dark gray, silty SAND (SP); poorly graded, fine to medium sand	10
		BC-SB16-12-13						
							Wet, dark gray GRAVEL (GP); poorly graded, fine, subrounded gravel, trace sand, trace silt	
		BC-SB16-14-15						
15							Bottom of boring at 15'	15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: MAR

Approved by: SJG

Figure No. A- 24

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB17	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS)
Sampling Method: 1.5" core
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Concrete	
							Slightly moist, gray, red, and brown, gravelly SAND (SP); fine to medium sand	
		BC-SB17-3-4						
		BC-SB17-4-5						
5	Hole backfilled with 3/8" bentonite chips						Crushed concrete	5
							Moist, brown, silty SAND (SM)	
		BC-SB17-6-7					Moist, brown to black SAND (SP); fine to medium sand	
							Strong petroleum-like odor	
		BC-SB17-8-9		31.5				
		BC-SB17-9-10					Woody debris	
10							Refusal on wood at 10'. Bottom of boring at 10'	10
15								15
20								20

Sampler Type:
No Recovery
Soil sample
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MAR
Approved by: SJG
Figure No. A- 25

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB18	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Slightly moist, brown to white, trace silt to slightly silty SAND (SM); medium sand, scattered woody debris, scattered concrete rubble	
		BC-SB18-3-4		0			Woody debris	
5	Hole backfilled with 3/8" bentonite chips							5
		BC-SB18-6-7		0				
							Becomes moist and brown	
							Strong petroleum-like odor and sheen 9.0' to 13.5'	
		BC-SB18-9-10		0			Becomes wet	
10								10
		BC-SB18-12-13		0				
							Wet, gray, slightly sandy SILT (ML); trace rounded gravel	
		BC-SB18-14-15						
15							No petroleum-like odor or sheen 15'-20'	15
				0				
		BC-SB-18-19		0			Woody debris	
20							Bottom of boring at 20'	20

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level
Water Level (ATD)

Logged by: SJG
Approved by: SJG
Figure No. A- 26

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB19	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/22/2010

Borehole Completion: Hole backfilled with 3/8" bentonite chips (0–20 ft)

Depth / Elevation (feet)	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0					Slightly moist, brown to gray, silty, gravelly, SAND (SM); scattered building material debris	
3	BC-SB19-3-4				Concrete debris Becomes black	
5						5
6	BC-SB19-6-7					
7					Becomes wet, becomes dark gray	
9	BC-SB19-9-10					
10					Petroleum-like odor	10
12	BC-SB19-12-13				Crushed concrete and woody debris	
13.5					Wet, dark gray, gravelly, slightly sandy SILT (ML); gravel to 1.5" diameter Petroleum-like odor	
15						15
15.5					No recovery	
17	BC-SB19-17-18				Wet, gray, silty SAND (SM); scattered woody debris, abundant seashell fragments	
18					Building material debris	
19					No recovery	
20					Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 27

_GP_ENV BORING LOG GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	BC-SB20	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev:
Depth to Water (ft BGS):
Start/Finish Date: 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0						SW	Wet, brown, silty, gravelly SAND (SW); well-graded fine to coarse sand, subrounded to angular gravel	
5	Hole backfilled with 3/8" bentonite chips					GP	Wet, dark gray, sandy GRAVEL (GP); subrounded fine gravel, coarse sand, trace silt	5
		BC-SB20-7-8						
							Hit refusal on cobbles, moved hole over two feet	
10							Poor recovery	10
						GM	Becomes wet, dark gray to black, silty, sandy GRAVEL (GM); subrounded gravel 1/2" to 1 1/2" diameter	
15		BC-SB20-14.5-15				SM	Wet, dark gray to black, gravelly, silty SAND (SM); poorly graded fine sand, subrounded fine gravel, scattered woody debris	15
		BC-SB20-19-20						
20							Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: MAR
Approved by: SJG
Figure No. A- 28

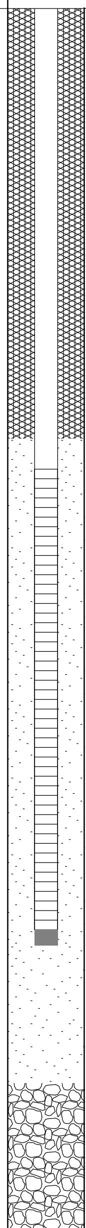
Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-VP01	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) not encountered
Start/Finish Date 2/2/2011



Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
	Hydrated bentonite crumbles						Moist, brown, gravelly SAND (SW); fine to coarse sand, trace silt	
1	3.4" diam Sch 40 PVC riser							1
	3/4" diam 0.010" slot Sch 40 PVC screen							
2								2
	10-20 sand							
3	Slip cap						Moist, gray, gravelly, very silty SAND (SM); fine to medium sand, abundant seashell fragments	3
	Slough							
4							Bottom of boring 4'	4

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MvdA
Approved by: SJG
Figure No. A- 29

_GP_MONITORING WELL GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	BC-VP02	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) not encountered
Start/Finish Date 2/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite crumbles						Asphalt	
							Moist, gray, gravelly SAND (SW); fine to coarse sand	
1	3.4" diam Sch 40 PVC riser							1
	3/4" diam 0.010" slot Sch 40 PVC screen							
2								2
	10-20 sand							
3	Slip cap						Moist, gravelly, silty SAND (SM); fine to medium sand	3
	Slough							
4							Bottom of boring at 4'	4

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MvdA
Approved by: SJG
Figure No. A- 30

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	BC-VP03	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS): not encountered
Start/Finish Date: 2/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite crumbles					GM	Moist, brown to gray, silty, sandy, GRAVEL (GM)	
1	3.4" diam Sch 40 PVC riser							1
	3/4" diam 0.010" slot Sch 40 PVC screen							
2	10-20 sand							2
3	Slip cap							3
	Slough						Bottom of boring at 3.6'	
4								4

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MvdA
Approved by: SJG
Figure No. A- 31

_GP_MONITORING WELL GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	BC-VP04	1 of 1

Project Name: Georgia Pacific West Site
Location: Bunker C Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) not encountered
Start/Finish Date 2/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite crumbles; 3.4" diam Sch 40 PVC riser						Concrete	
1							Moist, brown, gravelly SAND (SP); fine to medium sand, trace silt	1
2	3/4" diam 0.010" slot Sch 40 PVC screen; 10-20 sand							2
3	Slip cap							3
	Slough							
4							Bottom of boring at 4'	4

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MvdA
Approved by: SJG
Figure No. A- 32

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CF-MW01	1 of 1

Project Name: Georgia Pacific West Site
Location: Chemfix Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 12.51
Top of Casing Elev.: 12.21
Depth to Water (ft BGS): 2.18 - 3/30/2010
Start/Finish Date: 9/16/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Description
0		8" flush mount monument set in concrete	Asphalt
1		9/28/2009; 3/30/2010	Very stiff, moist, gray to brown, sandy, very gravelly SILT (ML); fine to coarse sand, fine to coarse gravel
2.5	10	3/4" sch 40 PVC riser	Occasional wood
5		3/8" bentonite chips	Very stiff, moist, gray, sandy, gravelly SILT (ML); fine to coarse sand, fine to coarse gravel
7	5		Very stiff, moist, mottled brown to gray, sandy, gravelly SILT (ML); trace iron oxide staining, trace organics, trace wood, fine to coarse sand, fine to coarse gravel
10			
11		10-20 silica sand	
12.5	0		
14		Prepacked screen, 0.020" slot, 3/4"	
15			6" bed of dark gray, fine, very sandy SILT (ML); with wood Becomes very moist Becomes brown
17		Threaded cap	Wet, dark gray, very silty SAND (SM); occasional wood, predominantly fine sand
17.5	-5		Stiff, very moist, sandy SILT (ML); frequent wood, thin beds of fine to very fine sand
19		3/8" bentonite chips	
20			Bottom of boring @ 20'
22.5	-10		

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 33

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CF-MW02	1 of 1

Project Name: Georgia Pacific West Site
Location: Chemfix Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 15.03
Top of Casing Elev.: 14.73
Depth to Water (ft BGS): 1.7 - 3/30/2010
Start/Finish Date: 9/16/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	5" flush-mount monument set in concrete						Asphalt	
	3/30/2010; 9/28/2009; 3/4" sch 40 PVC riser						Slightly moist, gray, silty, very gravelly SAND (SM); trace wood, grades to brown at 4'	
5 / 10	3/8" bentonite chips						Wet, gray, slightly sandy to silty GRAVEL (GM)	5
	10-20 silica sand							
10 / 5							Medium stiff, very moist, dark gray, slightly sandy, very silty gravel (GM); occasional wood, frequent organics, fine to coarse gravel	10
							Medium stiff, wet, gray, slightly sandy, very gravelly SILT (ML); trace wood	
	Prepacked screen, 0.020" slot, 3/4" ID						Wet, gray, silty, gravelly SAND (SM); fine to coarse sand, fine to coarse gravel, becomes slightly silty at 14' to 15'	
15 / 0	Threaded cap							15
							Bottom of boring 15.5'	
20 / -5								20

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 34

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-DS01	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Cascade / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 6/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0							Asphalt	
		CP-DS01-0-4					Medium dense, slightly moist, silty, sandy GRAVEL (GM/GW)	
3	▽						Medium dense, wet, gravelly SAND (SW), fine to coarse sand, with scattered organics	
5								5
6		CP-DS01-4-8					Medium dense, wet, gravelly, silty, SAND to sandy SILT (SP/SM)	
10								10
12		CP-DS01-8-12						
15								15
20								20

Sampler Type:
- ○ No Recovery
- ▮ Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 35

_GP_ENV BORING LOG GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-DS02	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Cascade / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 6/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0							Asphalt	
		CP-DS02-0-4					Medium dense, slightly moist, silty, sandy GRAVEL (GM/GW)	
5								5
							Medium dense, wet, gray SAND (SP/SM), fine to medium sand, trace silt	
		CP-DS02-4-8						
10								10
							Concrete (8") at 11 ft	
		CP-DS02-8-12						
15								15
20								20

Sampler Type:
No Recovery
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 36

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-DS03	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Cascade / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 6/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0							Asphalt	
							Medium dense, slightly moist, silty, sandy GRAVEL (GW), angular	
2		CP-DS03-0-4					Medium dense, wet, gray gravelly SAND (GW/SW)	
							scattered free-phase mercury present from 3.5 ft to 11 ft	
5							Medium dense, wet, silty, sandy GRAVEL (GW), angular	5
							Medium dense, wet, gray SAND (SP/SW) fine to medium sand with scattered gravel	
8		CP-DS03-4-8						
10								10
14		CP-DS03-8-12						
15								15
20								20

Sampler Type:

No Recovery

Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 37

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	CP-DS04	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Cascade / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 6/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							Medium dense, slightly moist, brown/gray, silty, sandy GRAVEL (GW), angular	
		CP-DS04-0-4					Grades to very silty GRAVEL (GM)	
5								5
							Medium dense, wet, gray, silty SAND (SP/SM), fine to medium sand	
		CP-DS04-4-8					Grades to slightly silty GRAVEL (GW/GM)	
10								10
							Medium dense, wet, gray SAND (SP), fine to medium	
		CP-DS04-8-12						
15								15
20								20

Sampler Type:

No Recovery

Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 38

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-DS05	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Cascade / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev:

Depth to Water (ft BGS):

Start/Finish Date: 6/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0		CP-DS05-0-4				Asphalt
						Medium dense, slightly moist, dark gray, silty, sandy GRAVEL (GW) "bar gravel fill"
						Concrete at 10-inches, 6-inches thick
	Water Level (ATD)					Gray, very silty GRAVEL to very gravelly SILT (GW/GM), wet at 3 ft.
5						Gray, very sandy GRAVEL (GW), trace silt
						Medium stiff, gray, gravelly SILT (ML)
		CP-DS05-4-8				Medium dense, wet, dark gray, SAND (SP) fine sand, with organics visible free-phase mercury at 7.5 ft
						Medium stiff to soft, gray-brown SILT with abundant organics (ML/OL), adundant visible free-phase mercury.
10						Grades to stiff, gray SILT (ML), abundant mercury visible in sleeve. No mercury visible in push-cap
						Medium dense, wet, gray and black (bedded) SAND (SP), with organics.
		CP-DS05-8-12				
15						
20						

Sampler Type:
- No Recovery
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 39

Boring Log

Project Number	Boring Number	Sheet
070188	CP-DS06	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Cascade / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 6/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							Medium dense, slightly moist, dark gray, slightly silty, sandy GRAVEL (GW) "bar gravel fill"	
		CP-DS06-0-4					Concrete at 10-inches, 6-inches thick	
	▽						Gray GRAVEL (GW), wet at 3 ft.	
5							Grades to gray, very silty GRAVEL to gravelly SILT (GM/ML)	5
		CP-DS06-4-8					Medium dense, wet, gray/black SAND (SW), fine to coarse sand, with organics	
							Medium dense, wet, dark gray, very silty SAND (SW/ML) fine to coarse sand	
10							Grades to medium stiff to soft, gray-brown SILT (ML/OL) with abundant brown organics (sawdust).	10
							Medium dense, wet, dark gray/black SAND (SP), with organics (layered).	
		CP-DS06-8-12						
15								15
20								20

Sampler Type:
No Recovery
Soil sample

PID - Photoionization Detector (Headspace Measurement)
▼ Static Water Level
▽ Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 40

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-DS07	1 of 1

Project Name: Georgia Pacific West Site

Ground Surface Elev

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Cascade / Direct push soil probe

Depth to Water (ft BGS)

Sampling Method: 1.5" core

Start/Finish Date 6/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							medium dense, slightly moist, dark gray, silty, sandy GRAVEL (GW)	
							concrete at 17" below ground surface (8" thick).	
		CP-DS07-0-4					Medium dense, wet, gray/brown solty, sandy GRAVEL (GW) (fill)	
5							Medium dense, wet, gray, slightly silty SAND (SW), fine to coarse sand	5
							Medium dense, wet, black, organic to slightly organic SILT (OL/ML)	
		CP-DS07-4-8					Medium dense, wet, gray, silty, sandy GRAVEL (GW)	
10							Medium dense, wet, slightly silty SAND (SW), fine to medium sand, scattered coarse sand and fine gravel with organics (layered); trace shell fragments	10
		CP-DS07-8-12						
15								15
20								20

Sampler Type:

No Recovery

Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 41

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-DS08	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Cascade / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 6/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							medium dense, slightly moist, dark gray/brown, slightly silty, sandy GRAVEL (GW)	
		CP-DS08-0-4					concrete at 16" below ground surface (18" thick).	
	▽						Stiff, wet, gray ti brown SILT (ML)	
5							Stiff, wet, gray ti brown SILT (ML), with trace coarse gravel to silty GRAVEL (GM)	5
							Medium dense, wet,dark gray to brown, fine SAND (SP); fine sand with organics	
		CP-DS08-4-8					Medium stiff to soft, wet, gray SILT (ML); with black and brown organics	
10							Medium dense, wet, dark gray to black SAND (SW), fine to coarse sand with layered organics.	10
		CP-DS08-8-12						
15								15
20								20

Sampler Type:
- No Recovery
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 42

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-DW1	1 of 2

Project Name: Georgia Pacific West Site
Location: Bellingham, Washington
Driller/Method: Holt Drilling / Cable tool
Sampling Method: 2" ID X 2.5" OD split spoon / Hammer Weight: 300 lb jars / Hammer Drop: 36", sand line

Ground Surface Elev: 15.7
Top of Casing Elev.: 15.48
Depth to Water (ft BGS): 10.5
Start/Finish Date: 6/21/2011-6/24/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 15	12"-diam. monument flush-mounted in concrete						Asphalt.	
							Moist, slightly brown, silty, sandy GRAVEL (GM).	
	Bentonite grout 1.5'-26'							
5 / 10	6/24/2011 (Water Level ATD)	Split spoon						5
	6" ID Sch 40 PVC riser, flush threaded, 0'-28'							
10 / 5	Static Water Level	Split spoon					Loose, wet, brown, slightly gravelly, silty SAND (SM); coarse sand.	10
		Split spoon					Medium dense, dark gray, very silty; fine to medium sand.	
15 / 0		Split spoon					Very dense, wet, dark gray, slightly gravelly SAND (SW); trace silt; fine to coarse sand.	15
	16"-diameter casing driven to 19', then 12" casing driven to depth, annulus sealed with bentonite	Split spoon					Stiff, wet, gray SILT (ML); trace sand; scattered wood and organics.	
20 / -5		Split spoon					Loose, wet, gray SAND (SP); fine to medium sand; abundant seashell fragments; thin silt lamina.	20
25 / -10		Split spoon					Loose, wet, dark gray, silty SAND (SM); fine to coarse sand; abundant seashell fragments.	25
	10/20 sand filter pack 26'-50.5'							

Sampler Type:
- No Recovery
- Split Spoon Sampler

PID - Photoionization Detector (Headspace Measurement)

- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: MvdA
Approved by: SJG
Figure No. A- 43

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.7
Location:	Bellingham, Washington	Top of Casing Elev.	15.48
Driller/Method:	Holt Drilling / Cable tool	Depth to Water (ft BGS)	10.5
Sampling Method:	2" ID X 2.5" OD split spoon / Hammer Weight: 300 lb jars / Hammer Drop: 36" / sand line	Start/Finish Date	6/21/2011-6/24/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
-15							Medium dense, wet, gray, slightly silty SAND (SW-SM); fine to coarse sand; abundant seashell fragments.	
35 / -20	6" ID stainless steel .030"-slot screen, welded connection 28'-48'						Dense, wet, gray, slightly silty SAND (SP-SM); fine to medium sand; abundant seashell fragments.	35
40 / -25							Loose, wet, gray SAND (SP); trace silt; fine to medium sand; abundant seashell fragments.	40
45 / -30							Dense, wet, gray SAND (SW); fine to coarse sand; abundant seashell fragments.	45
							Dense, wet, gray SAND (SP); fine to medium sand; abundant seashell fragments.	
	Centralizers							
							Dense, wet, gray SAND (SW); fine to coarse sand; abundant seashell fragments; scattered woody debris.	
50							Hard, wet, gray-brown, clayey SILT (ML-MH); medium plasticity; medium toughness.	50
-35							Dense, wet, gray SAND (SP); fine sand; trace silt; abundant seashell fragments.	
							Bottom of boring at 50.5 feet.	
							* "N" values are not equivalent to SPT values.	
55 / -40								55

Sampler Type:
- No Recovery
- Split Spoon Sampler

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 43

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW01	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 14.72
Top of Casing Elev.: 14.42
Depth to Water (ft BGS): 5.05 - 3/30/2010
Start/Finish Date: 9/22/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	8" flush mount monument set in concrete						Asphalt	
							Moist, dark brown, slightly gravelly, silty SAND (SM); topsoil and organics	
	soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MW01-V	CP-MW01-2-3	Total Hg				Moist, dark gray, gravelly, very silty SAND (SM); occasional wood, occasional organics, fine to medium sand	
	2" sch 40 PVC riser							
5 / 10	3/30/2010						Medium stiff, very moist to wet, dark gray to dark brown, slightly sandy SILT (ML); trace gravel, frequent organics	5
	9/28/2009							
	3/8" bentonite chips							
	10-20 silica sand		Soil pH=8.2 Soil pH=8.1				Abundant wood	
10 / 5			Soil pH=8.1 Soil pH=8.0					10
	2" sch 40 PVC 0.020" slot screen		Soil pH=7.9					
			Soil pH=8.3					
							Abundant wood	
		CP-MW01-14-15	Soil pH=9.6 Total Hg				Wet, dark gray, slightly silty SAND (SP-SM); fine to medium sand	
15 / 0	Slip cap		Soil pH=9.4				Stiff, wet, dark olive gray, slightly sandy SILT (ML); occasional wood, occasional very thin silty sand interbeds Frequent seashells	15
			Soil pH=8.0					
			Soil pH=8.2					
	10-20 silica sand							
20 / -5							Bottom of boring at 20'	20
-10								

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 44

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW02	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 12.67
Top of Casing Elev.: 12.37
Depth to Water (ft BGS): 4.79 - 3/30/2010
Start/Finish Date: 9/16/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 12.67	8" flush mount monument set in concrete						Asphalt	
1.5–2.5 / 10	soil vapor probe screeened 1.5-2.5' BGS, 3/4" PVC riser, CP-MW02-V	CP-MW02-1.5-2.5	Total Hg				Moist, brown, silty, gravelly SAND (SM); fine to coarse gravel, fine to coarse sand Becomes gray	
	3/4" sch 40 PVC riser						Medium stiff, moist, dark gray, slightlty sandy, gravelly SILT (ML); frequent wood Becomes sandy	
5	3/30/2010 9/28/2009 3/8" bentonite chips						Stiff, very moist to wet, gray, slightly gravelly, slightly sandy to sandy SILT (ML); with very thin interbeds of sand, fine to medium sand	5
/ 5			Soil pH=8.4 Soil pH=8.1 Soil pH=8.4				Occasional seashell fragment, trace wood.	
10	10-20 silica sand	CP-MW02-10-12	Soil pH=8.2 Total Hg				Wet, gray, very gravelly, very silty SAND (SM); occasional wood, fine to coarse sand Becomes very sandy silt	10
/ 0	0.020" slot prepacked screen		Soil pH=8.9 Soil pH=8.2 Soil pH=9.6 Soil pH=8.3				Hard, wet, slightly sandy SILT (ML); trace gravel, trace wood	
15	Threaded cap						Bottom of boring at 15'	15
/ -5								
20								20
/ -10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 45

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW03	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 15.15
Top of Casing Elev.: 14.85
Depth to Water (ft BGS): 1.39 - 3/30/2010
Start/Finish Date: 9/15/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0	15	8" flush mount monument set in concrete; ▼ 3/30/2010					Moist, brown, sandy, silty GRAVEL (GM); occasional wood, occasional organics	
		2" sch 40 PVC riser	CP-MW03-1.5-2.5	Total Hg				
		▼ 9/28/2009						
			CP-MW03-4-5	Dioxin			Becomes gray	
5	10	3/8" bentonite chips						5
		▽					Iron oxide staining	
							Wet, dark gray, slightly silty, sandy GRAVEL (GW); fine to coarse sand, predominantly coarse, fine to coarse gravel	
10	5	10-20 silica sand						10
		2" sch 40 PVC 0.020" slot screen	CP-MW03-13-15	Soil pH=8.1; Soil pH=9.5; Total Hg; Soil pH=8.7			Stiff, wet, dark gray, slightly gravelly, sandy SILT (ML); fine to coarse sand, predominantly fine to medium	
							Very moist to wet, gray to dark gray, silty, very sandy GRAVEL (GM)	
15	0	Slip cap						15
							Bottom of boring at 16'	
20	-5							20

Sampler Type:
- ○ No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 46

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW04	1 of 2

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / HSA, Sonic
Sampling Method: 10.25" HSA to 20.5, 8" Sonic to 40'

Ground Surface Elev: 15.22
Top of Casing Elev.: 14.92
Depth to Water (ft BGS): 7.5 - 3/30/2010
Start/Finish Date: 9/17/2009-9/21/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
	15	8" flush mount monument set in concrete					Loose, brown, slightly silty, sandy GRAVEL (GP)	
		Bentonite-cement grout	CP-MW04-2.5-4	Soil pH=8.7, total Hg			Stiff, moist, light brown, sandy SILT (ML); trace gravel	
5	10		CP-MW04-5-6.5	Soil pH=8.5, total Hg			Loose, wet, dark gray, slightly sandy GRAVEL (GP)	5
		3/30/2010; 2" Sch 40 PVC riser; 9/28/2009	CP-MW04-7.5-9	Soil pH=9.6, total Hg			Loose, wet, dark gray, slightly silty SAND (SM); fine to medium sand	
10	5		CP-MW04-10-11.5	Soil pH=9.6, total Hg			Loose, wet, gray, slightly gravelly SAND (SP); trace organics, trace roots, fine gravel, fine to medium sand	10
			CP-MW04-12.5-14	Soil pH=9.8, total Hg			Dense, wet, gray, slightly gravelly to gravelly SAND (SW); trace seashell fragments, trace wood, gravel to 2" diameter, fine to coarse sand	
15	0		CP-MW04-15-16.5	Soil pH=9.6, total Hg			Medium dense, wet, dark gray, slightly gravelly SAND (SW); trace seashell fragments, trace wood, fine to coarse sand	15
			CP-MW04-17.5-19	Soil pH=8.5, total Hg			Medium stiff, wet, olive gray, clayey SILT (ML); trace sand, with organics, wood, and seashell fragments	
20	-5						Wet, dark gray, gravelly SAND (SW); gravel to 2" diameter, fine to coarse sand	20
							Very thin bed organic silt	
			CP-MW04-22-23	Total Hg			Wet, trace to slightly silty, gravelly SAND (SP/SW); abundant seashell fragments	
							Wet, dark gray SAND (SP); trace gravel, abundant seashell fragments	

Sampler Type:
- No Recovery
- 3.25" OD Split-Spoon Ring Sampler
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: RRH
Approved by: SJG
Figure No. A- 47

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW04	2 of 2

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / HSA, Sonic
Sampling Method: 10.25" HSA to 20.5, 8" Sonic to 40'

Ground Surface Elev: 15.22
Top of Casing Elev.: 14.92
Depth to Water (ft BGS): 7.5 - 3/30/2010
Start/Finish Date: 9/17/2009-9/21/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
-10								
	3/8" bentonite chips	CP-MW04-26-27	Total Hg					
	10-20 silica sand							
30 / -15		CP-MW04-30-31	Total Hg				Wet, dark gray, slighly silty to silty SAND (SM); hydrogen-sulfide-like odor, abundant seashell fragments, fine to medium sand Medium bed of fine to coarse salt-&-pepper sand	30
							Wet, dark gray, slightly silty to silty SAND (SM); trace seashells, trace wood	
	2" Sch 40 0.010" slot screen							
		CP-MW04-34-35	Total Hg					
35 / -20							Wet, dark gray SAND (SP); salt-and-pepper appearance, fine to coarse, predominantly medium	35
							Wet, gray, silty SAND (SM); abundant seashell fragments, fine to medium sand	
		CP-MW04-38-39	Total Hg					
40 / -25	Slip cap						Bottom of boring at 40'	40
45 / -30								45

Sampler Type:
- No Recovery
- 3.25" OD Split-Spoon Ring Sampler
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: RRH
Approved by: SJG
Figure No. A- 47

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MW05	1 of 2

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.27
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	14.97
Driller/Method:	Northwest Probe / HSA, Sonic	Depth to Water (ft BGS)	7.6 - 3/30/2010
Sampling Method:	10.25" HSA to 21.5, 8" Sonic to 40'	Start/Finish Date	9/17/2009-9/21/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 15	8" flush mount monument set in concrete					GM	Moist, brown to gray, sandy, silty GRAVEL (GM); occasional wood and organics	
2.5	Bentonite-cement grout	CP-MW05-2.5-4	Total Hg			SW	Very dense, brown, very gravelly SAND (SW); trace silt, fine to coarse sand	
5 / 10	2" sch 40 PVC riser	CP-MW05-5-6.5	Soil pH=8.5, Total Hg			GP	Medium dense, wet, brown, sandy GRAVEL (GP); fine gravel, fine to coarse sand	5
7.6	3/30/2010	CP-MW05-7.5-9	Soil pH=8.6, Total Hg					
9	9/28/2009							
10 / 5		CP-MW05-10-11.5	Soil pH=7.9, Total Hg			GW	Medium dense, wet, brown, sandy GRAVEL (GW); gravel to 3" diameter, coarser gravel coated in black silt	10
12.5		CP-MW05-12.5-14	Soil pH=8.6, Total Hg					
15 / 0		CP-MW05-15-16.5	Soil pH=8.7, Total Hg					15
17.5		CP-MW05-17.5-19	Soil pH=8.9, Total Hg				Trace wood	
20 / -5		CP-MW05-20-21.5	Soil pH=8.3, Total Hg			OH	Medium stiff, wet, olive gray, clayey SILT (OH); with wood and organics	20
21.5						SP	Wet, dark gray SAND (SP); trace gravel, seashell fragments and wood	
22		CP-MW05-22-23	Soil pH=7.7, Total Hg				Thin bed brown organic silt	
24						SM	Wet, dark gray, trace to slightly silty SAND (SM); trace seashell fragments, trace wood, occasional silt laminae	

Sampler Type:
- No Recovery
- 3.25" OD Split-Spoon Ring Sampler
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: RRH

Approved by: SJG

Figure No. A- 48

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MW05	2 of 2

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / HSA, Sonic
Sampling Method: 10.25" HSA to 21.5, 8" Sonic to 40'

Ground Surface Elev: 15.27
Top of Casing Elev.: 14.97
Depth to Water (ft BGS): 7.6 - 3/30/2010
Start/Finish Date: 9/17/2009-9/21/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
-10								
		CP-MW05-26-27	Total Hg					
							Very thin bed of organic silt	
							Wet, dark gray, SAND (SP); medium to coarse sand	
	3/8" bentonite chips						Wet, dark gray SAND (SP); trace seashell fragments, fine to medium sand with interbeds of coarse sand	
30 / -15	10-20 silica sand	CP-MW05-30-31	Total Hg					30
	2" Sch 40 PVC 0.010" slot screen							
		CP-MW05-34-35	Total Hg				Dark gray, slightly silty to silty SAND (SM); trace wood, abundant seashell fragments	
35 / -20								35
		CP-MW05-38-39	Total Hg					
	Slip cap						Medium bed of medium to coarse sand	
40 / -25							Bottom of boring at 40'	40
45 / -30								45

Sampler Type:
- No Recovery
- 3.25" OD Split-Spoon Ring Sampler
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: RRH
Approved by: SJG
Figure No. A- 48

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW06	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 15.69
Top of Casing Elev.: 15.39
Depth to Water (ft BGS): 2.7 - 3/30/2010
Start/Finish Date: 9/16/2009

Borehole Completion:
- 8" flush mount monument set in concrete
- 3/4" sch 40 PVC riser
- 3/30/2010 (static water level)
- 9/28/2009 (static water level)
- soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MW06-V
- 3/8" bentonite chips
- 10-20 silica sand
- Prepacked screen, 0.020" slot
- Threaded cap
- 10-20 silica sand

Sample Type/ID: CP-MW06-1-2; CP-MW06-13-15

Tests: Total Hg; Soil pH=8.3; Soil pH=8.3; Soil pH=8.3; Soil pH=8.9; Soil pH=9.4; Soil pH=9.3; Total Hg; Soil pH=9.4; Soil pH=9.5; Soil pH=9.5; Soil pH=9.5; Soil pH=9.2; Soil pH=7.8; Soil pH=8.1

Depth / Elevation (feet): 5 / 10; 10 / 5; 15 / 0; 20 / -5 (elevation 15 at top)

Description:

- Asphalt
- Slightly moist, brown, sandy, very silty GRAVEL (GM)
- Slightly moist, brown, silty SAND (SM); trace gravel
- Medium stiff, moist, dark gray, sandy, very gravelly SILT (ML)
- Wood
- Medium stiff, very moist, dark gray, slightly gravelly, slightly sandy SILT (ML); frequent organics, frequent wood
- Wet, olive gray, slightly gravelly, very silty SAND (SM); occasional wood, occasional seashell
  - Thin bed of silt
  - Medium bed of very sandy silt
  - Trace gravel
  - Becomes silty, fine to medium sand
- Medium stiff, wet, dark gray to gray SILT (ML); trace sand, occasional organics, occasional wood
- Bottom of boring at 20'.

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 49

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MW07	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	12.98
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	12.98
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	6.25 - 3/30/2010
Sampling Method:	1.5" core	Start/Finish Date	3/26/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 12.98	8" flush mount monument set in concrete						Asphalt	
1	3/4" sch 40 PVC riser	Continuous Core					Silty, gravelly SAND (SM)	
2.5 / 10							Moist, brown/gray SAND (SP); trace silt, fine to medium sand	
5	3/8" bentonite chips							5
6.25	3/30/2010	No Recovery						
8 / 5		Continuous Core						
9							Concrete debris	
10		No Recovery					Wet, gray slightly silty SAND (SP); with seashell fragments, fine to medium sand	10
11	10-20 silica sand							
12 / 0		Continuous Core						
14	Prepacked screen, 0.020" slot							
15							Silt (ML)	15
15.5							Dark gray to black, silty SAND (SW); with gravel, fine to coarse sand	
17	Threaded cap							
18 / -5	Slough	No Recovery					Grades to very silty fine sand	
20							Bottom of boring at 20'	20
-10								

Sampler Type:
- No Recovery
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 50

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW08	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev: 13.41
Top of Casing Elev.: 13.11
Depth to Water (ft BGS): 4.4 - 3/30/2010
Start/Finish Date: 3/30/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	8" flush mount monument set in concrete						Asphalt	
	3/4" sch 40 PVC riser						Slightly moist, brown to gray, silty, sandy GRAVEL (GM); gravel is crushed rock	
10								
	3/30/2010							
5							Moist, gray, SAND (SP); trace silt, seashell fragments, fine to medium sand	5
	3/8" bentonite chips		Soil pH=7.0					
			Soil pH=7.3					
			Soil pH=7.5					
			Soil pH=7.5					
5			Soil pH=7.4					
			Soil pH=7.3					
			Soil pH=7.5					
10			Soil pH=7.2					10
	10-20 silica sand		Soil pH=7.7					
							Very thin silty bed	
			Soil pH=7.6					
	Prepacked screen, 0.020" slot		Soil pH=7.5					
0								
			Soil pH=7.5					
			Soil pH=7.6				Sandy SILT and silty SAND (SP/ML)	
15	Slip cap		Soil pH=7.8					15
			Soil pH=7.5					
			Soil pH=7.4					
			Soil pH=7.9					
-5	10-20 silica sand						Wet, gray, very silty SAND (SM); fine to coarse sand	
			Soil pH=7.6					
20			Soil pH=7.7				Bottom of boring at 20'	20
-10								

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

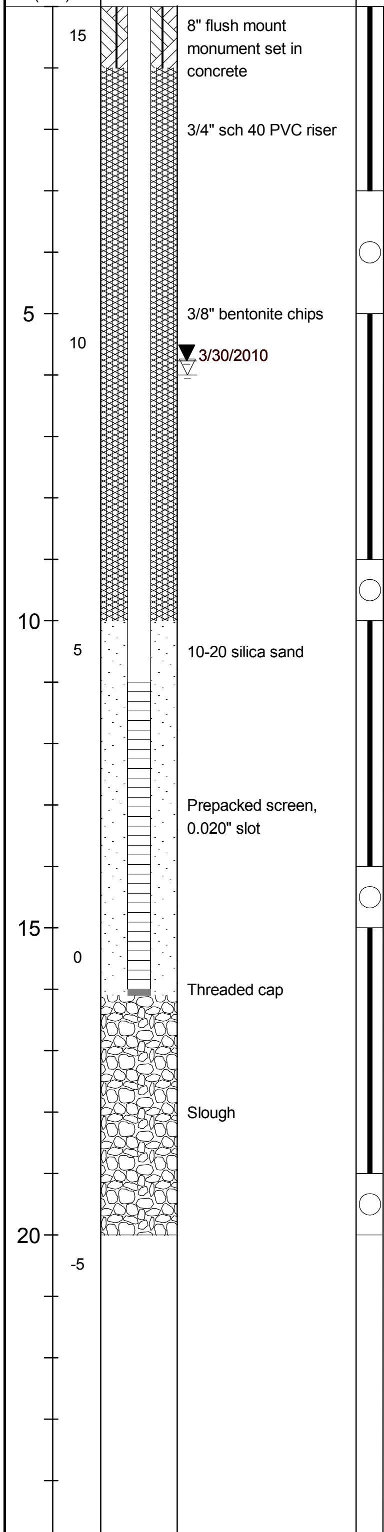
Logged by: JWC
Approved by: SJG
Figure No. A- 51

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MW09	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.47
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	15.17
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	5.77 - 3/30/2010
Sampling Method:	1.5" core	Start/Finish Date	3/30/2010



Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
				Asphalt	
				Moist, slightly silty, slightly gravelly SAND (SW); fine to coarse sand	
				Slightly moist, gray-brown SILT (ML)	
				Very moist, slightly gravelly SAND (SW); fine to coarse sand	5
Soil pH=7.7 Soil pH=7.6 Soil pH=7.5				Wet, gray to black, very silty SAND (SP/ML); fine to medium sand Grades to silt	
Soil pH=8.6 Soil pH=7.6 Soil pH=7.6 Soil pH=7.8				Wet, gray SAND (SP/SW); with seashell fragments, fine to coarse sand	10
Soil pH=7.6				Fine sand, silt, and sawdust (FILL)	
Soil pH=8.1 Soil pH=9.3 Soil pH=10.0 Soil pH=9.8				Wet, gray SAND (SP/SW); with seashell fragments, fine to coarse sand	15
Soil pH=9.8 Soil pH=8.8 Soil pH=8.0 Soil pH=7.4				Wet SAND and SILT (SP/ML); abundant organics, fine sand	
				Bottom of boring at 20'	20

Sampler Type:
- ○ No Recovery
- ▮ Continuous Core

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 52

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW10	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev: 13.15
Top of Casing Elev.: 12.85
Depth to Water (ft BGS): 2.69 - 3/30/2010
Start/Finish Date: 3/24/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	8" flush mount monument set in concrete; 3/4" sch 40 PVC riser					GM	Slightly moist to moist, gray, slightly silty, sandy GRAVEL (GM); scattered wood fragments	
2 / 10	3/30/2010 (static water level); 3/8" bentonite chips					SM	Moist, gray, silty, gravelly SAND (SM) Iron oxide staining	
5							Becomes olive gray	5
	10-20 silica sand (water level ATD)						Becomes wet	
	Prepacked screen, 0.020" slot						Red brick fragments	
5			Soil pH = 7.1					
10			Soil pH = 6.9				Wood debris	10
							Becomes mottled green gray, red brick fragments	
	Threaded cap		Soil pH = 7.2				Refusal at 12'.	
0								
15								15
-5								
20								20
-10								

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MvdA
Approved by: SJG
Figure No. A- 53

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MW11	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.55
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	15.25
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	4.15 - 3/30/2010
Sampling Method:	1.5" core	Start/Finish Date	3/24/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
15	8" flush mount monument set in concrete						Asphalt	
	3/4" sch 40 PVC riser						Moist, light to dark gray, slightly silty, sandy GRAVEL (GM); medium to coarse sand, fine gravel	
	3/30/2010							
5 / 10	3/8" bentonite chips		Soil pH = 9.2					5
			Soil pH = 7.8				Wet, gravelly, sandy SILT (ML); scattered organics, fine gravel, fine to coarse sand Wood debris	
	10-20 silica sand		Soil pH = 8.5				Clayey, black laminae	
10 / 5			Soil pH = 7.7 Soil pH = 7.2					10
	Prepacked screen, 0.020" slot						NO RECOVERY	
15 / 0	Threaded cap							15
			Soil pH = 7.5 Soil pH = 7.5				Wet, brown to dark gray, slightly sandy SILT (ML); trace fine gravel, abundant organics, fine to coarse sand	
	Slough		Soil pH = 7.5				Becomes black, gravelly and sandy	
			Soil pH = 9.0					
20 / -5			Soil pH = 8.2				Bottom of boring at 20'	20

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)

Static Water Level
Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 54

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW12	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Air knife + Vactor truck
Sampling Method: none

Ground Surface Elev: 13.13
Top of Casing Elev.: 12.77
Depth to Water (ft BGS): 5.1 - 3/30/2010
Start/Finish Date: 3/25/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	8" flush mount monument set in concrete						Asphalt	
	3/4" sch 40 PVC riser						Slightly moist, brown, silty sandy GRAVEL (GM); fill.	
10 (elev.)	3/8" bentonite chips							
5	3/30/2010						Very moist	5
	10-20 silica sand						Caving	
							Wet, gray SAND (SP); fine to medium sand, scattered seashell fragments	
5 (elev.)	Prepacked screen, 0.020" slot							
10								10
	Threaded cap						Bottom of boring at 11.5'	
0 (elev.)								
15								15
-5 (elev.)								
20								20
-10 (elev.)								

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 55

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW13	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 14.32
Depth to Water (ft BGS): 3.0 ATD
Start/Finish Date: 12/16/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
	8" flush mount monument set in concrete					Asphalt	
						Slightly moist, gray silty, sandy GRAVEL (GW/GM); fill	
		CP-MW13-1-2	Total Hg			Slightly moist, brown, slightly gravelly SAND (SW); fine to coarse subrounded sand, fine to coarse subrounded gravel, trace silt, trace organics (wood fragments) 1'-2'	
		CP-MW13-2-3	Total Hg			3" bed brown silt	
						Becomes wet	
	3/4" Sch 40 PVC riser						
		CP-MW13-4-5	Total Hg		8.5		
5							5
	3/8" bentonite chips						
						Wet, gray, GRAVEL (GP); fine to coarse subrounded gravel trace slightly subangular gravel, trace sand	
		CP-MW13-8-9	Total Hg		8.5		
10							10
	10-20 silica sand				8.5	Wet, gray, slightly gravelly SAND (SW); fine to coarse subrounded sand, trace silt, pred. fine to medium subrounded gravel	
	Prepacked screen, 0.020" slot	CP-MW13-12-14	Total Hg				
15							15
	Threaded cap	CP-MW13-15-16	Total Hg		9.1	Wet, gray SILT (ML); trace fine, black organics, woodchips/sawdust	
					8.4		
	Slough				8.7		
					8.3		
					8.4	Wet, gray fine SAND (SP); trace organics and shell fragments, grades to medium sand	
20						Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JWC/MAR

Approved by: SJG

Figure No. A- 56

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW14	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 16.14
Depth to Water (ft BGS): 5 ATD
Start/Finish Date: 12/21/2010

Borehole Completion

- 8" flush mount monument set in concrete
- 3/8" bentonite chips
- 3/4" Sch 40 PVC riser
- 10-20 silica sand
- Prepacked screen, 0.020" slot
- Threaded cap
- Slough

Samples

Sample Type/ID	Tests
CP-MW14-3-4	Total Hg
CP-MW14-5-6	Total Hg
CP-MW14-8-9	Total Hg
CP-MW14-14-15	Total Hg
CP-MW14-17-18	Total Hg

Soil pH (top to bottom): 10.2, 10.3, 8, 8, 7.8, 8.4, 8.6, 8.5, 9.5, 9.2, 9.3, 9.4, 9.2, 9.2, 9.1, 9.1

Description

- Asphalt
- Concrete and debris
- Moist, gray, silty, sandy GRAVEL (GM)
- Wet, dark gray, SILT (ML) with organics
- Woody debris
- Wet, brown-gray sandy SILT (ML); with organics
- Woody debris
- Wet, gray SAND (SP); fine sand
- grades to sandy SILT (ML)
- SAND (SP); fine sand
- gray SILT (ML)
- Bottom of boring at 18'

Depth (feet): 5, 10, 15, 20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 57

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MW15	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 15.62
Depth to Water (ft BGS): 5 ATD
Start/Finish Date: 12/20/2010

Borehole Completion

- 8" flush mount monument set in concrete
- 3/8" bentonite chips
- 3/4" Sch 40 PVC riser
- 10-20 silica sand
- Prepacked screen, 0.020" slot
- Threaded cap
- Slough

Samples

Sample Type/ID	Tests
CP-MW15-4-5	Total Hg
CP-MW15-6-7	Total Hg
CP-MW15-8-9	Total Hg
CP-MW15-10-11	Total Hg
CP-MW-12-14	Total Hg

Soil pH

Depth (ft)	Soil pH
5	11.8
6	11.8
7	12.3
8	12.2
9	11.6
10	10.4
11	11.2
12	10.8
13	11.9
14	11.5
15	11.4
16	10.5
17	11.6
18	11.3
19	9.9
20	9.9

Description

Concrete

Slightly moist, gray to brown, gravelly SAND (SW); trace silt, well-graded fine to coarse sand, visible elemental Hg

Visible elemental Hg 5'-8'.

Discoloration, sand becomes siltier

Slightly moist, dark gray, SILT (ML); trace fine sand, trace clay, scattered woody debris, thin beds siltly, fine sand

Woody debris

Wet, gray SAND (SW); trace silt, trace gravel, scattered woody debris

Very moist, dark gray, sandy SILT (ML); scattered woody debris

Moist, gray, gravelly SAND (SP); trace silt, fine to medium sand

Becomes siltier with depth

Wet, gray, SILT (ML); scattered woody debris

Bottom of boring at 20'.

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: MAR/Mv
Approved by: SJG
Figure No. A- 58

Monitoring Well Construction Log

Aspect Consulting	Project Number	Well Number	Sheet
	070188	CP-MWA1	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	14.46
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	14.16
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	4.14 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/21/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0		8" flush mount monument set in concrete					Asphalt	
							Slightly moist, dark gray, silty, sandy GRAVEL (GM).	
		3/4" Sch 40 PVC riser						
		Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWA1-V	CP-MWA1-2-3	Total Hg			Slightly moist, dark gray, slightly gravelly SAND (SW); trace silt, scattered seashell fragments, fine gravel, fine to coarse sand	
		3/30/2010						
5	10							5
		9/28/2009						
		3/8" bentonite chips						
				Soil pH=9.1			Wet, dark gray SAND (SP); trace silt, abundant seashell fragments, fine to medium sand	
				Soil pH=9.2				
				Soil pH=9.1				
	5			Soil pH=8.9			Coarse sand	
10				Soil pH=9.0			Abundant woood	10
		10-20 silica sand		Soil pH=8.6			Wet, dark gray, slightly silty to silty SAND (SM); abundant seashell fragments, fine to medium sand	
		Prepacked screen, 0.020" slot, 3/4" diam.		Soil pH=11.1			Soft, wet, dark brown to dark gray, very sandy SILT (SM-ML); abundant wood	
	0		CP-MWA1-14-15	Soil pH=11.4			Becomes dark gray.	
15				Total Hg Soil pH=12.4 Soil pH=12.3			Wood	15
		Slip cap		Soil pH=12.3			Stiff, wet, olive gray, slightly sandy SILT (ML); scattered wood and organics	
				Soil pH=11.2				
		10-20 silica sand		Soil pH=9.2				
				Soil pH=9.1				
				Soil pH=9.2			Very thinly bedded sandy silt	
	-5						Abundant wood	
20							Bottom of boring at 20'	20
	-10							

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 59

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MWA2	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	13.66
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	13.36
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	5.12 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/21/2009

Borehole Completion (Depth / Elevation (feet))

- 8" flush mount monument set in concrete
- 2" Sch 40 PVC riser
- Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWA2-V
- 3/30/2010
- 9/28/2009
- 3/8" bentonite chips
- 10-20 silica sand
- 2" Sch 40 PVC 0.020" slot screen
- Slip cap
- 10-20 silica sand

Sample Type/ID and Tests

Sample Type/ID	Tests
CP-MWA2-2-3	Total Hg
	Soil pH=8.7
	Soil pH=8.8
	Soil pH=8.8
CP-MWA2-11-12	Soil pH=8.9 Total Hg
	Soil pH=8.6
	Soil pH=8.2
	Soil pH=8.8
	Soil pH=8.5
	Soil pH=8.6

Description

Depth (ft)	Description
0	Asphalt
	Crushed rock and concrete
2	Slightly moist, gray SAND (SP); trace silt, occasional seashell fragments, fine to medium sand
	Trace gravel
	Trace gravel
8.5	Wet, dark gray SAND (SW); frequent seashell fragments, fine to coarse sand
12.5	Soft, wet, olive gray SILT (ML); trace sand
	Abundant wood
14	Wet, dark gray, slightly silty SAND (SP-SM); trace gravel, trace wood
	Becomes very silty, occasional organics and wood
17.5	Stiff, wet, dark olive gray SILT (ML); trace fine sand
19	Medium stiff, wet, dark olive gray sandy SILT (ML); abundant wood
20	Bottom of boring at 20'

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 60

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MWA3	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 12.47
Top of Casing Elev.: 12.17
Depth to Water (ft BGS): 4.78 - 3/30/2010
Start/Finish Date: 9/16/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–1	8" flush mount monument set in concrete						Gravel	
1–2	2" Sch 40 PVC riser						Moist, dark brown, gravelly, silty SAND (SM); frequent wood and organics, fine to coarse sand	
2–5 (Elev. 10)	Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWA3-V; ▼ 3/30/2010						Moist, brown, slightly silty SAND (SP-SM); trace gravel, frequent seashells, predominantly fine to medium sand	
5	3/8" bentonite chips; ▼ 9/28/2009		Soil pH in saturated zone was between 7.5 and 8.1				Wet, dark gray, slightly silty to silty SAND (SM); frequent seashell fragments, fine to medium sand, predominantly fine	5
(Elev. 5)	10-20 silica sand							
10	2" Sch 40 PVC 0.020" slot screen	CP-MWA3-11-13	Total Hg					10
(Elev. 0)							Thick bed of silty, fine sand	
	Slip cap; 10-20 silica sand						Thick bed of silty, fine sand	
15							Bottom of boring at 15'	15
(Elev. -5)								
20								20
(Elev. -10)								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level
▽ Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 61

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MWB1	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 15.01
Top of Casing Elev.: 14.71
Depth to Water (ft BGS): 6.23 - 3/30/2010
Start/Finish Date: 9/21/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 15	8" flush mount monument set in concrete						Asphalt	
	3/4" Sch 40 PVC riser						Slightly moist, brown, silty, sandy GRAVEL (GM); occasional wood, occasional organics	
	Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWB1-V	CP-MWB1-2-3	Total Hg					
5 / 10	3/8" bentonite chips						Very moist, dark gray, slightly silty SAND (SM); trace fine gravel, fine to coarse sand	5
	3/30/2010							
	9/28/2009						Frequent seashells	
			Soil pH=10.1				Wet, dark gray, trace to slighltly silty SAND (SP); frequent seashells, fine to medium sand	
			Soil pH=10.1 Soil pH=11.9 Soil pH=12.0 Soil pH=11.7				Trace wood	
10 / 5	10-20 silica sand						Coarse sand	10
			Soil pH=11.2 Soil pH=11.5 Soil pH=11.5					
	3/4" prepacked screen, 0.020" slot	CP-MWB1-12.5-13.5	Soil pH=11.5 Total Hg					
			Soil pH=11.5 Soil pH=10.9 Soil pH=10.8				Coarse sand	
15 / 0			Soil pH=10.7 Soil pH=9.8				Fine sand	15
	Threaded cap		Soil pH=8.6 Soil pH=8.5				Stiff, wet, dark olive gray, trace to slightly sandy SILT (ML)	
	10-20 silica sand						Occasional wood, very thin beds of fine sandy silt	
							Abundant wood	
20 / -5							Bottom of boring at 20'.	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 62

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MWB2	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 13.79
Top of Casing Elev.: 13.49
Depth to Water (ft BGS): 5.4 - 3/30/2010
Start/Finish Date: 9/17/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	8" flush mount monument set in concrete						Asphalt	
							Wet, gray, slightly silty, slightly sandy GRAVEL (GW)	
	Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWB2-V						Very thin, moist, brown, organic silt bed	
10	2" Sch 40 PVC riser	CP-MWB2-3-4	Total Hg				Moist, gray to olive gray, sandy, very silty GRAVEL (GM)	
5	3/30/2010; 3/8" bentonite chips; 9/28/2009						Moist, dark gray, slightly silty SAND (SM); frequent seashell fragments, fine sand	5
			Soil pH=7.3				Medium stiff, very moist to wet, dark gray SILT (ML); occasional wood, occasional organics	
5	10-20 silica sand		Soil pH=8.0 Soil pH=8.1				Wet, dark gray, silty SAND (SM); frequent seashells, predominantly fine to medium sand	
10		CP-MWB2-10-12	Soil pH=8.3 Soil pH=8.5 Total Hg Soil pH=8.4					10
	3/4" prepacked screen, 0.020" slot		Soil pH=7.3 Soil pH=7.6					
0			Soil pH=7.8				Occasional wood	
15	Threaded cap		Soil pH=7.8 Soil pH=7.4					15
			Soil pH=7.6				Stiff, wet, dark gray, slightly sandy SILT (ML)	
-5	10-20 silica sand		Soil pH=7.4				Wood	
			Soil pH=7.6				Wood Becomes gray	
20							Bottom of boring at 20'.	20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 63

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MWB3	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	12.85
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	12.55
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	5.01 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/17/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0	12.85	8" flush mount monument set in concrete; 3/4" Sch 40 PVC riser					Slightly moist, brown, gravelly, silty SAND (SM); scattered crushed rock, roots and organics
3	10	Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWB3-V					Very moist, gray, silty SAND (SM); occasional organics, frequent seashell fragments, fine to medium sand
5		3/30/2010; 3/8" bentonite chips; 9/28/2009					
8	5			Soil pH=7.8 to 8.2 in saturated zone			Wet, dark gray, silty to very silty SAND (SM); abundant seashells, fine to coarse sand Laminae of very silty sand
10		10-20 silica sand					
13	0	3/4" diam. prepacked screen, 0.020" slot	CP-MWB3-13-15	Total Hg			
15							Becomes very silty; sand becomes fine
16		Threaded cap					Stiff, wet, dark olive gray, slightly sandy SILT (ML); scattered organics
18	-5	10-20 silica sand					
20							Bottom of boring at 20'
	-10						

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 64

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MWC1	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	14.04
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	13.74
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	4.17 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/21/2009

Columns: Depth / Elevation (feet) | Borehole Completion | Sample Type/ID | Tests | PID (ppm) | Soil pH | Material Type | Description | Depth (ft)

Borehole Completion:
- 8" flush mount monument set in concrete
- 2" Sch 40 PVC riser
- 3/30/2010 (static water level)
- 9/28/2009 (static water level)
- Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWC1-V
- 3/8" bentonite chips (water level ATD)
- 10-20 silica sand
- 2" Sch 40 0.020" slot screen
- Slip cap
- 10-20 silica sand

Samples:
- CP-MWC1-2-3 — Total Hg
- CP-MWC1-12-13 — Total Hg

Tests: Total Hg; Soil pH=9.8; Soil pH=9.3; Soil pH=10.3; Soil pH=11.3; Soil pH=11.4; Soil pH=11.0; Soil pH=11.0; Soil pH=10.9; Soil pH=11.3; Total Hg; Soil pH=11.3; Soil pH=11.3; Soil pH=11.0; Soil pH=10.5; Soil pH=9.9; Soil pH=9.4

Description:
- Asphalt
- Slightly moist, gray, silty, very gravelly SAND (SM); fine to coarse sand
- Soft, slightly moist, dark gray SILT (ML)
- Moist to very moist, gray to dark gray, very silty SAND (SM); trace gravel
  - Thick silt bed
  - Becomes gray, occasional seashell fragments, very thin very gravelly bed
- Soft, wet, dark olive gray, slightly sandy SILT (ML); occasional wood
- Wet, dark gray, slightly silty SAND (SM); trace seashell fragments, fine to medium sand
  - Frequent seashell fragments
  - Grades to very silty sand to very sandy silt
- Stiff, wet, dark olive gray, slightly sandy SILT (ML)
  - Occasional wood
  - Occasional wood
- Bottom of boring at 18'

Depth scale (ft): 5, 10, 15, 20. Elevation scale: 10, 5, 0, -5, -10.

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 65

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-MWC2	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 14.09
Top of Casing Elev.: 13.79
Depth to Water (ft BGS): 6.17 - 3/30/2010
Start/Finish Date: 9/17/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–1		8" flush mount monument set in concrete						Asphalt	
1–2								Quarry spalls	
2–3		2" Sch 40 PVC riser	CP-MWC2-2-3	Total Hg				Slightly moist, dark olive brown, silty, very gravelly SAND (SM); organics and wood, fine to coarse gravel, fine to coarse sand	
3–8.5	10	soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWC1-S; 3/8" bentonite chips; 3/30/2010; 9/28/2009		Soil pH=8.1				Moist, gray, silty SAND (SM); frequent seashells, fine to medium sand, predominantly fine; Wood, very moist	5
8.5–13	5	10-20 silica sand		Soil pH=8.0; Soil pH=7.9; Soil pH=7.8; Soil pH=8.0; Soil pH=8.1; Soil pH=8.3				Medium stiff, wet, dark gray, slightly sandy to sandy SILT (ML); occasional wood, occasional seashell fragments; Gravel	10
13–15	0	2" Sch 40 PVC 0.020" slot screen	CP-MWC2-13-15	Soil pH=8.0; Total Hg; Soil pH=8.5				Wet, dark gray, silty SAND (SM); occasional wood and seashell fragments	
15–18		Slip cap; 10-20 silica sand		Soil pH=8.4; Soil pH=8.3; Soil pH=7.8; Soil pH=7.9; Soil pH=8.1				Medium stiff, wet, dark olive gray, silty to very sandy SILT (ML); very thin interbeds of silt and sandy silt, fine to medium sand, predominantly fine; Occasional wood	15
18–20	-5			Soil pH=8.1; Soil pH=8.0				Stiff, wet, dark gray SILT (ML); trace fine sand, trace seashells, trace wood	
20	-10							Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 66

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-MWC3	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.07
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	14.77
Driller/Method:	Northwest Probe / Direct push soil probe	Depth to Water (ft BGS)	8.03 - 3/30/2010
Sampling Method:	3.25" core	Start/Finish Date	9/16/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	8" flush mount monument set in concrete						Slightly moist to moist, brown, very silty, very gravelly SAND (SM); fine to coarse gravel, fine to coarse sand	
	2" Sch 40 PVC riser							
	soil vapor probe screeened 2-3' BGS, 3/4" PVC riser, CP-MWC1-V						3" thick gray gravel	
5 / 10							2" silt bed	5
	3/8" bentonite chips						1" light brown sand, iron oxide staining	
							Very moist to wet, slightly silty to silty SAND (SW-SM); frequent seashell fragments, fine to coarse sand	
	3/30/2010						Iron oxide staining	
	9/28/2009						2" coarse sand, seashell fragments, trace gravel	
	10-20 silica sand						1" fine, dark gray sand	
10 / 5							Wet, dark gray, slightly silty SAND (SP-SM); frequent seashell fragments, fine to medium sand	10
	2" Sch 40 PVC 0.020" slot screen	CP-MWC3-12-14	Total Hg					
							Trace coarse sand	
							Occasional wood	
15 / 0	Slip cap						Bottom of boring at 15'	15
20 / -5								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 67

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB01	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 15.2
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 1.5" core
Start/Finish Date: 3/28/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
15							Asphalt	
							Gravel	
							Sand	
							Very moist to wet, gray to dark brown, slightly sandy SILT (ML)	
5 / 10	Hole abandoned with 3/8" bentonite chips						Abundant organics	5
							Wood in cutting shoe	
10 / 5							Gray, wet, very silty SAND (SP/ML); fine sand	10
							Wet, gray SILT (ML); [tidal flats 10'-20']	
							Wet, gray, very silty SAND (SP/ML); fine sand	
15 / 0							Wet, gray SAND (SP); trace silt, trace seashell fragments, fine to medium sand	15
							Wet, gray, very silty SAND (SP/ML); fine sand	
							Silt	
20 / -5							Bottom of boring at 20'	20

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 68

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	CP-SB02	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/21/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0	Hole backfilled with 3/8" bentonite chips					Concrete	
		CP-SB02-1-2				Moist, brown-gray, slightly silty, slightly gravelly SAND (SP); fine to medium sand	
		CP-SB02-3-4				Crushed concrete	
5		CP-SB02-5-6			9.5 9.3	Wet, gray-brown, silty, slightly gravelly SAND (SM); fine to coarse sand Sheen, hydrocarbon-like odor	5
		CP-SB02-9-10			9.1 9.4	Wet, gray, slightly silty, slightly sandy GRAVEL (GP); fine gravel Woody debris, hydrocarbon-like odor	
10					8.9	Wet, dark brown, silty GRAVEL (GM); scattered woody debris	10
15		CP-SB02-17-18			8.6 8.8 8.8 9.3	Wet, gray, silty SAND (SM); fine to coarse sand, seashell fragments common, scattered woody debris, scattered fine gravel	15
						Bottom of boring at 18'	
20							20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: MAR/Mv
Approved by: SJG
Figure No. A- 69

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB03	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	Hole backfilled with 3/8" bentonite chips						Asphalt	
							Moist, brown to black, silty, gravelly SAND (SM); well-graded fine to coarse sand, fine angular gravel (crushed rock)	
		CP-SB03-2-3						
		CP-SB03-4-5					Becomes wet	
5								5
		CP-SB03-8-9						
							Wet, white, silty GRAVEL (GM); fine to coarse gravel, crushed marble rock and crushed concrete	
10							Moist, brown to black, silty, gravelly SAND (SM); well-graded fine to coarse sand, fine angular gravel (crushed rock)	10
		CP-SB03-11.5-12						
							Refusal on concrete at 12' Bottom of boring at 12'.	
15								15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 70

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	CP-SB04	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev:
Depth to Water (ft BGS):
Start/Finish Date: 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips						Asphalt	
		CP-SB04-2-3					Moist, brown-gray, silty, gravelly SAND (SM)	
							Perched water at 3.5'	
5		CP-SB04-4-5					Moist, brown and gray, sandy SILT (ML)	5
		CP-SB04-5-6						
							Refusal at 6' on concrete or boulder Bottom of boring at 6'. No saturation at depth.	
10								10
15								15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: MAR/SJG
Approved by: SJG
Figure No. A- 71

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB05	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/21/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips					Asphalt	
		CP-SB05-1-2				Slightly moist, gray and brown, silty GRAVEL (GM); trace coarse sand	
						Crushed concrete	
		CP-SB05-3-4			9.1	Moist, dark olive gray, slightly gravelly SILT (ML); fine, rounded gravel	
		CP-SB05-4-5			8	Set, gray-brown, slightly silty SAND (SM); increasingly silty with depth	
5					8.5		5
					9.4		
					9.5		
		CP-SB05-8-9			9.2		
10					8.8 9.9		10
					9.5 10.2	Wet, dark gray, slightly silty GRAVEL	
		CP-SB05-12-14			10.2 10.4 9.2		
					8.6	Wet, gray, silty SAND (SM)	
15					7.9	Wet, gray SILT (ML)	15
					8	Woody debris	
					9.1 7.8		
					8	Bottom of boring at 18'	
20							20

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MAR/Mv
Approved by: SJG
Figure No. A- 72

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	CP-SB06	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/20/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
						Asphalt	
						Moist, silty SAND (SM)	
						Crushed concrete	
		CP-SB06-2-3			9.2	Moist to wet, slightly silty, slightly gravelly SAND (SM); well-graded fine to coarse sand, fine angular gravel, seashell fragments common	
					8.9		
		CP-SB06-4-5			9.4		
5	Hole backfilled with 3/8" bentonite chips	CP-SB06-5-6			9.8		5
		CP-SB06-6-8			10.5 9.4	Visible elemental Hg 4'-8'	
					7.9	Moist, black, gravelly SILT (ML); crushed concrete	
10					8.5	Wet, brown-gray, slightly silty SAND (SW); well-graded fine to coarse sand, scattered fine gravel. Low recovery, probably slough.	10
					8.5 8.2		
					8		
15							15
					7.1		
					7.4		
		CP-SB06-19-20			8.2	Wet, black SAND (SP); poorly graded fine to medium sand. Low recovery, probaby slough	
20						Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 73

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB06A	1 of 1

Project Name: Georgia Pacific West Site

Ground Surface Elev

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Depth to Water (ft BGS)

Sampling Method: 1.5" core

Start/Finish Date 2/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0							Asphalt	
							Moist, silty SAND	
							Crushed concrete	
							Moist to wet, slightly silty, slightly gravelly SAND (SM); well-graded fine to coarse sand, fine angular gravel, seashell fragments abundant	
							Visible elemental Hg present to 2' - 10'	
5							Hg vapor >50 ug/m3 in borehole open to 5'	5
	Hole backfilled with 3/8" bentonite chips							
							Moist, black, gravelly silt (ML); scattered crushed concrete	
10							Wet, gray, gravelly SAND (SW)	10
		CP-SB06A-10-15					Visible elemental Hg in sample. Due to poor recovery, depth of sample uncertain.	
15							Bottom of boring at 15' BGS	15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 74

Aspect CONSULTING	**Boring Log**		
	Project Number 070188	Boring Number CP-SB07	Sheet 1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS)

Sampling Method: 1.5" core
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–0.5	Hole backfilled with 3/8" bentonite chips						Asphalt	
0.5–1							Concrete	
1–4	(water level ATD ~3 ft)	CP-SB07-3-4					Wet, brown SAND (SW); well-graded fine to coarse sand, trace fine to coarse gravel, trace silt	
4–9		CP-SB07-4-5; CP-SB07-6.5-7.5					Wet, brown-gray, gravelly SAND (SW); well-graded fine to coarse subangular sand, trace silt	5
9							Refusal on concrete at 9'. Bottom of boring 9'.	10
15								15
20								20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: MAR

Approved by: SJG

Figure No. A- 75

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB08	1 of 1

Project Name: Georgia Pacific West Site

Ground Surface Elev

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Depth to Water (ft BGS)

Sampling Method: 1.5" core

Start/Finish Date 12/23/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
		CP-SB08-1-2					Moist, gray/brown, silty, sandy GRAVEL (GM); fine to coarse angular gravel (crushed rock)	
		CP-SB08-2-3						
							Moist, very sandy GRAVEL (GP); gravel subrounded Becomes wet	
		CP-SB08-4-5						
5	Hole backfilled with 3/8" bentonite chips						Wet, gray, slightly silty SAND (SW); well-graded, fine to coarse, subrounded sand, trace gravel	5
							Wet, gray, very silty SAND (SM); fine, subrounded sand, scattered seashell fragments	
		CP-SB08-8-9					Organic silt (OL)	
10							Sawdust	10
							Wet, gray SILT (ML); abundant brown organics (sawdust)	
		CP-SB08-12-14						
							Becomes dark gray to black	
15							Bottom of boring at 15' This boring was moved 15' to the SW from original location. Original location had 6" asphalt, 18" gravel, 34" concrete.	15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 76

_GP_ENV BORING LOG GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB09	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 12/21/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips						Asphalt	
							Moist, brown, gravelly SAND (SW); well-graded fine to coarse sand, trace silt, fine angular gravel	
							Crushed concrete	
		CP-SB09-2-3			8.4			
		CP-SB09-4-5					Very moist to wet, brown to black, silty SAND (SM); scattered woody fragments, scattered seashell fragments	
5		CP-SB09-5-6						5
					9.9 8.7 7.6		Wet, brown-gray SILT (ML); scattered woody fragments, scattered fine gravel	
		CP-SB09-8-9			7.9			
					7.9			
10							Wet, gray, slightly gravelly, slightly silty SAND (SW); well-graded fine to coarse sand, fine angular gravel	10
							Sheen	
		CP-SB09-12-14			8.4 8.1		Wet, brown, slightly sandy SILT (ML); fine sand, scattered woody debris	
					7.5			
15								15
					7.3			
					7			
					7		Wood debris	
20					7.3		Bottom of boring at 20'	20

Sampler Type:

- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 77

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB10	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS)

Sampling Method: 1.5" core
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips						Asphalt	
							GRAVEL	
							Concrete (cored and vac'd)	
				50				
							No recovery	
5							Wet, dark gray SAND (SW); well-graded fine to coarse sand, trace gravel (probably slough)	5
		CP-SB10-5-6		511				
		CP-SB10-6-7		611			Wet, dark gray, sandy SILT (ML); scattered woody debris	
				710				
		CP-SB10-8-9		811				
				910				
10								10
				1022				
		CP-SB10-12-13						
		CP-SB10-14-15					Sand and woody debris	
15							Bottom of boring at 15'	15
20								20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: MAR

Approved by: SJG

Figure No. A- 78

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB11	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							Concrete	
		CP-SB11-3-5					Wet, gray SAND (SP); poorly graded fine to medium sand, trace silt, trace gravel Sheen	
5	Hole backfilled with 3/8" bentonite chips	CP-SB11-5-6					Petroleum-like odor, sheen.	5
							Wet, gray SILT (ML); scattered fine gravel	
		CP-SB11-7-9					Sand with scattered woody debris	
10								10
							Moist, dark gray SAND (SP); poorly graded medium to coarse sand, trace silt, scattered gravel	
		CP-SB11-12-14					Petroleum-like odor	
							Moist, dark gray SILT (ML); scatted woody debris	
15		CP-SB11-15-16						15
							Bottom of boring at 18'	
20								20

Sampler Type:
No Recovery
Soil sample
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MAR
Approved by: SJG
Figure No. A- 79

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB12	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 12/23/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips						Asphalt	
		CP-SB12-0.5-1					Slightly moist, gray GRAVEL (GW); angular to subangular fine to coarse gravel (crushed rock), trace silt, trace sand	
							Concrete	
							Becomes wet	
5		CP-SB12-5-6					Wet, gray SAND (SW); well graded fine to coarse subrounded sand	5
							Wet, gray, silty SAND (SP-SM); fine sand	
							Wet, gray SILT (ML)	
		CP-SB12-9-10					Wet, gray/black silty, sandy GRAVEL (GM); angular gravel, frequent wood fragments, creosote-like odor (pile?)	
10							Wet gray SAND (SW); well-graded fine to coarse sand, interfingered with silty SAND (SM); fine sand, scattered seashell fragments	10
		CP-SB12-12-13						
15		CP-SB12-15-16						15
							Moist, gray SILT (ML); trace fine brown organics	
							2" bed of sand	
							Bottom of boring at 18'	
20								20

Sampler Type:

- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 80

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	CP-SB13	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev:
Depth to Water (ft BGS):
Start/Finish Date: 12/21/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0	Hole backfilled with 3/8" bentonite chips					Asphalt
						Wet, black, slightly silty SAND (SM); scattered woody debris, scattered sheashell fragments
3		CP-SB13-2-4			8.2	
5		CP-SB13-5-6				Becomes brown
7–8					7.8 8.2	Charcoal
8		CP-SB13-8-9				
9					7.7	Wet, gray, slightly sandy SILT (ML); fine sand
10						
11					7.5	
12		CP-SB13-12-13			7.2	Petroleum-like odor
14					8.2 6.6	
15		CP-SB13-15-16			8	Petroleum-like odor
16–17					7.5 7.8	Woody debris.
17						Bottom of boring at 17'.
20						

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: Mv/MAR
Approved by: SJG
Figure No. A- 81

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB14	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS)
Sampling Method: 1.5" core
Start/Finish Date 1/31/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							Slightly moist to moist, brown, slightly silty, gravelly SAND (SW); fine to coarse sand, fine, angular gravel	
		CP-SB14-1-2						
		CP-SB14-2-3						
		CP-SB14-4-5			8		Building material debris, becomes black	
5								5
	Hole backfilled with bentonite chips				9.8			
		CP-SB14-6-7			9.5		Woody debris, visible elemental mercury	
					9.5			
		CP-SB14-8-9					Wet, black, slightly gravelly, silty SAND (SM/SP); fine to medium sand	
10							Abundant woody debris at 10'	10
		CP-SB14-10-11			10.3			
					9.7		Seashell fragments	
							Bottom of boring at 12' BGS; hit refusal on concrete	
15								15
20								20

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 82

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB15	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 1/31/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips						Asphalt	
		CP-SB15-2-3			7.6		Slightly moist, brown and gray, gravelly SAND (SW); fine to coarse sand, fine, angular gravel, trace silt	
5		CP-SB15-4-5			8.5 7.5		Wet, sandy GRAVEL (GP); fine gravel, coarse to medium sand	5
		CP-SB15-6-7			7.3			
		CP-SB15-8-9			7.5			
10							Wet, brown, silty GRAVEL (GM); trace coarse sand	10
		CP-SB15-11-12					Wet, gray SILT (ML); abundant woody debris	
							Bottom of boring at 13' BGS	
15								15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 83

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB16	1 of 1

Aspect CONSULTING

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 2/1/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							Moist, gravelly SAND (SW); fine to coarse sand, fine gravel, trace silt	
		CP-SB16-3-4					Hg vapor=24 ug/m3	
5					8.4		Color becomes brown, Hg vapor=5.4 ug/m3	5
	Hole backfilled with 3/8" bentonite chips	CP-SB16-5-6			11.1			
							Hg vapor=3.9 ug/m3	
					8.9		SILT (ML); Hg vapor=720 ng/m3	
		CP-SB16-7-8			8.8		Brick fragments-FILL	
					7.7		Silt (ML); Hg vapor=1907 ng/m3	
		CP-SB16-9-10			8.4		Wet, gray SAND (SP); fine to medium sand, trace silt, trace gravel	
10								10
					8.3		Hg vapor=655 ng/m3	
		CP-BS16-11-12					Wet, gray, slightly gravelly, silty SAND (SM)	
					8.1		Hg vapor=595 ng/m3	
					8.1			
							Hg vapor=510 ng/m3	
					7.9			
					8.7		Woody fragments at 14'	
							Hg vapor=417 ng/m3	
15					8.1		Hg vapor = 463 ng/m3; bottom of boring at 15' BGS	15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 84

_GP_ENV BORING LOG GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB17	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 1/31/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips						Slightly moist, brown and gray, silty, sandy GRAVEL (GM)	
		CP-SB17-2-3					Hg vapor=0.3 ug/m3	
							Hg vapor=208 ng/m3	
		CP-SB17-4-5						
5							Hg vapor=250 ng/m3	5
					8.6			
					8.5			
		CP-SB17-6.5-7.5					Hg vapor=156 ng/m3	
					9.7			
					9.5		Wet, gray SAND (SP); coarse sand, trace silt, trace gravel	
		CP-SB17-9-10			9		Hg vapor=50 ng/m3 from 9' to 18'	
10					9.1			10
					8.7			
		CP-SB17-14-15			9.6		Becomes wet, black, slightly silty, gravelly SAND (SP); fine to medium sand	
15					9.7			15
					8.3		Becomes brown	
					7.6		Presence of woody debris	
					8.7		Wet, gray SILT (ML); trace gravel	
					9.7		Bottom of boring at 18' BGS	
20								20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 85

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	CP-SB18	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 2/1/2011

Borehole Completion: Hole backfilled with 3/8" bentonite chips

Depth (ft)	Sample Type/ID	Soil pH	Description
0–0.5			Asphalt
0.5–1.5	CP-SB18-0.5-1.5		Moist, black and brown, gravelly SAND (SW); trace silt
1.5–5			Concrete
5–5.5	CP-SB18-5-6		Wet, gray SAND (SW), fine to coarse sand, trace silt
5.5–9.5		8.4	Wet, brown, slightly sandy SILT (ML); adundant woody debris
	CP-SB18-7-8	8.9	
		10.8	
	CP-SB18-9-10	9.8	
9.5–11.5		9.3	Wet, black SAND (SW); fine to coarse sand, trace gravel, trace silt
		11	
			Color becomes gray
11.5–14.5		9	Wet, black, silty SAND (SM); trace gravel
	CP-SB18-12-13	11.5	
			Scattered woody debris
		9.4	
		10.7	Becomes very silty
14.5–15			SILT (ML)
15			Bottom of boring at 15' BGS

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 86

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB18.5	1 of 1

Project Name: Georgia Pacific West Site

Ground Surface Elev

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Depth to Water (ft BGS)

Sampling Method: 1.5" core

Start/Finish Date 1/31/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
	Hole backfilled with 3/8" bentonite chips						Moist, dark gray, silty, gravelly SAND (SP)	
1		CP-SB18.5-0.5-1.5			7.7		Hg vapor=592	1
							Refusal on concrete; bottom of boring at 1.5' BGS	
2								2
3								3
4								4

Sampler Type:

No Recovery

Continuous Core

Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 87

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB19	1 of 1

Aspect CONSULTING

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev:

Depth to Water (ft BGS):

Start/Finish Date: 1/31/2011

Borehole Completion: Hole backfilled with 3/8" bentonite chips (0 to 18 ft)

Depth / Elevation (feet)	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description
0–0.5				7.9	Asphalt	Asphalt
0.5–3.5	CP-SB19-0.5-1.5; CP-SB19-2-3			9.6; 8.7	GM	Moist, gray, silty, sandy GRAVEL (GM) Hg Vapor=43,520 ng/m3 Hg vapor=317 ng/m3
3.5–9	CP-SB19-4-5; CP-SB19-6.5-7.5			8.6; 8.8; 7.2; 7.9	SM	Wet, brown and gray, slightly gravelly, silty, SAND (SM) Very gravelly from 4' to 6' Hg vapor=227 ng/m3 Hg vapor=418 ng/m3 Abundant woody debris from 6' to 9' Hg vapor=357 ng/m3 Hg vapor=475 ng/m3
9–10	CP-SB19-9-10			7.5	ML	SILT (ML)
10–14				7.8	SM	Wet, brown and gray gravelly, silty SAND (SM) Hg vapor=167 ng/m3
14–15					GP	Wet, black, slightly silty gravel Hg vapor=403 ng/m3
15–16.5	CP-SB19-15-16			9.8; 9.9	SM	Wet, dark gray, silty SAND (SM); fine to coarse sand Hg vapor=436 ng/m3
16.5–18				9.8	ML	Wet, dark gray SILT (ML) Hg vapor=241 ng/m3
18				9.3		Hg vapor=1200 ng/m3 Bottom of boring at 18' BGS

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 88

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-SB20	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 1/31/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips	CP-SB20-0.5-1.5				GM	Slightly moist, brown and gray, silty GRAVEL (GM)	
							Hg vapor >50 ug/m3	
		CP-SB20-3-4					Hg vapor=0.4 ug/m3	
						SM	Moist, gray, silty, gravelly SAND (SM); fine to medium sand	
5							Hg vapor=0.2 ug/m3	5
		CP-SB20-5-6					Hg vapor=0.8 ug/m3	
	▽				9.3	ML	Wet, dark gray SILT (ML); woody debris at 6.5' and 8'	
							Hg vapor=0.2 ug/m3	
					7.7		Hg vapor=0.08 ug/m3	
		CP-SB20-9-10			8	SM	Wet, gray, silty SAND (SM)	
10					8.6		Hg vapor=0.08 ug/m3	10
					10.6		Seashell fragments	
							Hg vapor=0.08 ug/m3	
					11.5			
							Hg vapor=0.2 ug/m3	
		CP-SB20-13-14			11.4		Color becomes blacks, becomes very silty with woody debris	
							Hg vapor=0.1 ug/m3	
					11.9			
15					10.8		Hg vapor=0.1 ug/m3	15
					10.9			
					10.4	ML	SILT (ML)	
					9.8		Bottom of boring at 18' BGS	
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 89

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	CP-SB22	1 of 1

Project Name: Georgia Pacific West Site

Ground Surface Elev

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Depth to Water (ft BGS)

Sampling Method: 1.5" core

Start/Finish Date 1/31/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
							Moist to wet, slightly silty, gravelly SAND (SM); fine to coarse sand, fine angular gravel	
		CP-SB19-2-3						
	Hole backfilled with 3/8" bentonite chips							
		CP-SB19-4-5						
5								5
		CP-SB19-6-7					Very silty from 6' to 7'	
							Bottom of boring at 7' BGS; hit refusal in concrete	
10								10
15								15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 90

_GP_ENV BORING LOG GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	CP-Treatability	1 of 1

Project Name: Georgia Pacific West Site

Location: Caustic Plume Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 2/1/2011-2/1/201

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–1		Continuous Core					Asphalt	
1–4							Silty, sandy GRAVEL (GM)	
4–10	Hole backfilled with 3/8" bentonite chips; Water Level (ATD) at ~4						Silty, gravelly SAND (SM); visible elemental Hg present Very gravelly from 4' to 6' Abundant woody debris from 6' to 10'	5
10							Bottom of boring at 10' BGS	10
15								15
20								20

Sampler Type:

No Recovery

Continuous Core

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 91

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-VP01	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method:

Ground Surface Elev: 14.5
Top of Casing Elev.:
Depth to Water (ft BGS):
Start/Finish Date: 3/30/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14.5							Asphalt	0
14							Slightly moist, brown, silty, sandy GRAVEL (GM); occasional wood, occasional organics	
1								1
13								
2	Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser							2
12								
3							Bottom of boring at 3'. Hole was decommissioned by removing PVC and backfilling with bentonite chips.	3
11								
4								4
10								

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 92

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-VP02	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method:

Ground Surface Elev: 15.2
Top of Casing Elev.:
Depth to Water (ft BGS):
Start/Finish Date: 3/30/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 15							Asphalt	
0.5							Slightly moist, brown, silty, sandy GRAVEL (GM); occasional wood, occasional organics	
1 / 14								1
2 / 13	Soil vapor probe screeened 2-3' BGS, 3/4" PVC riser							2
3 / 12							Bottom of boring at 3'. Hole was decommissioned by removing PVC and backfilling with bentonite chips.	3
4 / 11								4

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 93

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-VP03	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method:

Ground Surface Elev: 14.9
Top of Casing Elev.:
Depth to Water (ft BGS):
Start/Finish Date: 3/30/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14.9							Asphalt	
0.5							Slightly moist, brown, silty, sandy GRAVEL (GM); occasional wood, occasional organics	
1 / 14								1
2 / 13	Soil vapor probe screeened 1.5-2.5' BGS, 3/4" PVC riser							2
2.5							Bottom of boring at 2.5'. Hole was decommissioned by removing PVC and backfilling with bentonite chips.	
3 / 12								3
4 / 11								4
10								

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 94

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-VP04	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method:

Ground Surface Elev: 15.1
Top of Casing Elev.:
Depth to Water (ft BGS):
Start/Finish Date: 3/30/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
15							Asphalt	
	Soil vapor probe screeened 1.0'-1.5' BGS, 3/4" PVC riser						Slightly moist, brown, silty, sandy GRAVEL (GM); occasional wood, occasional organics	
1 / 14								1
							Bottom of boring at 1.5'. Hole was decommissioned by removing PVC and backfilling with bentonite chips.	
2 / 13								2
3 / 12								3
4 / 11								4

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 95

_GP_MONITORING WELL GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	CP-VP05	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) not encountered
Start/Finish Date 2/1/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite chips						Asphalt	
1	3.4" diam Sch 40 PVC riser						Slightly moist, gray, silty GRAVEL (GM)	1
2	3/4" diam 0.010" slot Sch 40 PVC screen 10-20 sand							2
3	Slip cap						moist, black, silty SAND	3
							Bottom of boring at 3.5'	
4								4

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 96

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-VP06	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) 2' ATD
Start/Finish Date 2/1/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite chips						Asphalt	
	3.4" diam Sch 40 PVC riser						Concrete	
1	3/4" diam 0.010" slot Sch 40 PVC screen							1
	Slip cap							
2	10-20 sand						Wet GRAVEL (GP)	2
							Bottom of boring at 2.5'	
3								3
4								4

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 97

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-VP07	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) not encountered
Start/Finish Date 2/1/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
	Hydrated bentonite chips						Moist, slightly silty, sandy GRAVEL (GP)	
1	3.4" diam Sch 40 PVC riser							1
							Hg vapor = 3600 ng/m3 in borehole	
2								2
	3/4" diam 0.010" slot Sch 40 PVC screen							
3	10-20 sand						Moist, silty SAND (SM); fine to medium sand	3
	Slip cap							
							Bottom of boring	
4								4

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 98

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-VP08	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) not encountered
Start/Finish Date 2/1/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite chips						Asphalt	
							Moist, silty, sandy GRAVEL (GM)	
1	3.4" diam Sch 40 PVC riser							1
2	3/4" diam 0.010" slot Sch 40 PVC screen							2
							Gravelly SAND (SP)	
3	Slip cap							3
	10-20 sand							
							Bottom of boring at 3.5'	
4								4

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 99

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-VP09	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	
Location:	Caustic Plume Area / Bellingham, Washington	Top of Casing Elev.	
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	3' ATD
Sampling Method:	1.5" core	Start/Finish Date	2/1/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	Hydrated bentonite chips						Asphalt	
							Brown, silty, sandy GRAVEL (GM)	
1	3/4" diam Sch 40 PVC riser							1
	10-20 sand							
2							Hg vapor= 4000 ng/m3 in borehole	2
	3/4" diam 0.010" slot Sch 40 PVC screen							
3	▽							3
	Slip cap						Bottom of boring at 3.6'	
4								4

Sampler Type:
- No Recovery
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 100

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	CP-VP10	1 of 1

Project Name: Georgia Pacific West Site
Location: Caustic Plume Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) 3' ATD
Start/Finish Date 2/1/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Silty, sandy GRAVEL (GM)	
	Hydrated bentonite chips							
1								1
	3.4" diam Sch 40 PVC riser							
							Hg vapor = 0.15 ug/m3 in borehole	
2								2
	3/4" diam 0.010" slot Sch 40 PVC screen							
3	Slip cap						Crushed concrete	3
	10-20 sand							
							Bottom of boring at 3.5'	
4								4

Sampler Type:
No Recovery
Continuous Core

PID - Photoionization Detector (Headspace Measurement)

Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 101

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	L1-MW01	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	
Location:	Law 1 Area / Bellingham, Washington	Top of Casing Elev.	13.2
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	5 ATD
Sampling Method:	1.5" core	Start/Finish Date	12/16/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
	5" flush mount monument set in concrete					Slightly moist, brown, sandy, gravelly SILT (ML)	
						Becomes olive gray	
	3/4" Sch 40 PVC riser						
	3/8" bentonite chips	L1-MW01-3-4	Total Hg				
5					8	Becomes wet	5
					8.8		
					8.9		
	10-20 silica sand	L1-MW01-7-9	Total Hg		8.8		
					9.4	Becomes brownish-olive-green	
10					10		10
	Prepacked screen, 0.020" slot				9.6	Wet, gray to black, very silty, very sandy GRAVEL (GW); fine to coarse gravel, abundant woody debris	
		L1-MW01-11-13	Total Hg		8.9		
	Threaded cap				8.6	Slightly moist, dark gray SILT (ML); scattered woody debris	
	Slough	L1-MW01-14-15	Total Hg		8.2		
15					8.6	Becomes sandy Bottom of boring at 15'	15
20							20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: MAR

Approved by: SJG

Figure No. A- 102

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	L1-MW02	1 of 1

Project Name: Georgia Pacific West Site
Location: Law 1 Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 13.6
Depth to Water (ft BGS): 6 ATD
Start/Finish Date: 12/17/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
	5" flush mount monument set in concrete					Asphalt	
						Moist, gray, gravelly, SAND (SW); fine to coarse sand, trace silt	
	3/4" Sch 40 PVC riser	L1-MW02-4-5	Total Hg			Becomes trace gravel	
5					7.9		5
					8.2		
	3/8" bentonite chips	L1-MW02-7-9	Total Hg		7.8		
	10-20 silica sand				7.7		
					8.7		
10					8.5	Wet, gray, silty GRAVEL (GM); trace sand	10
					9.2	Wet, gray, silty SAND (SM); trace gravel, scattered seashell fragments	
		L1-MW02-11-12	Total Hg		9.4		
	Prepacked screen, 0.020" slot				9.4	Wet, gray SAND (SP); fine to medium sand, trace silt, trace gravel, scattered seashell fragments	
					9.1		
		L1-MW02-13-14	Total Hg		9.2		
					9		
					8.8		
15	Threaded cap				9		15
		L1-MW02-16-17	Total Hg		8.7		
					8.4	Wood chips, sawdust	
	Slough					Moist, gray SILT (ML); trace fine sand	
					8		
					9		
20					7.7	Bottom of boring at 20'	20

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level
Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 103

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	L1-MW03	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	
Location:	Law 1 Area / Bellingham, Washington	Top of Casing Elev.	13.3
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	13.5 ATD
Sampling Method:	1.5" core	Start/Finish Date	12/15/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	5" flush mount monument set in concrete					GM	Slightly moist, dark brown to olive gray, slightly sandy, very silty GRAVEL (GM); fine to coarse gravel	
							Abundant woody debris	
							Scattered woody debris	
							Becomes olive gray Crushed rock	
	3/4" Sch 40 PVC riser	L1-MW03-4-5	Total Hg			ML	Moist, dark olive gray, trace to slightly sandy, slightly gravelly SILT (ML)	
5							Olive green 5' to 7'	5
							Becomes very moist	
					8.7		Trace gravel 7'-10'	
	3/8" bentonite chips	L1-MW03-7-9	Total Hg		8.9		Scattered wood 7'-20'	
					8.4			
10					8.4		Slightly gravelly 10'-12'	10
		L1-MW03-11-12	Total Hg		8.5			
					8.6		Gravelly 12'-14'	
	10-20 silica sand	L1-MW03-13-14	Total Hg		8.4		Driller indicates water level at 13'	
					8.7		Becomes sandy, very gravelly 14'-19'	
15		L1-MW03-15-16	Total Hg		8.5		Dark reddish brick-like coarse gravel	15
	Prepacked screen, 0.020" slot				8.4			
					8.8			
					8.4			
	Threaded cap Slough				8.6		Trace gravel	
20					8.6		Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: MAR

Approved by: SJG

Figure No. A- 104

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	L1-MW04	1 of 1

Project Name: Georgia Pacific West Site
Location: Law 1 Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev. 14.32
Depth to Water (ft BGS) 4 ATD
Start/Finish Date 12/16/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	5" flush mount monument set in concrete						Moist, brown, very sandy, very silty GRAVEL (GM)	
							Thin bed olive-gray silt	
		L1-MW04-3-4	Total Hg					
					7.9		Becomes wet	
							Woody debris	
5					7.7		Wet, gray, very sandy GRAVEL (GP); mostly fine gravel, fine to coarse sand, trace silt	5
	3/4" Sch 40 PVC riser	L1-MW04-5-7	Total Hg		7.7			
					7.7			
	3/8" bentonite chips				7.8			
		L1-MW04-8-10	Total Hg		7.6			
10	10-20 silica sand				7.5			10
		L1-MW04-10-12	Total Hg		7.6		Becomes brown	
					7.5			
	Prepacked screen, 0.020" slot				7.5			
		L1-MW04-13-15	Total Hg		7.5			
15					7.5		Becomes slightly sandy	15
	Threaded cap							
	Slough				7.6			
20							Bottom of boring at 20'	20

Sampler Type:
No Recovery
Continuous Core
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MAR
Approved by: SJG
Figure No. A- 105

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	L1-MW05	1 of 1

Project Name: Georgia Pacific West Site
Location: Law 1 Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 14.36
Depth to Water (ft BGS): 3 ATD
Start/Finish Date: 12/15/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	5" flush mount monument set in concrete					GM	Slightly moist to moist, dark brown, silty, very sandy GRAVEL (GM); fine to coarse gravel	
	3/8" bentonite chips	No Recovery			9.2			
					7.7		Driller indicates water at 3'	
	3/4" Sch 40 PVC riser	L1-MW05-3-5	Total Hg		9.3		Gray crushed rock	
5	10-20 silica sand				8.8		Becomes wet, olive gray	5
		No Recovery			9.7			
					9.6			
	Prepacked screen, 0.020" slot	L1-MW05-7-9	Total Hg		10.8		Coarse gravel	
					10.9			
10	Threaded cap	No Recovery			11	SP	Wet, gray, gravelly SAND (SP); trace silt	10
		L1-MW05-11-12	Total Hg		8.9			
		No Recovery			9.3			
		L1-MW05-13-14	Total Hg		9.2			
		Continuous Core			9.1			
15	Slough	No Recovery			9.6	ML	Wet, olive gray, slightly sandy SILT (ML); scattered seashell fragments, scattered woody debris	15
					9.6			
		L1-MW05-16-18	Total Hg		9.3			
		Continuous Core			9.3		Coarse gravel	
					8.7		Becomes slightly moist, dark gray	
20					8.3		Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 106

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	L1-MW06	1 of 1

Project Name: Georgia Pacific West Site
Location: Law 1 area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Top of Casing Elev.
Depth to Water (ft BGS) 8.5 ATD
Start/Finish Date 1/31/2011

Borehole Completion:

- 5" flush mount monument set in concrete
- 3/4" Sch 40 PVC riser
- 3/8" bentonite chips
- 10-20 silica sand
- Prepacked screen, 0.020" slot
- Threaded cap
- Slough

Sample Type/ID	Tests	PID (ppm)	Soil pH
L1-MW06-3-5	Total Hg		8.2
L1-MW06-5-7	Total Hg		8.1
			7.8
			7.3
			8
			8.5
L1-MW06-13-14			
			8.3
L1-MW06-16-17			8.3
			8
			7.5

Description:

- Asphalt
- Slightly moist, silty, sandy GRAVEL (GW)
- Slightly moist SAND (SW); fine to coarse grained sand, trace silt and trace gravel
- 5 — Slightly moist, very silty, very sandy GRAVEL (GW-GM)
- Silt (ML)
- Wet, gray, silty SAND (SM); shell fragments and scattered woody/organic debris
- Grades to soft, wet, gray SILT (ML); trace organics
- Bottom of boring at 17' BGS

Depth (ft): 5, 10, 15, 20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 107

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	L1-WP1	1 of 1

Project Name: Georgia Pacific West Site
Location: Law 1 Area / Bellingham, Washington
Driller/Method: SJG / Sledge hammer, well point
Sampling Method:

Ground Surface Elev: 6.45
Top of Casing Elev.: 8.12
Depth to Water (ft BGS): 1.7' ATD
Start/Finish Date: 12/16/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	1.25" diam stainless steel pipe						Beach sand (SP)	
6								
1	Beach sand							1
5								
2								2
	1/31/2011							
4								
3	1.25" diam stainless steel screen							3
3								
4								4
2								
	Drive point						Bottom of boring at 4.6'	

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 108

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	L1-WP2	1 of 1

Project Name: Georgia Pacific West Site
Location: Law 1 Area / Bellingham, Washington
Driller/Method: JWC / Sledge hammer, well point
Sampling Method:

Ground Surface Elev: 4.95
Top of Casing Elev.: 6.41
Depth to Water (ft BGS): 1.7' ATD
Start/Finish Date: 1/31/2011

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0		1.25" diam stainless steel pipe						Beach sand (SP)	
1	4	Beach sand							1
		1/31/2011							
2	3								2
3	2	1.25" diam stainless steel screen							3
4	1								4
		Drive point						Bottom of boring at 4.6'	
	0								

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 109

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	L1-WP3	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	5.2
Location:	Law 1 Area / Bellingham, Washington	Top of Casing Elev.	6.74
Driller/Method:	JWC / Sledge hammer, well point	Depth to Water (ft BGS)	1.5' ATD
Sampling Method:		Start/Finish Date	1/31/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
5	1.25" diam stainless steel pipe						Beach sand (SP)	
1 / 4	Beach sand							1
	▽							
	▼ 1/31/2011							
2 / 3								2
3 / 2	1.25" diam stainless steel screen							3
4 / 1								4
	Drive point						Bottom of boring at 4.6'	

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JWC

Approved by: SJG

Figure No. A- 110

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	LP-SB09	1 of 1

Project Name: Georgia Pacific West Site

Location: Lignin Plant South / Bellingham, Washington

Driller/Method: Northwest Probe / Direct push soil probe

Sampling Method: 2.25" core

Ground Surface Elev: 15.1

Depth to Water (ft BGS):

Start/Finish Date: 9/15/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0	15						Asphalt	
							Moist, brown, slightly silty sand (SP-SM); fine to coarse sand	
			LP-SB09-1-2					
							Wet, dark gray, silty SAND (SM); scattered seashell fragments	
			LP-SB09-3.5-4.5					
5	10							5
							Becomes very silty	
							Wood	
							Soft, wet, dark gray, slightly sandy SILT (ML)	
		Temporary 2" well installed: 0.020" screen @ 7'-12', 10-20 sand filter pack. Well removed, borehole abandoned with granular bentonite.	LP-SB09-8-9					
							Gravel	
10	5						Wet, dark gray, slightly silty SAND (SM); numerous seashells, fine to coarse sand	10
			LP-SB09-091509					
							Medium stiff, wet, olive gray, slightly sandy SILT (ML); scattered wood, fine sand	
15	0							15
							Becomes trace sand	
							Wood	
							Wet, dark, gray, gravelly, silty SAND (SM); numerous seashells, fine to coarse sand	
20	-5						Bottom of boring @ 20'	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample
- Grab Sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 111

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	LP-SB10	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 13.5
Location: Lignin Plant Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 2.25" core
Start/Finish Date: 9/15/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 13.5							Asphalt	
		LP-SB10-1-2					Moist, dark olive gray, silty, sandy GRAVEL (GM)	
4 / 10		LP-SB10-4-5					Wet, dark olive gray, silty SAND (SM); fine sand	
5								5
							Medium stiff, wet, dark gray SILT (ML); trace fine sand	
		LP-SB10-7-8					Very dark gray, with organics	
8 / 5	Temporary 2" well installed: 0.020" screen @ 9'-12', 10-20 sand filter pack. Well removed, borehole abandoned with granular bentonite.	LP-SB10-091509					Wet, dark gray, silty SAND (SM); fine to coarse sand	
10								10
							Fine gravel, coarse sand	
12							Bottom of boring at 12'	
0								
15								15
-5								
20								20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample
- Grab Sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 112

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	LP-SB11	1 of 1

Project Name: Georgia Pacific West Site
Location: Lignin Plant Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 2.25" core
Ground Surface Elev: 14.3
Depth to Water (ft BGS):
Start/Finish Date: 9/15/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0–0.5							Asphalt
0.5–4.5			LP-SB11-1-2				Slightly moist, gray to brown, slightly silty, sandy GRAVEL (GM)
4.5–8	10	Temporary 2" well installed: 0.020" screen, 7'-10', 10-20 sand filter pack. Well removed, borehole abandoned with granular bentonite.	LP-SB11-4-5; LP-SB11-091509				Wet, dark gray, slightly silty to silty SAND (SM); seashell fragments, fine sand Becomes very silty
8–10	5		LP-SB11-8-9				Wet, dark olive gray, slightly silty SAND to slightly sandy SILT (SM-ML); fine sand
10–12							Wet, dark gray, gravelly, silty SAND interbedded with sandy SILT(SM/ML); occasional seashells
12							Bottom of boring at 12'

Depth scale: 5, 10, 15, 20. Elevation scale: 10, 5, 0, -5, -10.

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample
- Grab Sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	LP-SB12	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 13.9
Location: Lignin Plant Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 2.25" core
Start/Finish Date: 9/15/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 13.9							Gravel	
		LP-SB12-1-2					Moist, gray to brown, silty, gravelly SAND (SM); frequent wood and crushed concrete	
							Dark gray organics	
10		LP-SB12-4-5					Very moist to wet, olive gray, silty to very silty SAND (SM); trace gravel, grace wood, sand fine to medium.	
5								5
							Medium stiff, wet, olive gray, slightly sandy to sandy SILT (ML); fine to coarse sand	
		LP-SB12-7-8						
5	Temporary 2" well installed: 0.020" screen @ 9'-12', 10-20 sand filter pack. Well removed, borehole abandoned with granular bentonite.						Grades to wet, olive gray, silty SAND (SM); trace seashell fragments, fine to coarse sand	
10		LP-SB12-091509						10
							Very thin bed of coarse sand	
							Very thin bed of coarse sand	
							Bottom of boring at 12'	
0								
15								15
-5								
20								20
-10								

Sampler Type:
No Recovery
Continuous Core
Soil sample
Grab Sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 114

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	LP-SB13	1 of 1

Project Name: Georgia Pacific West Site

Location: Lignin Plant Area / Bellingham, Washington

Driller/Method: Northwest Probe / Direct push soil probe

Sampling Method: 2.25" core

Ground Surface Elev: 14.3

Depth to Water (ft BGS):

Start/Finish Date: 9/15/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
							Asphalt	
		LP-SB13-1-2					Slightly moist, brown, slighty silty SAND (SM); fine to medium sand Thin bed of organic silt	
							Slightly moist to wet, gray, slightly silty, slightly gravelly SAND (SW-SM); fine to coarse sand	
10	Temporary 2" well installed: 0.020" screen @ 9'-12', 10-20 sand filter pack. Well removed, borehole abandoned with granular bentonite.	LP-SB13-4-5					Wet, gray, silty SAND (SP-SM); fine sand	
5		LP-SB13-091509						5
		LP-SB13-7-8					Stiff, wet, olive gray, clayey SILT (ML); trace wood	
							Wet, dark gray, slightly gravelly, silty SAND (SM); trace wood, fine gravel, fine to coarse sand	
5							Bottom of boring at 9'	
10								10
0								
15								15
-5								
20								20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample
- Grab Sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 115

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	LP-SB14	1 of 1

Project Name: Georgia Pacific West Site
Location: Lignin Plant Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 2.25" core
Ground Surface Elev: 14
Depth to Water (ft BGS):
Start/Finish Date: 9/15/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14							Asphalt	
		LP-SB14-1-2					Slightly moist, brown, slightly silty, very gravelly SAND (SW); fine to coarse sand	
4 / 10							No recovery	
5	Temporary 2" well installed: 0.020" screen @ 5'-10", 10-20 sand filter pack. Well removed, borehole abandoned with granular bentonite.	LP-SB14-5-6					Wet, dark gray, silty SAND (SM); frequent seashell fragments	5
		LP-SB14-091509					Silt	
9 / 5		LP-SB14-9-10					Coarse sand	
10							Bottom of boring at 10'	10
15 / 0								15
20 / -5								20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample
- Grab Sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 116

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	MG-MW02	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	14.73
Location:	Million Gallon Tank Area / Bellingham, Washington	Top of Casing Elev.	14.43
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	1.17 - 3/30/2010
Sampling Method:	1.5" core	Start/Finish Date	3/25/2010

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0		8" flush mount monument set in concrete					Asphalt
1		▼ 3/30/2010	MG-MW02-0-0.5	NWTPH-Dx, PAHs			Red brick fragmental debris
			MG-MW02-0.5-1.0	NWTPH-Dx, PAHs			
2		3/4" sch 40 PVC riser					
3.5		3/8" bentonite chips	MG-MW02-2-3	NWTPH-Dx, PAHs			Moist, dark gray to black, slightly silty, slightly gravelly SAND (SP-SM)
5	10		MG-MW02-5-6	NWTPH-Dx, PAHs			Abundant organics, wood chips
6		10-20 silica sand					
7							Wet, gray, gravelly, clayey SILT (ML); scattered seashell fragments
8		Prepacked screen, 0.020" slot	MG-MW02-8-9	NWTPH-Dx, PAHs			Wet, gray, slightly silty SAND (SM); scattered seashells, fine to coarse sand
10	5						
12		Threaded plug					Thick bed wet, brown silt
12.5							Wood chips
14		10-20 silica sand					
15	0						
16		Slough					Wet, brown, silt (ML); scattered organics, scattered seashell fragments
19							Bottom of boring at 19'
20	-5						
25	-10						

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: MvdA

Approved by: SJG

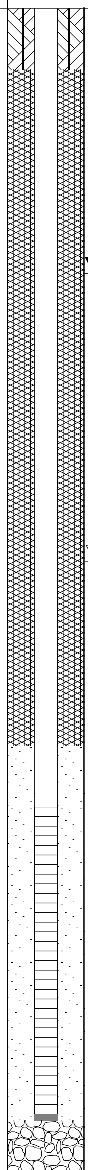
Figure No. A- 117

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	MG-MW03	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.1
Location:	Million Gallon Tank Area / Bellingham, Washington	Top of Casing Elev.	14.8
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	4.31 - 3/30/2010
Sampling Method:	1.5" core	Start/Finish Date	3/24/2010



Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0 / 15	8" flush mount monument set in concrete					Asphalt	
	3/4" sch 40 PVC riser					Slightly moist, gray, gravelly SAND (SP); trace silt, fine gravel, medium to coarse sand	
	3/30/2010					Very moist, dark gray, slightly sandy SILT (ML)	
5 / 10							5
	3/8" bentonite chips						
						Very moist to wet, gray-brown, silty, gravelly SAND (SM)	
10 / 5						Black stains	10
	10-20 silica sand					Becomes olive gray. Wood debris. Scattered seashell fragments	
						Wet, black, gravelly SAND (SP); scattered organics, faint burnt-wood smell, trace silt, fine gravel, fine to coarse sand.	
15 / 0	Prepacked screen, 0.020" slot						15
	Threaded cap						
	Slough					Wood chips Refusal at 19'.	
20 / -5							20

Sampler Type:
- No Recovery
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 118

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	MG-MW04	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 14.68
Depth to Water (ft BGS): 3 ATD
Start/Finish Date: 12/16/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	5" flush mount monument set in concrete						Asphalt	
							Moist, gray, silty, gravelly, SAND (SM)	
		MG-MW04-2-3	NWTPH-Dx	0				
	3/4" Sch 40 PVC riser						Moist, black, sandy, GRAVEL (GP); trace silt	
				0			Moist, black SAND (SP); trace silt Blue-green sandy material	
5	3/8" bentonite chips						Wet, silty, GRAVEL (GM)	5
		MG-MW04-6-7	NWTPH-Dx, TOC	0				
	10-20 silica sand	MG-MW04-7-8	NWTPH-Dx, PAH	0			Wet, dark brown to dark gray, silty, SAND (SM); abundant woody debris, scattered seashell fragments	
				0				
		MG-MW04-9-10	NWTPH-Dx	0				
10	Prepacked screen, 0.020" slot, 3/4" dia.			0				10
		MG-MW04-11-12	NWTPH-Dx, PAH					
	Threaded cap						Becomes very silty	
	Slough						Petroleum-like odor	
15							Bottom of boring at 15'	15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 119

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	MG-MW05	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev:
Top of Casing Elev.: 14.52
Depth to Water (ft BGS): 2.5 ATD
Start/Finish Date: 12/16/2010

Borehole Completion

- 5" flush mount monument set in concrete
- 3/4" Sch 40 PVC riser
- 3/8" bentonite chips
- 10-20 silica sand
- Prepacked screen, 0.020" slot, 3/4" dia.
- Threaded cap
- Slough

Sample Type/ID	Tests
MG-MW05-2-3	NWTPH-Dx, PAH
MG-MW05-5-6	NWTPH-Dx, TOC
MG-MW05-7-8	NWTPH-Dx
MG-MW05-9-10	NWTPH-Dx, PAH
MG-MW05-11-12	NWTPH-Dx

Description

- Slightly moist, green, silty, sandy GRAVEL (GM)
- Becomes black
- Wet, slightly gravelly, SAND (SW); fine to medium, subrounded to subangular sand, trace silt, scattered black organics
- Wet, silty SAND (SM); scattered fine to coarse woody fragments
- Woody debris
- Wet, silty SAND and silty GRAVEL (SM-GM)
- Wet GRAVEL (GW); angular gravel
- Gray, silty, gravelly, SAND (SP)
- Woody debris
- Wet SILT (ML); abundant woody debris
- Bottom of boring at 15'

Depth (ft): 5, 10, 15, 20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 120

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	MG-SB04	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 2.25" core
Ground Surface Elev: 14.8
Depth to Water (ft BGS):
Start/Finish Date: 9/14/2009

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–4		Hole abandoned with 3/8" bentonite chips	MG-SB04-2-4				SM	Moist, brown, silty, very gravelly SAND (SM); fine to medium gravel, fine to coarse sand	
4–11	10, 5		MG-SB04-6-8				SM	Wet, dark brown to black, silty, very gravelly SAND (SM); scattered wood, faint hydrocarbon-like odor, slight sheen, fine gravel, fine to coarse sand	5, 10
11–12			MG-SBO4-11-12				ML	Stiff, wet, dark brown, sandy SILT (ML); abundant wood, hydrocarbon-like odor, slight sheen, fine sand	
12–16	0						SM	Wet, dark brown to black, gravelly, silty SAND (SM); abundant wood, slight sheen, faint hydrocarbon-like odor, predominantly fine gravel, fine to coarse sand, predominantly coarse	15
16–20	-5		MG-SBO4-16-18				ML	Wet, olive gray, slightly sandy SILT (ML); wood at 16' Abundant wood, scattered seashells	20
20	-10							Bottom of boring @ 20'	

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 121

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB05	1 of 1

Project Name: Georgia Pacific West Site

Location: Million Gallon Tank Area / Bellingham, Washington

Driller/Method: Northwest Probe / Direct push soil probe

Sampling Method: 2.25" core

Ground Surface Elev: 14.9

Depth to Water (ft BGS):

Start/Finish Date: 9/14/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14.9						SM	Very moist, brown, silty, gravelly SAND (SM); fine gravel, fine to coarse sand	
		MG-SB05-2-4				ML	Soft, wet, dark brown to black SILT (ML); abundant organics and wood, hydrocarbon-like odor	
5 / 10	Hole abandoned with 3/8" bentonite chips					GM	Moist to wet, dark gray, slightly sandy, very silty GRAVEL (GM); organics, coarse gravel	5
		MG-SB05-7-8				GP	Slightly moist, light gray, slightly sandy GRAVEL (GP) (crushed rock)	
						SM	Wet, olive gray, slightly gravelly, silty SAND (SM); scattered wood	
10 / 5		MG-SBO5-10-11				SM	Wet, dark gray, silty SAND (SM); abundant seashell fragments	10
						ML	Medium stiff, wet, dark brown SILT (ML); mostly wood	
15 / 0		MG-SBO5-14-15						15
							Bottom of boring @ 16'	
20 / -5								20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 122

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB06	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 2.25" core
Ground Surface Elev: 15.4
Depth to Water (ft BGS):
Start/Finish Date: 9/21/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0	15						Concrete
3		Water level (ATD) ~4'	MG-SB06-3-5				Wet, dark gray, silty, gravelly SAND (SM); fine to coarse sand
5	10	Hole abandoned with 3/8" bentonite chips					
6							Very moist, dark gray to dark brown, slightly sandy to very sandy SILT (SP-ML) Gravelly @ 6'
7			MG-SB06-7-8				
8							Abundant wood @ 8'-9'
10	5		MG-SBO6-10-11				Scattered seashells @ 9'-15'
12							Gravelly @ 12'
14							Stiff, wet, dark olive gray to dark brown, trace to slightly sandy SILT (ML); scattered wood, scattered organics
15	0						
16							Abundant wood @ 16'-18'
20	-5						Bottom of boring @ 20'

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 123

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB07	1 of 1

Project Name: Georgia Pacific West Site

Location: Million Gallon Tank Area / Bellingham, Washington

Driller/Method: Northwest Probe / Direct push soil probe

Sampling Method: 2.25" core

Ground Surface Elev: 14.6

Depth to Water (ft BGS):

Start/Finish Date: 9/14/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–3	Hole abandoned with 3/8" bentonite chips	MG-SB07-1-2					Moist, brown, slightly silty, very gravelly SAND (SP-SM); fill with organics and grass, fine to coarse sand	
3–6							Wet, dark gray, slightly sandy, very silty GRAVEL (GM); abundant organics, hydrocarbon-like odor	5
6–14		MG-SB07-6-8 MG-SBO7-12-13					Wet, black, silty GRAVEL (GM); with sheen & hydrocarbon-like odor, with organics and crushed rock Thin bed silty fine sand Becomes slighly sandy	10
14–16		MG-SBO7-15-16					Soft, wet, dark brown, slightly sandy SILT (ML); with wood	15
16							Bottom of boring @16'	20

Depth scale: 5, 10, 15, 20. Elevation scale: 10, 5, 0, -5, -10.

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 124

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB08	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 2.25" core
Ground Surface Elev: 14.3
Depth to Water (ft BGS):
Start/Finish Date: 9/14/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14.3	Hole abandoned with 3/8" bentonite chips	MG-SB08-1-2				GM	Moist, brown to dark gray, slightly sandy, very silty GRAVEL (GM);	
4 / 10						SM	Very moist, dark gray, very silty SAND (SM); fine sand	
5								5
		MG-SB08-7-8					Wood	
							Gravel	
9 / 5						SM	Wet, dark brown to dark gray, silty SAND (SM); scattered wood and organics, fine to coarse sand, prodominantly fine	
10								10
		MG-SBO8-11-12						
12						SM-ML	Soft, wet, brown gray, very sandy SILT (SM-ML); abundant wood and organics, fine sand	
14 / 0							Wood	
15		MG-SBO8-15-16						15
16							Bottom of boring at 16'	
20 / -5								20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 125

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB09	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 2.25" core

Ground Surface Elev: 14.7
Depth to Water (ft BGS):
Start/Finish Date: 9/14/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14.7						GM	Moist to wet, brown, silty, very sandy GRAVEL (GM); coarse sand, fine gravel	
		MG-SB09-2-4					"Black organics," wet at 3.5'-4'	
4						SM	Very moist to wet, dark gray, silty SAND (SM); scattered wood and organics, trace seashell fragments, fine sand	
5 / 10	Hole abandoned with 3/8" bentonite chips							5
		MG-SB09-6-7					Hydrocarbon-like odor @ 6'-8'	
8						ML	Stiff, wet, dark brown, slightly sandy SILT (ML); scattered wood	
10 / 5								10
		MG-SBO9-11-12						
12							No recovery (wood in drive shoe?)	
15 / 0								15
16						ML	Soft, very moist, olive gray, slightly sandy SILT (ML); scattered seashell fragments, abundant wood, fine to medium sand, predominantly medium	
		MG-SBO9-19-20						
20 / -5							Bottom of boring @ 20'	20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 126

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB10	1 of 1

Project Name: Georgia Pacific West Site — Ground Surface Elev: 14.6

Location: Million Gallon Tank Area / Bellingham, Washington

Driller/Method: Northwest Probe / Direct push soil probe — Depth to Water (ft BGS):

Sampling Method: 2.25" core — Start/Finish Date: 9/14/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–4		MG-SB010-1-2					Medium stiff, slightly moist, gray, sandy, gravelly SILT (ML); black organic stain	
4–8 (5 / 10)	Hole abandoned with 3/8" bentonite chips	MG-SB010-7-8					Very moist, dark gray to black, silty SAND (SM); with bricks, wood, and organics.	5
8	▽						Wet	
8–10 (5)							Wet, dark brown, silty, gravelly SAND (SM); fine gravel, fine sand	
10–14 (10)		MG-SB10-11-12					Wet, dark gray, silty SAND (SM); abundant seashell fragments	10
14–16 (15 / 0)		MG-SB10-15-16					Wood	15
16							Bottom of boring @ 16'	
20 / -5								20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 127

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB11	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/20/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0	Hole backfilled with 3/8" bentonite chips					GP	Slightly moist, dark gray to dark brown, sandy GRAVEL (GP); angular to subangular gravel, trace silt	
2–3		MG-SB11-2-3						
3							Becomes wet	
4							Silty	
5		MG-SB11-5-6					Sandy	5
6						SP	Wet, dark gray SAND (SP); trace silt, trace gravel, scattered seashell fragments	
7		MG-SB11-7-8					Abundant woody debris	
9–10		MG-SB11-9-10						10
11						SM	Wet, dark gray, silty SAND (SM); fine to medium sand, scattered seashell fragments	
12–13		MG-SB11-12-13						
15								15
16							Woody debris	
16.5						ML	SILT (ML)	
17.5						SP	Silty SAND (SP); fine sand	
18							Bottom of boring at 18'	
20								20

Sampler Type:
No Recovery
Soil sample
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: MAR
Approved by: SJG
Figure No. A- 128

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	MG-SB12	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core
Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
	Hole backfilled with 3/8" bentonite chips					Slightly moist, gray, sightly silty, sandy GRAVEL (GW); medium to coarse angular gravel	
		MG-SB12-2-3				Moist, very silty, sandy GRAVEL (GM) Abundant organics	
						Woody debris	
5							5
		MG-SB12-6-7				Wet, gray, slightly silty to silty SAND (SP/SM); fine sand Petroleum-like odor and sheen 6'-7'	
		MG-SB12-8-9				Wet, gray-brown, SILT (OH); abundant woody debris	
						Wood	
10		MG-SB12-10-11				Wet, gray SAND (SW); fine to coarse (predominantly medium) angular to subrounded sand, trace fine organics, trace gravel	10
		MG-SB12-12-13				Petroleum-like odor and sheen	
		MG-SB12-13-14				Wet, dark gray SILT (ML)	
						Bottom of boring at 14'	
15							15
20							20

Sampler Type:
No Recovery
Soil sample
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JWC
Approved by: SJG
Figure No. A- 129

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB13	1 of 1

Project Name: Georgia Pacific West Site
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Sampling Method: 1.5" core

Ground Surface Elev
Depth to Water (ft BGS)
Start/Finish Date 12/20/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description	Depth (ft)
0–3.5		MG-SB13-2-3				Slightly moist, brown and gray, sandy GRAVEL (GP); angular, fine gravel, medium to coarse sand, trace silt	
3.5–6						Moist to wet, light gray to dark gray, silty, GRAVEL (GM); trace coarse sand	
5	Hole abandoned with 3/8" bentonite chips	MG-SB13-5-6					5
6–8.5		MG-SB13-7-8		0.4		Moist, black, gravelly, SILT (ML); abundant woody debris petroleum-like odor	
8.5–13		MG-SB13-9-10				Wet, gray, gravelly, silty, SAND (SM); woody fragments common	
10						Gravelly	10
		MG-SB13-12-13		0.8		Strong petroleum-like odor	
13–14						Wet, gray, sandy SILT; fine sand	
14–16						Woody debris	
15							15
16–17						Wet, gray, SILT (ML); trace fine gravel	
17–18						Wet, gray, silty SAND (SM)	
18						Bottom of boring at 18'	
20							20

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 130

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB14	1 of 1

Project Name: Georgia Pacific West Site

Location: Million Gallon Tank Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 12/20/2010

Borehole Completion: Hole backfilled with 3/8" bentonite chips

Depth / Elevation (feet)	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0					GM	Slightly moist, dark gray, silty, sandy, GRAVEL (GM); subangular fine gravel, scattered woody debris	
	MG-SB14-2-3					Becomes gray	
						Becomes brown	
5	MG-SB14-5-6					Beomes wet, green, very silty	5
	MG-SB14-7-8				SM	Moist, brown, silty SAND (SM); fine to medium sand, trace angular gravel, abundant woody debris	
					ML	SILT (ML)	
10	MG-SB14-9-10		0.2		SP	Moist, dark gray, SAND (SP); poorly-graded subrounded sand, trace gravel Becomes gravelly	10
	MG-SB14-12-13		0.7			Petroleum-like odor	
15						Woody debris	15
					ML	Wet, dark gray, SILT (ML)	
						Bottom of boring at 18'	
20							20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

▼ Static Water Level

▽ Water Level (ATD)

Logged by: MAR/Mv

Approved by: SJG

Figure No. A- 131

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB15	1 of 1

Project Name: Georgia Pacific West Site

Location: Million Gallon Tank Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

Ground Surface Elev

Depth to Water (ft BGS)

Start/Finish Date 12/20/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–1	Hole abandoned with 3/8" bentonite chips	No Recovery					Asphalt	
1–5				0			Slightly moist, brown, silty, gravelly SAND (SM); fine to coarse sand, scattered woody debris	
							Becomes yellow-gray, very silty	
		MG-SB15-3-4		0				
							Becomes dark gray	
5		MG-SB15-5-6		0			Moist, gray, slightly silty, sandy GRAVEL (GM); fine gravel, medium to coarse sand	5
6–13.5							Wet, gray, slightly silty SAND (SW); seashell fragments	
							Petroleum-like odor from 7' to 12.5', oily sheen	
		MG-SB15-7-8		0				
		MG-SB15-9-10		0				
10								10
		MG-SB15-12-13		0				
13.5–15				0			Wet, brown-gray SILT (ML)	
							Woody debris	
15							Bottom of boring at 15'	15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: MAR

Approved by: SJG

Figure No. A- 132

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	MG-SB16	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev
Location: Million Gallon Tank Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS)
Sampling Method: 1.5" core
Start/Finish Date 12/22/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–1		No Recovery					Asphalt	
1–4		MG-SB16-2-3					Slightly moist, brown and gray, gravelly SAND (SW); angular fine gravel, scattered woody debris, scattered concrete fragments	
4–7.5	Hole abandoned with 3/8" bentonite chips	MG-SB16-5-6					Moist, dark gray, silty, gravelly SAND (SM); fine to medium sand, woody debris	5
							Becomes dark gray to black, very silty	
7.5–8		MG-SB16-7-8					Woody debris	
8–14		MG-SB16-9-10					Wet, gray, slightly silty SAND (SP-SM); abundant seashell fragments, scattered fine gravel	10
		MG-SB16-12-13						
14–15							Wet, gray SILT (ML)	
15							Bottom of boring at 15'	15
20								20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: MAR
Approved by: SJG
Figure No. A- 133

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	MG-VP01	1 of 1

Project Name: Georgia Pacific West Site

Location: Million Gallon Tank Area / Bellingham, Washington

Driller/Method: Pacific NW Probe & Drill / Direct push soil probe

Sampling Method: 1.5" core

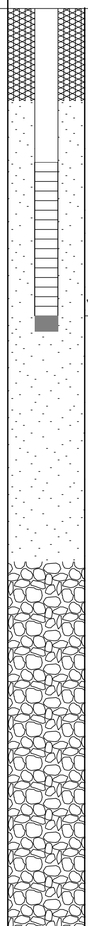
Ground Surface Elev

Top of Casing Elev.

Depth to Water (ft BGS) 1' ATD

Start/Finish Date 2/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite crumbles 3.4" diam Sch 40 PVC riser 10-20 sand 3/4" diam 0.010" slot Sch 40 PVC screen						Silty, sandy GRAVEL (GM)	
1	Slip cap						Becomes wet	1
2	Slough							2
3							Bottom of boring at 3' BGS.	3
4								4



Sampler Type:

No Recovery

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 134

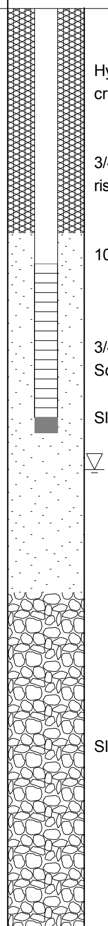
_GP_MONITORING WELL GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	MG-VP02	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	
Location:	Million Gallon Tank Area / Bellingham, Washington	Top of Casing Elev.	
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	1.5' ATD
Sampling Method:	1.5" core	Start/Finish Date	2/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite crumbles						Moist, brown, slighly silty, gravelly SAND (SW); well-graded fine to coarse sand	
	3/4" diam Sch 40 PVC riser							
	10-20 sand							
1	3/4" diam 0.010" slot Sch 40 PVC screen							1
	Slip cap							
							Becomes wet, become black	
2								2
	Slough							
3							Bottom of boring at 3' BGS	3
4								4



Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: MvdA

Approved by: SJG

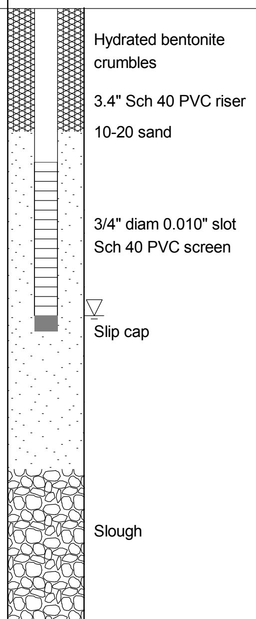
Figure No. A- 135

![Aspect Consulting]

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	MG-VP03	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	
Location:	Million Gallon Tank Area / Bellingham, Washington	Top of Casing Elev.	
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	1' ATD
Sampling Method:	1.5" core	Start/Finish Date	2/2/2011



Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0							Asphalt	
							Brown to black, silty, sandy GRAVEL (GM)	
1							Becomes wet, becomes black	1
2							Bottom of boring at 2' BGS	2
3								3
4								4

Sampler Type:
No Recovery

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 136

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
070188	MG-VP04	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	
Location:	Million Gallon Tank Area / Bellingham, Washington	Top of Casing Elev.	
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	not encountered
Sampling Method:	1.5" core	Start/Finish Date	2/2/2011

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	Hydrated bentonite crumbles						Asphalt	
	3.4" diam Sch 40 PVC riser						Silty, sandy GRAVEL (GM)	
1								1
	10-20 sand							
2								2
	3/4" diam 0.010" slot Sch 40 PVC screen							
							Gravelly, sandy SILT (ML)	
3	Slip cap							3
	Slough							
							Bottom of boring at 3.2' BGS	
4								4

Sampler Type:

No Recovery

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 137

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	PR-MW01	1 of 1

Project Name: Georgia Pacific West Site
Location: Laurel Street Pipe Rack / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 15.53
Top of Casing Elev.: 15.23
Depth to Water (ft BGS): 3.92 - 3/30/2010
Start/Finish Date: 9/14/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 15	8" flush mount monument set in concrete						Asphalt	
							Moist, dark olive gray, slightly gravelly, very silty SAND (SM); fine gravel, predominantly fine to medium sand	
		PR-MW01-1-3	Total Hg					
	3/4" Sch 40 PVC riser						Wood	
	3/30/2010 (static water level)						Very stiff, wet, dark gray, slighty sandy, slightly gravelly SILT (ML)	
	3/8" bentonite chips						Medium stiff, wet, dark gray, slightly gravelly, sandy SILT (ML)	
5 / 10	9/28/2009 (static water level)	PR-MW01-5-6	Dioxins					5
		PR-MW01-5-7	Total Hg				Wood	
	10-20 silica sand						Becomes darker	
							Loose, wet, dark gray, sandy SILT (ML)	
		PR-MW01-9-10	Total Hg					
10 / 5	Prepacked screen, 0.020" slot, 3/4" diam.						Wet, gray, silty SAND (SM); frequent seashell fragments, fine to medium sand, predominantly fine	10
	Slip cap	PR-MW01-13-14	Total Hg					
15 / 0							Wood	15
							Medium stiff, wet, olive brown, slightly sandy SILT (ML); occasional seashell fragments, trace wood, fine sand	
	3/8" bentonite chips	PR-MW01-17-18	Total Hg					
							Seashells	
20 / -5							Bottom of boring at 20'	20

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 138

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	PR-MW02	1 of 1

Project Name: Georgia Pacific West Site
Location: Laurel Street Pipe Rack / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 3.25" core

Ground Surface Elev: 14.62
Top of Casing Elev.: 14.32
Depth to Water (ft BGS): 3.02 - 3/30/2010
Start/Finish Date: 9/22/2009

Borehole Completion

- 8" flush mount monument set in concrete
- 3/4" Sch 40 PVC riser
- 3/30/2010 (static water level)
- 9/28/2009 (static water level)
- 3/8" bentonite chips
- 10-20 silica sand
- Prepacked screen, 0.020" slot, 3/4" diam.
- Slip cap
- 3/8" bentonite chips

Sample Type/ID	Tests
PR-MW02-1-2.5	Total Hg
PR-MW02-3.5-5	Total Hg
PR-MW02-9-10	Total Hg
PR-MW02-13-14	Total Hg
PR-MW02-17-18	Total Hg

Depth (ft)	Description
0–1.5	Slightly moist, brown, slightly silty, sandy GRAVEL (GW)
1.5–3	Moist, gray, slightly silty SAND (SP); trace gravel, fine sand
3–7	Moist, slightly silty, sandy GRAVEL (GW)
	Becomes black and wet
7–14	Wet, gray, SAND (SW); trace gravel, occasional seashell fragments, fine to coarse sand
14–15	Wet, gray SAND (SP); fine sand
15–20	Medium stiff, gray, wet, very sandy SILT (ML); trace gravel, trace wood, fine sand
20	Bottom of boring at 20'

Depth / Elevation (feet): 5 / 10, 10 / 5, 15 / 0, 20 / -5, -10

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 139

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
070188	PR-MW03	1 of 1

Project Name:	Georgia Pacific West Site	Ground Surface Elev	15.64
Location:	Laurel Street Pipe Rack / Bellingham, Washington	Top of Casing Elev.	15.34
Driller/Method:	Pacific NW Probe & Drill / Direct push soil probe	Depth to Water (ft BGS)	4.1 - 3/30/2010
Sampling Method:	1.5" core	Start/Finish Date	3/25/2010

Depth / Elevation (feet) | Borehole Completion | Sample Type/ID | Tests | PID (ppm) | Soil pH | Material Type | Description | Depth (ft)

Borehole Completion:
- 8" flush mount monument set in concrete
- 3/4" Sch 40 PVC riser
- 3/30/2010
- 3/8" bentonite chips
- 10-20 silica sand
- Prepacked screen, 0.020" slot, 3/4" diam.
- Threaded cap
- Slough

Samples / Tests:

Sample Type/ID	Tests
PR-MW03-1-2	Total Hg
PR-MW03-3-4	Total Hg
PR-MW03-7-8	Total Hg
PR-MW03-9-10	Total Hg
PR-MW03-13-14	Total Hg

Description:
- Asphalt
- Moist, brown to gray, gravelly, slightly silty SAND (SM); fine gravel, scattered wood debris, fine to coarse sand
- Becomes very silty and black
- Red brick fragments
- Creosote-like smell. Visible sheen.
- Wet, gray SAND (SP); scattered wood fragments, scattered seashell fragments, fine to coarse sand.
- Wood chips
- Wet, gray, slightly sandy SILT (ML); seashell fragments
- Bottom of boring at 20'.

Depth scale: 5, 10, 15, 20. Elevation scale: 15, 10, 5, 0, -5.

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 140

_GP_MONITORING WELL GEORGIA PACIFIC WEST SITE RIFS.GPJ September 11, 2012

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	PR-SB02	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 15.5
Location: Laurel Street Pipe Rack / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 2.25" core
Start/Finish Date: 9/14/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0–1	15	Hole abandoned with 3/8" bentonite chips					Asphalt
1–4			PR-SB02-1-3				Slightly moist, gray, sand, silty GRAVEL (FILL); appears to be mostly asphalt
4–7			PR-SB02-4-5				Moist, gray, slightly gravelly, silty sand (SM); predominantly fine sand Wood Fine to coarse sand
5	10		PR-SB02-6-7				
7–11			PR-SB02-9-10				Wet, dark gray, slightly gravelly, silty SAND (SM); fine to coarse gravel, fine to coarse sand
10	5						
11–15			PR-SB02-13-14				Wet, gray, silty SAND (SM); frequent seashell fragments, predominantly fine sand
15	0						Wood
16.5–20			PR-SB02-17-18				Stiff, wet, olive, brown silt (ML); trace fine sand, occasional seashell fragments
20	-5						Bottom of boring at 20'

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 141

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	PR-SB03	1 of 1

Project Name: Georgia Pacific West Site
Location: Laurel Street Pipe Rack / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Sampling Method: 2.25" core
Ground Surface Elev: 15.9
Depth to Water (ft BGS):
Start/Finish Date: 9/14/2009

Borehole Completion: Hole abandoned with 3/8" bentonite chips

Depth (ft)	Elevation (feet)	Sample Type/ID	Description
0	15.9		Asphalt
	15	PR-SB03-1-3	Moist, dark gray, gravelly, very silty SAND (SM); occasional wood, olive staining, trace seashell fragments, fine to medium sand
5	10	PR-SB03-5-7	Medium stiff, very moist, gray SILT(ML); trace gravel, trace sand, frequent wood, occasional seashell fragments
			Stiff, very moist, dark gray, slightly sandy SILT (ML); trace gravel, frequent wood and organics, occasional seashell fragments
		PR-SB03-9-10	Wood
10	5	PR-SB03-13-14	Wet, gray, very silty SAND (SM); trace gravel, frequent seashell fragments
15	0		Wood
		PR-SB03-17-18	Medium stiff, wet, olive brown, slightly sandy SILT (ML); occasional wood, occasional seashell fragments
20	-5		Bottom of boring at 20'

Sampler Type:
No Recovery
Soil sample
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 142

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	PR-SB04	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 14.3
Location: Laurel Street Pipe Rack / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 2.25" core
Start/Finish Date: 9/14/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0–4		Hole abandoned with 3/8" bentonite chips	PR-SB04-1-3				Slightly moist, gray to dark brown, silty, sandy GRAVEL (GM); fine to coarse sand, fine to coarse gravel
4–6	10						Wet, olive gray, slightly gravelly, very silty SAND (SM); fine to coarse sand, predominantly fine Wood
6–8			PR-SB04-5-7				Medium stiff, wet, dark gray, sandy, very gravelly SILT (ML) Coarse gravel. Wood.
8–12	5		PR-SB04-10-12				Slightly moist, gray, slightly silty, very gravelly SAND (SW); fine to coarse gravel, fine to coarse sand
12–15	0						No recovery. Concrete.
15							Bottom of boring at 15'

Sampler Type:
No Recovery
Soil sample
Continuous Core

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 143

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	PR-SB05	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 14.6
Location: Laurel Street Pipe Rack / Bellingham, Washington
Driller/Method: Northwest Probe / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 2.25" core
Start/Finish Date: 9/14/2009

Depth (ft)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Description
0							Asphalt
							Slightly moist, brown, sandy, very silty GRAVEL (GM)
1–2			PR-SB05-1-2				Medium stiff, very moist, gray, slightly sandy SILT (ML); few thin beds of fine sand
3.5	10	Hole abandoned with 3/8" bentonite chips					Wet, dark gray, slightly silty SAND (SP); fine to medium sand
5–7			PR-SB05-5-7				
9	5		PR-SB05-9-10				Wet, dark gray SILT (ML); trace fine sand
9.5							Wet, dark gray, slightly silty SAND (SW); frequent seashell fragments, gray and white sand, fine to coarse sand, predominantly fine to medium
13–14			PR-SB05-13-14				
15	0						Wood
16							Soft, wet, dark olive gray SILT (ML); trace fine sand, occasional wood
17–18			PR-SB05-17-18				
19.5	-5						Seashells
20							Bottom of boring at 20'
25	-10						

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: JTL
Approved by: SJG
Figure No. A- 144

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	PR-SB06	1 of 1

Project Name: Georgia Pacific West Site

Ground Surface Elev: 14.1

Location: Laurel Street Pipe Rack / Bellingham, Washington

Driller/Method: Northwest Probe / Direct push soil probe

Depth to Water (ft BGS):

Sampling Method: 2.25" core

Start/Finish Date: 9/14/2009

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14.1	Hole abandoned with 3/8" bentonite chips	PR-SB06-0.5-2.5				GM	Moist, dark brown, silty, sandy GRAVEL (GM)	
2.5		No Recovery				GM	Moist to wet, brown, sandy GRAVEL (GM); coarse sand, fine to coarse gravel	
3.5 / 10 (water level ATD)		PR-SB06-3.5-5						
5		PR-SB06-5-6.5				SP-SM	Wet, dark gray, slightly silty SAND (SP-SM); fine to coarse sand	5
							Trace fine gravel	
8		No Recovery						
9 / 5		PR-SB06-9-10						
10							Sand becomes fine to medium, predominantly fine	10
13		PR-SB06-13-14						
14 / 0		No Recovery					Abundant wood	
						ML	Stiff, wet, dark olive gray, slightly sandy SILT (ML); occasional seashells	15
							Becomes trace sand	
17		PR-SB06-17-18						
19 / -5		No Recovery					Abundant seashell fragments	
20							Bottom of boring at 20'	20
-10								

Sampler Type:
- No Recovery
- Continuous Core
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

- ▼ Static Water Level
- ▽ Water Level (ATD)

Logged by: JTL

Approved by: SJG

Figure No. A- 145

Boring Log

Project Number	Boring Number	Sheet
070188	SW-HA01	1 of 1

Project Name: Georgia Pacific West Site
Location: Swale Area / Bellingham, Washington
Driller/Method: JWC / Sharpshooter shovel
Sampling Method: Manual excavation
Ground Surface Elev: 14
Depth to Water (ft BGS):
Start/Finish Date: 3/24/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14	Backfilled with auger spoils	SW-HA01-0-0.5					Brown, moist, silty, sandy GRAVEL (GM)	
		SW-HA01-0.5-1.0						
1 / 13								1
2 / 12								2
3 / 11								3
4 / 10								4

Sampler Type:
No Recovery
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JCW
Approved by: SJG
Figure No. A- 146

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	SW-HA02	1 of 1

Project Name: Georgia Pacific West Site

Location: Swale Area / Bellingham, Washington

Driller/Method: JWC / Sharpshooter shovel

Sampling Method: Manual excavation

Ground Surface Elev: 14.3

Depth to Water (ft BGS):

Start/Finish Date: 3/24/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14	Backfilled with auger spoils	SW-HA02-0-0.5; SW-HA02-0.5-1.0					Gray to brown, silty, sandy GRAVEL (GM)	
1 / 13								1
2 / 12								2
3 / 11								3
4 / 10								4

Sampler Type:
- No Recovery
- Soil sample

PID - Photoionization Detector (Headspace Measurement)

Static Water Level

Water Level (ATD)

Logged by: JCW

Approved by: SJG

Figure No. A- 147

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	SW-HA03	1 of 1

Project Name: Georgia Pacific West Site
Location: Swale Area / Bellingham, Washington
Driller/Method: JWC / Sharpshooter shovel
Sampling Method: Manual excavation

Ground Surface Elev: 14.3
Depth to Water (ft BGS):
Start/Finish Date: 3/24/2010

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
	14	Backfilled with auger spoils	SW-HA03-0-0.5					Brown to black, silty, sandy GRAVEL (GM). Creosote-like odor.	
			SW-HA03-0.5-1.0						
1	13								1
2	12								2
3	11								3
4	10								4

Sampler Type:
No Recovery
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JCW
Approved by: SJG
Figure No. A- 148

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	SW-HA04	1 of 1

Project Name: Georgia Pacific West Site
Location: Swale Area / Bellingham, Washington
Driller/Method: JWC / Sharpshooter shovel
Sampling Method: Manual excavation
Ground Surface Elev: 14.3
Depth to Water (ft BGS):
Start/Finish Date: 3/24/2010

Depth (feet)	Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0–0.5	14	Backfilled with auger spoils	SW-HA04-0-0.5				GM	Brown to gray, silty, sandy GRAVEL (GM).	
0.5–1.0			SW-HA04-0.5-1.0				SP	Brown to gray SAND (SP); trace silt, trace gravel	
1	13								1
2	12								2
3	11								3
4	10								4

Sampler Type:
No Recovery
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JCW
Approved by: SJG
Figure No. A- 149

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	SW-HA05	1 of 1

Project Name: Georgia Pacific West Site
Location: Swale Area / Bellingham, Washington
Driller/Method: JWC / Sharpshooter shovel
Sampling Method: Manual excavation
Ground Surface Elev: 15
Depth to Water (ft BGS):
Start/Finish Date: 3/25/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 15	Backfilled with auger spoils	SW-HA05-0-0.5; SW-HA05-0.5-1.0				GP	Crushed rock gravel (GP); trace asphalt	0
1 / 14								1
2 / 13								2
3 / 12								3
4 / 11								4

Sampler Type:
- No Recovery
- Soil sample

PID - Photoionization Detector (Headspace Measurement)
- Static Water Level
- Water Level (ATD)

Logged by: JCW
Approved by: SJG
Figure No. A- 150

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	SW-HA06	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 14
Location: Swale Area / Bellingham, Washington
Driller/Method: JWC / Sharpshooter shovel
Depth to Water (ft BGS):
Sampling Method: Manual excavation
Start/Finish Date: 3/25/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14	Backfilled with auger spoils	SW-HA06-0-0.5					Asphalt	
		SW-HA06-0.5-1.0					Crushed rock gravel (GP)	
1 / 13								1
2 / 12								2
							Sand (SP); trace seashells	
3 / 11								3
4 / 10								4

Sampler Type:
No Recovery
Soil sample

PID - Photoionization Detector (Headspace Measurement)
Static Water Level
Water Level (ATD)

Logged by: JCW
Approved by: SJG
Figure No. A- 151

Aspect CONSULTING

Boring Log

Project Number	Boring Number	Sheet
070188	SW-SB01	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 14.2
Location: Swale Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 1.5" core
Start/Finish Date: 3/25/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 14.2	Hole abandoned with 3/8" bentonite chips						Asphalt	
1		SW-SB01-0-0.5; SW-SB01-0.5-1					Moist, gray, silty, gravelly SAND (SM); fine gravel, fine to coarse sand	
2		SW-SB01-2-3					Wood debris	
2.5							Wet, dark gray, SAND (SP)	
5 / 10		SW-SB01-5-6						5
6.5							Wet, dark gray, silty SAND (SM); abundant seashell fragments, abundant wood fragments, fine to medium sand	
8		SW-SB01-8-9						
10 / 5								10
11.5							Wet, dark gray SILT (ML)	
12							Bottom of boring at 12'	
15 / 0								15
20 / -5								20
-10								

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 152

Boring Log

Aspect CONSULTING

Project Number	Boring Number	Sheet
070188	SW-SB02	1 of 1

Project Name: Georgia Pacific West Site
Ground Surface Elev: 13.8
Location: Swale Area / Bellingham, Washington
Driller/Method: Pacific NW Probe & Drill / Direct push soil probe
Depth to Water (ft BGS):
Sampling Method: 1.5" core
Start/Finish Date: 3/25/2010

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Soil pH	Material Type	Description	Depth (ft)
0 / 13.8	Hole abandoned with 3/8" bentonite chips	SW-SB02-0-0.5; SW-SB02-0.5-1; SW-SB02-2-3				SP	Wet, light gray, gravelly SAND (SP); trace silt, fine gravel, fine to coarse sand. Predominantly coarse sand	
							No recovery	
5		SW-SB02-5-6				SP	Wet, gray SAND (SP); fine to coarse sand. Becomes fine to medium sand	5
		SW-SB01-8-9				ML	Wet, dark brown SILT (ML); abundant wood debris, abundant organics	
10								10
						SM	Wet, gray, slightly silty SAND (SM); scattered seashells, abundant wood debris	
		SW-SB01-14-15				ML	Wet, gray, slightly sandy SILT (ML); scattered seashells, scattered wood	
15							Bottom of boring at 15'	15
20								20

Elevation scale: 10, 5, 0, -5, -10

Sampler Type:
- No Recovery
- Soil sample
- Continuous Core

PID - Photoionization Detector (Headspace Measurement)

- Static Water Level
- Water Level (ATD)

Logged by: MvdA

Approved by: SJG

Figure No. A- 153

APPENDIX B

Hydrogeologic Data Evaluation

Table B-1 Tidal Study Data

GP West Site RI/FS

Well	Date of Tide Study		Dates Analyzed		Mean Groundwater Surface Elevation (Serfes)	Maximum Tidal Fluctuation	Maximum WL Fluctuation	Maximum Tidal Efficiency
	Start	Finish	Start	Finish	in Feet	in Feet	in Feet	
Fill Unit								
AA-MW01	10/15/09	10/29/09	10/19/09	10/21/09	7.62	9.3	1.51	0.16
CP-MWA3	10/15/09	10/29/09	10/19/09	10/21/09	6.82	9.3	1.15	0.12
CP-MWC3	10/15/09	10/29/09	10/19/09	10/21/09	6.53	9.3	2.27	0.24
AA-MW04	10/15/09	10/29/09	10/19/09	10/21/09	10.26	9.3	0.09	0.01
CF-MW02	10/15/09	10/29/09	10/19/09	10/21/09	12.30	9.3	0.17	0.02
CP-MW03	10/15/09	10/29/09	10/19/09	10/21/09	12.82	9.3	0.07	0.01
CP-MWA1	10/15/09	10/29/09	10/19/09	10/21/09	8.27	9.3	0.3	0.03
CP-MWC1	10/15/09	10/29/09	10/19/09	10/21/09	8.05	9.3	0.27	0.03
EMW-10S	10/15/09	10/29/09	10/19/09	10/21/09	9.63	9.3	0.11	0.01
LAW-1	10/15/09	10/29/09	10/19/09	10/21/09	8.46	9.3	0.25	0.03
CP-MW07	04/16/10	04/21/10	04/17/10	04/19/10	7.04	9.24	2.33	0.25
CP-MW08	04/16/10	04/21/10	04/17/10	04/19/10	8.55	9.24	0.14	0.02
CP-MW09	04/16/10	04/21/10	04/17/10	04/19/10	9.09	9.24	0.13	0.01
CP-MW12	04/16/10	04/21/10	04/17/10	04/19/10	8.02	9.24	0.51	0.06
CP-MW10	05/11/10	05/14/10	05/11/10	05/14/10	9.80	8.94	0.23	0.03
CP-MWB1	05/11/10	05/14/10	05/11/10	05/14/10	8.42	8.94	0.11	0.01
CP-MWB2	05/11/10	05/14/10	05/11/10	05/14/10	7.19	8.94	0.11	0.01
CP-MWB3	05/11/10	05/14/10	05/11/10	05/14/10	6.01	8.94	0.87	0.10
AA-MW01	05/11/10	05/14/10	05/11/10	05/14/10	7.32	8.94	0.95	0.11
AA-MW03	05/11/10	05/14/10	05/11/10	05/14/10	8.67	8.94	0.11	0.01
AA-MW04	05/11/10	05/14/10	05/11/10	05/14/10	11.39	8.94	0.07	0.01
FH-MW01	05/11/10	05/14/10	05/11/10	05/14/10	8.98	8.94	0.09	0.01
Lower Sand								
CP-MW04	10/15/09	10/29/09	10/19/09	10/21/09	6.66	9.3	0.52	0.06
CP-MW05	10/15/09	10/29/09	10/19/09	10/21/09	6.50	9.3	1.65	0.18
EMW-28D	10/15/09	10/29/09	10/19/09	10/21/09	7.20	9.3	0.6	0.06
EMW-29D	10/15/09	10/29/09	10/19/09	10/21/09	6.66	9.3	2.38	0.26

Table B-2 Ferris Method K Estimates

GP West Site RI/FS

Hydraulic Conductivity (K) Calculations Using Stage Ratio Method

	CP-MW05	CP-MW04	EMW-29D	EMW-28D
Distance from Tide in Feet	216	522	95	450
Storage Coefficient	1E-05	1E-05	1E-05	1E-05
Tidal Period in Hours	12.4	12.4	12.4	12.4
Tidal Period in Days	0.5	0.5	0.5	0.5
Tidal Efficiency	0.16	0.05	0.24	0.05
Aquifer Thickness in Feet	25	25	25	25
T in ft2/day	1.075	1.935	0.372	1.594
K in ft/min	0.000	0.000	0.000	0.000
K in cm/sec	**2E-05**	**3E-05**	**5E-06**	**2E-05**

Hydraulic Conductivity (K) Calculations Using Time Lag Method - Min Peaks

	CP-MW05	CP-MW04	EMW-29D	EMW-28D
Distance from Tide in Feet	216	500	95	450
Storage Coefficient	1E-05	1E-05	1E-05	1E-05
Tidal Period in Hours	12.4	12.4	12.4	12.4
Time Lag in Hours	1.25	1.90	1.28	2.38
Aquifer Thickness in Feet	25	25	25	25
K in cm/sec	**1E-04**	**3E-04**	**3E-05**	**1E-04**

Hydraulic Conductivity (K) Calculations Using Time Lag Method - Max peaks

	CP-MW05	CP-MW04	EMW-29D	EMW-28D
Distance from Tide in Feet	216	500	95	450
Storage Coefficient	1.23387E-05	1.0824E-05	1.36098E-05	1.09068E-05
Tidal Period in Hours	12.4	12.4	12.4	12.4
Time Lag in Hours	1.07	1.24	1.07	1.67
Aquifer Thickness in Feet	25	25	25	25
K in cm/sec	**2E-04**	**6E-04**	**4E-05**	**3E-04**

Table B-3 - Slug Test Analyses to Estimate Aquifer Hydraulic Conductivity

GP West Site RI/FS 070188

Monitoring Well	CP-MW05		CP-MW04		CP-MWC3		CP-MWB3		CP-MWA3		CP-MWC2		CP-MWB2		CP-MWA2		CP-MWC1		CP-MWB1		CP-MWA1	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
Well Depth in Feet	**39.7**	**39.7**	**39.7**	**39.7**	**15.5**	**15.5**	**16.0**	**16.0**	**13.5**	**13.5**	**16.0**	**16.0**	**16.0**	**16.0**	**16.0**	**16.0**	**14.0**	**14.0**	**16.0**	**16.0**	**16.0**	**16.0**
Screen Length in Feet	**9.8**	**9.8**	**9.8**	**9.8**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**
Depth to Screen in Feet	**29.7**	**29.7**	**29.7**	**29.7**	**10.6**	**10.6**	**11.1**	**11.1**	**8.6**	**8.6**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**9.1**	**9.1**	**11.1**	**11.1**	**11.1**	**11.1**
Depth to Aquitard in Feet	**120**	**120**	**120**	**120**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**
Depth to Water in Feet	**9.5**	**9.5**	**8.9**	**8.9**	**9.9**	**9.9**	**7.0**	**7.0**	**6.2**	**6.2**	**7.6**	**7.6**	**7.3**	**7.3**	**7.0**	**7.0**	**5.8**	**5.8**	**7.6**	**7.6**	**6.2**	**6.2**
Depth to Sandpack in Feet	**27.0**	**27.0**	**27.0**	**27.0**	**8.6**	**8.6**	**9.1**	**9.1**	**6.6**	**6.6**	**9.1**	**9.1**	**9.1**	**9.1**	**9.1**	**9.1**	**7.1**	**7.1**	**9.1**	**9.1**	**9.10**	**9.1**
Slug Displacement (H_o) in Feet	**13.31**	**13.29**	**13.62**	**14.01**	**2.08**	**1.35**	**5.26**	**5.46**	**3.02**	**4.05**	**3.09**	**2.01**	**2.94**	**1.87**	**3.05**	**2.03**	**2.93**	**2.07**	**4.46**	**1.92**	**3.12**	**2.47**
Porosity (n)	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**
Radius of Casing (r_c) in Feet	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**
Radius of Borehole (r_w) in Feet	**0.25**	**0.25**	**0.25**	**0.25**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**	**0.13**
Saturated Aquifer Thickness (H) in Feet	110.5	110.5	111.1	111.1	10.1	10.1	13.0	13.0	13.8	13.8	12.4	12.4	12.7	12.7	13.0	13.0	14.2	14.2	12.4	12.4	13.8	13.8
Saturated Well Thickness (L_w) in Feet	30.0	30.0	30.6	30.6	5.6	5.6	9.0	9.0	7.3	7.3	8.4	8.4	8.7	8.7	9.0	9.0	8.2	8.2	8.4	8.4	9.8	9.8
Effective Radius (r_{eff}) in Feet	0.083	0.083	0.083	0.083	0.098	0.098	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
Effective Screen Length (L_e) in Feet	9.8	9.8	9.8	9.8	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Rising/Falling Head Test	Rising	Rising	Rising	Rising	Rising	Falling	Rising	Rising	Falling	Rising	Falling	Rising	Falling	Rising	Falling	Rising	Falling	Rising	Falling	Rising	Falling	Rising
Fully Submerged Sandpack	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	Yes
Transiently Exposed Sandpack	No	No	No	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No
Transiently Exposed Screen	No	No	No	No	Yes	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Partially Submerged Screen	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Bouwer and Rice Parameters																						
Normalized Head at t_1 (y_1) in Feet	**0.79**	**0.96**	**0.83**	**0.69**	**0.68**	**0.40**	**0.31**	**0.53**	**0.15**	**0.71**	**0.54**	**0.63**	**0.36**	**0.28**	**0.51**	**0.70**	**0.51**	**0.84**	**0.28**	**0.59**	**0.14**	**0.64**
Time - t_1 in Seconds	**2.60**	**0.80**	**3.90**	**7.50**	**12.40**	**11.10**	**10.60**	**6.30**	**20.10**	**6.20**	**10.50**	**38.80**	**10.50**	**30.90**	**10.10**	**30.90**	**34.50**	**32.40**	**17.90**	**31.80**	**427.50**	**424.00**
Normalized Head at t_2 (y_2) in Feet	**0.15**	**0.23**	**0.30**	**0.19**	**0.32**	**0.27**	**0.15**	**0.28**	**0.05**	**0.59**	**0.51**	**0.27**	**0.19**	**0.13**	**0.31**	**0.45**	**0.36**	**0.75**	**0.18**	**0.44**	**0.08**	**0.52**
Time - t_2 in Seconds	**19.5**	**15.2**	**24.7**	**33.4**	**37.8**	**18.8**	**18.3**	**12.7**	**37.7**	**11.2**	**15.5**	**139.1**	**24.9**	**55.5**	**52.4**	**79.0**	**88.1**	**56.9**	**51.5**	**56.5**	**882.0**	**880.5**
L_e/r_w	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2
Coefficient A [a]	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Coefficient B [a]	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Coefficient C [a]	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Partially Penetrating Well																						
$\ln(R_e/r_w)$ [b]	2.7	2.7	2.8	2.8	2.5	2.5	2.7	2.7	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8
K in cm/sec	**2.9E-03**	**2.9E-03**	**1.5E-03**	**1.5E-03**	**2.2E-03**	**3.8E-03**	**5.6E-03**	**5.9E-03**	**3.9E-03**	**2.1E-03**	**7.0E-04**	**5.0E-04**	**2.5E-03**	**1.9E-03**	**7.0E-04**	**5.4E-04**	**3.9E-04**	**2.5E-04**	**8.1E-04**	**6.8E-04**	**7.8E-05**	**2.7E-05**
Fully Penetrating Well																						
$\ln(R_e/r_w)$ [b]	3.5	3.5	3.5	3.5	2.9	2.9	3.2	3.2	3.0	3.0	3.1	3.1	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.2	3.2
K in cm/sec	**3.6.E-03**	**3.7.E-03**	**1.9.E-03**	**1.9.E-03**	**2.5.E-03**	**4.4.E-03**	**6.5.E-03**	**6.8.E-03**	**4.6.E-03**	**2.4.E-03**	**8.1.E-04**	**5.8.E-04**	**2.9.E-03**	**2.2.E-03**	**8.1.E-04**	**6.2.E-04**	**4.5.E-04**	**2.9.E-04**	**9.4.E-04**	**7.9.E-04**	**9.1.E-05**	**3.1.E-05**
K in ft/day	8.13	8.26	4.20	4.18	6.22	10.82	15.80	16.73	11.16	5.90	1.99	1.43	7.04	5.28	1.98	1.52	1.10	0.70	2.29	1.92	0.22	0.08

Data analysis by method of Bouwer and Rice (1976; 1989)
Bold values are entered from field data and other values are calculated.
All depths are below ground surface
[a] A, B, and C coefficients are calculated using regression equations of Van Rooy (1988).
[b] R_e/r_w is the effective radial distance over which y is dissipated, divided by the radial distance of well development.

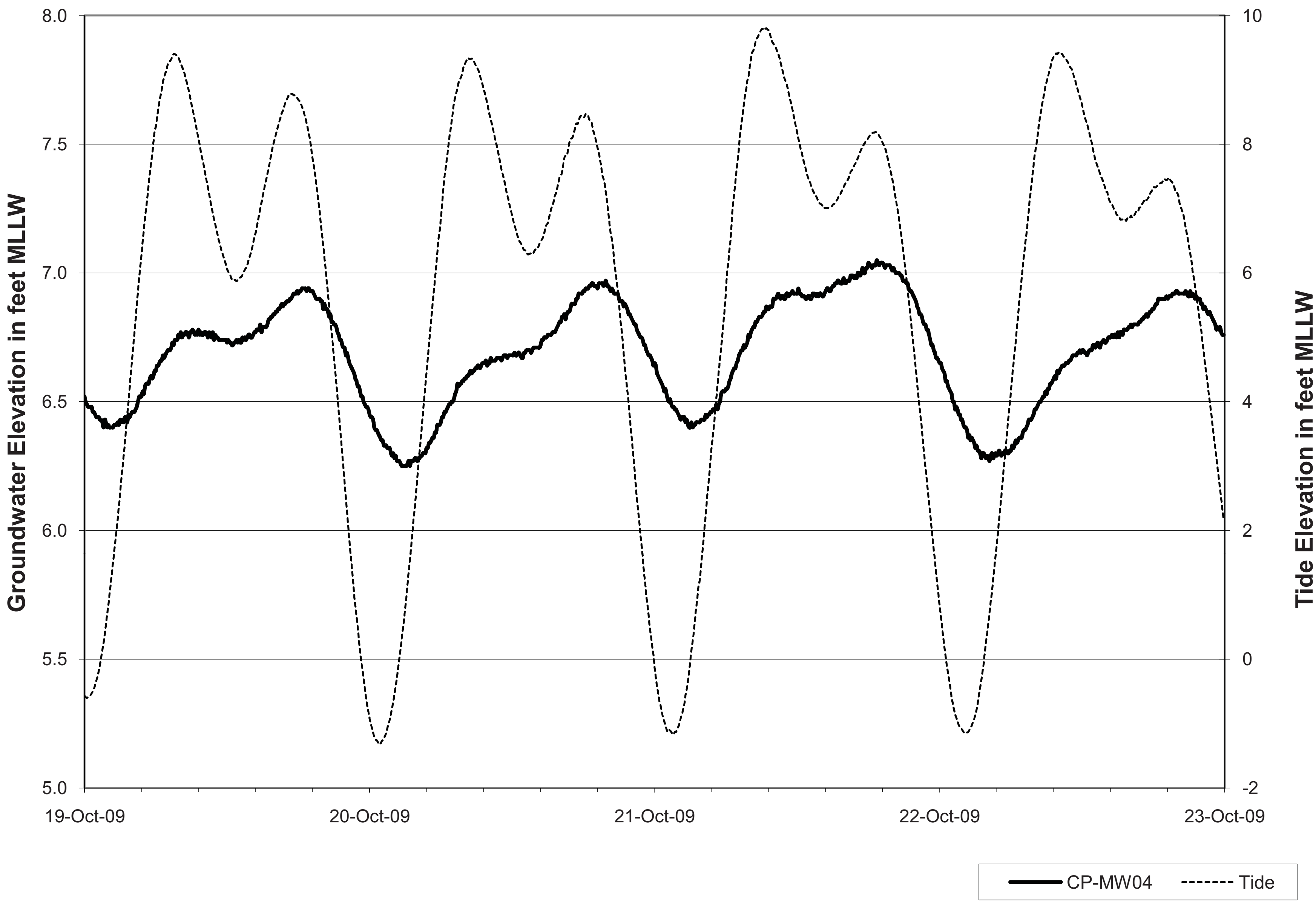


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Figure B1 - CP-MW04 Tidal Study Data
RI/FS - GP West Site

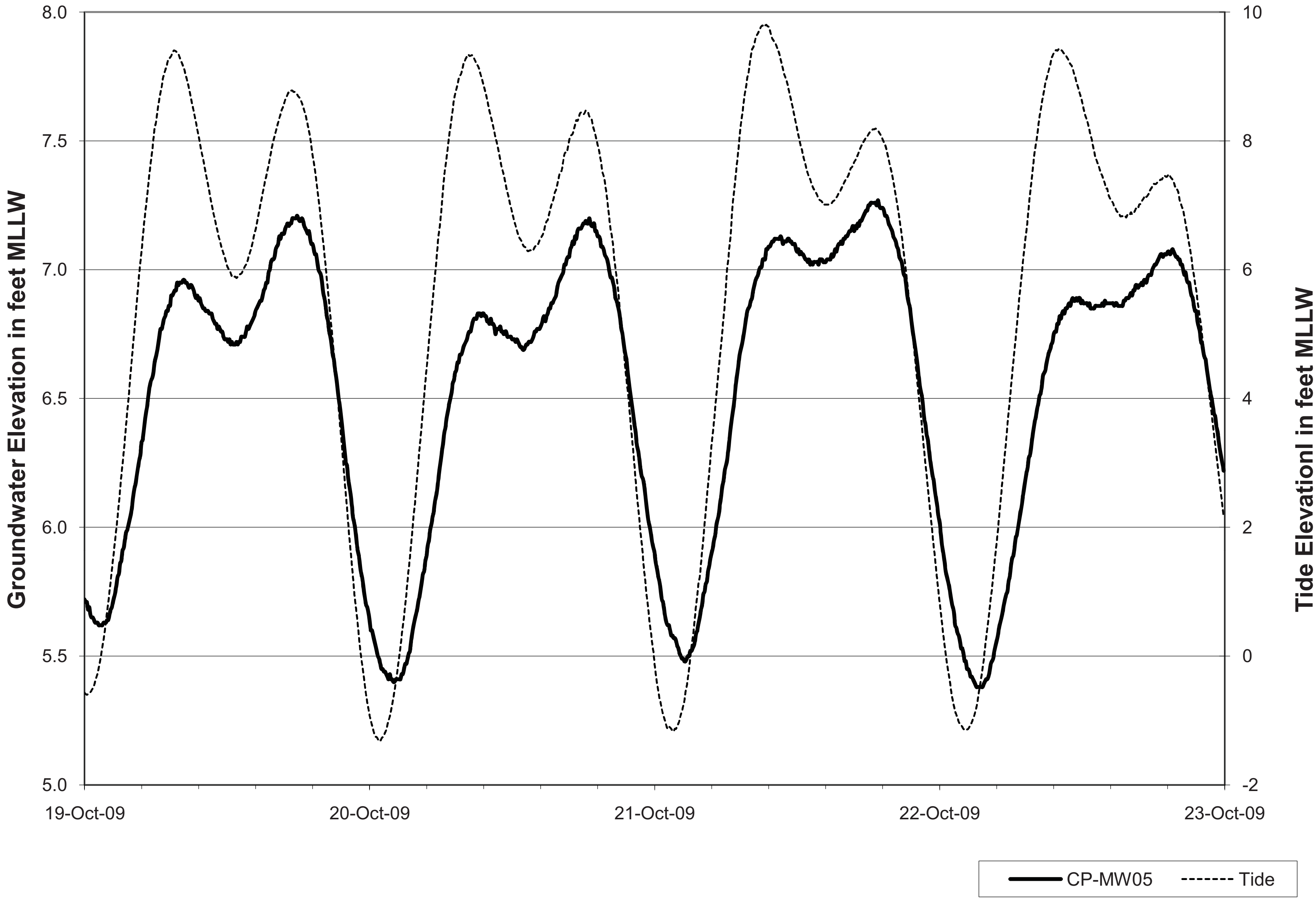

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Figure B2 - CP-MW05 Tidal Study Data

RI/FS - GP West Site

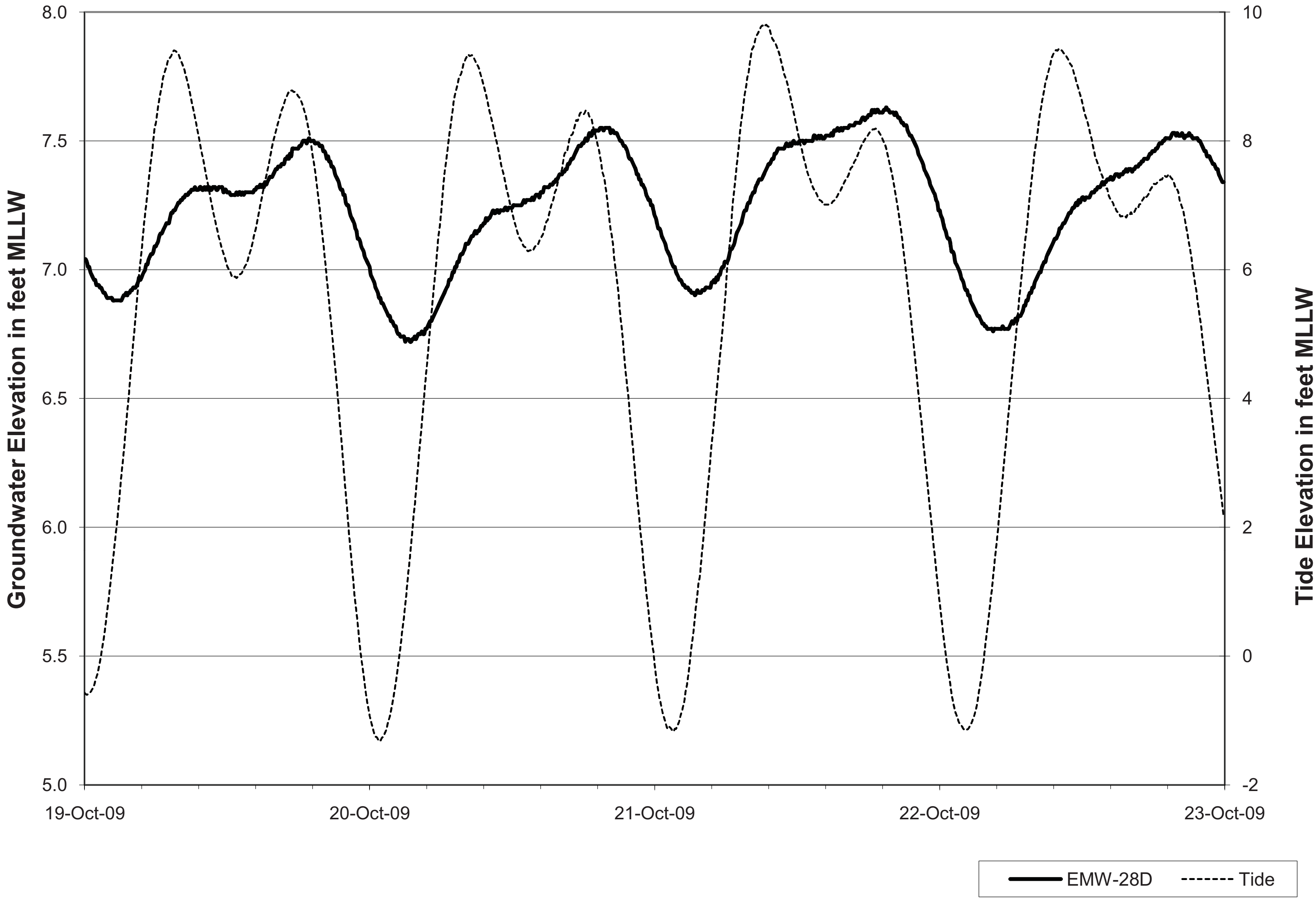

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Figure B3 - EMW-28D Tidal Study Data
RI/FS - GP West Site

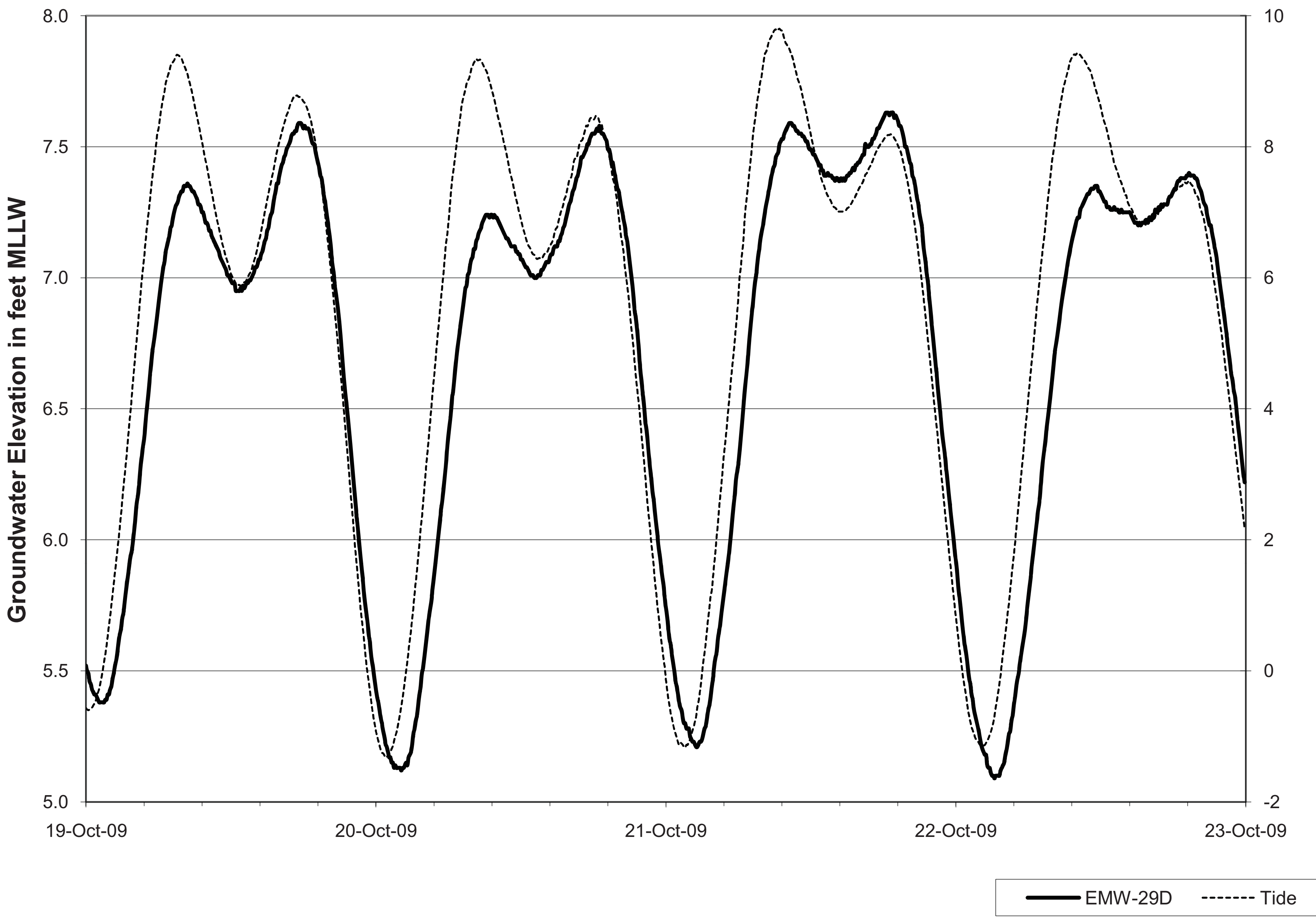

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Figure B4 - EMW-29D Tidal Study Data
RI/FS - GP West Site

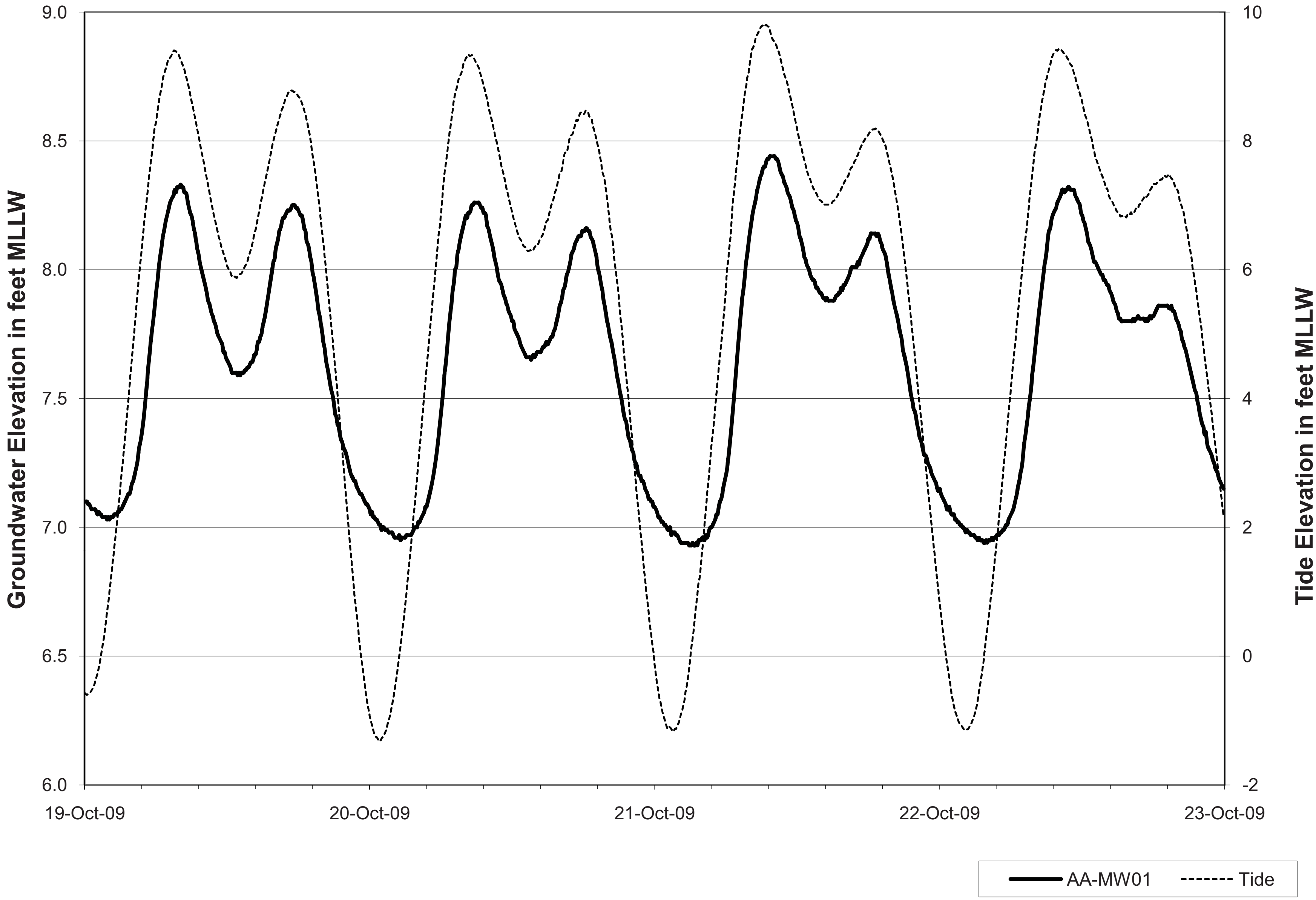

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Figure B5 - AA-MW01 Tidal Study Data

RI/FS - GP West Site

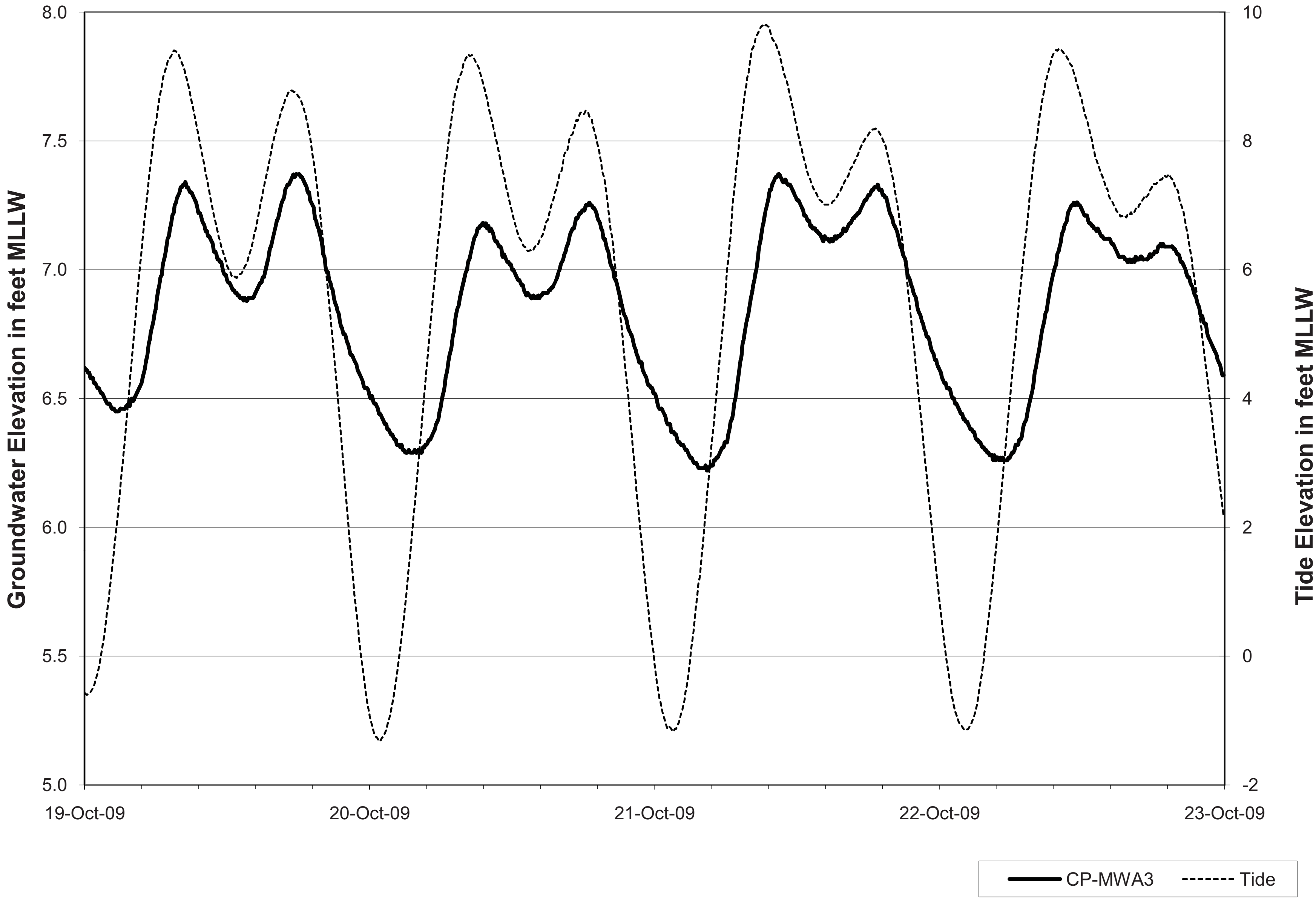

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Figure B6 - CP-MWA3 Tidal Study Data
RI/FS - GP West Site

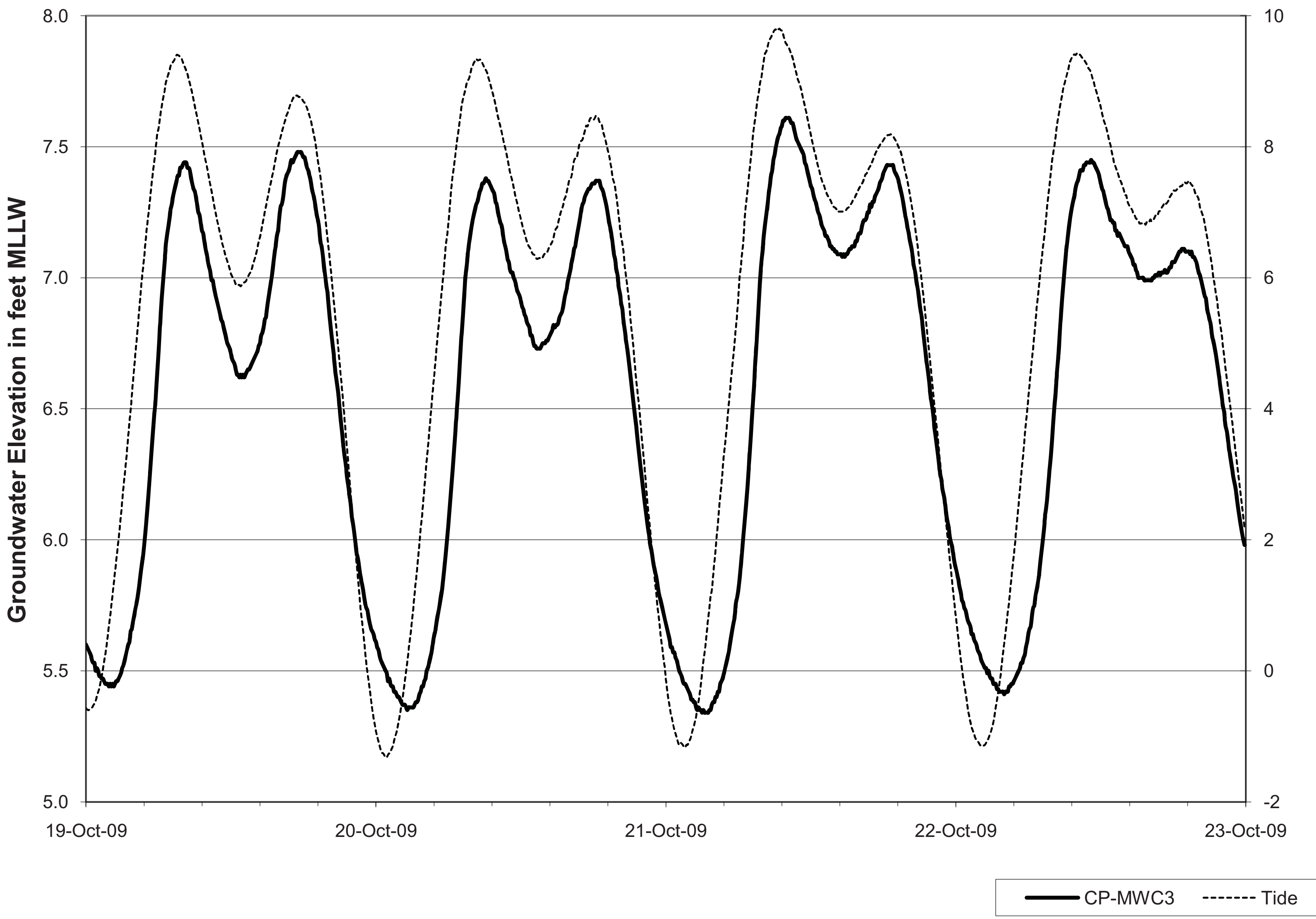

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Figure B7 - CP-MWC3 Tidal Study Data

RI/FS - GP West Site

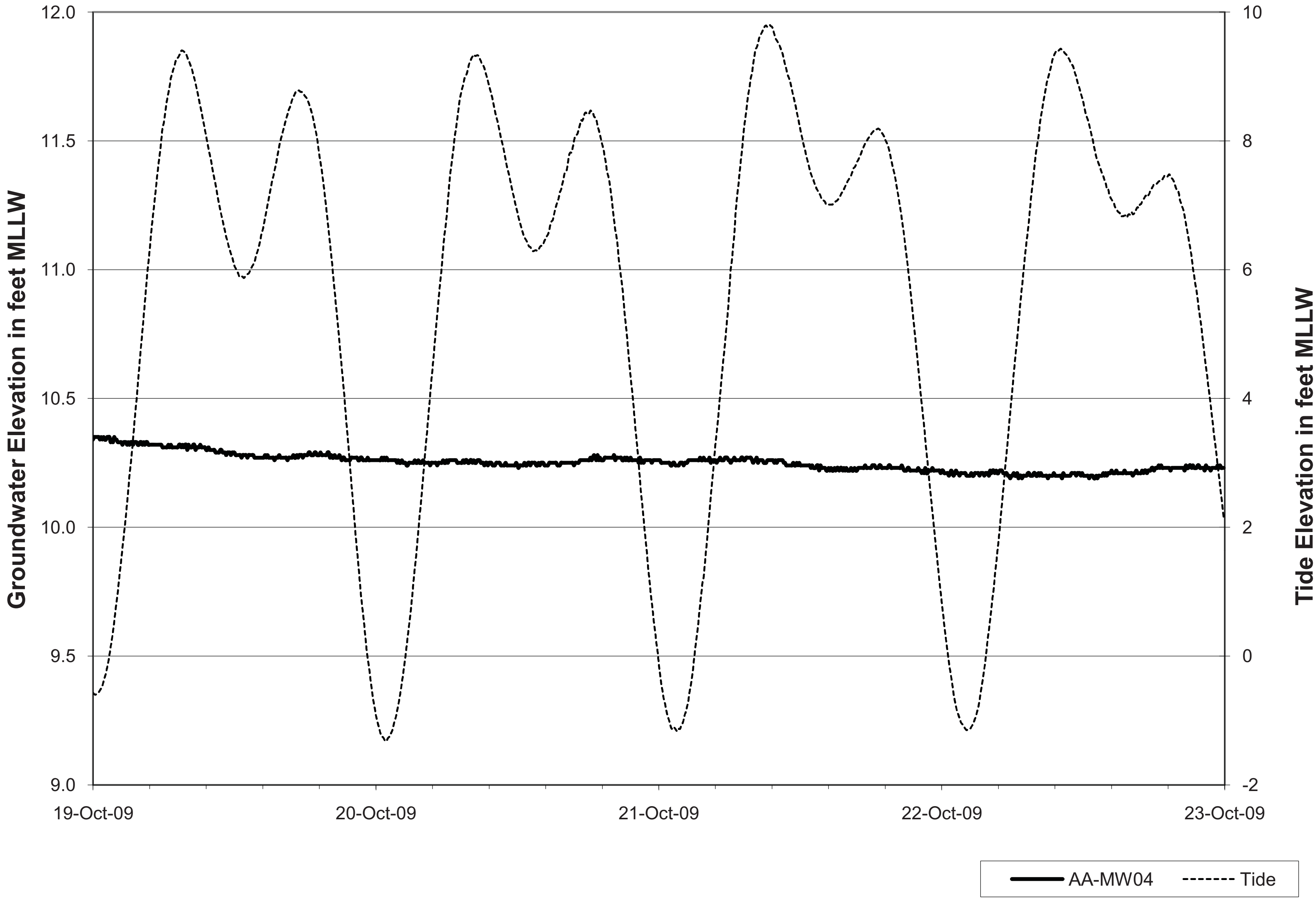

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Figure B8 - AA-MW04 Tidal Study Data
RI/FS - GP West Site

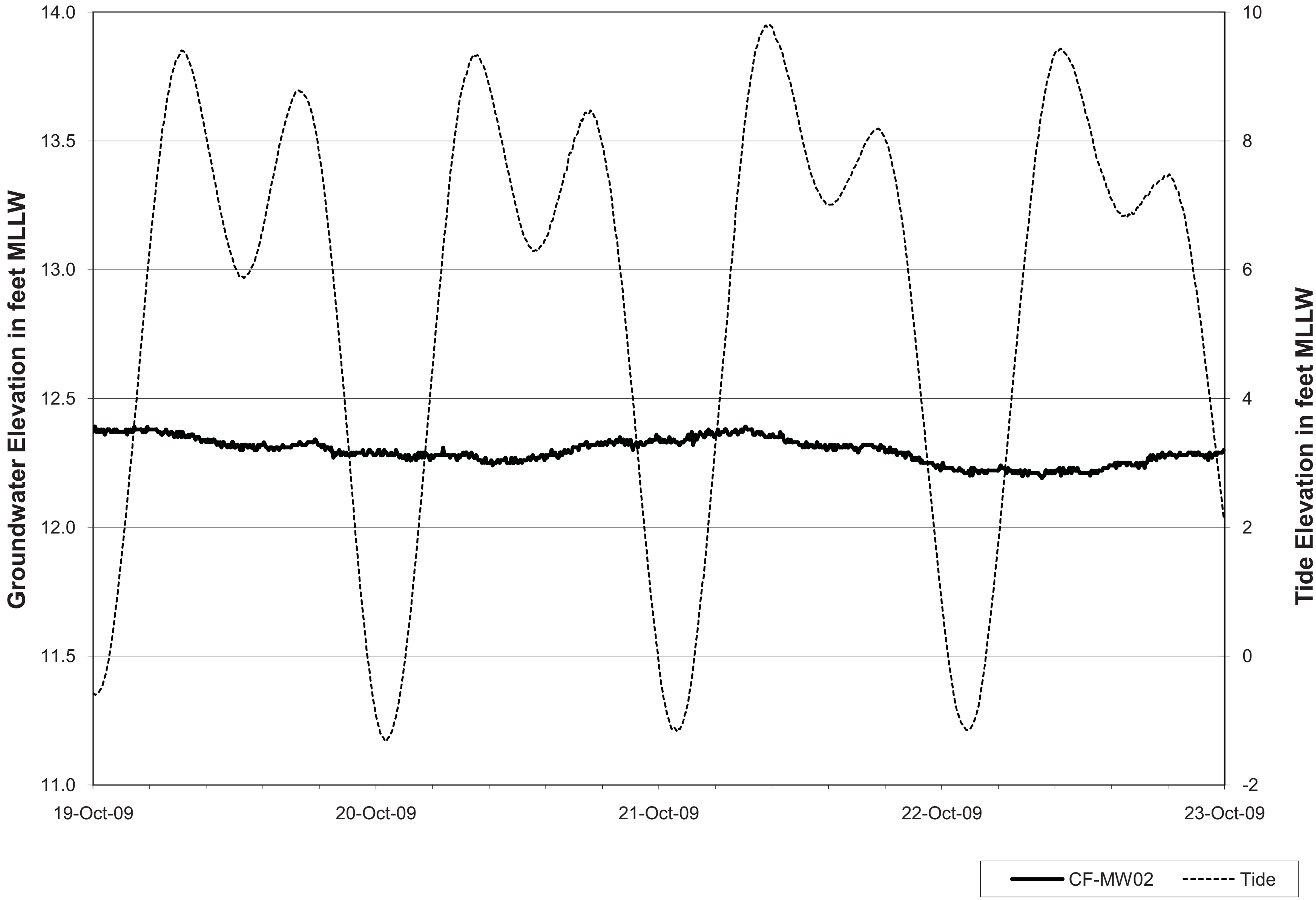

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Figure B9 - CF-MW02 Tidal Study Data

RI/FS - GP West Site

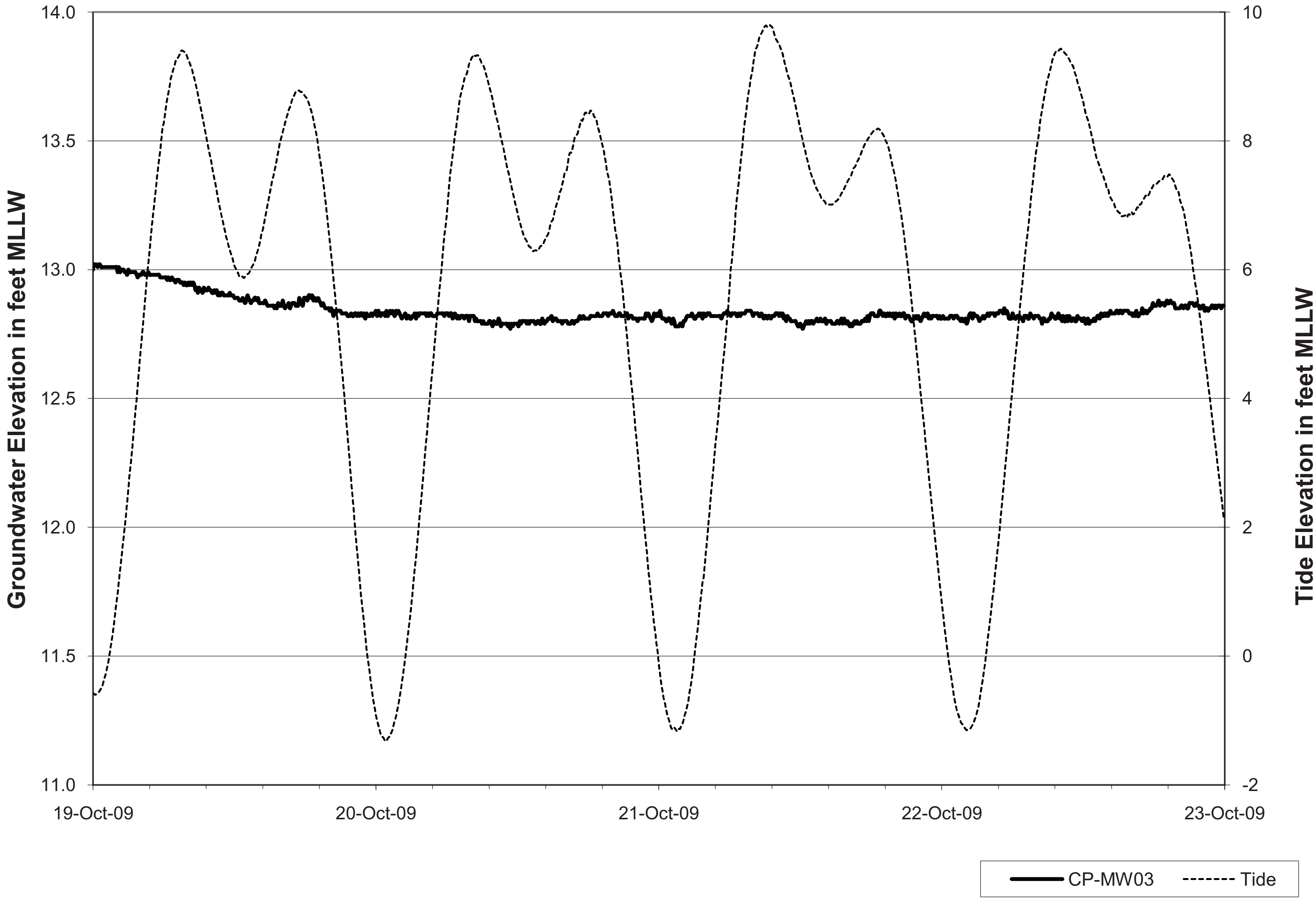

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Figure B10 - CF-MW03 Tidal Study Data
RI/FS - GP West Site

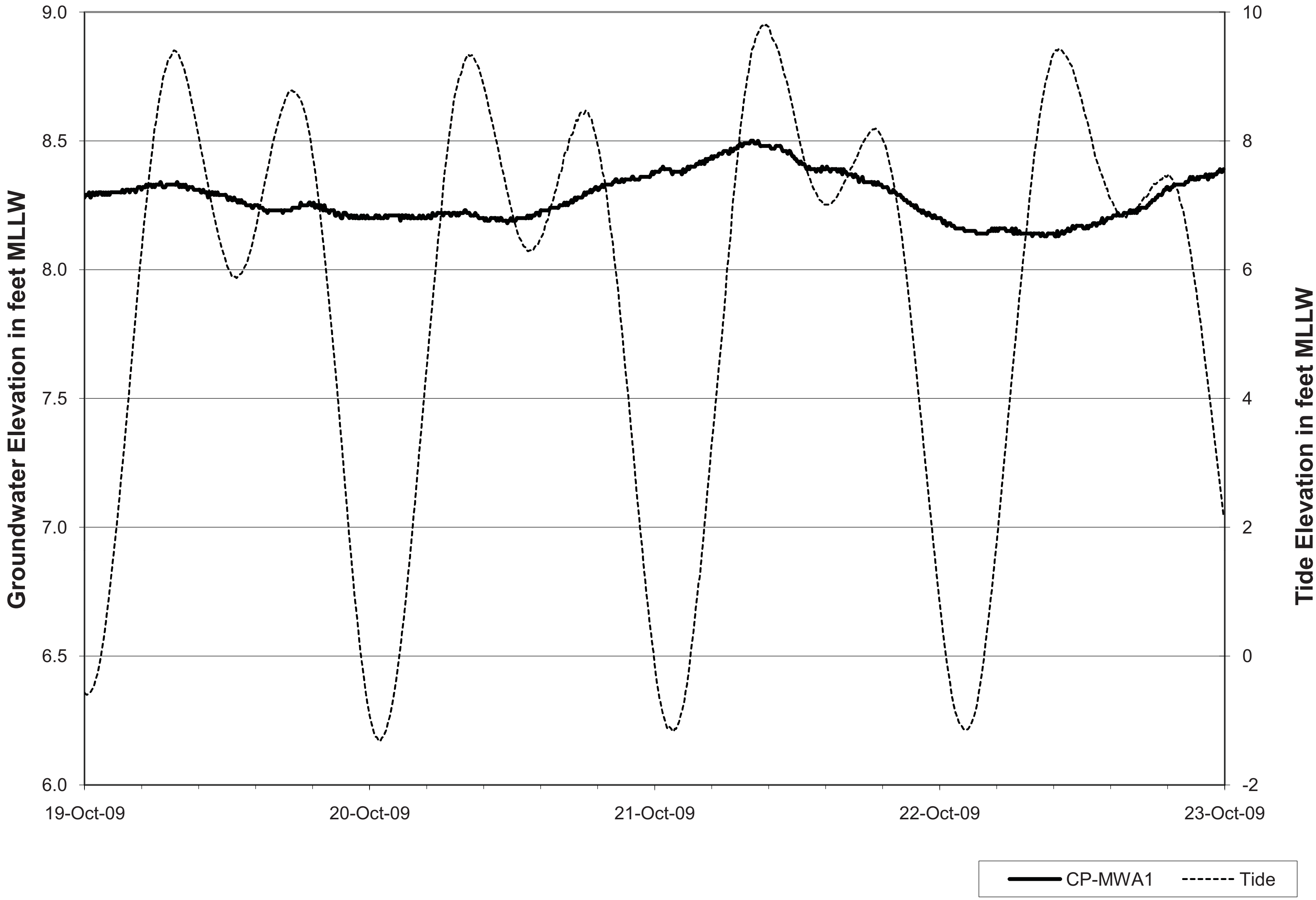

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Figure B11 - CP-MWA1 Tidal Study Data
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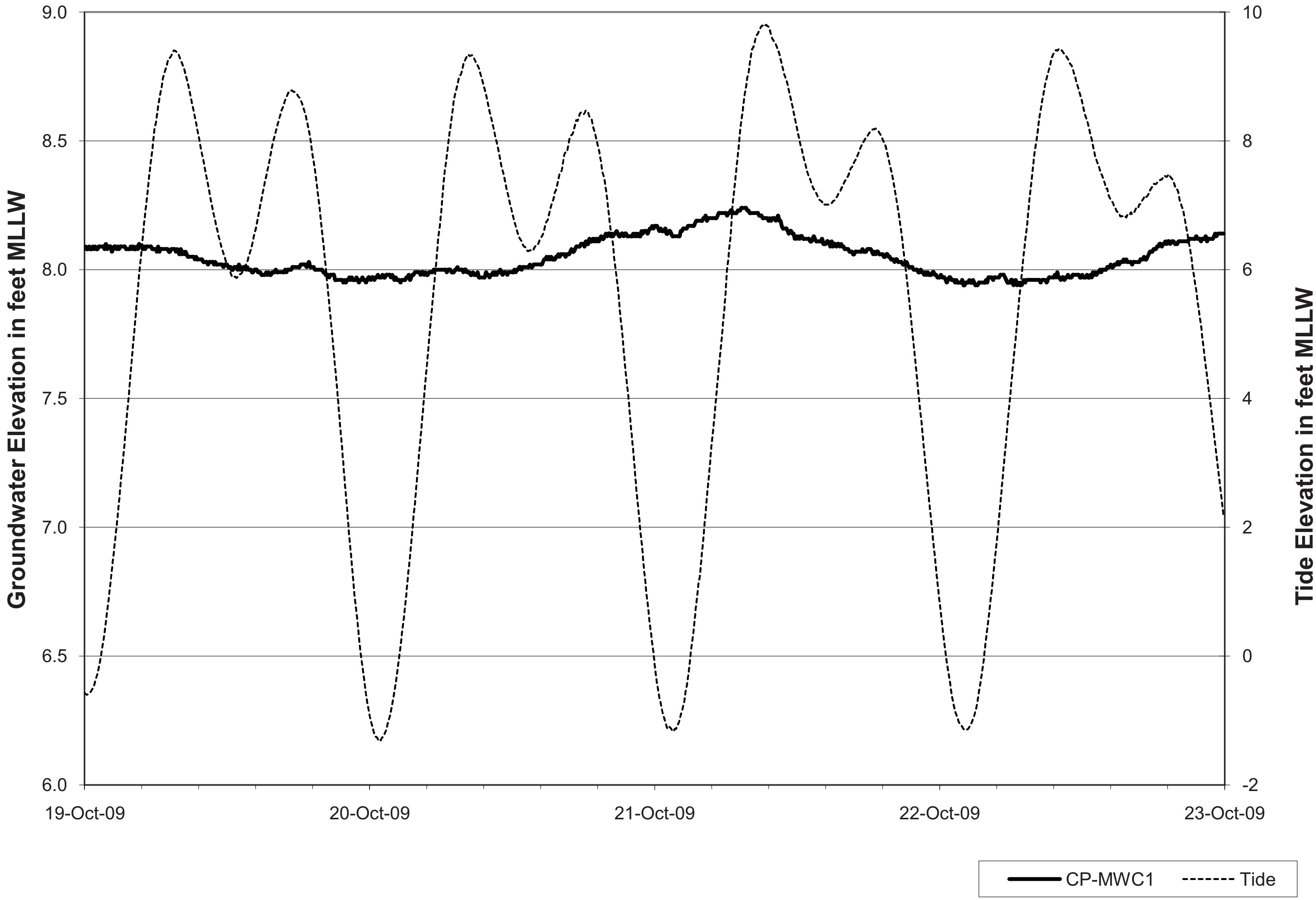

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Figure B12 - CP-MWC1 Tidal Study Data
RI/FS - GP West Site

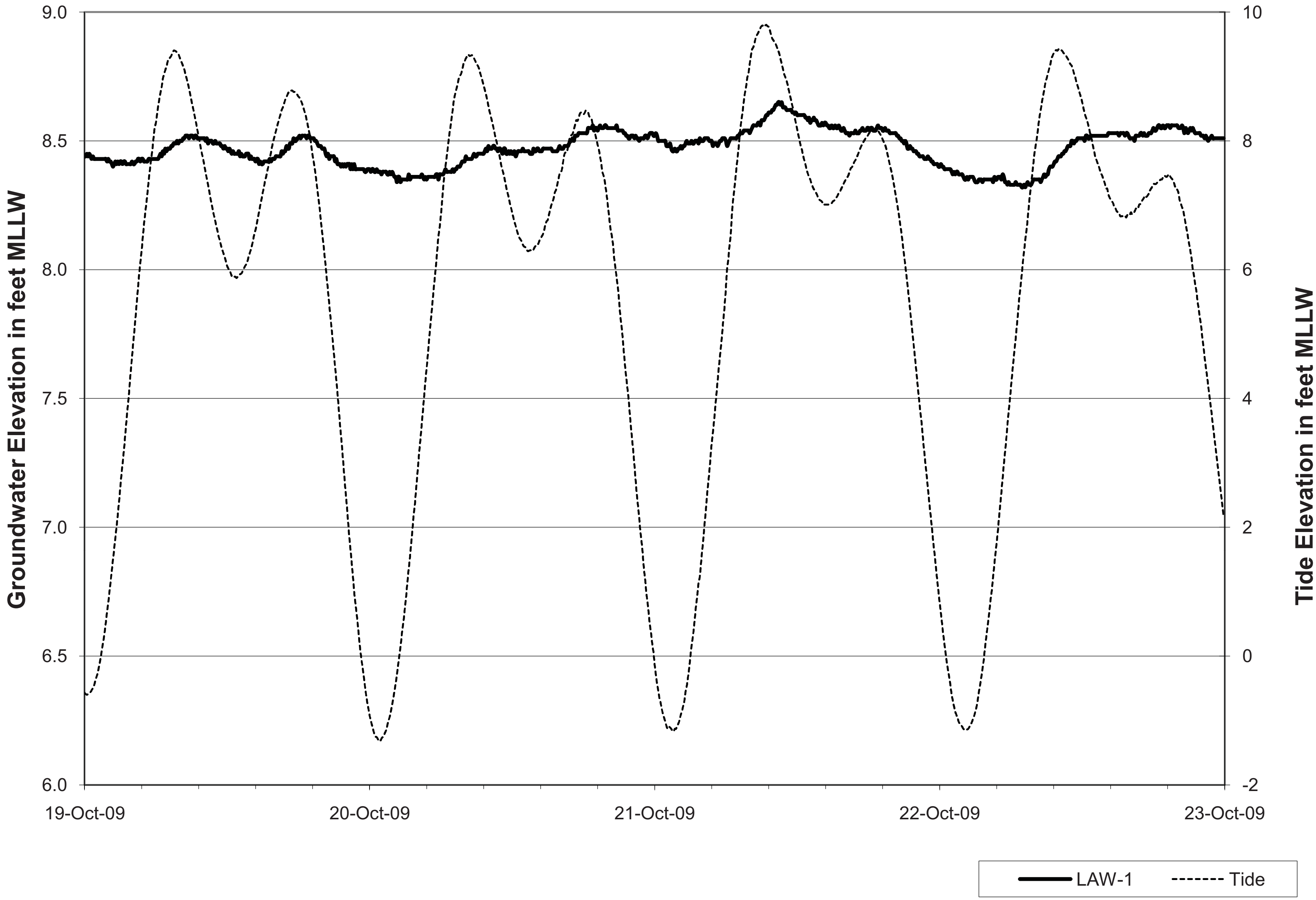

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Figure B13 - LAW-1 Tidal Study Data
RI/FS - GP West Site

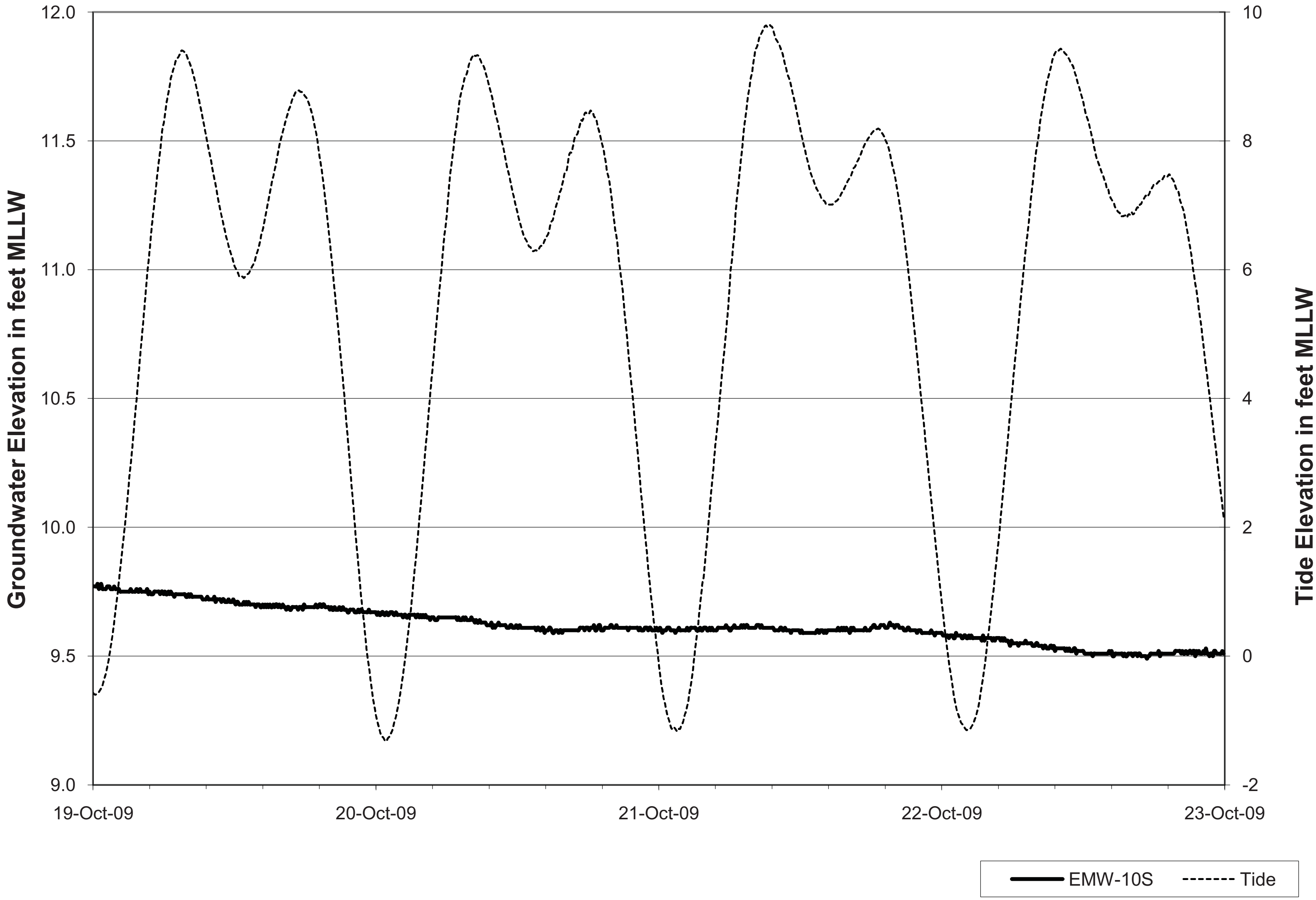

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Figure B14 - EMW-10S Tidal Study Data
RI/FS - GP West Site

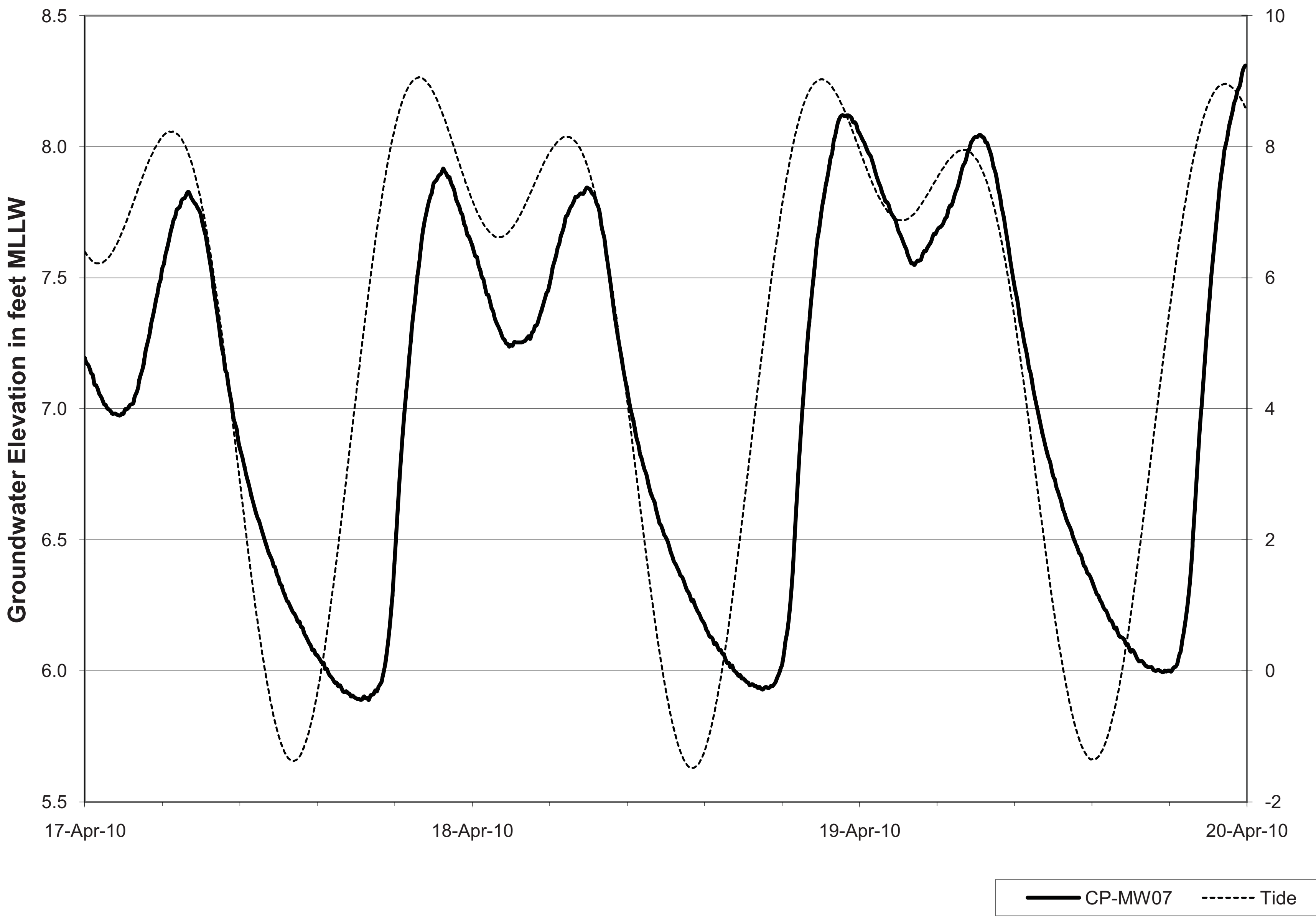

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Figure B15 - CP-MW07 Tidal Study Data

RI/FS - GP West Site

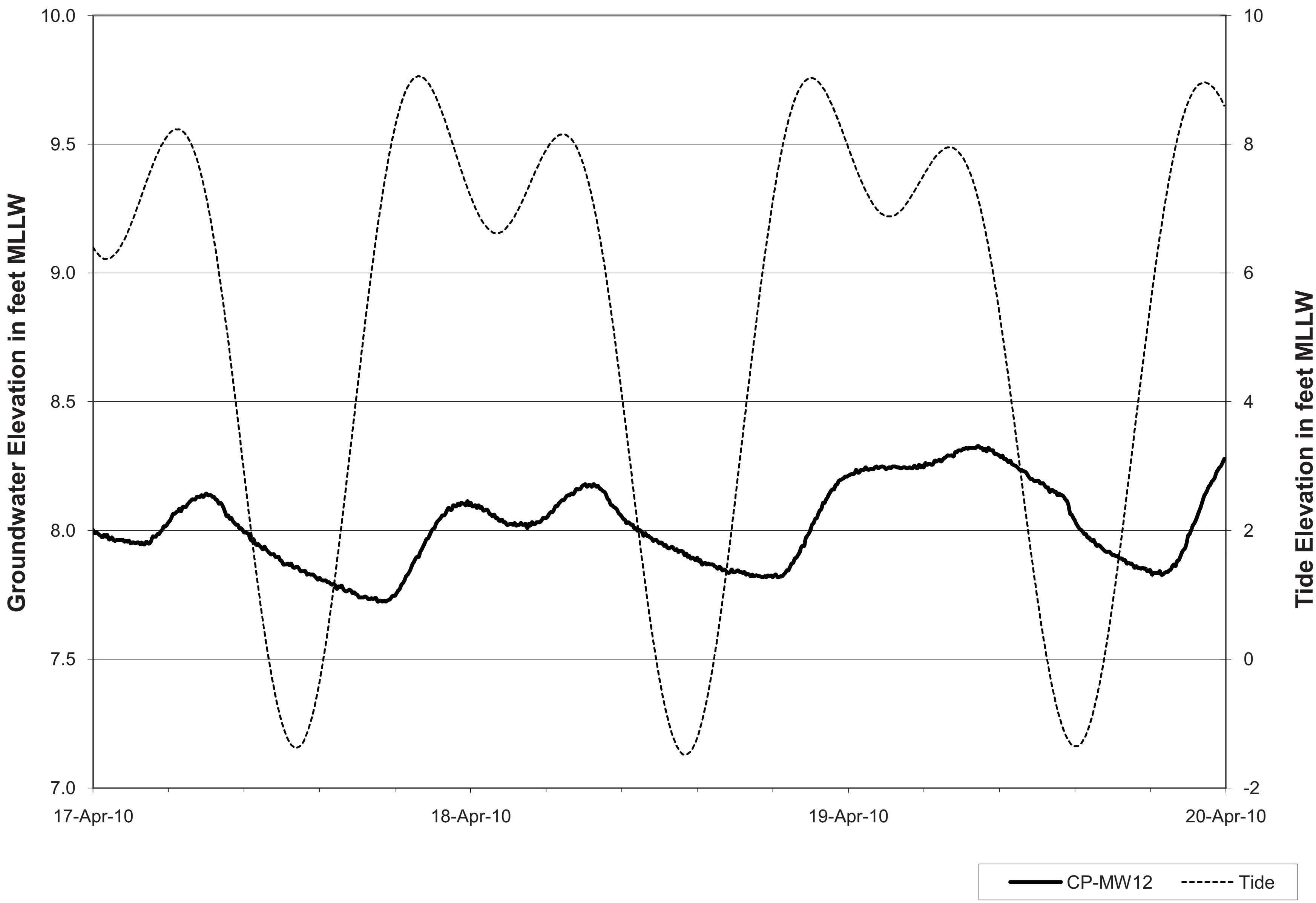

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Figure B16 - CP-MW12 Tidal Study Data
RI/FS - GP West Site

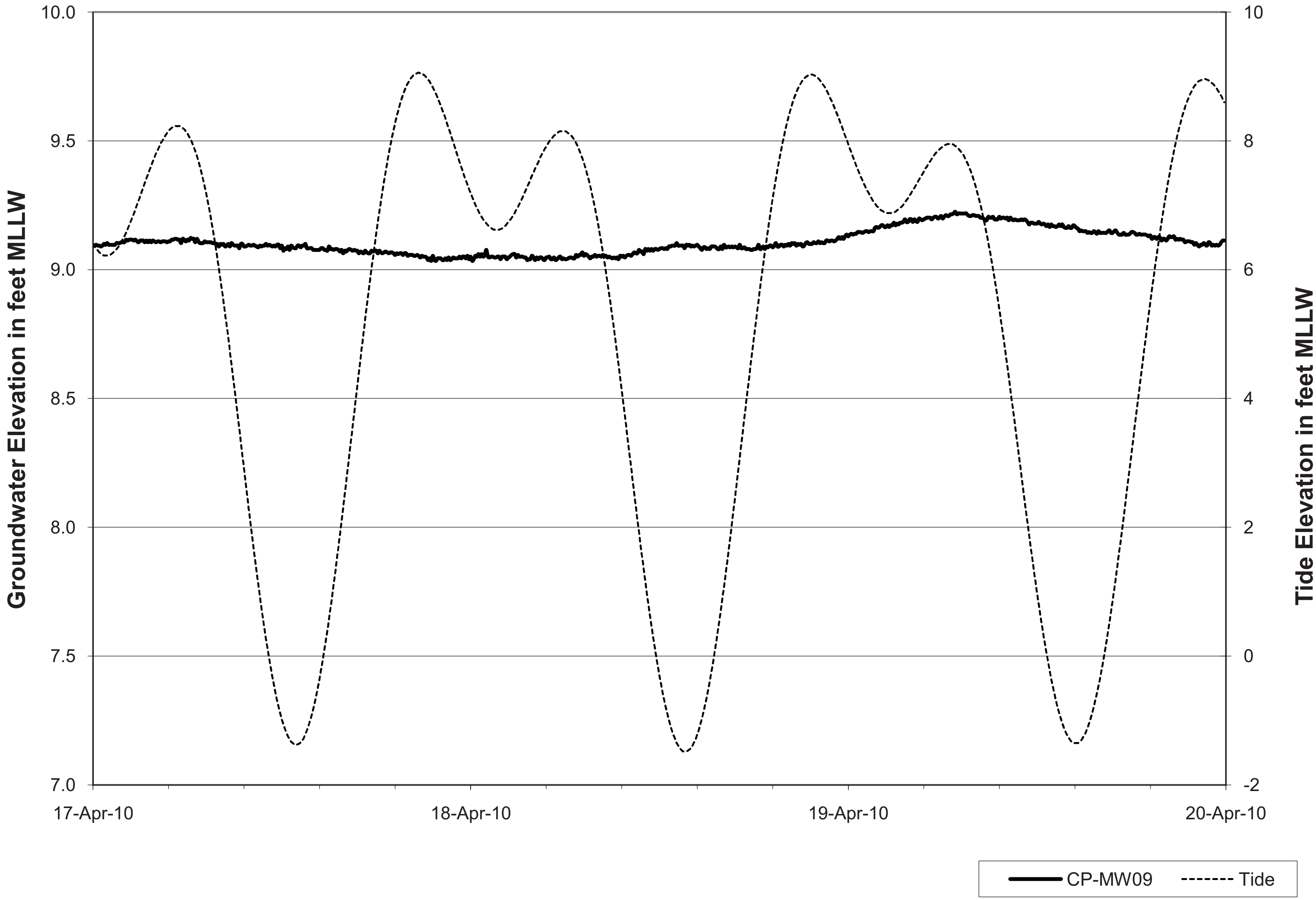

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Figure B17 - CP-MW09 Tidal Study Data
RI/FS - GP West Site

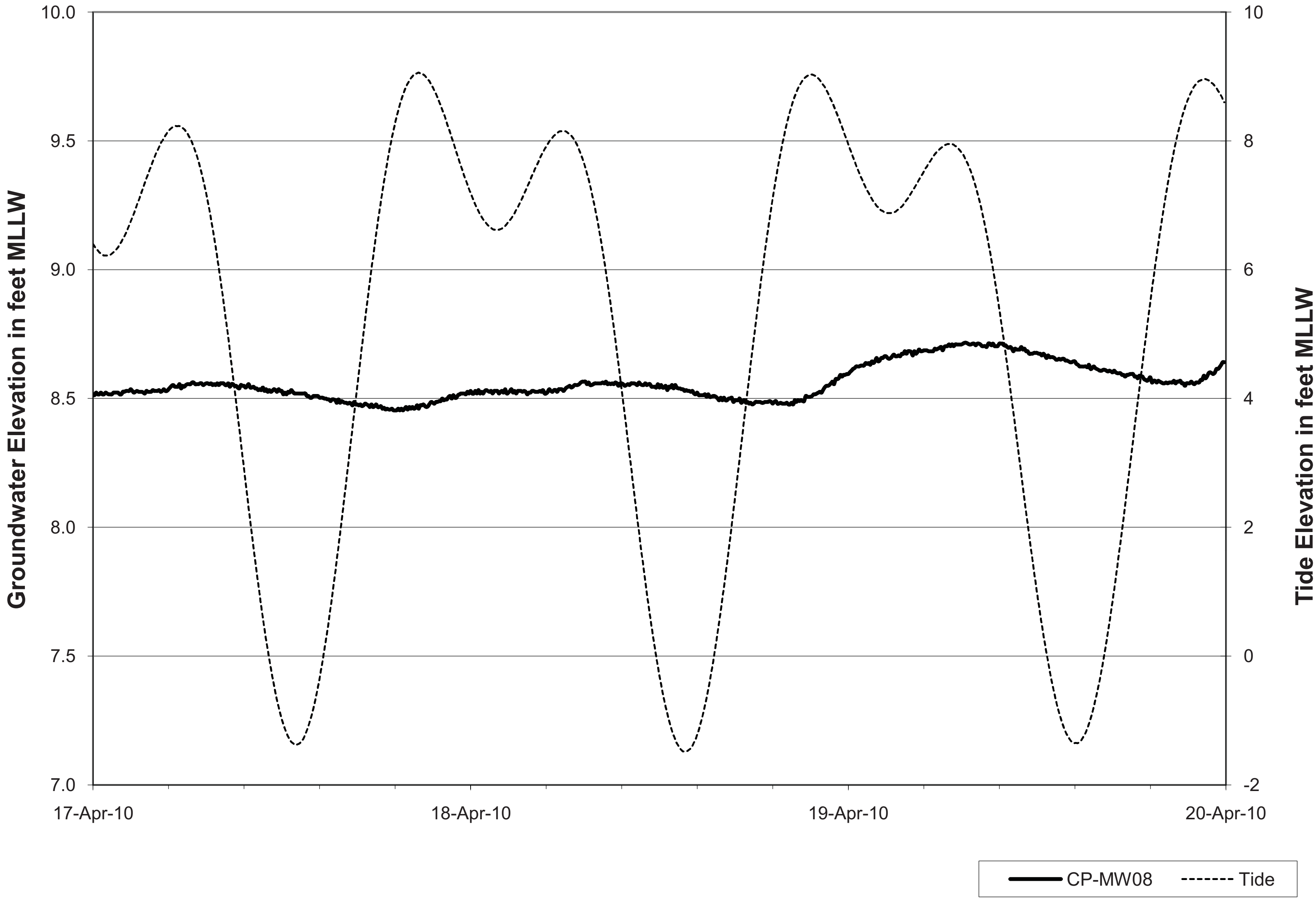

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Figure B18 - CP-MW08 Tidal Study Data
RI/FS - GP West Site

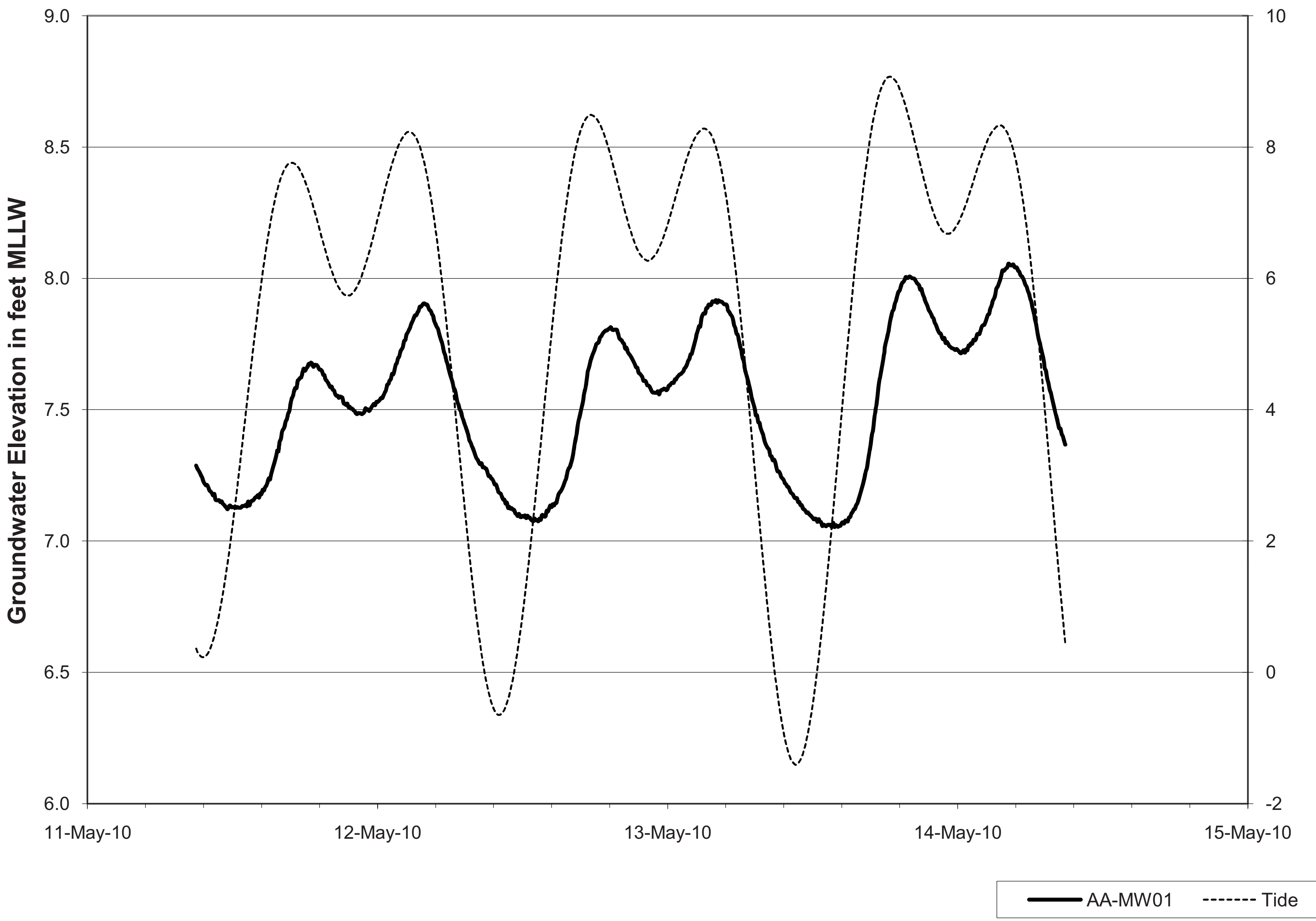

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Figure B19 - AA-MW01 Tidal Study Data
RI/FS - GP West Site

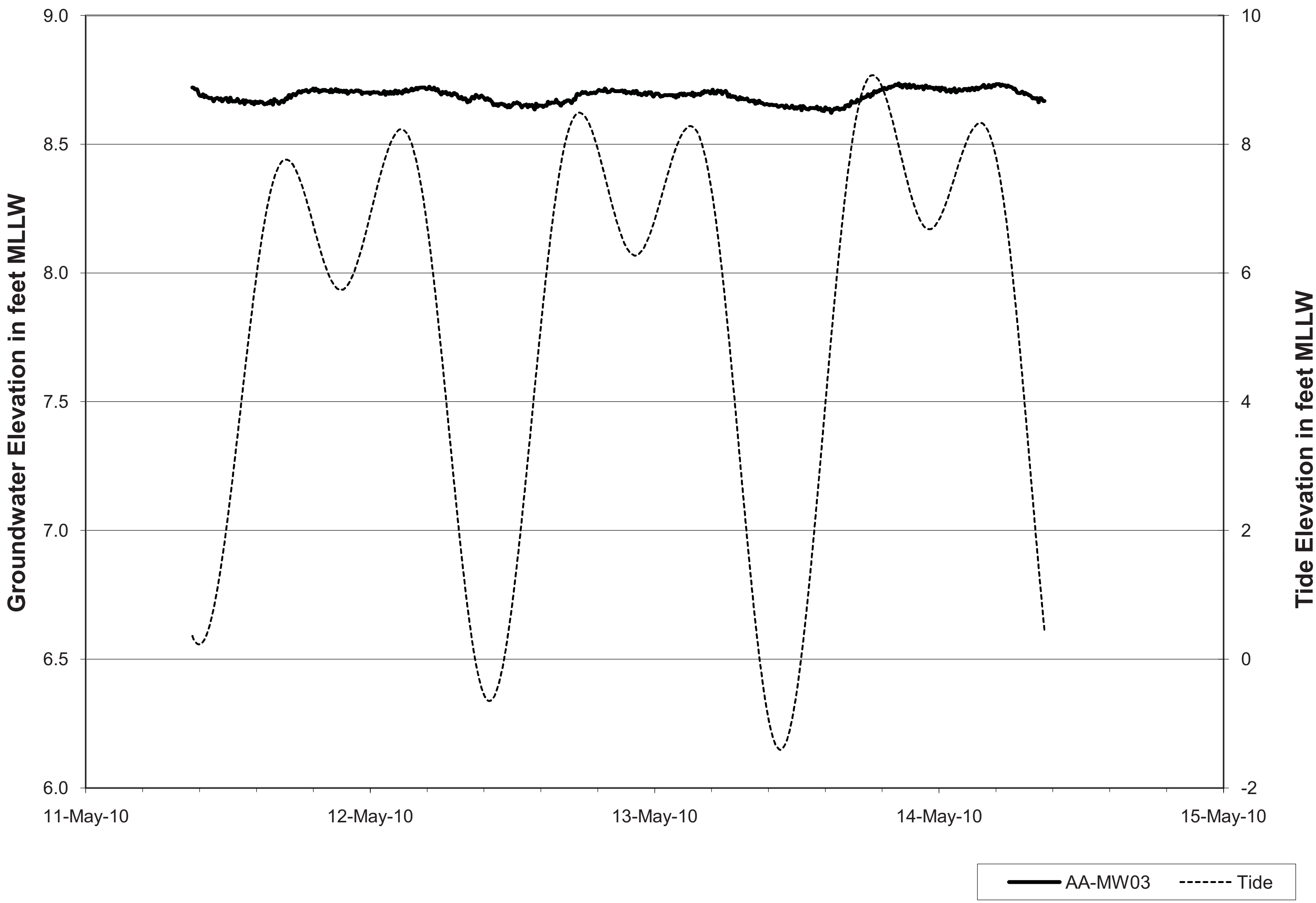

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Figure B20 - AA-MW03 Tidal Study Data

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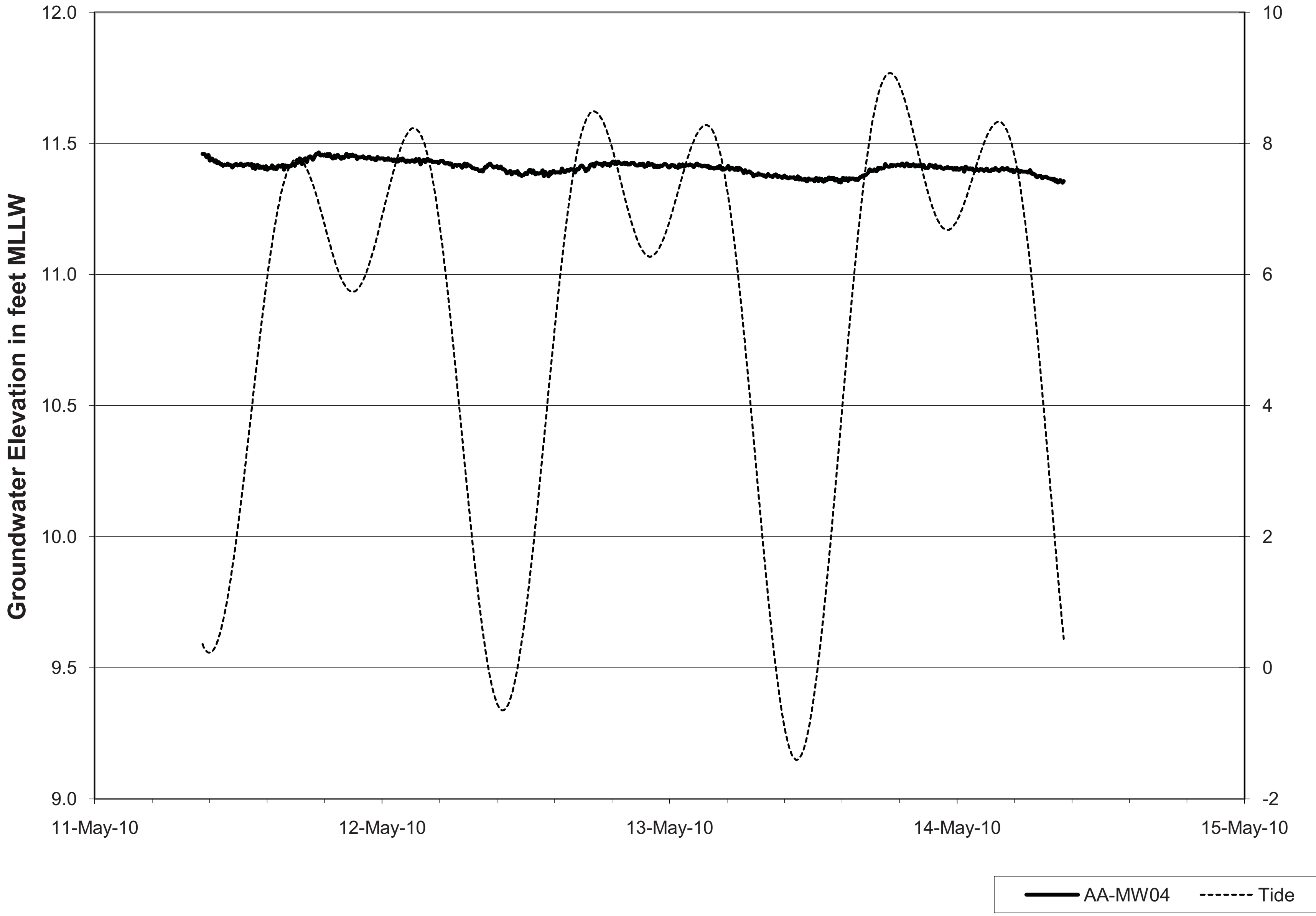

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Figure B21 - AA-MW04 Tidal Study Data
RI/FS - GP West Site

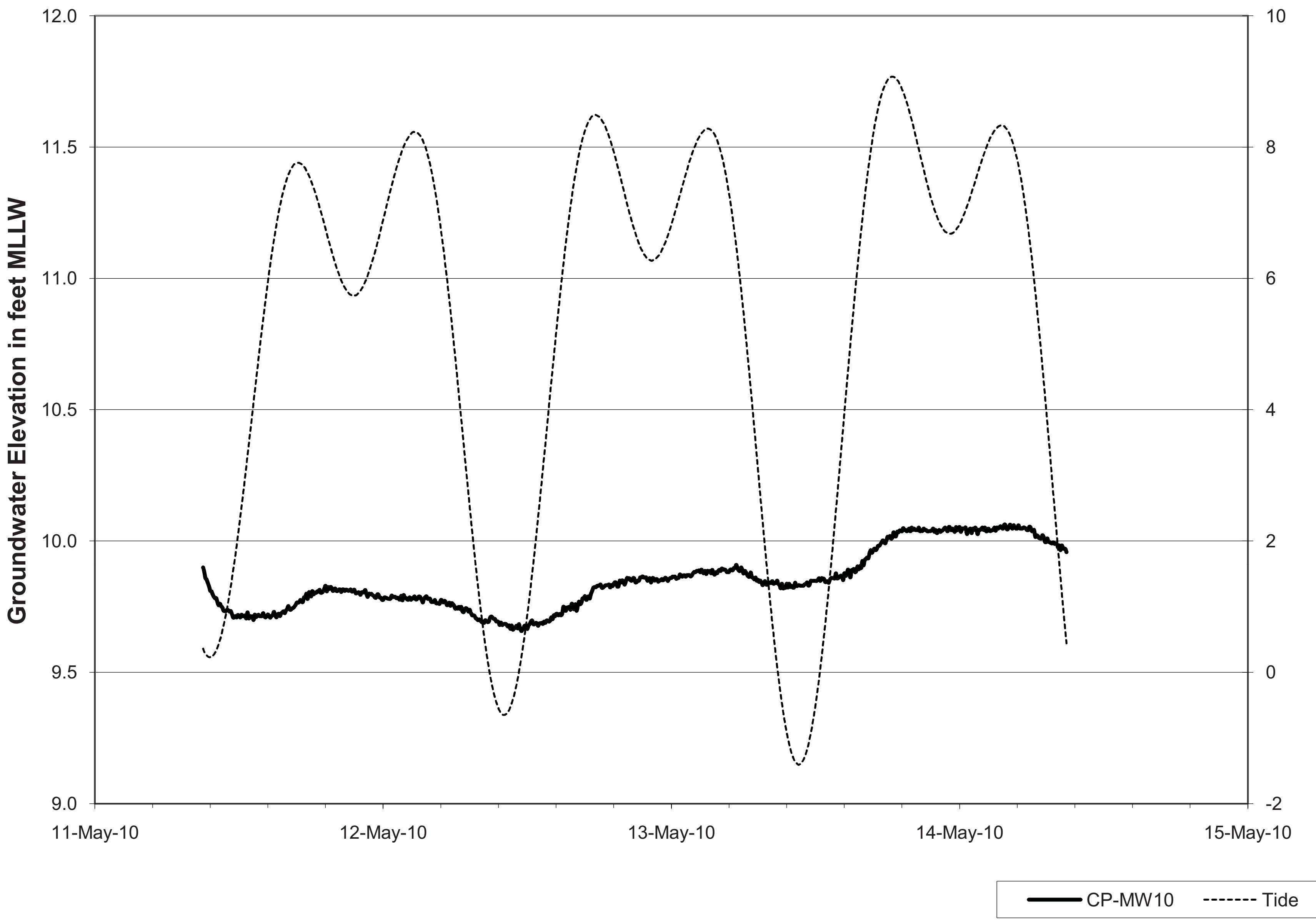

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Figure B22 - CP-MW10 Tidal Study Data

RI/FS - GP West Site

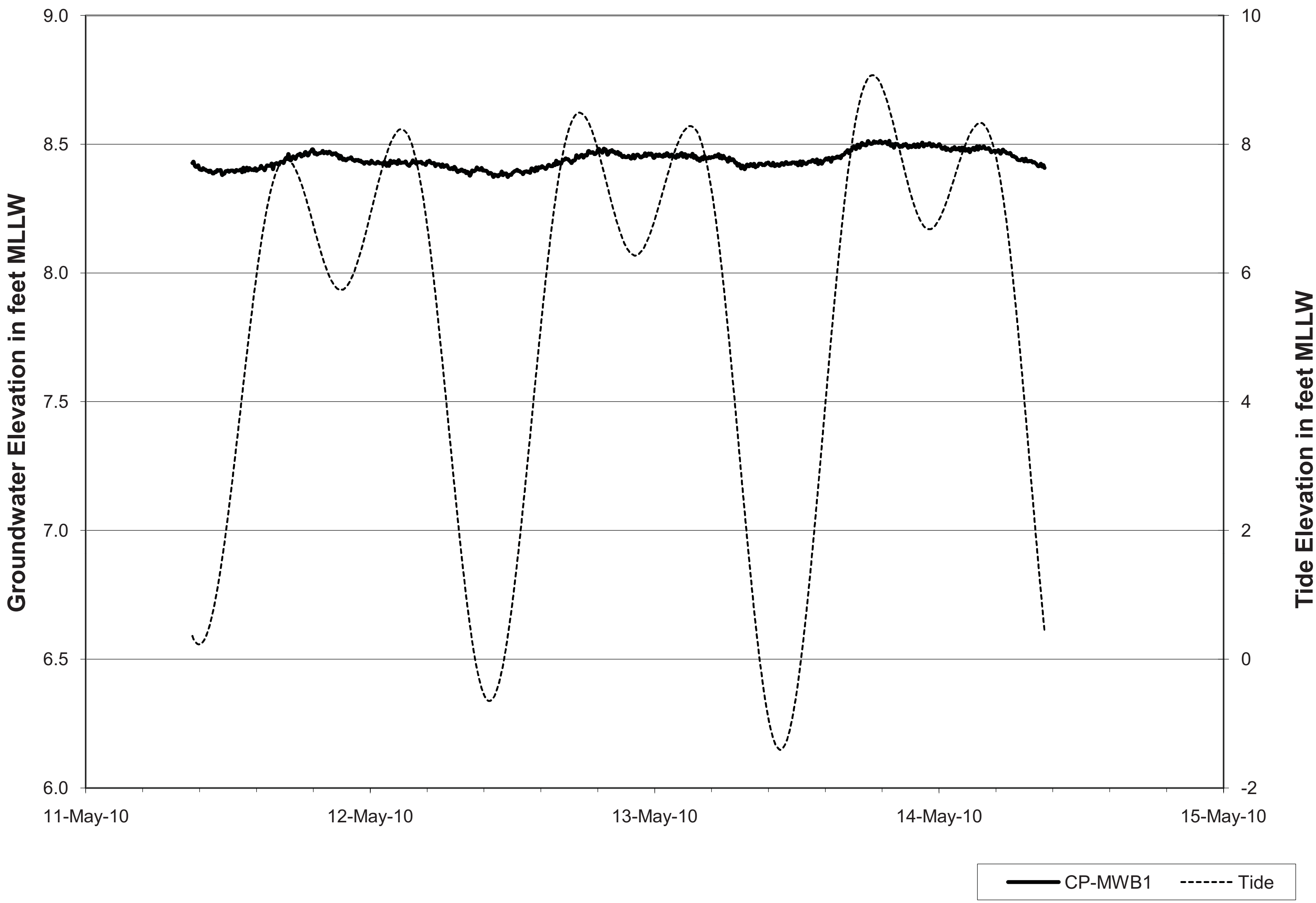

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Figure B23 - CP-MWB1 Tidal Study Data
RI/FS - GP West Site

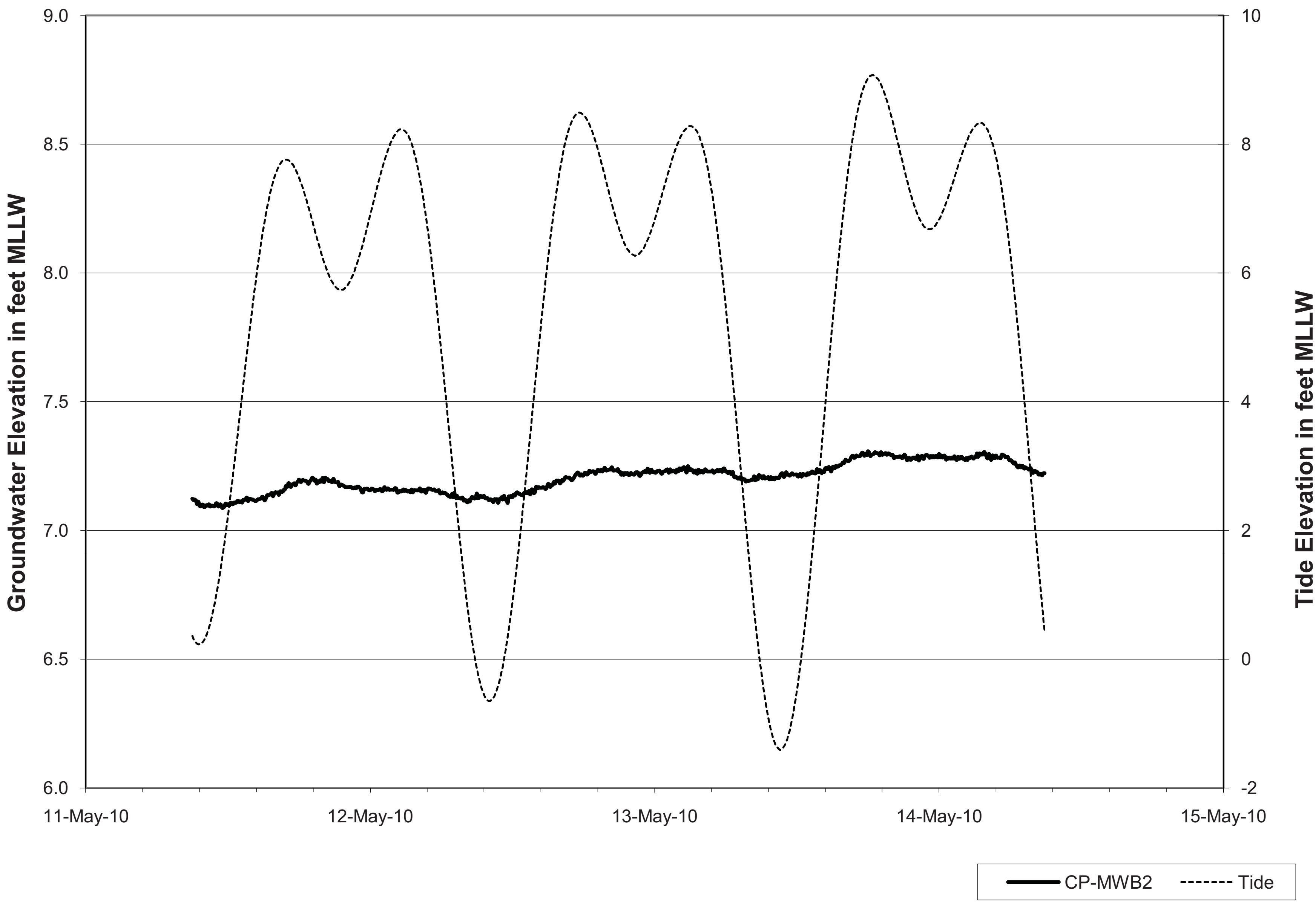

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Figure B24 - CP-MWB2 Tidal Study Data
RI/FS - GP West Site

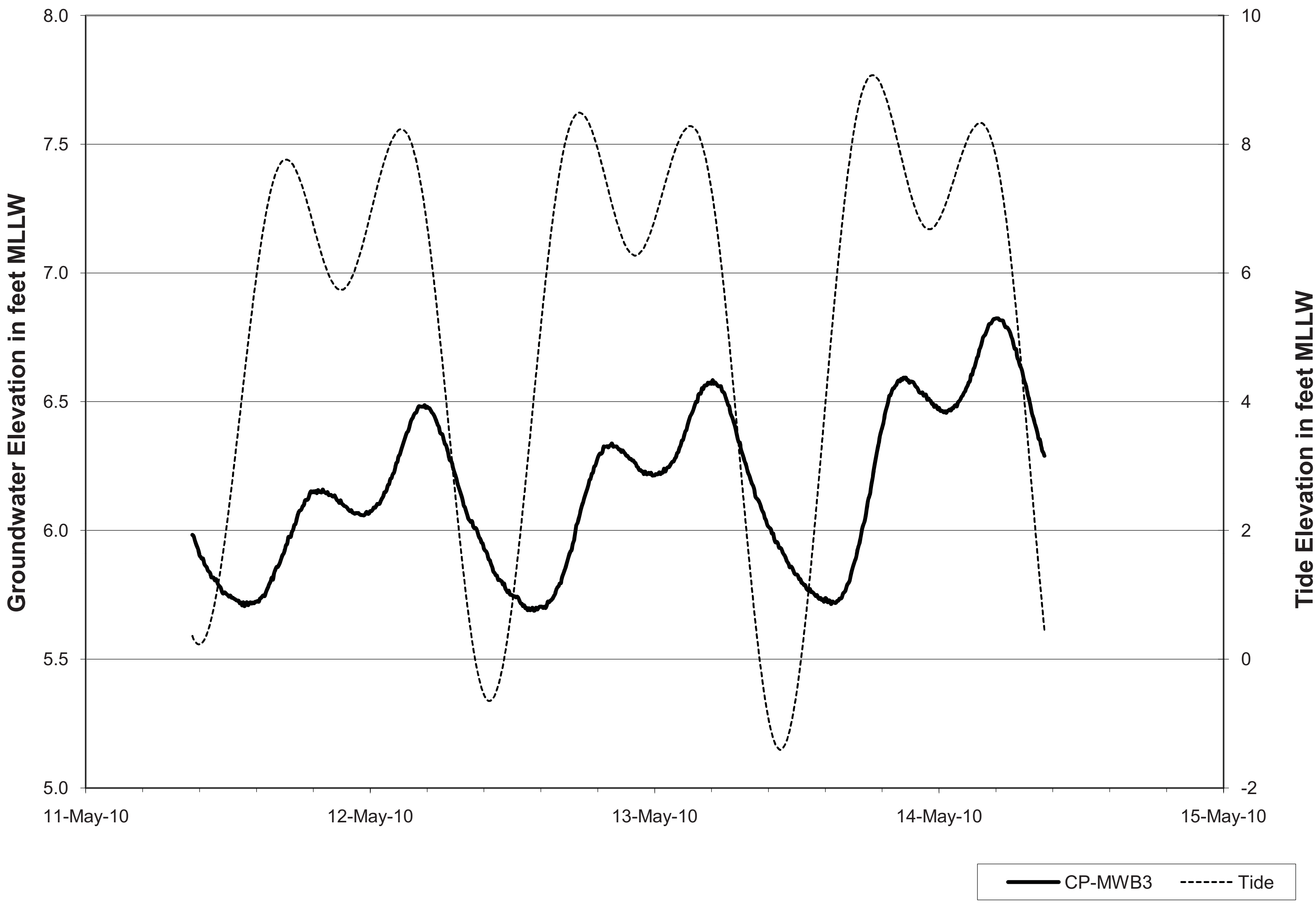

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Figure B25 - CP-MWB3 Tidal Study Data
RI/FS - GP West Site

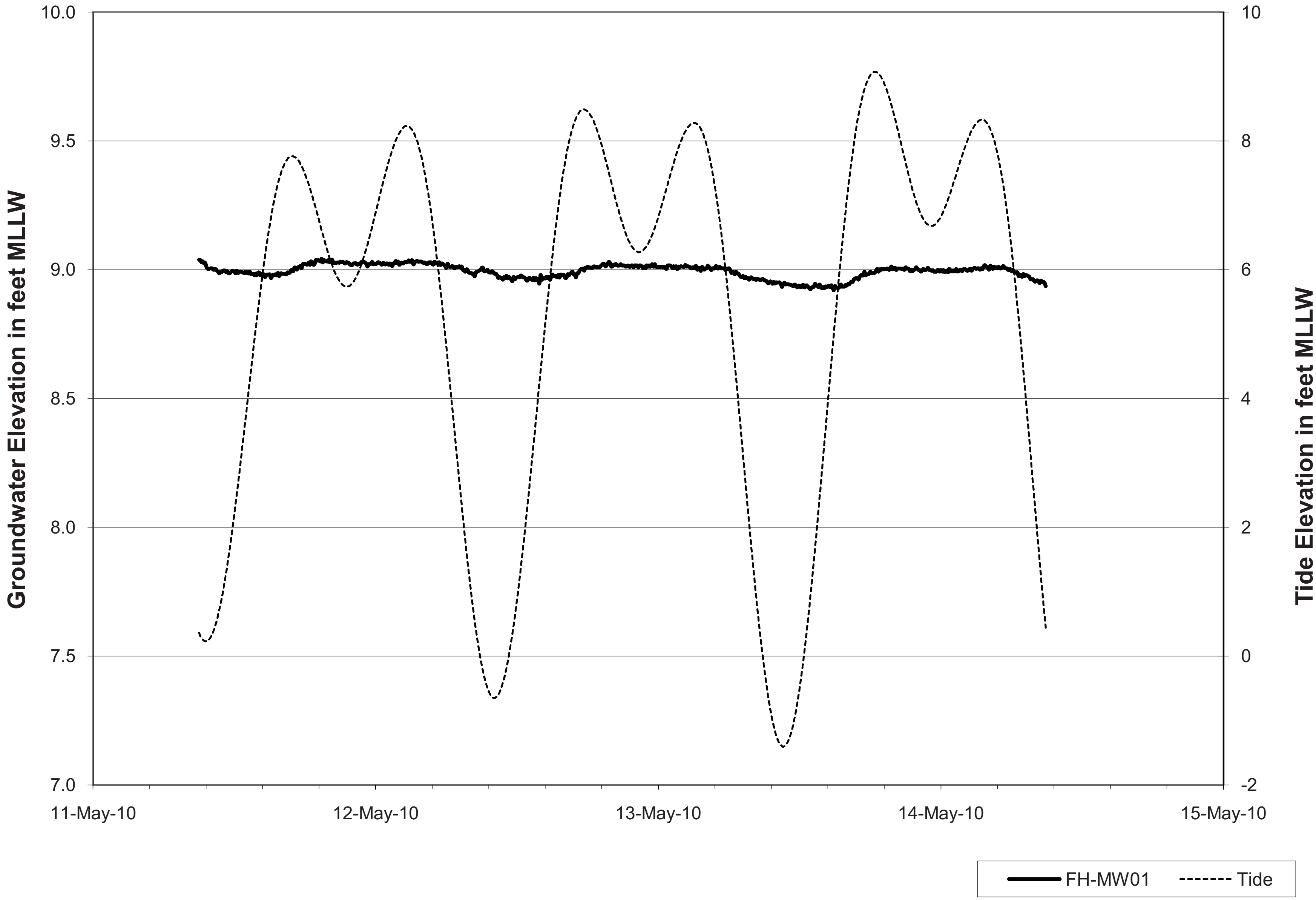

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Figure B26 - FH-MW01 Tidal Study Data
RI/FS - GP West Site

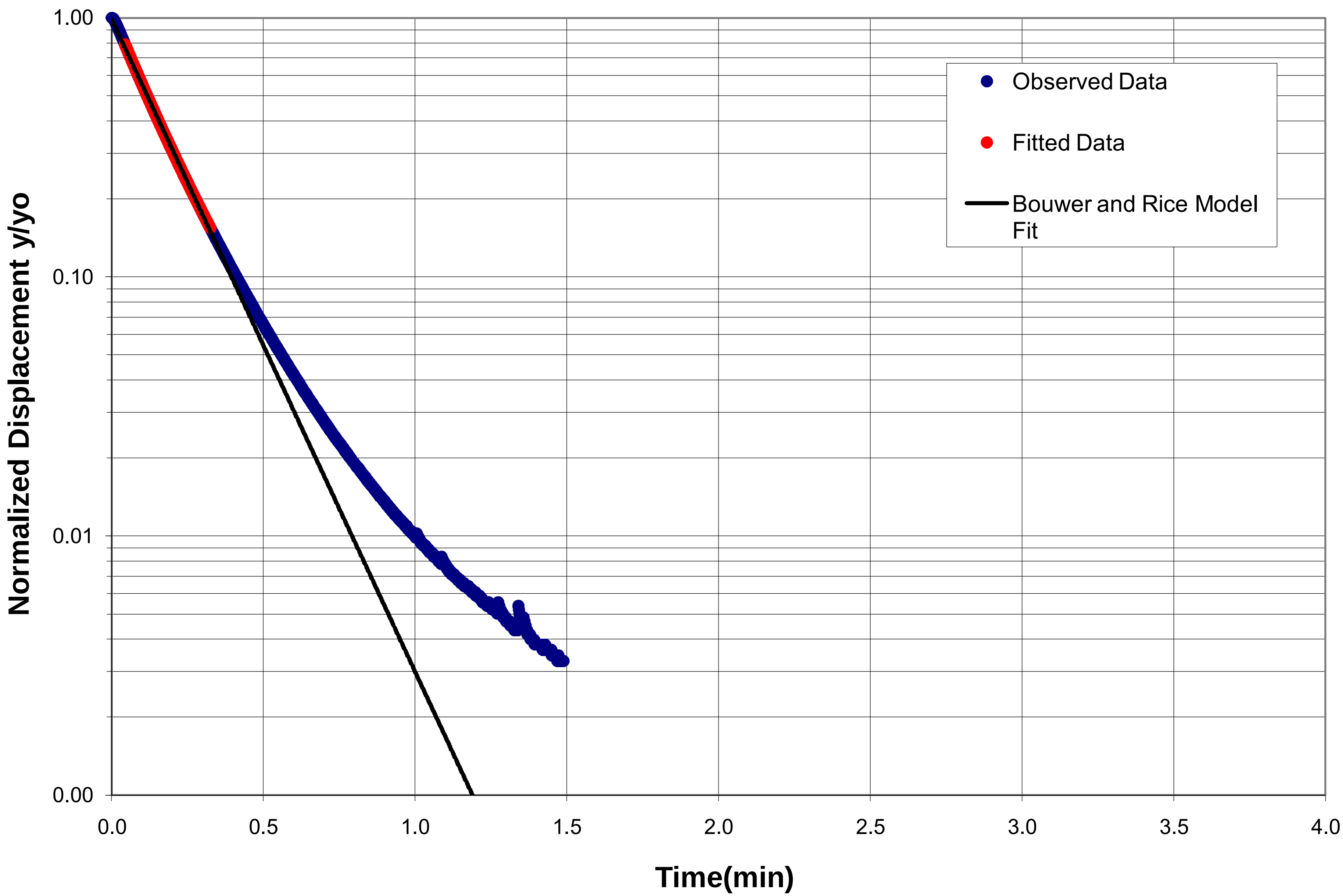

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Figure B27 - CP-MW05 Test 1 Slug Test Data
RI/FS - GP West Site

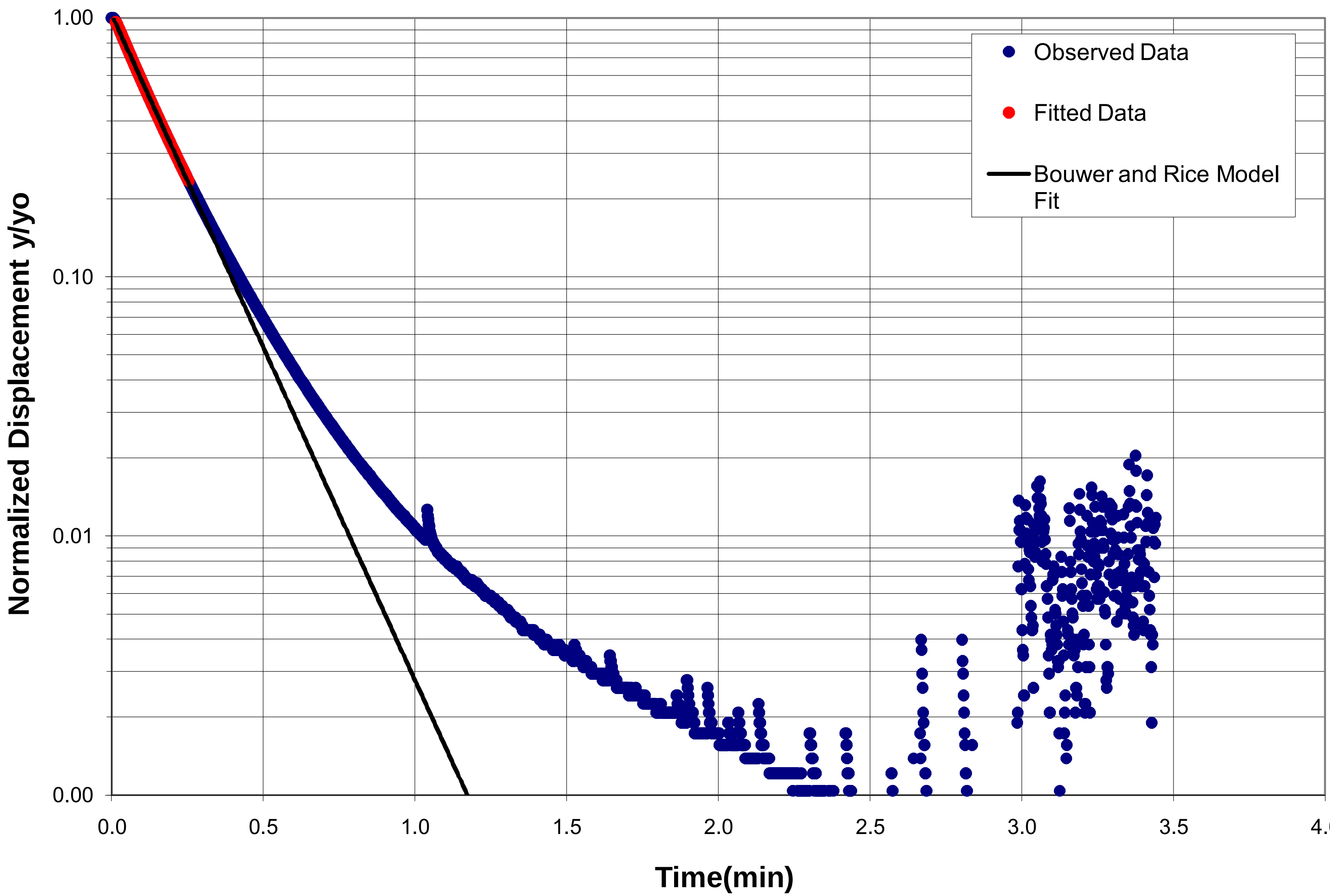

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Figure B28 - CP-MW05 Test 2 Slug Test Data
RI/FS - GP West Site

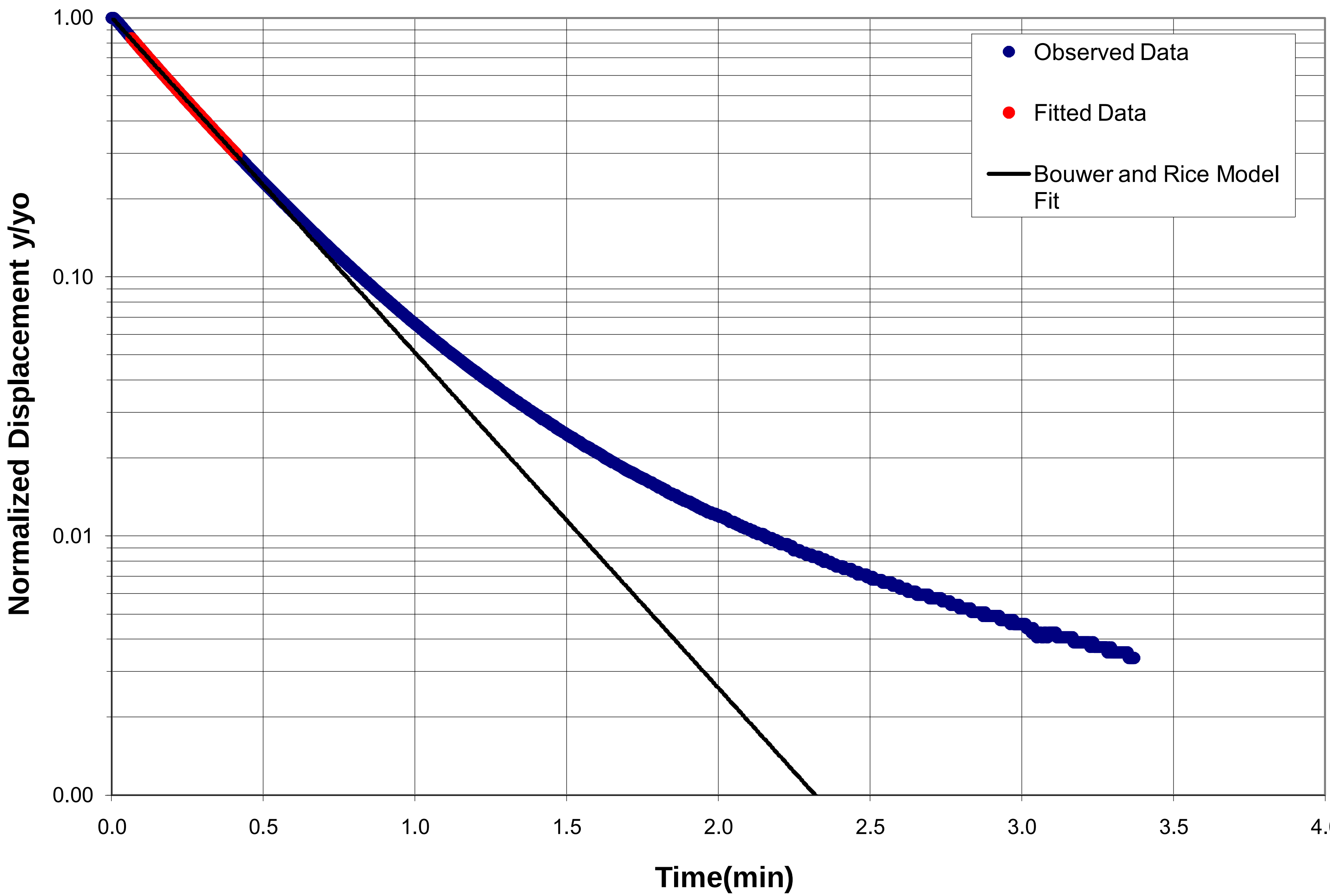

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Figure B29 - CP-MW04 Test 1 Slug Test Data
RI/FS - GP West Site

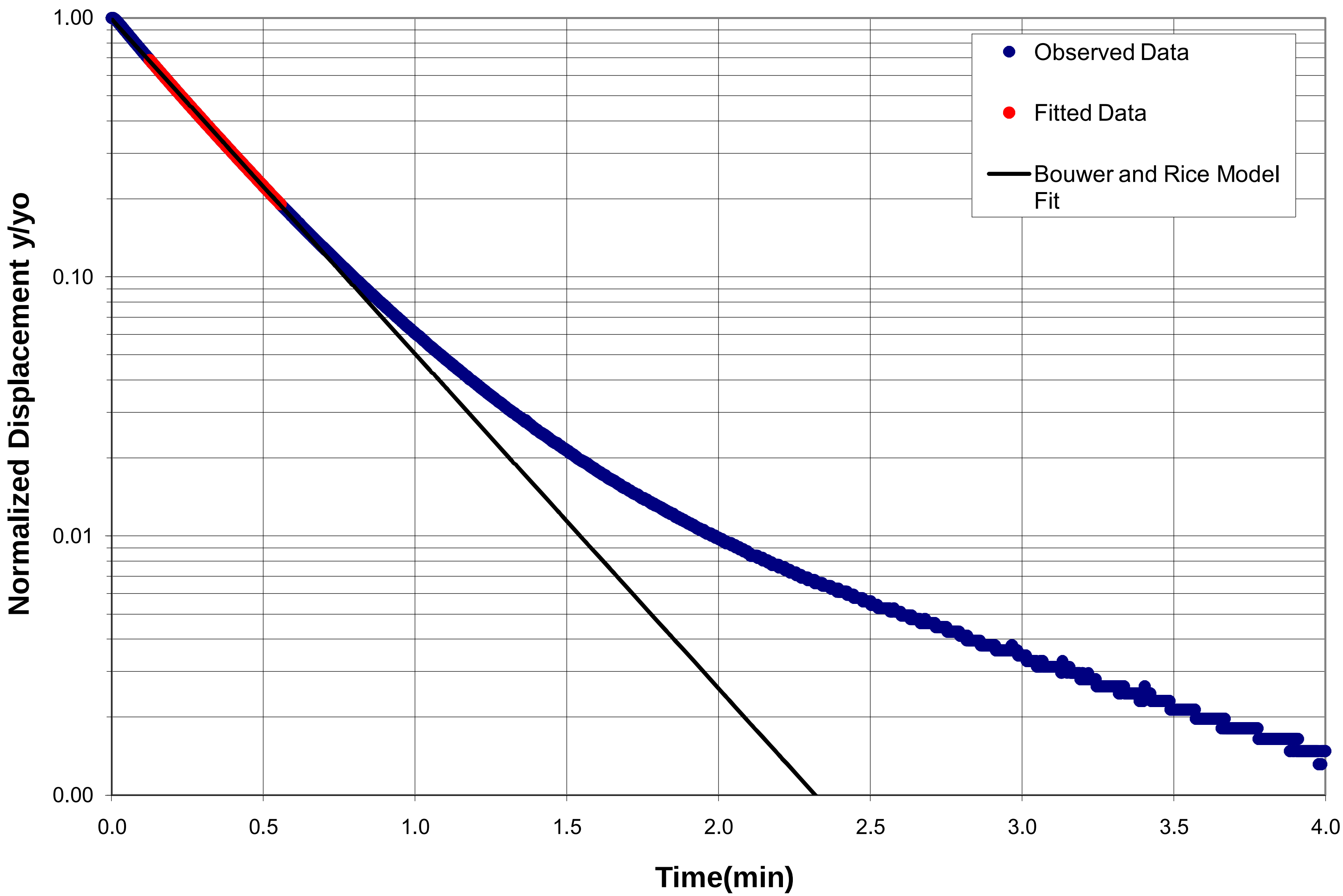

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Figure B30 - CP-MW04 Test 2 Slug Test Data
RI/FS - GP West Site

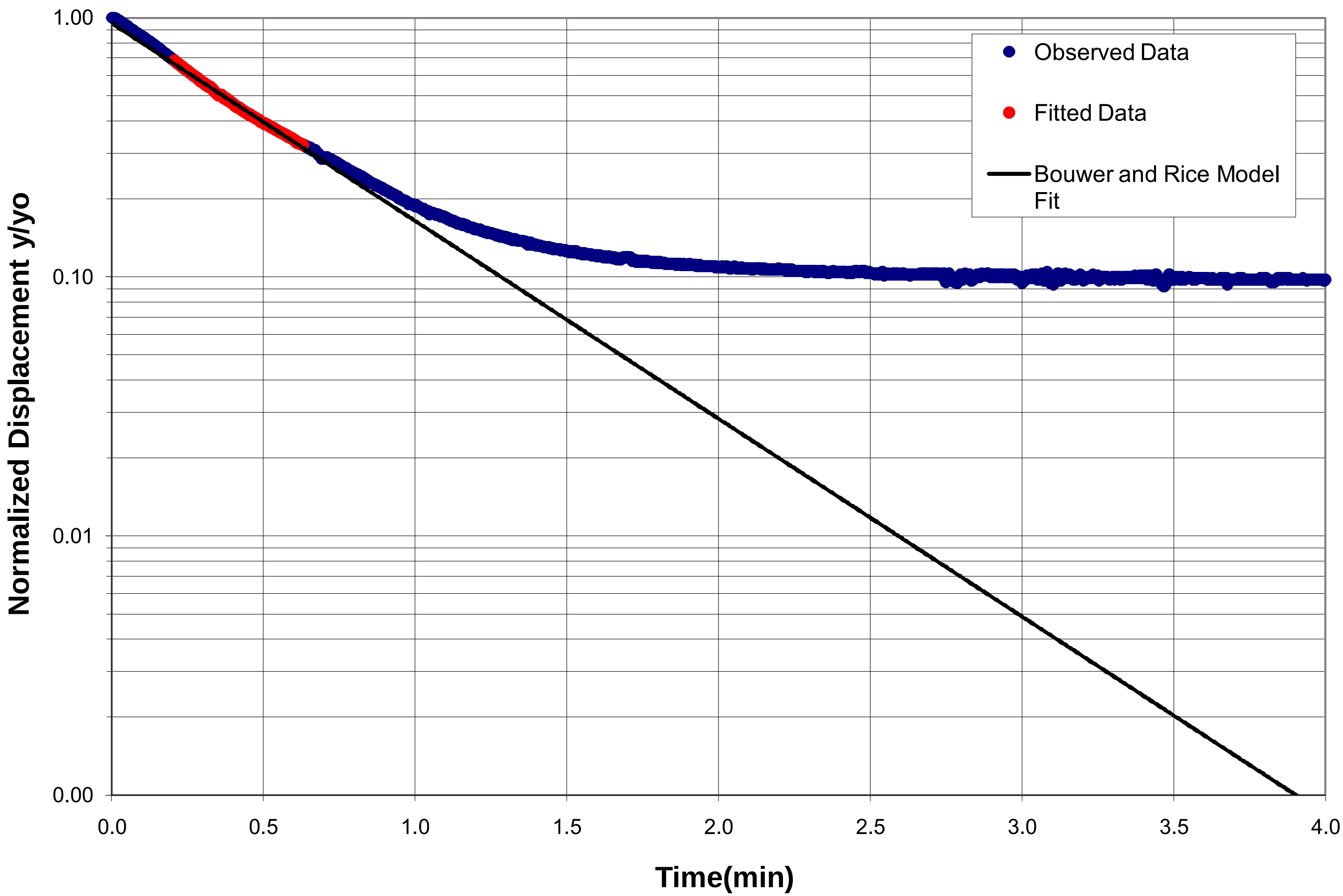

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Figure B31 - CP-MWC3 Test 1 Slug Test Data
RI/FS - GP West Site

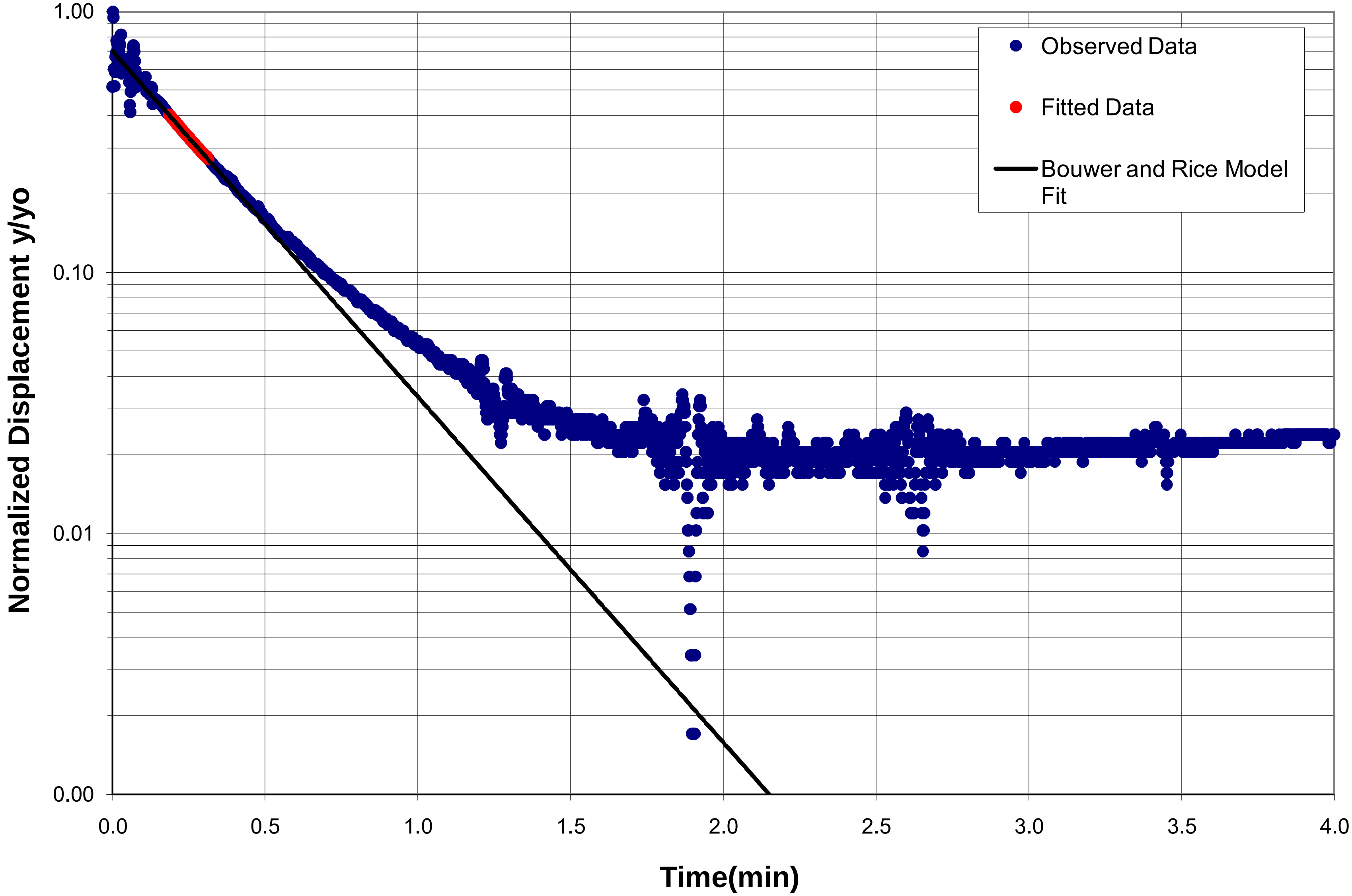

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Figure B32 - CP-MWC3 Test 2 Slug Test Data
RI/FS - GP West Site

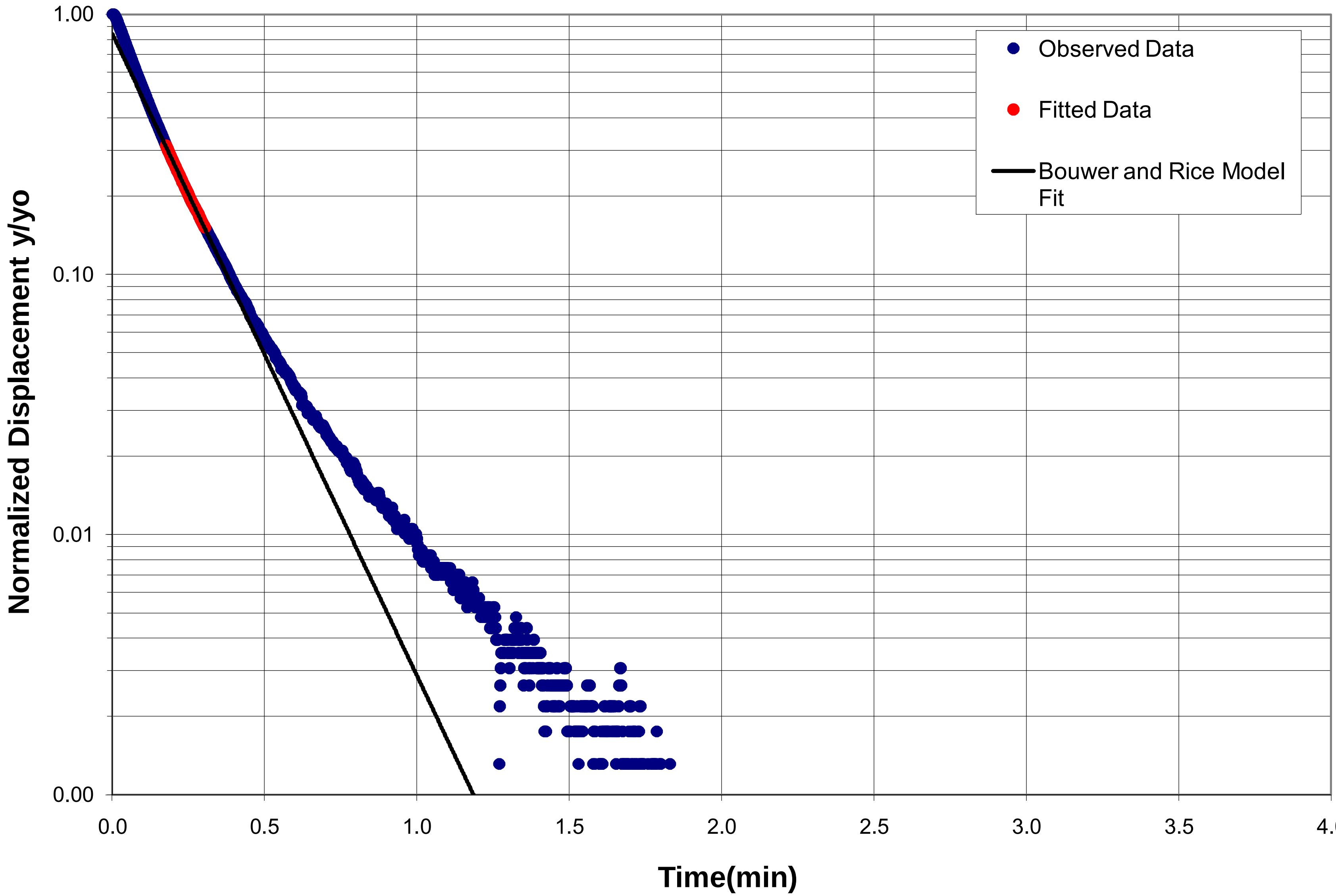

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Figure B33 - CP-MWB3 Test 1 Slug Test Data
RI/FS - GP West Site

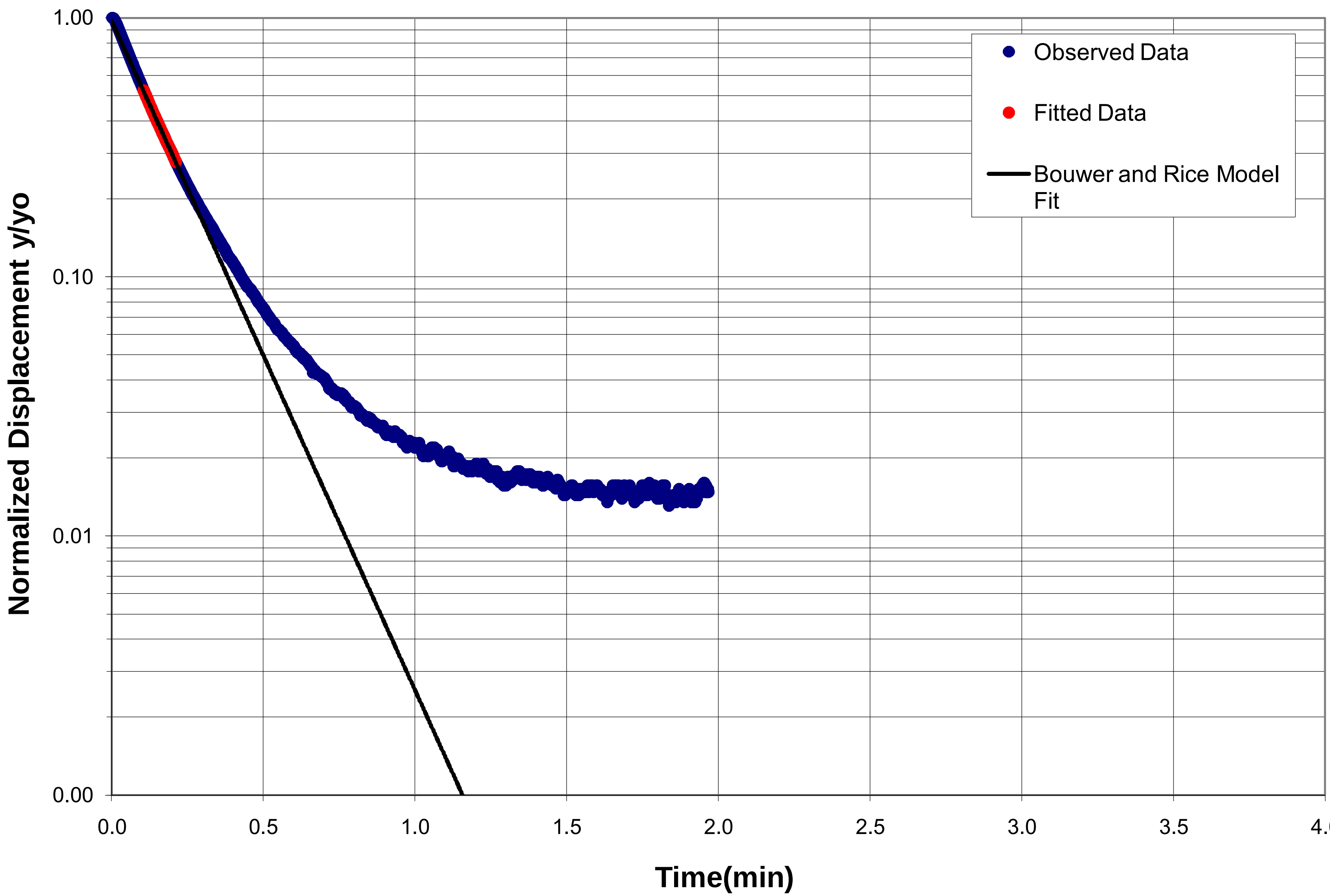

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Figure B34 - CP-MWB3 Test 2 Slug Test Data
RI/FS - GP West Site

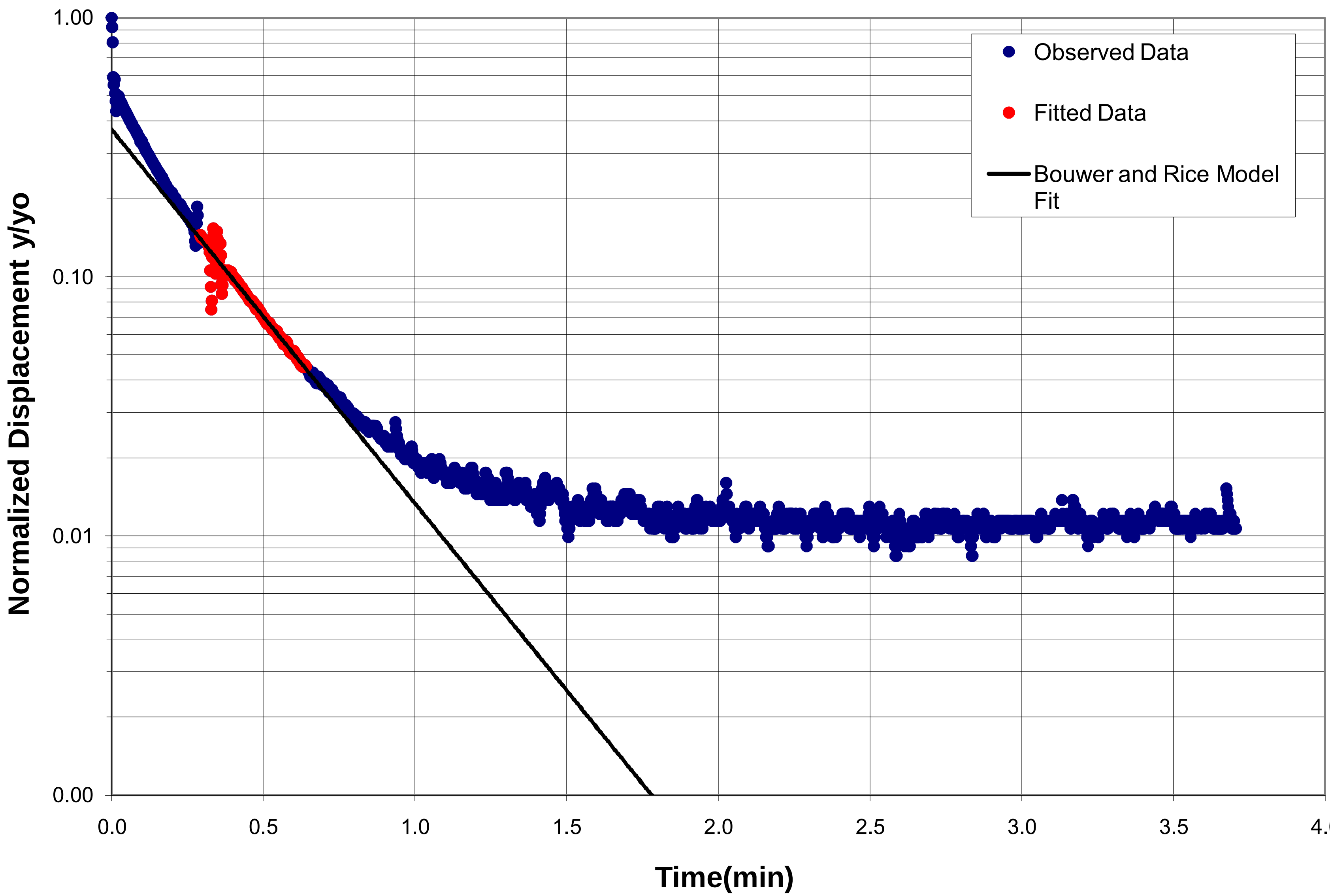

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Figure B35 - CP-MWA3 Test 1 Slug Test Data
RI/FS - GP West Site

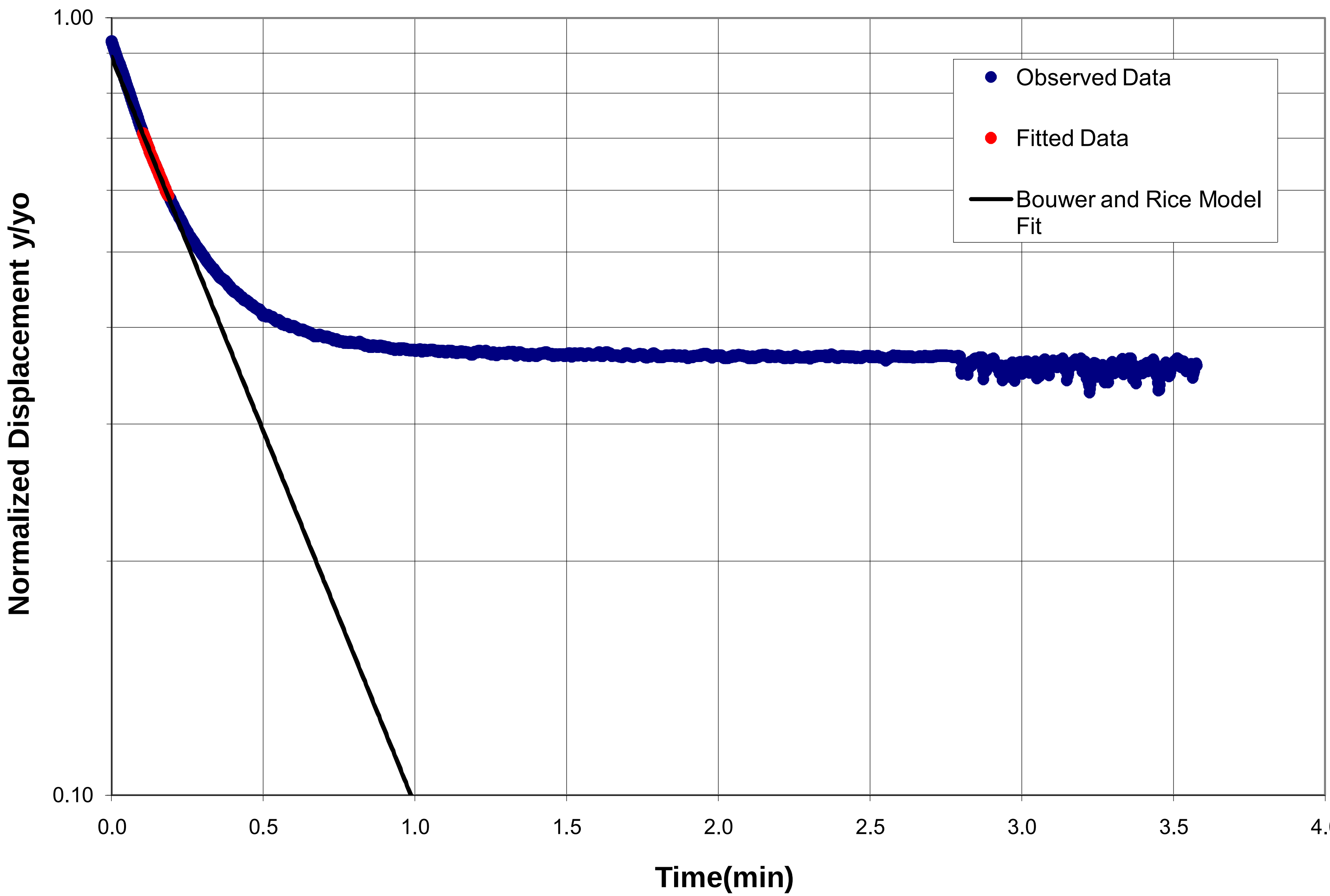

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Figure B36 - CP-MWA3 Test 2 Slug Test Data
RI/FS - GP West Site

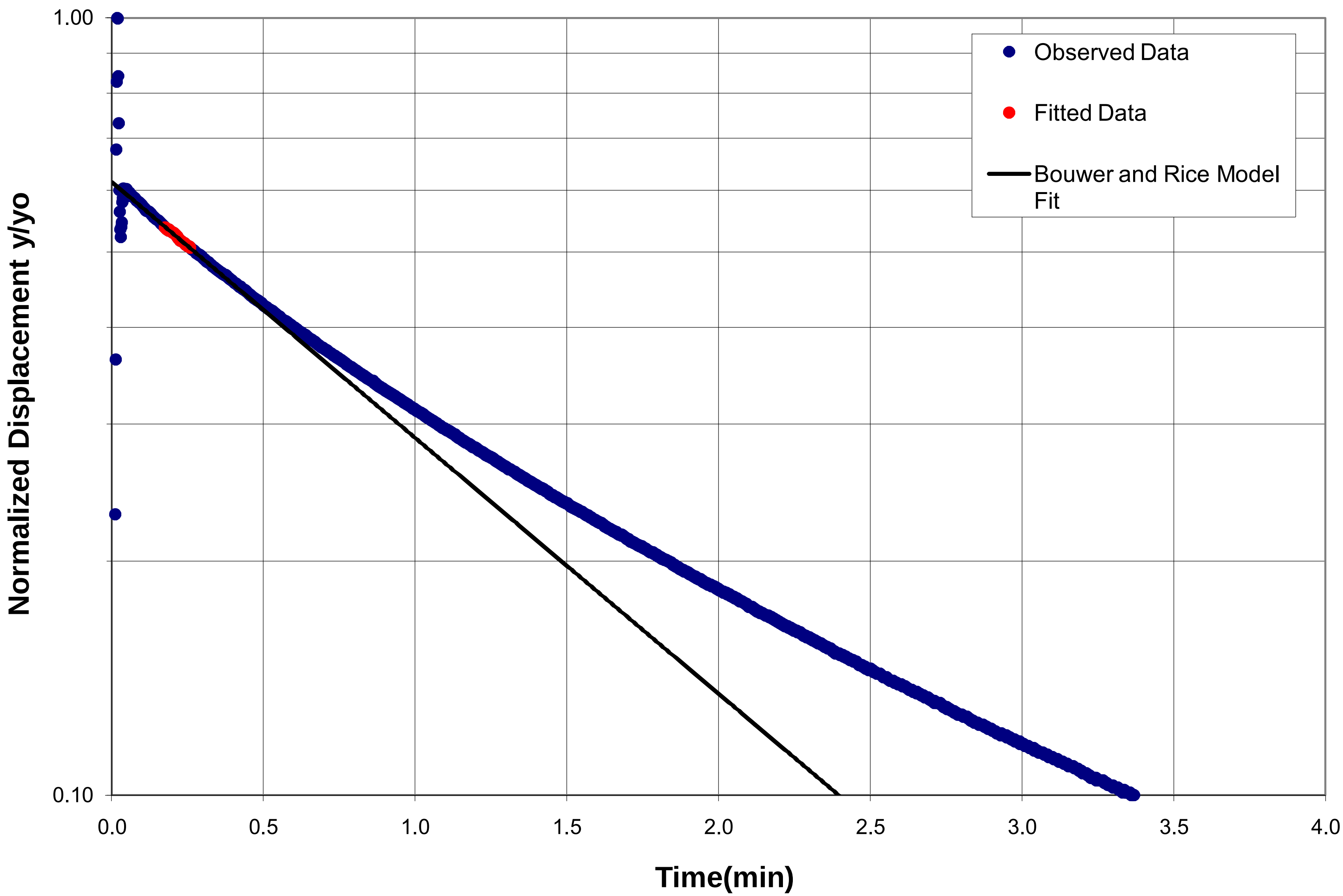

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Figure B37 - CP-MWC2 Test 1 Slug Test Data
RI/FS - GP West Site

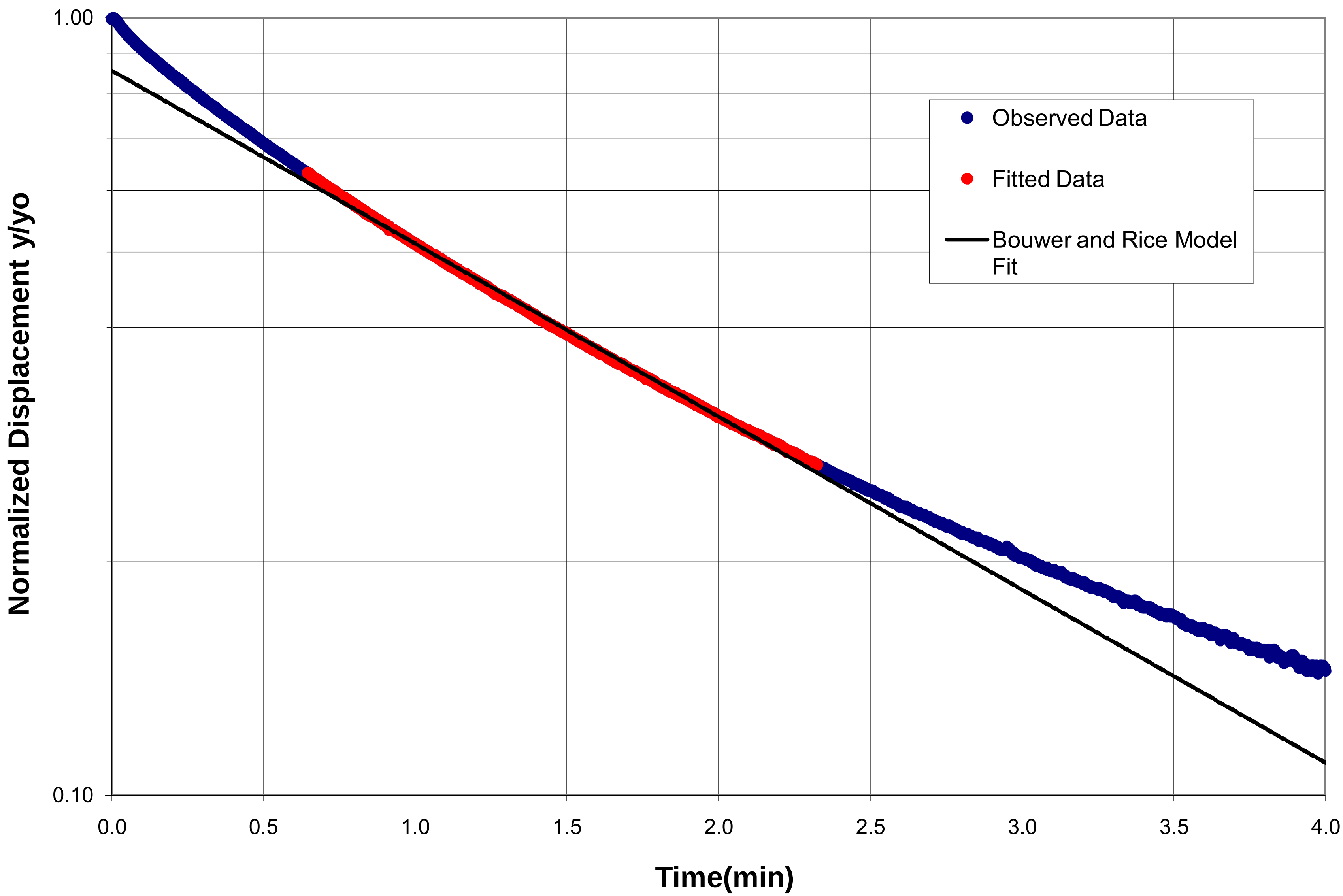

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Figure B38 - CP-MWC2 Test 2 Slug Test Data
RI/FS - GP West Site

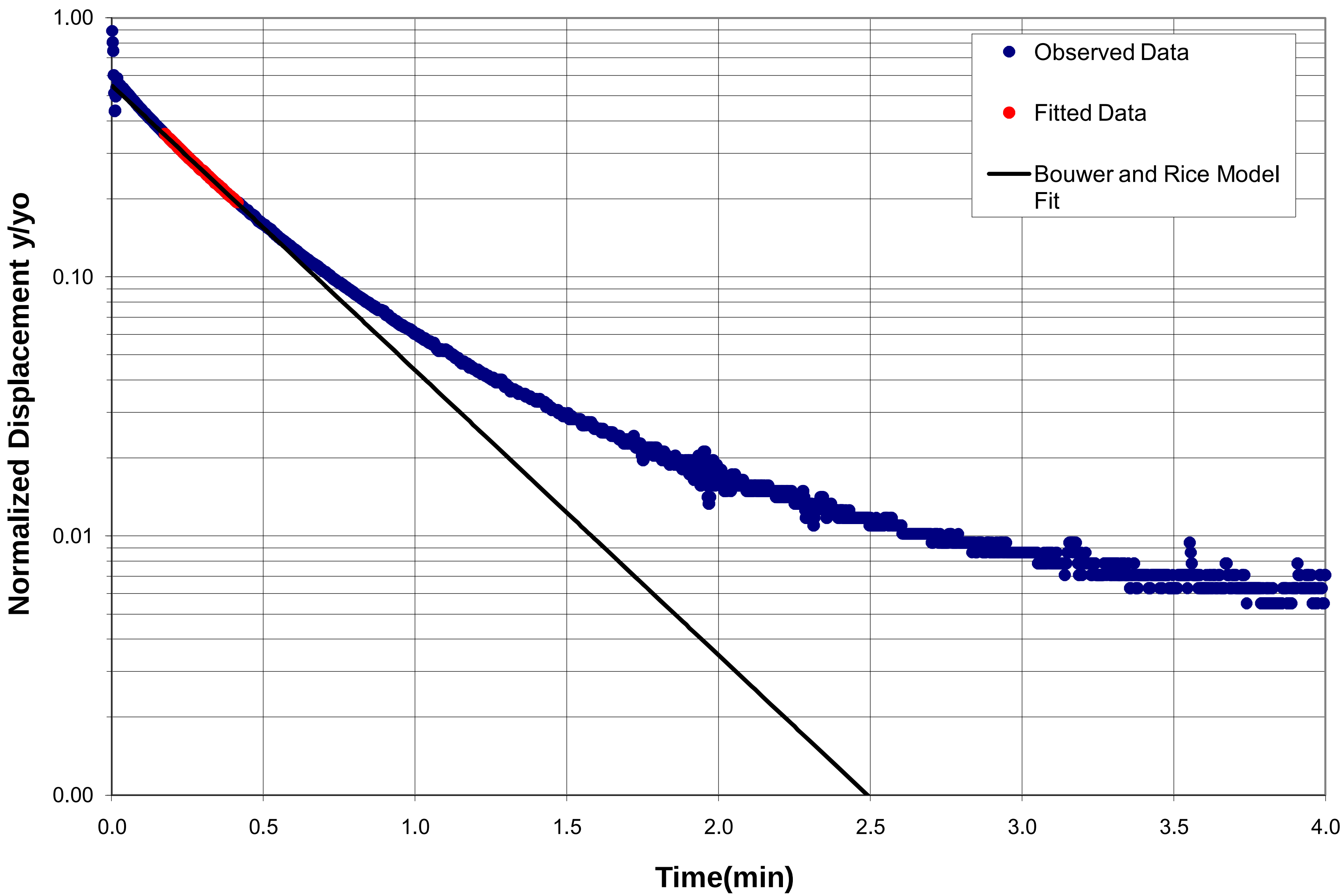

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Figure B39 - CP-MWB2 Test 1 Slug Test Data
RI/FS - GP West Site

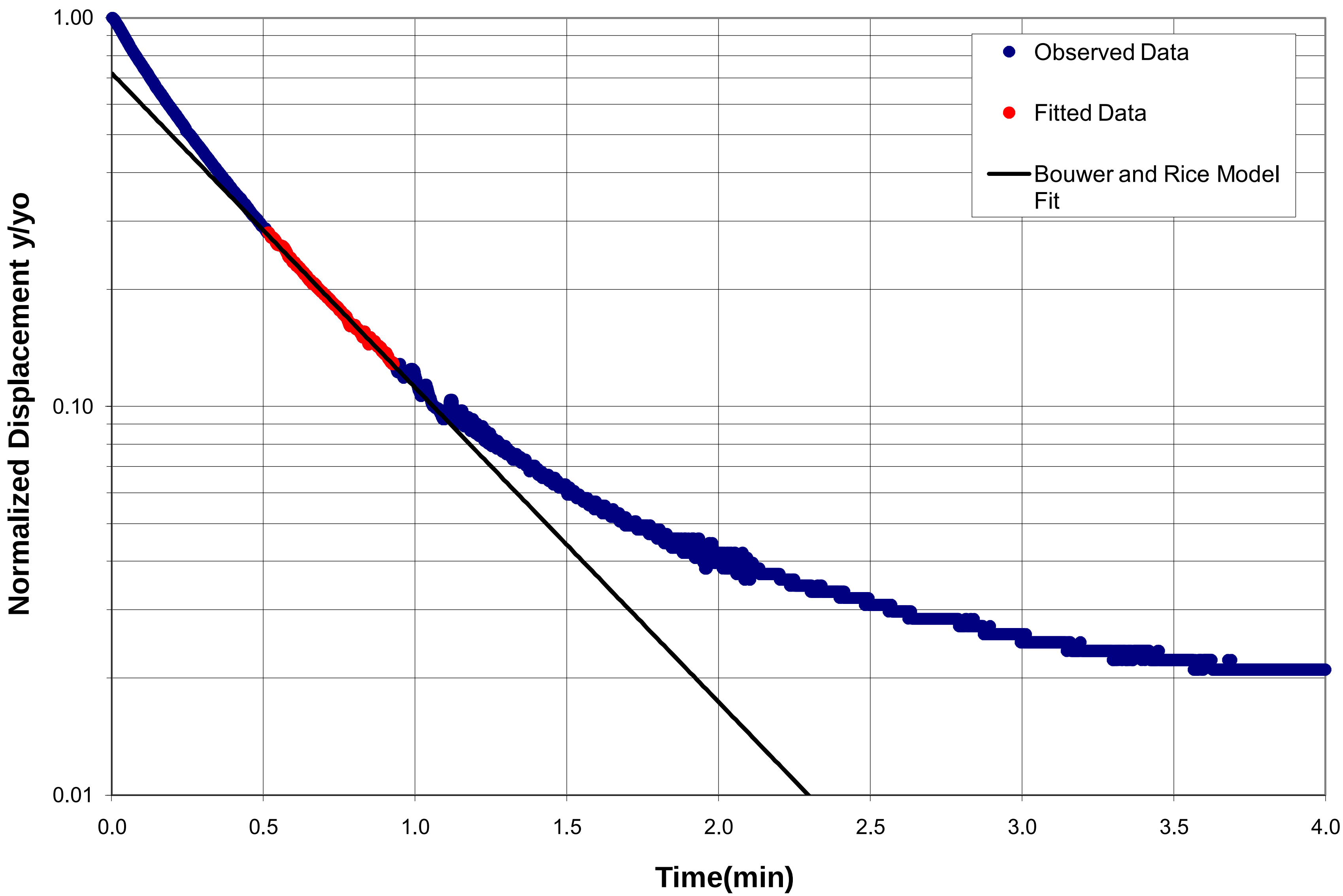

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Figure B40 - CP-MWB2 Test 2 Slug Test Data
RI/FS - GP West Site

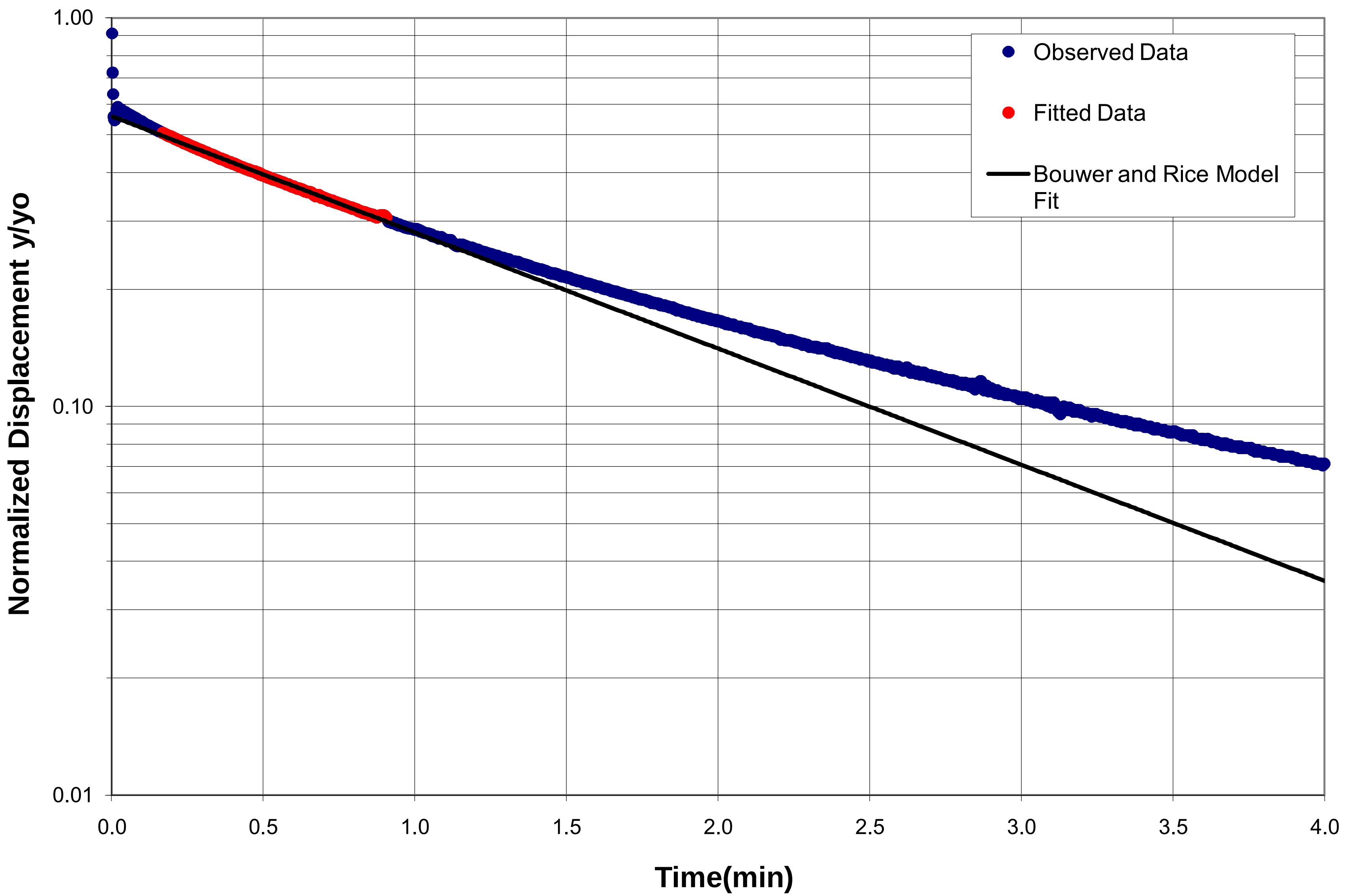

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Figure B41 - CP-MWA2 Test 1 Slug Test Data
RI/FS - GP West Site

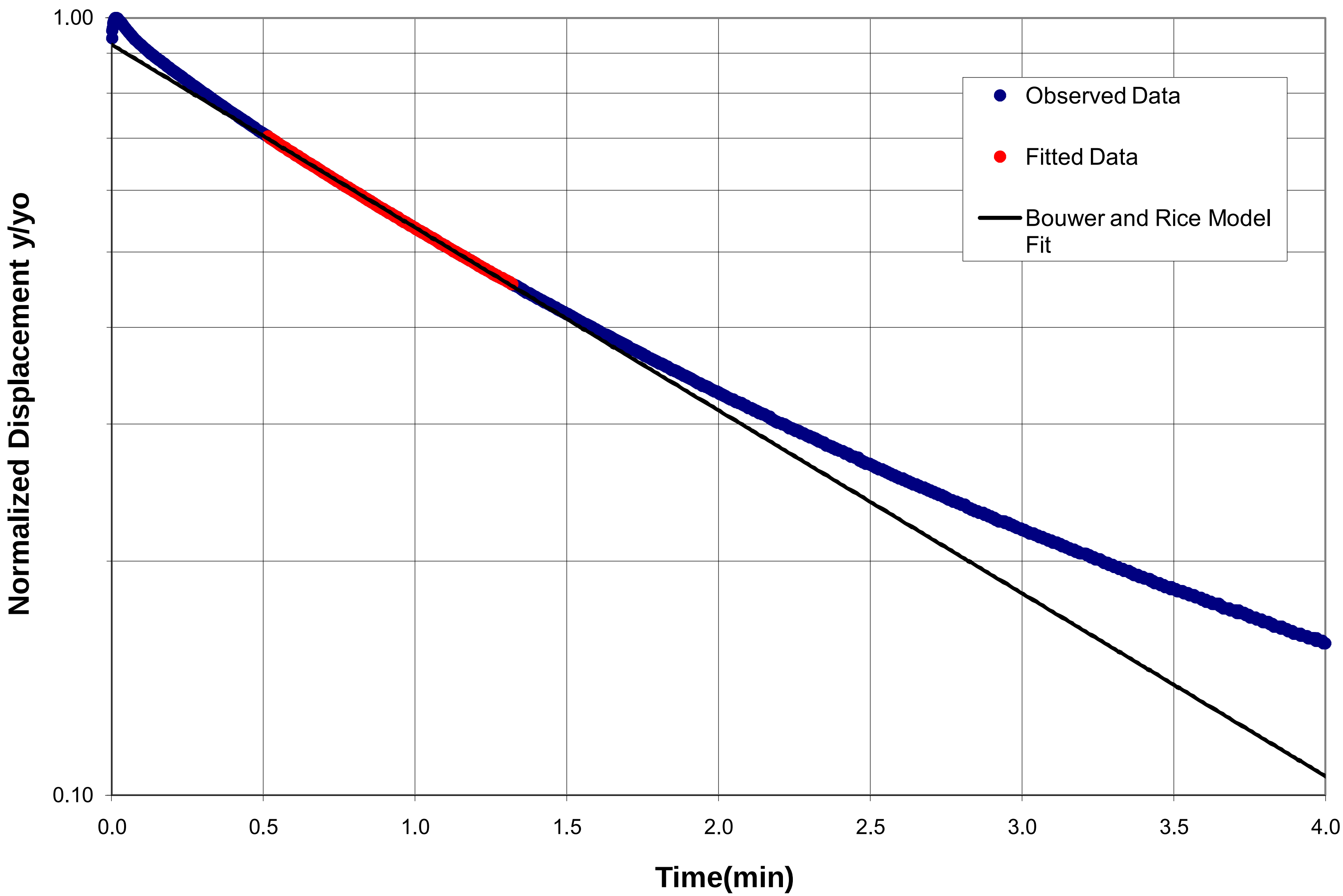

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Figure B42 - CP-MWA2 Test 2 Slug Test Data
RI/FS - GP West Site

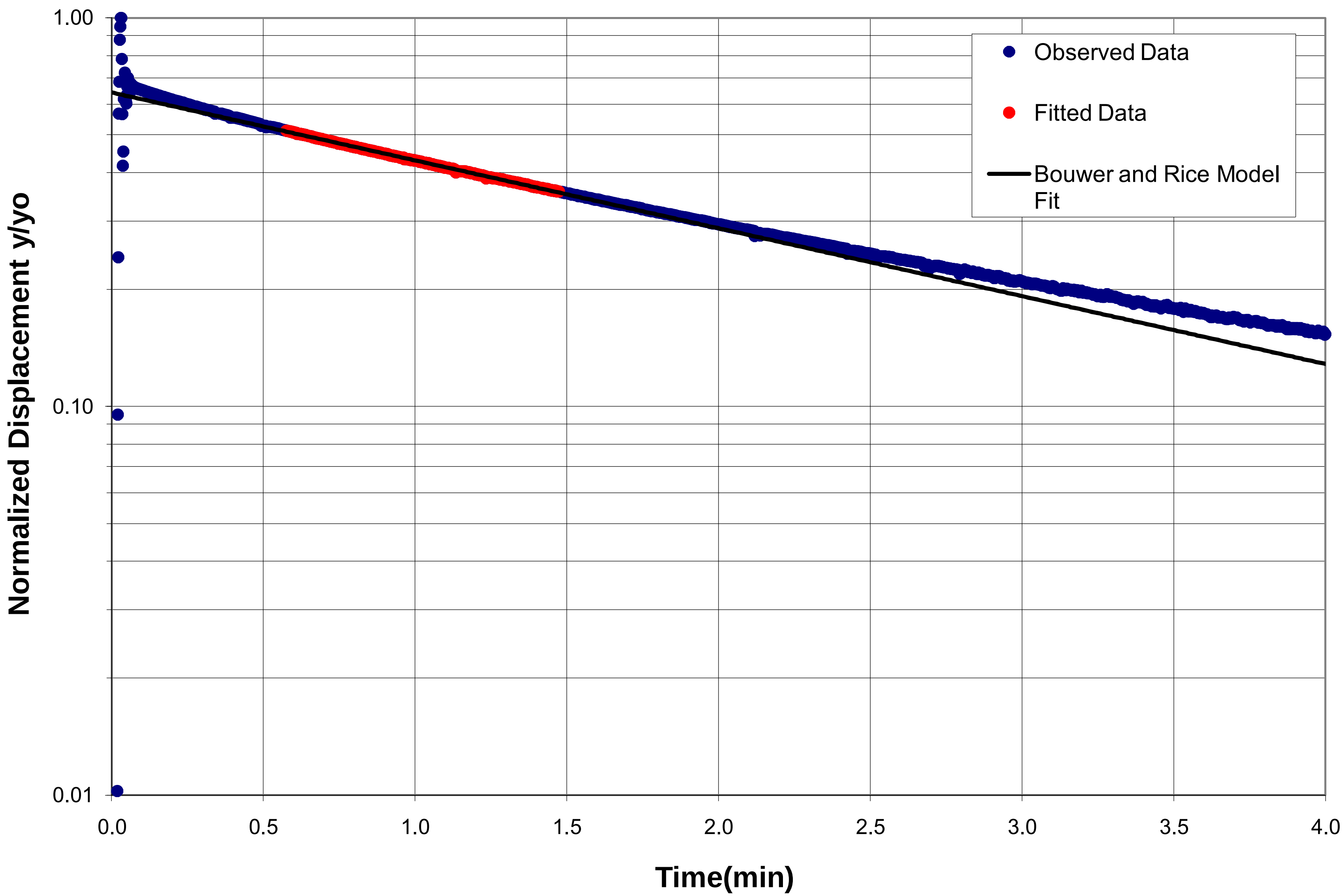

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Figure B43 - CP-MWC1 Test 1 Slug Test Data
RI/FS - GP West Site

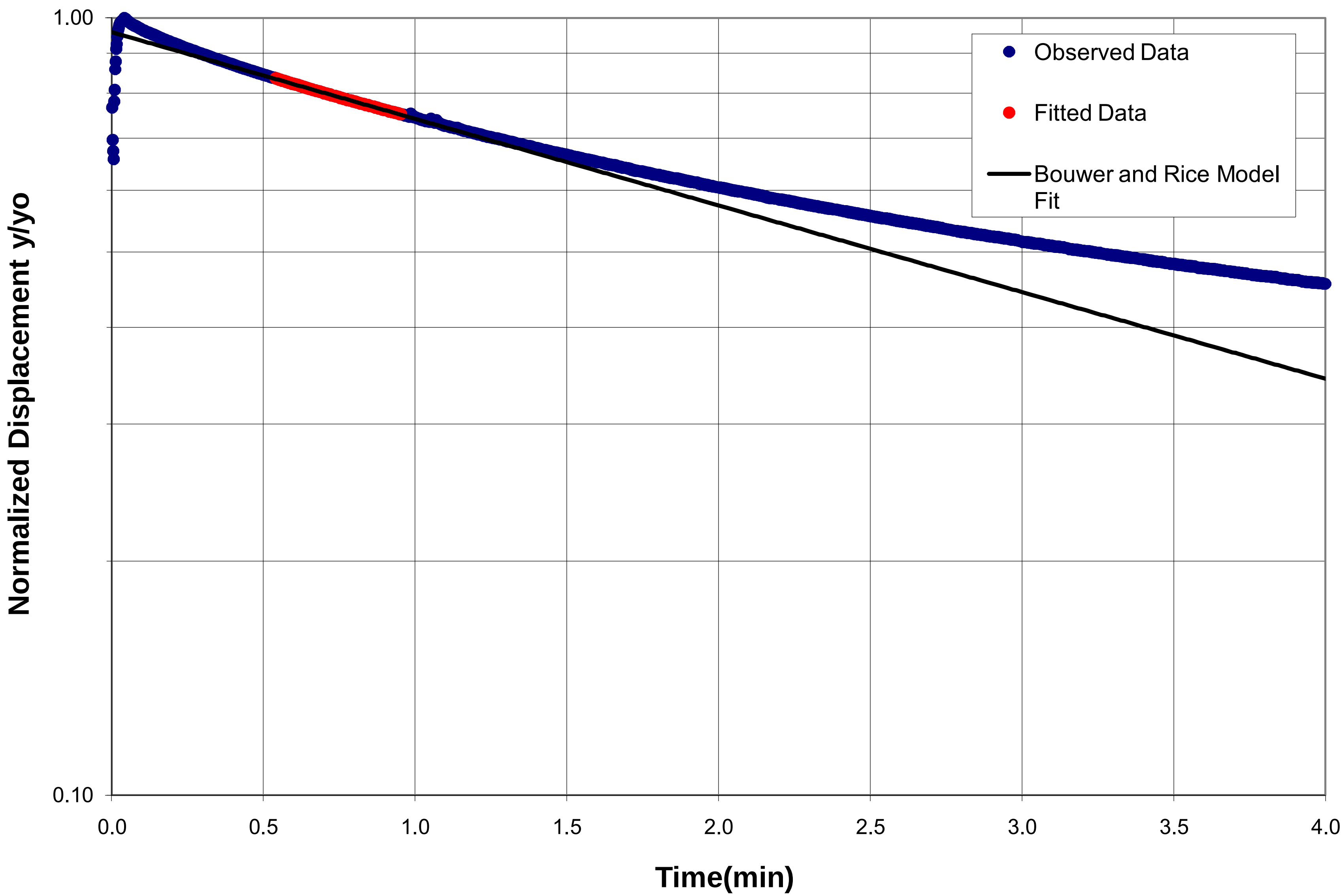

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Figure B44 - CP-MWC1 Test 2 Slug Test Data
RI/FS - GP West Site

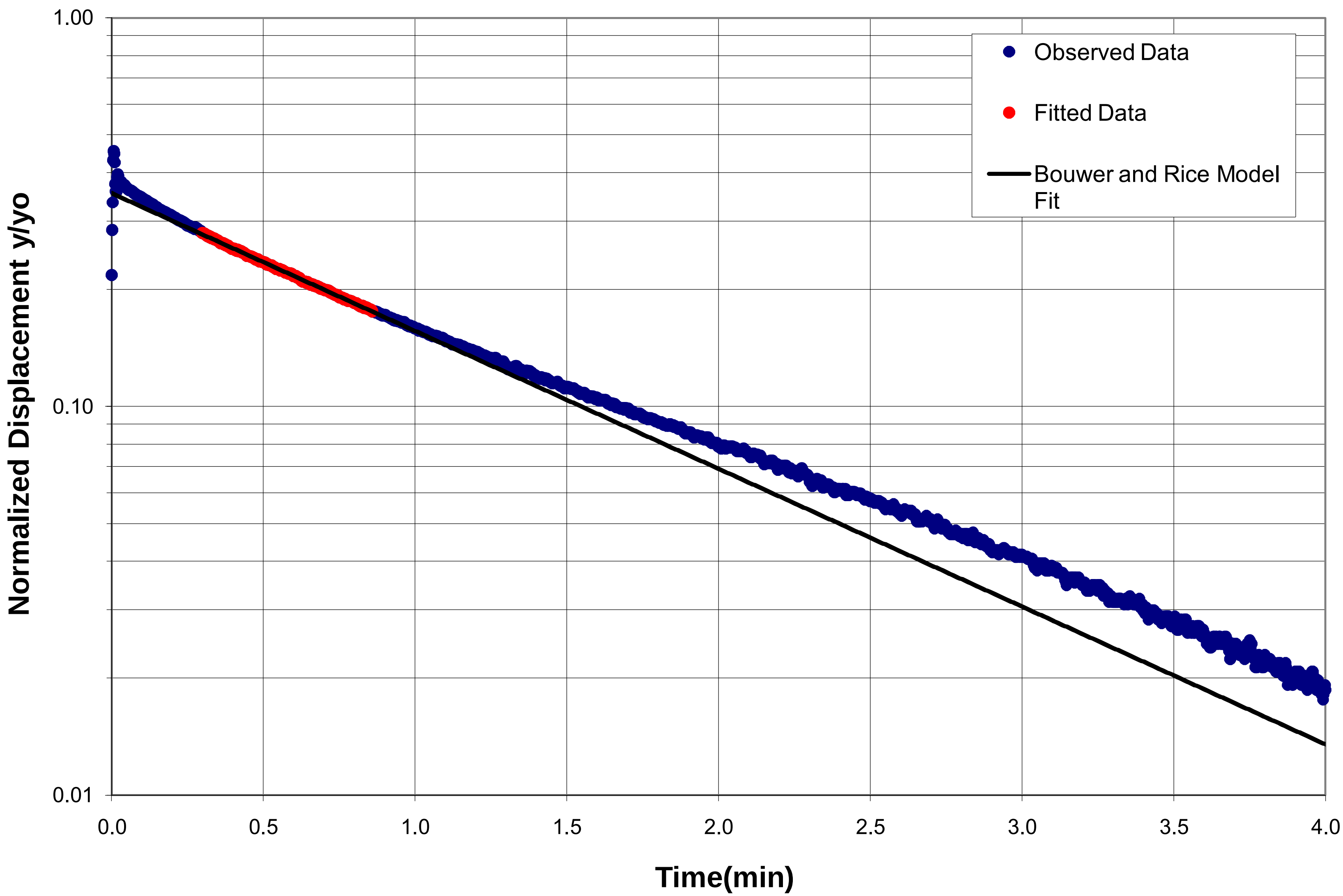

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Figure B45 - CP-MWB1 Test 1 Slug Test Data
RI/FS - GP West Site

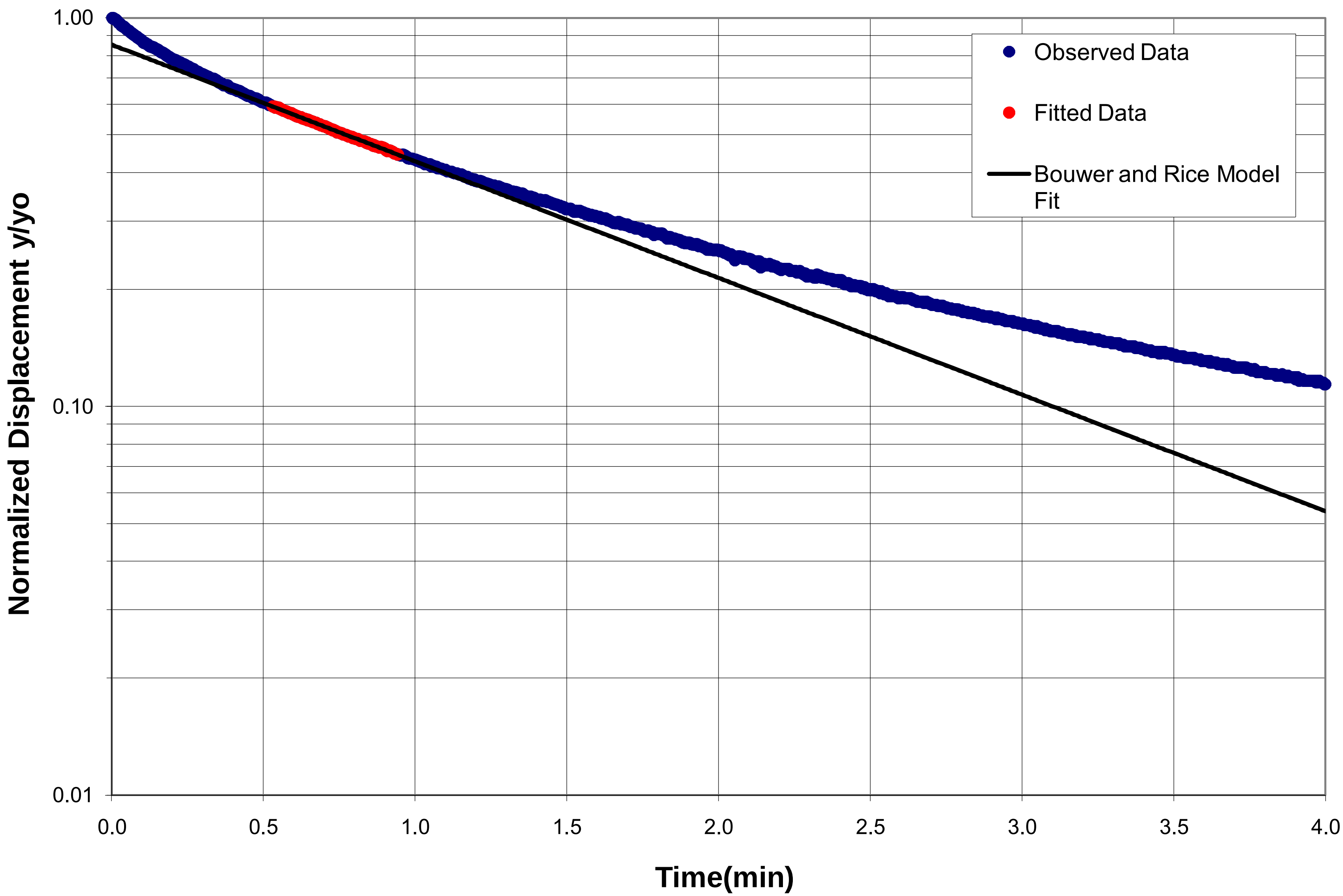

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Figure B46 - CP-MWB1 Test 2 Slug Test Data
RI/FS - GP West Site

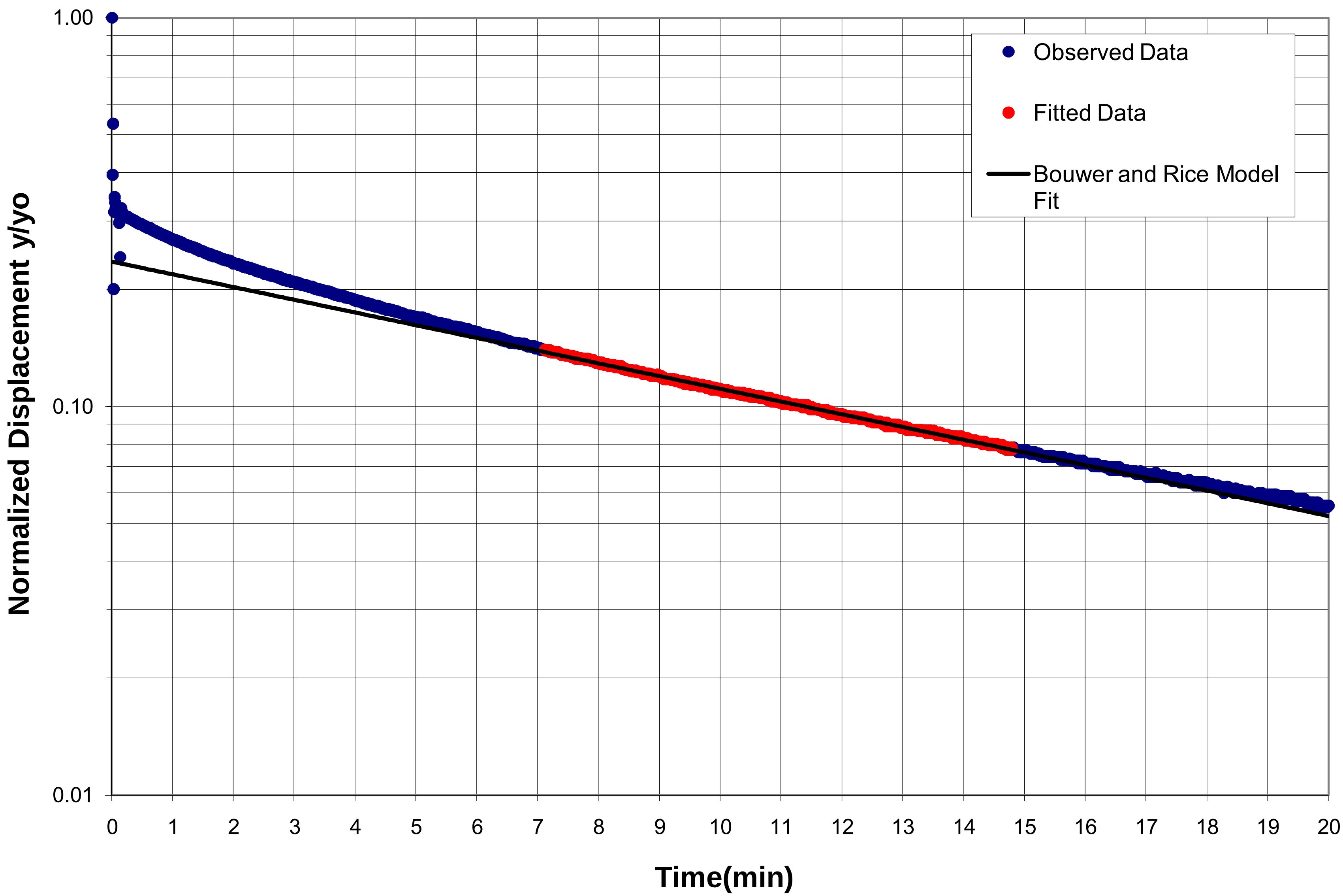

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Figure B47 - CP-MWA1 Test 1 Slug Test Data
RI/FS - GP West Site

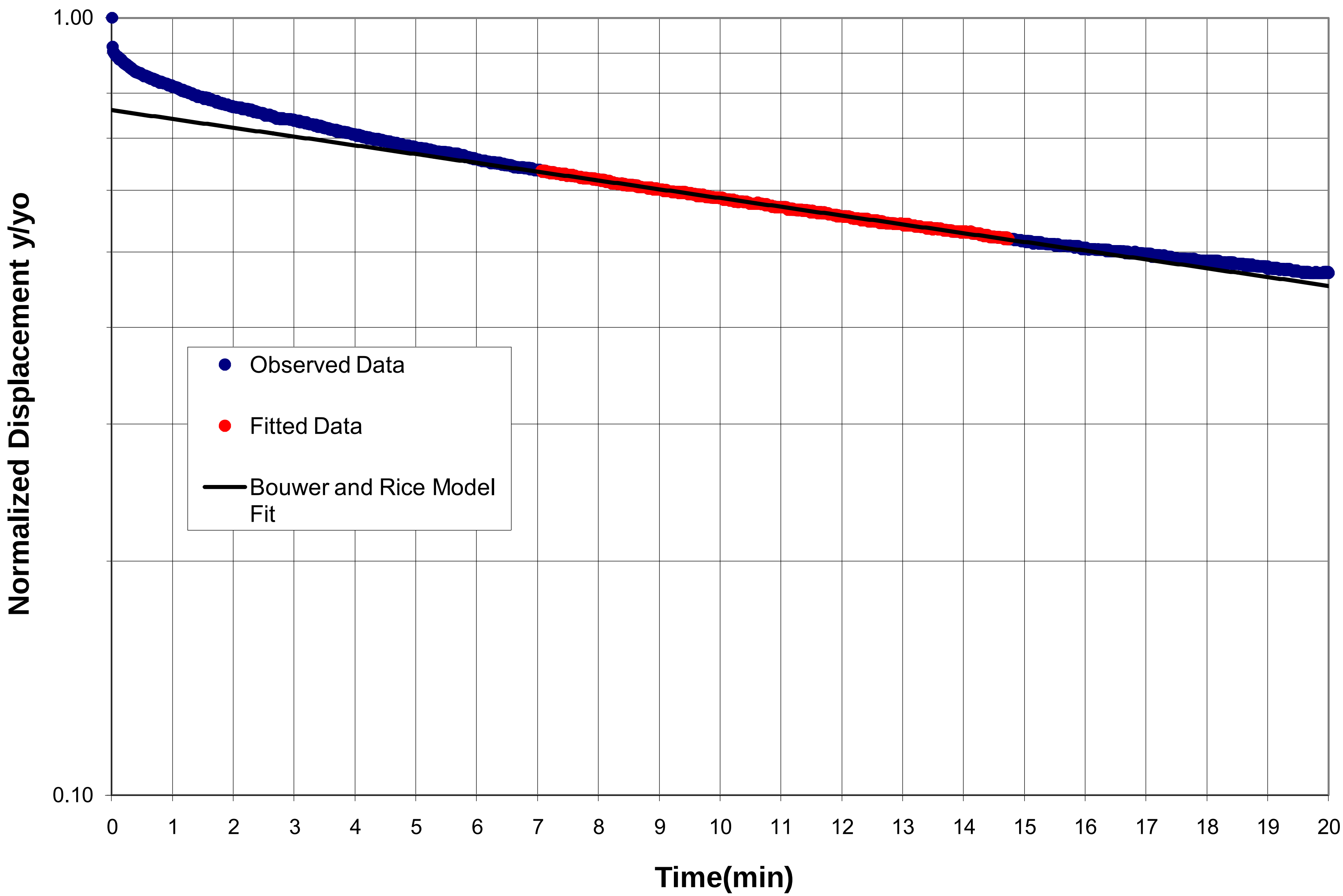

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Figure B48 - CP-MWA1 Test 2 Slug Test Data
RI/FS - GP West Site

MEMORANDUM

Project No.: 070188-001-14B

July 29, 2011

To: File

From: Joe Morrice, LHG
Senior Hydrogeologist

Steve Germiat, LHG
Senior Associate Hydrogeologist

Re: **Pumping Test Results, Bunker C Tank Interim Action Area, GP West Site**

This memorandum presents data and results of a pumping test performed within the Bunker C Tank interim action area of the Georgia-Pacific West Site (Site), located in Bellingham, Washington. The pumping test was performed to estimate aquifer hydraulic parameters to support Contractor design of an excavation dewatering system for planned interim action (soil removal) for the Bunker C Tank Area. The following sections briefly discuss the dewatering test well installation, data collection and pumping tests, and test results.

Dewatering Test Well

Under the direction of Aspect Consulting, a dewatering test well (BC-DW1) was drilled by Holt Services using cable tool methods. Total depth of the borehole was 51.5 feet below ground surface (bgs). The well was installed to a depth of 26 feet, and constructed with 6-inch-diameter PVC casing with a 6-inch-diameter, 30-slot stainless steel wire-wrapped screen extending from 16 to 26 feet bgs. The well is screened in the upper sand unit (fill over potential native sand), which is underlain by an aquitard (predominantly silt) extending the 51-foot depth of exploration. A soil boring and well construction log for well BC-DW1 is provided elsewhere in the Geotechnical Information Compilation (Appendix A to Technical Specifications for the Bunker C Tank Area interim action).

Pumping Test Methods

Pumping tests for BC-DW1 included a short-term step-rate test and a 24-hour constant-rate test conducted between July 18 and 20, 2011. Water levels were monitored at test well BC-DW1 and nearby monitoring wells BC-MW01 (located 112 feet north), BC-MW02 (located 166 feet north), and BC-MW04 (located 146 feet north-northwest) for five days prior to the pumping tests (July 13, through July 17, 2011) and through the step- and constant-rate pumping test and recovery periods. The monitoring wells are screened in the same upper sand unit as BC-DW1 is screened. Soil boring and well construction logs of the monitoring wells are provided in the Geotechnical Information Compilation. Water levels in Bellingham Bay adjacent to the Site were also monitored. Figure 1 shows hydrographs of groundwater elevations and tide elevations in Bellingham Bay over the pre-test and testing periods. Based on pre-test water level response in the pumping and monitoring wells, groundwater levels throughout the Bunker C Tank Area are clearly influenced by changes in tide stage.

Pumping tests were performed using an electric submersible pump fitted with a shroud and intake screen. The pump was set near the bottom of the well, with the top of the pump at about 23 feet bgs, or about 16 feet below the average pre-test static water level. A short-term step-rate test was performed on July 18 to assess the sustainable pumping rate for the 24-hour constant rate test. Given the low pumping rates that could be produced from well BC-DW1, only two steps were conducted, with the second step at about 5 gallons per minute (gpm). This rate was selected as the target rate for the constant-rate test.

A 24-hour constant-rate drawdown and recovery test was performed from approximately 8:00 AM July 19 to 8:00 AM July 20. Measured pumping rates during the test varied from about 4.6 to 5.0 gpm, with an average rate of about 4.7 gpm. Figure 2 shows hydrographs of groundwater elevations in the pumping well and three monitoring wells and tide elevation in Bellingham Bay during the constant-rate pumping and recovery period. Maximum drawdown in the pumping well was about 10.5 feet, or to about 5.5 feet above the pump intake. There was no discernable drawdown at any of the monitoring wells. Electronic files of pumping test data are available from Aspect Consulting on request.

Constant-Rate Pumping Test Results

Figure 3 shows drawdown data from the pumping well graphed on a semi-log scale. To accommodate analysis of the data using the Cooper-Jacob Straight line method, drawdown data shown on Figure 3 were corrected to account for unconfined conditions using the method of Jacob (1946).

Drawdown data from about the first 7 minutes appear to be heavily influenced by well casing storage, followed by a slight decrease in drawdown as pumping rates were adjusted. Between about 10 minutes and 200 minutes of pumping, drawdown appears to reflect aquifer response to pumping, without casing storage or recharge boundary effects. The average pumping rate over this period was about 4.9 gpm. From about 200 to 400 minutes, there is a slight increase in drawdown rate, corresponding to a small increase in average pumping rate to 5 gpm, followed by a sharp flattening of the drawdown curve that appears to be the effect of a recharge boundary at Bellingham Bay. Average pumping rate over the final 1,000 minutes of the test also decreased to about 4.6 gpm.

Using the straight-line part of the curve between 10 and 200 minutes, that appears to represent primarily aquifer response, produces a slope of about 1.2 feet of drawdown per log-cycle of time. Applying this slope and the average pumping rate over this period of 4.9 gpm to the Cooper-Jacob Straight line time-drawdown equation produces an estimated transmissivity of about 140 ft^2/day for the upper sand water-bearing unit. The saturated thickness of sand above the clay layer encountered at 26 feet bgs (see log for BC-DW1) is about 19 feet, indicating an estimated hydraulic conductivity of about 7.4 ft/day (3×10^{-3} cm/sec) for the upper sand water-bearing unit. Given that no drawdown was observed in the monitoring wells, storage properties of the water-bearing unit could not be estimated from the test.

Recovery test data are shown on Figure 4. Recovery rates were significantly faster than drawdown rates, and appear to be affected by the recharge boundary at Bellingham Bay. Because the recovery data do not represent only aquifer response to pumping, these data were not used to estimate aquifer properties.

Limitations

Work for this project was performed and this memorandum prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Port of Bellingham for specific application to the referenced property. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

Attachments

Figure 1 – Tide and Groundwater Hydrographs
Figure 2 – Constant Rate Pumping Test Hydrographs
Figure 3 – Constant Rate Drawdown Data, Pumping Well BC-DW1
Figure 4 – Constant Rate Test Recovery Data, Pumping Well BC-DW1

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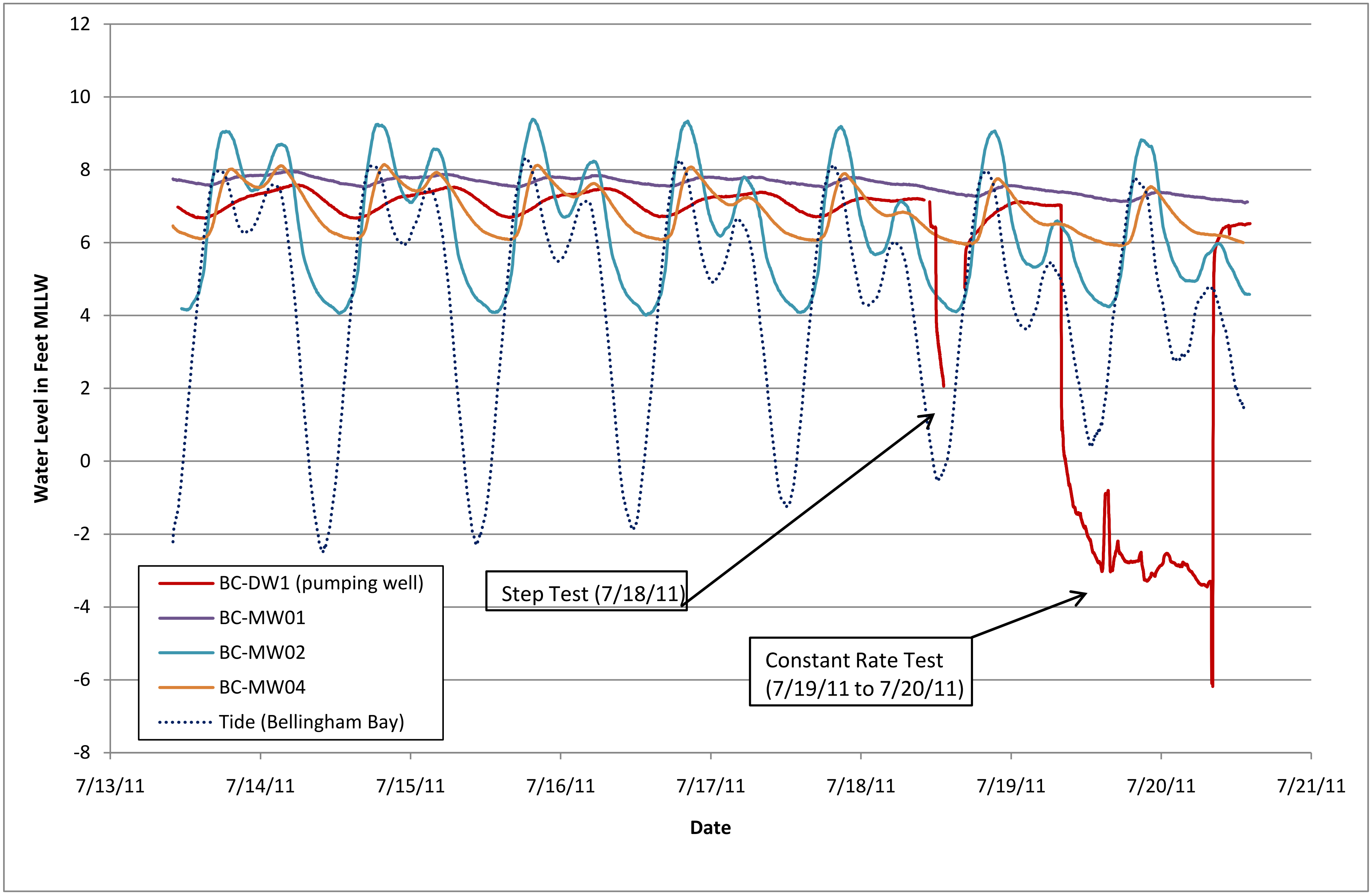

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July 29, 2011
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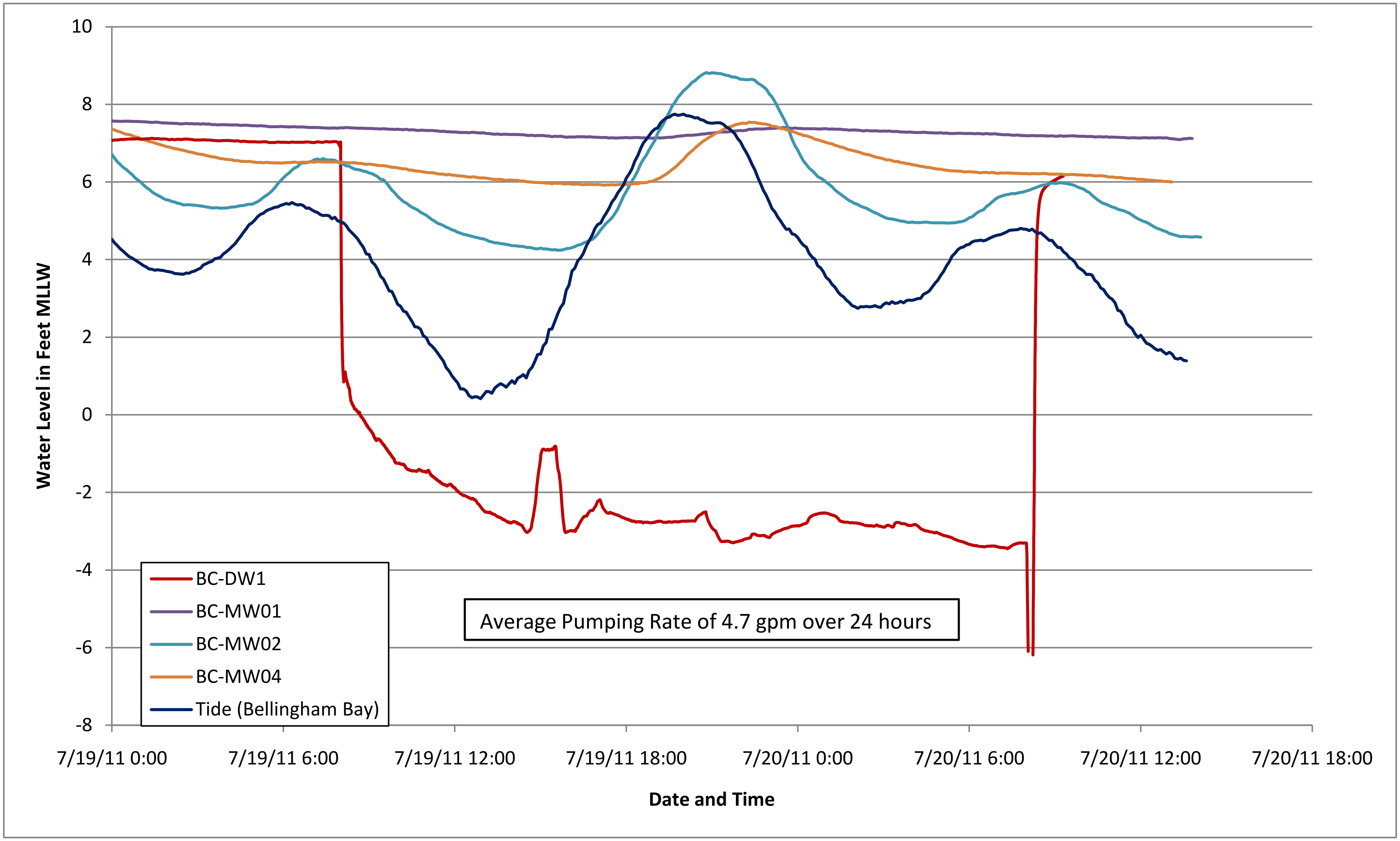
Figure 1
Tide and Groundwater Hydrographs
Bunker C Tank Area Interim Action, GP West Site



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July 29, 2011
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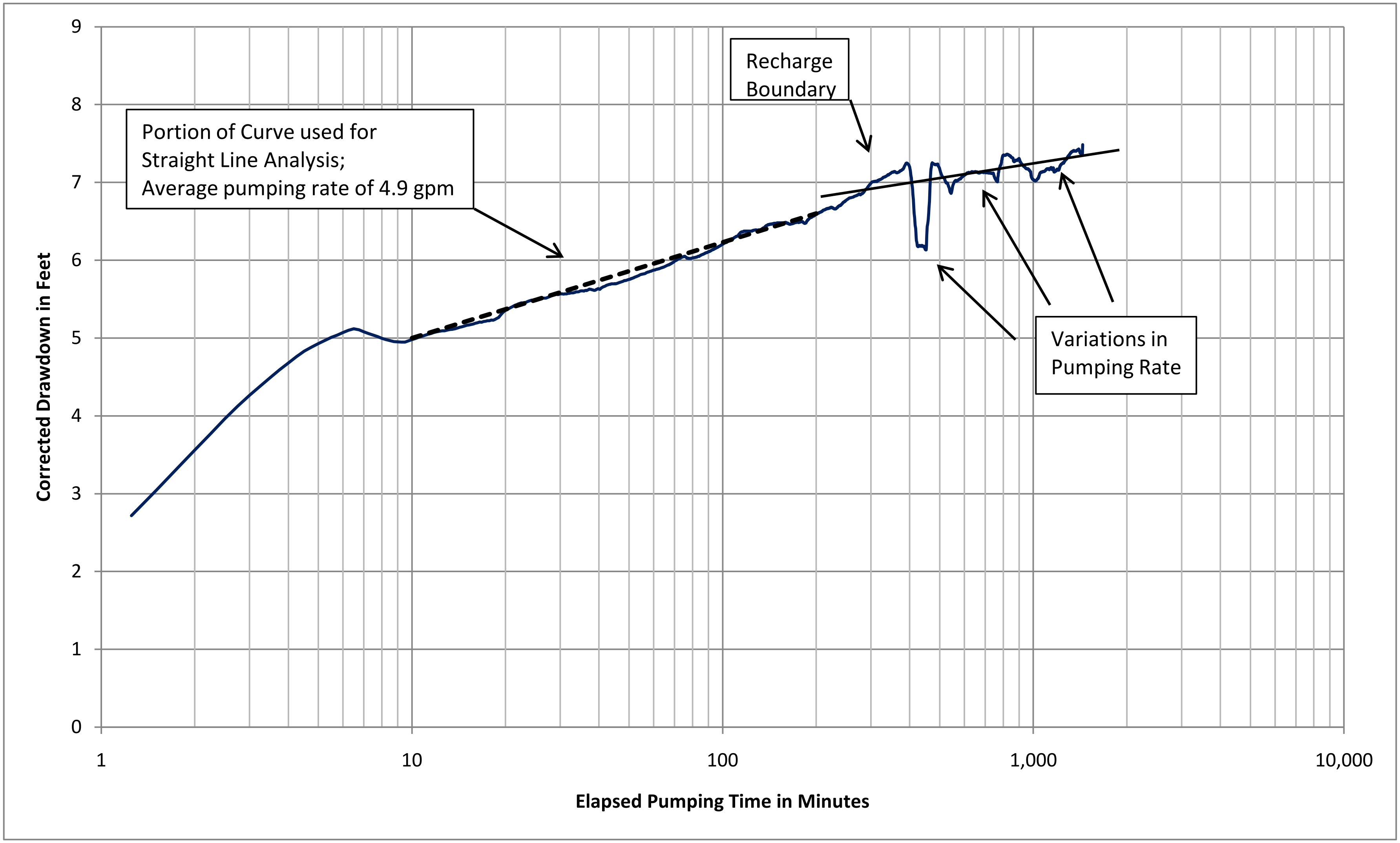
Figure 2
Constant Rate Pumping Test Hydrographs
Bunker C Tank Area Interim Action, GP West Site



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July 29, 2011
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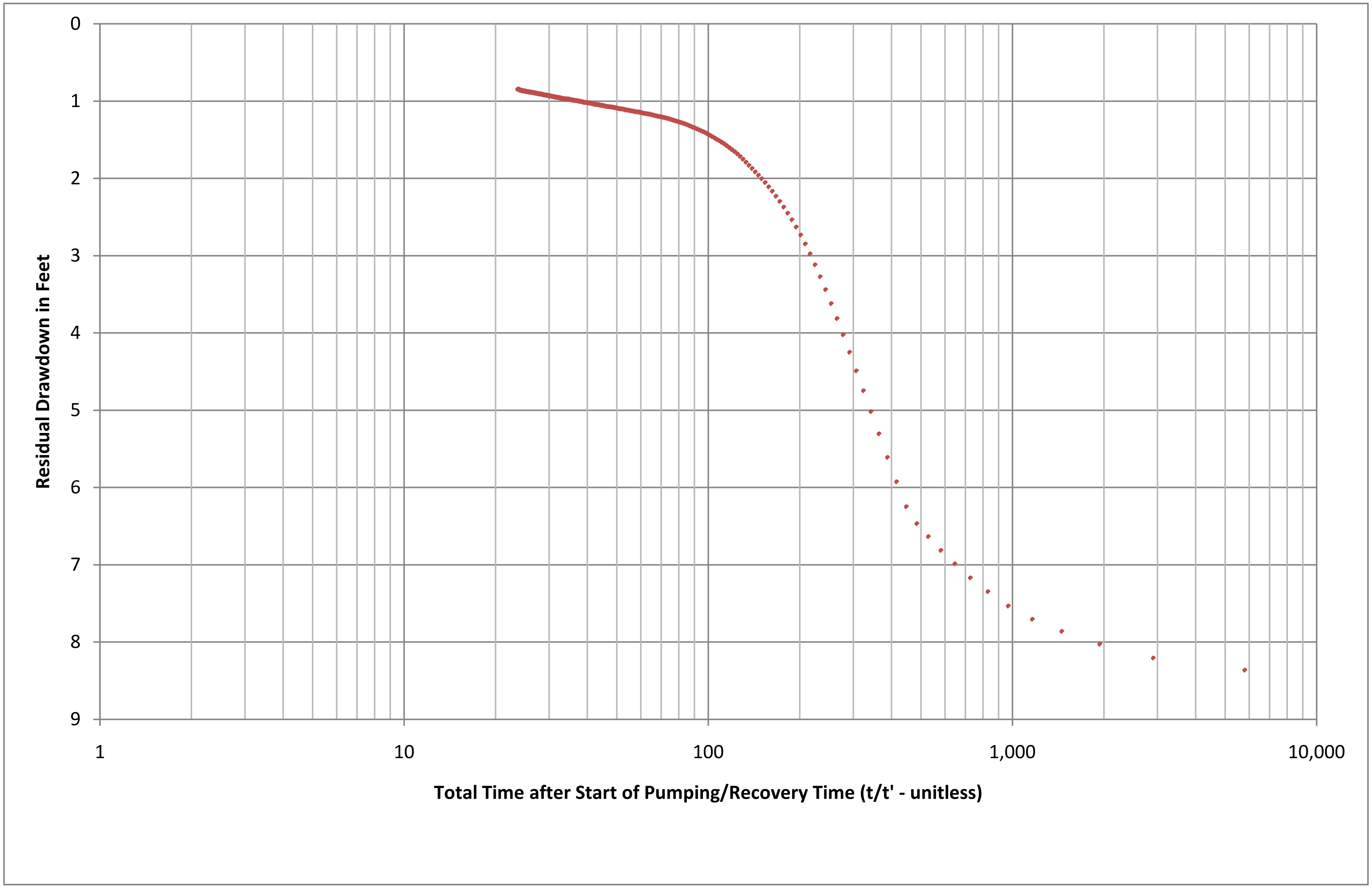
Figure 3
Constant Rate Drawdown Data, Pumping Well BC-DW1
Bunker C Tank Area Interim Action,
GP West Site



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July 29, 2011
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Figure 4
Constant Rate Test Recovery Data, Pumping Well BC-DW1
Bunker C Tank Area Interim Action, GP West Site

Aspect CONSULTING

MEMORANDUM

Project No.: 070188-001-14A

August 1, 2011

To: File

From: Joe Morrice, LHG
Senior Hydrogeologist

Steve Germiat, LHG
Senior Associate Hydrogeologist

Re: **Pumping Test Results, Lower Sand Unit, Caustic Plume Interim Action Area, GP West Site**

This memorandum presents data and results of a pumping test performed within the Caustic Plume interim action area of the Georgia-Pacific West Site (Site), located in Bellingham, Washington. The pumping test was performed to estimate aquifer hydraulic parameters for the Lower Sand unit to support Contractor design of a depressurization system for the deep aquifer (Lower Sand), which would be used during the planned interim action (soil removal) for the Caustic Plume Area.

For reference, the hydrogeologic units of relevance within the interim action area, from ground surface down, are as follows:

- **Fill Unit –** A shallow unconfined water-bearing sandy fill unit which contains the contaminated soil to be removed during the interim action. The Fill Unit water table is typically present at depths ranging from about 2 to 6 feet below grade in this interim action area;
- **Tidal Flat Aquitard –** A low-permeability silt and silty sand unit ranging from approximately 3 to 15 feet in thickness, which hydraulically separates and maintains a downward vertical gradient between the shallower Fill Unit and the deeper Lower Sand; and
- **Lower Sand –** A deeper confined water-bearing marine sand unit that, on average, is more uniform and more permeable than the Fill Unit. The potentiometric surface (hydraulic head) in the Lower Sand is several feet above the top of the Tidal Flat Aquitard (i.e., artesian pressure), but below the water table elevation in the Fill Unit.

During excavation of contaminated Fill Unit soil during the interim action, the groundwater level (head) in the Lower Sand unit must be reduced to approximately the bottom of the excavation (Fill Unit) so as to minimize the hydraulic gradient across the intervening Tidal Flat Aquitard, and limit the potential for breach (liquefaction) of the excavation bottom. The depressurization will require pumping from wells completed in the Lower Sand. The required number and location (spacing) of depressurization wells will be determined by the Port's selected Contractor, based upon site-specific hydrogeologic data including the pumping test information presented herein.

The following sections briefly discuss the test well installation, data collection and pumping tests, and test results.

Lower Sand Test Well

Under the direction of Aspect Consulting, a test well (CP-DW1) was drilled and completed into the Lower Sand by Holt Services using cable tool methods. Total depth of the borehole was 50.5 feet below ground surface (bgs). The observed depths of hydrogeologic units encountered during drilling were as follows:

- Fill Unit to a depth of 17.5 feet;
- Tidal Flat Aquitard between depths of 17.5 and 21 feet; and
- Lower Sand from a depth of 21 feet to greater than the 50.5-foot depth of exploration (total depth of Lower Sand is not known).

The well was drilled by the cable tool method, and was constructed with 6-inch-diameter PVC casing and 6-inch-diameter, 30-slot stainless steel wire-wrapped screen extending from 28 to 48 feet bgs – screened within the Lower Sand. To limit the potential for contaminant carry-down from the Fill Unit to the Lower Sand, the 6-inch test well was drilled using a dual casing technique, as follows. A nominal 18-inch-diameter steel conductor casing was advanced to a depth of 19 feet below grade, terminating in the Tidal Flat Aquitard. The bottom 3 feet of the conductor casing was sealed with a grout plug. A nominal 12-inch drill casing was then telescoped within the conductor casing, through the grout plug, to the bottom of the 18-inch borehole. Drilling of the 12-inch borehole then continued through the remaining Aquitard thickness and into the underlying Lower Sand. Once the 12-inch borehole was advanced to total depth, construction of the permanent 6-inch well began. With the conductor casing remaining in place, the 12-inch casing was gradually withdrawn as the bentonite annular seal (around the 6-inch casing) was incrementally placed from the bottom of the borehole, always maintaining the bentonite level above the bottom of the 12-inch casing. Once the annular seal reached the bottom of the conductor casing (depth of 19 feet), the 12-inch casing was withdrawn completely, so the annular seal filled the larger-diameter conductor casing (thicker annular seal above 19 feet). The conductor casing was withdrawn only after full placement of the annular seal, and placement of the surface seal started.

A soil boring and well construction log for well CP-DW1 is provided elsewhere in the Geotechnical Information Compilation (Appendix A to Technical Specifications for the Caustic Plume Area interim action).

Pumping Test Methods

Pumping tests for CP-DW1 included a short-term step-rate test and a 24-hour constant-rate test conducted between July 18 and 20, 2011. Water levels were monitored using pressure transducers and data loggers at test well CP-DW1 and monitoring wells CP-MW04 (located about 50 feet west) and EMW-28D (located about 270 feet east) for five days prior to the pumping tests (July 13, through July 17, 2011) and through the step- and constant-rate pumping tests and recovery periods. The monitoring wells are screened in the same sand unit as CP-DW1 is screened; the sand unit is in continuity with Bellingham Bay and is tidally influenced. Soil boring and well construction logs of the monitoring wells are provided in the Geotechnical Information Compilation. Water levels in

Bellingham Bay adjacent to the Site were also monitored. Figure 1 shows hydrographs of groundwater elevations and tide elevations in Bellingham Bay over the pre-test and testing periods. Based on pre-test water level response in the pumping and monitoring wells, groundwater levels throughout the Caustic Plume Area are influenced by changes in tide stage, with tidal response of about 1 foot over the course of a tidal cycle.

Pumping tests were performed using an electric submersible pump fitted with a shroud and intake screen. The pump was set near the bottom of the well, with the top of the pump at about 43.3 feet bgs, or about 34 feet below the average pre-test static water level. A short-term step-rate test was performed on July 18 to assess the sustainable pumping rate for the 24-hour constant rate test. Given the low range of pumping rates that could be produced from well CP-DW1, steps with stable pumping rates were not achieved; however a pumping rate of about 6 gallons per minute (gpm) appeared sustainable and was selected as the target rate for the constant-rate test.

A 24-hour constant-rate drawdown and recovery test was performed from approximately noon July 19 to 12:15 PM July 20. Measured pumping rates during the test varied from about 5.1 to 5.9 gpm, with an average rate of about 5.6 gpm. The pressure transducer installed in the pumping was lowered twice during the test (0.4 feet after 320 minutes and 2.9 feet after 1,102 minutes). Water levels and drawdown in plots attached to this memorandum are corrected to account for lowering of the transducer. Figure 2 shows hydrographs of groundwater elevations in the pumping well and two monitoring wells and tide elevation in Bellingham Bay during the constant-rate pumping and recovery period. Maximum drawdown in the pumping well during the test was about 34.5 feet, to near the pump intake. Maximum drawdown at monitoring wells CP-MW04 and EMW-28D was about 1.5 and 0.3 feet, respectively. At the end of pumping, the check valve in the pump column failed, allowing water to flow back into the well; as such, recovery data from the pumping well are not considered valid. Electronic files of pumping test data are available from Aspect Consulting on request.

Constant-Rate Pumping Test Results

Figure 3 shows drawdown data from the pumping well graphed on a semi-log scale. Drawdown data from about the first 12 minutes appear to be heavily influenced by well casing storage. Between about 12 minutes and 300 minutes of pumping, drawdown appears to reflect aquifer response to pumping, without casing storage or significant recharge boundary effects. The average pumping rate over this period was about 5.9 gpm. From about 300 to 650 minutes, the drawdown curve flattens, corresponding to a decrease in average pumping rate to 5.1 gpm and the apparent effects of rising tide. From 650 to about 1,050 minutes the drawdown increases again, reflecting increased pumping rate of 5.6 gpm and a falling tide. From 1,050 minutes to the end of the test drawdown decreases, apparently due to rising tide, although the average pumping rate increased to about 5.9 gpm.

Using the straight-line part of the curve between 12 and 300 minutes, which appears to represent primarily aquifer response, produces a slope of about 6.9 feet of drawdown per log-cycle of time. Applying this slope and the average pumping rate over this period (5.9 gpm) to the Cooper-Jacob Straight line time-drawdown equation produces an estimated transmissivity of about 30 ft^2/day for the Lower Sand water-bearing unit. The saturated thickness of Lower Sand in this area is uncertain, but assuming a thickness on the order of 50 feet results in an estimated hydraulic conductivity of about 0.6 ft/day (2 x 10^{-4} cm/sec) for the Lower Sand water-bearing unit.

Figures 4 and 5 show drawdown data from monitoring wells CP-MW04 and EMW-28D, respectively.

Data from monitoring well EMW-28D, located about 270 feet from the pumping well, show some initial drawdown response to pumping before tidal effects dominate. Average late-time drawdown appears to be on the order of 0.3 feet.

Data from monitoring well CP-MW04, located about 50 feet from the pumping well, show about 1.3 feet of drawdown after 100 minutes of pumping before tidal and/or recharge boundary effects are apparent. The straight-line part of the curve between 12 and 100 minutes, which appears to represent primarily aquifer response, produces a slope of about 1.2 feet of drawdown per log-cycle of time. Applying this slope and the average pumping rate over this period of 5.9 gpm to the Cooper-Jacob straight line time-drawdown equation produces an estimated transmissivity of about 175 ft^2/day for the Lower Sand water-bearing unit. Assuming a Lower Sand saturated thickness of 50 feet produces an estimated hydraulic conductivity of about 7.0 ft/day (2 x 10^{-3} cm/sec).

Projecting the straight-line portion of the time-drawdown data from CP-MW04 to time when drawdown equals zero (t_o) produces a time of 7.4 minutes. Applying this t_o, the estimated transmissivity of 175 ft^2/day, and the average pumping rate of 5.9 gpm, with the Cooper-Jacob method results in an estimated storage coefficient of 0.008.

Limitations

Work for this project was performed and this memorandum prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Port of Bellingham for specific application to the referenced property. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

Attachments

Figure 1 – Tide and Groundwater Hydrographs
Figure 2 – Constant Rate Pumping Test Hydrographs
Figure 3 – Constant Rate Test Drawdown Data, Pumping Well CP-DW1
Figure 4 – Constant Rate Test Drawdown Data, Monitoring Well CP-MW04
Figure 5 – Constant Rate Test Drawdown Data, Monitoring Well EMW-28D

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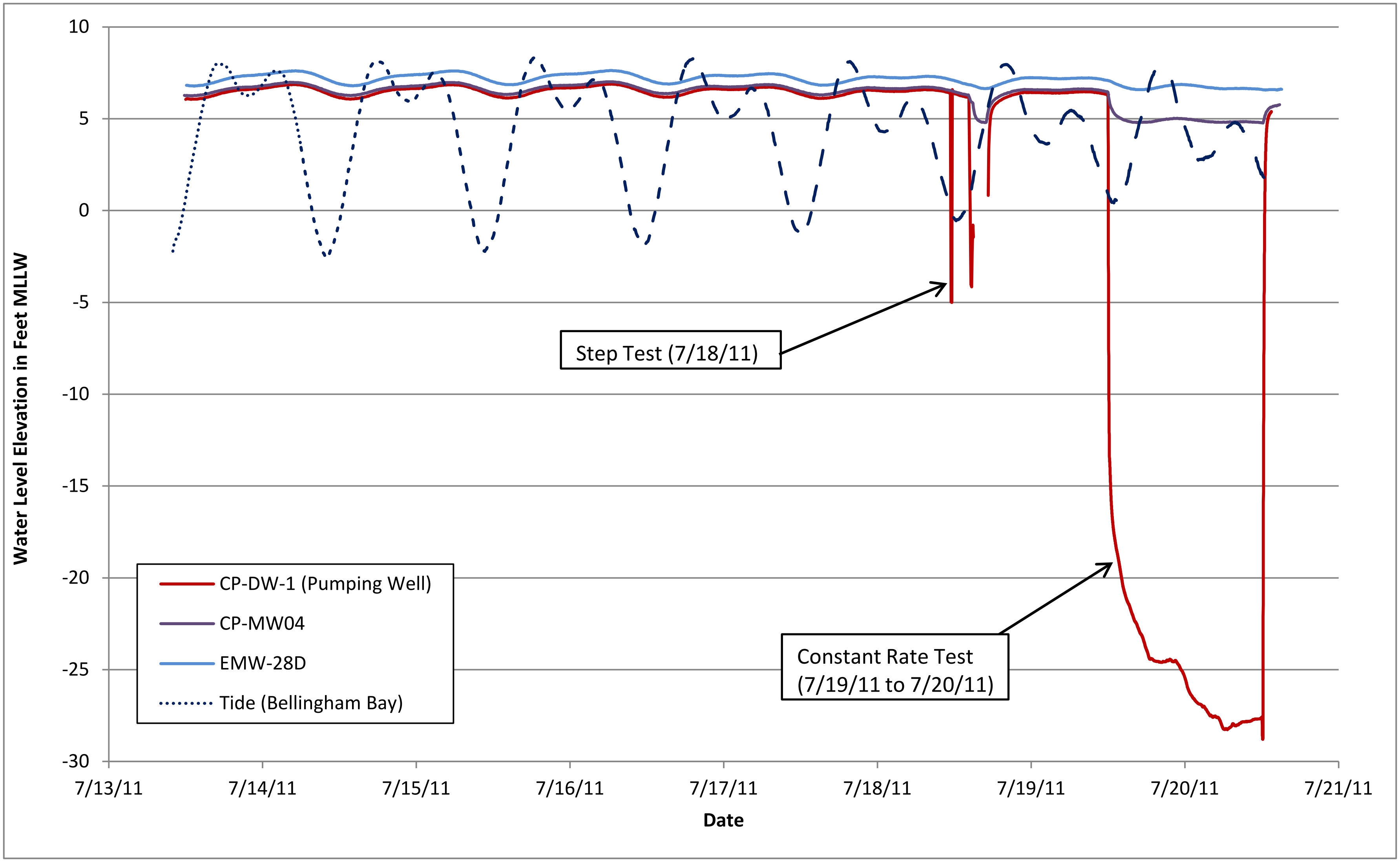

Aspect Consulting
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Figure 1
Tide and Groundwater Hydrographs
Caustic Plume Area Interim Action, GP West Site

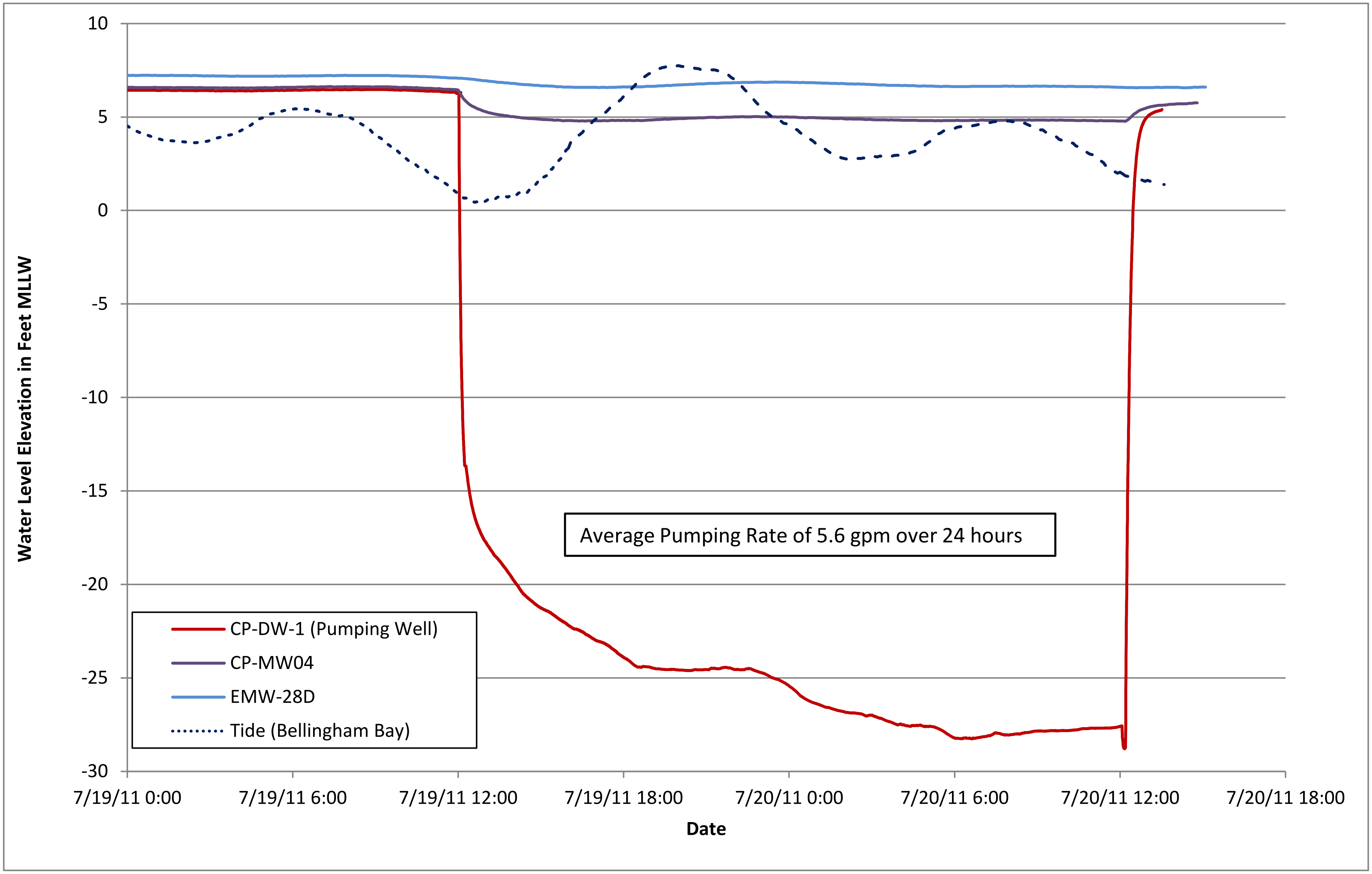

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Figure 2
Constant Rate Pumping Test Hydrographs
Caustic Plume Area Interim Action, GP West Site

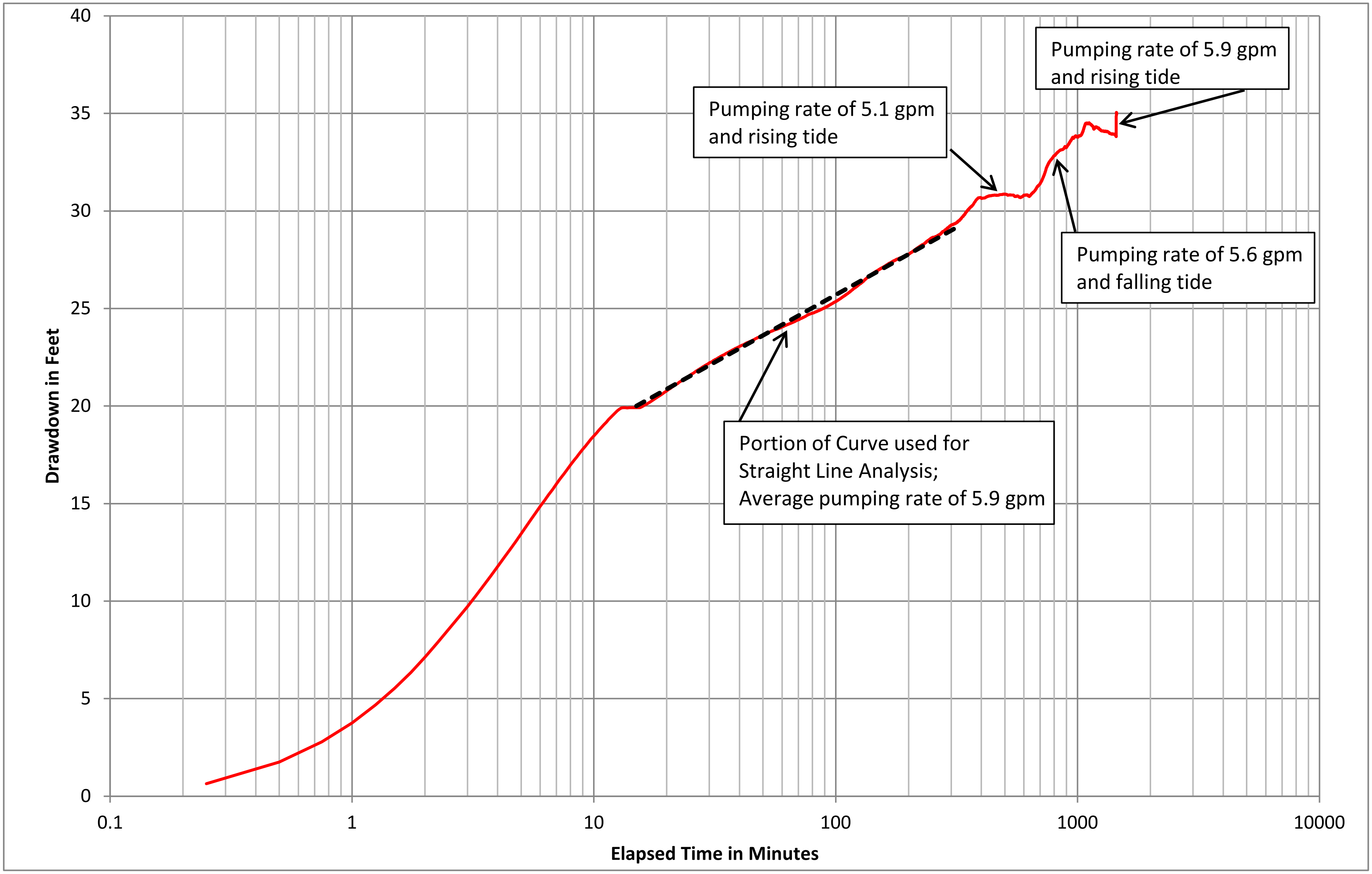

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Figure 3
Constant Rate Drawdown Data, Pumping Well CP-DW1
Caustic Plume Area Interim Action, GP West Site

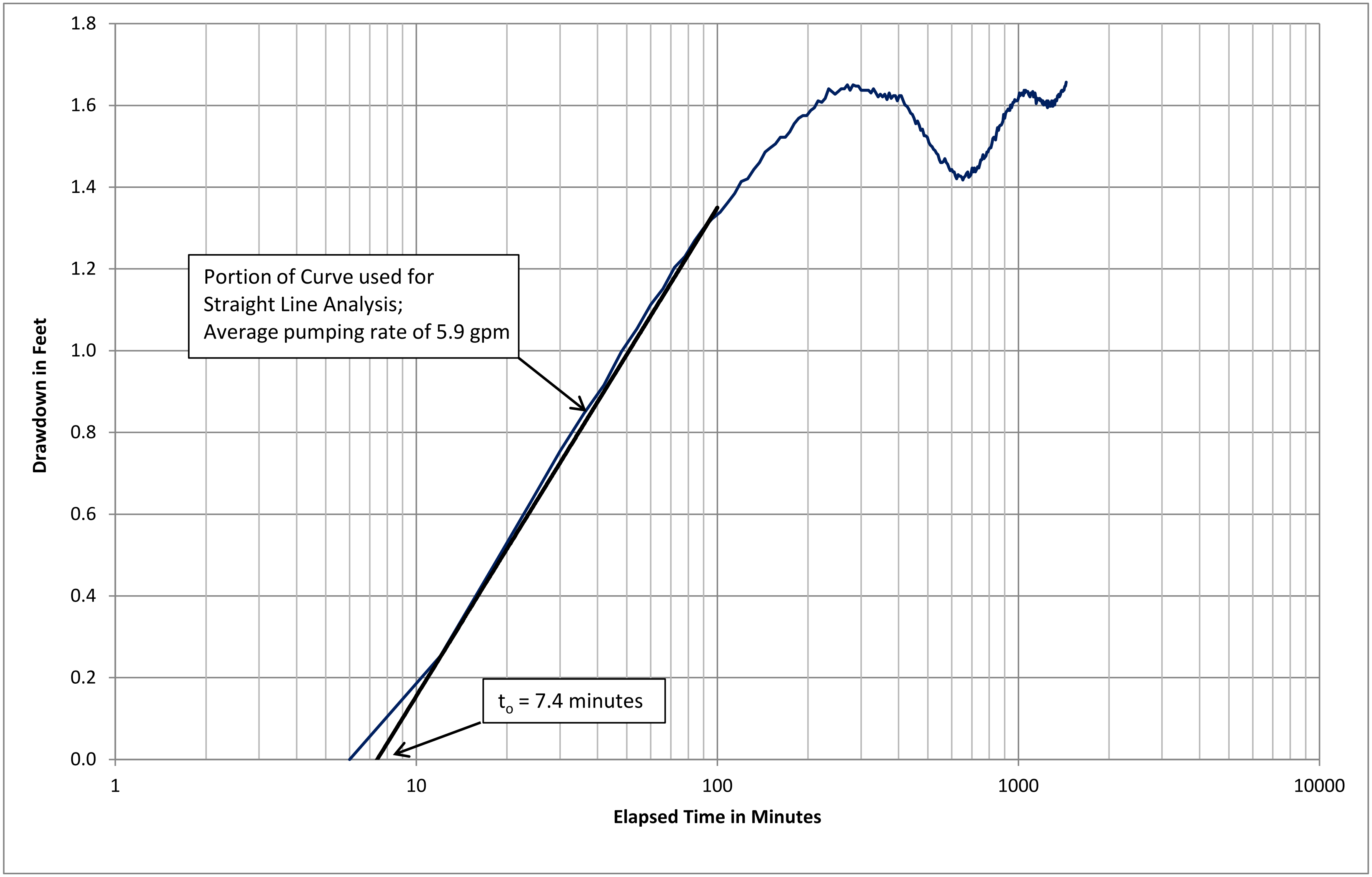

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Figure 4
Constant Rate Drawdown Data, Monitoring Well CP-MW04
Caustic Plume Area Interim Action, GP West Site

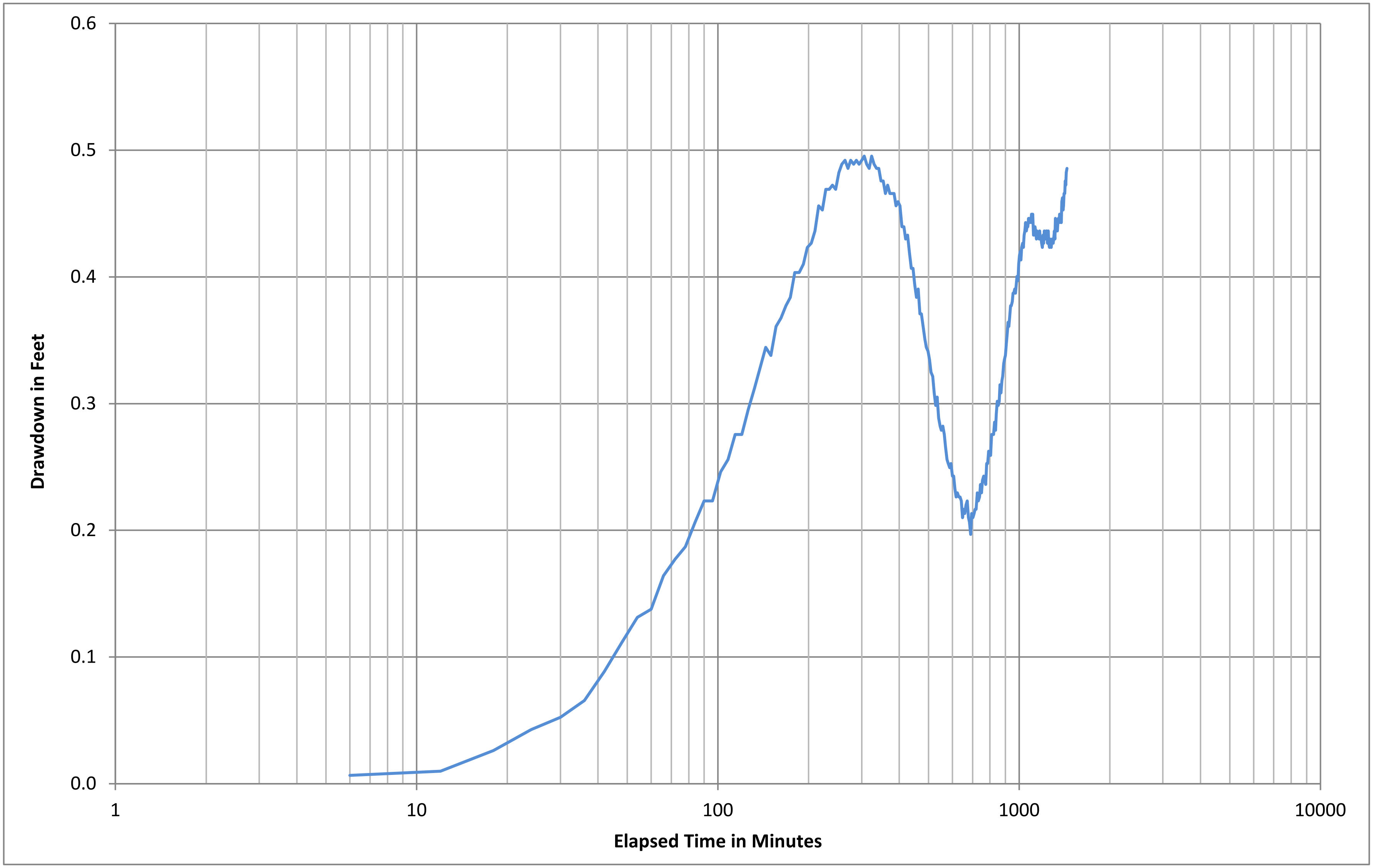

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Figure 5
Constant Rate Drawdown Data, Monitoring Well EMW-28D
Caustic Plume Area Interim Action, GP West Site

APPENDIX C

Conceptual Site Model for Mercury Transport and Attenuation

Conceptual Site Model for Mercury Transport

Mercury is a contaminant of concern at the GP West Site (Site). Soil mercury concentrations exceeding 24 mg/kg, a screening level based on unrestricted direct contact, have been detected in the following areas of the Site: former Wastewater Settling Basin, Cell Building, Mercury Source Area (former Caustic Filter House, Mercury Recovery Unit, 72 Catch Basin, and related infrastructure west of Cell Building), Stormwater Swale, Laurel Street Pipe Rack, and Chemfix material. With the exception of the stormwater swale, soil mercury concentrations in one or more samples in each of these areas are equal to or greater than 1,050 mg/kg, a soil screening level based on industrial direct contact.

Empirical groundwater quality data indicate that these areas with elevated soil mercury concentrations generally are not leaching mercury to groundwater at concentrations that pose a risk to marine surface water and/or sediment (Table C-1). In contrast, mercury in the core of the Caustic Plume subarea (defined by highly alkaline and reducing conditions) is primarily in the dissolved phase, indicating much greater environmental mobility in this area. Figure C-1 illustrates the locations of Site areas where elevated mercury is present in soils, and briefly summarizes pertinent soil and groundwater mercury data for them. The data collected during the pre-RI and RI investigations indicate that subsurface mercury transport and fate mechanisms depend on the geochemical conditions present at the Site. On Figure C-1, the Caustic Plume subarea is divided into three zones (Zones A, B, and C) based on mercury concentrations in specific media (vapor, groundwater, etc) and differing geochemical conditions.

The following conceptual site model describes the general behavior of mercury in the subsurface and applies that understanding to Site-specific conditions. We present the observed distribution of mercury in soil, soil vapor, and groundwater at the Site and describe the observed mechanisms controlling the fate and transport of mercury between these phases. Because of the complex geochemical conditions and elevated dissolved mercury concentrations in the shallow aquifer (Fill Unit) within the Caustic Plume subarea, this discussion focuses on that area. No elevated mercury is detected in soil or groundwater within the deeper aquifer (Lower Sand Unit) at the Site. The geochemical analyses are intended to refine the current conceptual site model for mercury fate/transport to support the RI and, perhaps more importantly, the FS for the Site.

Overview of Mercury Geochemistry and Behavior

Mercury is a naturally occurring element present at varying concentrations in soils, sediments, surface water, and groundwater, but is also derived from anthropogenic sources. Mercury can exist in several valence states in the environment, each with different chemical affinities and reactivity. Elemental mercury (Hg^0) is a dense, silvery-white liquid at room temperature and pressure. Although Hg^0 may be relatively stable as small droplets in soils, the vapor pressure of Hg^0 is sufficiently high to generate mercury vapors under typical environmental conditions (i.e., ambient temperature and pressure).

In addition, while Hg^0 is relatively insoluble in water, its solubility can be enhanced under oxidizing conditions due to the formation of higher valence state species, which tend to be more soluble (EPA, 1997).

The most common oxidation state for dissolved mercury is divalent Hg(II). Dissolved mercury may also occur in the Hg(I) oxidation state (as Hg_2^{2+}; however, this species is generally unstable under typical environmental conditions; EPA, 1997). Hg(II) combines with other chemical constituents of natural water systems to form a variety of complex ions and solid phase compounds .

Hg(II) in solution forms very stable complexes with sulfide and natural organic matter (NOM) if these are present. Dissolved sulfide complexes predominate under reducing conditions even at very low sulfide concentrations, while mercury-NOM complexes are stable under oxidizing conditions or in the absence of sulfide. In the absence of NOM (uncommon for most groundwaters), under oxidizing conditions, mercury may form soluble complexes or precipitates with a variety of ions including sulfate, chloride, and hydroxide. A number of factors including pH, Eh, and concentrations of mercury and other groundwater constituents control the distribution of mercury between these various forms.

Inorganic mercury binds strongly to NOM, in both dissolved phase and solid phase. This is the result of thiol-sulfur groups present within the organic matter structure (Skyllberg, 2008), and is analogous to mercury's strong affinity for inorganic sulfide ions. Mercury also forms organomercury complexes (e.g., methyl mercury) in which the mercury is directly bonded to carbon (e.g., methylmercury). In contrast to the ionic Hg-NOM bonds, organomercury molecules are formed through strong covalent bonds between mercury and carbon. Numerous studies have shown that organomercury compounds generally constitute a very small percentage of the total mercury in natural systems. The higher levels of methylmercury are typically observed in areas of active biomethylation, such as wetland and reduced sediment environments. Methylated mercury has been shown to comprise less than 1 percent of the total mercury concentrations in all media at the GP West Site (ENSR, 1994; Anchor Environmental, 2003), and is not a constituent of concern for the Site.

Within soil, mercury can be precipitated with neoformed mineral phases or adsorbed onto particle surfaces. Precipitation involves the growth of a mineral structure. Most mercury solid compounds (mercury- chlorides, -sulfates, -oxides and -hydroxides) are generally too soluble relative to groundwater mercury concentrations to form spontaneously. An important exception is the very insoluble mercury sulfide mineral metacinnabar (HgS), which has been shown to precipitate under reducing (anoxic) conditions (Bloom et al., 2003; Liu et al., 2008).

Adsorption occurs when dissolved mercury binds to the surfaces or solid particles in the soil, such as iron hydroxides, iron sulfides (e.g., pyrite), clay minerals, and organic matter. When in solution, mercury competes with other constituents for available adsorption sites on solid-phase surfaces. Surface adsorption processes are sensitive to groundwater chemistry and pH, among other factors. In general, higher concentrations in groundwater correspond to higher adsorbed concentrations. Mineral and other surfaces (iron oxides, organic matter, etc.) are electrically charged due to the termination of the solid structures at the mineral-water interface. The net surface charge is a strong function of pH, a measure of the concentration of positively charged H+ ions in solution. In general, mineral surfaces in alkaline pH groundwaters (low solution H+ concentrations) have a net negative charge, as the mineral surfaces are occupied by more OH- ions than H+ ions. Conversely, at acidic pH (high solution H+ concentrations), mineral surfaces are generally positively charged. The crossover from negative to positive net charge, called the point of zero charge (PZC) depends on the mineral. For example, the PZC of quartz occurs at around pH 3, while the PZC of iron oxyhydroxide is near 8. Since like charges repel and opposite charges attract, positively charged surfaces may preferentially adsorb negatively charged ions and vice versa.

The speciation or ionic forms of dissolved Hg(II) in groundwater are determined by pH and the concentrations of complex-forming constituents. For example, in reducing sulfidic groundwater, Hg(II) is mainly present in solution as the neutral $Hg(HS)_2$ at pH < 6.3, and as the negatively charged $HgHS_2^-$ (6.3< pH < 8.3) and HgS_2^{2-} (pH > 8.3). In groundwaters with elevated dissolved organic carbon (DOC), Hg-NOM complexes are predominant. The net charge on NOM is determined by the carboxylic acid groups which are largely dissociated at near-neutral to alkaline pH and thus negatively charged. Partitioning of NOM-bound Hg between dissolved and adsorbed phases is linked to the partitioning of NOM, which favors the dissolved phase at alkaline pH. Groundwater composition and pH are important factors in understanding mercury partitioning between dissolved and adsorbed phases and mobility at the Site.

Under suitable redox and pH conditions, dissolved inorganic mercury precipitates as the mercury-sulfide mineral metacinnabar, a relatively stable and insoluble mercury-sulfide (HgS) mineral or in solid solution with other sulfides such as pyrite (FeS_2). Other attenuation mechanisms for dissolved mercury include ion exchange, adsorption, and volatilization. The major biogeochemical processes controlling mercury behavior in the groundwater and surface water environments are summarized schematically on Figure C-2.

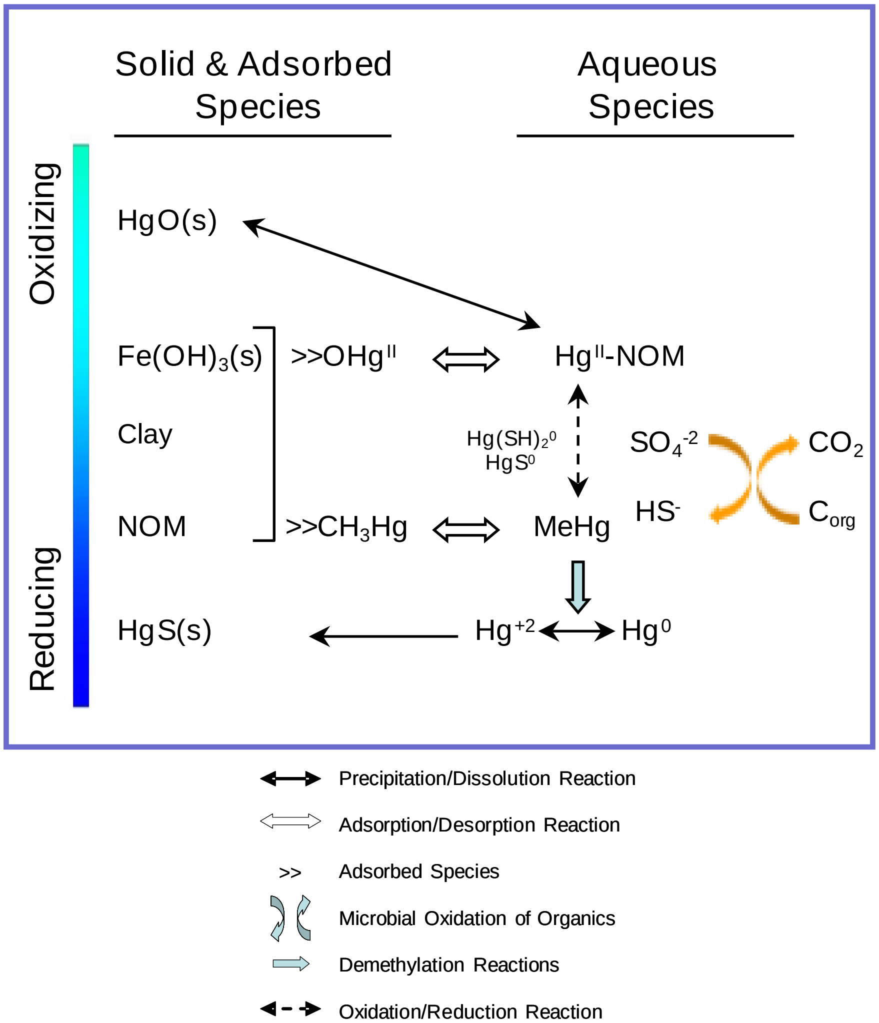

Figure C-2: Mercury Chemistry and Behavior (S.S. Papadopulos and Associates, Inc. 2009)

Mercury in Soil

Low-level mercury is naturally present in soil. Average natural background concentrations of mercury in the United States soils are reported at 0.09 mg/kg with a range of <0.01 to 4.6 mg/kg (Shacklette and Boerngen, 1984). For Washington State as a whole, the median soil mercury concentration has been estimated at 0.03 mg/kg (range 0.004 to 0.185 mg/kg). The median mercury concentration in Group-W (including Whatcom, Skagit, Grays Harbour, Lewis, and Pacific Counties) soils is 0.038 mg/kg (range 0.009 to 0.185 mg/kg) (Ecology, 1994).

As described above, elevated soil mercury concentrations (>24 mg/kg, based on unrestricted direct contact) have been detected in the following areas of the Site: Mercury Source Area (including the former Mercury Recovery Unit and Caustic Filter House where visible elemental mercury is present), Wastewater Settling Basin, 72 Catch Basin, Cell Building, Stormwater Swale, Laurel Street Pipe Rack, and Chemfix material (Figure C-1). One or more samples from each of these areas, except the Stormwater Swale, are at or above 1,050 mg/kg (industrial direct contact); however, higher-concentration soils at the Cell Building were previously removed by GP in an independent cleanup action.

In comparison, soil mercury concentrations in RI explorations located within and downgradient of the caustic plume core are low and typically consistent with, or just above, regional background levels. The median reported mercury concentration in saturated soil (aquifer matrix) downgradient of the caustic plume core (including the nine -A, -B, and C transect wells, CP-MW02, and CP-MW01) is 0.026 mg/kg with a range from 0.016 to 0.175 mg/kg. Soil mercury concentrations at percent levels (>10,000 mg/kg) occur in the two areas of visible elemental mercury (Figure C-1). The highest measured soil mercury in the caustic plume core, from well CP-MWA1 (groundwater pH 11), was 0.125 mg/kg. A slightly higher concentration was observed in well CP-MWB2 (0.175 mg/kg), slightly downgradient of the caustic plume core. The soil mercury data are described in greater detail in Section 8-1 of this RI.

Fill Unit Mineralogical Composition

As part of the RI, five samples of Fill Unit aquifer matrix material (saturated soil) and one sample of suspended solids from groundwater collected from mercury-contaminated areas at the Site were analyzed for their mineralogical and chemical composition. Four of the aquifer matrix material samples were collected along a generalized groundwater flowpath within the caustic plume (CP-MWA1, CP-MWB1, CP-MWB2, CP-MWB3), and one was collected from the base of the former wastewater settling basin on the northern edge of the caustic plume (CP-MW05). Mineralogical determinations were made using qualitative X-ray diffraction (XRD) and thin-section petrography. Scanning electron microscopy (SEM) was also performed to provide qualitative spot chemical analysis and produce elemental mercury maps. In addition, one sample of suspended solids from a groundwater sample collected within the core of the caustic plume was filtered and analyzed using XRD and SEM. The petrographic analysis results are summarized briefly below, and are presented in more detail in a memo titled *Summary of Aquifer Mineralogy*, *GP West Site*, *Bellingham*, *Washington*, which is included in Appendix D to this RI.

The mineral compositions of the Fill Unit matrix samples are relatively uniform and typical of Puget Sound glacial/interglacial sediments (dominated by quartz and plagioclase, with lesser amounts of amphibole, chlorite, and muscovite, and traces of other minerals including iron sulfide). Based on petrographic observations of the sample matrix thin-sections, the iron sulfide phases identified by SEM are most likely pyrite grains. Based on their large grain-size and sub-angular to sub-rounded textures, the pyrite grains were likely present in the original fill material.

Soil mercury concentrations (0.016 to 0.125 mg/kg; Table C-2) were very low in the four samples collected along the inferred groundwater flowpath in the caustic plume downgradient of the source area. The SEM imagery indicates that the mercury is present throughout the pyrite grains, rather than forming a coating on the grains. This indicates that most of the mercury in the downgradient caustic plume soil samples is of natural origin and originally present in the fill materials. Conversely, mercury sulfide identified in the sample of wastewater settling basin soil (375 mg/kg mercury) is likely of a secondary origin and provides evidence of mercury sulfide precipitation. Mercury identified in the suspended matter recovered from CP-MWA1 may be an amorphous colloidal or microcrystalline mercury sulfide suspension (Deonarine and Hsu-Kim, 2009).

Mercury in Soil Vapor

Elemental mercury (Hg^0) is volatile and will partition from soil or groundwater into soil vapor. During the 2010 interim action pre-design investigation, visible elemental mercury was encountered within the footprint of the former Caustic Filter House and Mercury Recovery Unit, facilities where mercury was removed from the sodium hydroxide (caustic) product and process wastewaters (Figure C-1). Visible occurrences of elemental mercury had not been reported previously at the Site, but, as the volatile form of mercury, its presence is consistent with elevated soil vapor mercury concentrations measured in this subarea (Zone C on Figure C-1); it is also a source for elevated groundwater mercury concentrations in the subarea.

Mercury in soil vapor has been measured in 27 locations across the Site. Three of these locations, AS-03, CP-MV06V, and CP-VP14, located adjacent to the areas of visible elemental mercury, had concentrations (720.3, 339.9, and 4.58 $\mu g/m^3$, respectively) above the 1.4 $\mu g/m^3$ unrestricted air screening level. Away from the areas of visible mercury, low or non-detect soil vapor mercury was observed in the areas with elevated dissolved-phase mercury (Zone B). The mercury soil vapor data are described in greater detail in Section 8-1 (and 8-2) of this RI.

We evaluated reduction and subsequent volatilization of divalent mercury as a potential source of mercury vapor, but our observations suggest that reduction and volatilization are not occurring. In addition, reduction of divalent mercury is inhibited by strong complexation of Hg2+ with ligands such as sulfide and NOM (Schluter, 2000), and elemental mercury (Hg^0) is generally less abundant than Hg(II) (Svensson et al., 2006), even in environments where formation of elemental mercury may be thermodynamically favored (Brandon et al., 2001). Of wells with collocated groundwater and soil vapor measurements, the well with highest dissolved mercury was non-detect for soil vapor mercury (CP-MWA1; Figure C-1). The separate areas of highest vapor-phase mercury (high soil mercury) vs. highest groundwater mercury and pH suggest separate historical releases of mercury and caustic. Caustic soda was a commercial product loaded onto rail and trucks near the upgradient edge of Zone B. These inferred separate release areas appear to be an important factor in explaining the spatial distribution of mercury in groundwater versus in soil vapor.

Mercury in Groundwater

Dissolved mercury speciation in groundwater is typically dominated by divalent (Hg^{2+}) complexes, with minor amounts of Hg^{1+} and Hg^{0} also possible.

Dissolved mercury concentrations in the Fill Unit aquifer across most of the Site are below 1 µg/L. Based on results of the 2009-2011 sampling and analysis, dissolved mercury concentrations above the 0.059 µg/L RI screening level (based on marine sediment recontamination) occur within the caustic plume area and Wastewater Settling Basin/ Law-1 area (encompassed by Zone A on Figure C-1). This conservative groundwater screening level is protective of the sediment bioactive zone, but is applied across the Site in the RI (potential conditional point of compliance is not considered in RI). The highest dissolved mercury concentrations occur within the caustic plume core (Zone B, pH > 10), with concentrations ranging from 10.8 to 619 µg/L. Within the mercury attenuation zone of the caustic plume (Zone A, pH < 10), dissolved mercury concentrations occur up to 8.65 µg/L.

Shoreline wells with dissolved mercury detected above 0.059 µg/L include wells in the Law-1 area (Law-1 and adjacent L1-MW01 and L1-MW02), and well CP-MWB3 on the downgradient edge of the caustic plume (only one of two RI samples exceeded). Immediately downgradient of Law-1, dissolved mercury concentrations measured in intertidal wellpoints were roughly 50 times lower than the adjacent upland monitoring wells, indicating concentration attenuation as groundwater approaches the sediment mudline (point of exposure). Because the intertidal wellpoints extended into mercury-contaminated Log Pond sediment, some dissolved-phase mercury concentrations measured in the wellpoint groundwater samples is likely generated within the contaminated sediment. Therefore, the magnitude of concentration attenuation occurring between the upland wells and intertidal wellpoints is likely greater than indicated from the wellpoint data. Contaminant concentration attenuation due solely to tidally induced physical mixing in the Law-1 area has been simulated by groundwater modeling (Aspect, 2012), and this information will be factored into the FS.

Other Site areas with observed elevated soil mercury concentrations (former Wastewater Settling Basin, 72 Catch Basin, Cell Building, Stormwater Swale, Laurel Street Pipe Rack, and Chemfix) have less alkaline and less reducing groundwater conditions than the caustic core, and correspondingly lower dissolved mercury concentrations.

Controls on Transport of Dissolved Mercury

Mercury mobility is controlled by a number of biogeochemical processes that occur under varying groundwater conditions. Our observations provide evidence of processes that enhance and/or limit the mobility of mercury including complexation, mineral precipitation, adsorption, and volatilization. Environmental conditions including pH, redox, groundwater chemistry, and the nature and abundance of solid-phase components control mercury mobility and transport.

Sulfide

Sulfide is an important control on mercury transport under reducing conditions. At low to moderate sulfide concentrations, dissolved complexes range from the neutral $Hg(HS)_2$

aqueous complex at acidic pHs, to $HgS(HS)^{1-}$ at circum-neutral pH, to HgS^{2-} under the most reducing and caustic pH conditions. The negatively charged complexes in the caustic plume core (HgS^{2-}) are not expected to adsorb appreciably to mineral surfaces because of the negative surface charges developed at the attendant high pH conditions. The similarly charged mercury-sulfide complexes are repulsed by these surfaces and mercury partitioning to the dissolved phase is favored. Conversely, under low to near neutral pH conditions, mineral surfaces become positively charged or neutral, and mercury sulfides have a greater tendency to adsorb under these conditions, removing mercury from solution and resulting in lower dissolved-phase concentrations, and thereby limiting its dissolved-phase transport.

Dissolved sulfur speciation and concentrations vary in the caustic plume zones. In the moderately to strongly reducing, high pH caustic plume core (Zone B), both sulfide and sulfate species are present at high concentrations in groundwater. Detected sulfide concentrations range from 3.57 to 296 mg/L, and sulfate concentrations in the caustic plume core range from 23 to 601 mg/L. Both sulfate and sulfide are generally elevated in Zone B and sulfate is the predominant sulfur species.

In the moderately reducing groundwater at pH between 9 and 10 (Zone A), sulfate is depressed relative to that in Zone B. Sulfide concentrations remain high, thus making sulfide the predominant sulfur species in Zone B.

In wells downgradient of Zones A and B, sulfate is the predominant sulfur species. In these wells, sulfate ranges from 0.1 to 1,300 mg/L, and sulfide ranges from 0.012 to 0.82 mg/L. Both sulfate and sulfide are below 1 mg/L in most wells downgradient of Zone A; however. sulfate is elevated (above 10 mg/L) in shoreline wells CP-MWC3 and CP-MWB3, and slightly elevated in CP-MWB2. For reference, Table C-1 presents the RI (2009-2010) groundwater chemistry data, including mercury and other water quality parameters, for the Caustic Plume subarea.

The solubility of mercury sulfide (metacinnabar, HgS) decreases with decreasing pH, so that dissolved mercury may also precipitate as the solid HgS under mildly reducing to strongly reducing and near-neutral to acidic conditions. Once formed, HgS is generally stable and insoluble under a wide range of pH and redox conditions.

Organic Carbon

Mercury binds to NOM under oxidizing to mildly reducing conditions. The Hg-NOM complex is stable under a range of pHs from very acidic to very basic. Under caustic pH conditions, Hg-NOM complexes are predominantly negatively charged because of the dissociation of acidic NOM groups and are thus repelled by like-charged surfaces, which favors partitioning of mercury to the dissolved phase and enhances its mobility in the Caustic Plume subarea. Under mildly reducing to mildly oxidizing conditions, however, iron oxides may also be present as mineral grain coatings that adsorb Hg-NOM, further reducing dissolved mercury concentrations at lower pHs.

Dissolved organic carbon (DOC) is elevated in the caustic plume core (2,270 mg/L at CP-MWA1) and generally coincides with high pH. The DOC decreases substantially to about 100 mg/L in wells downgradient along the transport pathway, as pH decreases (Table C-1). The source of elevated DOC in the plume core appears to be related to the effect of the caustic (alkaline pH), which solubilizes NOM from the sediment via alkaline hydrolysis. The observed downgradient reduction in DOC concentrations is likely due in part to increased adsorption of DOC onto aquifer matrix surfaces as groundwater pH is neutralized.

Summary

The highest dissolved-phase mercury at the Site occurs within the most alkaline and reducing groundwater conditions (caustic plume core; Zone B on Figure C-1). Mercury mobility is enhanced in the Fill Unit aquifer by caustic pH and reducing Eh. The reducing conditions and caustic pH in Zone B indicate that mercury is stable as the negatively charged dissolved sulfide complexes. The mineral particle surfaces in the Fill Unit aquifer matrix in this regime are also negatively charged (high pH) thus limiting the potential for mercury adsorption. In areas downgradient of the caustic core, groundwater is less sulfidic, more oxidizing, and neutral to slightly acidic; therefore, mercury transport is rapidly attenuated at the edges of the caustic plume. This is also typical of Site groundwater conditions outside of the Caustic Plume subarea.

Within the mercury plume outside of the caustic core (Zone A), mercury is present in the dissolved phase and may be bound to both dissolved organic matter and sulfide, both of which are elevated in the caustic core (Zone B). Dissolved mercury concentrations decrease downgradient along the inferred dissolved mercury transport flow path (i.e., decreasing pH) from the caustic plume core to the shoreline. Along the inferred mercury transport pathway, the downgradient groundwater (approximately west towards the shoreline from CP-MW15) becomes progressively less alkaline, more oxidized, and depleted of dissolved sulfur (sulfate + sulfide) and dissolved mercury. Depletion of dissolved mercury and sulfur downgradient suggests HgS mineral precipitation is occurring, as observed in the petrographic analysis of mercury-contaminated soil from the former wastewater settling basin (Appendix D to this RI). In general, dissolved-phase mercury concentrations decrease as pH decreases (Zone A), which may reflect both an increase in adsorption of dissolved mercury by mineral surfaces and soil organic matter, as well as precipitation of HgS due to its increased stability under pH and redox conditions observed outside of the caustic plume core.

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Attachments

Table C-1 – Fall 2009 and Spring 2010 Groundwater Chemistry Data for Caustic Plume Subarea

Figure C-1 – Mercury Areas of Site

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Table C-1 - Fall 2009 and Spring 2010 Fill Unit Groundwater Chemistry Data for Caustic Plume Subarea

GP West Site RI/FS 070188

Chemical Name	AMW-01 10/1/2009	AMW-01 3/29/2010	AMW-02 10/2/2009	AMW-02 4/6/2010	AMW-03 10/2/2009	AMW-03 4/6/2010	CP-MW01 10/2/2009	CP-MW01 4/6/2010	CP-MW02 10/1/2009	CP-MW02 4/5/2010	CP-MW03 9/28/2009	CP-MW03 3/31/2010	CP-MW06 10/2/2009	CP-MW06 4/5/2010	CP-MW07 4/6/2010	CP-MW08 4/1/2010	CP-MW09 4/1/2010	CP-MW10 4/5/2010	CP-MW11 4/5/2010	CP-MW12 4/13/2010	CP-MWA1 10/2/2009	CP-MWA1 FD 10/2/2009	CP-MWA1 4/6/2010
Metals																							
Dissolved Mercury in µg/L	0.00109	0.00029 J	41.7	28.1	14.1	11.1	6.61	1.32	0.0812	0.0979	0.763	0.391	4.9	8.65	0.00072 J	0.00165	0.164	0.0297	0.00414	0.00034 J	10.8	11.3	14.3
Conventional Chemistry Parameters																							
Alkalinity, Total as CaCO3 in mg/L			8,450	5,350	5,240	6070					714	846	1,550	1,470							11,800	11,300	13,400
Bromide in mg/L			1.1 J		0.3						1.5 J		0.4 J								0.1 U	5 U	
Carbon, Dissolved Organic (DOC) in mg/L						644																	2,270
Chloride in mg/L			5,490	3,800	261	318					4,140	2,160	3,270	2,690							1,980	1,920	2,160
Dissolved Calcium in mg/L			14.3	12	6.69	4.33					32.4	60.4	6.92	12							19.1	18.3	6.11
Dissolved Iron in mg/L			7.27		4.94						1.2		2.3								9.84	9.74	10.1
Dissolved Magnesium in mg/L			0.692	1.04	0.163	0.0481					9.1	39.6	0.681	1.48							2.61	2.44	0.135
Dissolved Manganese in mg/L			0.0873		0.096						1.09		0.028								0.207	0.192	0.0199
Dissolved Potassium in mg/L			26.4	20.7	14.9	20.2					14.4	25	5.65	4.96							52.3	52.3	61
Dissolved Sodium in mg/L			7550	5080	2660	3160					3180	2100	2820	2490							7730	7570	7740
Fluoride in mg/L			2.1 J		5.7						4 U		2.3 J								4.34 J	3.95 J	
Nitrate as Nitrogen in mg/L			5 UJ		2 U						2 U		5 UJ								5 U	5 UJ	
Nitrite as Nitrogen in mg/L			20 U		2 U						2 U		10 U								5 U	5 U	
Sulfate in mg/L			52	10 J	25	23					276	222	30	23							65	56	62
Sulfide in mg/L			7.55	199	3.57	46.3					0.346	0.025	13.4	0.92							13.5	14.3	296
Total Dissolved Solids in mg/L			21,800	14,900	9,770	11,000					8,520	5,260	8,240	6,640							23,600	23,400	27,700
Total Suspended Solids in mg/L																							
Field Parameters																							
Spec. Conductance in umhos/cm	2,031	3,402	27,700	18,920	9,018	10,300	7,469	6,405	104,300	90,260	14,580	8,454	12,870	10,500	2,172	976	1,354	4,954	5,183		22,830		18,000
Dissolved Oxygen in mg/L	2.8	0.5	0.5	0.3	0.3	0.5	0.4	0.3	0.3	0.4	0.2	0.7	0.4	0.2	0.7	0.5	0.4	2.2	1.3		258.6		0.4
Eh (ORP) in mVolts[1]	-82	-24	-525	-217	-229	-293	-267	-68	-16	29	-92	58	-398	-73	23	38	-143	111	109		-545		-232
pH in pH Units	6.7	6.3	10.0	9.8	11.8	12.2	10.0	9.8	7.1	7.2	7.2	7.3	9.3	8.9	6.6	7.1	9.1	6.9	6.7	7.3	11.0		11.1
Temperature in deg C	15.7	10.0	17.6	11.5	17.9	12.3	16.6	11.8	18.3	12.5	15.3	10.7	18.8	14.2	11.4	12.4	12.6	10.4	11.9		17.1		12.6

Notes

J - Analyte was positively identified. The reported result is an estimate. U - Analyte was not detected at or above the reported result. UJ - Analyte was not detected at or above the reported estimate.

[1] - Eh Standard Hydrogen Electrode (SHE) was calculated by adding 200 mVolts to field measured oxidation-reduction potential (ORP) value (Nordstrom and Wilde, 2005).

* - Result from separate sample taken at same location on 4/6/2010.

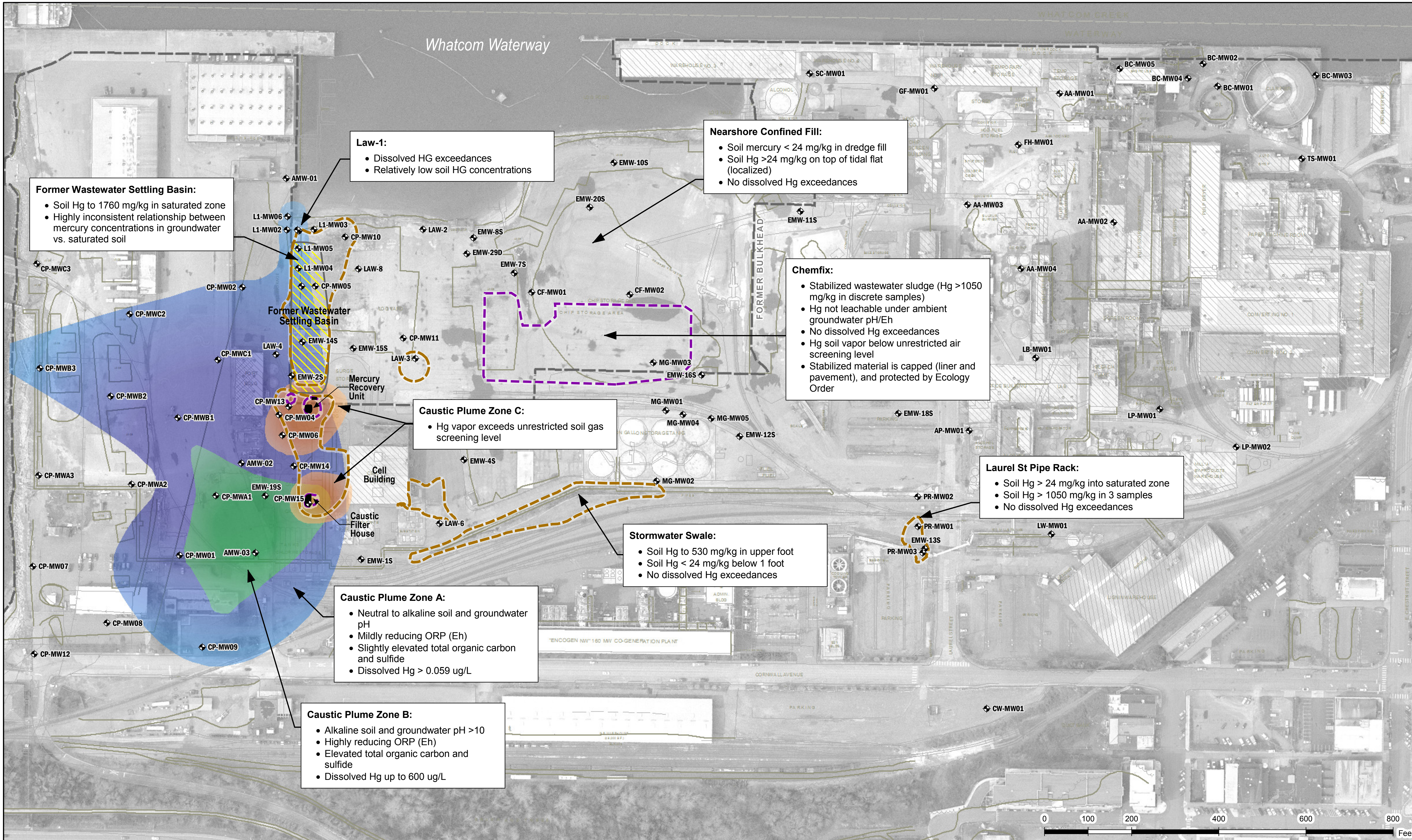
** - Result from separate sample taken at same location on 3/31/2010.

Table C-1 - Fall 2009 and Spring 2010 Fill Unit Groundwater Chemistry Data for Caustic Plume Subarea

GP West Site RI/FS 070188

Chemical Name	CP-MWA1 FD 4/6/2010	CP-MWA2 10/2/2009	CP-MWA2 3/29/2010	CP-MWA3 9/28/2009	CP-MWA3 3/29/2010	CP-MWB1 10/1/2009	CP-MWB1 4/6/2010	CP-MWB2 10/2/2009	CP-MWB2 4/6/2010	CP-MWB3 9/28/2009	CP-MWB3 3/29/2010	CP-MWC1 10/1/2009	CP-MWC1 4/6/2010
Metals													
Dissolved Mercury in µg/L	9.61	0.00301	0.0001 J	0.00103 U	0.00058 J	1.24	1.71	1.11	1.18	0.306	0.0479	1.84	2.75
Conventional Chemistry Parameters													
Alkalinity, Total as CaCO3 in mg/L	11,800	1,230	1,330	1,210	1,040	2,270	2,080	1,870	1,730	2,380	1,770	1,160	1,080
Bromide in mg/L		0.68		0.76		0.9 J		2.3 J		5.5		0.2 J	
Carbon, Dissolved Organic (DOC) in mg/L	2,320						114		121		87 *		
Chloride in mg/L	1,780	250	280	307	161	5,110	2,460	6,560	5,580	9,350	6,810	598	658
Dissolved Calcium in mg/L	6.52	132	145	166	163	4.59	3.29	49.6	54.7	206	238	4.57	3.8
Dissolved Iron in mg/L		27		19.7		0.748	0.806	0.137	0.0877	2.98	1.88	0.455	
Dissolved Magnesium in mg/L	0.132	110	121	69.6	51.6	3.91	4.61	38.5	48.3	222	167	0.414	0.381
Dissolved Manganese in mg/L		2.78		2.9		0.0217	0.032	0.0315	0.0211	0.377	0.348	0.0427	
Dissolved Potassium in mg/L	64.6	51.1	49.4	40.9	30.6	27.4	14.4	65.7	63.2	170	120	3.61	3.1
Dissolved Sodium in mg/L	8070	355	369	330	280	4000	2450	5020	4640	6500	4810	983	978
Fluoride in mg/L		0.2 U		0.359 J		0.89 J		2.47 J		4 U		0.52 J	
Nitrate as Nitrogen in mg/L		0.1 UJ		0.5 U		5 U		5 UJ		2 U		5 U	
Nitrite as Nitrogen in mg/L		5 U		0.5 U		10 U		20 U		20 U		5 U	
Sulfate in mg/L	51	0.2 U	0.1 J	1 U	0.69	2 J	1 J	10 U	5 J	0.4 J	42.6	2 J	15
Sulfide in mg/L	269	0.245	0.034	0.33	0.012	22.3	23.3	15.3	23	0.357	0.401	6.2	6.76
Total Dissolved Solids in mg/L	24,100	1,670	1,760	1,740	1,340	11,700	6,820	14,800	11,800	19,500	14,100	2,610	2,580
Total Suspended Solids in mg/L													
Field Parameters													
Spec. Conductance in umhos/cm		2,878	2,932	2,880	2,033	15,880	9,042	22,320	17,860	31,080	24,940	3,956	3,910
Dissolved Oxygen in mg/L		0.6	0.6	0.5	1.1	0.6	0.4	0.5	0.5	0.9	0.5	0.4	0.5
Eh (ORP) in mVolts[1]		-119	126	-86	172	-172	-109	-184	-84	-143	-42	-150	-121
pH in pH Units		6.7	6.5	6.7	6.6	9.5	9.7	7.3	7.1	6.9	6.6	9.6	9.8
Temperature in deg C		15.9	11.7	16.0	10.5	17.8	11.9	17.0	11.5	15.4	10.6	19.0	11.6

Chemical Name	CP-MWC2 10/1/2009	CP-MWC2 3/29/2010	CP-MWC3 9/28/2009	CP-MWC3 3/29/2010	EMW-01S 10/2/2009	EMW-01S 3/31/2010	EMW-02S 10/1/2009	EMW-02S 4/5/2010	EMW-04S 10/2/2009	EMW-04S 3/31/2010	EMW-14S 10/1/2009	EMW-14S 4/5/2010	EMW-19S 10/2/2009	EMW-19S 4/5/2010
Metals														
Dissolved Mercury in µg/L	0.129	0.00406	0.00171 U	0.00092 J	0.0167	0.0079	2.39	1.63	0.0032	0.00094 J	2.53	5.03	18.5	28.5
Conventional Chemistry Parameters														
Alkalinity, Total as CaCO3 in mg/L	1,800	1,840	393	256			862	768			512	549	1,710	4,900
Bromide in mg/L	1.1 J		22.4				0.3 J				5 U		5 U	
Carbon, Dissolved Organic (DOC) in mg/L														
Chloride in mg/L	1,560	1,300	6,650	9,560			700	391			514	628	557	3,310
Dissolved Calcium in mg/L	42	70.2	277	307			10.2	3.8			5.78	6.96	5.96	9.9
Dissolved Iron in mg/L	0.491		1				1.68				0.924		6.6	
Dissolved Magnesium in mg/L	44.4	49.8	481	612			1.9	0.56			0.638	0.609	0.0411	0.0215 J
Dissolved Manganese in mg/L	0.0575		0.0588				0.125				0.158		0.0451	
Dissolved Potassium in mg/L	38.6	36.1	154	178			3.81	2.22			1.79	2.06	8.87	25.2
Dissolved Sodium in mg/L	1800	1570	3840	5460			880	663			531	712	1480	4310
Fluoride in mg/L	1.07 J		4 U				0.39 J				0.44 J		10 U	
Nitrate as Nitrogen in mg/L	5 U		2 U				5 U				5 U		5 UJ	
Nitrite as Nitrogen in mg/L	5 U		20 U				5 U				5 U		5 U	
Sulfate in mg/L	10 U	0.3 J	872	1,300			43	55.6			23	21.7	601	296
Sulfide in mg/L	0.589	0.185	0.82	0.015			0.643	2.06			1.19	0.769	7.57	82.7
Total Dissolved Solids in mg/L	4,880	4,630	13,100	17,700			2,380	1,640			1,600	1,870	4,520	13,700
Total Suspended Solids in mg/L														
Field Parameters														
Spec. Conductance in umhos/cm	7,813	6,912	21,900	26,810	1,347	1,175	3,354	2,643	2,365	2,161	2,601	2,926	6,342	1,779
Dissolved Oxygen in mg/L	0.7	0.5	0.5	1.0	0.7	0.4	0.7	0.4	0.5	0.4	0.4	0.3	0.4	0.4
Eh (ORP) in mVolts[1]	15	109	-90	197	-94	71	-157	-55	-103	72	-132	-24	-441	-278
pH in pH Units	7.0	7.0	7.0	7.2	7.0	7.0	7.7	8.9	6.5	6.5	8.5	9.2	10.9	11.1
Temperature in deg C	17.3	11.9	17.7	10.7	19.8	11.7	19.6	12.5	20.8	11.8	18.8	11.9	19.2	12.4



Monitoring Wells

Area of Visible Elemental Mercury

Soil Mercury > 1050 mg/kg

Soil Mercury > 24 mg/kg

MILL NORTH

TRUE NORTH

Aspect CONSULTING

Mercury Areas of Site

GP West Site RI/FS

Bellingham, WA

DATE: Jan 2013

DESIGNED BY: SJG

DRAWN BY: PPW

REVISED BY: PPW

PROJECT NO. 070188

FIGURE NO. C-1

Path: T:\projects_8\Port_of_Bellingham\Working\Draft_RI_Dec2012\C-1 MercuryAreas.mxd

APPENDIX D

Aquifer Matrix Mineralogy (Petrography) Evaluation (prepared by MWH Americas Inc.)

MWH

BUILDING A BETTER WORLD

TECHNICAL MEMORANDUM

TO: Steve Germiat, Jeff Landrum – Aspect Consulting, LLC
David Keith – Anchor QEA, LLC

DATE: May 6, 2010

FROM: Ken Esposito

SUBJECT: Summary of aquifer mineralogy, GP West Site, Bellingham, Washington

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INTRODUCTION

Five samples of aquifer matrix material and one sample of suspended solids from groundwater collected from mercury-contaminated areas at the GP West Site were analyzed for their mineralogical and chemical composition. Four of the aquifer matrix material samples were collected along a generalized flow-path of a caustic plume, and one was collected from a former wastewater settling basin at the site. Mineralogical determinations were made using qualitative x-ray diffraction (XRD) and thin-section petrography. Scanning electron microscopy (SEM) was also conducted to provide qualitative spot chemical analysis and produce elemental mercury maps. In addition, one sample of suspended solids from a groundwater sample was filtered and analyzed using XRD and SEM.

TESTS PERFORMED

Table 1 summarizes the tests conducted on each sample. Samples CP-MWA1, CP-MWB1, CP-MWB2, and CP-MWB3 are aquifer matrix samples down a generalized contaminant flow path in the mercury/caustic plume: A1 in the plume core through B3 beyond the plume's downgradient edge. Sample CP-MW-05 is aquifer matrix from the former wastewater settling basin. The CP-MWA1 TSS Filtrate sample is suspended solids filtered from a groundwater sample collected at the CP-MWA1 location (caustic plume core).

X-ray diffraction mineralogical analysis was conducted on all of the samples. Thin-section petrography was conducted on four of the six samples. Scanning electron microscopy was conducted on all six samples and either a whole rock sample or a polished thin-section of the sample was examined. SEM analyses of whole rock samples provides information regarding the exterior of the grains (i.e., coatings and surface chemistry), while examination of the thin-sections provides information about the grain interiors.

Table 1 Samples analyzed and tests conducted on each sample.

	Reported Total Hg (mg/Kg)	XRD	Thin-section	SEM – Whole Rock	SEM – Polished Thin Section
CP-MWA1 (14'-15')	0.125	X	X	X	
CP-MWB1 (12.5'-13.5')	0.082	X	X		X
CP-MWB2 (10'-12')	0.016	X	X		X
CP-MWB3 (13'-15')	0.026	X	X		X
CP-MW-05 (12.5'-14')	375	X		X	
CP-MWA1 TSS Filtrate	NA	X		X	

SAMPLE PREPARATION

Solid samples were analyzed on an "as received" basis. Solid samples were air dried and crushed for XRD analysis and the air-dried samples were impregnated with clear epoxy for thin-section preparation. The whole rock samples used for the SEM analyses were air-dried and glued to a blank SEM stub.

The suspended particulate sample was received as 2-liters of unpreserved, unfiltered ground water that was filtered upon receipt using 0.45 μm Millipore filtering apparatus. The water was jet black in appearance and contained small amounts of suspended particulates that tended to clog the filter membrane. The filtered particulate material was scraped from each clogged filter to obtain approximately 20 mg of material used for analysis.

RESULTS

X-ray Diffraction

The semi-quantitative XRD results are summarized below in Table 2. As shown in Table 2, the samples are nearly identical to one another and dominated by the phases identified manually: quartz and plagioclase (predominately albite), with minor amounts of amphibole, chlorite, and muscovite. The XRD results were analyzed using the publically available computer program RockJock11 (Eberl, 2003). The RockJock program can identify phases below the standard 3% detection limit, because it "fits" user defined phases to the measured pattern. However, phases identified at concentrations well below 1% are always in question, unless they are confirmed in thin-section of SEM (such as

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pyrite). Cinnabar (mercury sulfide) was searched for in the XRD data, but was not identified in any of the samples.

Although the weight percent of each phase is presented with a high degree of precision, the accuracy of those numbers is far less. The numbers are intended to show that quartz and plagioclase generally constitute about 40% each in most samples and several trace phases were also identified.

Table 2 Semi-quantitative results of x-ray diffraction mineralogical analysis

Sample name:	**CP-MWA1**	**CP-MWB1**	**CP-MWB2**	**CP-MWB3**	**CP-MW-05**	**TSS filtrate**
Full pattern degree of fit:	0.4593	0.3065	0.3279	0.3201	0.1788	0.1736
Mineral	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
NON-CLAYS						
Quartz	40.2	38.3	40.1	44.8	39.1	15.0
Kspar (intermediate microcline)	1.9	5.0	4.5	1.3	8.2	8.4
Plagioclase (albite, var. cleavelandite)	16.0	18.7	19.4	17.7	12.5	25.6
Plagioclase (oligoclase; NC)	3.4	7.0	3.1	6.4	9.9	0.0
Plagioclase (andesine)	11.4	6.5	11.6	11.0	10.6	18.6
Plagioclase (labradorite)	7.1	5.7	5.5	0.5	0.0	0.0
Calcite	2.1	0.9	0.1	1.3	0.9	1.1
Dolomite	0.6	0.9	0.6	0.5	0.6	0.2
Amphibole (ferrotschermakite)	0.0	0.2	0.0	1.5	0.0	0.0
Pyroxene (diopside)	1.3	1.4	1.8	1.9	0.9	0.6
Pyrite	0.3	0.4	0.5	0.6	0.0	1.4
Hematite	0.2	0.4	0.1	0.0	0.0	0.7
Rutile	0.3	0.0	0.2	0.2	0.0	0.0
Cinnabar	0.0	0.0	0.0	0.0	0.0	0.0
Amphibole (tremolite)	0.0	2.4	0.0	0.8	0.0	0.0
Amphibole (actinolite)	3.4	3.3	3.5	3.7	2.9	0.0
Total non-clays	88.4	91.1	91.0	92.3	85.6	71.7
CLAYS						
Kaolinite (disordered)	0.5	0.0	0.0	0.0	0.0	5.7
Kaolinite (Dry Branch)	0.0	0.0	0.0	0.0	0.0	0.0
Smectite (Ca-Kinney montmorillonite)	1.2	0.0	0.0	0.0	5.2	16.2
Illite (1M; RM30)	3.7	2.5	3.1	0.9	1.4	0.0
Chlorite (CCa-2)	4.3	1.8	1.8	2.5	2.5	3.4
Chlorite (Fe-rich; Tusc)	1.8	4.6	4.1	4.3	5.3	0.0
Chlorite (Mg; Luzenac)	0.0	0.0	0.0	0.0	0.0	3.0
Muscovite (2M1)	0.0	0.0	0.0	0.0	0.0	0.0
Total clays	11.6	8.9	9.0	7.7	14.4	28.3
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Thin-section Petrography

The grain-mounts examined provided limited usefulness in identifying textural relationships between the grains, but provided ample visual evidence of the detrital nature of the fill material (that is, sub angular to sub-rounded grains with a wide variety of mineral phases randomly oriented). Detrital metallic phases, including metal sulfides and metal oxides were observed in quantities of less than 1%, which is consistent with the XRD results.

Metallic phases were observed in all of the samples examined. Nearly all of the metallic phases observed in thin-section were sulfides, rather than oxide or sulfate minerals. Oxide phases were observed on rare occasions.

Scanning Electron Microscope

Nearly all of the metallic phases observed in thin-section were sulfides, rather than oxides. Although the spot chemical analysis available in the SEM only provides information about the elements detected and not their oxidation state, all of the sulfur containing phases were presumed to be sulfides.

As shown in elemental mercury map in Figure 1, the SEM results for sample CP-MWA1 (14'-15') revealed low concentrations of mercury distributed evenly across the rock surfaces with occasional grains showing higher mercury concentrations. Figure 2 shows the highlighted grain in Figure 1 in more detail. Other locations on the sample mount showed a similar even distribution of mercury across the sample (Figure 3) with iron sulfide grains having elevated amounts of mercury (Figure 4).

The polished thin-sections examined using the SEM revealed that the iron sulfide phases containing elevated mercury typically contained elevated mercury throughout the grain and not formed as a surface feature (such as a mercury-rich coating or rind). Figure 5 shows a silicate grain with inclusions of mercury-rich sulfide phase in sample CP-MWB1 (12.5'-13.5'). Further down gradient, at location CP-MWB2 (10'-12'), mercury containing iron sulfide grains similarly show elevated mercury throughout the grain (Figure 6). The grain shown in Figure 6 shows textures and morphology that are consistent with dissolution. Dissolution of iron sulfide is expected in highly alkaline environments, because such conditions are beyond the pyrite stability field.

Elsewhere on the same sample an iron sulfide grain is completely encapsulated in a much larger silicate grain (Figure 7) and shows the same elevated mercury distribution throughout the grain. Taken as a whole, the even distribution of mercury throughout the iron sulfide grains strongly suggests that these grains did not form in-place and were likely a component of the original fill material.

Unlike the samples collected in wells CP-MWA1 through CP-MWB3, the sample collected from CP-MW-05 (wastewater settling basin) showed grains with a mercury sulfur coating. Figure 8 shows an example of the mercury sulfur coating that has likely formed in-place, rather than being a remnant of the detrital grain. The total mercury concentration in this sample was reportedly several orders of magnitude greater than in the four samples from the caustic plume (Table 1).

Due to its extreme fine-grained nature, identifying individual phases in the suspended particulate sample was difficult; however, Figures 9 and 10 show clearly identifiable mercury-containing iron sulfide phases (bright specks) in a silicate matrix. It is possible that the sulfur phases identified in the suspended particulates are amorphous and could be forming in-place.

IMPLICATIONS

Based on petrographic observations of the thin-sections, the iron sulfide phases identified by SEM in the rock samples are most likely pyrite grains. Due to their large grain-size and sub-angular to sub-rounded textures the pyrite grains were likely deposited along with the original fill material and are apparently dissolving in some locations. It does not appear that the grains were enriched in mercury as a result of the plume migration, but contained elevated mercury content due to natural process during formation. However, it is possible that the fine-grained suspended particulate material recovered from the ground water is an amorphous (or poorly crystalline) phase that could be precipitating from solution.

REFERENCES

Eberl, D.D. (2003) User's guide to RockJock--A program for determining quantitative mineralogy from powder X-ray diffraction data. Revised 11/30/09. U.S. Geological Survey Open File Report 03-78, 48 p.

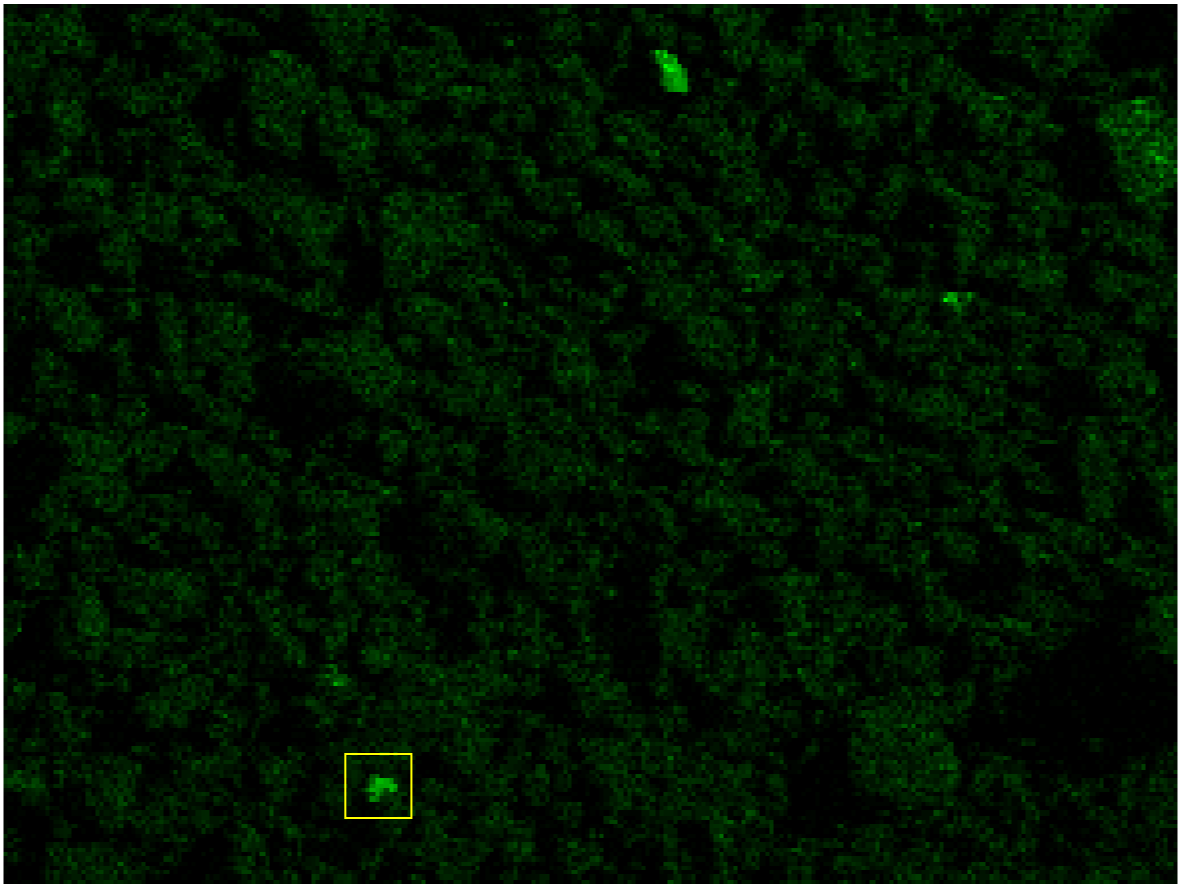


Figure 1 Sample CP-MWA1 (14’-15’). Elemental map of mercury containing phases (mercury is represented by green color). Elevated mercury concentrations appear brighter and correspond to individual grains. Scope magnification: 50X

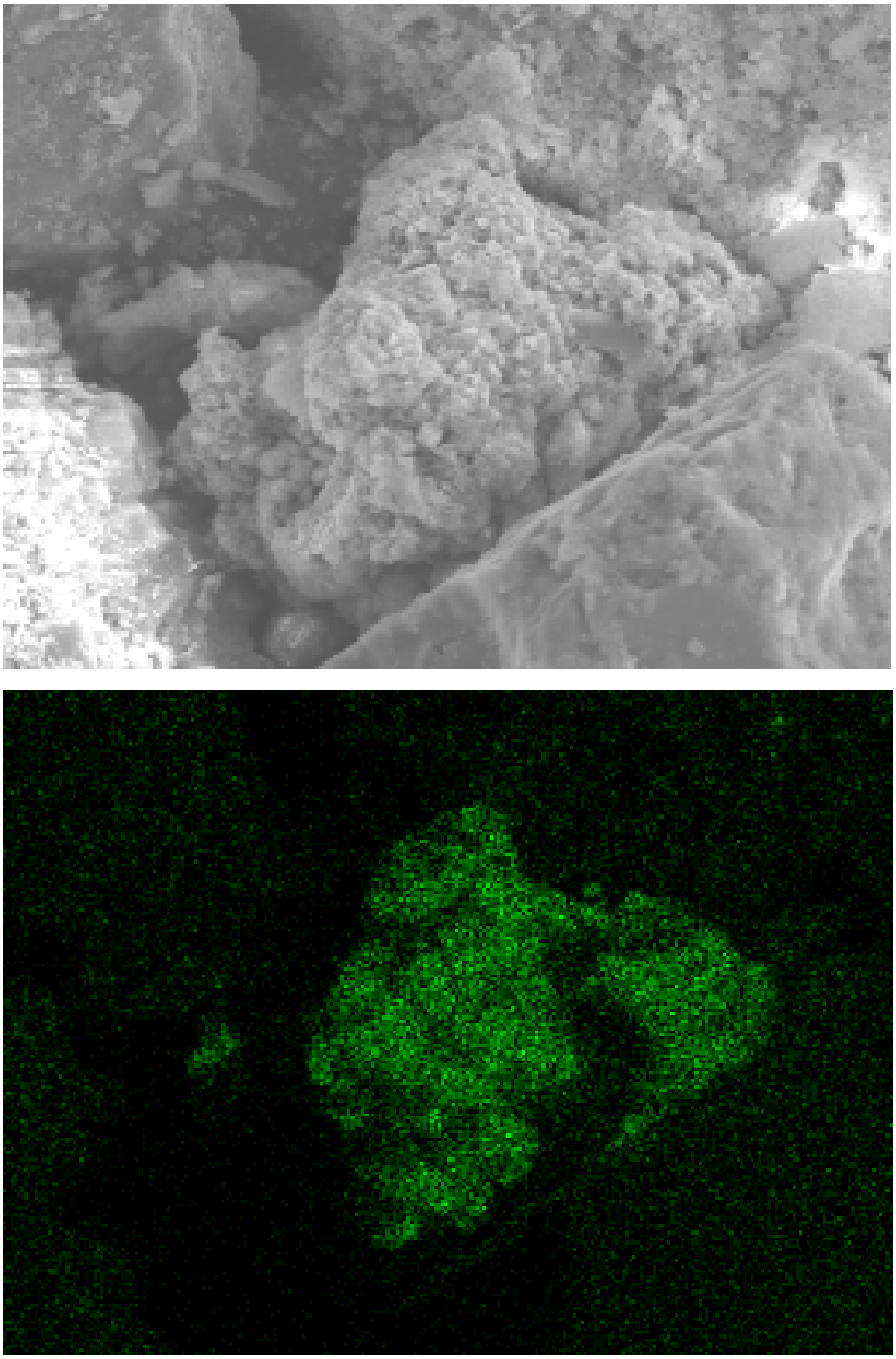


Figure 2 Close up of detrital pyrite grain (highlighted area in Figure 1) of sample CP-MWA1 (14’-15’). Grain is predominately iron sulfide containing trace amounts of mercury. Top image: secondary electrons; bottom image elemental map of mercury containing phases. Scope magnification: 200X

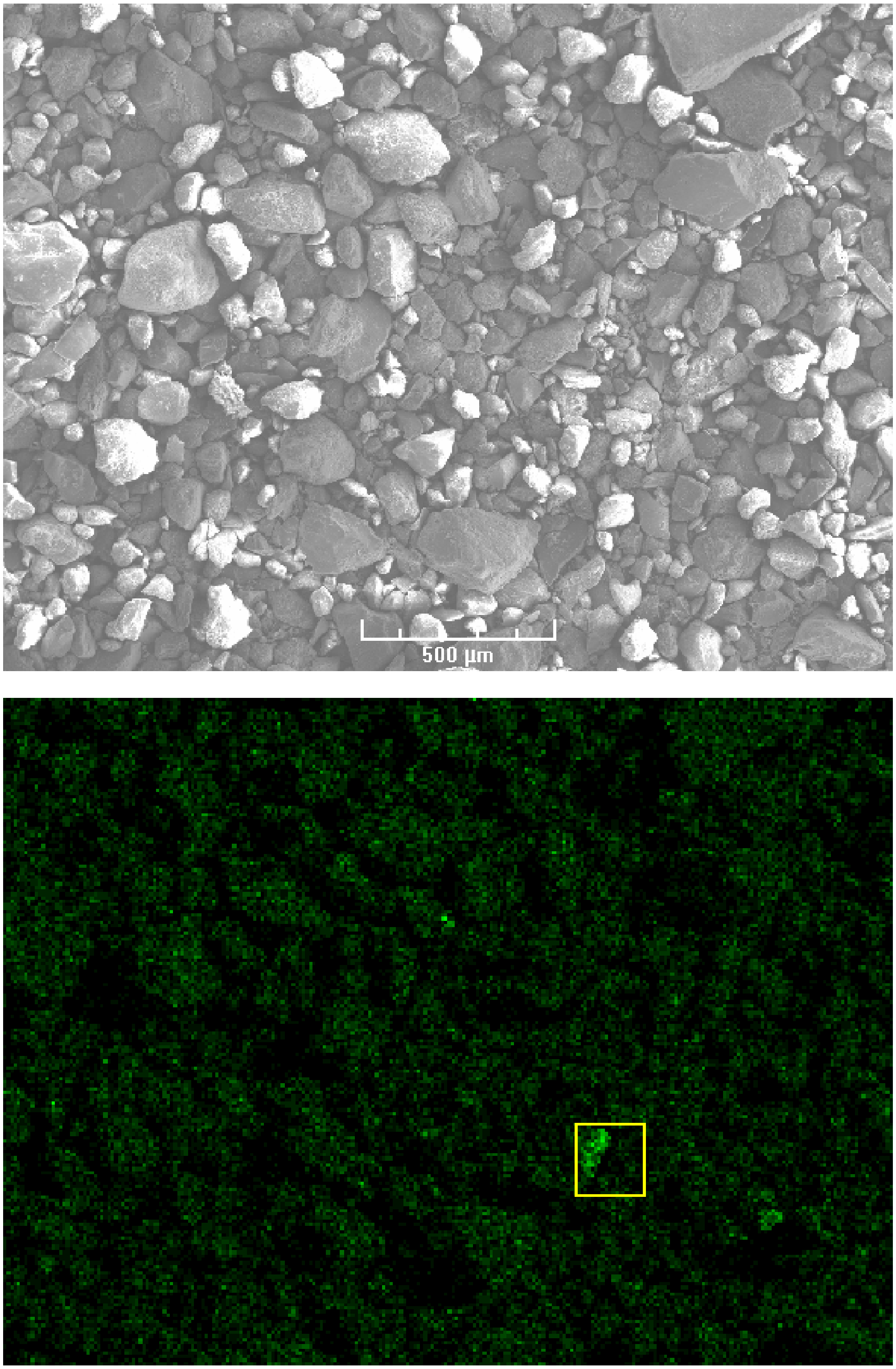


Figure 3 Sample CP-MWA1 (14'-15'). Wide field view showing multiple grains in secondary electron mode (top) and an elemental map of mercury containing phases of the same field of view. Scope magnification: 50X.

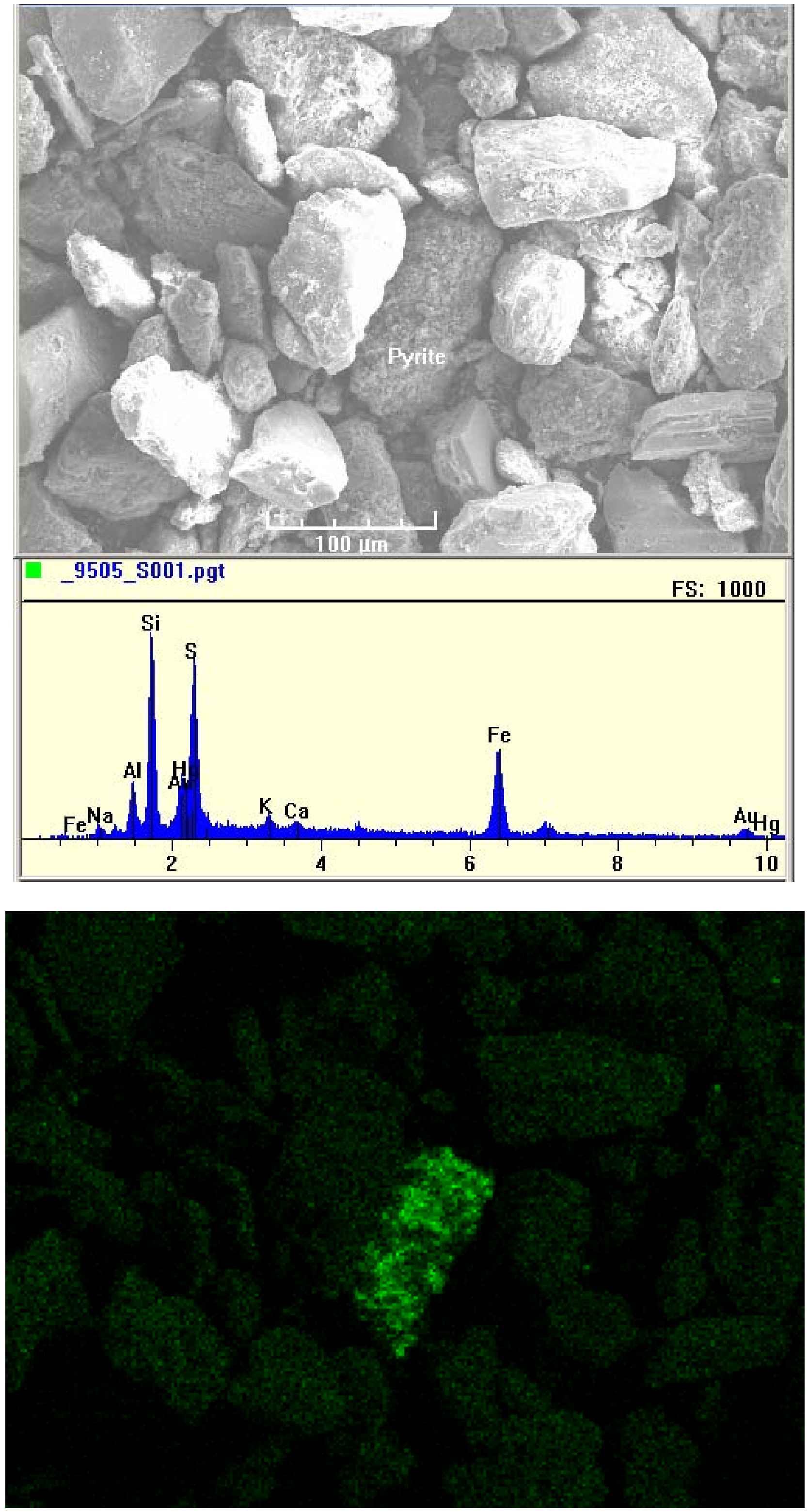


Figure 4 Sample CP-MWA1 (14’-15’). Detrital pyrite grain (highlighted in Figure 3) shown in secondary electron mode with a spot EDAX spectra (top) and an elemental map of mercury containing phases (bottom). Scope magnification: 250X.

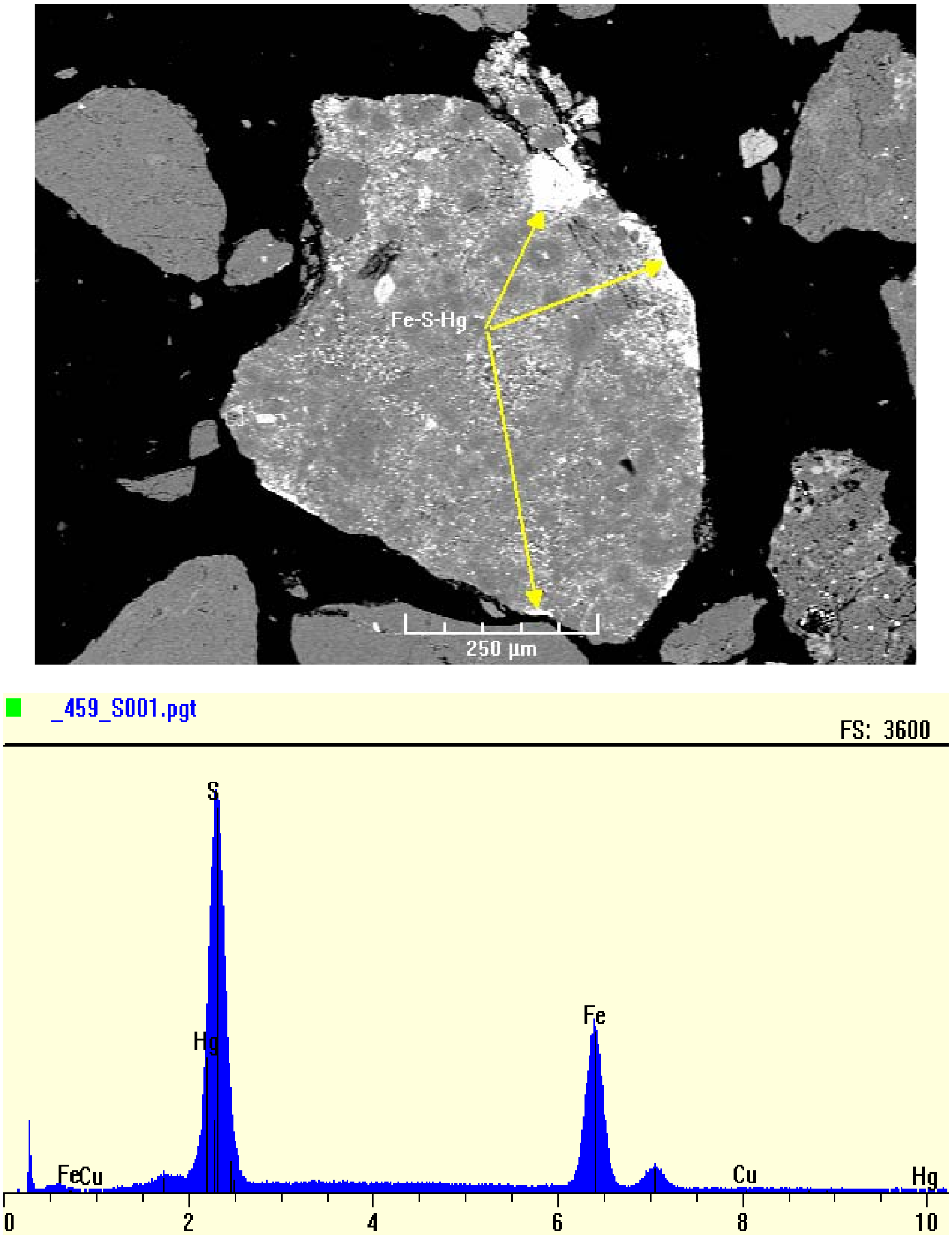


Figure 5 Sample CP-MWB1 (12.5’-13.5’). Silicate grain (top) containing inclusions of iron sulfate containing elevated mercury (light areas throughout grain). Spot EDAX spectra of mercury-rich areas. Scope magnification: 250X.

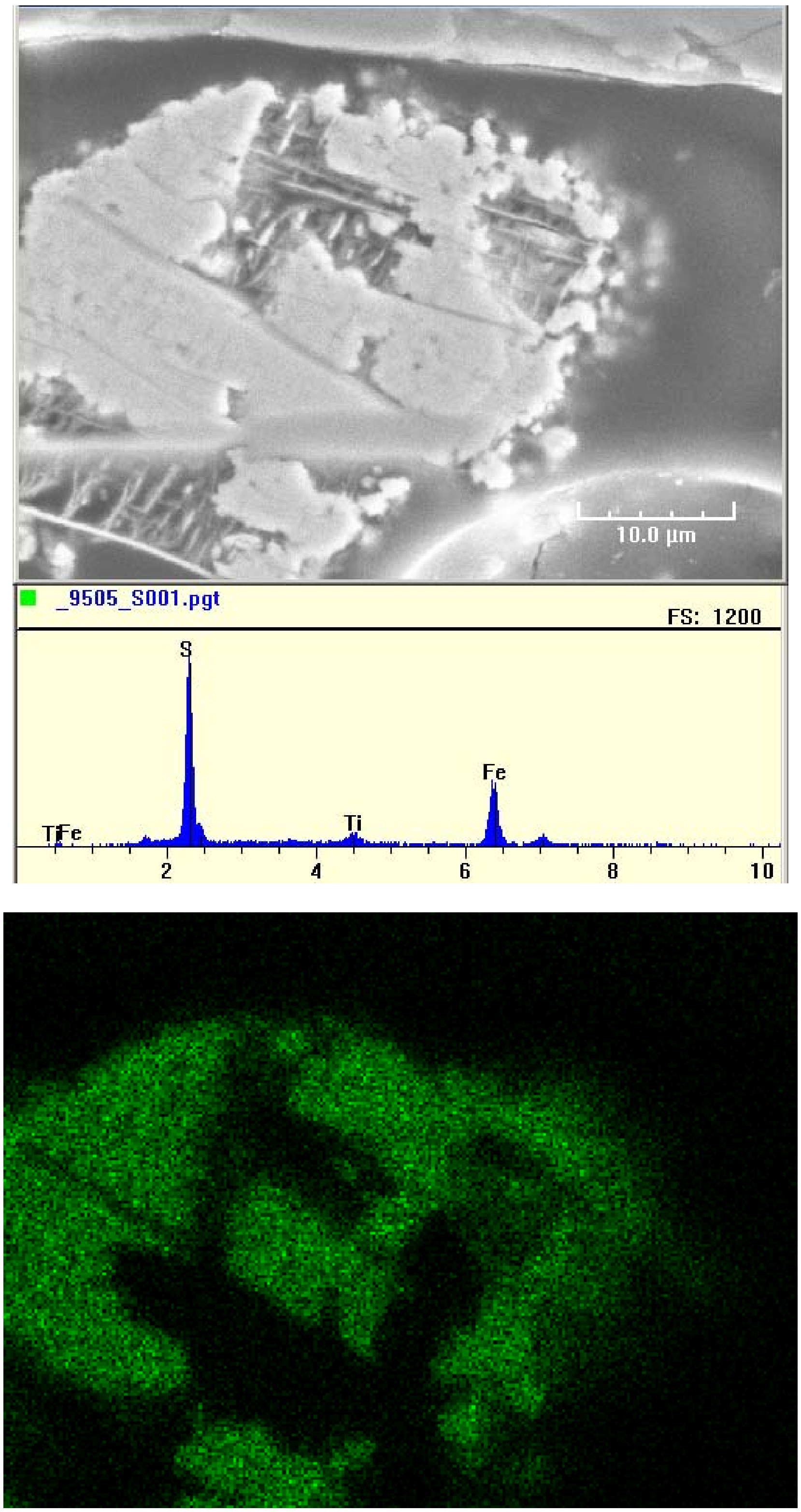


Figure 6 Sample CP-MWB2 (10’-12’). Iron sulfide grain (containing titanium) shows elevated mercury concentrations throughout the grain (bottom: elemental map of mercury containing phases of same grain). Scope magnification: 2000X.

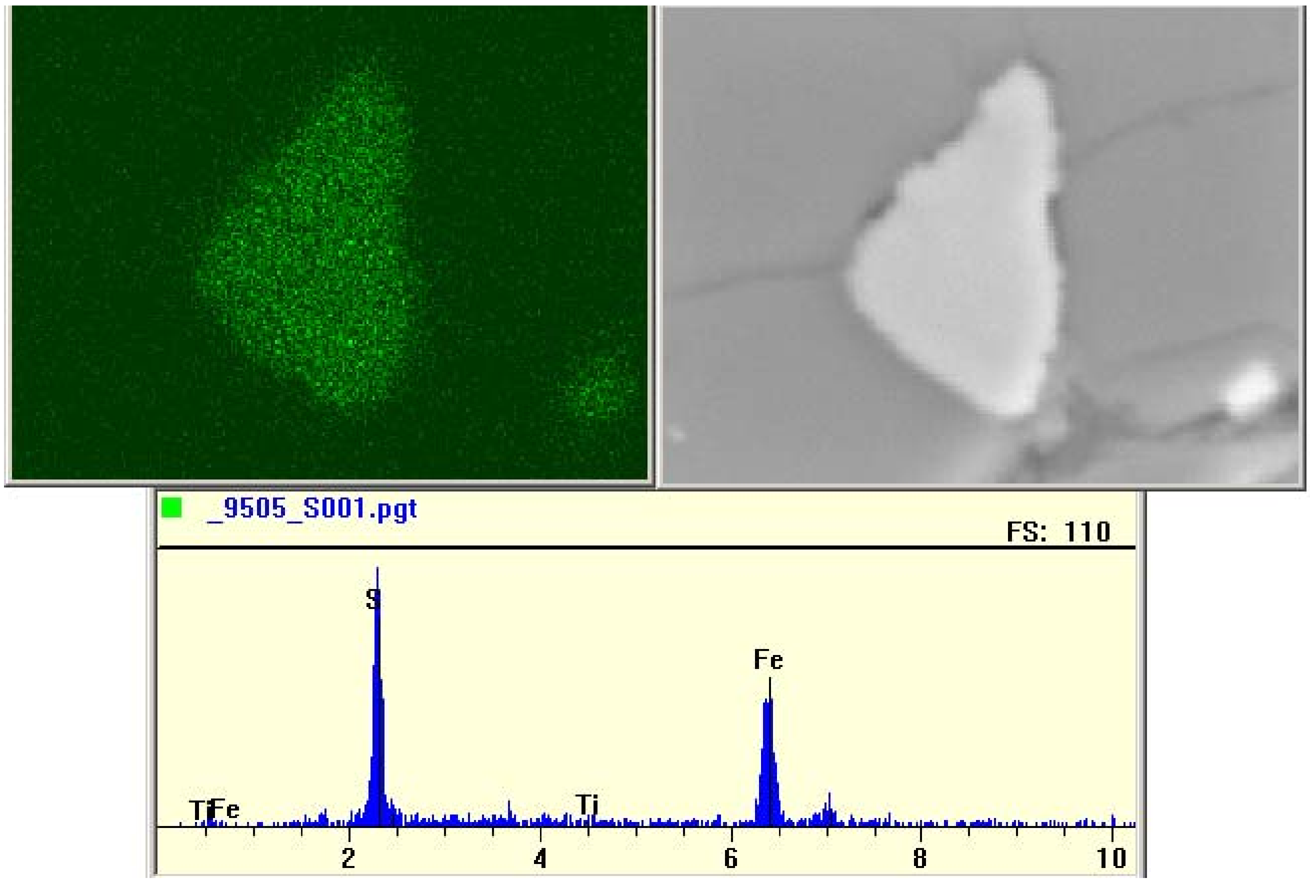


Figure 7 Sample CP-MWB2 (10’-12’). Iron sulfide grain completely encapsulated in larger silicate grain (top right) shows uniformly elevated mercury concentrations throughout the grain (top left) (bottom: EXAX spectra of iron grain). Scope magnification: 6000X.

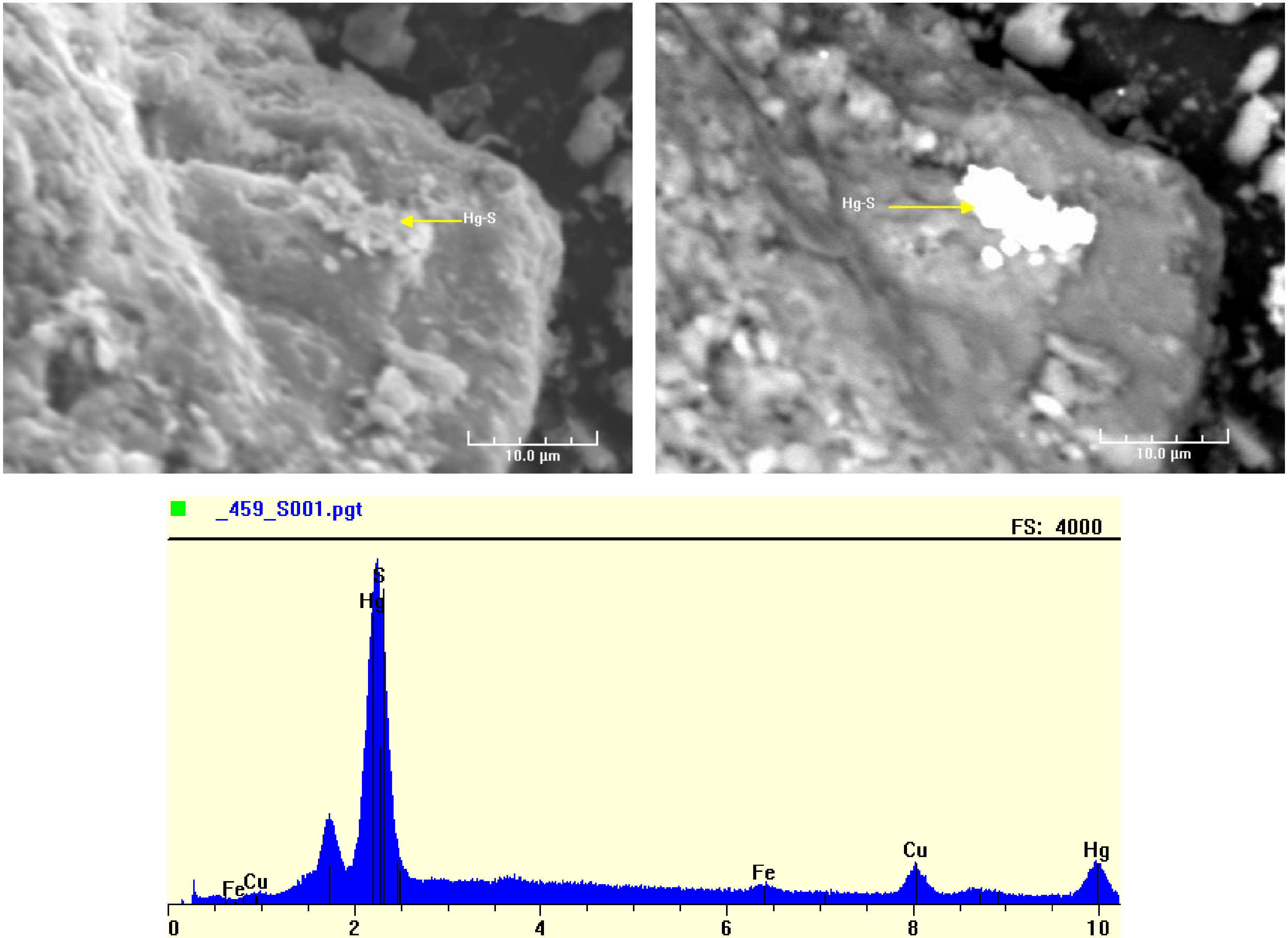
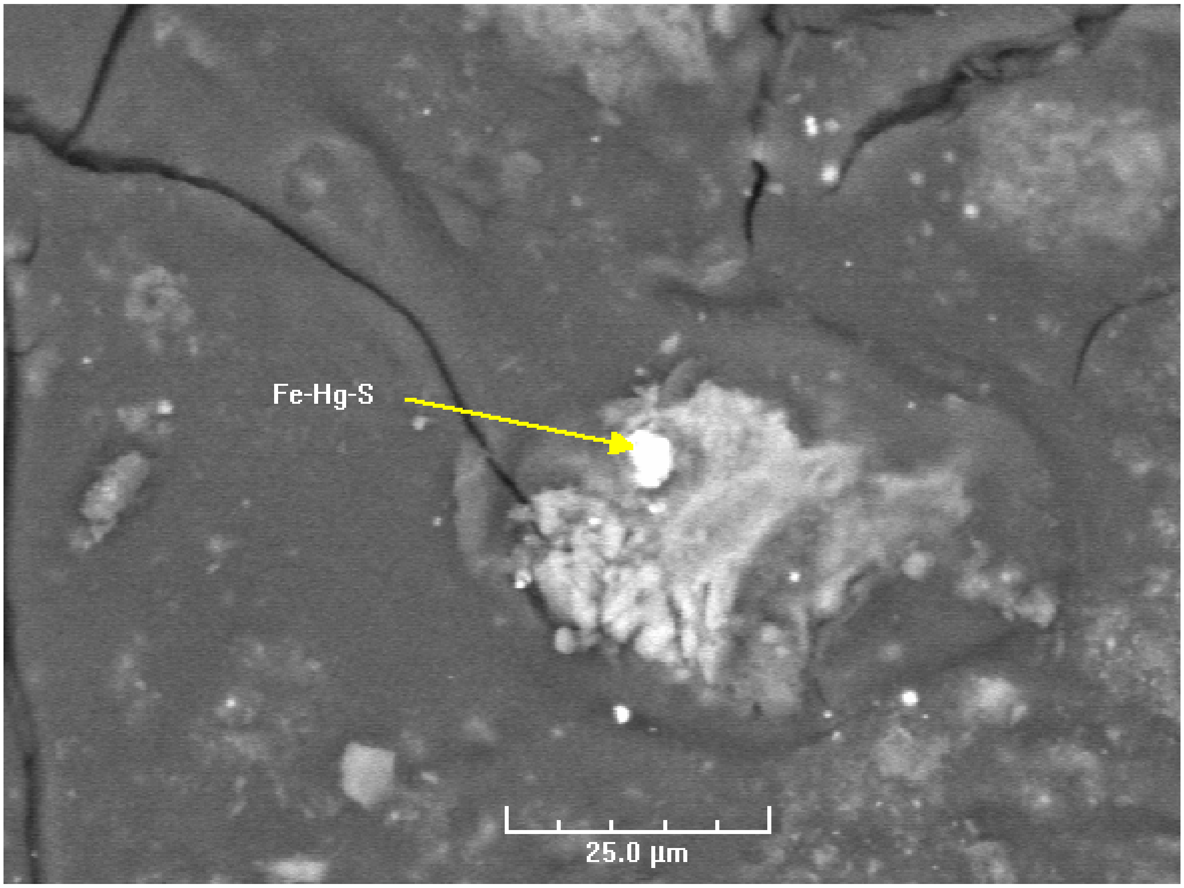


Figure 8 Sample CP-MW-05 (12.5’-14’). Silicate grain with mercury sulfide surface coating in secondary electron mode (top left) and backscatter mode (top right). Heaver elements appear brighter in backscatter mode. An EDAX spectrum (bottom) shows that the coating is composed nearly entirely of mercury and sulfur (with traces of copper and iron). Scope magnification: 2000X.



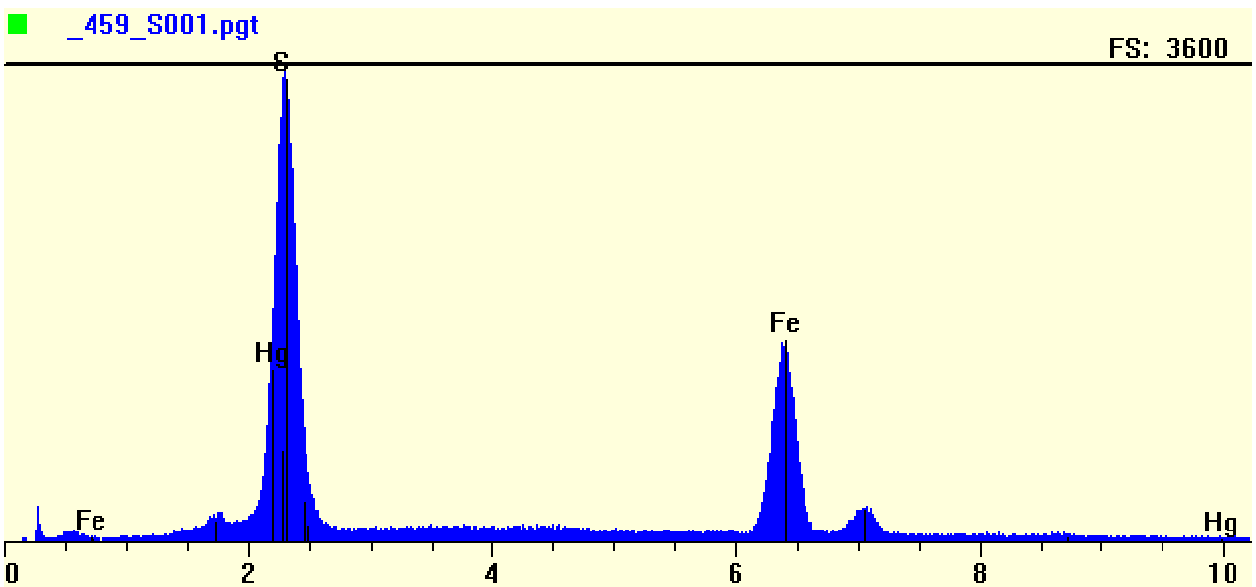


Figure 9 Sample CP-MWA1 Groundwater filtrate. Top image is a backscatter image showing mercury containing iron-sulfide phases as bright specks in a dull silicate matrix. Bottom image is an EDAX spectra of the Fe-Hg-S phase identified in top image. Scope magnification: 1000X.

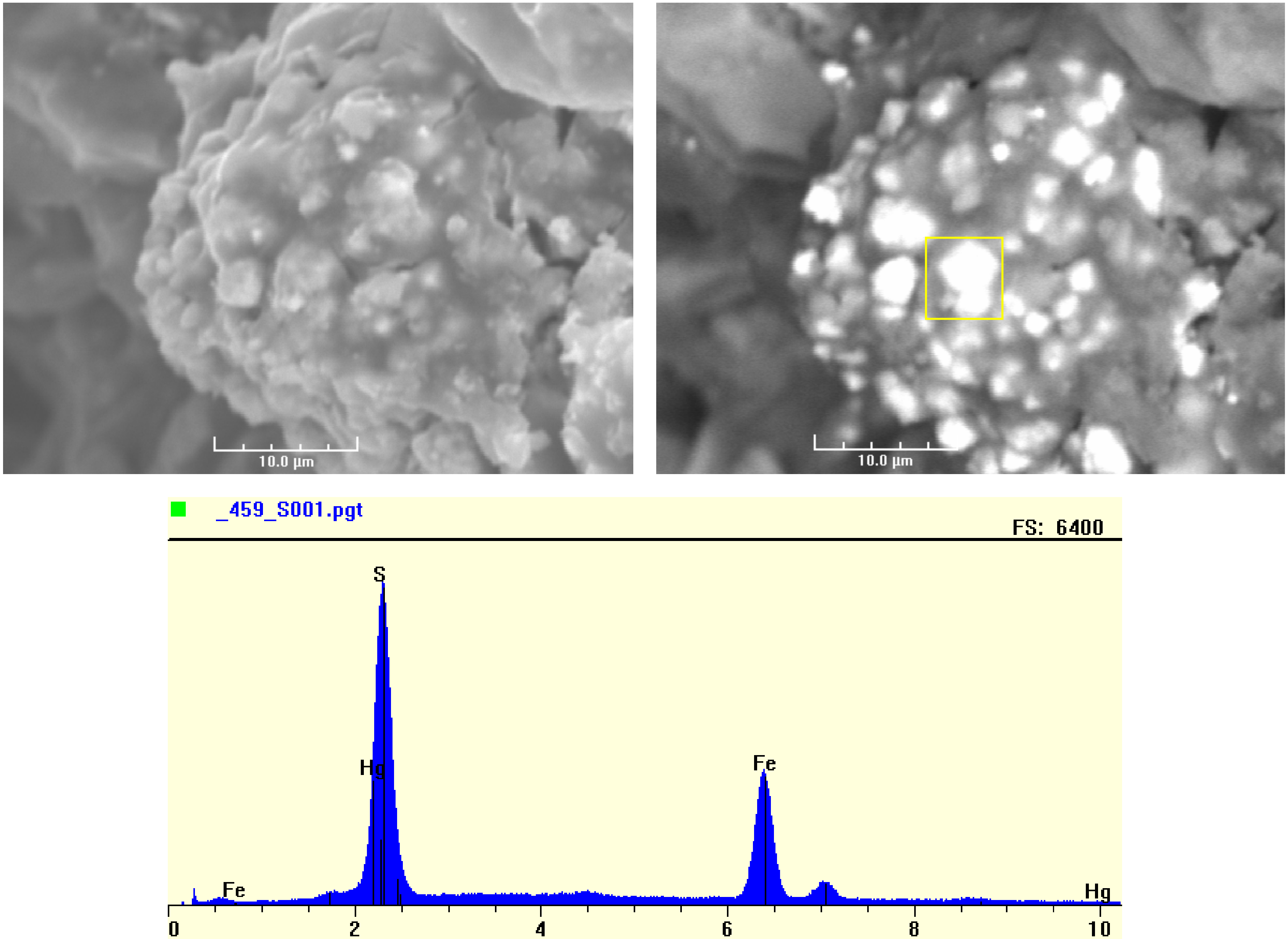


Figure 10 Sample CP-MWA1 Groundwater filtrate. Top right is a backscatter image (bright areas have higher average atomic number) showing mercury containing iron-sulfide phases as bright specks and top left is a secondary electron image of the same area. Bottom image is an EDAX spectra of the bright area identified in top image. Scope magnification: 2500X.

APPENDIX E

Soil Vapor and Ambient Air Monitoring Data Reports (prepared by Frontier Geosciences Inc., and Air Toxics Ltd.)

Frontier Geosciences Reports for Mercury Soil Vapor and Ambient Air Data

Final Report:

Mercury Soil Vapor Monitoring

(Port Of Bellingham)
Sampling Events:
09/24/2009 & 03/30/2010

In Support Of:

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May 20, 2010

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Madrone Lane N
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Mr. Jeff Landrum,

I am pleased to provide the following final report for the two mercury soil vapor sampling efforts at the former Georgia-Pacific/Port Of Bellingham (see report for specific location), performed back September 24, 2009 and March 30, 2010 in support of Aspect Consulting.

Preliminary data reports were sent via email to Aspect Consulting for this sampling effort in December 2009 and April 2010 respectively.

If you have any questions in regards to this report please do not hesitate to contact me directly.

Best Regards,

Bob

Robert C. Brunette
Senior Project Manager

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Case Narrative – 9/24/09 Sampling

Frontier Geosciences Inc of Seattle Washington was engaged by Aspect Consulting LLC to support mercury screening/monitoring from 9 soil vapor monitoring wells at the former Georgia Pacific/Port of Bellingham property near downtown Bellingham Washington (described as Georgia-Pacific West Site RI/FS – see map of study location (further map courtesy of Aspect Consulting).

Frontier arrived in Bellingham on the afternoon of 9/24/09 and met with project lead Jeff Landrum of Aspect consulting to tour the site, identify each sampling well and any go through information related to the sampling locations including power access, safety and site security. Frontier spent the rest of the afternoon on 09/24/09 securing power to each of the 9 sampling locations and setting up for the next day's sampling effort. On 09/25/09, Frontier performed the on-site, short term (20 minutes) real-time Hg monitoring and began the long-term (~ 20 hour) samples. The Long Term Hg Solid Sorbent Trap samples (Modified EPA 30B) were retrieved on 09/26/09 and each well was returned to its original condition (sealed).

Field Sampling Summary and Results: Short Term Sampling Via Hg Sorbent Trap Method

Sample Type	Lab Data Set ID	Lab Run #	Sample ID	FSTM A Hg (ng/trap)	FSTM B Hg (ng/trap)	Total (A + B Trap) (ng /trap)	Total Hg FB Cor (ng / trap)	Sample Volume (Liters)	Total Hg (µg/m³)	Estimated Detection Limit (µg/m³)
Short Term Samples (Hg Solid Sorbent Method - Mod EPA 30B) (20 Minute Samples)	THG16-090929-1	19	A1-VL FSTM A	0.20	0.26	0.45	0.00	10.7	**0.04**	**0.19**
	THG16-090929-1	22	A2-VL FSTM A	0.30	0.24	0.54	0.00	10.8	**0.05**	**0.19**
	THG16-090929-1	23	B1-VL FSTM A	0.17	0.17	0.35	0.00	10.4	**0.03**	**0.19**
	THG16-090929-1	24	C1-VL FSTM A	0.20	0.11	0.30	0.00	10.0	**0.03**	**0.20**
	THG16-090929-1	25	C2-VL FSTM A	0.35	0.22	0.58	0.00	10.5	**0.05**	**0.19**
	THG16-090929-1	26	01-VL FSTM A	0.25	0.37	0.62	0.00	10.5	**0.06**	**0.19**
	THG16-090929-1	27	02-VL FSTM A	0.72	0.11	0.82	0.07	10.4	**0.08**	**0.19**
	THG16-090929-1	28	03-VL FSTM A	1.39	0.16	1.55	0.79	10.0	**0.16**	**0.20**
	THG16-090929-1	29	06-VL FSTM A	4103.16	1.99	4105.15	4104.39	10.2	**402.47**	**0.20**

1) The Short Term sampling/Real-Time measurements were all at or near the instruments detection limit with the exception of well 06-VL which had a very pronounced and sustained signal.

2) The Short Term sampling using the Hg solid sorbent traps (Modified EPA Method 30B) were also all found to be below the detection limit (~ 0.19 µg Hg/m³) with the exception of well 06-VL which was measured well above the detection limit reporting a value of 402.47 µg Hg/m³.

3) There was no breakthrough from the "A" section to the "B" section of the Modified EPA 30B traps and therefore the traps performed well for this field quality assurance (QA) criteria.

Field Sampling Summary and Results: Long Term Sampling Via Hg Sorbent Trap Method

Sample Type	Lab Data Set ID	Lab Run #	Sample ID	FSTM A Hg (ng/trap)	FSTM B Hg (ng/trap)	Total (A + B Trap) (ng /trap)	Total Hg FB Cor (ng / trap)	Sample Volume (Liters)	Total Hg (µg/m³)	Estimated Detection Limit (µg/m³)
Long Term Samples (Hg Solid Sorbent Method - (Mod EPA 30B) 24 Hour Samples	THG17-090929-1	26491	A1-V24 FSTM A	0.32	0.16	0.48	0.00	287.616	**0.002**	**0.007**
	THG17-090929-1	26492	A2-V24 FSTM A	0.48	0.35	0.84	0.08	307.304	**0.003**	**0.007**
	THG17-090929-1	26493	B1-V24 FSTM A	0.38	0.31	0.69	0.00	313.938	**0.002**	**0.006**
	THG17-090929-1	26494	C1-V24 FSTM A	0.18	0.82	0.99	0.24	261.508	**0.004**	**0.008**
	THG17-090929-1	26495	C2-V24 FSTM A	0.41	0.23	0.64	0.00	291.040	**0.002**	**0.007**
	THG17-090929-1	26498	01-V24 FSTM A	0.34	0.32	0.66	0.00	280.768	**0.002**	**0.007**
	THG17-090929-1	26499	02-V24 FSTM A	4.68	0.13	4.82	4.06	254.446	**0.019**	**0.008**
	THG17-090929-1	26500	03-V24 FSTM A	10.90	0.24	11.14	10.38	263.220	**0.042**	**0.008**
	THG17-090929-1	26489	06-V24 FSTM A	92011.57	3.52	92015.10	92014.34	270.710	**339.903**	**0.007**
Field Blank	THG17-090929-1	26490	06-V24FB FSTM A	0.376 ng	0.38	0.76	NA	NA	**NA**	**NA**

1) The long term samples (~ 20 hours) all produced results below the detection limit (~ 0.007 µg Hg/m³) with the exception of three wells: 02-V24, 03-V24 and 06-V24.

2) There was no breakthrough from the "A" section to the "B" section of the Modified EPA 30B traps and therefore the traps performed well for this field quality assurance (QA) criteria.

3) No Field Duplicates were taken during this sampling effort as logistically setting up this number of sampling wells to run concurrently. However, the short term samples and long term samples are in a sense duplicate samples at each site. The short term samples had a higher detection limit than that of the long term samples. Further, it can be seen that there was some consistency for well 06-V24 for both the short and long term sample indicating good control of the system.

Frontier's scope of work to support Aspect Consulting involved the following:

1) **Short-Term Hg Screening Measurements (Lumex/Mod EPA30B):** Perform short term/mercury screening sampling using a real-time measurement instrument and simultaneously sample using Frontier's Modified US EPA Method 30B mercury sorbent traps. The results of the real-time screening were designed to aid in determining a sufficient flow rate and long-term sampling approach for the Modified US EPA Method 30B mercury measurements that were to follow. The long term Modified US EPA Method 30B measurements are considered the official reporting values for this effort. Each of the short term screening samples were accomplished at each of 9 wells and ran for ~ 20 minutes at approximately 0.5 slpm.

2) **Long-Term Hg Sampling via a Modified Version of US EPA Method 30B:** After the short term screening with the real-time instrument and Modified EPA 30B was accomplished, each site was then set-up with a long-term, Modified, US EPA Method 30B Hg sorbent trap and ran for nearly 20 hours at each site. Each of the 9 sampling wells was set up with its' own sampling system to enable 9 samples to be taken simultaneously (same period of time). The long term, simultaneous sampling was important to accomplish the following:

    a. Ensure that each of the Modified US EPA Method 30B traps were sampled long enough to ensure the highest probability of obtaining a large enough mercury sample mass.

    b. Obtain a representative sample (~ 20 hour integrated) of each sample location that would reflect any potential Hg fluxes over a longer time period (i.e. diurnal flux, change in water table, other) as well as enable the comparison of each well from one to the other.

Long Term Modified US EPA Method 30B Mercury Vapor Measurements: The Long Term mercury monitoring samples were performed from 09/25/09-09/26/09 and involved special critical sampling orifices set at 0.214 SLPM and ran for approximately 20 minutes. Each of the Modified US EPA Method 30B samples (short and long term) were hand carried back Frontier Geosciences Inc where they were checked in to Frontier's LIMS system and a Chain Of Custody Record was created.

Sample Digestion and Analysis: All of the Modified US EPA Method 30B sorbent traps samples were digested and analyzed following Frontier Geosciences Inc SOP FGS-069 for the determination of Total Hg. This method and approach is a National Environmental Laboratory Accreditation Program (NELAP) Accredited Method in the state of Washington as well as ISO-17025.

Project Preparation: Frontier Geosciences Inc worked directly with Jeff Lundrum of Aspect Consulting and performed the following in preparation of the project:

a) Obtained historical data from past measurements to estimate mercury concentrations in order to estimate/calculate field sampling parameters such as sampling time and flow rates to meet minimum sampling parameters.

b) Adapted/Modified US EPA Method 30B (Mercury Sorbent Method) that Frontier designed for emissions monitoring to that of the conditions and logistics for vapor well sampling.

c) Adapted Modified EPA 30B to work in conjunction with Aspect soil vapor wells and purchased/prepared special air tight adaptors to ensure no in-leakage to the soil vapor well during sampling.

Frontier Hg Soil Vapor Measurements - Key Sampling Parameters

Location	Sample Depth (ft)	Formation	* Total Mercury (ng/m3)		Flow Rate (slpm)	Sample Time (Min)	Sample Vol (m3)	Hg Capture ng Hg/Trap	Min Hg Mass (ng Hg/ Trap)
AS3	1.3-1.5	FU	720,308		1	1440	1.44	1,037,244	4
AS7	1.3-1.5	FU	158	U	1	1440	1.44	227.52	4
AS12	1.3-1.5	Chemfix	142	U	1	1440	1.44	204.48	4
AS13	1.3-1.5	Chemfix	779		1	1440	1.44	1121.76	4
AS14	1.3-1.5	Chemfix	143	U	1	1440	1.44	205.92	4
AS15	1.3-1.5	Chemfix	117	U	1	1440	1.44	168.48	4

* Numbers From 2003 Sampling Effort - Aspect Consulting, LLC

Summary of Results

Total Gaseous Hg Summary

Sample Type	Sample ID	Start Time	End Time	Minutes Sampled	Flow Rate	Sample Volume	Corrected Total Hg (µg/m³)
Short Term Samples (Mercury Sorbent Trap Method + Lumex)	A1-VL FSTM A	9/26/13 11:08	9/26/13 11:28	20	NA (Mass Flow Totalizer)	10.7	**0.04**
	A2-VL FSTM A	9/26/13 9:25	9/26/13 9:45	20	NA (Mass Flow Totalizer)	10.8	**0.05**
	B1-VL FSTM A	9/26/13 8:30	9/26/13 8:50	20	NA (Mass Flow Totalizer)	10.4	**0.03**
	C1-VL FSTM A	9/25/13 18:10	9/25/13 18:30	20	NA (Mass Flow Totalizer)	10.0	**0.03**
	C2-VL FSTM A	9/26/13 10:15	9/26/13 10:35	20	NA (Mass Flow Totalizer)	10.5	**0.05**
	01-VL FSTM A	9/26/13 11:49	9/26/13 12:09	20	NA (Mass Flow Totalizer)	10.5	**0.06**
	02-VL FSTM A	9/26/13 14:14	9/26/13 14:34	20	NA (Mass Flow Totalizer)	10.4	**0.08**
	03-VL FSTM A	9/26/13 13:32	9/26/13 13:52	20	NA (Mass Flow Totalizer)	10.0	**0.16**
	06-VL FSTM A	9/26/13 12:41	9/26/13 13:01	20	NA (Mass Flow Totalizer)	10.2	**402.47**
24 Hour Samples (Mercury Sorbent Trap Method)	A1-V24 FSTM A	9/26/13 11:31	9/27/13 9:55	1344	0.204	275	**0.00**
	A2-V24 FSTM A	9/26/13 9:50	9/27/13 9:46	1436	0.204	293	**0.00**
	B1-V24 FSTM A	9/26/13 8:56	9/27/13 9:23	1467	0.205	301	**0.00**
	C1-V24 FSTM A	9/25/13 18:39	9/26/13 15:01	1222	0.208	254	**0.00**
	C2-V24 FSTM A	9/26/13 10:46	9/27/13 9:26	1360	0.207	282	**0.00**
	01-V24 FSTM A	9/26/13 12:15	9/27/13 10:07	1312	0.206	270	**0.00**
	02-V24 FSTM A	9/26/13 14:39	9/27/13 10:28	1189	0.222	264	**0.02**
	03-V24 FSTM A	9/26/13 13:56	9/27/13 10:26	1230	0.206	253	**0.04**
	06-V24 FSTM A	9/26/13 13:10	9/27/13 10:15	1265	0.210	266	**333.82**
Field Blank	06-VFB FSTM A						**NA**

Short Term Sampling Results

Description of Short-Term Sampling Approach:

Frontier's real-time mercury sampling system was designed to allow us to screen mercury in real-time while also capturing a Modified US EPA Method 30B sample:

1) Each sampling location identification was confirmed by observing the adjacent well cap identification and the site ID was then recorded on the mercury vapor well itself.

2) Each monitoring well was fitted with a leak-proof well head that allowed Frontier to incorporate a Trace Clean ¼" OD Teflon line through a bulk head fitting.

3) A leak-proof bulk head fitting was fixed at the top of each well head cap. The ¼' trace-clean Teflon tubing was then placed approximately 12 inches down inside each sampling well.

4) The Teflon sample line from the well was then plumbed into the Real Time Hg Screening Instrument (Lumex RA-915).

5) A Modified US EPA Method 30B sorbent trap was set at the outlet of the Real Time Hg Screening Instrument to capture mercury after it passed through the instrument detector.

6) At the Outlet of the Modified US EPA trap, another sample line ran from the Modified EPA 30B trap and then onto Mass Flow Meter, Volume Totalizer, Flow Controller and Pump. This device was used to pull at approximately 0.5 slpm from the well, through the real-time instrument, through the Modified EPA 30B trap and then into the Mass Flow Meter/Volume Totalizer and pump.

Frontier Mobile Real-Time + Modified EPA 30B Hg System Set-Up at One Sampling Well Head

Frontier Well Cap with Teflon Trace-Clean Bulk Head Fitting and Trace-Clean ¼” Sample Line

Frontier Mobile Real-Time + Modified EPA 30B Hg System

-Sampling Station (Right)

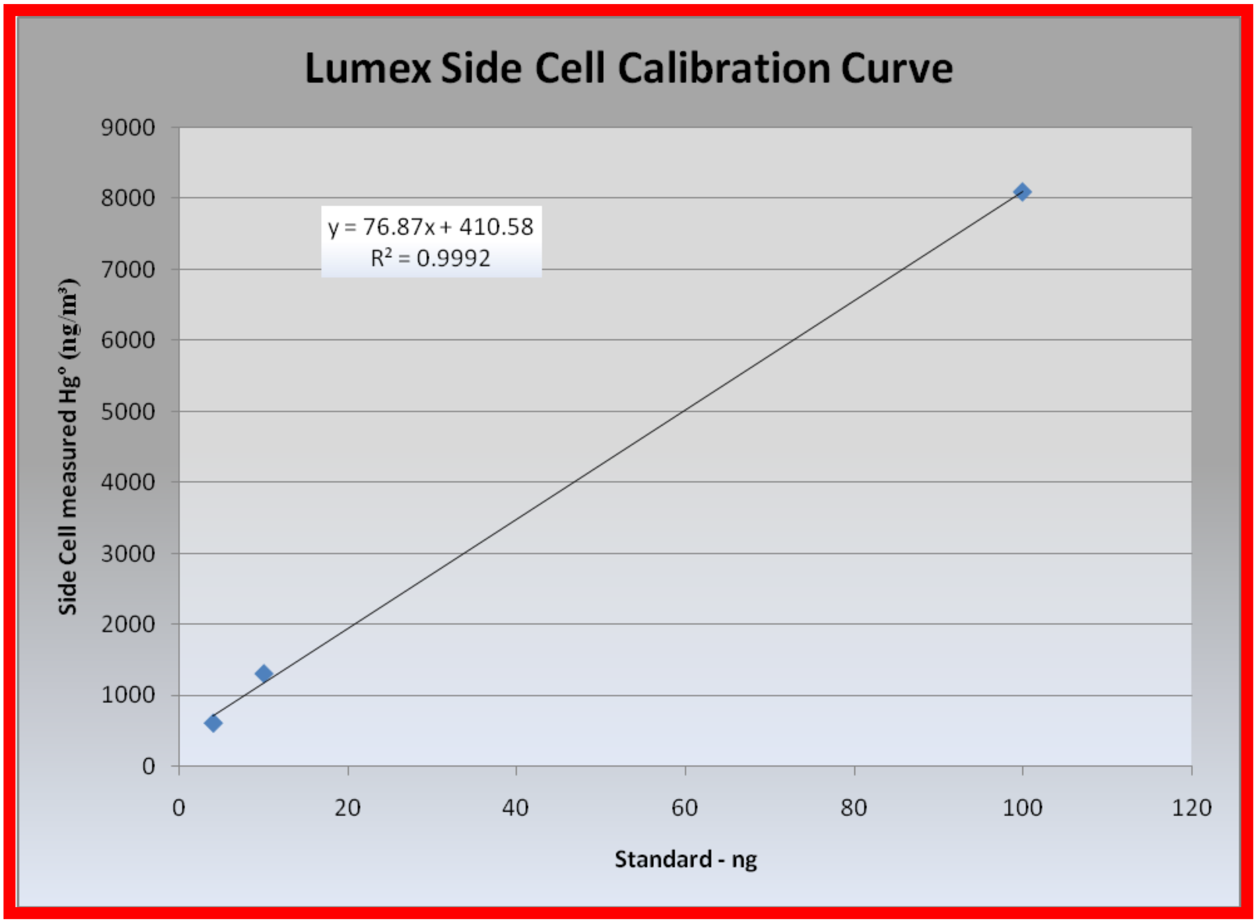
- Real Time Instrument

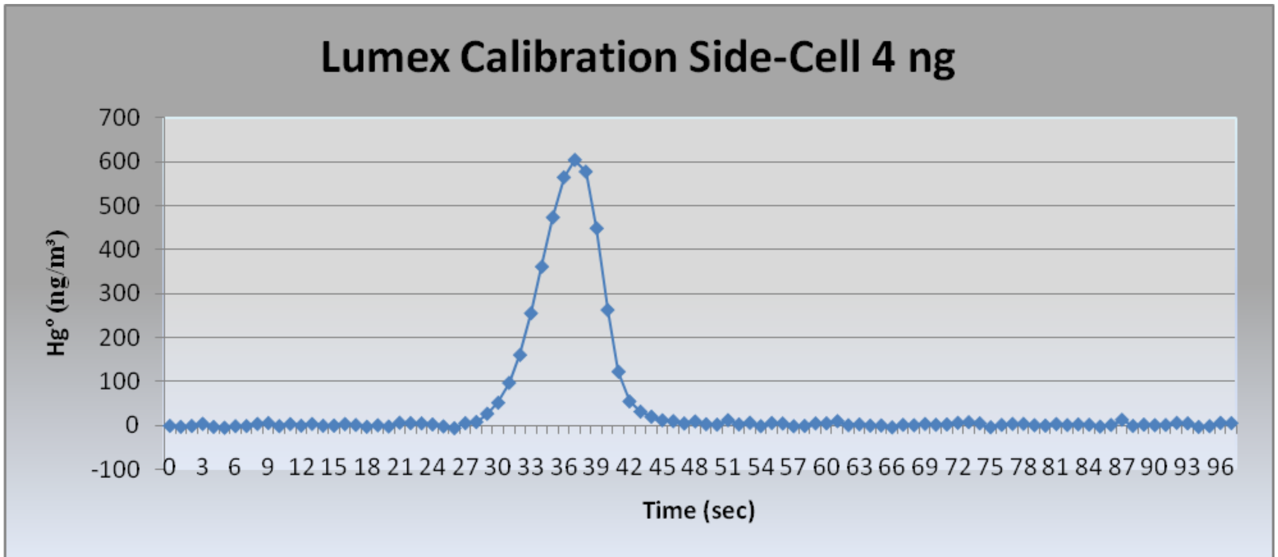
- Modified EPA 30B Trap

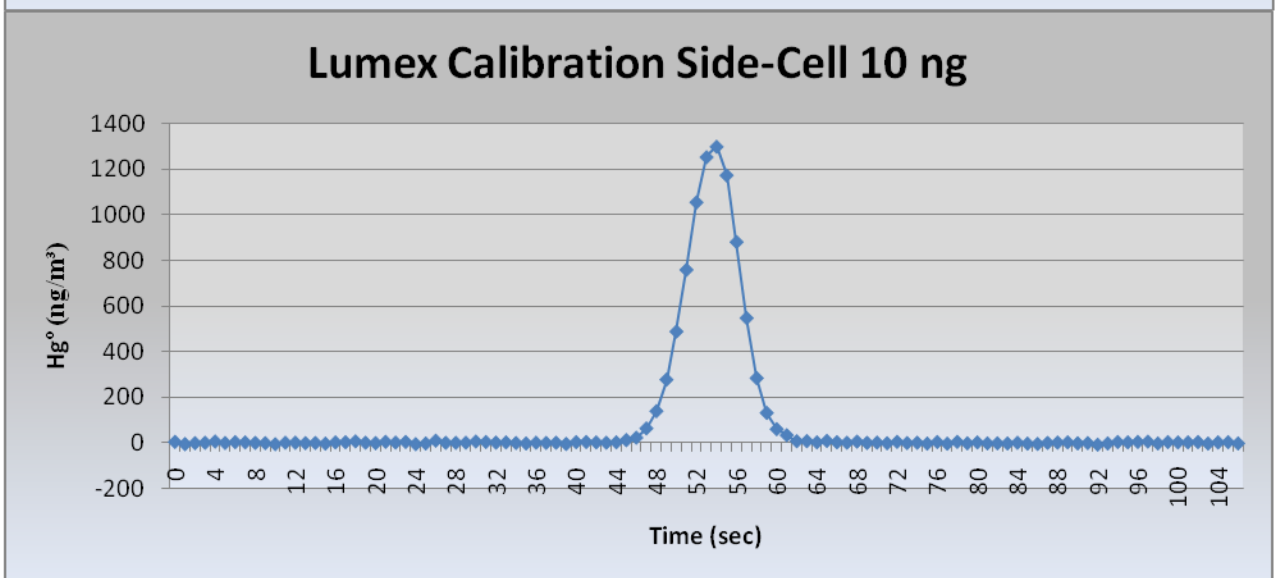
- Mass Flow Meter / Sample Volume Totalizer / Pump

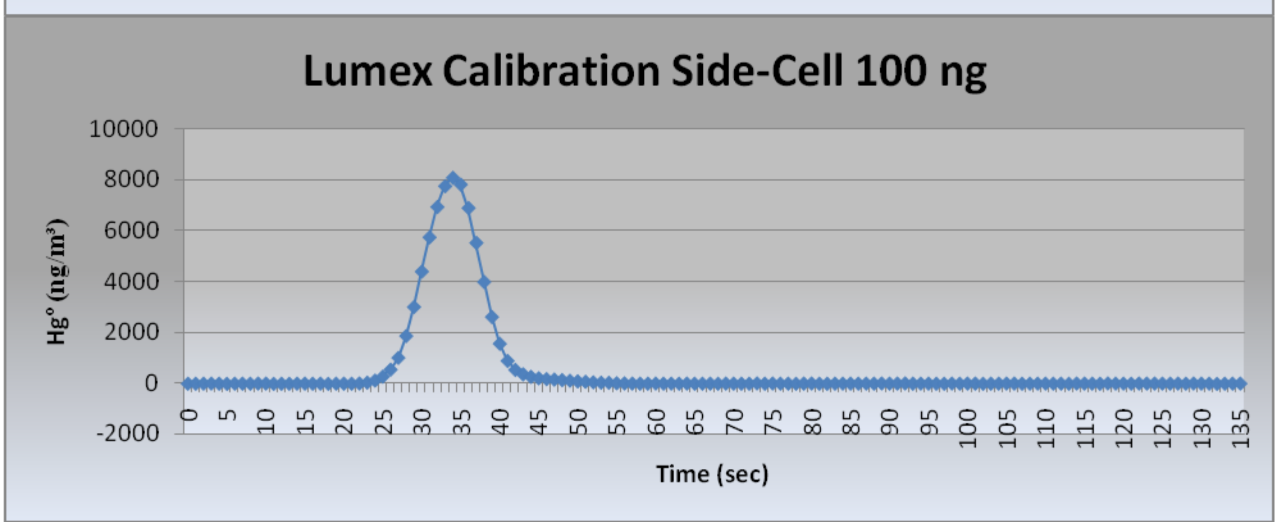
Calibration Data

The Real-Time Instrument (Lumex) was intended for screening in order to determine target sampling parameters for the Modified EPA Method 30B sampling effort. The Real-Time instrument was therefore calibrated with a simple 3 point curve using a NIST Traceable mercury standard. The calibration points were intended to cover a broad range including 400ng Hg/m³ to as high as 8000ng Hg/m³.



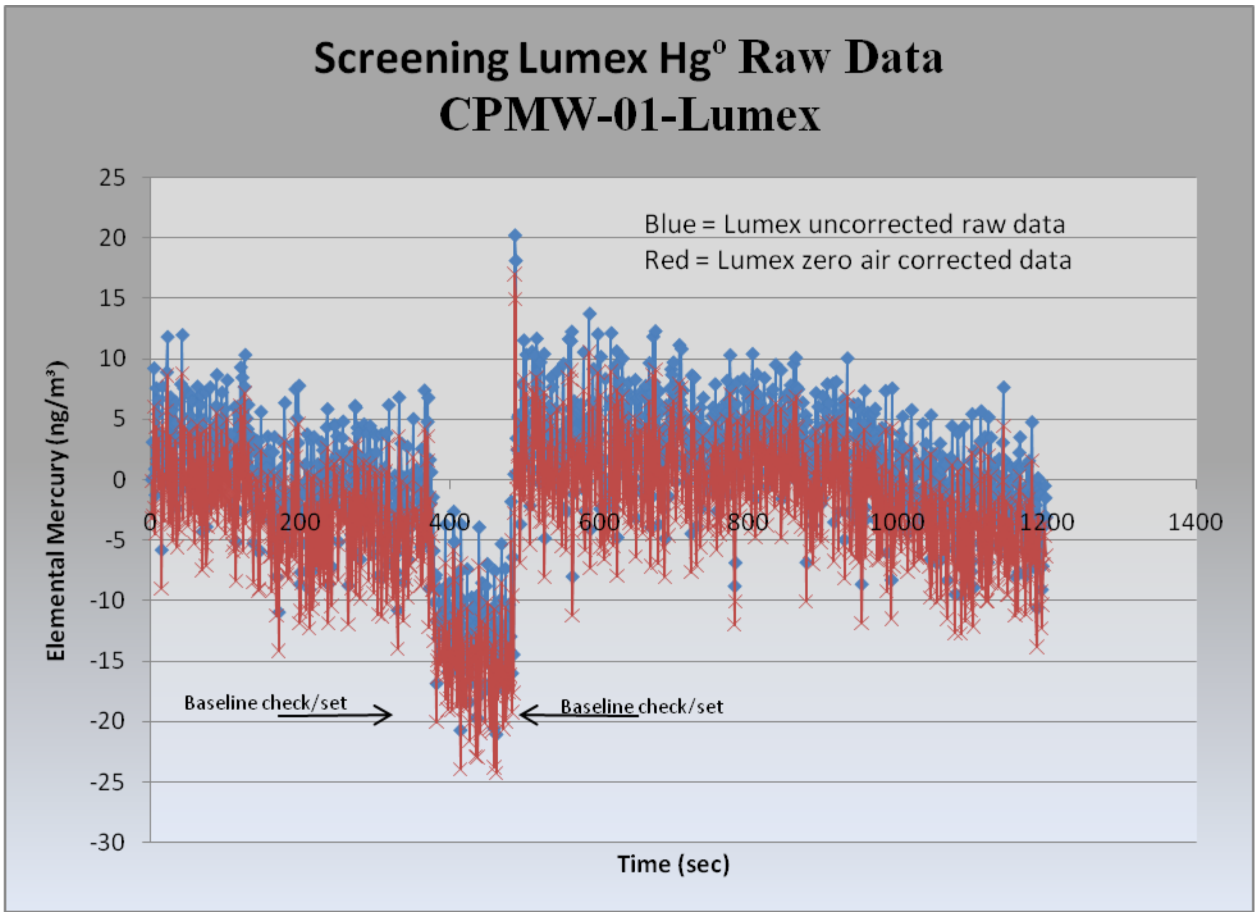

Lumex Calibration Side-Cell 4 ng
Hg° (ng/m³)
Time (sec)

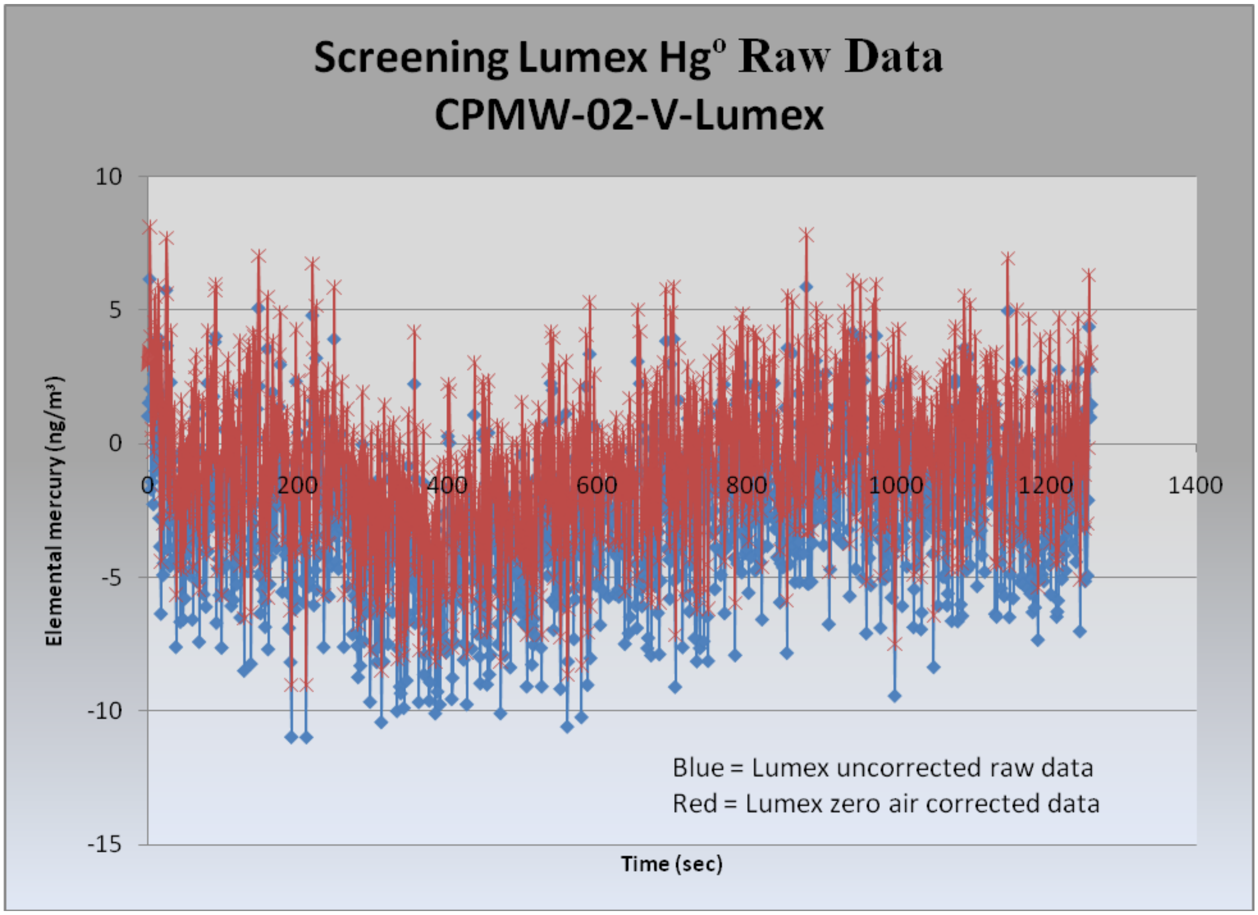

Lumex Calibration Side-Cell 10 ng
Hg° (ng/m³)
Time (sec)


Lumex Calibration Side-Cell 100 ng
Hg° (ng/m³)
Time (sec)

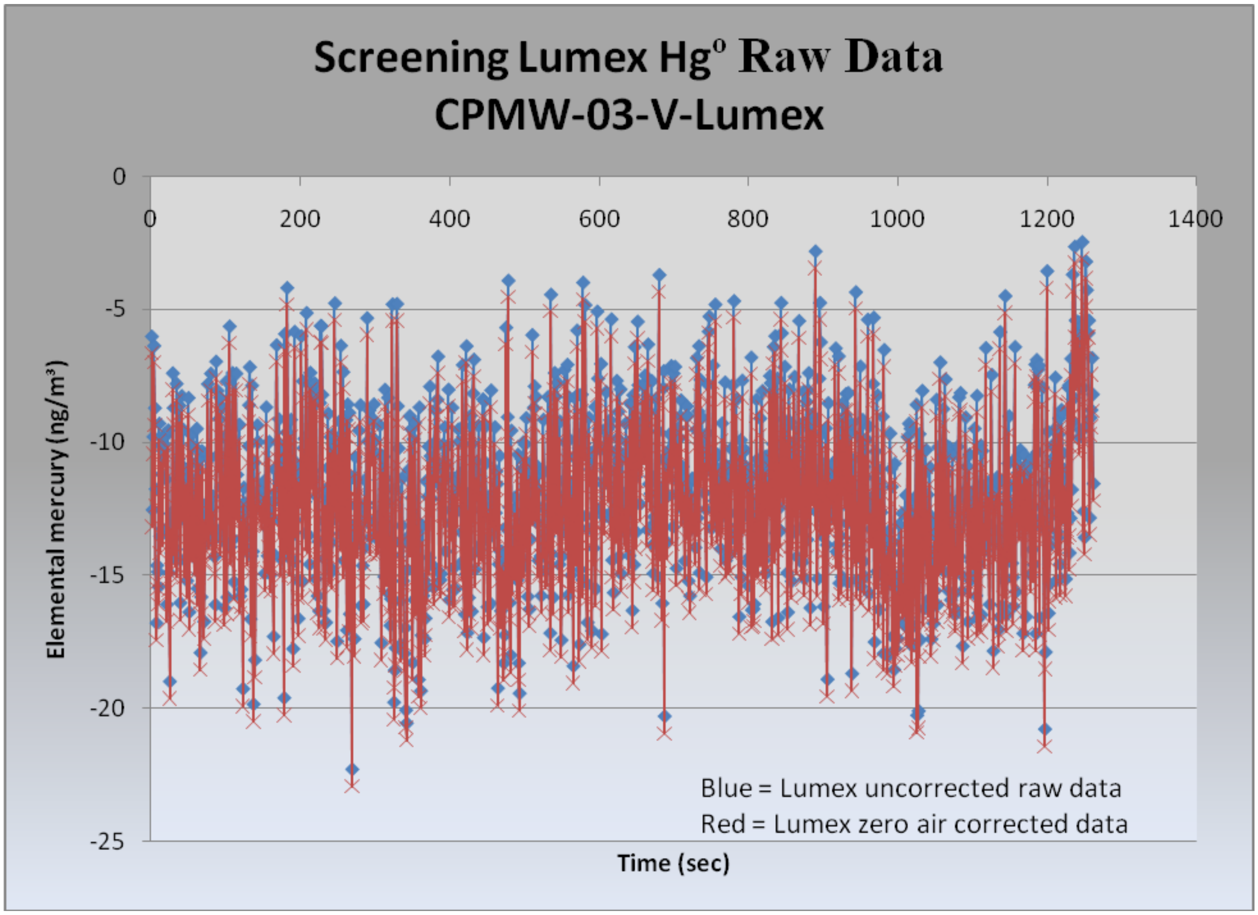
Real-Time Mercury Instrument (Lumex) Results

Before and after each Lumex run FSTM zero-air blank checks were performed. In order to determine the blank level, a 3-way valve with an FSTM zero-air trap was located between the soil gas probe and the Lumex. By turning the flow path to the FSTM zero-air trap, a source of air without mercury present was generated to determine the blank baseline response of the Lumex. The baseline check was also performed during the first sampling period (which was. The average of the FSTM zero-air measurements was used to blank-correct the actual Lumex measurements.





Screening Lumex Hg° Raw Data
CPMW-02-V-Lumex
10
5
0
-5
-10
-15
0
200
400
600
800
1000
1200
1400
Elemental mercury (ng/m³)
Time (sec)
Blue = Lumex uncorrected raw data
Red = Lumex zero air corrected data



Screening Lumex Hg° Raw Data
CPMW-03-V-Lumex
Elemental mercury (ng/m³)
Time (sec)
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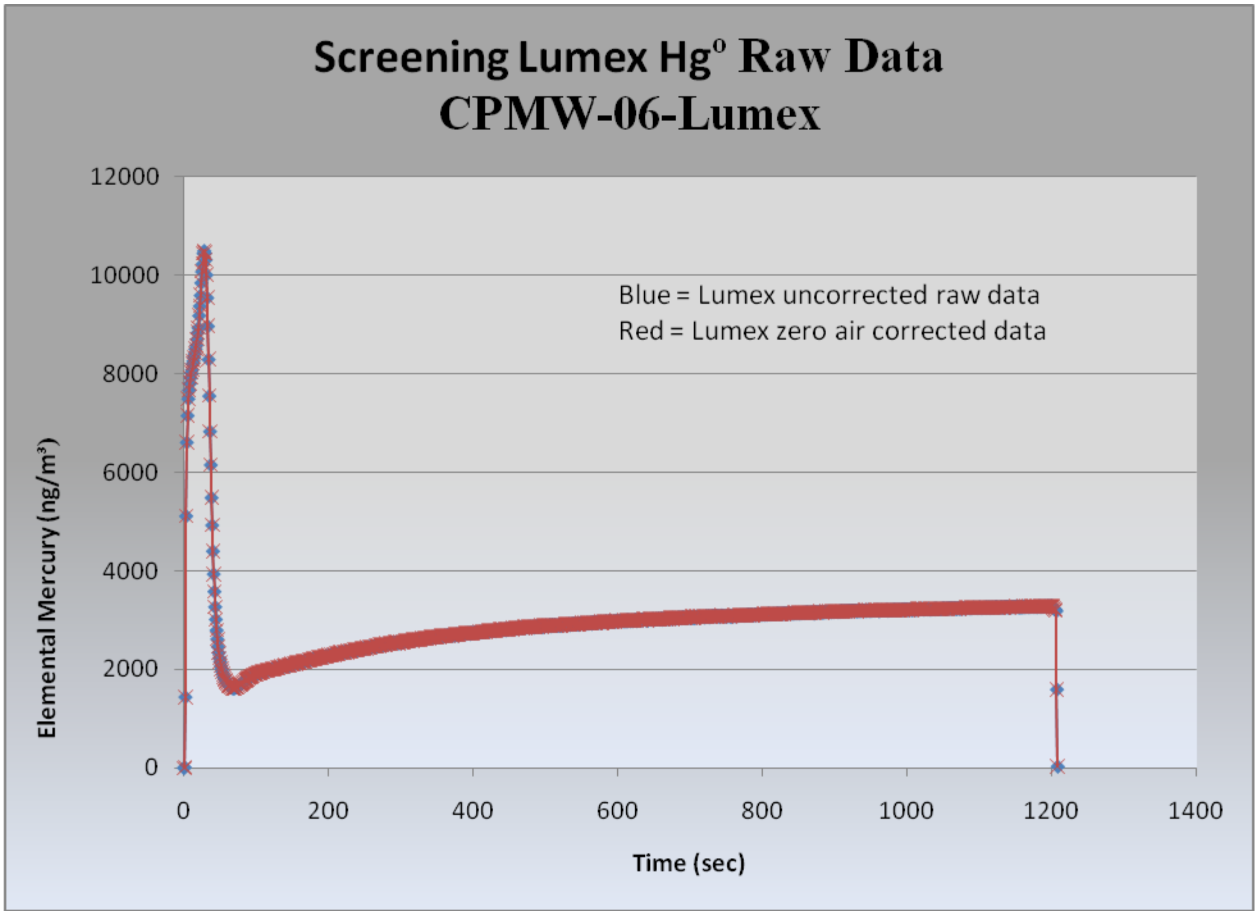
-5
-10
-15
-20
-25
0
200
400
600
800
1000
1200
1400
Blue = Lumex uncorrected raw data
Red = Lumex zero air corrected data


Screening Lumex Hg° Raw Data
CPMW-06-Lumex
Blue = Lumex uncorrected raw data
Red = Lumex zero air corrected data
Elemental Mercury (ng/m³)
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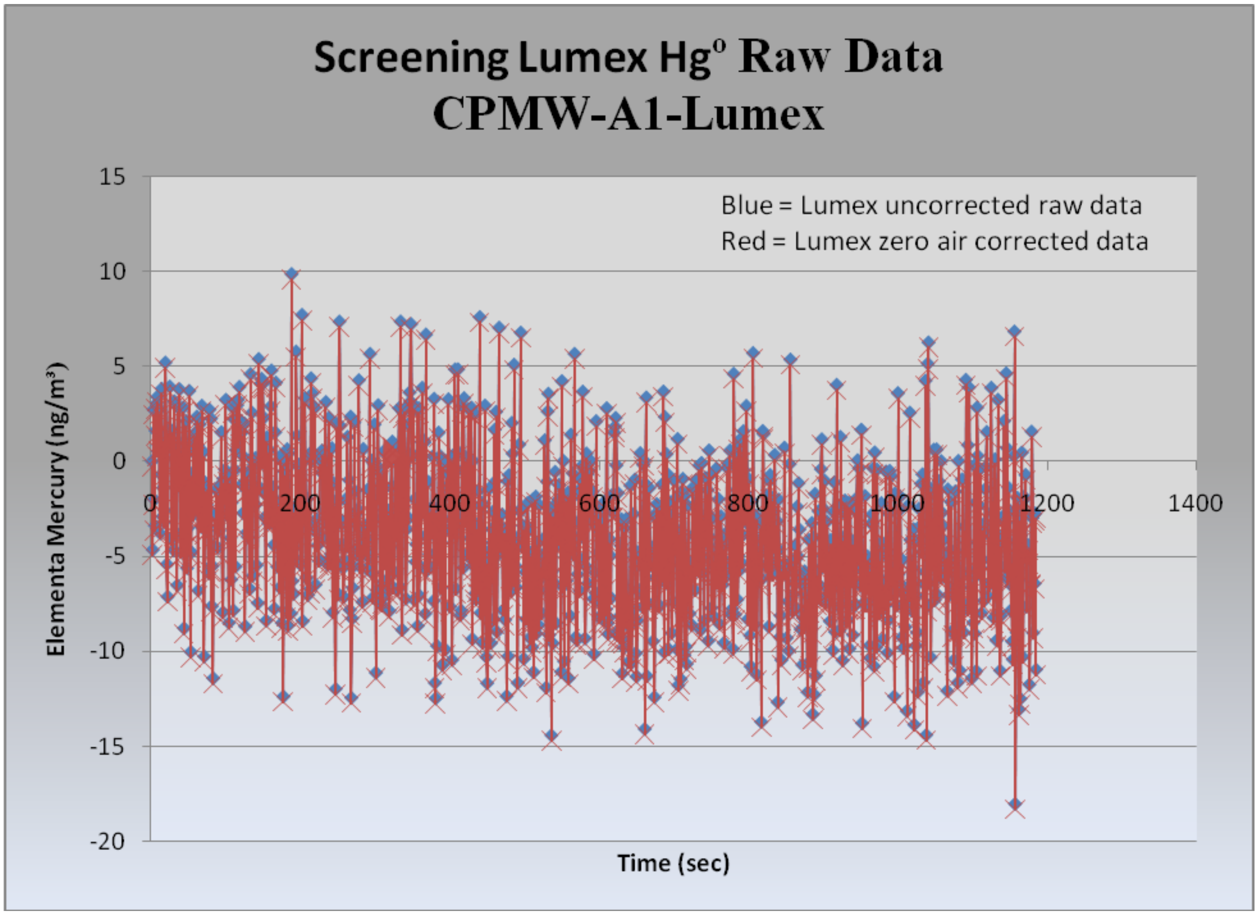
4000
6000
8000
10000
12000
0
200
400
600
800
1000
1200
1400


Screening Lumex Hg° Raw Data
CPMW-A1-Lumex
Blue = Lumex uncorrected raw data
Red = Lumex zero air corrected data
Elementa Mercury (ng/m³)
Time (sec)
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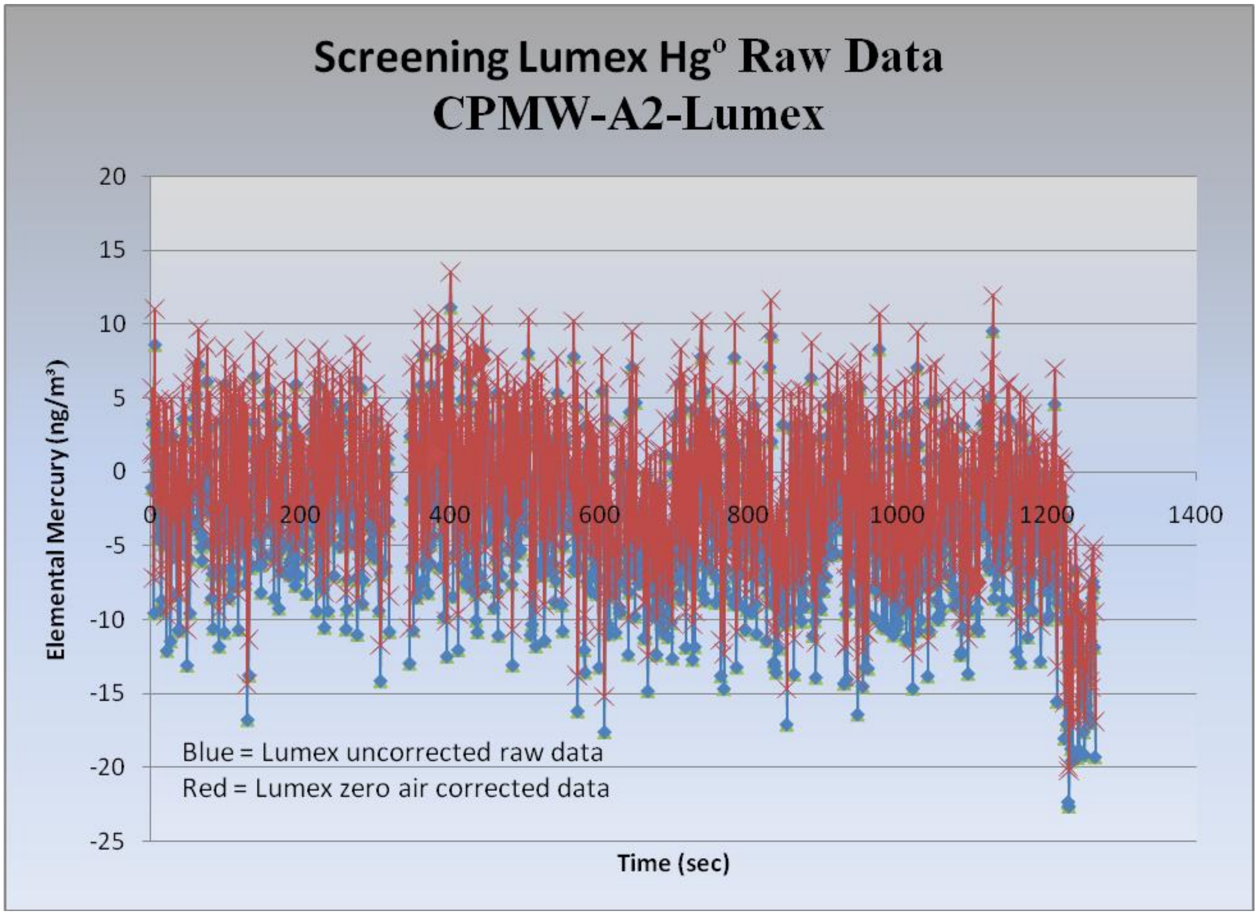
10
5
0
-5
-10
-15
-20
0
200
400
600
800
1000
1200
1400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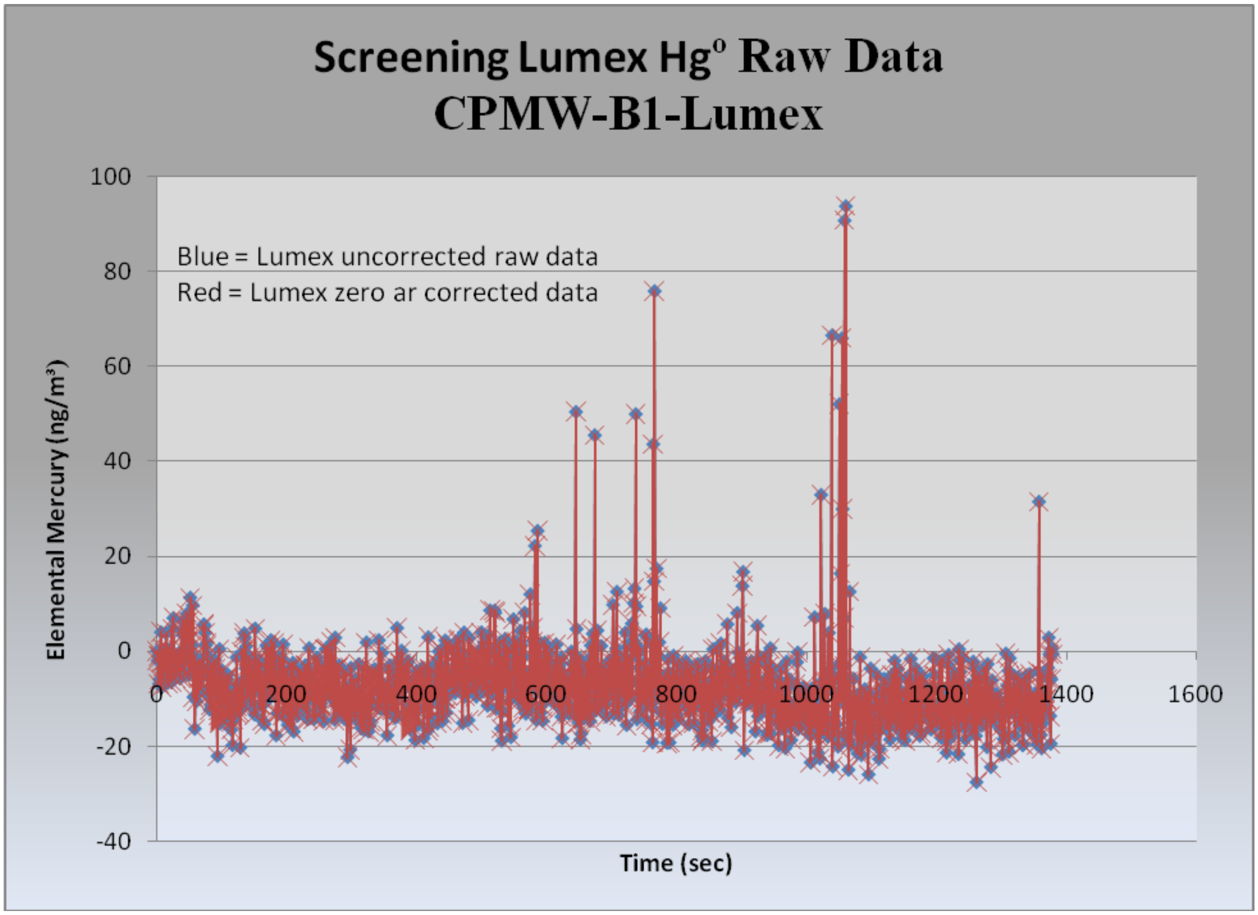
CPMW-A2-Lumex
20
15
10
5
0
-5
-10
-15
-20
-25
0
200
400
600
800
1000
1200
1400
Elemental Mercury (ng/m³)
Time (sec)
Blue = Lumex uncorrected raw data
Red = Lumex zero air corrected data



Screening Lumex Hg° Raw Data
CPMW-B1-Lumex
Blue = Lumex uncorrected raw data
Red = Lumex zero ar corrected data
Elemental Mercury (ng/m³)
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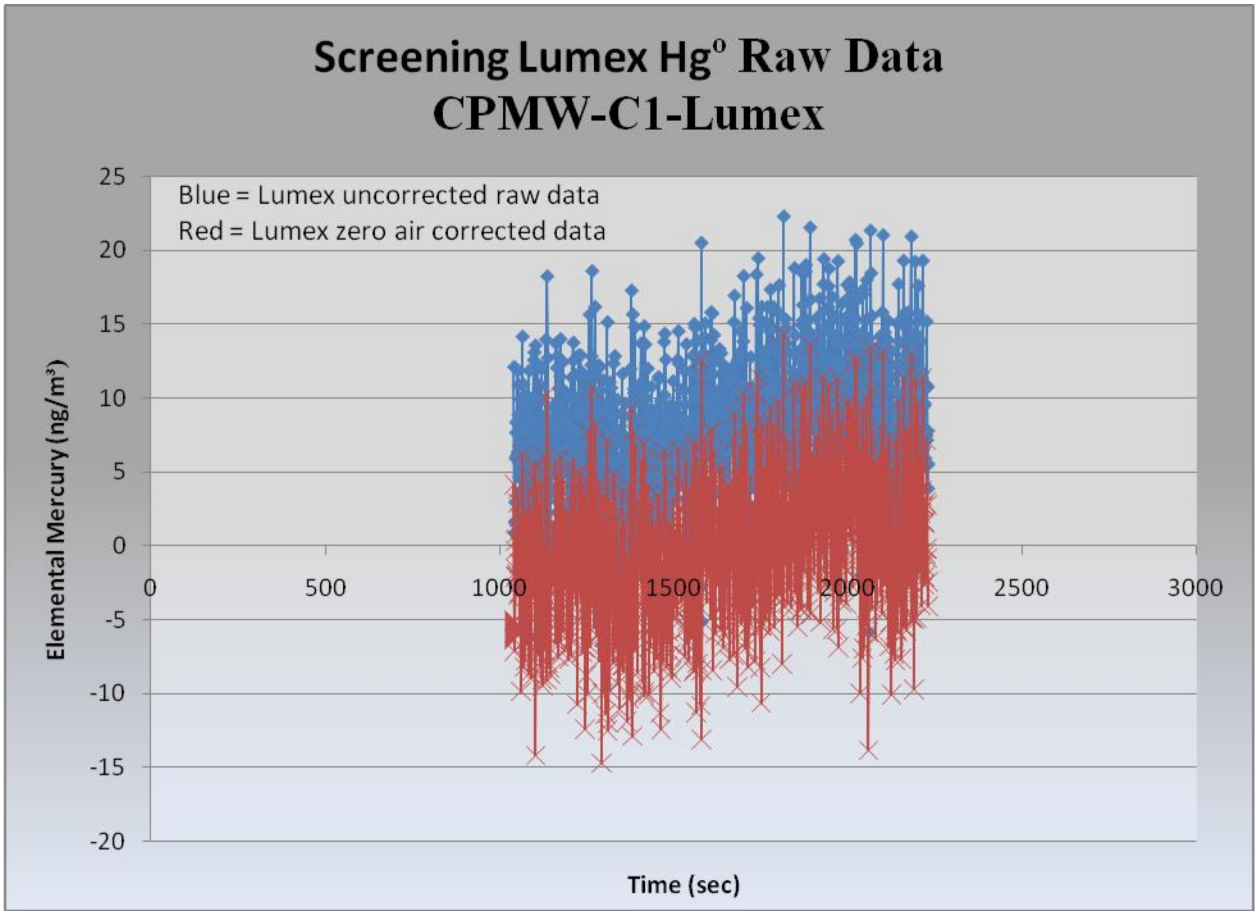
80
60
40
20
0
-20
-40
0
200
400
600
800
1000
1200
1400
1600
Time (sec)


Screening Lumex Hg^{o} Raw Data
CPMW-C1-Lumex
Blue = Lumex uncorrected raw data
Red = Lumex zero air corrected data
Elemental Mercury (ng/m³)
Time (sec)
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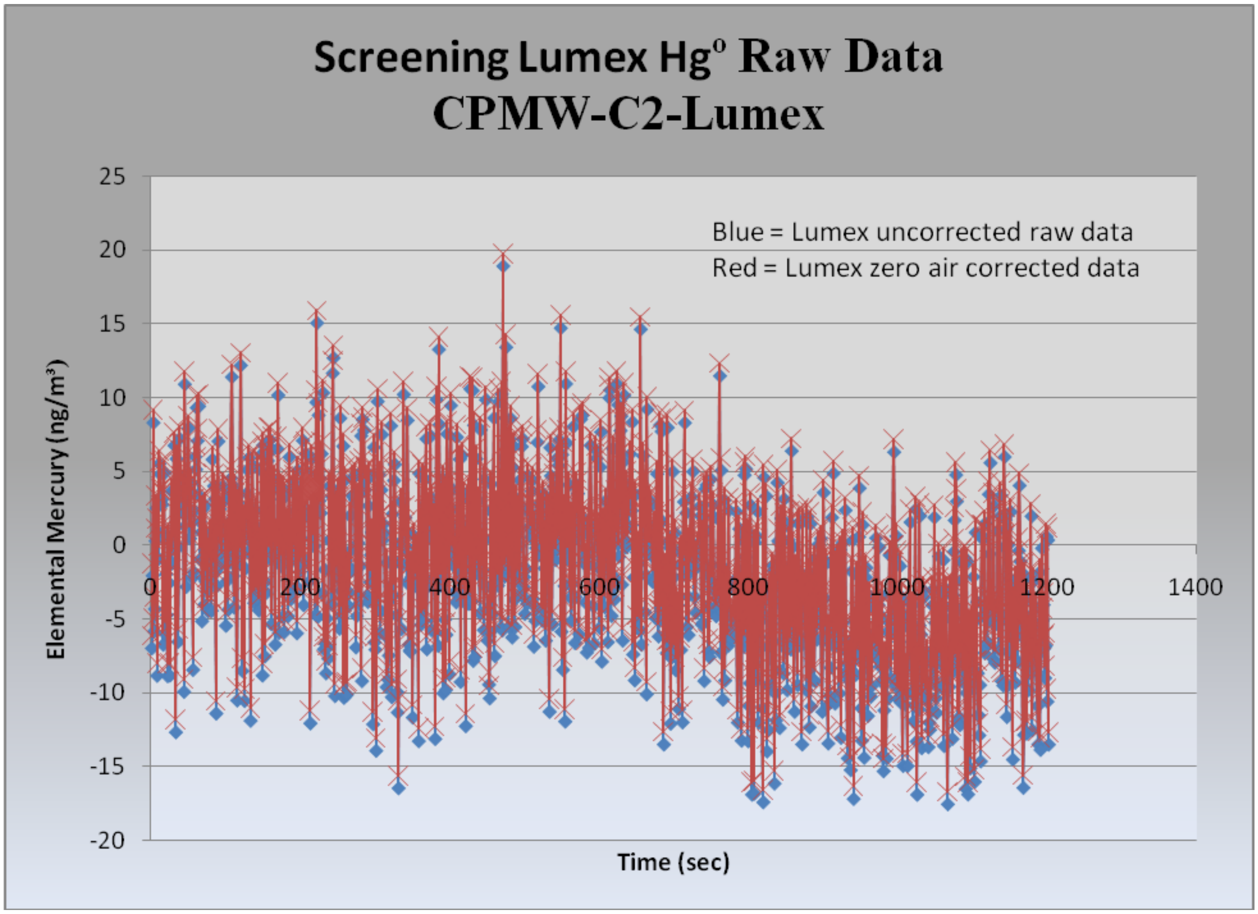
20
15
10
5
0
-5
-10
-15
-20
0
500
1000
1500
2000
2500
3000


Screening Lumex Hg° Raw Data
CPMW-C2-Lumex
Blue = Lumex uncorrected raw data
Red = Lumex zero air corrected data
Elemental Mercury (ng/m³)
Time (sec)
25
20
15
10
5
0
-5
-10
-15
-20
0
200
400
600
800
1000
1200
1400

Long Term Sampling Results

Description Of Long-Term Sampling Approach: After the real-time / Modified EPA 30B short term screening was performed, each site was then prepared to take a Long Term (~ 20 hour sample) using a Modified US EPA Method 30B mercury sorbent trap.

TABLE 1 - Total Gaseous Hg Summary

Sample Type	Sample ID	Start Time	End Time	Minutes Sampled	Flow Rate	Sample Volume	Corrected Total Hg (µg/m³)
Short Term Samples (Mercury Sorbent Trap Method + Lumex)	A1-VL FSTM A	9/26/13 11:08	9/26/13 11:28	20	NA (Mass Flow Totalizer)	10.7	**0.04**
	A2-VL FSTM A	9/26/13 9:25	9/26/13 9:45	20	NA (Mass Flow Totalizer)	10.8	**0.05**
	B1-VL FSTM A	9/26/13 8:30	9/26/13 8:50	20	NA (Mass Flow Totalizer)	10.4	**0.03**
	C1-VL FSTM A	9/25/13 18:10	9/25/13 18:30	20	NA (Mass Flow Totalizer)	10.0	**0.03**
	C2-VL FSTM A	9/26/13 10:15	9/26/13 10:35	20	NA (Mass Flow Totalizer)	10.5	**0.05**
	01-VL FSTM A	9/26/13 11:49	9/26/13 12:09	20	NA (Mass Flow Totalizer)	10.5	**0.06**
	02-VL FSTM A	9/26/13 14:14	9/26/13 14:34	20	NA (Mass Flow Totalizer)	10.4	**0.08**
	03-VL FSTM A	9/26/13 13:32	9/26/13 13:52	20	NA (Mass Flow Totalizer)	10.0	**0.16**
	06-VL FSTM A	9/26/13 12:41	9/26/13 13:01	20	NA (Mass Flow Totalizer)	10.2	**402.47**
24 Hour Samples (Mercury Sorbent Trap Method)	A1-V24 FSTM A	9/26/13 11:31	9/27/13 9:55	1344	0.204	275	**0.00**
	A2-V24 FSTM A	9/26/13 9:50	9/27/13 9:46	1436	0.204	293	**0.00**
	B1-V24 FSTM A	9/26/13 8:56	9/27/13 9:23	1467	0.205	301	**0.00**
	C1-V24 FSTM A	9/25/13 18:39	9/26/13 15:01	1222	0.208	254	**0.00**
	C2-V24 FSTM A	9/26/13 10:46	9/27/13 9:26	1360	0.207	282	**0.00**
	01-V24 FSTM A	9/26/13 12:15	9/27/13 10:07	1312	0.206	270	**0.00**
	02-V24 FSTM A	9/26/13 14:39	9/27/13 10:28	1189	0.222	264	**0.02**
	03-V24 FSTM A	9/26/13 13:56	9/27/13 10:26	1230	0.206	253	**0.04**
	06-V24 FSTM A	9/26/13 13:10	9/27/13 10:15	1265	0.210	266	**333.82**
Field Blank	06-VFB FSTM A						**NA**

TABLE 2: A Trap Hg Results and Trap Summary- FSTM Method

Sample Type	Lab Data Set ID	Lab Run #	Sample ID	FSTM A Hg (ng/trap)	FSTM B Hg (ng/trap)	Total (A + B Trap) (ng /trap)	Sample Volume (Liters)	Total Hg (µg/m³)	Corrected Total Hg (µg/m³)
Short Term Samples	THG16-090929-1	19	A1-VL FSTM A	0.196 ng	0.26	0.45	10.7	**0.04**	**0.04**
	THG16-090929-1	22	A2-VL FSTM A	0.297 ng	0.24	0.54	10.8	**0.05**	**0.05**
	THG16-090929-1	23	B1-VL FSTM A	0.173 ng	0.17	0.35	10.4	**0.03**	**0.03**
	THG16-090929-1	24	C1-VL FSTM A	0.199 ng	0.11	0.30	10.0	**0.03**	**0.03**
	THG16-090929-1	25	C2-VL FSTM A	0.354 ng	0.22	0.58	10.5	**0.05**	**0.05**
	THG16-090929-1	26	01-VL FSTM A	0.250 ng	0.37	0.62	10.5	**0.06**	**0.06**
	THG16-090929-1	27	02-VL FSTM A	0.718 ng	0.11	0.82	10.4	**0.08**	**0.08**
	THG16-090929-1	28	03-VL FSTM A	1.395 ng	0.16	1.55	10.0	**0.16**	**0.16**
	THG16-090929-1	29	06-VL FSTM A	4103.159 ng	1.99	4105.15	10.2	**402.47**	**402.47**
24 Hour Samples	THG17-090929-1	26491	A1-V24 FSTM A	0.322 ng	0.16	0.48	287.616	**0.00**	**0.00**
	THG17-090929-1	26492	A2-V24 FSTM A	0.484 ng	0.35	0.84	307.304	**0.00**	**0.00**
	THG17-090929-1	26493	B1-V24 FSTM A	0.376 ng	0.31	0.69	313.938	**0.00**	**0.00**
	THG17-090929-1	26494	C1-V24 FSTM A	0.177 ng	0.82	0.99	261.508	**0.00**	**0.00**
	THG17-090929-1	26495	C2-V24 FSTM A	0.408 ng	0.23	0.64	291.040	**0.00**	**0.00**
	THG17-090929-1	26498	01-V24 FSTM A	0.340 ng	0.32	0.66	280.768	**0.00**	**0.00**
	THG17-090929-1	26499	02-V24 FSTM A	4.684 ng	0.13	4.82	254.446	**0.02**	**0.00**
	THG17-090929-1	26500	03-V24 FSTM A	10.901 ng	0.24	11.14	263.220	**0.04**	**0.00**
	THG17-090929-1	26489	06-V24 FSTM A	92011.574 ng	3.52	92015.10	270.710	**339.90**	**0.00**
Field Blank	THG17-090929-1	26490	06-VFB FSTM A	0.376 ng	0.38	0.76	NA		

TABLE 3: B Trap Hg Results - FSTM Method

Sample Type	Lab Data Set ID	Lab Run #	Sample ID	FSTM B (ng/trap)
Short Term Samples	THG16-090929-1	30	A1-VL FSTM B	0.257 ng
	THG16-090929-1	31	A2-VL FSTM B	0.240 ng
	THG16-090929-1	34	B1-VL FSTM B	0.173 ng
	THG16-090929-1	35	C1-VL FSTM B	0.105 ng
	THG16-090929-1	36	C2-VL FSTM B	0.223 ng
	THG16-090929-1	37	01-VL FSTM B	0.375 ng
	THG16-090929-1	38	02-VL FSTM B	0.105 ng
	THG16-090929-1	42	03-VL FSTM B	0.156 ng
	THG16-090929-1	43	06-VL FSTM B	1.990 ng
24 Hour Samples	THG17-090929-1	26501	A1-V24 FSTM B	0.162 ng
	THG17-090929-1	26502	A2-V24 FSTM B	0.355 ng
	THG17-090929-1	26506	B1-V24 FSTM B	0.312 ng
	THG17-090929-1	26507	C1-V24 FSTM B	0.818 ng
	THG17-090929-1	26510	C2-V24 FSTM B	0.229 ng
	THG17-090929-1	26512	01-V24 FSTM B	0.321 ng
	THG17-090929-1	26513	02-V24 FSTM B	0.133 ng
	THG17-090929-1	26514	03-V24 FSTM B	0.236 ng
	THG17-090929-1	26517	06-V24 FSTM B	3.521 ng
Field Blank	THG17-090929-1	26515	06-VFB FSTM B	0.380 ng

TABLE 4: Analysis QA/QC Performance Summary - Initial Calibration Verification Results (Secondary Standard)

Lab Data Set ID	Lab Run #	QC Parameter	Observed Value	True Value	SRM % Recovery	QA/QC Range
THG16-090929-1	08	ICV	13.5 ng/L	15.0 ng/L	**89.9%**	**80%-120%**
THG17-090929-1	26472	ICV	15.1 ng/L	15.0 ng/L	**100.9%**	**80%-120%**

TABLE 5: Initial and Continued Calibration Blanks (ICB and CCBs)

Lab Data Set ID	Lab Run #	CCB ID	ICB/CCB (ng Hg/Blank)	QA/QC Acceptance
THG16-090929-1	09	ICB	0.017 ng/L	< **0.50**
THG16-090929-1	21	CCB1	0.013 ng/L	< **0.50**
THG16-090929-1	33	CCB2	0.055 ng/L	< **0.50**
THG16-090929-1	45	CCB3	0.013 ng/L	< **0.50**
THG17-090929-1	26473	ICB	0.032 ng/L	< **0.50**
THG17-090929-1	26485	CCB1	0.024 ng/L	< **0.50**
THG17-090929-1	26497	CCB2	0.029 ng/L	< **0.50**
THG17-090929-1	26509	CCB3	0.025 ng/L	< **0.50**
THG17-090929-1	26519	CCB4	0.022 ng/L	< **0.50**

TABLE 6: Continued Calibration Verification (Secondary Standard)

Lab Data Set ID	Lab Run #	CCV ID	Measured	True Value	% Rec.	QA/QC Acceptance
THG16-090929-1	20	CCV1	19.4 ng/L	20.0 ng/L	**97.1%**	**80%-120%**
THG16-090929-1	32	CCV2	18.5 ng/L	20.0 ng/L	**92.5%**	**80%-120%**
THG16-090929-1	44	CCV3	19.8 ng/L	20.0 ng/L	**98.8%**	**80%-120%**
THG17-090929-1	26484	CCV1	20.0 ng/L	20.0 ng/L	**99.8%**	**80%-120%**
THG17-090929-1	26496	CCV2	20.6 ng/L	20.0 ng/L	**103.0%**	**80%-120%**
THG17-090929-1	26508	CCV3	20.8 ng/L	20.0 ng/L	**104.1%**	**80%-120%**
THG17-090929-1	26518	CCV4	20.7 ng/L	20.0 ng/L	**103.3%**	**80%-120%**
				Average	**99.8%**	**80%-120%**

TABLE 7: Reagent Blank - FSTM Method

Lab Data Set ID	Lab Run #	Sample ID	ng
THG16-090929-1	10	PB1	0.072 ng
THG16-090929-1	11	PB2	-0.029 ng
THG16-090929-1	12	PB3	-0.013 ng
THG17-090929-1	26474	PB1	0.171 ng
THG17-090929-1	26475	PB2	0.016 ng
THG17-090929-1	26476	PB3	0.003 ng
		Average >	**0.04**
		Standard Deviation (SD) >	**0.07**
		Relative Standard Deviation (RSD) >	**203.1%**

TABLE 8: Frontier Geosciences Lab Control Spike Recovery

Lab Data Set ID	Lab Run #	Lab Sample ID	Measured (ng/trap)	Expected (ng/Trap)	% Recovery	QA/QC Range
THG16-090929-1	13	BS1+100ng	87.0 ng	100 ng	**87.0%**	**75%-125%**
THG16-090929-1	14	BSD1+100ng	95.5 ng	100 ng	**95.5%**	**75%-125%**
THG17-090929-1	26477	BS1+100ng	98.6 ng	100 ng	**98.6%**	**75%-125%**
THG17-090929-1	26478	BSD1+100ng	103 ng	100 ng	**102.7%**	**75%-125%**

TABLE 9: Frontier Geosciences Analytical Spike Recovery

Lab Data Set ID	Lab Run #	Lab Sample ID	Measured (ng/trap)	Net Measured (ng/Trap)	Expected (ng/Trap)	% Recovery	QA/QC Range	RPD
THG16-090929-1	40	06-VL FSTM A AS+20,000ng	21497 ng	17521	20000	**87.6%**	**75%-125%**	
THG16-090929-1	41	06-VL FSTM A ASD+20,000ng	23348 ng	19373	20000	**96.9%**	**75%-125%**	**8.26%**
THG17-090929-1	26504	06-V24 FSTM A AS+400,000ng	501532 ng	404291	400000	**101.1%**	**75%-125%**	
THG17-090929-1	26505	06-V24 FSTM A ASD+400,000ng	490840 ng	393599	400000	**98.4%**	**75%-125%**	**2.15%**

TABLE 10: Lab Replicate Results

Lab Data Set ID	Lab Run #	Sample ID	Replicate#1 (ng/Trap)	Replicate#2 (ng/Trap)	RPD	QA/QC Range
THG16-090929-1	39	06-VL FSTM A AD	3847 ng	4103 ng	**6.4%**	**0% - 25% RPD**
THG17-090929-1	26503	06-V24 FSTM A AD	102471 ng	92012 ng	**10.8%**	**0% - 25% RPD**

TABLE 11: Field Blank Spike Recovery

Lab Data Set ID	Lab Run #	Lab Sample ID	Measured (ng/trap)	Expected (ng/Trap)	% Recovery	QA/QC Range
THg16-091228-2	41	NNP2093 FSTM A+30ng	28.7 ng	30.0 ng	**95.8%**	**75%-125%**
THg16-091228-2	42	NNP2095 FSTM A+30ng	28.3 ng	30.0 ng	**94.2%**	**75%-125%**

Volume Corrections

Approach for Low Flow Sampling and Critical Orifice Calibration: Frontier used low-flow critical orifices to perform the long term (~ 20 hour) sampling. This low-flow sampling approach was important for this type of sampling, due to the small diameter sampling well pipe and relatively small volume air column to sample from. If the flow rate was too high (fast) the air column of the sampling well would be evacuated and lead to the possibility of air being pulled from the outside (ambient air) down into the surrounding well overpack. This was prevented by using very low flow critical orifices.

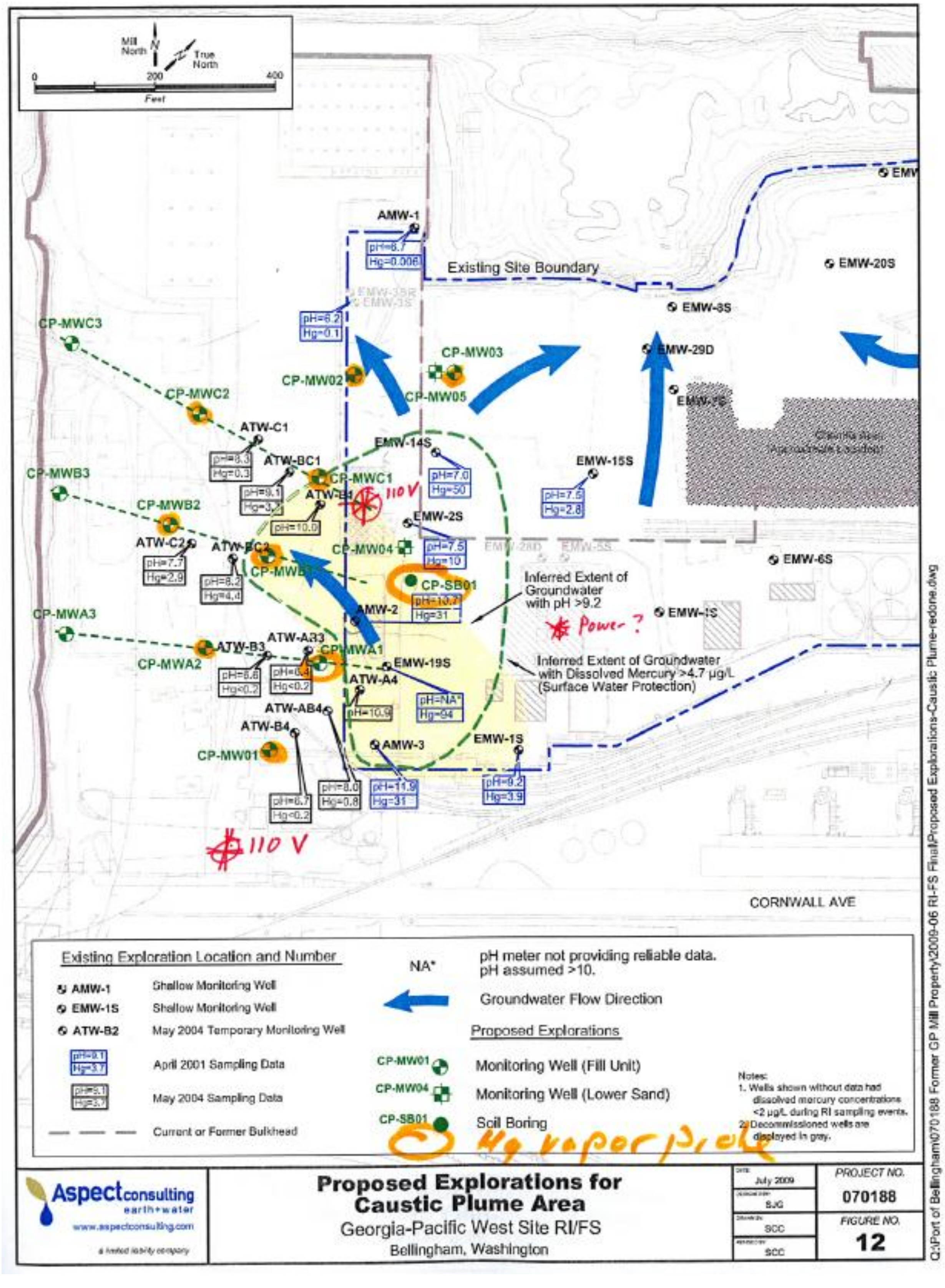
Critical Orifice Calibration: After the sampling event each critical orifice and sampling pump system was checked for flow rate verification using a NIST Traceable flow calibration system (Gilian® Gilibrator 2 with a standard flow bubbler generator, serial number 904-172-5, calibration date 12/06/06). The flow rate was tested ten times for each critical orifice and the mean of these readings was used as the true flow rate allowed by the critical orifice. This value was then used to calculate the total volume of gas pulled through each sorbent trap.

Critical Orifice Calibration Check Vs. NIST Tracable Flow Meter (24 Hour Sampling)

(Critical Orifice Fixed @ 0.214 lpm Vs. Actual flow NIST Standard)

Site ID/Pump Label	C1 V24/CPMC IV	A1 V24/CPWM AI-V	01 V24/CPMW 01V	02 V24/CPMW-O2V	03 V24/CPMW-03V	A2 V24/FGS0002040	06 V24/CPMW 06V	C2 V24/CPMWC-2	B1 V24/CPMW BIV
Rep #1	0.2099	0.2045	0.2055	0.2233	0.2061	0.2040	0.2100	0.2076	0.2054
Rep #2	0.2081	0.2042	0.2055	0.2230	0.2056	0.2042	0.2104	0.2070	0.2049
Rep #3	0.2080	0.2046	0.2056	0.2229	0.2062	0.2042	0.2125	0.2068	0.2049
Rep #4	0.2080	0.2043	0.2054	0.2222	0.2063	0.2043	0.2102	0.2076	0.2049
Rep #5	0.2078	0.2043	0.2054	0.2228	0.2062	0.2044	0.2096	0.2073	0.2049
Rep #6	0.2080	0.2043	0.2059	0.2221	0.2065	0.2046	0.2103	0.2074	0.2048
Rep #7	0.2080	0.2045	0.2062	0.2221	0.2048	0.2033	0.2098	0.2074	0.2049
Rep #8	0.2081	0.2046	0.2059	0.2218	0.2056	0.2032	0.2090	0.2073	0.2047
Rep #9	0.2076	0.2049	0.2061	0.2223	0.2065	0.2043	0.2097	0.2073	0.2047
Rep #10	0.2081	0.2045	0.2061	0.2218	0.2066	0.2042	0.2102	0.2071	0.2048
Average (lpm)	**0.2082**	**0.2045**	**0.2058**	**0.2224**	**0.2060**	**0.2041**	**0.2102**	**0.2073**	**0.2049**
Std Dev (lpm)	0.0006	0.0002	0.0003	0.0005	0.0006	0.0005	0.0009	0.0003	0.0002
Correction Factor	97.3%	95.5%	96.1%	103.9%	96.3%	95.4%	98.2%	96.9%	95.7%

Study Location


Mill North
True North
0
200
400
Feet
Existing Site Boundary
AMW-1
pH=6.7
Hg=0.006
pH=6.2
Hg=0.1
CP-MWC3
CP-MWC2
CP-MW02
CP-MW03
CP-MW05
EMW-20S
EMW-3S
EMW-29D
ATW-C1
pH=8.3
Hg=0.3
ATW-BC1
pH=9.1
CP-MWC1
CP-MWB3
CP-MWB2
110V
EMW-14S
pH=7.0
Hg=50
EMW-15S
pH=7.5
Hg=2.8
pH=10.0
EMW-2S
pH=7.5
Hg=10
ATW-C2
pH=7.7
Hg=2.9
pH=8.2
Hg=4.4
CP-MW04
CP-SB01
pH=10.7
Hg=31
EMW-6S
Inferred Extent of Groundwater with pH >9.2
CP-MWA3
AMW-2
Power-?
ATW-AB3
ATW-B3
CP-MWA1
CP-MWA2
pH=6.8
Hg<0.2
Hg<0.2
EMW-19S
ATW-A4
pH=NA*
Hg=94
Inferred Extent of Groundwater with Dissolved Mercury >4.7 µg/L (Surface Water Protection)
ATW-AB4
pH=10.9
ATW-B4
AMW-3
EMW-1S
CP-MW01
pH=8.0
Hg=0.8
pH=11.9
Hg=31
pH=9.2
Hg=3.9
pH=6.7
Hg<0.2
110 V
CORNWALL AVE
Existing Exploration Location and Number
AMW-1 Shallow Monitoring Well
EMW-1S Shallow Monitoring Well
ATW-B2 May 2004 Temporary Monitoring Well
pH=9.1 Hg=3.7 April 2001 Sampling Data
pH=9.1 Hg=3.7 May 2004 Sampling Data
Current or Former Bulkhead
NA* pH meter not providing reliable data. pH assumed >10.
Groundwater Flow Direction
Proposed Explorations
CP-MW01 Monitoring Well (Fill Unit)
CP-MW04 Monitoring Well (Lower Sand)
CP-SB01 Soil Boring
Hg vapor probe
Notes:
1. Wells shown without data had dissolved mercury concentrations <2 µg/L during RI sampling events.
2. Decommissioned wells are displayed in gray.
Aspect consulting earth+water
www.aspectconsulting.com
a limited liability company
Proposed Explorations for Caustic Plume Area
Georgia-Pacific West Site RI/FS
Bellingham, Washington
July 2009
SJG
SCC
SCC
PROJECT NO. 070188
FIGURE NO. 12
Q:\Port of Bellingham\070188 Former GP Mill Property\2009-06 RI-FS Final\Proposed Explorations-Caustic Plume-redone.dwg

Sample Field Forms

Frontier GeoSciences Inc.
414 Pontius Ave N. • Seattle WA 98109
(206) 622-6960 • fax: (206) 622-6870
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Field Sample Data Sheet

Sample Date: 9/25/09

Sample Box ID: ________

24 hrs

Sample Location: CPMW-A1-V

Sample Matrix: Soil Gas

Pre-Sample Leak Check: 22" Hg ~~(slpm)~~ Good.

Post-Sample Leak Check: 23 Hg ~~(slpm)~~ good

Sample Trap ID: CPMW-A1-V-24hr

		Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
9/25	1	11:31 AM	—	0.214	—	—	0
9/26	2	09:55 AM	—	0.214	—	—	0
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						

Notes: 9/25 pre — Leak check: 22" Hg Vac
9/26/post leak check: 23 Hg Vac

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp ________

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PLANT Port of Bellinghan
DATE 9/25 RUN NO. ___
STACK DIA. OR DIMENSIONS, m (in.) ___
BAROMETRIC PRESS., mm Hg (in. Hg) ___
CROSS SECTIONAL AREA, m^2 (ft^2) ___
OPERATORS ___
PITOT TUBE I.D. NO. ___
AVG. COEFFICIENT, Cp = ___
LAST DATE CALIBRATED ___
SCHEMATIC OF STACK

CPMW-A2-V
24hr

CROSS SECTION

	Time ~~Traverse Pt. No.~~	Flow ~~Vel. Hd., Δp~~ mm (in.) H_2O	Stack Temperature T_s, °C (°F)	T_s, °K (°R)	Vacuum ~~Pg~~ mm Hg (in. Hg)	~~(Δp)~~$^{1/2}$ Volume Liters
09/25	9:50	0.214	—	—	28	0
09/26	9:46AM		—	—	28	
			Average			

09/25 leak check: 21" Hg Vacuum = OK
09/26 post leak ck: 28" Hg Vac = OK

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PLANT Port of Bellingham
DATE 9/25/09 RUN NO. ______
STACK DIA. OR DIMENSIONS, m (in.) ____
BAROMETRIC PRESS., mm Hg (in. Hg) ____
CROSS SECTIONAL AREA, m^2 (ft^2) ______
OPERATORS ______
PITOT TUBE I.D. NO. ______
AVG. COEFFICIENT, Cp = ______
LAST DATE CALIBRATED ______
SCHEMATIC OF STACK

CPMWB1-V
24hr

12 1/2" down from inlet.

CROSS SECTION

Time ~~Traverse Pt. No.~~	Flow ~~Vel. Hd., Δp~~ mm ~~(in.)~~ H_2O	Stack Temperature T_s, °C (°F)	T_s, °K (°R)	~~P_g~~ mm Hg (in.Hg)	~~(Δp)^{1/2}~~ Liters
09-26-09 8:56 Am	0.214			22	0
~~9:18 Am~~ OFF 09:23 Am	0.214			22.8	OFF
		Average			

20" Hg Vacuum = leak check = OK

8:56 22" Hg Vacuum during test

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~~PLANT~~ Sample ID

DATE 9/24/09 RUN NO. ______

STACK DIA. OR DIMENSIONS, m (in.) ______

BAROMETRIC PRESS., mm Hg (in. Hg) ______

CROSS SECTIONAL AREA, m^2 (ft^2) ______

OPERATORS ______

PITOT TUBE I.D. NO. ______

AVG. COEFFICIENT, Cp = ______

LAST DATE CALIBRATED ______

SCHEMATIC OF STACK

CPMW-C1-

24 hrs

Vacuum : 27" Hg

CROSS SECTION

~~Traverse Pt. No.~~ Time	Vel. Hd., ~~Δp mm (in.) H_2O~~	Stack Temperature T_s, °C (°F)	T_s, °K (°R)	Vacuum ~~P_g~~ mm Hg (in.Hg)	$(\Delta p)^{1/2}$
6:35 pm		0.214			
Start 9/24 6:39 PM		0.214			⊖
9/25 8:46 AM				26	
9/25 15:01		0.214		22	
Average					

8:46 am. 26" Hg vacuum.

9/25. 15:01 22" Hg vacuum.

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PLANT Port of Bellingham

DATE 9/25/09 RUN NO. ______

STACK DIA. OR DIMENSIONS, m (in.) ______

BAROMETRIC PRESS., mm Hg (in. Hg) ______

CROSS SECTIONAL AREA, m^2 (ft^2) ______

OPERATORS ______

PITOT TUBE I.D. NO. ______

AVG. COEFFICIENT, Cp = ______

LAST DATE CALIBRATED ______

SCHEMATIC OF STACK

CPMW-C2-V

24 hr.

CROSS SECTION

	~~Traverse Pt. No.~~ Time	~~Vel. Hd., Δp~~ Flow mm (in.) ~~H_2O~~	Stack Temperature T_s, °C (°F)	T_s, °K (°R)	~~P_g~~ Vacuum mm Hg (in. Hg)	~~$(\Delta p)^{1/2}$~~ Volume (L)
9/25/09	10:46 AM	0.214	/	/	22	0
09/26/09	09:26 AM	0.214	/	/	23	
			Average			

09/25 Pre - leak check : Vacuum 21" Hg /w critical orifice = OK

09/26 Post leak check : Vacuum 22 Hg /w " " = OK

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Field Sample Data Sheet

Sample Date: 9/25/09

Sample Box ID: ______

24 hr

Sample Location: CPMW-01-V

Sample Matrix: Soil Gas

Pre-Sample Leak Check: OK 22" Hg VAC (slpm)

Post-Sample Leak Check: OK 23.5" Hg VAC (slpm)

Sample Trap ID: CPMW-01-V-24

		Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
09/25	1	12:15 pm	—	0.214	—	—	0
09/26	2	10:10	—	0.214	—	—	
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						

Notes:

Stack Gas Parameters

% M ______

% O2 ______ (wet or dry)

%CO2 ______ (wet or dry)

Barometric Pressure ______

Temp ______

09/25 pre Vacuum = 22" Hg

09/26 post VAC = 23.5" Hg

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Field Sample Data Sheet

Sample Date: 9/25/09

Sample ~~Box~~ ID: 24 HR

Sample Location: CPMW-02-V

Sample Matrix: Soil Gas

Pre-Sample Leak Check: ~~0.105~~ (~~slpm~~) 21" Hg Vac good

Post-Sample Leak Check: ______ (~~slpm~~)

Sample Trap ID: CPMW-02-V-24HR

		Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
09/25	1	14:39 pm	—	0.214	—	—	0
09/26	2	10:28 Am	—	0.214	—	—	
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						

Notes:

09/25 pre - Vacuum: 21.5" Hg

09/26 post vac: 25" Hg

~~Stack Gas Parameters~~

~~% M ______~~

~~% O2 ______ (wet or dry)~~

~~%CO2 ______ (wet or dry)~~

~~Barometric Pressure ______~~

~~Temp ______~~

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Field Sample Data Sheet

Sample Date: 9/25/09

Sample Box ID: ________

24 HR

Sample Location: CPMW-03-V

Sample Matrix: Soil Gas

~~**Pre-Sample Leak Check:** ________ (slpm)~~

Post-~~Sample~~ Leak Check: ________ (slpm)

Sample Trap ID: CPMW-03-V-24hrs

		Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
09/25	1	13:56 pm	—	0.214	—	—	0
09/26	2	10:26 Am		0.214	—	—	
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ________

Temp ________

09/25 pre Vacuum: 21" Hg

09/26/ Vac post: 24" Hg

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Field Sample Data Sheet

Sample Date: 9/25/09 **Sample Box ID:** ______

Sample Location: CPMW-06-V

Sample Matrix: Soil Gas (21" Hg) 24 hr

Pre-Sample Leak Check: Good (slpm)

Post-Sample Leak Check: Good (21" Hg) (slpm)

Sample Trap ID: CPMW-06-V-24hr

		Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
09/25	1	13:10	0.214	—	—	—	0
09/26	2	10:15	0.24	—	—	—	
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						

Notes:

Stack Gas Parameters
% M ______
% O2 ______ (wet or dry)
%CO2 ______ (wet or dry)
Barometric Pressure ______
Temp ______

09/25 pre Vacuum 21" Hg
09/26 post " 21" Hg

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Field Sample Data Sheet

Sample Date: 9/25/09 **Sample Box ID:** ________

Sample Location: CPMW-06-V

Sample Matrix: Soil Gas

Pre-Sample Leak Check: -0.076 (slpm) OK

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPMW-06-V-FB

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp __________

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Field Sample Data Sheet

Sample Date: 9/25/09 **Sample Box ID:** ________

Sample Location: CQMW- A1-V - Lumex

Sample Matrix: Soil Gas

Pre-Sample Leak Check: -0.089 (slpm)

Post-Sample Leak Check: -0.076 (slpm)

Sample Trap ID: CQMW- A1-V Lumex

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	11:08	-0.089	.514			0
2	11:14		0.542			3.3
3	11:22		0.555			8.0
4	11:28	-0.103	0.548			10.7
5						
6						
7						
8						
9						
10						

Notes:

Zero : -0.099 -
Leak - Pre -0.084

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ________

Temp ________

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PLANT Port of Bellingham

DATE 9/25 RUN NO. ____

STACK DIA. OR DIMENSIONS, m (in.) ____

BAROMETRIC PRESS., mm Hg (in. Hg) ____

CROSS SECTIONAL AREA, m^2 (ft^2) ____

OPERATORS ____

PITOT TUBE I.D. NO. ____

AVG. COEFFICIENT, Cp = ____

LAST DATE CALIBRATED ____

SCHEMATIC OF STACK

CPMW-A2-V
Lumex

CROSS SECTION

Time ~~Traverse Pt. No.~~	Flow ~~Vel. Hd.,~~ Δp ~~mm (in.)~~ H_2O	Zero offset ~~Stack Temperature~~ ~~T_{s},~~ ~~°C~~ (°F)	T_s, °K (°R)	Vacuum ~~Pg~~ mm Hg (in.Hg)	Vol ~~(Δp)$^{1/2}$~~ Liters
9:25	0.510	-0.085			~~0~~
9:27	0.731				3.0 * adjusted flow
9:35	0.515				5.5
9:45	0.510	-0.110			10.8
			Average		

Pre - leak check : -0.086 OK.
Post - leak check : -0.075 ok
B-TRAP - seperated.
320 / 345 Base line check

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Last 2 min zero

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PLANT ____________________

DATE __________ RUN NO. __________

STACK DIA. OR DIMENSIONS, m (in.) ____

BAROMETRIC PRESS., mm Hg (in. Hg) ____

CROSS SECTIONAL AREA, m^2 (ft^2) ________

OPERATORS ____________________

PITOT TUBE I.D. NO. __________

AVG. COEFFICIENT, Cp = __________

LAST DATE CALIBRATED __________

SCHEMATIC OF STACK

CPMWB1-4

Lumex

9/25/09

Flow CROSS SECTION Volume

~~Traverse Pt. No.~~ Time	~~Vel. Hd., Δp~~ mm (in.) H_2O	Zero Offset Stack Temperature ~~T_s~~, ~~°C~~ (°F)	~~T_s~~, °K (°R)	P_g mm Hg (in.Hg)	~~(Δp)$^{1/2}$~~ Liters
8:30	.543				Ø
8:38	.525				4.4
8:44	.523				7.3
8:50	.523	-0.099			10.4
		Average			

Zero: ~~240~~ 100 fth

1300 second pump off

206-337-1764 phil

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Field Sample Data Sheet

Sample Date: 9/24

Sample Box ID: ________

Sample Location: CPMW-C1-V

Lumex
Real time

Sample Matrix: ________

Pre-Sample Leak Check: ________ (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPMW-C1-V-

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	6:10		0.5		NA	0
2	6:30		0.5			10 L
3						
4						
5						
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

6:30 to 635 zero air

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ________

Temp ________

1040 second start of sample

2230 zero air

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PLANT Port of Bellingham

DATE 9/25/09 RUN NO. ______

STACK DIA. OR DIMENSIONS, m (in.) ______

BAROMETRIC PRESS., mm Hg (in. Hg) ______

CROSS SECTIONAL AREA, m^2 (ft^2) ______

OPERATORS ______

PITOT TUBE I.D. NO. ______

AVG. COEFFICIENT, Cp = ______

LAST DATE CALIBRATED ______

SCHEMATIC OF STACK

CPMW-C2-V
Lumex

CROSS SECTION

Time ~~Traverse Pt.~~ No.	Flow ~~Vel. Hd., Δp~~ mm ~~(in.) H_2O~~	Zero offset ~~Stack Temperature~~ ~~T_s~~ °C (°F)	T_s, °K (°R)	P_g mm Hg (in. Hg)	~~$(\Delta p)^{1/2}$~~ Vol (Liters)
10:15	0.515	-0.084			0
10:20	0.568				2.8
10:25	0.517				5.4
10:30	0.520				8.2
10:35	0.522	-0.108			10.5
		Average			

Pre - Leak check: -0.071 = Good.

Post - Leak check: -0.79 = Good

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Field Sample Data Sheet

Sample Date: 9/25/09 **Sample Box ID:** ________

Sample Location: CPMW-01-V

Sample Matrix: Soil Gas

Pre-Sample Leak Check: -0.074 (slpm)

Post-Sample Leak Check: -0.066 (slpm)

Sample Trap ID: CPMW-01-V lumex

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	11:49:30	-0.078	0.542			0
2	11:54		0.542			2.2
3	12:01		0.538			6.3
4	12:09	-0.091	0.536			10.5
5						
6						
7						
8						
9						
10						

Notes: Pre-leak: Zero-offset: -0.091

Stack Gas Parameters
% M ________
% O2 ________ (wet or dry)
%CO2 ________ (wet or dry)
Barometric Pressure ________
Temp ________

2485 pushed cell back.

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Field Sample Data Sheet

Sample Date: 9/25/09 **Sample Box ID:** ________

Sample Location: CPMW-02-V Lumex

Sample Matrix: Soil Gas

Pre-Sample Leak Check: -0.109 (slpm) good

Post-Sample Leak Check: -0.110 (slpm) good

Sample Trap ID: CPMW-02-V-Lumex

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	14:14	-0.106	0.515			0
2	14:19		0.582			2.7
3	14:26		0.502			6.4
4	14:34	-0.128	0.502			10.4
5						
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp ____________

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Field Sample Data Sheet

Sample Date: 5/25/09 **Sample Box ID:** ________

Sample Location: CQMW-03-V- turnex

Sample Matrix: Soil Gas

Pre-Sample Leak Check: -0.073 (slpm)

Post-Sample Leak Check: -0.093 (slpm)

Sample Trap ID: CQMW-03-V- turnex

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	13:32	-0.089	0.524			Ø
2	13:37		0.504			2.8
3	13:42		0.500			5.1
4	13:47		0.496			7.9
5	13:52	-0.103	0.496			10.3
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp __________

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Field Sample Data Sheet

Sample Date: 9/25/09

Sample Box ID: ______ Lumex

Sample Location: CPMW-06-V

Sample Matrix: Soil Gas

Pre-Sample Leak Check: -0.066 (slpm)

Post-Sample Leak Check: -0.082 (slpm)

Sample Trap ID: CPMW-06-V-Lumex

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	12:41	-0.088	0.500			0
2	12:46	79	0.511			2.5
3	12:51		0.515			5.3
4	13:01	-0.092	0.517			10.2 *
5						
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

% M ______

% O2 ______ (wet or dry)

%CO2 ______ (wet or dry)

Barometric Pressure ______

Temp ______

* ~1210 switched to Zero Air.

Sample Digestion Logs

Sample Digestion and Percent Solids Log

Name: Nick
Client Name: Aspect Consulting
Date: 9/28/09
Final volume: 40 mL

Sample Matrix: ☑ FSTM ☐ Waters ☐ KCL ☐ PHg Plug ☐ Coal ☐ Other ____

Analysis: ☑ Total Hg ☐ Methyl Hg ☐ Other ____

Digestion type: ☑ 70/30 Digestion, 2 Hours @ ~55°C ☐ 5% BrCl Oxidation, 4 hours

Digest #	Sample ID Number	Sample Size ☑ml ☐g
	PB 1	40
	2	
	3	
	BS + 100ng	
	BSD + 100ng	
	A1-VL FSTM A	
	B	
	A2-VL A	
	B	
	B1-VL A	
	B	
	C1-VL A	
	B	
	C2-VL A	
	B	
	01-VL A	
	B	
	02-VL A	
	B	
	03-VL A	
	B	
	06-VL A	
	B	

Spike ID: 0900838
Spike Amount: 100 uL
Spike Witness: JS
BrCl ID:
HNO_3:
H2SO4:

Comments:

Sample Digestion and Percent Solids Log

Name: Nick Date: 9/28/09 Final volume: 40mL

Client Name: Aspect Consulting

Sample Matrix: ☑ FSTM ☐ Waters ☐ KCL ☐ PHg Plug ☐ Coal ☐ Other

Analysis: ☑ Total Hg ☐ Methyl Hg ☐ Other

Digestion type: ☑ 70/30 Digestion, 2 Hours @ ~55°C ☐ 5% BrCl Oxidation, 4 hours

Digest #	Sample ID Number	Sample Size ☑ml ☐g
	PB 1	40 mL
	2	
	3	
	BS +100ng	
	BSD +100ng	
	A1 - V24 FSTM A	
	B	
	A2 - V24 A	
	B	
	B1 - V24 A	
	B	
	C1 - V24 A	
	B	
	C2 - V24 A	
	B	
	01 - V24 A	
	B	
	02 - V24 A	
	B	
	03 - V24 A	
	B	
	06 - V24 A	
	B	
	06 - VFB A	
	B	

Spike ID: 0900838

Spike Amount: 100mL

Spike Witness: CR

BrCl ID:

HNO_3:

H2SO4:

Comments:

NIST Certificates of Analytical Standards

HIGH-PURITY STANDARDS
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P.O. Box 41727
Charleston, SC 29423
Phone (843) 767-7900
Fax (843) 767-7906

Mercury Standard 1000 ug/mL

LIMS ID:	0900498
Prep Date:	28-May-09 00:00
Prep By:	Teresa Einhaus
Expire Date:	20-Nov-10 00:00

Verified by JCS 06/04/09

Certificate of Analysis

Product Description:

Name:	Mercury
Part number:	**100033-1**
Lot number:	**0906835**
Source Material:	Mercury Metal
Material Purity:	99.9998%
Matrix:	2% HNO_3

Certified Value: 1000 µg/mL ± 6 µg/mL

The Certified value is based on gravimetric preparation, and verified against SRM 3133 (lot number 061204) developed by National Institute of Standards and Technology (NIST) via inductively coupled plasma optical emission spectrometry (ICP-OES) using an internal laboratory-developed method. The uncertainty in the certified value is calculated for a 95% confidence interval.

Reference Values:

Density: 1.0102 g/mL @ 21.8°C

Trace Metal Impurity Scan via ICP Analysis in µg/L: The typical values detected in the mercury standard solution at 1000 µg/mL are listed below. The values are based upon the analysis results for the starting source material.

Ag	<0.02	Cu	<0.25	La	<0.02	Pt	<0.02	Te	<0.02
Al	<0.1	Dy	<0.02	Li	<0.02	Rb	<0.02	Th	<0.02
As	<0.05	Er	<0.02	Lu	<0.02	Re	<0.02	Ti	<0.02
Au	<0.02	Eu	<0.02	Mg	<0.5	Rh	<0.02	Tl	<0.02
B	<1	Fe	<1	Mn	<0.1	Ru	<0.02	Tm	<0.02
Ba	<0.02	Ga	<0.02	Mo	<0.02	Sb	<0.02	U	<0.1
Be	<0.02	Gd	<0.02	Na	<1	Sc	<0.02	V	<0.05
Bi	<0.02	Ge	<0.02	Nb	<0.02	Se	<0.1	W	<0.02
Ca	<0.1	Hf	<0.02	Nd	<0.02	Si	<1	Y	<0.02
Cd	<0.02	Hg	M	Ni	<0.02	Sm	<0.02	Yb	<0.02
Ce	<0.02	Ho	<0.02	Os	<0.02	Sn	<1	Zn	<0.1
Co	<0.05	In	<0.02	Pb	<0.05	Sr	<0.02	Zr	<0.02
Cr	<0.1	Ir	<0.02	Pd	<0.02	Ta	<0.02		
Cs	<0.02	K	<1	Pr	<0.02	Tb	<0.02		

Preparation Information:

The highest purity source materials were purchased from qualified vendors per ISO 9001:2000 guidelines and assayed by ICP-OES for conformity prior to use. This standard was prepared using methods developed at NIST for the preparation of SRM Spectrometric Standard Solutions. Sub-boiling distilled high-purity acid has been used to place the materials in solution and to stabilize the standard. The matrix is as noted above in 18 megaohm deionized water.

Traceability Information:

The traceability of this standard is maintained through an unbroken chain of comparisons to appropriate standards with suitable procedure and measurement uncertainties.

a. **Analytical Balance Calibration**: All balances are calibrated weekly by an in-house method using NBS weights Inventory No 20231A. The balances are calibrated yearly and the calibration weights are checked biennially by a qualified metrology company with weights traceable to the primary standards developed by NIST.

b. **Volumetric Device Calibration**: The calibration of all volumetric vessels is checked using the NBS 602 method where all vessels are weighed to five significant figures.

c. **Calibration Standards**: The Calibration Standard is directly traceable to SRM 3100 Series Spectrometric Standard Solutions.

Packaging and Storage Conditions:

The standard is packaged in a pre-cleaned polyethylene bottle and is guaranteed to be valid for eighteen months from the shipping date, provided the solution is kept tightly capped and stored under normal laboratory conditions.

Expiration Information:

Preparation Date: March 9, 2009

Shipped Date: MAY 20 2009

Expiration Date: NOV 20 2010

Amy Adams, Inorganic Laboratory Manager

Connie Hayes

Connie Hayes, Quality Manager

Theodore C Rains

Theodore Rains, PhD, President

March 10, 2009

Certificate Issue Date

PJLA Testing

Accreditation # 49337

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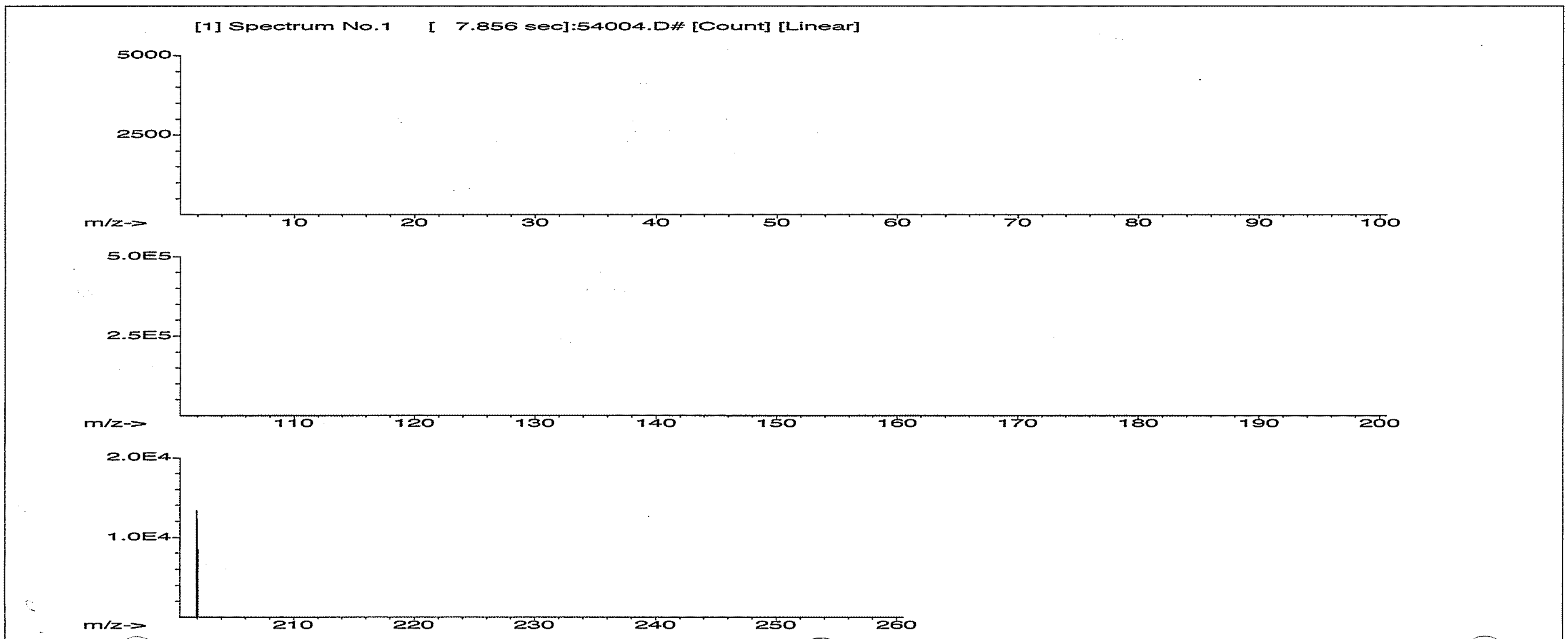
CERTIFIED WEIGHT REPORT:

		Lot #	Solvent(s):	
Part Number:	54005	P889768	Nitric Acid	
Lot Number:	072409			
Description:	Total Mercury (Hg)			
	Mercury Nitrate & Methylmercury Chloride [1:1]	5%	25.0	Nitric Acid
Expiration Date:	072412		(mL)	
	Storage: 20 ˚C			
Nominal Concentration (µg/mL):	100			
		5E-05	Balance Uncertainty	
Volume(s) shown below were combined and diluted to (mL):	500.38	0.058	Flask Uncertainty	

Formulated By:	Lawrence Barry	072409
Reviewed By:	Pedro L. Rentas	072409

MSDS Information
(Solvent Safety Info. On Attached pg.)

Compound	Part Number	Lot Number	Dilution Factor	Initial Volume	Uncertainty Pipette	Initial Conc. (ug/mL)	Final Conc. (µg/mL)	Expanded Uncertainty (+/-)	CAS#	OSHA PEL (TWA)	LD50	NIST SRM
1. Mercury Nitrate (Hg)	54004	121808	0.1000	50.0	0.016	500.2	50.0	0.00213	07783-34-8	N/A	orl-rat 51 mg/kg	3133
2. Methylmercury (II) Chloride (Hg)	54004	121808	0.1000	50.0	0.016	500.2	50.0	0.00216	00115-09-3	0.01mg/m3	orl-rat 29.9 mg/kg	3133
Total Mercury							**100.0**	0.00429	NA			



AbsoluteGrade™ Solution **Total Mercury (Hg)**

Part# 54005
Lot# 072409

	(µg/mL)	(+/-)
Certified Concentration (µg/mL)	100.0	0.1

The certified value is the concentration calculated from gravimetric and volumetric measurements unless otherwise specified.

TRACEABILITY DOCUMENTATION:

A) Classical Chemical Analysis:

Method	Traceability	Concentration (µg/mL)
EDTA Titration	NIST SRM 928 Lead Nitrate	N/A
Gravimetric Analysis	NIST Weights	N/A

B) Instrumental Analysis by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS):

Trace Metals Verification by ICP-MS (µg/mL)

Al	<0.02	Cd	<0.02	Dy	<0.02	Hf	<0.02	Li	<0.02	Ni	<0.02	Pr	<0.02	Se	<0.2	Tb	<0.02	W	<0.02
Sb	<0.02	Ca	<0.2	Er	<0.02	Ho	<0.02	Lu	<0.02	Nb	<0.02	Re	<0.02	Si	<0.02	Te	<0.02	U	<0.02
As	<0.2	Ce	<0.02	Eu	<0.02	In	<0.02	Mg	<0.01	Os	<0.02	Rh	<0.02	Ag	<0.02	Tl	<0.02	V	<0.02
Ba	<0.02	Cs	<0.02	Gd	<0.02	Ir	<0.02	Mn	<0.02	Pd	<0.02	Rb	<0.02	Na	<0.2	Th	<0.02	Yb	<0.02
Be	<0.01	Cr	<0.02	Ga	<0.02	Fe	<0.2	Hg	*	P	<0.02	Ru	<0.02	Sr	<0.02	Tm	<0.02	Y	<0.02
Bi	<0.02	Co	<0.02	Ge	<0.02	La	<0.02	Mo	<0.02	Pt	<0.02	Sm	<0.02	S	<0.02	Sn	<0.02	Zn	<0.02
B	<0.02	Cu	<0.02	Au	<0.02	Pb	<0.02	Nd	<0.02	K	<0.2	Sc	<0.02	Ta	<0.02	Ti	<0.02	Zr	<0.02

(*) =Target Element

C) Physical Characterization:

Analyzed Density of Solution (g/mL): 1.019
Temperature (°C): 23.0
Homogeneity: No heterogeneity was observed in the preparation of this standard.

Certified by:

We use purified acids, 18.2 megohm double deionized water, calibrated Class A glassware and the highest purity raw materials available, (typically 99.999%). We meticulously clean our bottles by acid leaching and then triple rinsing with ASTM Type I water prior to use. Our standards are made gravimetrically using balances that are calibrated with weights traceable to NIST. (NIST Test #: 732/245790). We certify that all our standards are (+/-) 0.5% of the stated value unless otherwise stated, assuming that the bottle is kept tightly capped and stored under normal laboratory conditions.

Reference: Taylor, B.N. and Kuyatt, C.E., "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Result," NIST Technical Note 1297, U.S. government Printing Office, Washington DC, (1994).

Original Frontier Project Proposal

The following is a general scope of work designed to meet the needs of the study from our described to me via our phone call on Tuesday October 7, 2008. The project scope involves measuring Ambient/Indoor Air Mercury Concentrations in a facility located in Oakland, California.

The proposed scope of work would include the following:

1. **Study Location:** The study location is on the former Georgia Pacific property located near downtown Bellingham, Washington.

2. **Area Monitoring Locations:** Ten (10) soil probes will be installed in predetermined locations by Aspect Consulting, LLC.

3. **Field Sampling:** Upon installation of each soil probe (installation and design of soil probe to be provided by Aspect Consulting, LLC), Frontier will then perform the mercury gas phase measurements.

Soil Probe Description: In our preliminary phone conversation, the soil probe was described as a ½ inch PVC pipe that will be driven into the ground, at a predetermined depth at 10 locations on the property.

1) **Frontier's Bulk Head Fitting On Top Of Soil Probe:** Frontier will develop a bulk head fitting to be fixed on top of the soil probe so that our Teflon sample line can be extended down into the soil probe. This key fitting will not allow air flow except through the sample line which then will be interfaced to our FSTM – Total Gaseous Hg Sorbent Traps and the LUMEX. This is critical to ensure that we are not diluting (biasing) the concentration being pulled off the soils with ambient air vs. soil flux (our target).

2) **Sample Line Fixed At Height Above The Soil:** Sample Line to be fixed at a height above the soil according to the direction of Aspect Consulting. Further, Frontier's sample line will be fixed in the center of the soil probe to ensure that we are not sampling right up against the PVC.

3) **Frontier Sample Line:** Frontier will use special ultra-trace-metal-clean ¼" OD tubing to pull the sample from inside the soil probe to the sample traps and LUMEX. New Hg trace-clean tubing will be used at each sampling location.

4) **Frontier Sample Pumps:** Frontier will use a digital sampling pump that has been previously tested with our specialized Hg air sampling traps. These pumps will have a calibration check performed on each prior to and after use at each of these sampling locations.

5) **Frontier Sampling Pump At Each Sampling Location:** Frontier has a sufficient quantity of these sampling systems to enable us to install one pump per sample soil probe. This is key to allow enough sampling time for each soil probe sampling location to quantify mercury in the limit of quantitation range at the 95% confidence interval. It is now more and more difficult to report non-detects due to short sampling intervals to regulatory agencies as there are more sensitive methods available. Frontier's method will give the highest probability of measuring these locations accurately to show if they are below or above the Action Limit.

6) **Frontier Sorbent Trap Sampling Times Vs. Detection Limit:** After each location is screened by a short measurement using the Lumex, Frontier proposes to use this concentration to then calculate the flow rate and time needed to accurately measure each soil probe by our Hg Sorbent Trap method.

a) Sample Flow Rate: The flow rate of Frontier's digital sampling pumps is ~ 1 slpm. Frontier will need to discuss what flow rate is needed so as to not create a gradient and thus a biased-high Hg flux.

b) Frontier US EPA Method 30B Proficiency Tests: In order to perform these tests, Frontier as a NELAP laboratory was required to perform a series of Proficiency Tests. We have demonstrated our capability (see attached) with our US EPA Method 30B test package. This includes our MDL studies, minimum sample mass studies, NIST traceable spike studies etc.

c) Key Sampling Parameters: The following are key sampling parameters based on 1 slpm flow and a ~ 16 hour sampling time.

Frontier Hg Soil Vapor Measurements - Key Sampling Parameters

Location	Sample Depth (ft)	Formation	* Total Mercury (ng/m3)		Flow Rate (slpm)	Sample Time (Min)	Sample Vol (m3)	Hg Capture ng Hg/Trap	Min Hg Mass (ng Hg/ Trap)
AS3	1.3-1.5	FU	720,308		1	1440	1.44	1,037,244	4
AS7	1.3-1.5	FU	158	U	1	1440	1.44	227.52	4
AS12	1.3-1.5	Chemfix	142	U	1	1440	1.44	204.48	4
AS13	1.3-1.5	Chemfix	779		1	1440	1.44	1121.76	4
AS14	1.3-1.5	Chemfix	143	U	1	1440	1.44	205.92	4
AS15	1.3-1.5	Chemfix	117	U	1	1440	1.44	168.48	4

* Numbers From 2003 Sampling Effort - Aspect Consulting, LLC

d) FGS Hg Sorbent Trap Detection Limit and Minimum Sample Mass: Frontier's detection limits were calculated following the industry standard 40 CFR Part 136 method. Frontier has provided our EPA 30B proficiency study to show our qualifications. In brief, the following are the results:

1) Minimum Sample Mass: 4 ng Hg/Trap

2) MDL (40 CFR Part 136): 0.317 ng Hg/Trap

e) Frontier Recommended Sampling Configuration:

1) Field Duplicates (Precision): It is recommended that out of the 10 locations, at least 2 locations have a matrix duplicate (simultaneous field duplicate samples to measure precision). EPA Method 30B requires duplicate samples for every sample pulled, however, for soil flux measurements, we do not see that this is needed especially considering that this is a screening effort.

2) NIST Traceable Spiked Traps (Accuracy): EPA 30B requires at least 25% of the samples taken to be field spikes. Frontier recommends that that at least 4 locations have a field spike performed.

e) Option to Measure Ambient Air Mercury At Site: It is also suggested that we pull perhaps one ambient air samples at 2 meters above the ground as a reference to the soil probe measurements. This will help in two ways: (1) asses a mercury flux that has evaded and reached the ambient air and (2) provides a key reference to show that perhaps there is no apparent impact in ambient air vs. soil flux below the surface.

f) Option to Measure Soil To Ambient Air Hg Flux: Frontier can also offer soil Hg flux measurements using and EPA approved flux chamber which is fixed to the soil surface. The key difference to the soil probe vs. soil flux measurements is to measure if any Hg is in fact evading into the ambient air.

4. **Proposed Procedure For Field Sampling:** Frontier suggests the following procedure to perform the Hg flux measurement from the soil probes:

    a) Aspect installs the soil probe.
    b) Frontier installs the bulk head interface for the sampling line.
    c) Frontier installs the ultra-clean Teflon sample line down into the soil probe.
    d) Frontier samples the soil probe using a Lumex to "screen" each of the sampling locations for Hg concentrations.
    e) The LUMEX screening measurements will then be used to set the sample time and duration of the sample in order to accurately measure the Hg coming off the soil probe.
    f) Frontier calculates the flow rate and sample time based on each locations LUMEX measurements, however, using a +/- 30% variance from the LUMEX.
    g) Frontier to then set sample traps and sample pumps and start sampling at each location one at a time, leaving the sampling pumps running and moving to the next location.
    h) Frontier proposes, once all 10 locations are running, to allow these sampling locations to run overnight in order to capture a sufficient enough sample volume.
    i) During the course of the day, Frontier will take measurements at each sampling location to ensure all sampling systems are running properly and to ensure that there is no moisture building up in the sample trap.
    j) It is also possible to bring on a generator to power these systems although not necessary.
    k) The next morning, each sampling location and associated sample will be terminated, sample trap recovered and prepared for shipment back to the lab.

5. **Reporting.** Once the samples taken are back to Frontier Geosciences Inc, Frontier will analyze the samples and report the results via email. The report will be emailed in an excel spread sheet and followed in 30 days with a hard copy report. We will provide a 5 day Turn-Around-Time for the project. If aspect would like a fast TAT, please let us know.

6. **Proposed Project Summary:**

    a) **4 Hours Preparation/Equipment Mobilization**

(14 sample pumps, Lumex, samples lines, bulk head fittings etc)

= 4 hrs x $50/hr = $200

    b) **Travel Time:** 2.5 Hours Driving Each Way (Total of 5 Hours)

= 2.5 hrs each way x 2 = 5 hrs x $50/hour = $250

c) **<u>Travel Expenses:</u>** Vehicle mileage (240miles x $0.58/mile = $136.80), gasoline(20 gal x$2.50/gal=$50), 1 night hotel ($90), Per diem x 2 days ($35/day x 2 = $70)

= 346.80

d) <u>Labor Time – Lead Field Tech: 12 Hours x $110.00/Hour</u>

= $1,320

<u>Day #1: (Estimated ~ 8.5 hrs)</u>

<u>30 min per site = 6 hrs</u>

- Install Bulk Head On Each Soil Probe x 10
- Attach Sample Line x 10
- Screening each soil probe x 10 w/ Lumex
- Record Data Electronically + Manual
- Lumex Screening (+/- 30%) Of Each Soil Probe
- Using Lumex Estimate – Calculate Hg Conc – Sorbent Run Time

15 minutes per site = 2.5 hrs

- Install Digital Sample Pumps – Run @ 1 slpm x ~ 16 hours (30 minutes per site)
  - 10 – Hg Sorbent Traps Samples ~ 16 hours each
  - 4 Field Duplicates/4 NIST Traceable Hg Spikes
- Take a 1-3 flow measures prior to leaving site for the day

Day #2: (Estimated ~ 3.5 hrs)

- Next morning, take flow measures, volume measures, terminate and recover each sample.
- Take another measurement using the LUMEX (use for calculation of average results as compared to
- Breakdown sample lines, pumps, recovery equipment and Travel back to Seattle

Case Narrative – 3/30/10

Frontier Geosciences Inc of Seattle Washington was engaged by Aspect Consulting LLC to support mercury screening/monitoring from 4 additional soil vapor monitoring wells at the former Georgia Pacific/Port of Bellingham property near downtown Bellingham Washington (described as Georgia-Pacific West Site RI/FS – see map of study location (map courtesy of Aspect Consulting). Frontier performed the field sampling following the same protocols as that performed at this site back on 09/24/09 at this same location.

Frontier staff arrived in Bellingham on the afternoon of 10/30/10 and met with Aspect Consulting staff to identify the 4 sampling wells that required soil vapor mercury sampling. Frontier secured power to each of the 4 sampling locations, performing the real-time screening measurements as well as started the ~ 20 hour samples at each site. Frontier returned on April 1, 2010 and collected the ~ 20 hour long term samples.

Field Sampling Summary and Results: Short Term Sampling Via Hg Sorbent Trap Method

Sample Type	Sample ID (Aspect Well ID)	Start Time	End Time	Minutes Sampled	Flow Rate (SLPM)	Sample Volume (Liters)	Total Hg (µg/m³)	Estimted Detection Limit (ug Hg/m^3)
Short Term Samples (Mercury Sorbent Trap Method)	CPUP-01-FSTM A	9/26/13 11:08	9/26/13 11:28	20	~ 0.5	10.7	**0.14**	**0.187**
	CPUP-02-FSTM A	9/26/13 9:25	9/26/13 9:45	20	~ 0.5	10.8	**0.21**	**0.185**
	CPUP-03-FSTM A	9/26/13 13:32	9/26/13 13:52	20	~ 0.5	10.0	**0.24**	**0.200**
	CPUP-04-FSTM A	9/26/13 12:41	9/26/13 13:01	20	~ 0.5	10.2	**3.81**	**0.196**

1) The Short Term sampling/Real-Time measurements were all at or near the instruments detection limit.

2) The Short Term sampling using the Hg solid sorbent traps (Modified EPA Method 30B) measured Hg concentrations above the approximate method detection limit (as estimated by US EPA Method 30B) with the exception of CPVP-01.

3) Well CPVP-3, during the short term screening, produced water which ran up through the real-time instrument. The run was scratched, the instrument tubing and vapor well tubing was changed and the instrument detection cell was cleaned, the instrument re-zeroed and the short term sampling was re-started and completed the second time successfully.

Field Sampling Summary and Results: Long Term Sampling Via Hg Sorbent Trap Method

Sample Type	Sample ID (Aspect Well ID)	Start Time	End Time	Minutes Sampled	Flow Rate (SLPM)	Sample Volume (Liters)	Total Hg (µg/m³)	Estimted Detection Limit (ug Hg/m^3)	Relative Percent Difference (%) (Field Dupliacate)
24 Hour Samples (Mercury Sorbent Trap Method)	CPUP-01-A FSTM A	4/1/14 15:40	4/2/14 15:04	1404	0.214	300	**0.09**	**0.007**	**2%**
	CPUP-01-B FSTM A	4/1/14 15:40	4/2/14 15:04	1404	0.214	300	**0.10**	**0.007**	
	CPUP-02-A FSTM A	4/1/14 12:34	4/2/14 15:25	1611	0.214	345	**0.01**	**0.006**	**9%**
	CPUP-02-B FSTM A	4/1/14 12:34	4/2/14 15:25	1611	0.214	345	**0.01**	**0.006**	
	CPUP-03-A FSTM A	4/1/14 18:07	4/2/14 15:56	1309	0.214	280	**0.05**	**0.007**	**NA**
	CPUP-04-A FSTM A	4/1/14 16:55	4/2/14 15:37	1362	0.214	291	**1.54**	**0.007**	**73%**
	CPUP-04-B FSTM A	4/1/14 16:55	4/2/14 15:37	1362	0.214	291	**0.24**	**0.007**	
Field Blank	CPUP-03-B-Blk FSTM A	NA	NA	NA	NA	NA	**NA**		

1) The long term samples (~ 20 hours) all produced results well above the detection limit of the method.

2) There was no breakthrough from the "A" section to the "B" section of the Modified EPA 30B traps and therefore the traps performed well for this field quality assurance (QA) criteria.

3) Field Duplicates were taken on all wells with the exception of CPVP-03 as during the short term sampling effort this well produced water (water came up through the well and flooded the instrument). It was suspected that this well was sensitive to the 0.5 slpm flow rate being pulled up through the well and into the instrument. In order to ensure that we did not risk losing the ~ 20 hour sample, only one sample (run at ~0.2 slpm) was utilized.

4) The Field Duplicate results for well CPVP-1 and CPVP-02 showed excellent agreement (2% and 9% respectively) and were within EPA 30B Field QA criteria. EPA 30B QA field criteria are not required for this sampling effort but are simply used to put the results in context.

5) **Field Duplicate taken at CPVP-04 however was significantly off reporting a 73% difference.** It is suspected that potentially one of two things may have happened:

   a. **Particulate Hg Entrained Into EPA 30B Trap:** No particulate bound mercury was suspected to be produced from the soil vapor wells due to the very low flow rates from the well and that soil/particulate is located at the bottle of the well and far from the inlet of the EPA 30B traps (and thus would need to overcome a significant vertical distance to enter the sample trap. It is possible that a grain of particulate, somewhat enriched in Hg, was pulled up off the inside wall of the soil vapor well itself and pulled up onto the trap thus impacting the results. This can neither be confirmed nor denied since there was not a particulate trap fixed to the inlet of the EPA 30B trap. EPA 30B is not run with a particulate trap and therefore this would be a non-standard approach for sampling but a possible option for future sampling.

   b. **Sample CPVP-B Under Sampled During The Run:** The other possibility is that other sample (that reported 0.24 µg Hg/m^3) experienced some sort of failure during the sample run however there was no indication of this at the start, during the sampling (all four sites were checked before leaving the site in 20/30/2010 several times) or at the point of ending the sample (pump was running well and there were no issues observed with that system). This does not seem to be a possibility and is therefore highly unlikely.

6) **Field Spike Results:** Field Spikes were taken in this sampling effort as none were taken in the original sampling effort back on 09/24/2009 due to logistical difficulties. The Field Sampling spikes were taken following a similar approach as that described in 40 CFR Part 75 App K where a 3rd section of the trap was spiked with a NIST traceable amount of Hg. The amount of mercury spiked to spike on each trap was estimated based on previous long term sampling and therefore 5 ng Hg per trap was used.

The results (shown in the table below and in Table 4: C Trap Hg Results - FSTM Method) are summarized below.

Sample Type	Lab Data Set ID	Lab Run #	Sample ID	FSTM B (ng/trap)	True Value	Recovery
24 Hour Samples	THG16-100409-1	29	CPUP-01-B FSTM C+5ng	5.923 ng	5.0 ng	118%
	THG16-100409-1	36	CPUP-02-B FSTM C+5ng	5.009 ng	5.0 ng	100%
	THG16-100409-1	37	CPUP-03-A FSTM C+5ng	5.296 ng	5.0 ng	106%
	THG16-100409-1	38	CPUP-04-A FSTM C+5ng	6.300 ng	5.0 ng	126%

Method EPA 30B offers an 85-115% spike recovery range. EPA 30B Field QA criteria were only being used for comparative purposes with these tests. CPVP-02 and CPVP-03 both recovered well at 100% and 106% respectively, well with EPA 30B QA criteria. Field Spike recoveries from CPVP-1 and CPVP-4 reported outside of this recovery range (118% and 126% respectively). There was no breakthrough on the "B" traps of these samples and therefore no indication of Hg moving from one trap to the next. This coupled with the fact that these are very low spike levels (5ng /trap), it is possible that the higher recoveries are simply due to analytical variability with the spiking and analysis method.

Frontier's scope of work to support Aspect Consulting involved the following:

1) **Short-Term Hg Screening Measurements (Lumex/Mod EPA30B):** Perform short term/mercury screening sampling using a real-time measurement instrument and simultaneously sample using Frontier's Modified US EPA Method 30B mercury sorbent traps. The results of the real-time screening were designed to aid in determining a sufficient flow rate and long-term sampling approach for the Modified US EPA Method 30B mercury measurements that were to follow. The long term Modified US EPA Method 30B measurements are considered the official reporting values for this effort. Each of the short term screening samples were accomplished at each of 9 wells and ran for ~ 20 minutes at approximately 0.5 slpm.

2) **Long-Term Hg Sampling via a Modified Version of US EPA Method 30B:** After the short term screening with the real-time instrument and Modified EPA 30B was accomplished, each site was then set-up with a long-term, Modified, US EPA Method 30B Hg sorbent trap and ran for nearly 20 hours at each site. Each of the 9 sampling wells was set up with its' own sampling system to enable 9 samples to be taken simultaneously (same period of time). The long term, simultaneous sampling was important to accomplish the following:

    a. Ensure that each of the Modified US EPA Method 30B traps were sampled long enough to ensure the highest probability of obtaining a large enough mercury sample mass.

    b. Obtain a representative sample (~ 20 hour integrated) of each sample location that would reflect any potential Hg fluxes over a longer time period (i.e. diurnal flux, change in water table, other) as well as enable the comparison of each well from one to the other.

Long Term Modified US EPA Method 30B Mercury Vapor Measurements: The Long Term mercury monitoring samples were performed from 10/2409-09/26/09 and involved special critical sampling orifices set at 0.214 SLPM and ran for approximately 20 minutes. Each of the Modified US EPA Method 30B samples (short and long term) were hand carried back Frontier Geosciences Inc where they were checked in to Frontier's LIMS system and a Chain Of Custody Record was created.

Sample Digestion and Analysis: All of the Modified US EPA Method 30B sorbent traps samples were digested and analyzed following Frontier Geosciences Inc SOP FGS-069 for the determination of Total Hg. This method and approach is a National Environmental Laboratory Accreditation Program (NELAP) Accredited Method in the state of Washington as well as ISO-17025.

Project Preparation: Frontier Geosciences Inc worked directly with Jeff Lundrum of Aspect Consulting and performed the following in preparation of the project:

a) Obtained historical data from past measurements to estimate mercury concentrations in order to estimate/calculate field sampling parameters such as sampling time and flow rates to meet minimum sampling parameters.

b) Adapted/Modified US EPA Method 30B (Mercury Sorbent Method) that frontier designed for emissions monitoring to that of the conditions and logistics for vapor well sampling.

c) Adapted Modified EPA 30B to work in conjunction with Aspect soil vapor wells and purchased/prepared special air tight adaptors to ensure no in-leakage to the soil vapor well during sampling.

d) Chose a flow rate and sampling system to do our best to prevent "over sampling" (pulling too much air mass from the well) and therefore potentially over estimate the Hg concentrations by creating such a positive air flow that the soil column would never see).

The original sampling effort utilized previously sampled locations to estimate the amount of mercury that would be captured by the sampling system during the course of the sampling effort.

Frontier Hg Soil Vapor Measurements - Key Sampling Parameters

Location	Sample Depth (ft)	Formation	* Total Mercury (ng/m3)		Flow Rate (slpm)	Sample Time (Min)	Sample Vol (m3)	Hg Capture ng Hg/Trap	Min Hg Mass (ng Hg/ Trap)
AS3	1.3-1.5	FU	720,308		1	1440	1.44	1,037,244	4
AS7	1.3-1.5	FU	158	U	1	1440	1.44	227.52	4
AS12	1.3-1.5	Chemfix	142	U	1	1440	1.44	204.48	4
AS13	1.3-1.5	Chemfix	779		1	1440	1.44	1121.76	4
AS14	1.3-1.5	Chemfix	143	U	1	1440	1.44	205.92	4
AS15	1.3-1.5	Chemfix	117	U	1	1440	1.44	168.48	4

* Numbers From 2003 Sampling Effort - Aspect Consulting, LLC

Summary of Results

Total Gaseous Hg Summary								
Sample Type	**Sample ID**	**Start Time**	**End Time**	**Minutes Sampled**	**Flow Rate**	**Sample Volume**	**Total Hg ($\mu g/m^3$)**	**RD Between Paired Samples**
Short Term Samples (Mercury Sorbent Trap Method + Lumex)	Shed-33110-Lumex	3/31/10 14:53	3/31/10 15:31	38	NA (Mass Flow Totalizer)	10.7	**0.14**	
	CPUP-02-Lumex	3/31/10 11:25	3/31/10 12:25	30	NA (Mass Flow Totalizer)	10.8	**0.21**	
	CPUP-03-Lumex	3/31/10 17:08	3/31/10 18:01	53	NA (Mass Flow Totalizer)	10.0	**0.24**	
	CPUP-04-Lumex	3/31/10 16:06	3/31/10 16:48	42	NA (Mass Flow Totalizer)	10.2	**3.81**	
24 Hour Samples (Mercury Sorbent Trap Method)	CPUP-01-A	4/1/14 15:40	4/2/14 15:04	1404	0.214	300	**0.09**	**2%**
	CPUP-01-B	4/1/14 15:40	4/2/14 15:04	1404	0.214	300	**0.10**	
	CPUP-02-A	4/1/14 12:34	4/2/14 15:25	1611	0.214	345	**0.01**	**9%**
	CPUP-02-B	4/1/14 12:34	4/2/14 15:25	1611	0.214	345	**0.01**	
	CPUP-03-A	4/1/14 18:07	4/2/14 15:56	1309	0.214	280	**0.05**	
	CPUP-04-A	4/1/14 16:55	4/2/14 15:37	1362	0.214	291	**1.54**	**73%**
	CPUP-04-B	4/1/14 16:55	4/2/14 15:37	1362	0.214	291	**0.24**	
Field Blank	CPUP-03-B-Blk						**NA**	

Short Term Sampling Results

Description of Short-Term Sampling Approach:

Frontier's real-time mercury sampling system was designed to allow us to screen mercury in real-time while also capturing a Modified US EPA Method 30B sample:

1) Each sampling location identification was confirmed by observing the adjacent well cap identification and the site ID was then recorded on the mercury vapor well itself.

2) Each monitoring well was fitted with a leak-proof well head that allowed Frontier to incorporate a Trace Clean ¼" OD Teflon line through a bulk head fitting.

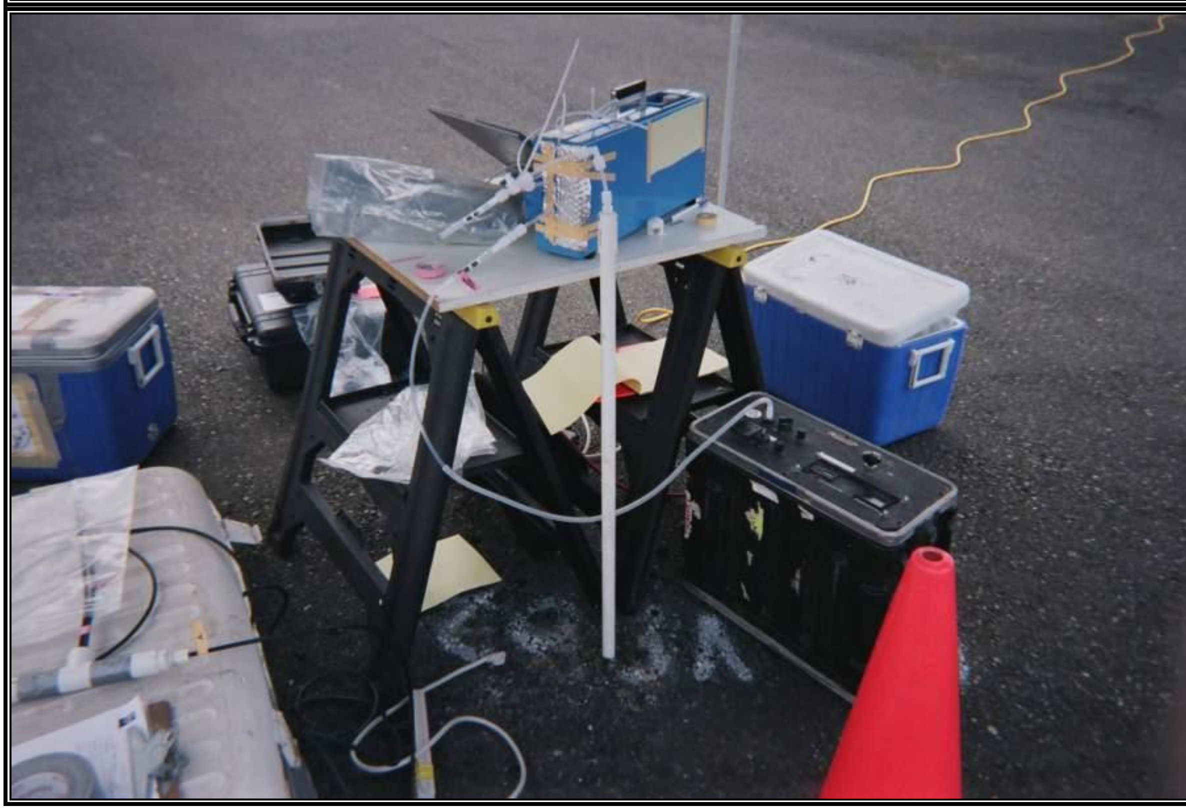
3) A leak-proof bulk head fitting was fixed at the top of each well head cap. The ¼' trace-clean Teflon tubing was then placed approximately 12 inches down inside each sampling well.

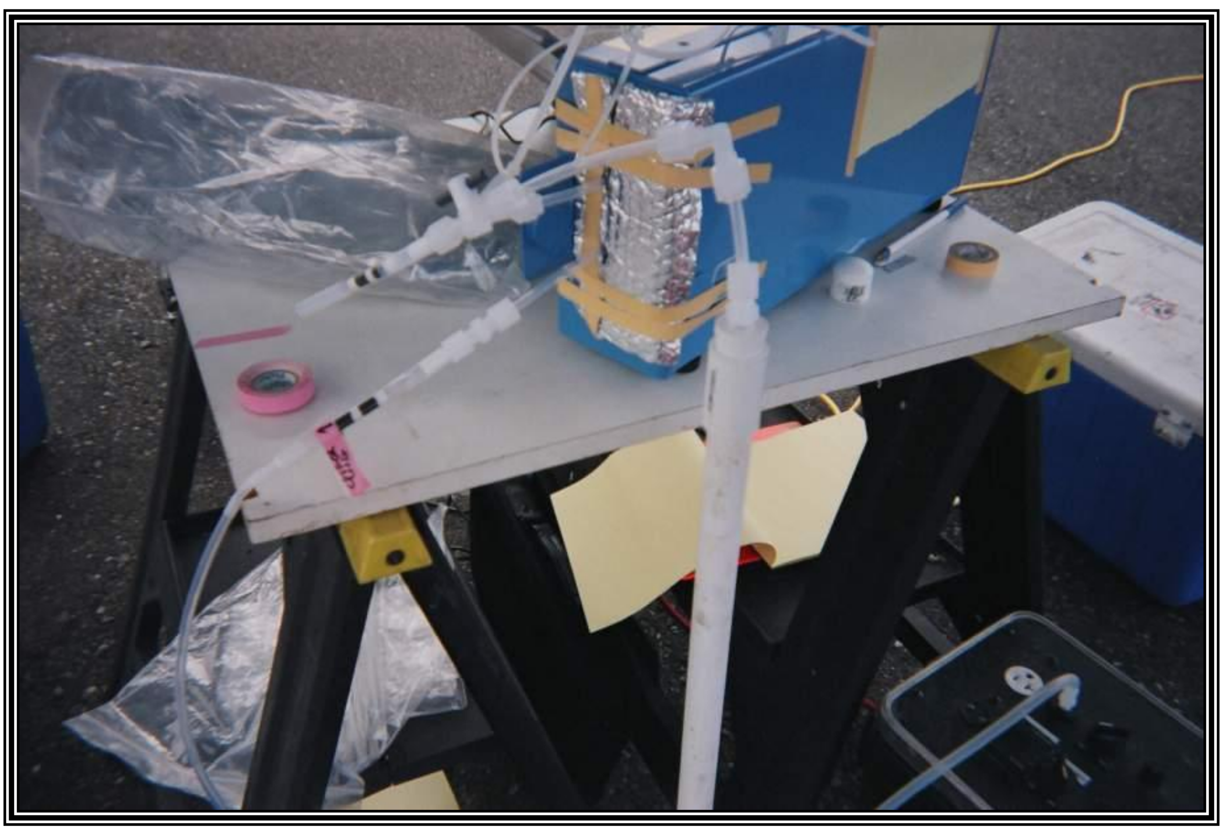
4) The Teflon sample line from the well was then plumbed into the Real Time Hg Screening Instrument (Lumex RA-915).

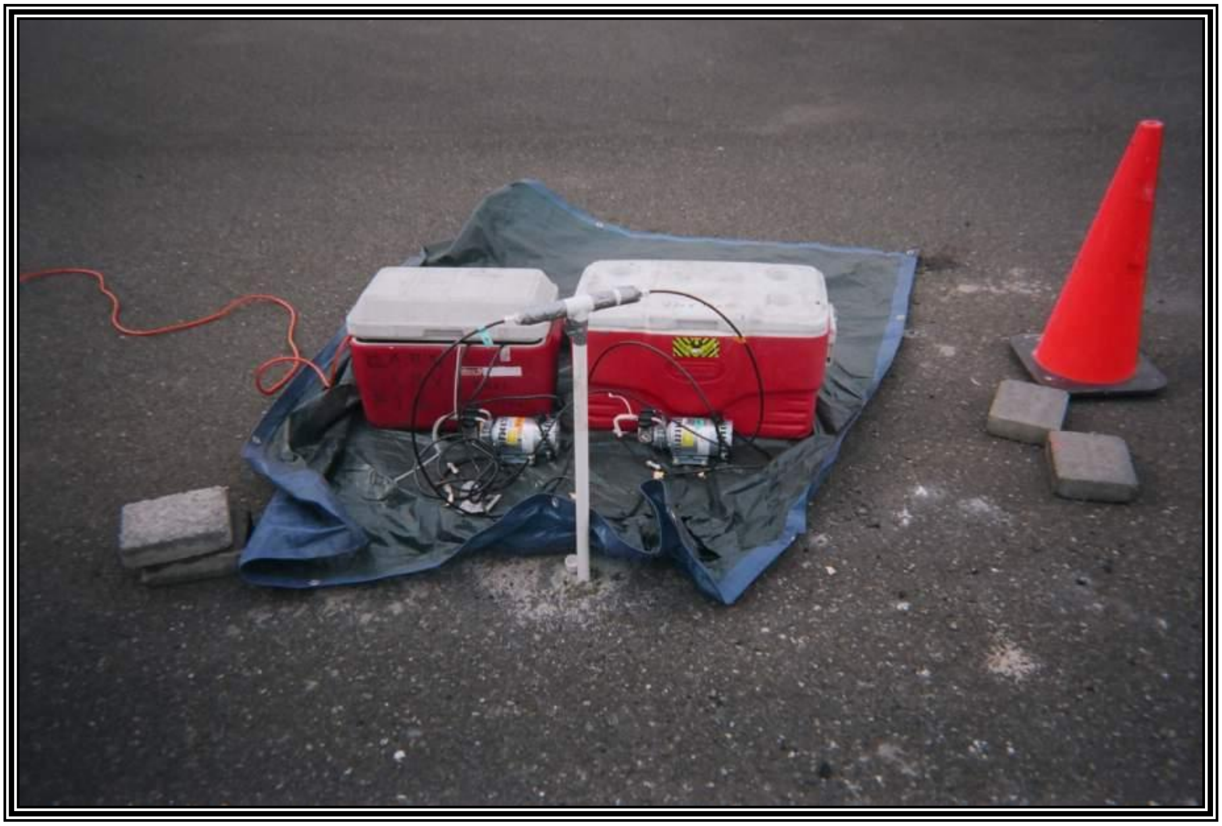
5) A Modified US EPA Method 30B sorbent trap was set at the outlet of the Real Time Hg Screening Instrument to capture mercury after it passed through the instrument detector.

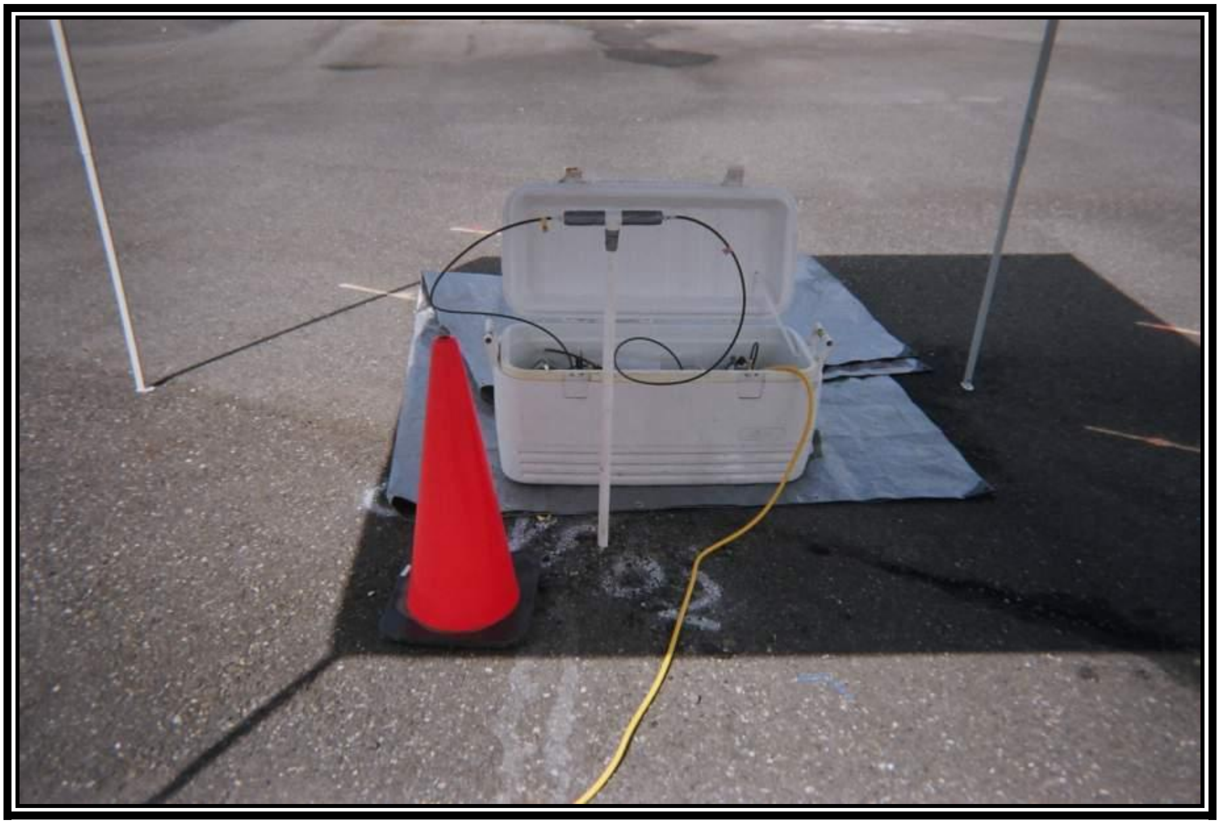
6) At the Outlet of the Modified US EPA trap, another sample line ran from the Modified EPA 30B trap and then onto Mass Flow Meter, Volume Totalizer, Flow Controller and Pump. This device was used to pull at approximately 0.5 slpm from the well, through the real-time instrument, through the Modified EPA 30B trap and then into the Mass Flow Meter/Volume Totalizer and pump.

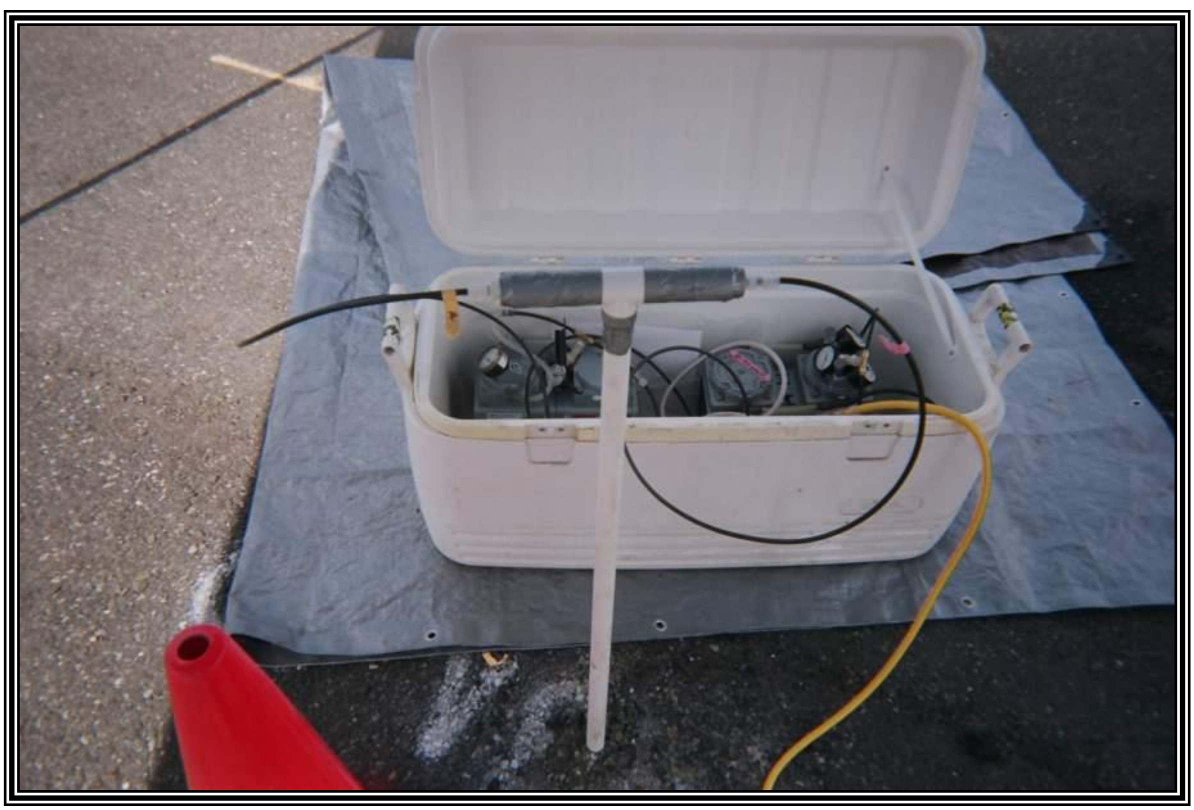
Frontier On Site – Real-Time/Short Term Screening





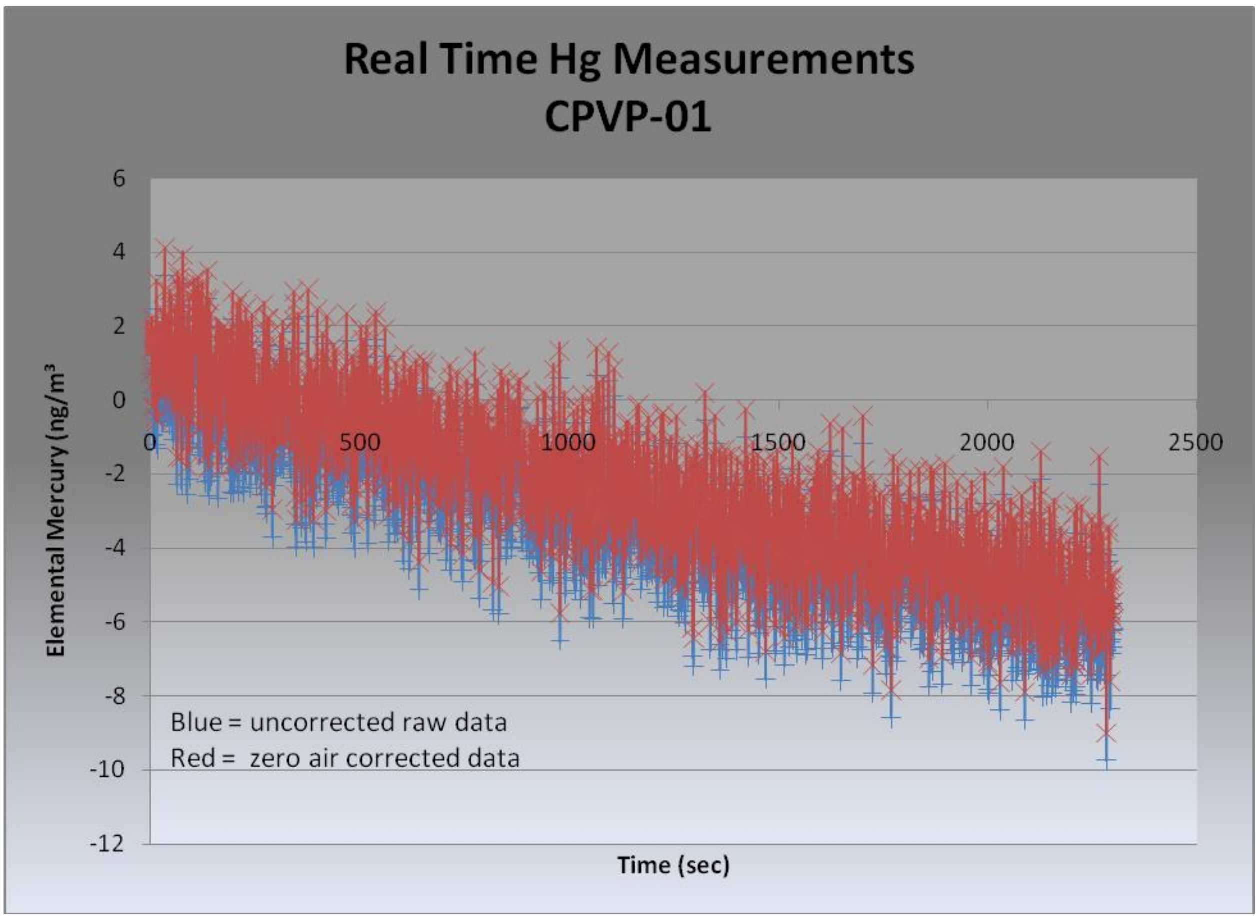


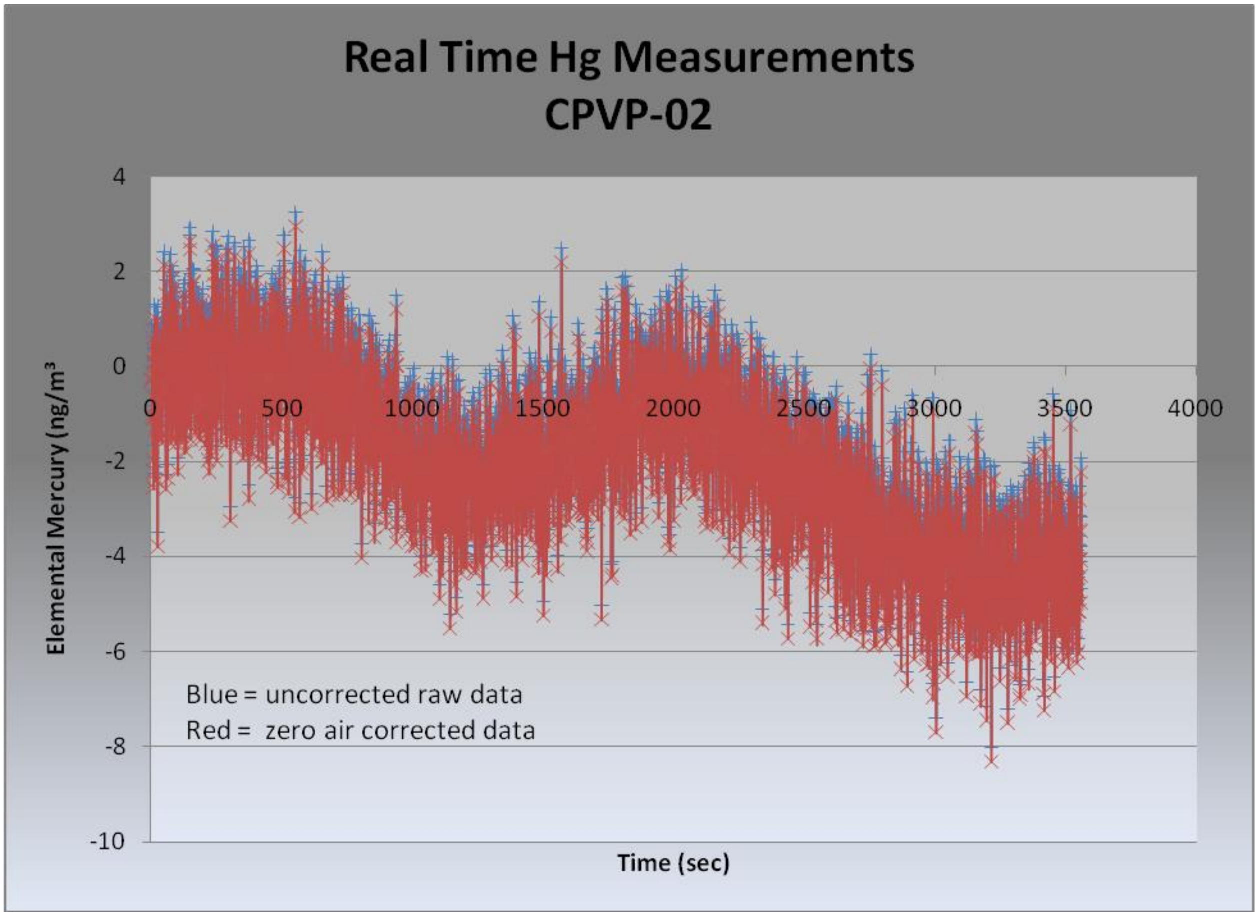


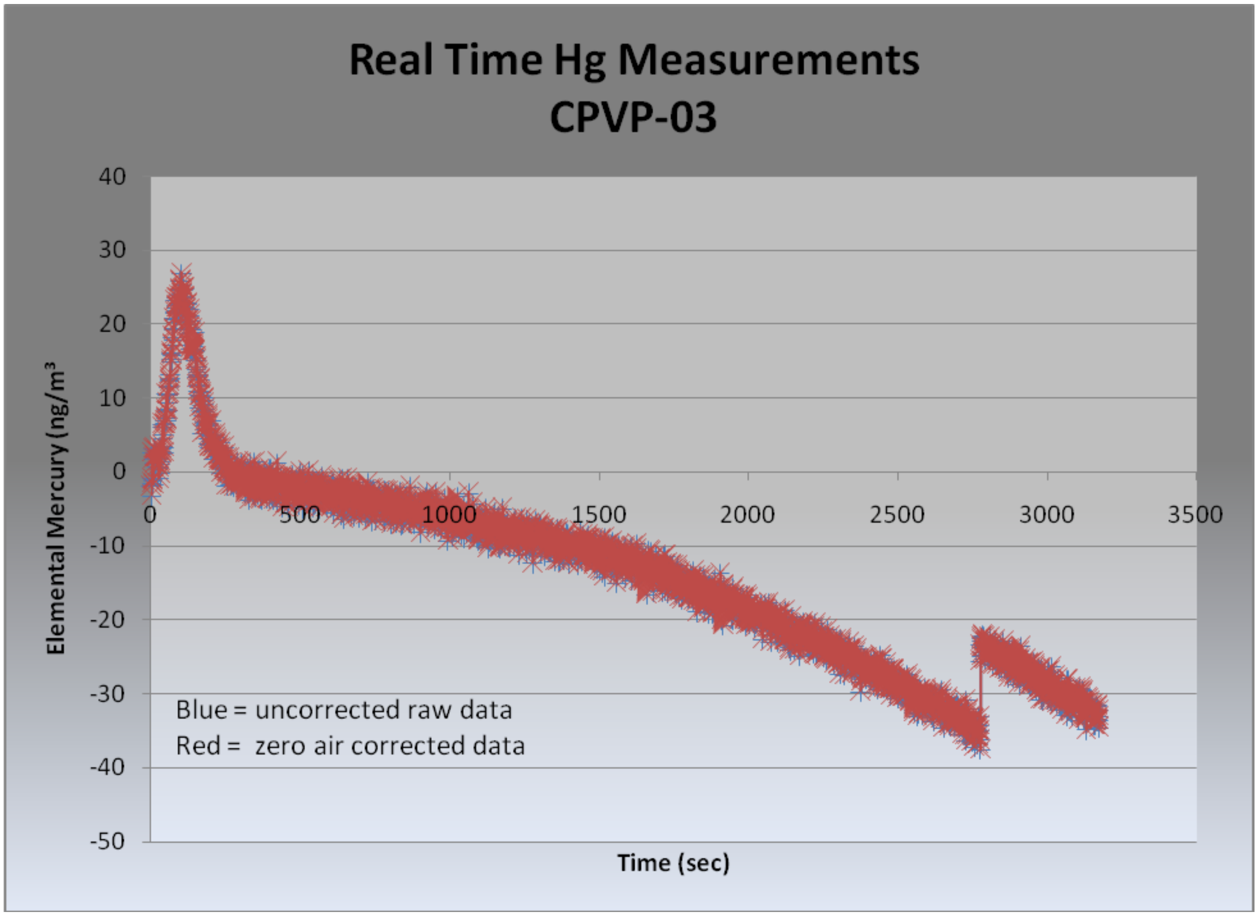


Real-Time Mercury Instrument (Lumex) Results

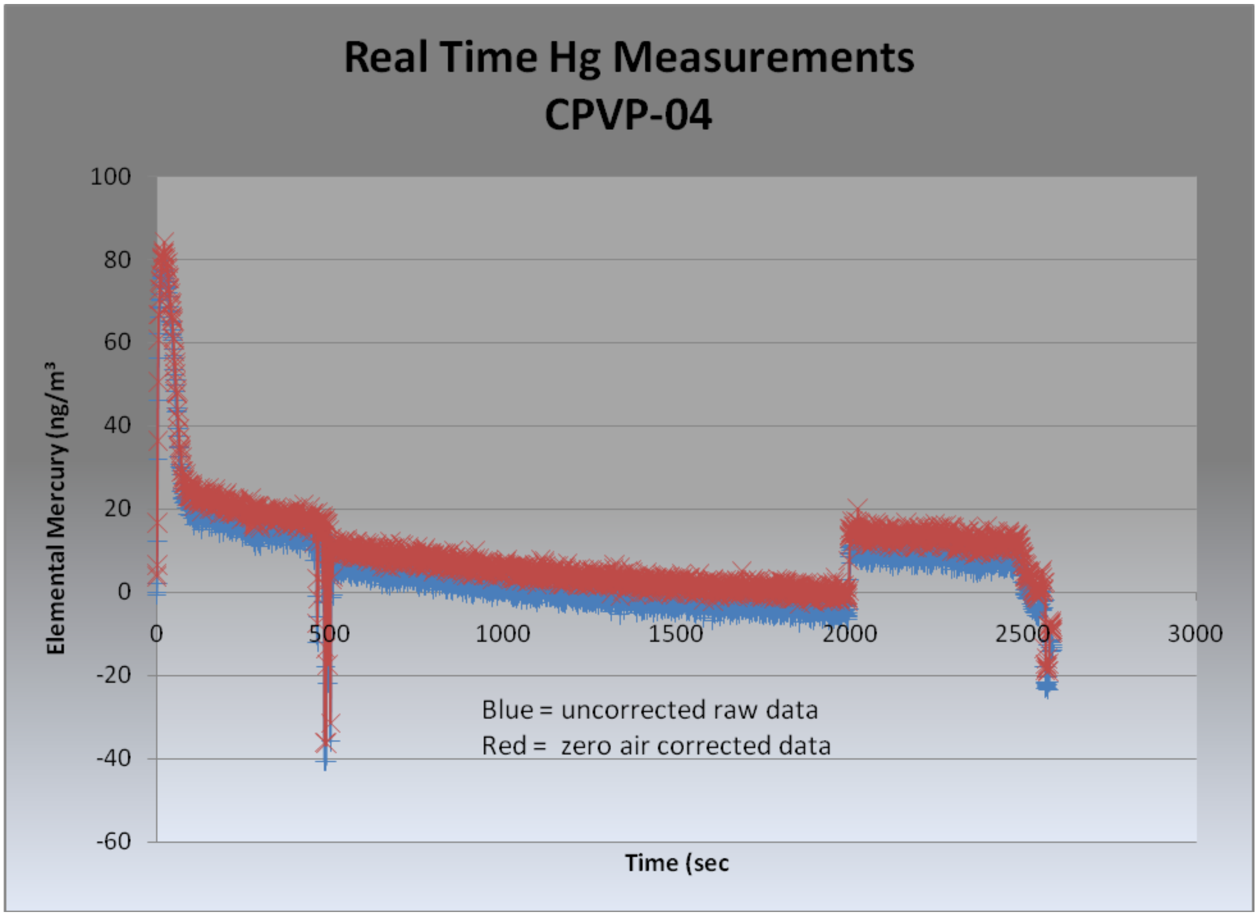
Before and after each Lumex run FSTM zero-air blank checks were performed. In order to determine the blank level, a 3-way valve with an FSTM zero-air trap was located between the soil gas probe and the Lumex. By turning the flow path to the FSTM zero-air trap, a source of air without mercury present was generated to determine the blank baseline response of the Lumex. The baseline check was also performed during the first sampling period (which was. The average of the FSTM zero-air measurements was used to blank-correct the actual Lumex measurements.




Real Time Hg Measurements
CPVP-02
Elemental Mercury (ng/m³)
Time (sec)
Blue = uncorrected raw data
Red = zero air corrected data
4
2
0
-2
-4
-6
-8
-10
0
500
1000
1500
2000
2500
3000
3500
4000



Real Time Hg Measurements
CPVP-03
40
30
20
10
0
-10
-20
-30
-40
-50
0
500
1000
1500
2000
2500
3000
3500
Elemental Mercury (ng/m³)
Time (sec)
Blue = uncorrected raw data
Red = zero air corrected data



Real Time Hg Measurements
CPVP-04
100
80
60
40
20
0
-20
-40
-60
Elemental Mercury (ng/m³)
0
500
1000
1500
2000
2500
3000
Blue = uncorrected raw data
Red = zero air corrected data
Time (sec

Long Term Sampling Results

Description Of Long-Term Sampling Approach: After the real-time / Modified EPA 30B short term screening was performed, each site was then prepared to take a Long Term (~ 20 hour sample) using a Modified US EPA Method 30B mercury sorbent trap.

TABLE 1 - Total Gaseous Hg Summary

Sample Type	Sample ID	Start Time	End Time	Minutes Sampled	Flow Rate	Sample Volume	Total Hg (μg/m³)	RD Between Paired Samples
Short Term Samples (Mercury Sorbent Trap Method + Lumex)	Shed-33110-Lumex	3/31/10 11:08	3/31/10 11:28	20	NA (Mass Flow Totalizer)	10.7	**0.14**	
	CPUP-02-Lumex	3/31/10 9:25	3/31/10 9:45	20	NA (Mass Flow Totalizer)	10.8	**0.21**	
	CPUP-03-Lumex	3/31/10 13:32	3/31/10 13:52	20	NA (Mass Flow Totalizer)	10.0	**0.24**	
	CPUP-04-Lumex	3/31/10 12:41	3/31/10 13:01	20	NA (Mass Flow Totalizer)	10.2	**3.81**	
24 Hour Samples (Mercury Sorbent Trap Method)	CPUP-01-A	4/1/14 15:40	4/2/14 15:04	1404	0.214	300	**0.09**	**2%**
	CPUP-01-B	4/1/14 15:40	4/2/14 15:04	1404	0.214	300	**0.10**	
	CPUP-02-A	4/1/14 12:34	4/2/14 15:25	1611	0.214	345	**0.01**	**9%**
	CPUP-02-B	4/1/14 12:34	4/2/14 15:25	1611	0.214	345	**0.01**	
	CPUP-03-A	4/1/14 18:07	4/2/14 15:56	1309	0.214	280	**0.05**	
	CPUP-04-A	4/1/14 16:55	4/2/14 15:37	1362	0.214	291	**1.54**	**73%**
	CPUP-04-B	4/1/14 16:55	4/2/14 15:37	1362	0.214	291	**0.24**	
Field Blank	CPUP-03-B-Blk						**NA**	

TABLE 2: A Trap Hg Results and Trap Summary - FSTM Method

Sample Type	Lab Data Set ID	Lab Run #	Sample ID	FSTM A Hg (ng/trap)	FSTM B Hg (ng/trap)	Total (A + B Trap) (ng /trap)
Short Term Samples	THG17-100409-1	1596	Shed-33110-Lumex FSTM A	1.23 ng	0.29	1.52
	THG17-100409-1	1597	CPUP-02-Lumex FSTM A	1.97 ng	0.32	2.29
	THG17-100409-1	1598	CPUP-03-Lumex FSTM A	1.98 ng	0.39	2.37
	THG17-100409-1	1599	CPUP-04-Lumex FSTM A	38.4 ng	0.55	38.9
24 Hour Samples	THG16-100409-1	13	CPUP-01-A FSTM A	27.8 ng	0.38	28.2
	THG16-100409-1	21	CPUP-01-B FSTM A	28.9 ng	0.33	29.2
	THG16-100409-1	41	CPUP-02-A FSTM A	3.25 ng	0.26	3.51
	THG16-100409-1	22	CPUP-02-B FSTM A	2.98 ng	-0.03	2.95
	THG16-100409-1	15	CPUP-03-A FSTM A	12.7 ng	0.51	13.2
	THG16-100409-1	28	CPUP-04-A FSTM A	448 ng	0.74	448
	THG16-100409-1	50	CPUP-04-B FSTM A	69.1 ng	1.01	70.1
Field Blank	THG16-100409-1	23	CPUP-03-B-Blk FSTM A	0.061 ng	0.04	0.10

TABLE 3: B Trap Hg Results - FSTM Method

Sample Type	Lab Data Set ID	Lab Run #	Sample ID	FSTM B (ng/trap)
Short Term Samples	THG17-100409-1	1603	Shed-33110-Lumex FSTM B	0.287 ng
	THG17-100409-1	1605	CPUP-02-Lumex FSTM B	0.320 ng
	THG17-100409-1	1606	CPUP-03-Lumex FSTM B	0.386 ng
	THG17-100409-1	1607	CPUP-04-Lumex FSTM B	0.547 ng
24 Hour Samples	THG16-100409-1	39	CPUP-01-A FSTM B	0.384 ng
	THG16-100409-1	40	CPUP-01-B FSTM B	0.330 ng
	THG16-100409-1	14	CPUP-02-A FSTM B	0.258 ng
	THG16-100409-1	42	CPUP-02-B FSTM B	-0.029 ng
	THG16-100409-1	43	CPUP-03-A FSTM B	0.509 ng
	THG16-100409-1	45	CPUP-04-A FSTM B	0.742 ng
	THG16-100409-1	48	CPUP-04-B FSTM B	1.01 ng
Field Blank	THG16-100409-1	44	CPUP-03-B-Blk FSTM B	0.043 ng

TABLE 4: C Trap Hg Results - FSTM Method

Sample Type	Lab Data Set ID	Lab Run #	Sample ID	FSTM C (ng/trap)	True Value	Recovery
24 Hour Samples	THG16-100409-1	29	CPUP-01-B FSTM C+5ng	5.92 ng	5.0 ng	118%
	THG16-100409-1	36	CPUP-02-B FSTM C+5ng	5.01 ng	5.0 ng	100%
	THG16-100409-1	37	CPUP-03-A FSTM C+5ng	5.30 ng	5.0 ng	106%
	THG16-100409-1	38	CPUP-04-A FSTM C+5ng	6.30 ng	5.0 ng	126%
					Average	**113%**

TABLE 5: Analysis QA/QC Performance Summary - Initial Calibration Verification Results (Secondary Standard)

Lab Data Set ID	Lab Run #	QC Parameter	Observed Value	True Value	SRM % Recovery	QA/QC Range
THG17-100409-1	1563	ICV	16.2 ng/L	15.0 ng/L	**108.1%**	**80%-120%**
THG16-100409-1	06	ICV	15.3 ng/L	15.0 ng/L	**102.3%**	**80%-120%**

TABLE 6: Initial and Continued Calibration Blanks (ICB and CCBs)

Lab Data Set ID	Lab Run #	CCB ID	ICB/CCB (ng Hg/Blank)	QA/QC Acceptance
THG17-100409-1	1564	ICB	0.023 ng/L	< **0.50**
THG17-100409-1	1576	CCB1	0.081 ng/L	< **0.50**
THG17-100409-1	1588	CCB2	0.076 ng/L	< **0.50**
THG17-100409-1	1601	CCB3	0.044 ng/L	< **0.50**
THG17-100409-1	1615	CCB4	0.057 ng/L	< **0.50**
THG16-100409-1	07	ICB	0.036 ng/L	< **0.50**
THG16-100409-1	19	CCB1	0.152 ng/L	< **0.50**
THG16-100409-1	34	CCB2	0.018 ng/L	< **0.50**
THG16-100409-1	47	CCB3	0.081 ng/L	< **0.50**
THG16-100409-1	52	CCB4	0.099 ng/L	< **0.50**

TABLE 7: Continued Calibration Verification (Secondary Standard)

Lab Data Set ID	Lab Run #	CCV ID	Measured	True Value	% Rec.	QA/QC Acceptance
THG17-100409-1	1575	CCV1	21.3 ng/L	20.0 ng/L	**106.4%**	**80%-120%**
THG17-100409-1	1587	CCV2	21.1 ng/L	20.0 ng/L	**105.5%**	**80%-120%**
THG17-100409-1	1600	CCV3	20.9 ng/L	20.0 ng/L	**104.3%**	**80%-120%**
THG17-100409-1	1612	CCV4	21.0 ng/L	20.0 ng/L	**104.9%**	**80%-120%**
THG16-100409-1	18	CCV1	19.8 ng/L	20.0 ng/L	**99.1%**	**80%-120%**
THG16-100409-1	31	CCV2	19.8 ng/L	20.0 ng/L	**99.1%**	**80%-120%**
THG16-100409-1	46	CCV3	19.6 ng/L	20.0 ng/L	**98.2%**	**80%-120%**
THG16-100409-1	51	CCV4	19.6 ng/L	20.0 ng/L	**98.2%**	**80%-120%**
				Average	**102.0%**	**80%-120%**

TABLE 8: Reagent Blank - FSTM Method

Lab Data Set ID	Lab Run #	Sample ID	ng/blank
THG17-100409-1	1590	PB1	0.253 ng
THG17-100409-1	1591	PB2	0.293 ng
THG17-100409-1	1592	PB3	0.216 ng
THG16-100409-1	08	PB1	-0.011 ng
THG16-100409-1	09	PB2	0.061 ng
THG16-100409-1	10	PB3	-0.047 ng
		Average >	**0.13**
		Standard Deviation (SD) >	**0.14**
		Relative Standard Deviation (RSD) >	**113.5%**

TABLE 9: Frontier Geosciences Lab Control Spike Recovery

Lab Data Set ID	Lab Run #	Lab Sample ID	Measured (ng/trap)	Expected (ng/Trap)	% Recovery	QA/QC Range
THG17-100409-1	1602	BS+100ng	86.3 ng	100 ng	**86.3%**	**75%-125%**
THG17-100409-1	1595	BSD+100ng	102 ng	100 ng	**102.4%**	**75%-125%**
THG16-100409-1	11	BS+100ng	97.8 ng	100 ng	**97.8%**	**75%-125%**
THG16-100409-1	12	BSD+100ng	96.0 ng	100 ng	**96.0%**	**75%-125%**

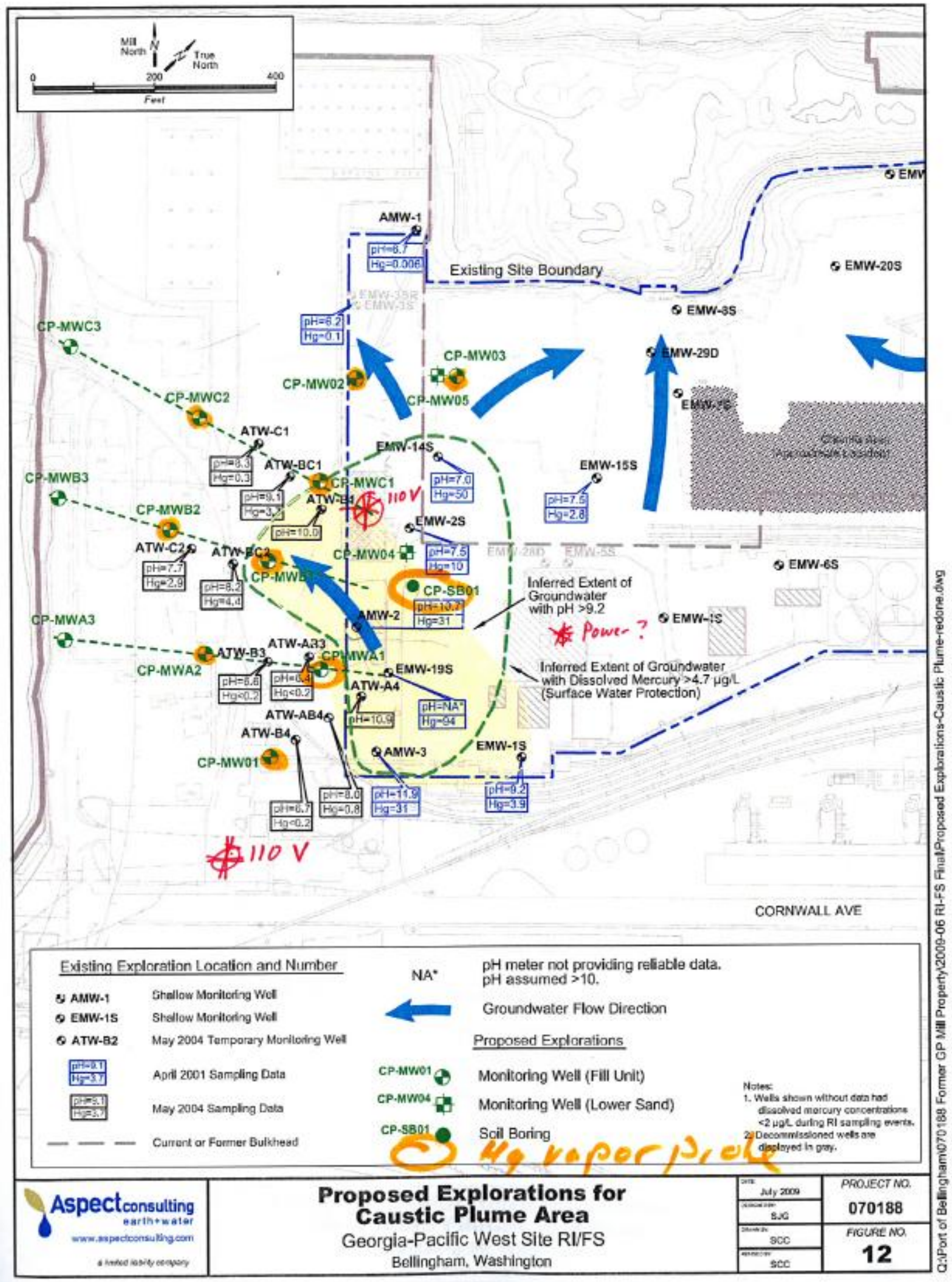
TABLE 10: Frontier Geosciences Analytical Spike Recovery

Lab Data Set ID	Lab Run #	Lab Sample ID	Measured (ng/trap)	Net Measured (ng/Trap)	Expected (ng/Trap)	% Recovery	QA/QC Range	RPD
THG17-100409-1	1609	CPUP-04-Lumex FSTM A AS+80ng	120 ng	81.0 ng	80.0 ng	**101.2%**	**75%-125%**	
THG17-100409-1	1611	CPUP-04-Lumex FSTM A ASD+80ng	123 ng	84.3 ng	80.0 ng	**105.3%**	**75%-125%**	**2.70%**
THG16-100409-1	26	CPUP-03-A FSTM A AS+40ng	52.9 ng	40.2 ng	40.0 ng	**100.6%**	**75%-125%**	
THG16-100409-1	27	CPUP-03-A FSTM A ASD+40ng	48.6 ng	35.9 ng	40.0 ng	**89.8%**	**75%-125%**	**8.48%**

TABLE 11: Lab Replicate Results

Lab Data Set ID	Lab Run #	Sample ID	Replicate#1 (ng/Trap)	Replicate#2 (ng/Trap)	RPD	QA/QC Range
THG17-100409-1	1608	CPUP-04-Lumex FSTM A AD	40.0 ng	38.4 ng	**4.3%**	**0% - 25% RPD**
THG16-100409-1	25	CPUP-03-A FSTM A AD	12.6 ng	12.7 ng	**0.6%**	**0% - 25% RPD**

Study Location



Mill North
True North
0
200
400
Feet
AMW-1
pH=8.7
Hg=0.006
Existing Site Boundary
EMW-20S
EMW-3S
EMW-29D
pH=8.2
Hg=0.1
CP-MWC3
CP-MW03
CP-MW02
CP-MW05
CP-MWC2
ATW-C1
EMW-14S
EMW-15S
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Hg=0.3
ATW-BC1
CP-MWB3
CP-MWC1
110 V
pH=7.0
Hg=50
pH=7.5
Hg=2.8
CP-MWB2
pH=10.0
EMW-2S
ATW-C2
ATW-BC2
CP-MW04
pH=7.5
Hg=10
EMW-6S
pH=7.7
Hg=2.9
pH=8.2
Hg=4.4
CP-SB01
pH=10.7
Hg=31
Inferred Extent of Groundwater with pH >9.2
CP-MWA3
AMW-2
Power-?
ATW-AB3
ATW-B3
CP-MWA1
EMW-19S
CP-MWA2
pH=8.8
Hg<0.2
Hg<0.2
ATW-A4
Inferred Extent of Groundwater with Dissolved Mercury >4.7 µg/L (Surface Water Protection)
pH=NA*
Hg=94
ATW-AB4
pH=10.9
ATW-B4
AMW-3
EMW-1S
CP-MW01
pH=8.0
Hg=0.8
pH=11.9
Hg=31
pH=9.2
Hg=3.9
pH=8.7
Hg<0.2
110 V
CORNWALL AVE
Existing Exploration Location and Number
AMW-1 Shallow Monitoring Well
EMW-1S Shallow Monitoring Well
ATW-B2 May 2004 Temporary Monitoring Well
pH=9.1
Hg=3.7
April 2001 Sampling Data
May 2004 Sampling Data
Current or Former Bulkhead
NA* pH meter not providing reliable data. pH assumed >10.
Groundwater Flow Direction
Proposed Explorations
CP-MW01 Monitoring Well (Fill Unit)
CP-MW04 Monitoring Well (Lower Sand)
CP-SB01 Soil Boring
Hg vapor probe
Notes:
1. Wells shown without data had dissolved mercury concentrations <2 µg/L during RI sampling events.
2. Decommissioned wells are displayed in gray.
Aspect consulting
earth+water
www.aspectconsulting.com
a limited liability company
Proposed Explorations for Caustic Plume Area
Georgia-Pacific West Site RI/FS
Bellingham, Washington
July 2009
SJG
SCC
SCC
PROJECT NO.
070188
FIGURE NO.
12
Q:\Port of Bellingham\070188 Former GP Mill Property\2009-06 RI-FS Final\Proposed Explorations-Caustic Plume-redone.dwg

Sample COCs

FRONTIER™ GLOBAL SCIENCES

Chain of Custody Record & Laboratory Analysis Request: Air, Water, Sediments, Plant and Animal Tissue, Hydrocarbon & Other Samples

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Phone: 206-622-6960
Fax: 206-622-6870
info@FrontierGS.com
http://www.FrontierGS.com

1004045 Page 1 of 1

Client: Aspect Consulting	Contact:
Address:	Phone: Fax:
	E-mail:
Project Name:	Contract/PO:
Report To:	Invoice To:
Address:	Address:
Phone: Fax:	Phone: Fax:
E-mail:	E-mail:

FGS PM: Nate
Date: 4/8/10
TAT (business days): **20** (std) **15 10 5 4 3 2 24 hrs.**
(For TAT < 10 days, contact PM. Surcharges apply for expedited TAT)
Saturday delivery? ☐ Y ☐ N
(If yes, please contact PM)
EDD ☐ Y ☐ N
QA ☐ Standard ☐ High

No.	Engraved Bottle ID	Sample ID	# of Bottles	Matrix	Date & Time	Sampled By	Field Filtered (Y/N)	Field Preserved: HNO_3 HCl BrCl Other (%)	Analyses Requested: Hg						Comments
1	CPUP-01-green-A		1	Trap	3/31/10				X						
2	CPUP-01-orange-B-spike		1	Trap	3/31/10				X						
3	CPUP-04-A-orange-spike		1	Trap	3/31/10				X						
4	CPUP-04-B-green		1	Trap	3/31/10				X						
5	CPUP-03-B-Peach Field Blank		1	Trap	3/31/10				X						
6	CPUP-03-A-Pink-Spike		1	Trap	3/31/10				X						
7	CPUP-02-A		1	Trap	3/31/10				X						
8	CPUP-02-B		1	Trap	3/31/10				X						
9	GP-CPUP-04-Lumex		1	Trap					X						
10	Shed-33110-Lumex		1	Trap	3/31/10				X						
11	CPUP-02-Lumex		1	Trap	3/31/10				X						
12	CPUP-03-Lumex		1	Trap	3/31/10				X						

For Laboratory Use Only		Matrix Codes:	Relinquished By: Fedex / COC	Received By: DWestb	Received By:
COC Seal:	Comments:	FW: Fresh Water	Name:	Name: David Westbr	Name:
Cooler Temp:		WW: Waste Water	Organization: COC	Organization: FGS	Organization:
Carrier:		SB: Sea and Brackish Water	Date & Time:	Date & Time: 4/8/10 9:25	Date & Time:
VTSR:		SS: Soil and Sediment	Tracking number:		
# of Coolers:		TS: Plant and Animal Tissue			
		HC: Hydrocarbons			
		TR: Trap			
		OT: Other			

Sample Disposal:
☐ Return (shipping fees may apply)
☐ Standard Disposal – 30 Days after report
☐ Retain for ____ weeks after report (storage fees may apply)

By signing, you declare that you agree with FGS' terms and conditions, and that you authorize FGS to perform the specified analyses.

Customer Approval: ____________ Date: ____________

Sample Field Forms

Frontier GeoSciences Inc.
414 Pontius Ave N. • Seattle WA 98109
(206) 622-6960 • fax: (206) 622-6870
www.FrontierGeoSciences.com

Field Sample Data Sheet

Sample Date: 03/31/~~00~~10 **Sample Box ID:** ________

Sample Location: ~~Maintenance Shed~~ CPUP-01 - green - A ~~Blank~~ 04/01/10

Sample Matrix: VAPOR - SOIL

Pre-Sample Leak Check: ________ (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: ~~Maint Shed~~ CPUP-01 - green - A - ~~Blank~~ 04/01/10

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)	
04/31/10 1	15:40	NA	~~NA~~ 0.24	NA	NA	Ø	ON
04/01/10 2	~~15~~ 15:04	NA	0.214	NA	NA		OFF
3	04/01/10						
4							
5							
6							
7							
8							
9							
10							

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ______________

Temp __________

off @ 3:04 pm 04/01/10

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Field Sample Data Sheet

Sample Date: 03/31/10 REB - 04/01/10 Sample Box ID: ________

Sample Location: GP-Aspect ~~Maint Shed~~ CPVR01 - Spike

Sample Matrix: Soil Vapor

Pre-Sample Leak Check: ________ (slpm) Duplicate

Post-Sample Leak Check: ________ (slpm) CPVP-01-

Sample Trap ID: ~~Maint Shed~~-Orange-B-Spike

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)	
ON 1	15:40	NA	0.24	NA	NA	0	
OFF 2	15:04 pm	NA	0.24	NA	NA	/	OFF
3							
4							
5							
6							
7							
8							
9							
10							

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ________

Temp ________

off @ 3:04 pm 04/01/10

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pioneering environmental solutions

CPVP-02-A

PLANT GP-Bellingham

DATE 03/31/10 RUN NO. CPVP-02-(A)

~~STACK DIA. OR DIMENSIONS, m (in.)~~

~~BAROMETRIC PRESS., mm Hg (in. Hg)~~

~~GROSS SECTIONAL AREA, m^2 (ft^2)~~

OPERATORS Bob/Gerard

~~PITOT TUBE I.D. NO.~~

~~AVG. COEFFICIENT, Cp =~~

~~LAST DATE CALIBRATED~~

~~SCHEMATIC OF STACK~~

Long term pre LEAK CHECK = -28" Hg OK

~~Orange~~ PEACH

POST LEAK =

CROSS SECTION

~~START~~ Time

~~Traverse Pt. No.~~	~~Vel. Hd., Δp mm (in.) H_2O~~	~~Stack Temperature T_s, °C (°F)~~	~~Stack Temperature T_s, °K (°R)~~	~~P_g mm Hg~~ (in.Hg) VAC gau	~~$(\Delta p)^{1/2}$~~ Liters
03/31/10 12:34pm (ON)				27.5	Ø
04/01/10 15:25pm (OFF)				28.0	
3					
4					
5					
4					
			Average		

OFF

FRONTIER GEOSCIENCES INC.

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CPUP-02-B

PLANT GP - Aspect

DATE 03/31/10 RUN NO. CPUP-02-B

~~STACK DIA. OR DIMENSIONS, m (in.)~~

~~BAROMETRIC PRESS., mm Hg (in. Hg)~~

~~CROSS SECTIONAL AREA, m^2 (ft^2)~~

OPERATORS Bch / Gerard

~~PITOT TUBE I.D. NO.~~

~~AVG. COEFFICIENT, Cp =~~

~~LAST DATE CALIBRATED~~

~~SCHEMATIC OF STACK~~

Paired Sample

Pink

Spiked Sample

5ng

Long term = 23 1/2 in Hg OK

Paired sample w/ Peach

CROSS SECTION

DATE

~~Traverse Pt. No.~~	~~Vel. Hd., Δp mm (in.) H_2O~~	~~Stack Temperature T_s, °C (°F)~~	~~T_s, °K (°R)~~	P_g ~~mm Hg~~ (in.Hg) Vac Gauge	~~$(\Delta p)^{1/2}$~~ Liters
12:34 (on)				-25	Ø
0528 pm (off)				-26	
	Average				

03/31/10
04/01/10
3
4
5
6

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www.FrontierGeoSciences.com

Field Sample Data Sheet

Sample Date: 03/31/10 **Sample Box ID:** ________

Sample Location: CPVP-03 ~~B~~-A- Pink -spike

Sample Matrix: Soil Vapor

Pre-Sample Leak Check: ________ (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPVP-03-A-Pink - Spike

Date		Time of Volume Reading (HH:MM;SS)	~~Zero Offset~~ (slpm)	Flow Rate (slpm)	Hg(II) ~~or THg~~ Trap Temp (F)	(inches Hg) ~~Probe Temp~~ (F)	Total Volume (Liters)	
03/31/10	1	18:07	NA	0.214	/	24"Hg	Ø	
04/01/10	2	15:56	NA	0.214	/	22.5	/	OFF
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ________

Temp ________

3:56 pm @ 04/01/10

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PLANT GP - Aspen
DATE 03/31/06 RUN NO. CPVP-03-B - Peach
~~STACK DIA. OR DIMENSIONS, m (in.)~~
~~BAROMETRIC PRESS., mm Hg (in. Hg)~~
~~GROSS SECTIONAL AREA, m² (ft²)~~
OPERATORS Bb/Gen
~~PITOT TUBE I.D. NO.~~
~~AVG. COEFFICIENT, Cp~~
~~LAST DATE CALIBRATED~~
~~SCHEMATIC OF STACK~~

Field Blank

CROSS SECTION

QATZ

~~Traverse Pt. No.~~	~~Vel. Hd. Δp mm (in.) H_2O~~	~~Stack Temperature T_s, °C (°F)~~	~~T_s, °K (°R)~~	~~P_g mm Hg~~ (in.Hg)	~~$(\Delta p)^{1/2}$~~
1				WC	Ø
2					
3					
4					
		Average			

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www.FrontierGeoSciences.com

Field Sample Data Sheet

Sample Date: 03/31/10 **Sample Box ID:** ________

Sample Location: CPVP-04-A-~~Orang~~ Orange-Spike

Sample Matrix: Vapor-Soil

Pre-Sample Leak Check: ________ (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPVP-04-A-orange-spike

		Time of Volume Reading (HH:MM;SS)	~~Zero Offset (slpm)~~	~~Flow Rate~~ (slpm)	Hg(II) or ~~THg Trap~~ Temp (F)	~~Probe Temp~~ (F)	Total ~~Volume~~ (Liters)
03/31/10	1	1656	NA	0.24	NA	NA	0
04/01/10	2	15:37	NA	0.24	NA	NA	0
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp ________

Off @ 3:37 pm
04/01/10

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Field Sample Data Sheet

Sample Date: 03/31/10 **Sample Box ID:** ________

Sample Location: CPVP-04-B-Green

Sample Matrix: Sorption

Pre-Sample Leak Check: OK (slpm)

Post-Sample Leak Check: OK (slpm)

Sample Trap ID: CPVP-04-B-Green

03/31/10 GN 04/01/10

	Time of Volume Reading (HH:MM;SS)	~~Zero Offset (slpm)~~	~~Flow Rate (slpm)~~	Hg(II) or THg ~~Trap Temp (F)~~	~~Probe Temp (F)~~	Total Volume (Liters)
1	16:55	NA	0.214	NA	NA	Ø
2	15:37	NA	0.214	NA	NA	
3						
4						
5						
6						
7						
8						
9						
10						

ER

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp ____________

OFF @ 3:37pm 04/01/10

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PLANT ______

DATE ______ RUN NO. ______

STACK DIA. OR DIMENSIONS, m (in.) ____

BAROMETRIC PRESS., mm Hg (in. Hg) ____

CROSS SECTIONAL AREA, m^2 (ft^2) ______

OPERATORS ______

PITOT TUBE I.D. NO. ______

3/31/10

AVG. COEFFICIENT, Cp = ______

LAST DATE CALIBRATED ______

SCHEMATIC OF STACK

Shed - Lumex

Flow CROSS SECTION 2220 offset Vol

~~Traverse Pt. No.~~ Time	Vel. Hd., Δp mm (in.) H_2O	Stack Temperature T_s, °C (°F)	Stack Temperature T_s, °K (°R)	P_g mm Hg (in.Hg)	$(\Delta p)^{1/2}$
2:53	0.257			-0.087	0
3:06	0.264				3.5
3:22	0.265				7.9
3:31	0.265			-0.099	10.1
		Average			

Sample ID: Shed.33110.Lumex

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Field Sample Data Sheet

Sample Date: 3/31/10 **Sample Box ID:** ________

Sample Location: CPVP-02 - Lumex short term.

Sample Matrix: Soil Gas

Pre-Sample Leak Check: ________ (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPVP-02 - Lumex

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	11:25	-0.076	0.211			0
2	11:37		0.211			2.4
3	12:02		0.195			7.4
4	12:25	-0.297	0.195			11.7
5						
6						
7						
8						
9						
10						

Notes:

Zero offset: -0.076

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ________

Temp ________

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Field Sample Data Sheet

Sample Date: 3/31/10 **Sample Box ID:** ________

Sample Location: CP VP-03

Sample Matrix: ____________

Pre-Sample Leak Check: ________ (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: 3.31.10 CPVP-03 Liner

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	5:08	-0.089	0.220			0
2	5:19		0.202			2.3
3	5:31		0.187			4.5
4	5:50		0.176			8.0
5	6:01	-0.103	0.186			10.0
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp __________

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PLANT ______

DATE ______ RUN NO. ______

STACK DIA. OR DIMENSIONS, m (in.) ______

BAROMETRIC PRESS., mm Hg (in. Hg) ______

CROSS SECTIONAL AREA, m^2 (ft^2) ______

OPERATORS ______

PITOT TUBE I.D. NO. ______

AVG. COEFFICIENT, Cp = ______

LAST DATE CALIBRATED ______

SCHEMATIC OF STACK

CROSS SECTION

Traverse ~~Pt. No.~~ Time	Vel. Hd., Δp mm (in.) H_2O	Stack Temperature T_s, °C (°F)	Stack Temperature T_s, °K (°R)	P_g mm Hg (in.Hg) Zero offset	~~$(\Delta p)^{1/2}$~~ VoL
4:06	0.251			-0.088	0
4:17	0.243				2.8
4:33	0.240				6.7
4:48	0.241			~~-0.103~~	10.1
				-0.094	
Average					

Sample ID GP - CPVP - 04 - Lumex

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Sample Digestion Logs

Sample Digestion and Percent Solids Log

Name: Nick　　Date: 4/8/10　　Final volume: 20ml

Client Name: Aspect

Sample Matrix: ☑ FSTM ☐ Waters ☐ KCL ☐ PHg Plug ☐ Coal ☐ Other

Analysis: ☑ Total Hg ☐ Methyl Hg ☐ Other

Digestion type: ☑ 70/30 Digestion, 2 Hours @ ~55°C ☐ 5% BrCl Oxidation, 4 hours

Digest #	Sample ID Number	Sample Size ☐ml ☐g
	PB 1	20ml
	2	
	3	
	BS +100ng	
	BSD +100ng.	
	CPUP-01-G-A Fsm A	
	B	
	-0-B-S A	
	B	
	C + 5m	
	CPUP-04-A-0-S A	
	B	
	C + 5ms	
	B-G A	
	B	
	CPUP-03-B-Pc-Blk A	
	B	
	-A-Pi-Spk ~~A~~	
	B	
	C + 5m	
	CPUP-02-A A	
	B	
	CPUP-02-B A	
	B	
	C + 5ng	

Spike ID: '000260

Spike Amount: 100ml

Spike Witness:

BrCl ID:

HNO₃:

H2SO4:

Comments:

Sample Digestion and Percent Solids Log

Name: Nick Date: 4/8/10 Final volume: 40 mL

Client Name: Aspect

Sample Matrix: ☑ FSTM ☐ Waters ☐ KCL ☐ PHg Plug ☐ Coal ☐ Other

Analysis: ☑ Total Hg ☐ Methyl Hg ☐ Other

Digestion type: ☑ 70/30 Digestion, 2 Hours @ ~55°C ☐ 5% BrCl Oxidation, 4 hours

Digest #	Sample ID Number	Sample Size ☐ml ☐g
	PB 1	40 mL
	2	
	3	
	BS Hoons	
	BSD Hoons	
	GP-CPUP-04-L FSM A	
	B	
	Shed-33/10-L A	
	B	
	CPUP-02-L A	
	B	
	CPUP-03-L A	
	B	

Spike ID: 1000260

Spike Amount: 100 uL

Spike Witness:

BrCl ID:

HNO_3:

H2SO4:

Comments:

NIST Certificates of Analytical Standards

HIGH-PURITY STANDARDS
www.highpuritystandards.com
P.O. Box 41727
Charleston, SC 29423
Phone (843) 767-7900
Fax (843) 767-7906

Mercury Standard 1000 ug/mL

LIMS ID:	0900498
Prep Date:	28-May-09 00:00
Prep By:	Teresa Einhaus
Expire Date:	20-Nov-10 00:00

VERIFIED BY JCS 06/04/09

Certificate of Analysis

Product Description:

Name:	Mercury
Part number:	**100033-1**
Lot number:	**0906835**
Source Material:	Mercury Metal
Material Purity:	99.9998%
Matrix:	2% HNO_3

Certified Value: 1000 µg/mL ± 6 µg/mL

The Certified value is based on gravimetric preparation, and verified against SRM 3133 (lot number 061204) developed by National Institute of Standards and Technology (NIST) via inductively coupled plasma optical emission spectrometry (ICP-OES) using an internal laboratory-developed method. The uncertainty in the certified value is calculated for a 95% confidence interval.

Reference Values:

Density: 1.0102 g/mL @ 21.8°C

Trace Metal Impurity Scan via ICP Analysis in µg/L: The typical values detected in the mercury standard solution at 1000 µg/mL are listed below. The values are based upon the analysis results for the starting source material.

Ag	<0.02	Cu	<0.25	La	<0.02	Pt	<0.02	Te	<0.02
Al	<0.1	Dy	<0.02	Li	<0.02	Rb	<0.02	Th	<0.02
As	<0.05	Er	<0.02	Lu	<0.02	Re	<0.02	Ti	<0.02
Au	<0.02	Eu	<0.02	Mg	<0.5	Rh	<0.02	Tl	<0.02
B	<1	Fe	<1	Mn	<0.1	Ru	<0.02	Tm	<0.02
Ba	<0.02	Ga	<0.02	Mo	<0.02	Sb	<0.02	U	<0.1
Be	<0.02	Gd	<0.02	Na	<1	Sc	<0.02	V	<0.05
Bi	<0.02	Ge	<0.02	Nb	<0.02	Se	<0.1	W	<0.02
Ca	<0.1	Hf	<0.02	Nd	<0.02	Si	<1	Y	<0.02
Cd	<0.02	Hg	M	Ni	<0.02	Sm	<0.02	Yb	<0.02
Ce	<0.02	Ho	<0.02	Os	<0.02	Sn	<1	Zn	<0.1
Co	<0.05	In	<0.02	Pb	<0.05	Sr	<0.02	Zr	<0.02
Cr	<0.1	Ir	<0.02	Pd	<0.02	Ta	<0.02		
Cs	<0.02	K	<1	Pr	<0.02	Tb	<0.02		

Preparation Information:

The highest purity source materials were purchased from qualified vendors per ISO 9001:2000 guidelines and assayed by ICP-OES for conformity prior to use. This standard was prepared using methods developed at NIST for the preparation of SRM Spectrometric Standard Solutions. Sub-boiling distilled high-purity acid has been used to place the materials in solution and to stabilize the standard. The matrix is as noted above in 18 megaohm deionized water.

Traceability Information:

The traceability of this standard is maintained through an unbroken chain of comparisons to appropriate standards with suitable procedure and measurement uncertainties.

a. **Analytical Balance Calibration**: All balances are calibrated weekly by an in-house method using NBS weights Inventory No 20231A. The balances are calibrated yearly and the calibration weights are checked biennially by a qualified metrology company with weights traceable to the primary standards developed by NIST.

b. **Volumetric Device Calibration**: The calibration of all volumetric vessels is checked using the NBS 602 method where all vessels are weighed to five significant figures.

c. **Calibration Standards**: The Calibration Standard is directly traceable to SRM 3100 Series Spectrometric Standard Solutions.

Packaging and Storage Conditions:

The standard is packaged in a pre-cleaned polyethylene bottle and is guaranteed to be valid for eighteen months from the shipping date, provided the solution is kept tightly capped and stored under normal laboratory conditions.

Expiration Information:

Preparation Date: March 9, 2009

Shipped Date: MAY 2 0 2009

Expiration Date: NOV 2 0 2010

Amy Adams, Inorganic Laboratory Manager

Connie Hayes

Connie Hayes, Quality Manager

Theodore C Rains

Theodore Rains, PhD, President

PJLA Testing
Accreditation # 49337

March 10, 2009

Certificate Issue Date

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Lot No.: 0906835
Rev. No.: 2.0.0
Page 2 of 2

Absolute Standards, Inc.
800-368-1131
www.absolutestandards.com

ISO 9001 QS Registered
ISO 17025 Accredited

CERTIFIED WEIGHT REPORT:

		Lot #	Solvent(s):
Part Number:	54005	P889768	Nitric Acid
Lot Number:	072409		
Description:	Total Mercury (Hg)		
	Mercury Nitrate & Methylmercury Chloride [1:1]	5%	25.0 (mL) Nitric Acid
Expiration Date:	072412		
	Storage: 20 °C		
Nominal Concentration (µg/mL):	100		

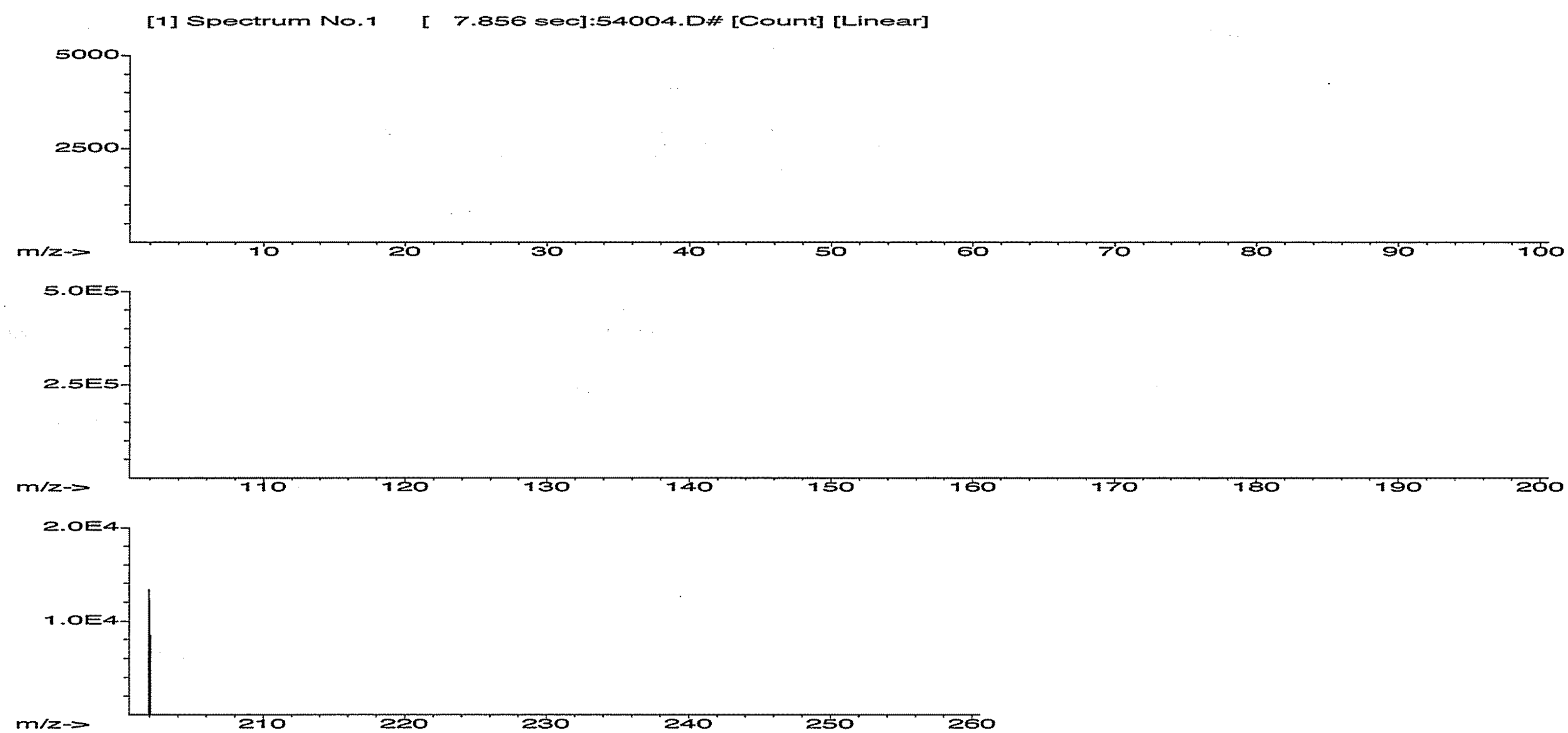
5E-05 Balance Uncertainty

Volume(s) shown below were combined and diluted to (mL): 500.38 — 0.058 Flask Uncertainty

Formulated By:	Lawrence Barry	072409
Reviewed By:	Pedro L. Rentas	072409

MSDS Information
(Solvent Safety Info. On Attached pg.)

Compound	Part Number	Lot Number	Dilution Factor	Initial Volume	Uncertainty Pipette	Initial Conc. (ug/mL)	Final Conc. (µg/mL)	Expanded Uncertainty (+/-)	CAS#	OSHA PEL (TWA)	LD50	NIST SRM
1. Mercury Nitrate (Hg)	54004	121808	0.1000	50.0	0.016	500.2	50.0	0.00213	07783-34-8	N/A	orl-rat 51 mg/kg	3133
2. Methylmercury (II) Chloride (Hg)	54004	121808	0.1000	50.0	0.016	500.2	50.0	0.00216	00115-09-3	0.01mg/m3	orl-rat 29.9 mg/kg	3133
Total Mercury							**100.0**	0.00429	NA			



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AbsoluteGrade™ Solution — **Total Mercury (Hg)**

Part# 54005
Lot# 072409

	(µg/mL)	(+/-)
Certified Concentration (µg/mL)	100.0	0.1

The certified value is the concentration calculated from gravimetric and volumetric measurements unless otherwise specified.

TRACEABILITY DOCUMENTATION:

A) Classical Chemical Analysis:

Method	Traceability	Concentration (µg/mL)
EDTA Titration	NIST SRM 928 Lead Nitrate	N/A
Gravimetric Analysis	NIST Weights	N/A

B) Instrumental Analysis by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS):

Trace Metals Verification by ICP-MS (µg/mL)

Al	<0.02	Cd	<0.02	Dy	<0.02	Hf	<0.02	Li	<0.02	Ni	<0.02	Pr	<0.02	Se	<0.2	Tb	<0.02	W	<0.02
Sb	<0.02	Ca	<0.2	Er	<0.02	Ho	<0.02	Lu	<0.02	Nb	<0.02	Re	<0.02	Si	<0.02	Te	<0.02	U	<0.02
As	<0.2	Ce	<0.02	Eu	<0.02	In	<0.02	Mg	<0.01	Os	<0.02	Rh	<0.02	Ag	<0.02	Tl	<0.02	V	<0.02
Ba	<0.02	Cs	<0.02	Gd	<0.02	Ir	<0.02	Mn	<0.02	Pd	<0.02	Rb	<0.02	Na	<0.2	Th	<0.02	Yb	<0.02
Be	<0.01	Cr	<0.02	Ga	<0.02	Fe	<0.2	Hg	*	P	<0.02	Ru	<0.02	Sr	<0.02	Tm	<0.02	Y	<0.02
Bi	<0.02	Co	<0.02	Ge	<0.02	La	<0.02	Mo	<0.02	Pt	<0.02	Sm	<0.02	S	<0.02	Sn	<0.02	Zn	<0.02
B	<0.02	Cu	<0.02	Au	<0.02	Pb	<0.02	Nd	<0.02	K	<0.2	Sc	<0.02	Ta	<0.02	Ti	<0.02	Zr	<0.02

(*) =Target Element

C) Physical Characterization:

Analyzed Density of Solution (g/mL): 1.019
Temperature (°C): 23.0
Homogeneity: No heterogeneity was observed in the preparation of this standard.

Certified by:

We use purified acids, 18.2 megohm double deionized water, calibrated Class A glassware and the highest purity raw materials available, (typically 99.999%). We meticulously clean our bottles by acid leaching and then triple rinsing with ASTM Type I water prior to use. Our standards are made gravimetrically using balances that are calibrated with weights traceable to NIST. (NIST Test #: 732/245790). We certify that all our standards are (+/-) 0.5% of the stated value unless otherwise stated, assuming that the bottle is kept tightly capped and stored under normal laboratory conditions.

Reference: Taylor, B.N. and Kuyatt, C.E., "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Result," NIST Technical Note 1297, U.S. government Printing Office, Washington DC, (1994).

Steve J. Germiat

From:	Bob Brunette [Bobb@frontiergeosciences.com]
Sent:	Wednesday, February 23, 2011 5:40 PM
To:	Steve J. Germiat; Jay Chennault
Subject:	Re: Preliminary Report - Port Of Bellingham Soil Vapor and Ambient Air Hg Monitoring
Attachments:	Frontier - Preliminary Report Event 021711.xls; CPVP 05 02172011 sample only.xlsx; VP 06 02172011sample only.xlsx; VP 07 02172011 sample only.xlsx; VP 08 02172011 sample only.xlsx; VP 09 02172011 sample only.xlsx; VP 10 02172011 sample only.xlsx

Hi Steve and Jay,

Hope you are both doing well.

Attached are the preliminary results for the Port of Bellingham Soil Vapor and Ambient Air Hg Monitoring performed February 17-18, 2011.

Notes:

1) **Well Monitoring Strategy:** We talked with Jay at front end of project and he pointed out which wells were predicted to be low and then work our way up to the higher wells….this to be sure that we did not contaminate our real-time instruments on the high wells and potentially have background issues on the lower level wells.

2) **Sample Volume and Flow Rate Checks:** We will be running each sampling system against a NIST traceable system to validate the flow rates the critical orifice are rated at. This is the reason why the reports are noted as preliminary as we were not able to perform these checks prior to this report (and will be in the subsequent final report).

3) **Conditions During Monitoring:** The conditions on 02/17 where temperatures running from 41F as a high and dropped to 34-37F during the evening. Next day, temperature dropped down to freezing as evidenced by frozen standing water on pavement.

4) **Real-Time Measurements:** The first several wells predicted to be low-level in Hg, produced near zero measurements (as experienced in past sampling efforts). As we got close to the wells considered to be higher level, we realized our real-time instrument had noticeably different calibration factors and had lower than normal "oven" temps. We consulted the manual and the instrument is rated to be able to function down to near freezing conditions and we have had experience running these instruments at high altitude low temperatures with no issues in the past. We switched to our 2nd real-time instrument and discovered the same issue. Therefore, the real-time measurements are not considered to be valid. For future tests, we will put the real-time instrument inside

a heated enclosure to prevent similar issues. Attached are the results which show that it was detecting mercury, however, very noisy.

5) **Well CP-VP09 produced water** during the short term run (Real-time + short term Modified EPA 30B trap). Groundwater came up into our real-time instrument and made its way into the EPA 30B sorbent trap. This run was scrapped – real time instrument cell was switched out with another cell. We replaced, ran background check and saw no further issues with water. The well was re-run for short term sampling and the long term sample was installed and started without incident. The long term sample showed no water on the long term sorbent trap either.

6) **Ambient Air Trap** – Taken at the gate to the back of Port facility was discovered on 02/18 to have been unplugged sometime in the morning. This run was scrapped and another 24 hour sample was started at that time and run through to Saturday morning.

7) **Well CP-VP06 Long Term Sample – Invalid Due To Water On Trap:** Well CP-VP06 did not produce water during short term sampling, but the long term sample, when the sample was taken off the next day, showed that the trap was thoroughly wet - both in the "A" and "B" sections of the trap. This is the first time that this has happened since we started sampling for this project. It is therefore impossible to tell if the Hg in the groundwater that got onto the trap generated the signal of Hg that we measured on the trap OR if this was from the well vapor. The sample should be considered invalid. The short term run did produce a valid result of 0.28 ug Hg/m^3. In the future, we will put heating cartridges down inside each well….so should any moisture be produced again, it will vaporize (water vapor) and pass through the traps. The Hg in the water vapor will similarly vaporize and be captured on the sorbent trap as part of the signal.

8) **Ambient Air Results:** The Inlet value (taken at the back gate of the secured port facility (pictures to come with final report) was in the range seen with Global Background levels measured and published. The Cell Building reported a 1.28 ug Hg/m^3 value. Both were run at 4 slpm for nearly 24 hours for the best integrated results.

9) **Short Term - Soil Vapor Well Results – Modified EPA 30B:** All with the exception of well CP-VP06, produced results at or below the minimum sample mass of 2ng Hg/trap. The reporting limit (according to EPA 30B) ranged from 0.17-0.23 ug Hg/m^3 for the low level samples).

10) **Long Term – Soil Vapor Well Results – Modified EPA 30B:** All of the results from the long term measurements produced values well above the Reporting Limit which for the Long Term samples ranged from 0.006 – 0.009 ug Hg/m^3.

If you would like to go through this Thursday, please feel free to call anytime.

Best Regards,

Bob

Robert C. Brunette
Senior Manager
Scientist

Frontier Geosciences Inc
Emissions Measurements Laboratory
206 957 1461 (Phone)
206 660 7307 (Cell)

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Port of Bellingham
Results: Total Mercury
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**** Note - Each Sampling System Will Be Checked Against A NIST Traceable System To Determine Actual Flow Rate And Final Sample Volume (Not Available For This Report)***

TABLE 1 - Sample Volume Calculations

Sample Type	Sample ID	Start Time	End Time	Minutes Sampled	Flow Rate (Liters/Min)	Sample Volume (Liters)	
Short Term Samples (Mercury Sorbent Trap Method + Real Time)	CP-VP08	2/17/11 11:13	2/17/11 11:45	32	NA (Mass Flow Totalizer)	10.5	
	CP-VP10	2/17/11 13:19	2/17/11 13:51	32	NA (Mass Flow Totalizer)	11.8	
	CP-VP09	2/17/11 15:34	2/17/11 16:13	39	NA (Mass Flow Totalizer)	8.7	**< 1st Sample Run Lost - Well Produced Water - Had To Rerun and Clean Instrument**
	CP-VP07	2/17/11 17:11	2/17/11 17:42	31	NA (Mass Flow Totalizer)	10.4	
	CP-VP06	2/17/11 18:11	2/17/11 18:50	39	NA (Mass Flow Totalizer)	11.9	
	CP-VP05	2/17/11 19:13	2/17/11 19:45	32	NA (Mass Flow Totalizer)	10.4	
24 Hour Samples (Mercury Sorbent Trap Method)	CP-VP08	2/17/11 11:56	2/18/11 15:15	1629	0.214	349	**< Power Loss @ 2:05pm and 5:40pm (approximately 5 minutes each time) = 10 minutes**
	CP-VP10	2/17/11 13:55	2/18/11 15:25	1530	0.214	327	
	CP-VP09	2/17/11 16:19	2/18/11 15:21	1382	0.214	296	
	CP-VP07	2/17/11 17:47	2/18/11 15:41	1314	0.214	281	
	CP-VP06	2/17/11 19:01	2/18/11 15:52	1251	0.214	268	
	CP-VP05	2/17/11 21:28	2/18/11 15:46	1098	0.214	235	
Ambient Air Samples	Cell Building	2/17/11 16:02	2/18/11 15:28	1406	4.000	5624	
	Inlet To Property	2/18/11 10:42	2/19/11 10:57	1455	4.000	5820	**< 1st Sample Run - Power Unplugged By Someone At Facility (ran a 2nd 24 hr sample)**

TABLE 2: Summary Results - Soil Vapor Wells + Ambient Air Monitoring

Sample Type	Sample ID	FSTM A Hg (ng/trap)	FSTM B Hg (ng/trap)	Total (A + B Trap) (ng /trap)	Total Hg FB Cor (ng / trap)	Sample Volume (Liters)	Total Hg ($\mu g/m^3$)	Comments / Notes	RL
Short Term Samples (20 Minute Samples)	CP-VP08	1.47	0.03	1.50	1.49	10.5	**0.14**	< Sample Trap Below 2 ng/trap EPA 30B Minimum Sample Mass	**0.19**
	CP-VP10	1.81	0.07	1.88	1.88	11.8	**0.16**	< Sample Trap Below 2 ng/trap EPA 30B Minimum Sample Mass	**0.17**
	CP-VP09	0.68	0.04	0.73	0.72	8.7	**0.08**	< Sample Trap Below 2 ng/trap EPA 30B Minimum Sample Mass	**0.23**
	CP-VP07	0.83	0.09	0.92	0.92	10.4	**0.09**	< Sample Trap Below 2 ng/trap EPA 30B Minimum Sample Mass	**0.19**
	CP-VP06	2.59	0.73	3.33	3.32	11.9	**0.28**		**0.17**
	CP-VP05	1.10	0.19	1.29	1.28	10.4	**0.12**	< Sample Trap Below 2 ng/trap EPA 30B Minimum Sample Mass	**0.19**
24 Hour Samples	CP-VP08	4.65	0.06	4.70	4.70	348.6	**0.01**		**0.006**
	CP-VP10	3.01	0.14	3.15	3.14	327.4	**0.01**		**0.006**
	CP-VP09	8.38	0.04	8.43	8.42	295.7	**0.03**		**0.007**
	CP-VP07	6.83	0.19	7.01	7.01	281.2	**0.02**		**0.007**
	CP-VP06	301.96	55.05	357.01	357.01	267.7	**1.33**	**< Well produced water overnight ~20hr long term run - had wet traps (both A and B Sections) - Odd as short term produced no H20**	
	CP-VP05	5.06	0.19	5.25	5.25	235.0	**0.02**		**0.009**
Ambient Air Samples	Cell Building	7132.000 ng	69.62	7201.62	7201.52	5624.0	**1.280**		
	Inlet To Property	16.380 ng	0.34	16.72	16.62	5820.0	**0.003**	**< Consitent With Global Background Levels Of Mercury**	

Well Vapor Sample Trap - Lab Blanks

Lab Blank #	ng Hg/Trap
Lab Blank - 1 (6mm)	0.00
Lab Blank - 2 (6mm)	0.01
Lab Blank - 3 (6mm)	0.00
Average Blk >	0.00

Ambient Air Sample Trap - Lab Blanks

Lab Blank #	ng Hg/Trap
Lab Blank - 1 (10mm)	0.09
Lab Blank - 2 (10mm)	0.18
Lab Blank - 3 (10mm)	0.02
Average Blk >	0.10

Final Report:

Mercury Soil Vapor Monitoring

(Port Of Bellingham)
Sampling Events:
10/20/2011

In Support Of:

Mr. Steve Germiat
Madrone Ln. N.
Bainbridge Island, WA 98110
Direct: 206.838.5830
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Prepared By:

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425-686-1461 (Phone)
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425-686-3096 (fax)
BobB@frontiergs.com

Mr. Germiat,

I am pleased to provide the following final report for the mercury soil vapor sampling efforts at the former Georgia-Pacific/Port Of Bellingham (see report for specific location), performed back on October 20, 2011 in support of Aspect Consulting.

Preliminary data reports were sent via email to Aspect Consulting for this sampling effort in November 2011 respectively.

If you have any questions in regards to this report please do not hesitate to contact me directly.

Best Regards,

Bob

Robert C. Brunette
Senior Project Manager

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Case Narrative-Executive Summary: 10/21/2011 Sampling Effort

Case Narrative – Executive Summary

Field Sampling Summary and Results: Long Term Sampling Via Hg Sorbent Trap Method

1) The long term samples (~ 20 hours) all produced results well above the detection limit of the method.

2) There was no breakthrough from the "A" section to the "B" section of the Modified EPA 30B traps and therefore the traps performed well for this field quality assurance (QA) criteria.

3) For the long term samples, we discovered that upon performing a post flow calibration check for the critical orifice used on CP-VP12, that the flow rate was ~ ½ (0.110 slpm) of what it should be (0.214 slpm). We discovered that it had a small obstruction on the inlet of the critical orifice and once it was cleared, the flow rate (checked against a NIST traceable source) checked out normal. We do not know if this happened during or after the sampling event. Therefore, the long term sample, for CP-VP12 has two reported values – the first as normal flow and the 2nd reported as obstructed flow. The results can therefore be reported in this range (0.23-0.44 ug Hg/m^3).

4) The Real-Time Results shown below for CP-VP12 are below the detection limit of the real-time instrument and therefore cannot be used to corroborate the result for the long term sample at CP-VP12.

5) The short term (20 minute) results and the long-term result however for CP-VP14 and CPVP11 correspond very well. The real-time instrument only had one result above the detection limit (CP-VP14) and the results correspond very well with both the short term (Mod EPA 30B 20 minute sample taken at the outlet end of the real-time instrument during the run) and the long term results from Mod EPA 30B.

Frontier's scope of work to support Aspect Consulting involved the following:

Short-Term Hg Screening Measurements (Lumex/Mod EPA30B): Perform short term/mercury screening sampling using a real-time measurement instrument and simultaneously sample using Frontier's Modified US EPA Method 30B mercury sorbent traps. The results of the real-time screening were designed to aid in determining a sufficient flow rate and long-term sampling approach for the Modified US EPA Method 30B mercury measurements that were to follow. The long term Modified US EPA Method 30B measurements are considered the official reporting values for this effort. Each of the short term screening samples were accomplished at each of 9 wells and ran for ~ 20 minutes at approximately 0.5 slpm.

Long Term Modified US EPA Method 30B Mercury Vapor Measurements: The Long Term mercury monitoring samples were performed from 10/20/11-10/21/11 (less than 24 hours) and involved special critical orifices set at 0.214 SLPM and ran for approximately 20 minutes. Each of the Modified US EPA Method 30B samples (short and long term) were hand carried back Frontier Geosciences Inc where they were checked in to Frontier's LIMS system and a Chain Of Custody Record was create.

Sample Digestion and Analysis: All of the Modified US EPA Method 30B sorbent trap samples were digested and analyzed following Frontier Geosciences Inc SOP FGS-069 for the determination of Total Hg. This method and approach is a National Environmental Laboratory Accreditation Program (NELAP) Accredited Method in the state of Washington as well as ISO-17025.

Project Preparation: Frontier Geosciences Inc worked directly with Jeff Lundrum of Aspect Consulting and performed the following in preparation of the project:

a) Obtained historical data from past measurements to estimate mercury concentrations in order to estimate/calculate field sampling parameters such as sampling time and flow rates to meet minimum sampling parameters.

b) Adapted/Modified US EPA Method 30B (Mercury Sorbent Method) that frontier designed for emissions monitoring to that of the conditions and logistics for vapor well sampling.

c) Adapted Modified EPA 30B to work in conjunction with Aspect soil vapor wells and purchased/prepared special air tight adaptors to ensure no in-leakage to the soil vapor well during sampling.

d) Chose a flow rate and sampling system to do our best to prevent “over sampling” (pulling too much air mass from the well) and therefore potentially over estimate the Hg concentrations by creating such a positive air flow that the soil column would never see).

The original sampling effort utilized previously sampled locations to estimate the amount of mercury that would be captured by the sampling system during the course of the sampling effort.

Hg Vapor Screening Results – Short Term Sampling

<u>Real Time Screening + Modified EPA 30B Results</u>

<u>Description of Sampling Approach:</u>

Frontier's real-time mercury sampling system (portable Zeeman Corrected GFAA) was designed to screen gaseous mercury in real-time while also capturing a Modified US EPA Method 30B sample (NIST Traceable, NELAP Accredited Method):

1) Each sampling location identification was confirmed by observing the adjacent well cap identification and the site ID was then recorded on the mercury vapor well itself.

2) Each monitoring well was fitted with a leak proof well head that allowed Frontier to incorporate a Trace Clean ¼" OD Teflon line through a bulk head fitting.

3) A leak proof bulk head fitting was fixed at the top of each well head cap. The ¼ trace clean Teflon tubing was then placed approximately 12 inches down inside each sampling well.

4) The Teflon sample line from the well was then plumbed into the Real Time Hg Screening Instrument (Lumex RA-915).

5) At the outlet of the Real Time Hg Screening Instrument, a Modified US EPA Method 30B sorbent trap was set inches outside of the instruments detector where as mercury past through the instrument detector, it was then captured onto the Modified EPA Method 30B trap.

6) At the Outlet of the Modified US EPA trap, another sample line ran from the Modified EPA 30B trap and then onto Mass Flow Meter, Volume Totalizer, Flow Controller and Pump. This device was used to pull at approximately 0.5 slpm from the well, through the real-time instrument, into the Modified EPA 30B trap and then into the Mass Flow Meter/Volume Totalizer and pump.

7) At each sampling station, a new piece of ¼ Teflon tubing was used to insert into each well head and

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Port of Bellingham
Results: Total Mercury
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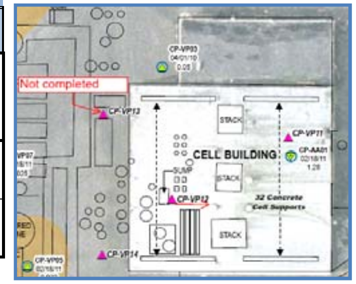
TABLE 1 - Summary Table Of Sample Time, Flow Rate and Sample Volume (Short and Long Term Soil Vapor Hg Monitoring)

Sample Type	Sample ID	Start Time	End Time	Minutes Sampled	Flow Rate (Liters/Min)	Sample Volume (Liters)
Short Term Samples (Mercury Sorbent Trap Method + Real Time)	CP-VP12	10/20/11 14:40	10/20/11 15:13	33	NA (Mass Flow Totalizer)	17.2
	CP-VP14	10/20/11 12:01	10/20/11 12:35	34	NA (Mass Flow Totalizer)	16.6
	CP-VP11	10/20/11 13:38	10/20/11 14:09	31	NA (Mass Flow Totalizer)	18.3
24 Hour Samples (Mercury Sorbent Trap Method)	CP-VP12 **(Normal Flow)**	10/20/11 13:10	10/21/11 11:19	1319	0.210	277
	CP-VP12 **(Obstructed Flow)**	10/20/11 13:10	10/21/11 11:19	1319	0.110	145
	CP-VP14	10/20/11 14:45	10/21/11 11:29	1244	0.206	256
	CP-VP11	10/20/11 16:01	10/21/11 11:40	1179	0.206	242

Aspect Monitoring Map For 10/20-10/21/11 Sampling Event



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Results: Total Mercury
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TABLE 2: Summary Tables Of Results - Short and Long Term Soil Vapor Hg Monitoring (Modified US EPA 30B)

Sample Type	Sample ID	FSTM A Hg (ng/trap)	FSTM B Hg (ng/trap)	Total (A + B Trap) (ng /trap)	Sample Volume in STP (Liters)	Gaseous Hg (µg Hg/m^3) *	Comments / Notes	Reporting Limit (ug Hg/m^3)
Short Term Samples (20 Minute Samples)	CP-VP12	1.81	ND	1.81	17.2	0.11	Valid Result - Above RL - (~6 times average FSTM Blank)	0.06
	CP-VP14	75.20	ND	75.20	16.6	4.53	Valid Result - Above RL - (~ 250 times average FSTM Blank)	0.06
	CP-VP11	0.98	ND	0.98	18.3	0.05	Valid Result - Above RL - (~3 times average FSTM Blank)	0.05
24 Hour Samples	CP-VP12 (Normal Flow)	65.30	ND	65.30	285	0.23	Post sample critical orifice check - normal flow after obstruction in CO removed	0.004
	CP-VP12 (Obstructed Flow)	65.30	ND	65.30	149	0.44	Post sample critical orifice check - showed flow rate 1/2 of actual due to obstruction in CO	0.007
	CP-VP14	1220.00	ND	1220.00	267	4.58		0.004
	CP-VP11	15.10	0.30	15.40	252	0.06		0.004

ND = sample is below 0.17 ng Hg/trap

*** STP Corrected**

TABLE 2A: Summary Tables Of Results - Real-Time Mercury Instrument Measurements

Sample Type	Sample ID	Area	ng Hg/test run	Sample Volume	ug Hg/m^3	Reporting Limit *	
Short Term Samples (20 Minute Samples)	CP-VP12	55.00	1.09	17.2	0.06	0.29	< Less than detection limit
	CP-VP14	4073.00	80.52	16.6	4.85	0.30	
	CP-VP11	127.00	2.51	18.3	0.14	0.27	< Less than detection limit

*** STP Corrected**

TABLE 3a- Sample Volume Conversion to STP (For Long Term Samples Only)

Sample ID	Pressure (mbar)	Temperature (°C)	Sample Volume (L)	STP Sample Volume (L)
CP-VP12 (Normal Flow)	1013.0	15.9	277	285
CP-VP12 (Obstructed Flow)	1013.0	15.9	145	149
CP-VP14	1013.0	13.6	256	267
CP-VP11	1013.0	14.0	242	252

TABLE 3b- Sample Volume Conversion to STP

Sample ID	STP (°C and mbar)
Temperature	25.0
Pressure	1013.3

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TABLE 4: A Trap Hg Results (Short Term and Long Term Samples - Modified EPA 30B)

Lab Data Set ID	Lab Run #	Sample ID	Hg-A (ng/trap)	Hg-B (ng/trap)	Total (A + B Trap) (ng/trap)
THg17-111027-1	1716	CPUP-14 ShortTerm Lumex FSTM	75.2 ng	ND	**75.2 ng**
THg17-111027-1	1717	West Well Cell Bldg-Short Term Lumex FSTM	1.0 ng	ND	**1.0 ng**
THg17-111027-1	1718	East Cell-CPUP-12-ShortTerm-Lumex FSTM	1.4 ng	ND	**1.4 ng**
THg17-111027-1	1719	CPUP-12-Cell Bldg-102011-Field Blank-ShortTerm	ND	ND	**0.0 ng**
THg17-111027-1	1720	CPUP-14-Longterm-FSTM	1220.0 ng	ND	**1220.0 ng**
THg17-111027-1	1723	East Well- Cell Bldg-102011-LongTerm	15.1 ng	0.3 ng	**15.4 ng**
THg17-111027-1	1724	CPUP-12-East Cell Bldg- Long Term-102011-Spike	65.3 ng	ND	**65.3 ng**
THg17-111027-1	1725	CPUP-12-West Cell Bldg-102111-Field Blank	ND	ND	**0.0 ng**
THg17-111027-1	1726	Trip Blank/Lab Blank	ND	ND	**0.0 ng**
THg17-111027-1	1727	Lab Spike/Spike/Trip Blank	ND	ND	**0.0 ng**

ND = sample is below 0.17ng/trap

TABLE 5: B Trap Hg Results (Short Term and Long Term Samples - Modified EPA 30B)

Lab Data Set ID	Lab Run #	Sample ID	Hg-B (ng/trap)
THg17-111027-1	1732	CPUP-14 ShortTerm Lumex FSTM	ND
THg17-111027-1	1735	West Well Cell Bldg-Short Term Lumex FSTM	ND
THg17-111027-1	1736	East Cell-CPUP-12-ShortTerm-Lumex FSTM	ND
THg17-111027-1	1741	CPUP-12-Cell Bldg-102011-Field Blank-ShortTerm	ND
THg17-111027-1	1742	CPUP-14-Longterm-FSTM	ND
THg17-111027-1	1743	East Well- Cell Bldg-102011-LongTerm	0.260 ng
THg17-111027-1	1744	CPUP-12-East Cell Bldg- Long Term-102011-Spike	ND
THg17-111027-1	1749	CPUP-12-West Cell Bldg-102111-Field Blank	ND
THg17-111027-1	1750	Trip Blank/Lab Blank	ND
THg17-111027-1	1751	Lab Spike/Spike/Trip Blank	ND

TABLE 6: C Trap Results (Short Term and Long Term Samples - Modified EPA 30B)

Lab Data Set ID	Lab Run #	Sample ID	Hg-C (ng/trap)	True Value	% Recovery
THg17-111027-1	1752	CPUP-12-East Cell Bldg- Long Term-102011-Spike	50.7 ng	60ng	**84.5%**
THg17-111027-1	1753	Lab Spike/Spike/Trip Blank	45.1 ng	60ng	**75.2%**

TABLE 7: Reagent Blank - FSTM Method

Lab Data Set ID	Lab Run #	Sample ID	ng/blank
THg17-111027-1	1711	F110361-BLK1	0.00 ng
THg17-111027-1	1712	F110361-BLK2	0.09 ng
THg17-111027-1	1713	F110361-BLK3	0.73 ng
		Average >	0.27
		Standard Deviation (SD) >	0.40
		Relative Standard Deviation (RSD) >	144.4%
		Minimum Detection Limit (MDL)	0.340 ng
		Minimum Reporting Limit (MRL)	2.00 ng

TABLE 8: Analysis QA/QC Performance Summary - ICV Results (Secondary Standard)

Lab Data Set ID	Lab Run #	QC Parameter	Observed Value	True Value	SRM % Recovery	QA/QC Range
THg17-111027-1	1706	SEQ-ICV1	4.54 ng/L	5.0	90.8%	90%-110%

TABLE 9: Frontier Geosciences Analytical Spike Recovery

Lab Data Set ID	Lab Run #	Sample ID	Measured (ng/trap)	Net Measured (ng/trap)	Expected (ng/trap)	% Recovery	QA/QC Range
THg17-111027-1	1738	F110361-MS1	272.9 ng	197.7 ng	200	98.9%	
THg17-111027-1	1747	F110361-MSD1	277.2 ng	202.0 ng	200	101.0%	75%-125%

TABLE 10: Lab Replicate Results

Lab Data Set ID	Lab Run #	Sample ID	Replicate#1 (ng/trap)	Replicate#2 (ng/trap)	RPD	QA/QC Range
THg17-111027-1	1737	F110361-DUP1	75.2 ng	64.5 ng	15.4%	< 25%

TABLE 11: Lab Control Spike Results

Lab Data Set ID	Lab Run #	Sample ID	Measured (ng/trap)	Expected (ng/trap)	% Recovery	QA/QC Range
THg17-111027-1	1714	F110361-BS1	24.3 ng	25	97.1%	75%-125%
THg17-111027-1	1715	F110361-BSD1	20.8 ng	25	83.0%	75%-125%

TABLE 12: Initial and Continued Calibration Blanks (ICB and CCBs)

Lab Data Set ID	Lab Run #	CCB ID	ICB/CCB (ng Hg/Blank)	QA/QC Acceptance
THg17-111027-1	1707	SEQ-IBL1	0.020 ng/L	< 0.50
THg17-111027-1	1708	SEQ-IBL2	-0.004 ng/L	< 0.50
THg17-111027-1	1709	SEQ-IBL3	-0.030 ng/L	< 0.50
THg17-111027-1	1710	SEQ-IBL4	0.008 ng/L	< 0.50
THg17-111027-1	1722	SEQ-CCB1	0.130 ng/L	< 0.50
THg17-111027-1	1734	SEQ-CCB2	0.050 ng/L	< 0.50
THg17-111027-1	1746	SEQ-CCB3	0.090 ng/L	< 0.50
THg17-111027-1	1756	SEQ-CCB4	0.030 ng/L	< 0.50

TABLE 13: Continued Calibration Verification (Primary Standard)

Lab Data Set ID	Lab Run #	CCV ID	Measured	True Value	% Rec.	QA/QC Acceptance
THg17-111027-1	1721	SEQ-CCV1	17.87 ng/L	20.0	89.4%	80% - 120%
THg17-111027-1	1733	SEQ-CCV2	18.65 ng/L	20.0	93.3%	80% - 120%
THg17-111027-1	1746	SEQ-CCV3	19.31 ng/L	20.0	96.6%	80% - 120%
THg17-111027-1	1755	SEQ-CCV4	5.33 ng/L	5.0	106.6%	80% - 120%

Field Forms

1110335

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Short Term w/ Lumex

Field Sample Data Sheet

Sample Date: 10/20/11 Sample Box ID: 11621

Sample Location: CPVP-14

Sample Matrix: Soil VAPOR

Pre-Sample Leak Check: ~~-0.012~~ -0.001 OK & -0.005 OK (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPVP-14 - Short Term - Lumex - FTSM

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	12:01 pm	-0.012	0.488	—	—	Ø
2	~~12:06~~ 12:08 pm ON		0.493	—	—	3.00
3	12:15 pm		0.495	—	—	6.92
4	12:27 pm		0.497	—	—	12.29
5	12:31 pm		0.498	—	—	14.35
6	12:35 pm OFF		0.499			16.19 STOP
7						
8						
9						
10						

Notes:

Stack Gas Parameters
% M ________
% O2 ________ (wet or dry)
%CO2 ________ (wet or dry)
Barometric Pressure ____________
Temp __________

NEW WATER TRAP METHOD

Received by - [illegible] FGS

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NN9540

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Short TERM LUMEX

Field Sample Data Sheet

Sample Date: 10-20-11 **Sample Box ID:** 1162 1

Sample Location: West well in cell Bldg Cell Bldg WEST Well

Sample Matrix: Soil VAPOR

Pre-Sample Leak Check: -0.002 ↓ OK (slpm)

Post-Sample Leak Check: 0.016 ↓ OK (slpm) West well Cell Bldg -

Sample Trap ID: ~~[illegible]~~ Short Term - LUMEX - PTSM 10-20-11

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
ON 1	1:38 pm	-0.010	0.513	/	/	Ø
* 2	1:49 pm		0.514	/	/	7.63 Liters
3	2:03 pm		0.520	/	/	14.79 Liters
OFF 4	~~2:08~~ 2:09		0.522			17.98
5						
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

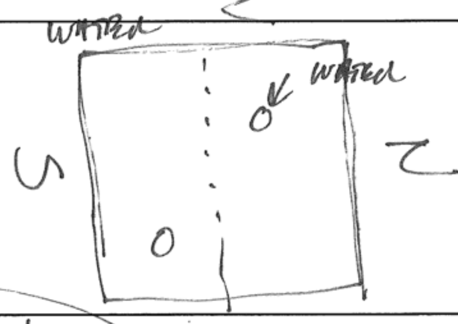
% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp ____________



* Flow Ran up to 0.75 slpm
Adjusted down

Received by: [illegible]
FGS

1110335

NNP 9543

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Field Sample Data Sheet

Sample Date: 10-20-11 **Sample Box ID:** 11621

Sample Location: East Cell-CPVP-12 Lumex Short Term

Sample Matrix: Soil

Pre-Sample Leak Check: 0.004 ↓ OK (slpm)

Post-Sample Leak Check: -0.005 OK (slpm)

Sample Trap ID: East Cell-CPVP-12-Short term Lumex 102011

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)	
Start 1	2:40 pm	-0.008	0.501	/	/	0	
2	2:53 pm		0.501	/	/	7.01	Liters
3:06 3	~~[illegible]~~ pm		0.505	/	/	13.47	
4	3:13 pm		0.505	/	/	16.90	Liter Off
5							
6							
7							
8							
9							
10							

Notes:
Stack Gas Parameters
% M ________
% O2 ________ (wet or dry)
%CO2 ________ (wet or dry)
Barometric Pressure ____________
Temp __________

Note - CPVP-12 was difficult to read as it looked like it had been written over on cement - no signal w/ Lumex

Received by: [signature], FGS

NNP 9524

1110335

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(206) 622-6960 • fax (206) 622-6870
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Field Sample Data Sheet

Sample Date: 102011 **Sample Box ID:** 11621

Sample Location: CPVP-12-Cell Bldg-102011 Field Blank Short term

Sample Matrix: Soil VAPO

Pre-Sample Leak Check: -0.005 ↓ Ok (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPVP-12-Cell Bldg-102011-Field Blank

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1	3:28 pm	NA		—	—	Ø
2						
3						
4						
5						
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp ________

Field Blank

Short Term

Received by: [illegible], FGS

1110335

NNP 9541

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Field Sample Data Sheet

Sample Date: 10-20-11 **Sample Box ID:** CPVP-14 Long term (outside)

Sample Location: CPVP-14

Sample Matrix: Soil Vapor

Pre-Sample Leak Check: OK (slpm) (Through Alt MPM #10956)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPVP-14 - Long term - FSTM 10-20-11

	10/20/11 Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	VAC ~~Hg(II) or THg Trap Temp (F)~~	Probe Temp (F)	Total Volume (Liters)
START 1	1:10 pm	NA	~0.214	20" Hg	—	0
2					—	
3	4:30 pm	/	~0.214	~20" Hg		
4	10/21/11 - 11:18Am		~0.214	~20" Hg	—	0
OFF 5	11:19Am		~0.214	~20" Hg	—	OFF
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp __________

~1013 mb/hPa
~13.6 °C
@ 11:18Am.

Received by: [signature], FGS

NNP9550

1110335

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Field Sample Data Sheet

Cell Bldg East ~~West~~ Well

Sample Date: 10-20-11

Sample Box ID: (no ID)

Sample Location: East ~~West~~ Well - Cell BLD

Long Term

Sample Matrix: Soil Vapor

Pre-Sample Leak Check: OK (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: Cell Bldg - West Well - Long Term - 102011 - FSTM

Gauge

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	~~Probe Temp (F)~~	Total Volume (Liters)
1	2:45 pm		~0.214	-25"Hg	/	Ø
2	4:10 pm		.01	-26"Hg	/	
3	10-21-11 @ 11:29 am			-26"Hg		
4						
5						
6						
7						
8						
9						
10						

stop → off

off

Logged to reflect sample label That was in bag w/this paperwork. Sample label reads:

East Well - Cell Bldg - 102011 Long Term

No

1013 mb/hPa

14.0C

@ 11:29 Am 10-21-11

Received by: [signature] FGS

1110335

NO NNP# VISIBLE - AMB 10-25-11

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Field Sample Data Sheet

Sample Date: 10-20-11

Sample Box ID: ~~East~~ West CPVP-12 cell Bldg Long Term

Sample Location: CPVP-12 - West Cell Bldg -

Sample Matrix: Soil Vapor

Pre-Sample Leak Check: ________ (slpm)

Post-Sample Leak Check: ________ (slpm)

Sample Trap ID: CPVP-12-West cell-Long Term-102011-FSpm

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	~~Hg(II) or THg~~ Gauge Trap Temp (F)	~~Probe Temp (F)~~	Total Volume (Liters)
ON 10/20/11 1	4:01 pm	NA	~0.214	-25" Hg		Ø
2						
OFF 10/21/11 3	11:40 Am	NA	~0.214	-25" Hg		OFF
4						

Sample logged to reflect what its label read that was in same bag as this paperwork. Sample label reads: CPUP-12-East Cell-Bldg-LongTerm-102011 SPIKE

-4:13 pm 17.7°C

1013 mb/hPa

11:37 Am 10/21/11 1013 mb/hPa 14.1°C

Well ~~H2O~~ FSm

outside well Cor/ct

Received by: [signature], FGS

1110335

NNP9546

Frontier GeoSciences Inc.
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Field Sample Data Sheet

Sample Date: 10-21-11 **Sample Box ID:** (West Bld)

Sample Location: CPVP-12 (West Bldg)

Sample Matrix: Soil Vapor

Pre-Sample Leak Check: ✓ (slpm) OK

Post-Sample Leak Check: ✓ (slpm) OK Cuf

11:43 am

Sample Trap ID: CPVP-12 - West Bld - 112111 - Field Blan

	Time of Volume Reading (HH:MM;SS)	Zero Offset (slpm)	Flow Rate (slpm)	Hg(II) or THg Trap Temp (F)	Probe Temp (F)	Total Volume (Liters)
1						
2						
3						
4	Field					
5		Blank				
6						
7						
8						
9						
10						

Notes:

Stack Gas Parameters

% M ________

% O2 ________ (wet or dry)

%CO2 ________ (wet or dry)

Barometric Pressure ____________

Temp __________

Received by: [signature], FGS

Frontier – Critical Orifice Calibration Check Vs. NIST Traceable Flow Meter

<u>Approach for Low Flow Sampling and Critical Orifice Calibration:</u> Frontier used special low-flow critical orifices to perform the long term (~ 20 hour) sampling. Frontier recognized that this low-flow sampling approach was very important dynamic for this type of sampling due to the small diameter sampling well pipe and relatively small volume air column to sample from. If the flow rate was too high (fast) the air column of the sampling well would be evacuated and lead to the possibility of air being pulled from the outside (ambient air) down into the surrounding well overpack. This was prevented by using very low flow critical orifices.

<u>Critical Orifice Calibration:</u> After the sampling event, each critical orifice and sampling pump system was then checked for flow rate verification by running against a NIST Traceable flow calibration system (Gilibrator model x). Each critical orifice was checked for accuracy of flow rate by running 10 runs against the NIST traceable calibration system. In turn, the average of the 10 critical orifice flow measurements from the NIST traceable flow check system was used to calculate the sample flow rate and correction factor that was then applied to each long term sample volume.

Due to the relative small size of the soil gas wells (3/4" Schedule 80), our approach was to take low flow (0.214 liter per minute) sample flow rates through our modified US EPA 30B Traps. This was to ensure that we did not pull at such a flow rate that we would evacuate the soil gas probe, draw a vacuum and potentially over estimate the flux of mercury from the soil gas well by drawing it up and out of soils.

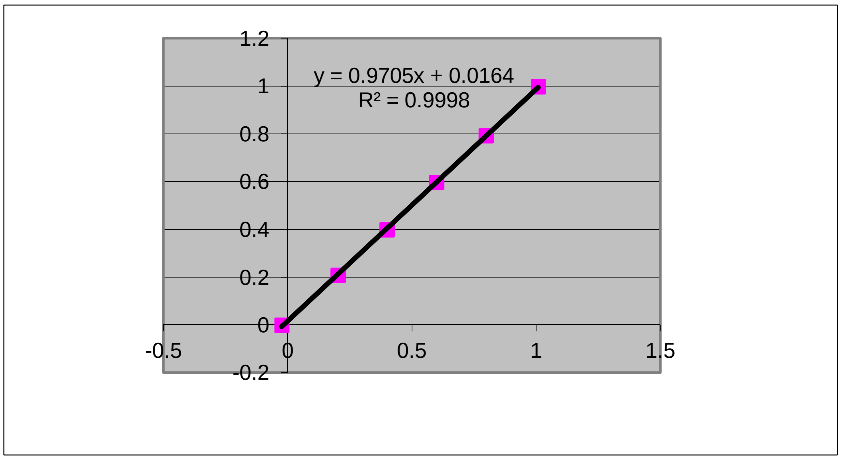
A 0.214 slpm critical orifice was chosen to regulate the air flow through the modified US EPA 30B sorbent trap. This was in turn attached to the sample line with a pressure gauge to ensure critical vacuum was maintained. After the sampling event, each critical orifice and sampling pump system was then checked for flow rate verification by running against a NIST Traceable flow calibration system (Gilibrator model x).

Each critical orifice was checked for accuracy of flow rate by running 10 runs against the NIST traceable calibration system. In turn, the average of the 10 critical orifice flow measurements from the NIST traceable flow check system was used as

Critical Orifice Calibration Check vs NIST Traceable Flow Meter (24 hour sampling) (Critical Orifice fixed @ 0.214 lpm vs Actual flow NIST standard)				
Site ID/ Pump Label	**CPVP-12 (Before)**	**CPVP-12 (After)**	**CPVP-14**	**CPVP-11**
Rep #1	0.1099	0.2094	0.2056	0.2061
Rep #2	0.1098	0.2095	0.2058	0.2062
Rep #3	0.1096	0.2096	0.2059	0.2065
Rep #4	0.1095	0.2097	0.2060	0.2064
Rep #5	0.1095	0.2097	0.2061	0.2056
Rep #6	0.1096	0.2100	0.2066	0.2052
Rep #7	0.1098	0.2098	0.2060	0.2049
Rep #8	0.1097	0.2100	0.2062	0.2033
Rep #9	0.1098	0.2100	0.2062	0.2056
Rep #10	0.1096	0.2100	0.2068	0.2051
Average (lpm)	**0.1097**	**0.2098**	**0.2061**	**0.2055**
St Dev (lpm)	0.0001	0.0002	0.0004	0.0010
Correction Factor	51.2%	97.9%	96.2%	95.9%

Date: 10/27/2011

Average flow flow meter	Avg Flow Gillibrator
-0.024	0
0.202	0.2079
0.399	0.3983
0.599	0.5964
0.799	0.7931
1.008	0.9976



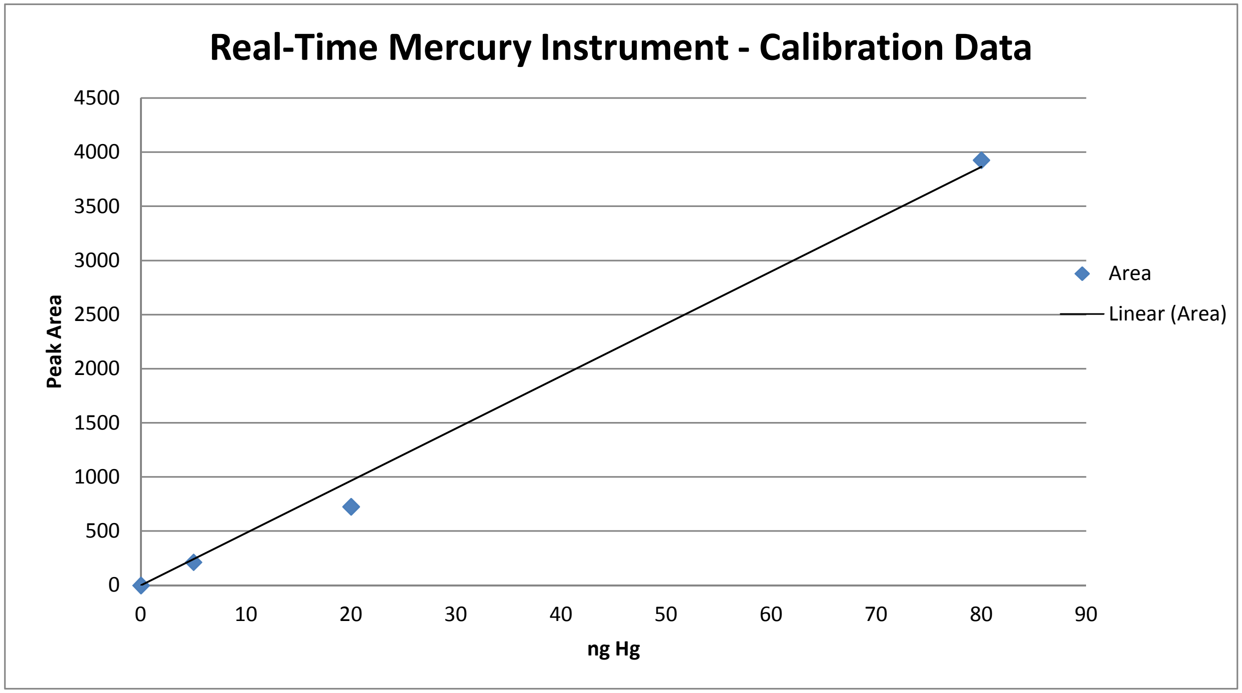
30 minutes @ 500 cc/min = 150.4

Calibration Data

ng Hg	Area	%rec
0	0	NA
5	214	0.846089
20	727	0.718582
80	3926	0.970136

Curve slope= 50.6

R= 0.9981



Real-Time Hg Instrument - Calculated Values

Site Name	Area	ng Hg	Sample Volume (Liters)	ug Hg/m^3	Reporting Limit (ug Hg/m^3)
CPVP 12	55	1.1	17.2	0.063	0.291
CPVP 14	4073	80.5	16.6	4.848	0.301
CPVP 11	127	2.5	18.3	0.137	0.273

Frontier Digestion Logbook Pages

Sample Digestion and Percent Solids Log

Name: David W.   Date: 10/27/11   Final volume: 20

Client Name: Aspect Consulting

Sample Matrix: ☒ FSTM ☐ Waters ☐ KCL ☐ PHg Plug ☐ Coal ☐ Other

Analysis: ☑ Total Hg ☐ Methyl Hg ☐ Other

Digestion type: ☒ 70/30 Digestion, 2 Hours @ ~55°C ☐ 5% BrCl Oxidation, 4 hours

Digest #	Sample ID Number	Sample Size ☒ml ☐g
	F110361-Blk1	20
	Blk2	20
	Blk3	20
	BS1	20
	BSD1	20
	1110335-01	20
	-01	20
	-02	20
	-02	20
	-03	20
	-03	20
	-04	20
	-04	20
	-05	20
	-05	20
	-06	20
	-06	20
	-07 A	20
	-07 B	20
	-07 C	20
	-08	20
	-08	20
	-09	20
	-09	20
	-10	20
	-10	20
	-10	20

RW 10/27/11

Spike ID: 1101702

Spike Amount: 25 µL

Spike Witness: —

BrCl ID: 1102966

HNO_3:

H_2SO_4:

70/30: 1102096

Thermometer:

Dispenser: ~~V75~~ RW 10/27/11 0128684

Dispenser: 026247

Balance:

Comments:
* Client added arrow to show flow of trap. Orientation was opposite of normal A & B bed positioning. Analyst followed client arrow to determine A & B beds.

Frontier Global Sciences, Inc
Sample Digestion and Percent Solids Log
LOG-HG-015.07
Effective: June 2, 2011
Page 74 of 100

NIST Certificates for Analytical Standards

HIGH-PURITY STANDARDS
www.highpuritystandards.com

Mercury Standard 1000 ug/mL

LIMS ID:	1001474
Prep Date:	07-Oct-10 00:00
Prep By:	Teresa Einhaus
Expire Date:	23-Mar-12 00:00

P.O. Box 41727
Charleston, SC 29423
Phone (843) 767-7900
Fax (843) 767-7906

Verified LMK 10/11/10

Certificate of Analysis

Product Description:

Name:	Mercury	Source Material:	Mercury Metal
Part Number:	**100033-1**	Material Purity:	99.9998%
Lot Number:	**1019407**	Matrix:	2% (v/v) HNO_3

Certified Value: 1000 µg/mL ± 6 µg/mL

The Certified value is based on gravimetric and volumetric preparation, and confirmed against SRM 3133 (lot number 061204) by inductively coupled plasma optical emission spectrometry (ICP-OES) using an internal laboratory-developed method. The uncertainty in the certified value is calculated for a 95% confidence interval and coverage factor *k* is about 2.

Uncertified Values:

Density: 1.0083 g/mL @ 24.1°C

Trace Metal Impurity Scan:
The typical values detected in the standard solution at 1000 µg/mL are listed below in µg/L. The values are based upon the ICP analysis results for the starting source material.

Ag	<0.02	Cu	<0.25	La	<0.02	Pt	<0.02	Te	<0.02
Al	<0.1	Dy	<0.02	Li	<0.02	Rb	<0.02	Th	<0.02
As	<0.05	Er	<0.02	Lu	<0.02	Re	<0.02	Ti	<0.02
Au	<0.02	Eu	<0.02	Mg	<0.5	Rh	<0.02	Tl	<0.02
B	<1	Fe	<1	Mn	<0.1	Ru	<0.02	Tm	<0.02
Ba	<0.02	Ga	<0.02	Mo	<0.02	Sb	<0.02	U	<0.1
Be	<0.02	Gd	<0.02	Na	<1	Sc	<0.02	V	<0.05
Bi	<0.02	Ge	<0.02	Nb	<0.02	Se	<0.1	W	<0.02
Ca	<0.1	Hf	<0.02	Nd	<0.02	Si	<1	Y	<0.02
Cd	<0.02	Hg	M	Ni	<0.02	Sm	<0.02	Yb	<0.02
Ce	<0.02	Ho	<0.02	Os	<0.02	Sn	<1	Zn	<0.1
Co	<0.05	In	<0.02	Pb	<0.05	Sr	<0.02	Zr	<0.02
Cr	<0.1	Ir	<0.02	Pd	<0.02	Ta	<0.02		
Cs	<0.02	K	<1	Pr	<0.02	Tb	<0.02		

Preparation Information:

The standard solution is prepared using high purity materials and assayed by analytical methods for conformity prior to use. This standard was prepared using the methods developed at NIST for SRM Spectrometric Standard Solutions under appropriate laboratory conditions.

Sub-boiling distilled high-purity acid has been used to place the materials in solution and to stabilize the standard. The matrix is as noted above in 18 megaohm deionized water.

Stability of this product is based upon rigorous short term and long term testing of the solution for the certified value. This testing includes, but is not limited to, the effect of temperature and packaging on the product.

Intended Use:

This Certified Reference Material (CRM) is intended for use as a calibration standard for the quantitative determination of mercury, calibration of instruments such as ICPOES, ICPMS, AAS and XRF, and validation of analytical methods. It also can be used in EPA, ASTM and other methods.

Air Toxics Ltd. Report for Petroleum Hydrocarbon Soil Vapor Data

3/2/2011
Mr. Jeff Landrum
Aspect Consulting LLC
401 Second Avenue South
Suite 201
Seattle WA 98104

Project Name: GP West
Project #: 070188
Workorder #: 1102159AR2

Dear Mr. Jeff Landrum

The following report includes the data for the above referenced project for sample(s) received on 2/9/2011 at Air Toxics Ltd.

The data and associated QC analyzed by Modified TO-15 are compliant with the project requirements or laboratory criteria with the exception of the deviations noted in the attached case narrative.

Thank you for choosing Air Toxics Ltd. for your air analysis needs. Air Toxics Ltd. is committed to providing accurate data of the highest quality. Please feel free to contact the Project Manager: Kelly Buettner at 916-985-1000 if you have any questions regarding the data in this report.

Regards,

Kelly Buettner

Project Manager

Air Toxics LTD.
Laboratory Services Since 1989

WORK ORDER #: 1102159AR2

Work Order Summary

CLIENT:	Mr. Jeff Landrum Aspect Consulting LLC 401 Second Avenue South Suite 201 Seattle, WA 98104	**BILL TO:**	Accounts Payable Aspect Consulting LLC 179 Madrone Lane North Bainbridge Island, WA 98110
PHONE:	206-328-7443	**P.O. #**	070188-001-11
FAX:	206-838-5853	**PROJECT #**	070188 GP West
DATE RECEIVED:	02/09/2011	**CONTACT:**	Kelly Buettner
DATE COMPLETED:	02/16/2011		
DATE REISSUED:	03/02/2011		

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	FINAL PRESSURE
01A	BC- VP04	Modified TO-15	3.8 "Hg	5 psi
02A	BC- VP02	Modified TO-15	2.4 "Hg	5 psi
03A	BC- VP01	Modified TO-15	2.0 "Hg	5 psi
04A	MG- VP03	Modified TO-15	4.0 "Hg	5 psi
05A	MG- VP01	Modified TO-15	2.0 "Hg	5 psi
06A	MG- VP02	Modified TO-15	3.2 "Hg	5 psi
07A	BC- VP03	Modified TO-15	2.4 "Hg	5 psi
08A	MG- VP04	Modified TO-15	2.0 "Hg	5 psi
09A	Lab Blank	Modified TO-15	NA	NA
09B	Lab Blank	Modified TO-15	NA	NA
10A	CCV	Modified TO-15	NA	NA
10B	CCV	Modified TO-15	NA	NA
11A	LCS	Modified TO-15	NA	NA
11AA	LCSD	Modified TO-15	NA	NA
11B	LCS	Modified TO-15	NA	NA
11BB	LCSD	Modified TO-15	NA	NA

CERTIFIED BY: Linda L. Freeman DATE: 03/02/11

Laboratory Director

Certfication numbers: CA NELAP - 02110CA, LA NELAP/LELAP- AI 30763,
NY NELAP - 11291, UT NELAP - 9166389892, AZ Licensure AZ0719
Name of Accrediting Agency: NELAP/Florida Department of Health, Scope of Application: Clean Air Act,
Accreditation number: E87680, Effective date: 07/01/09, Expiration date: 06/30/11
Air Toxics Ltd. certifies that the test results contained in this report meet all requirements of the NELAC standards

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA - 95630
(916) 985-1000 . (800) 985-5955 . FAX (916) 985-1020

LABORATORY NARRATIVE
EPA Method TO-15
Aspect Consulting LLC
Workorder# 1102159AR2

Eight 6 Liter Summa Canister samples were received on February 09, 2011. The laboratory performed analysis via modified EPA Method TO-15 using GC/MS in the full scan mode.

This workorder was independently validated prior to submittal using 'USEPA National Functional Guidelines' as generally applied to the analysis of volatile organic compounds in air. A rules-based, logic driven, independent validation engine was employed to assess completeness, evaluate pass/fail of relevant project quality control requirements and verification of all quantified amounts.

Receiving Notes

The Chain of Custody (COC) information for sample MG- VP01 did not match the information on the canister with regard to canister identification. The client was notified of the discrepancy and the information on the canister was used to process and report the sample.

Analytical Notes

Dilution was performed on sample MG- VP04 due to the presence of high level non-target species.

PER CLIENT'S REQUEST, THE WORKORDER WAS REISSUED ON 2/23/11 TO AMEND THE TARGET COMPOUND LIST. CHANGING THE COMPOUND LIST CAUSED SOME PREVIOUSLY REPORTED COMPOUNDS TO BECOME NOT REPORTED.

THE WORKORDER WAS REISSUED ON MARCH 02, 2011 TO UPDATE THE PREVIOUSLY REPORTED NARRATIVE REGARDING THE DILUTION OF SAMPLE BC- VP01 TO REFLECT THE CURRENT COMPOUND LIST AS FOLLOWS:

DILUTION WAS PERFORMED ON SAMPLE BC- VP01 DUE TO THE PRESENCE OF HIGH LEVEL NON-TARGET SPECIES.

Definition of Data Qualifying Flags

Eight qualifiers may have been used on the data analysis sheets and indicates as follows:

B - Compound present in laboratory blank greater than reporting limit (background subtraction not performed).

J - Estimated value.

E - Exceeds instrument calibration range.

S - Saturated peak.

Q - Exceeds quality control limits.

U - Compound analyzed for but not detected above the reporting limit.

UJ- Non-detected compound associated with low bias in the CCV and/or LCS.

N - The identification is based on presumptive evidence.

File extensions may have been used on the data analysis sheets and indicates

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as follows:
a-File was requantified
b-File was quantified by a second column and detector
r1-File was requantified for the purpose of reissue

Summary of Detected Compounds
MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

Client Sample ID: BC- VP04

Lab ID#: 1102159AR2-01A

No Detections Were Found.

Client Sample ID: BC- VP02

Lab ID#: 1102159AR2-02A

No Detections Were Found.

Client Sample ID: BC- VP01

Lab ID#: 1102159AR2-03A

No Detections Were Found.

Client Sample ID: MG- VP03

Lab ID#: 1102159AR2-04A

No Detections Were Found.

Client Sample ID: MG- VP01

Lab ID#: 1102159AR2-05A

No Detections Were Found.

Client Sample ID: MG- VP02

Lab ID#: 1102159AR2-06A

No Detections Were Found.

Client Sample ID: BC- VP03

Lab ID#: 1102159AR2-07A

No Detections Were Found.

Client Sample ID: MG- VP04

Lab ID#: 1102159AR2-08A

No Detections Were Found.

Client Sample ID: BC- VP04

Lab ID#: 1102159AR2-01A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020920**	**Date of Collection:**	**2/3/11 1:37:00 PM**
Dil. Factor:	**1.53**	**Date of Analysis:**	**2/10/11 04:27 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	3.1	Not Detected	16	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	104	70-130
Toluene-d8	101	70-130
4-Bromofluorobenzene	95	70-130

Client Sample ID: BC- VP02

Lab ID#: 1102159AR2-02A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020921**	**Date of Collection: 2/3/11 2:05:00 PM**
Dil. Factor:	**1.46**	**Date of Analysis: 2/10/11 04:59 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	2.9	Not Detected	15	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	100	70-130
Toluene-d8	100	70-130
4-Bromofluorobenzene	98	70-130

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Client Sample ID: BC- VP01

Lab ID#: 1102159AR2-03A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020923**	**Date of Collection:**	**2/3/11 2:20:00 PM**
Dil. Factor:	**5.76**	**Date of Analysis:**	**2/10/11 06:32 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	12	Not Detected	60	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	110	70-130
Toluene-d8	110	70-130
4-Bromofluorobenzene	101	70-130

Client Sample ID: MG- VP03

Lab ID#: 1102159AR2-04A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020924**	**Date of Collection: 2/3/11 2:50:00 PM**
Dil. Factor:	**1.55**	**Date of Analysis: 2/10/11 06:51 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	3.1	Not Detected	16	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	100	70-130
Toluene-d8	101	70-130
4-Bromofluorobenzene	97	70-130

Client Sample ID: MG- VP01

Lab ID#: 1102159AR2-05A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020925**	**Date of Collection:**	**2/3/11 3:15:00 PM**
Dil. Factor:	**1.44**	**Date of Analysis:**	**2/10/11 07:41 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	2.9	Not Detected	15	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	103	70-130
Toluene-d8	106	70-130
4-Bromofluorobenzene	99	70-130

Client Sample ID: MG- VP02

Lab ID#: 1102159AR2-06A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020926**	**Date of Collection:**	**2/3/11 3:35:00 PM**
Dil. Factor:	**1.50**	**Date of Analysis:**	**2/10/11 08:00 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	3.0	Not Detected	16	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	105	70-130
Toluene-d8	99	70-130
4-Bromofluorobenzene	92	70-130

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Client Sample ID: BC- VP03

Lab ID#: 1102159AR2-07A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6021118**	**Date of Collection:**	**2/8/11 10:40:00 AM**
Dil. Factor:	**1.46**	**Date of Analysis:**	**2/11/11 03:10 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	2.9	Not Detected	15	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	103	70-130
Toluene-d8	97	70-130
4-Bromofluorobenzene	103	70-130

Client Sample ID: MG- VP04

Lab ID#: 1102159AR2-08A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6021119**	**Date of Collection: 2/8/11 11:00:00 AM**
Dil. Factor:	**28.8**	**Date of Analysis: 2/11/11 03:30 PM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	58	Not Detected	300	Not Detected

Container Type: 6 Liter Summa Canister

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	98	70-130
Toluene-d8	104	70-130
4-Bromofluorobenzene	99	70-130

Client Sample ID: Lab Blank

Lab ID#: 1102159AR2-09A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020913**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 2/10/11 11:05 AM**	

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	2.0	Not Detected	10	Not Detected

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	101	70-130
Toluene-d8	104	70-130
4-Bromofluorobenzene	95	70-130

Client Sample ID: Lab Blank

Lab ID#: 1102159AR2-09B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6021108**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 2/11/11 11:13 AM**

Compound	Rpt. Limit (ppbv)	Amount (ppbv)	Rpt. Limit (ug/m3)	Amount (ug/m3)
Naphthalene	2.0	Not Detected	10	Not Detected

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	107	70-130
Toluene-d8	103	70-130
4-Bromofluorobenzene	92	70-130

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Client Sample ID: CCV

Lab ID#: 1102159AR2-10A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020904**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 2/9/11 10:49 PM**

Compound	%Recovery
Naphthalene	72

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	98	70-130
Toluene-d8	106	70-130
4-Bromofluorobenzene	103	70-130

Client Sample ID: CCV

Lab ID#: 1102159AR2-10B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6021102**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 2/11/11 08:42 AM**

Compound	%Recovery
Naphthalene	71

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	96	70-130
Toluene-d8	101	70-130
4-Bromofluorobenzene	105	70-130

Client Sample ID: LCS

Lab ID#: 1102159AR2-11A

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020905**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 2/9/11 11:38 PM**

Compound	%Recovery
Naphthalene	73

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	99	70-130
Toluene-d8	102	70-130
4-Bromofluorobenzene	97	70-130

Client Sample ID: LCSD

Lab ID#: 1102159AR2-11AA

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6020906**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 2/10/11 07:19 AM**

Compound	%Recovery
Naphthalene	69

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	91	70-130
Toluene-d8	104	70-130
4-Bromofluorobenzene	97	70-130

Client Sample ID: LCS

Lab ID#: 1102159AR2-11B

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6021103**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 2/11/11 09:03 AM**

Compound	%Recovery
Naphthalene	75

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	95	70-130
Toluene-d8	109	70-130
4-Bromofluorobenzene	102	70-130

Client Sample ID: LCSD

Lab ID#: 1102159AR2-11BB

MODIFIED EPA METHOD TO-15 GC/MS FULL SCAN

File Name:	**6021104**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 2/11/11 09:36 AM**

Compound	%Recovery
Naphthalene	74

Container Type: NA - Not Applicable

Surrogates	%Recovery	Method Limits
1,2-Dichloroethane-d4	90	70-130
Toluene-d8	104	70-130
4-Bromofluorobenzene	103	70-130

APPENDIX F

MTCATPH Analyses Supporting Site-Specific TPH Soil Screening Levels, and MTCAstat Analyses for Soil TPH Data (Million Gallon Tanks and Bunker C Tank Subareas)

Table F-1 - Extractable Petroleum Hydrocarbon (EPH) Data for Soil Petroleum, Million Gallon Tanks and Bunker C Tank Subareas

GP West Site RI/FS

Bunker C Tank Subarea

Chemical Name	BC-MW02 (8-10 ft.)		BC-MW02 (17-19 ft.)		BC-SB07 (4-5 ft.)		BC-SB08 (15.5-16.5 ft)		BC-SB14 (6.5-7.5 ft)		BC-SB17 (8-9 ft)		BC-SB18 (9-10ft)		**Average for Bunker C Tank Subarea**
Total Petroleum Hydrocarbons (NWTPH-D) in mg/kg															
Diesel Range Hydrocarbons	360		950		350		2,600		5,500		16,000				**553**
Oil (C25-C36)	840		2,000		4,300		3,000		8,000		15,000				**2,380**
Total TPH	1,200		2,950		4,650		5,600		13,500		31,000				**2,933**
Extractable Petroleum Hydrocarbons (EPH) in mg/kg															
Aliphatics C8-C10 (EPH)	3 U	0.5%	20	0.5%	4.3 U	0.3%	24 U	0.5%	13 U	0.1%	64	0.3%	49 U	0.3%	**12**
Aliphatics C10-C12 (EPH)	3 U	0.5%	35	0.8%	4.3 U	0.3%	150	3.4%	120	1.2%	650	3.2%	340	1.9%	**185**
Aliphatics C12-C16 (EPH)	12	2.2%	58	1.4%	12	0.7%	430	9.8%	560	5.8%	3100	15.4%	2200	12.4%	**910**
Aliphatics C16-C21 (EPH)	38	6.8%	120	2.8%	20	1.2%	420	9.6%	770	8.0%	1900	9.4%	2100	11.9%	**767**
Aliphatics C21-C34 (EPH)	320	57.7%	1,600	37.6%	610	36.0%	1,400	32.0%	3200	33.2%	4700	23.3%	4400	24.9%	**2,319**
Aromatics C8-C10 (EPH)	3 U	0.5%	28 U	0.7%	11 U	0.6%	24 U	0.5%	67 U	0.7%	44 U	0.2%	49 U	0.3%	**-**
Aromatics C10-C12 (EPH)	3 U	0.5%	28 U	0.7%	11 U	0.6%	24 U	0.5%	49	0.5%	44 U	0.2%	49 U	0.3%	**7**
Aromatics C12-C16 (EPH)	3 U	0.5%	28 U	0.7%	11 U	0.6%	100	2.3%	450	4.7%	1066	5.3%	795	4.5%	**344**
Aromatics C16-C21 (EPH)	20	3.6%	240	5.6%	33	1.9%	500	11.4%	1400	14.5%	3400	16.9%	2700	15.3%	**1,185**
Aromatics C21-C34 (EPH)	150	27.0%	2,100	49.3%	980	57.8%	1,300	29.7%	3000	31.2%	5200	25.8%	5000	28.3%	**2,533**
Total EPH	555	100.0%	4,257	100.0%	1,697	100.0%	4,372	100.0%	9,629	100.0%	20,168	100.0%	17,682	100.0%	**8,262**
Polycyclic Aromatic Hydrocarbons (PAHs) in mg/kg															
Naphthalene	0.029		0.96		0.098		0.037		na		14		1.5		**2.77**
2-Methylnaphthalene	0.061		0.35		0.140		0.058		na		120		3.1		**20.62**
Total cPAH (TEF)	0.07		1.92		0.29		0.07		na		6.10		6.7		**2.52**

Million Gallon Tank Subarea

Chemical Name	MG-SB07 (6-8 ft.)		MG-SB09 (6-7 ft.)		MG-SB12 (6-7 ft.)		MG-SB13 (7-8 ft.)		MG-SB14 (12-13 ft.)		MG-SB15 (9-10 ft.)		**Average for Million Gallon Tank Subarea**
Total Petroleum Hydrocarbons (NWTPH-D) in mg/kg													
Diesel Range Hydrocarbons	4,200		9,200		580		920		92		14		**2,107**
Oil (C25-C36)	5,100		1,200		4,000		1,700		180		44		**2,572**
Total TPH	9,300		10,400		4,580		2,620		272		58		**4,679**
Extractable Petroleum Hydrocarbons (EPH) in mg/kg													
Aliphatics C8-C10 (EPH)	41 U	0.4%	12 U	0.2%	15	0.7%	3.6	0.4%	2.5 U	6.7%	2.3 U	6.8%	**3**
Aliphatics C10-C12 (EPH)	41 U	0.4%	88	1.4%	10	0.4%	3.8	0.4%	2.5 U	6.7%	2.3 U	6.8%	**17**
Aliphatics C12-C16 (EPH)	220	2.4%	860	13.4%	39	1.7%	31	3.1%	2.5 U	6.7%	2.3 U	6.8%	**192**
Aliphatics C16-C21 (EPH)	510	5.6%	3,000	46.6%	140	6.2%	140	14.2%	2.5 U	6.7%	2.3 U	6.8%	**632**
Aliphatics C21-C34 (EPH)	2,900	31.6%	1,200	18.6%	1600	70.4%	440	44.6%	6.7	18.1%	11	32.6%	**1,026**
Aromatics C8-C10 (EPH)	41 U	0.4%	24 U	0.4%	2.7 U	0.1%	2.9 U	0.3%	2.5 U	6.7%	2.3 U	6.8%	**-**
Aromatics C10-C12 (EPH)	58	0.6%	24 U	0.4%	2.7 U	0.1%	2.9 U	0.3%	2.5 U	6.7%	2.3 U	6.8%	**10**
Aromatics C12-C16 (EPH)	362	3.9%	72	1.1%	7.83	0.3%	2.9 U	0.3%	2.5 U	6.7%	2.3 U	6.8%	**74**
Aromatics C16-C21 (EPH)	1,300	14.2%	820	12.7%	94	4.1%	170	17.2%	4.5	12.1%	2.8	8.3%	**399**
Aromatics C21-C34 (EPH)	3,700	40.3%	340	5.3%	360	15.9%	190	19.2%	8.4	22.6%	3.8	11.3%	**767**
Total EPH	9,173	100.0%	6,440	100.0%	2,271	100.0%	987	100.0%	37	100.0%	34	100.0%	**3,119**
Polycyclic Aromatic Hydrocarbons (PAHs) in mg/kg													
Naphthalene	4.1		0.860		1.30		na		0.140		na		**1.6**
2-Methylnaphthalene	24		0.350		0.27		na		0.110		na		**6.2**
Total cPAH (TEF)	3.55		1.14		0.77		na		0.11		na		**1.4**

na: No analysis.
U: Not detected at associated reporting limit.
The listed percentages are each petroleum fraction's relative percentage of total petroleum mixture composition.

A2. 1B Worksheet for Calculating Soil Cleanup Levels for Protection of Human Health: (Soil Direct Contact Pathway) Method B: Unrestricted Land Use (WAC 173-340-740)

Date: 2/11/2011
Site Name: GP West
Sample Name: Average concentrations for Million Gallon Tanks Subarea

Chemical of Concern or EC group	Current Condition				Adjusted Condition			
	Measured Soil Conc @dry basis	HQ	RISK	Pass or Fail?	Soil Conc being tested	HQ	RISK	Pass or Fail?
	mg/kg	unitless	unitless		mg/kg	unitless	unitless	
Petroleum EC Fraction								
AL_EC >5-6	0				0.00E+00			
AL_EC >6-8	0				0.00E+00			
AL_EC >8-10	3.1	1.40E-03			3.99E+00	1.80E-03		
AL_EC >10-12	16.96666667	7.65E-03			2.18E+01	9.84E-03		
AL_EC >12-16	191.6666667	1.15E-01			2.47E+02	1.48E-01		
AL_EC >16-21	631.6666667	5.69E-03			8.12E+02	7.31E-03		
AL_EC >21-34	1026.283333	9.24E-03			1.32E+03	1.19E-02		
AR_EC >8-10	0				0.00E+00			
AR_EC >10-12	9.666666667	6.54E-03			1.24E+01	8.41E-03		
AR_EC >12-16	73.58666667	2.65E-02			9.46E+01	3.41E-02		
AR_EC >16-21	398.55	2.39E-01			5.13E+02	3.08E-01		
AR_EC >21-34	767.0333333	3.45E-01			9.87E+02	4.44E-01		
Benzene	0		0.00E+00		0.00E+00		0.00E+00	
Toluene	0				0.00E+00			
Ethylbenzene	0				0.00E+00			
Total Xylenes	0				0.00E+00			
Naphthalene	1.6	1.32E-03			2.06E+00	1.70E-03		
1-Methyl Naphthalene	0				0.00E+00	0.00E+00		
2-Methyl Naphthalene	6.2	1.99E-02			7.97E+00	2.56E-02		
n-Hexane	0				0.00E+00	0.00E+00		
MTBE	0				0.00E+00			
Ethylene Dibromide (EDB)	0		0.00E+00		0.00E+00	0.00E+00	0.00E+00	
1,2 Dichloroethane (EDC)	0		0.00E+00		0.00E+00	0.00E+00	0.00E+00	
Benzo(a)anthracene	1.30575		1.26E-06	*For*	1.68E+00		1.62E-06	*For*
Benzo(b)fluoranthene	0.8185		7.90E-07	*all*	1.05E+00		1.02E-06	*all*
Benzo(k)fluoranthene	0.23275		2.25E-07	*cPAHs*	2.99E-01		2.89E-07	*cPAHs*
Benzo(a)pyrene	1.06725		1.03E-05		1.37E+00		1.32E-05	
Chrysene	2.505		2.42E-07	*Fail*	3.22E+00		3.11E-07	*Fail*
Dibenz(a,h)anthracene	0.278575		2.69E-07	Σ Risk=	3.58E-01		3.46E-07	Σ Risk=
Indeno(1,2,3-cd)pyrene	0.35125		3.39E-07	1.34E-05	4.52E-01		4.36E-07	1.73E-05
Sum	**3132.879075**	7.78E-01	1.34E-05	Fail	4.03E+03	1.00E+00	1.73E-05	Fail

TEST CURRENT CONDITION

Measured TPH Soil Conc, mg/kg= 3132.879
HI= 7.775E-01
RISK= 1.342E-05
Pass or Fail? ***Fail***

CALCULATE PROTECTIVE CONDITION

This tool allows the user to calculate protective TPH soil concentration based on various soil quality criteria. The Workbook uses the same composition ratio as for the measured data.

Calculate Protective TPH Soil Conc

Selected Criterion: @HI=1
Most Stringent? ***NO***
Protctive TPH Soil Conc, mg/kg = 4029.28
HI = 1.00E+00
RISK = 1.73E-05

TEST ADJUSTED CONDITION

This tool allows the user to test whether a particular TPH soil concentration is protective of human health. The Workbook uses the same composition ratio as for the measured data.

Test Adjusted TPH Soil Conc

Tested TPH Soil Conc, mg/kg =
HI =
RISK =
Pass or Fail?

A2. 1C Worksheet for Calculating Soil Cleanup Levels for Protection of Human Health: (Soil Direct Contact Pathway) Method C: Industrial Land Use (WAC 173-340-745)

Date: 2/11/2011
Site Name: GP West
Sample Name: Average concentrations for Million Gallon Tanks Subarea

Chemical of Concern or EC Group	Current Condition				Adjusted Condition			
	Measured Soil Conc @dry basis	HQ	RISK	Pass or Fail?	Soil Conc being tested	HQ	RISK	Pass or Fail?
	mg/kg	unitless	unitless		mg/kg	unitless	unitless	
Petroleum EC Fraction								
AL_EC >5-6	0				0.00E+00			
AL_EC >6-8	0				0.00E+00			
AL_EC >8-10	3.1	7.10E-05			4.88E+01	1.12E-03		
AL_EC >10-12	16.96666667	3.89E-04			2.67E+02	6.12E-03		
AL_EC >12-16	191.6666667	9.58E-03			3.02E+03	1.51E-01		
AL_EC >16-21	631.6666667	4.74E-04			9.95E+03	7.46E-03		
AL_EC >21-34	1026.283333	7.70E-04			1.62E+04	1.21E-02		
AR_EC >8-10	0				0.00E+00			
AR_EC >10-12	9.666666667	3.32E-04			1.52E+02	5.23E-03		
AR_EC >12-16	73.58666667	2.21E-03			1.16E+03	3.48E-02		
AR_EC >16-21	398.55	1.99E-02			6.28E+03	3.14E-01		
AR_EC >21-34	767.0333333	2.88E-02			1.21E+04	4.53E-01		
Benzene	0		0.00E+00		0.00E+00		0.00E+00	
Toluene	0				0.00E+00			
Ethylbenzene	0				0.00E+00			
Total Xylenes	0				0.00E+00			
Naphthalene	1.6	9.84E-05			2.52E+01	1.55E-03		
1-Methyl Naphthalene	0				0.00E+00	0.00E+00		
2-Methyl Naphthalene	6.2	8.72E-04			9.77E+01	1.37E-02		
n-Hexane	0				0.00E+00	0.00E+00		
MTBE	0				0.00E+00			
Ethylene Dibromide (EDB)	0		0.00E+00		0.00E+00	0.00E+00	0.00E+00	
1,2 Dichloroethane (EDC)	0		0.00E+00		0.00E+00	0.00E+00	0.00E+00	
Benzo(a)anthracene	1.30575		3.13E-07		2.06E+01		4.93E-06	
Benzo(b)fluoranthene	0.8185		1.96E-07		1.29E+01		3.09E-06	
Benzo(k)fluoranthene	0.23275		5.57E-08		3.67E+00		8.78E-07	
Benzo(a)pyrene	1.06725		2.56E-06		1.68E+01		4.03E-05	
Chrysene	2.505		6.00E-08		3.95E+01		9.45E-07	
Dibenz(a,h)anthracene	0.278575		6.67E-08		4.39E+00		1.05E-06	
Indeno(1,2,3-cd)pyrene	0.35125		8.41E-08		5.53E+00		1.33E-06	
Sum	**3132.879075**	6.35E-02	3.33E-06		4.93E+04	1.00E+00	5.25E-05	Fail

TEST CURRENT CONDITION

Measured TPH Soil Conc, mg/kg= 3132.879
HI= 6.349E-02
RISK= 3.331E-06
Pass or Fail? Pass
Check Residual Saturation (WAC340-747(10))

CALCULATE PROTECTIVE CONDITION

This tool allows the user to calculate protective TPH soil concentration based on various soil quality criteria. The Workbook uses the same composition ratio as for the measured data.

Calculate Protective TPH soil Conc

Selected Criterion: @HI=1
Most Stringent? *NO*
Protctive TPH Soil Conc, mg/kg = 49345.925
HI = 1.000E+00
RISK = 5.247E-05

TEST ADJUSTED CONDITION

This tool allows the user to test whether a particular TPH soil concentration is protective of human health. The Workbook uses the same composition ratio as for the measured data.

Test Adjusted TPH Soil Conc

Tested TPH Soil Conc, mg/kg=
HI=
RISK=
Pass or Fail?

A2. 2 Worksheet for Calculating Soil Cleanup Level for the Protection of Ground Water Quality: (Leaching Pathway) WAC 173-340-740 and 747

Date: 2/11/2011

Site Name: GP West

Sample Name: Average concentrations for Million Gallon Tanks Subarea

Chemical of Concern or EC Group	Measured Soil Conc @dry basis	GW Cleanup Level	Adjusted Condition: Soil Conc being tested	Predicted Conc @Well	HQ @ Well	RISK @ Well	Pass or Fail?
	mg/kg	ug/L	mg/kg	ug/L	unitless	unitless	
Petroleum EC Fraction							
AL_EC >5-6	0		0.00E+00	0.00E+00	0.00E+00		
AL_EC >6-8	0		0.00E+00	0.00E+00	0.00E+00		
AL_EC >8-10	3.1		9.90E+00	8.33E-01	3.47E-03		
AL_EC >10-12	16.96666667		5.42E+01	3.00E-01	1.25E-03		
AL_EC >12-16	191.6666667		6.12E+02	6.13E-02	1.28E-04		
AL_EC >16-21	631.6666667		2.02E+03	2.53E-04	7.91E-09		
AL_EC >21-34	1026.283333		3.28E+03	3.27E-09	1.02E-13		
AR_EC >8-10	0		0.00E+00	0.00E+00	0.00E+00		
AR_EC >10-12	9.666666667		3.09E+01	1.30E+02	8.10E-01		
AR_EC >12-16	73.58666667		2.35E+02	2.22E+02	2.78E-01		
AR_EC >16-21	398.55		1.27E+03	8.92E+01	1.86E-01		
AR_EC >21-34	767.0333333		2.45E+03	1.79E+00	2.80E-03		
Benzene	0	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Toluene	0	1000	0.00E+00	0.00E+00	0.00E+00		
Ethylbenzene	0	700	0.00E+00	0.00E+00	0.00E+00		
Total Xylenes	0	1000	0.00E+00	0.00E+00	0.00E+00		
Naphthalene	1.6	160	5.11E+00	2.91E+01	1.82E-01		
1-Methyl Naphthalene	0		0.00E+00	0.00E+00	0.00E+00		
2-Methyl Naphthalene	6.2		1.98E+01	7.39E+01	2.31E+00		
n-Hexane	0		0.00E+00	0.00E+00	0.00E+00		
MTBE	0	20	0.00E+00	0.00E+00	0.00E+00		
Ethylene Dibromide (EDB)	0	0.01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
1,2 Dichloroethane (EDC)	0	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Benzo(a)anthracene	1.30575	for	4.17E+00	4.54E-03		3.79E-08	for
Benzo(b)fluoranthene	0.8185	all	2.61E+00	4.12E-04		3.44E-09	all
Benzo(k)fluoranthene	0.23275	cPAHs	7.43E-01	6.26E-05		5.22E-10	cPAHs
Benzo(a)pyrene	1.06725	Risk=	3.41E+00	5.81E-04		4.84E-08	
Chrysene	2.505	1E-05	8.00E+00	1.49E-03		1.24E-09	
Dibenz(a,h)anthracene	0.278575		8.89E-01	2.10E-04		1.76E-09	Σ Risk=
Indeno(1,2,3-cd)pyrene	0.35125		1.12E+00	2.38E-06		1.98E-11	9.33E-08
Sum	3132.879075		1.00E+04	5.47E+02	3.77E+00	9.33E-08	***Fail***

Site-Specific Hydrogeological Properties previously entered:

Item	Symbol	Value	Units
Total soil porosity:	n	0.43	unitless
Volumetric water content:	Q_w	0.3	unitless
Volumetric air content:	Q_a	0.13	unitless
Soil bulk density measured:	r_b	1.5	kg/L
Fraction Organic Carbon:	f_{oc}	0.017	unitless
Dilution Factor:	DF	1	unitless

Target Ground Water TPH conc adjusted previously if any:

Target Ground Water TPH Conc, ug/L ⇒ 500

CALCULATE PROTECTIVE CONDITION OR TEST ADJUSTED CONDITION

Calculate or Test

TPH Test button used.

Pass or Fail? *Fail*

Tested TPH Soil Conc, mg/kg = **10000.00**

Predicted TPH GW Conc, ug/L = 5.47E+02

RISK @ Well = 9.33E-08

HI @Well = 3.77E+00

DEDAILED MODEL RESULTS TPH Range Test

Type of model used for computation:	4-Phase Model
Computation completed?	Yes!
Initial Weighted Average MW of NAPL, g/mol:	262.5
Equilibrated Weighted Average MW of NAPL, g/mol:	263.4
Initial Weighted Average Density of NAPL, kg/L:	0.917
Volumetric NAPL Content, Q_{NAPL} :	1.6E-02
NAPL Saturation (%), Q_{NAPL}/n :	3.76%
100% NAPL, mg/kg	79497.4

Mass Distribution Pattern @ 4-phase in soil pore system: Mass Balance Pattern

Total Mass distributed in Water Phase: 0.00% in Solid: 1.05%

Total Mass distributed in Air Phase: 0.00% in NAPL: 98.95%

Please Check Soil Residual Saturation TPH Levels: Refer to Table 747-5!

A2. 2 Worksheet for Calculating Soil Cleanup Level for the Protection of Ground Water Quality: (Leaching Pathway)
WAC 173-340-740 and 747

Date: 2/28/2011
Site Name: GP West
Sample Name: Average concentrations for Million Gallon Tanks Subarea

Chemical of Concern or EC Group	Measured Soil Conc @dry basis	GW Cleanup Level	Adjusted Condition: Soil Conc being tested	Predicted Conc @Well	HQ @ Well	RISK @ Well	Pass or Fail?
	mg/kg	ug/L	mg/kg	ug/L	unitless	unitless	
Petroleum EC Fraction							
AL_EC >5-6	0		0.00E+00	0.00E+00	0.00E+00		
AL_EC >6-8	0		0.00E+00	0.00E+00	0.00E+00		
AL_EC >8-10	3.1		9.64E+01	8.57E-01	3.57E-03		
AL_EC >10-12	16.96666667		5.28E+02	3.02E-01	1.26E-03		
AL_EC >12-16	191.6666667		5.96E+03	6.11E-02	1.27E-04		
AL_EC >16-21	631.6666667		1.96E+04	2.55E-04	7.96E-09		
AL_EC >21-34	1026.283333		3.19E+04	3.23E-09	1.01E-13		
AR_EC >8-10	0		0.00E+00	0.00E+00	0.00E+00		
AR_EC >10-12	9.6666667		3.01E+02	1.53E+02	9.54E-01		
AR_EC >12-16	73.58666667		2.29E+03	2.37E+02	2.96E-01		
AR_EC >16-21	398.55		1.24E+04	8.96E+01	1.87E-01		
AR_EC >21-34	767.0333333		2.39E+04	1.77E+00	2.77E-03		
Benzene	0	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Toluene	0	1000	0.00E+00	0.00E+00	0.00E+00		
Ethylbenzene	0	700	0.00E+00	0.00E+00	0.00E+00		
Total Xylenes	0	1000	0.00E+00	0.00E+00	0.00E+00		
Naphthalene	1.6	160	4.98E+01	3.21E+01	2.01E-01		
1-Methyl Naphthalene	0		0.00E+00	0.00E+00	0.00E+00		
2-Methyl Naphthalene	6.2		1.93E+02	8.79E+01	2.75E+00		
n-Hexane	0		0.00E+00	0.00E+00	0.00E+00		
MTBE	0	20	0.00E+00	0.00E+00	0.00E+00		
Ethylene Dibromide (EDB)	0	0.01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
1,2 Dichloroethane (EDC)	0	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Benzo(a)anthracene	1.30575	for	4.06E+01	4.51E-03		3.76E-08	for
Benzo(b)fluoranthene	0.8185	all	2.55E+01	4.08E-04		3.41E-09	all
Benzo(k)fluoranthene	0.23275	cPAHs	7.24E+00	6.19E-05		5.17E-10	cPAHs
Benzo(a)pyrene	1.06725	Risk=	3.32E+01	5.75E-04		4.80E-08	
Chrysene	2.505	1E-05	7.79E+01	1.47E-03		1.23E-09	
Dibenz(a,h)anthracene	0.278575		8.67E+00	2.09E-04		1.75E-09	Σ Risk=
Indeno(1,2,3-cd)pyrene	0.35125		1.09E+01	2.35E-06		1.96E-11	9.25E-08
Sum	3132.879075		9.75E+04	6.02E+02	4.39E+00	9.25E-08	***Fail***

Site-Specific Hydrogeological Properties previously entered:

Item	Symbol	Value	Units
Total soil porosity:	n	0.43	unitless
Volumetric water content:	Θ_w	0.3	unitless
Volumetric air content:	Θ_a	0.13	unitless
Soil bulk density measured:	ρ_b	1.5	kg/L
Fraction Organic Carbon:	f_{oc}	0.017	unitless
Dilution Factor:	DF	1	unitless

Target Ground Water TPH conc adjusted previously if any:

Target Ground Water TPH Conc, ug/L ⇒ 500

CALCULATE PROTECTIVE CONDITION OR TEST ADJUSTED CONDITION

Calculate or Test

TPH Test button used.

Pass or Fail? *Fail*

Tested TPH Soil Conc, mg/kg = **97454.00**
Predicted TPH GW Conc, ug/L = 6.02E+02
RISK @ Well = 9.25E-08
HI @Well = 4.39E+00

DEDAILED MODEL RESULTS TPH Range Test

Type of model used for computation: 4-Phase Model
Computation completed? Yes!
Initial Weighted Average MW of NAPL, g/mol: 262.5
Equilibrated Weighted Average MW of NAPL, g/mol: 262.6
Initial Weighted Average Density of NAPL, kg/L: 0.917
Volumetric NAPL Content, Θ_{NAPL} : 1.6E-01
NAPL Saturation (%), Θ_{NAPL}/n : 37.02%
100% NAPL, mg/kg 79497.4
Mass Distribution Pattern @ 4-phase in soil pore system: Mass Balance Pattern
Total Mass distributed in Water Phase: 0.00% in Solid: 0.11%
Total Mass distributed in Air Phase: 0.00% in NAPL: 99.89%
NAPL is supersaturated, Computation is not Correct!
Please Check Soil Residual Saturation TPH Levels: Refer to Table 747-5!

A2. 1B Worksheet for Calculating Soil Cleanup Levels for Protection of Human Health: (Soil Direct Contact Pathway) Method B: Unrestricted Land Use (WAC 173-340-740)

Date: 2/11/2011
Site Name: GP West
Sample Name: Average concentrations for Bunker C Subarea

Chemical of Concern or EC group	Current Condition				Adjusted Condition			
	Measured Soil Conc @dry basis	HQ	RISK	Pass or Fail?	Soil Conc being tested	HQ	RISK	Pass or Fail?
	mg/kg	unitless	unitless		mg/kg	unitless	unitless	
Petroleum EC Fraction								
AL_EC >5-6	0				0.00E+00			
AL_EC >6-8	0				0.00E+00			
AL_EC >8-10	12	5.41E-03			4.43E+00	2.00E-03		
AL_EC >10-12	185	8.34E-02			6.82E+01	3.08E-02		
AL_EC >12-16	910.2857143	5.46E-01			3.36E+02	2.01E-01		
AL_EC >16-21	766.8571429	6.90E-03			2.83E+02	2.55E-03		
AL_EC >21-34	2318.571429	2.09E-02			8.55E+02	7.70E-03		
AR_EC >8-10	0				0.00E+00			
AR_EC >10-12	7	4.74E-03			2.58E+00	1.75E-03		
AR_EC >12-16	344.4721429	1.24E-01			1.27E+02	4.57E-02		
AR_EC >16-21	1184.714286	7.11E-01			4.37E+02	2.62E-01		
AR_EC >21-34	2532.857143	1.14E+00			9.34E+02	4.20E-01		
Benzene	0		0.00E+00		0.00E+00		0.00E+00	
Toluene	0				0.00E+00			
Ethylbenzene	0				0.00E+00			
Total Xylenes	0				0.00E+00			
Naphthalene	2.77	2.29E-03			1.02E+00	8.44E-04		
1-Methyl Naphthalene	0				0.00E+00	0.00E+00		
2-Methyl Naphthalene	20.62	6.62E-02			7.61E+00	2.44E-02		
n-Hexane	0				0.00E+00	0.00E+00		
MTBE	0				0.00E+00			
Ethylene Dibromide (EDB)	0		0.00E+00		0.00E+00	0.00E+00	0.00E+00	
1,2 Dichloroethane (EDC)	0		0.00E+00		0.00E+00	0.00E+00	0.00E+00	
Benzo(a)anthracene	2.888166667		2.79E-06	*For*	1.07E+00		1.03E-06	*For*
Benzo(b)fluoranthene	1.216333333		1.17E-06	*all*	4.49E-01		4.33E-07	*all*
Benzo(k)fluoranthene	0.276333333		2.67E-07	*cPAHs*	1.02E-01		9.83E-08	*cPAHs*
Benzo(a)pyrene	1.934		1.87E-05		7.13E-01		6.88E-06	
Chrysene	4.57		4.41E-07	*Fail*	1.69E+00		1.63E-07	*Fail*
Dibenz(a,h)anthracene	0.425333333		4.10E-07	Σ Risk=	1.57E-01		1.51E-07	Σ Risk=
Indeno(1,2,3-cd)pyrene	0.645166667		6.22E-07	2.44E-05	2.38E-01		2.30E-07	8.98E-06
Sum	**8297.10319**	2.71E+00	2.44E-05	Fail	3.06E+03	1.00E+00	8.98E-06	Fail

TEST CURRENT CONDITION

Measured TPH Soil Conc, mg/kg= 8297.103
HI= 2.711E+00
RISK= 2.435E-05
Pass or Fail? ***Fail***

CALCULATE PROTECTIVE CONDITION

This tool allows the user to calculate protective TPH soil concentration based on various soil quality criteria. The Workbook uses the same composition ratio as for the measured data.

Calculate Protective TPH Soil Conc

Selected Criterion: @HI=1
Most Stringent? ***NO***
Protctive TPH Soil Conc, mg/kg = 3060.92
HI = 1.00E+00
RISK = 8.98E-06

TEST ADJUSTED CONDITION

This tool allows the user to test whether a particular TPH soil concentration is protective of human health. The Workbook uses the same composition ratio as for the measured data.

Test Adjusted TPH Soil Conc

Tested TPH Soil Conc, mg/kg =
HI =
RISK =
Pass or Fail?

A2. 1C Worksheet for Calculating Soil Cleanup Levels for Protection of Human Health: (Soil Direct Contact Pathway) Method C: Industrial Land Use (WAC 173-340-745)

Date: 2/11/2011
Site Name: GP West
Sample Name: Average concentrations for Bunker C Subarea

Chemical of Concern or EC Group	Current Condition: Measured Soil Conc @dry basis	Current Condition: HQ	Current Condition: RISK	Current Condition: Pass or Fail?	Adjusted Condition: Soil Conc being tested	Adjusted Condition: HQ	Adjusted Condition: RISK	Adjusted Condition: Pass or Fail?
	mg/kg	unitless	unitless		mg/kg	unitless	unitless	
Petroleum EC Fraction								
AL_EC >5-6	0				0.00E+00			
AL_EC >6-8	0				0.00E+00			
AL_EC >8-10	12	2.75E-04			5.45E+01	1.25E-03		
AL_EC >10-12	185	4.24E-03			8.40E+02	1.93E-02		
AL_EC >12-16	910.2857143	4.55E-02			4.13E+03	2.07E-01		
AL_EC >16-21	766.8571429	5.75E-04			3.48E+03	2.61E-03		
AL_EC >21-34	2318.571429	1.74E-03			1.05E+04	7.90E-03		
AR_EC >8-10	0				0.00E+00			
AR_EC >10-12	7	2.41E-04			3.18E+01	1.09E-03		
AR_EC >12-16	344.4721429	1.03E-02			1.56E+03	4.69E-02		
AR_EC >16-21	1184.714286	5.92E-02			5.38E+03	2.69E-01		
AR_EC >21-34	2532.857143	9.50E-02			1.15E+04	4.31E-01		
Benzene	0		0.00E+00		0.00E+00		0.00E+00	
Toluene	0				0.00E+00			
Ethylbenzene	0				0.00E+00			
Total Xylenes	0				0.00E+00			
Naphthalene	2.77	1.70E-04			1.26E+01	7.74E-04		
1-Methyl Naphthalene	0				0.00E+00	0.00E+00		
2-Methyl Naphthalene	20.62	2.90E-03			9.36E+01	1.32E-02		
n-Hexane	0				0.00E+00	0.00E+00		
MTBE	0				0.00E+00			
Ethylene Dibromide (EDB)	0		0.00E+00		0.00E+00	0.00E+00	0.00E+00	
1,2 Dichloroethane (EDC)	0		0.00E+00		0.00E+00	0.00E+00	0.00E+00	
Benzo(a)anthracene	2.888166667		6.92E-07		1.31E+01		3.14E-06	
Benzo(b)fluoranthene	1.216333333		2.91E-07		5.52E+00		1.32E-06	
Benzo(k)fluoranthene	0.276333333		6.62E-08		1.25E+00		3.01E-07	
Benzo(a)pyrene	1.934		4.63E-06		8.78E+00		2.10E-05	
Chrysene	4.57		1.09E-07		2.08E+01		4.97E-07	
Dibenz(a,h)anthracene	0.425333333		1.02E-07		1.93E+00		4.63E-07	
Indeno(1,2,3-cd)pyrene	0.645166667		1.55E-07		2.93E+00		7.02E-07	
Sum	**8297.10319**	2.20E-01	6.05E-06		3.77E+04	1.00E+00	2.75E-05	Fail

TEST CURRENT CONDITION

Measured TPH Soil Conc, mg/kg= 8297.103
HI= 2.202E-01
RISK= 6.047E-06
Pass or Fail? Pass
Check Residual Saturation (WAC340-747(10))

CALCULATE PROTECTIVE CONDITION

This tool allows the user to calculate protective TPH soil concentration based on various soil quality criteria. The Workbook uses the same composition ratio as for the measured data.

Calculate Protective TPH soil Conc

Selected Criterion: @HI=1
Most Stringent? *NO*

Protctive TPH Soil Conc, mg/kg = 37678.880
HI = 1.000E+00
RISK = 2.746E-05

TEST ADJUSTED CONDITION

This tool allows the user to test whether a particular TPH soil concentration is protective of human health. The Workbook uses the same composition ratio as for the measured data.

Test Adjusted TPH Soil Conc

Tested TPH Soil Conc, mg/kg=
HI=
RISK=
Pass or Fail?

A2. 2 Worksheet for Calculating Soil Cleanup Level for the Protection of Ground Water Quality: (Leaching Pathway)
WAC 173-340-740 and 747

Date: 2/11/2011

Site Name: GP West

Sample Name: Average concentrations for Bunker C Subarea

Chemical of Concern or EC Group	Measured Soil Conc @dry basis	GW Cleanup Level	Adjusted Condition: Soil Conc being tested	Adjusted Condition: Predicted Conc @Well	Adjusted Condition: HQ @ Well	Adjusted Condition: RISK @ Well	Adjusted Condition: Pass or Fail?
	mg/kg	ug/L	mg/kg	ug/L	unitless	unitless	
Petroleum EC Fraction							
AL_EC >5-6	0		0.00E+00	0.00E+00	0.00E+00		
AL_EC >6-8	0		0.00E+00	0.00E+00	0.00E+00		
AL_EC >8-10	12		1.45E+01	1.13E+00	4.73E-03		
AL_EC >10-12	185		2.23E+02	1.15E+00	4.80E-03		
AL_EC >12-16	910.2857143		1.10E+03	1.03E-01	2.15E-04		
AL_EC >16-21	766.8571429		9.24E+02	1.08E-04	3.39E-09		
AL_EC >21-34	2318.571429		2.79E+03	2.62E-09	8.18E-14		
AR_EC >8-10	0		0.00E+00	0.00E+00	0.00E+00		
AR_EC >10-12	7		8.44E+00	3.23E+01	2.02E-01		
AR_EC >12-16	344.4721429		4.15E+02	3.64E+02	4.55E-01		
AR_EC >16-21	1184.714286		1.43E+03	9.36E+01	1.95E-01		
AR_EC >21-34	2532.857143		3.05E+03	2.09E+00	3.27E-03		
Benzene	0	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Toluene	0	1000	0.00E+00	0.00E+00	0.00E+00		
Ethylbenzene	0	700	0.00E+00	0.00E+00	0.00E+00		
Total Xylenes	0	1000	0.00E+00	0.00E+00	0.00E+00		
Naphthalene	2.77	160	3.34E+00	1.75E+01	1.09E-01		
1-Methyl Naphthalene	0		0.00E+00	0.00E+00	0.00E+00		
2-Methyl Naphthalene	20.62		2.49E+01	8.45E+01	2.64E+00		
n-Hexane	0		0.00E+00	0.00E+00	0.00E+00		
MTBE	0	20	0.00E+00	0.00E+00	0.00E+00		
Ethylene Dibromide (EDB)	0	0.01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
1,2 Dichloroethane (EDC)	0	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Benzo(a)anthracene	2.888166667	for	3.48E+00	3.55E-03		2.96E-08	for
Benzo(b)fluoranthene	1.216333333	all	1.47E+00	2.17E-04		1.81E-09	all
Benzo(k)fluoranthene	0.276333333	cPAHs	3.33E-01	2.63E-05		2.20E-10	cPAHs
Benzo(a)pyrene	1.934	Risk=	2.33E+00	3.72E-04		3.11E-08	
Chrysene	4.57	1E-05	5.51E+00	9.62E-04		8.03E-10	
Dibenz(a,h)anthracene	0.425333333		5.13E-01	1.14E-04		9.49E-10	Σ Risk=
Indeno(1,2,3-cd)pyrene	0.645166667		7.78E-01	1.55E-06		1.29E-11	6.45E-08
Sum	8297.10319		1.00E+04	5.96E+02	3.61E+00	6.45E-08	***Fail***

Site-Specific Hydrogeological Properties previously entered:

Item	Symbol	Value	Units
Total soil porosity:	n	0.43	unitless
Volumetric water content:	Q_w	0.3	unitless
Volumetric air content:	Q_a	0.13	unitless
Soil bulk density measured:	r_b	1.5	kg/L
Fraction Organic Carbon:	f_{oc}	0.021	unitless
Dilution Factor:	DF	1	unitless

Target Ground Water TPH conc adjusted previously if any:

Target Ground Water TPH Conc, ug/L ⇒ 500

CALCULATE PROTECTIVE CONDITION OR TEST ADJUSTED CONDITION

Calculate or Test

TPH Test button used.

Pass or Fail? *Fail*

Tested TPH Soil Conc, mg/kg = **10000.00**

Predicted TPH GW Conc, ug/L = 5.96E+02

RISK @ Well = 6.45E-08

HI @Well = 3.61E+00

DEDAILED MODEL RESULTS TPH Range Test

Type of model used for computation:	4-Phase Model
Computation completed?	Yes!
Initial Weighted Average MW of NAPL, g/mol:	245.5
Equilibrated Weighted Average MW of NAPL, g/mol:	246.6
Initial Weighted Average Density of NAPL, kg/L:	0.952
Volumetric NAPL Content, Q_{NAPL} :	1.6E-02
NAPL Saturation (%), Q_{NAPL}/n :	3.62%
100% NAPL, mg/kg	82484.2

Mass Distribution Pattern @ 4-phase in soil pore system: Mass Balance Pattern

Total Mass distributed in Water Phase: 0.00% — in Solid: 1.22%

Total Mass distributed in Air Phase: 0.00% — in NAPL: 98.78%

Please Check Soil Residual Saturation TPH Levels: Refer to Table 747-5!

A2. 2 Worksheet for Calculating Soil Cleanup Level for the Protection of Ground Water Quality: (Leaching Pathway)

WAC 173-340-740 and 747

Date: 2/28/2011

Site Name: GP West

Sample Name: Average concentrations for Bunker C Tank Subarea

Chemical of Concern or EC Group	Measured Soil Conc @dry basis	GW Cleanup Level	Adjusted Condition: Soil Conc being tested	Predicted Conc @Well	HQ @ Well	RISK @ Well	Pass or Fail?
	mg/kg	ug/L	mg/kg	ug/L	unitless	unitless	
Petroleum EC Fraction							
AL_EC >5-6	0		0.00E+00	0.00E+00	0.00E+00		
AL_EC >6-8	0		0.00E+00	0.00E+00	0.00E+00		
AL_EC >8-10	12		2.93E+02	1.17E+00	4.89E-03		
AL_EC >10-12	185		4.52E+03	1.16E+00	4.85E-03		
AL_EC >12-16	910.2857143		2.22E+04	1.02E-01	2.13E-04		
AL_EC >16-21	766.8571429		1.87E+04	1.09E-04	3.41E-09		
AL_EC >21-34	2318.571429		5.67E+04	2.58E-09	8.05E-14		
AR_EC >8-10	0		0.00E+00	0.00E+00	0.00E+00		
AR_EC >10-12	7		1.71E+02	3.94E+01	2.46E-01		
AR_EC >12-16	344.4721429		8.42E+03	3.93E+02	4.91E-01		
AR_EC >16-21	1184.714286		2.90E+04	9.41E+01	1.96E-01		
AR_EC >21-34	2532.857143		6.19E+04	2.06E+00	3.22E-03		
Benzene	0	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Toluene	0	1000	0.00E+00	0.00E+00	0.00E+00		
Ethylbenzene	0	700	0.00E+00	0.00E+00	0.00E+00		
Total Xylenes	0	1000	0.00E+00	0.00E+00	0.00E+00		
Naphthalene	2.77	160	6.77E+01	1.97E+01	1.23E-01		
1-Methyl Naphthalene	0		0.00E+00	0.00E+00	0.00E+00		
2-Methyl Naphthalene	20.62		5.04E+02	1.04E+02	3.26E+00		
n-Hexane	0		0.00E+00	0.00E+00	0.00E+00		
MTBE	0	20	0.00E+00	0.00E+00	0.00E+00		
Ethylene Dibromide (EDB)	0	0.01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
1,2 Dichloroethane (EDC)	0	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Benzo(a)anthracene	2.888166667	for	7.06E+01	3.52E-03		2.94E-08	for
Benzo(b)fluoranthene	1.216333333	all	2.97E+01	2.14E-04		1.79E-09	all
Benzo(k)fluoranthene	0.276333333	cPAHs	6.75E+00	2.60E-05		2.16E-10	cPAHs
Benzo(a)pyrene	1.934	Risk=	4.73E+01	3.68E-04		3.07E-08	
Chrysene	4.57	1E-05	1.12E+02	9.49E-04		7.91E-10	
Dibenz(a,h)anthracene	0.425333333		1.04E+01	1.13E-04		9.41E-10	Σ Risk=
Indeno(1,2,3-cd)pyrene	0.645166667		1.58E+01	1.52E-06		1.27E-11	6.38E-08
Sum	8297.10319		2.03E+05	6.55E+02	4.33E+00	6.38E-08	***Fail***

Site-Specific Hydrogeological Properties previously entered:

Item	Symbol	Value	Units
Total soil porosity:	n	0.43	unitless
Volumetric water content:	Θ_w	0.3	unitless
Volumetric air content:	Θ_a	0.13	unitless
Soil bulk density measured:	ρ_b	1.5	kg/L
Fraction Organic Carbon:	f_{oc}	0.021	unitless
Dilution Factor:	DF	1	unitless

Target Ground Water TPH conc adjusted previously if any:

Target Ground Water TPH Conc, ug/L ⇒ 500

CALCULATE PROTECTIVE CONDITION OR TEST ADJUSTED CONDITION

Calculate or Test

TPH Test button used.

Pass or Fail? *Fail*

Tested TPH Soil Conc, mg/kg = **202767.00**

Predicted TPH GW Conc, ug/L = 6.55E+02

RISK @ Well = 6.38E-08

HI @Well = 4.33E+00

DEDAILED MODEL RESULTS

TPH Range Test

Type of model used for computation:	4-Phase Model
Computation completed?	Yes!
Initial Weighted Average MW of NAPL, g/mol:	245.5
Equilibrated Weighted Average MW of NAPL, g/mol:	245.6
Initial Weighted Average Density of NAPL, kg/L:	0.952
Volumetric NAPL Content, Θ_{NAPL} :	3.2E-01
NAPL Saturation (%), Θ_{NAPL}/n :	74.27%
100% NAPL, mg/kg	82484.2
Mass Distribution Pattern @ 4-phase in soil pore system:	Mass Balance Pattern
Total Mass distributed in Water Phase: 0.00%	in Solid: 0.06%
Total Mass distributed in Air Phase: 0.00%	in NAPL: 99.94%

NAPL is supersaturated, Computation is not Correct!

Please Check Soil Residual Saturation TPH Levels: Refer to Table 747-5!

MTCAstat Calculations for Soil TPH Data

	A	B	C	D	E	F	G	H
2	15	12/20/10	MTCAStat 97 Site Module				Paste values	
3	18	12/20/10	**Number of samples**		**Uncensored values**		Sort data	
4	18	(7-8 ft)	Uncensored	89	Mean	1192.590		
5	34	(10-11 ft)	Censored		Lognormal mean	1464.950	**Calculate UCL**	
6	37	12/20/10	Detection limit or PQL		Std. devn.	1702.063		**Finished**
7	55	(12-16 ft)	Method detection limit		Median	524	Lognormal	
8	57	12/16/10	TOTAL	89	Min.	14.9		**Exit MTCA*Stat***
9	58	12/20/10	**ENTER DATA**		Max.	10400	Normal	
10	64	(10-11 ft)	*Distribution Decision*					
11	72	(16-18 ft)					Neither	
12	75	(7-8 ft)	**Probability plot method**		W test	D'Agostino's test		
13	91	12/17/10					Clear messages	
14	98	12/20/10	Lognormal distribution?		Normal distribution?			
15	99	12/20/10	r-squared is:	**0.983**	r-squared is:	**0.632**		
16	102	(19-20 ft)	*Recommendations:*				Clear all	
17	124	(2-4 ft)	**Use lognormal distribution.**					
18	146	12/16/10					**Histogram**	
19	153	(14-15 ft)						
20	179	(11-12 ft)					5 10 20	
21	196	(2-3 ft)	*Upper Confidence Limit (UCL)*					
22	196	(11-12 ft)					Create report	
23	197	(0-4 ft)					Sample size	
24	198	(12-13 ft)	**UCL (Land's method) is 2223.20723837943**					
25	201	12/20/10						
26	216	(4-8 ft)						
27	226	12/20/10						
28	227	12/20/10						
29	254	12/20/10						
30	272	12/20/10						
31	284	(5-7.5 ft)						
32	289	(4-8 ft)						
33	300	12/16/10						
34	309	(15-16 ft)						
35	310	(2-4 ft)						
36	320	(15-16 ft)						
37	360	12/20/10						
38	366	12/16/10						
39	371	(2-4 ft)						
40	380	(3-5 ft)						
41	410	12/20/10						
42	440	(0-2 ft)						
43	442	12/22/10						
44	450	(7-8 ft)						
45	490	12/20/10						
46	524	12/17/10						
47	570	12/22/10						
48	590	12/17/10						
49	600	(6-8 ft)						
50	701	(2 ft.)						
51	745	(1.5 ft.)						
52	800	(7-8 ft)						
53	830	12/20/10						
54	834	(8-12 ft)						
55	850	(2.5-5 ft)						
56	985	12/20/10						
57	1010	(1-2 ft)						
58	1130	(11-12 ft)						
59	1170	12/17/10						
60	1170	12/16/10						
61	1190	(1-2 ft)						
62	1260	(2.5-4 ft)						
63	1270	(1-2 ft)						
64	1310	(11-12 ft)						
65	1370	(8-12 ft)						
66	1585	(1.5 ft.)						
67	1700	12/20/10						
68	1724	(3 ft.)						
69	1750	12/17/10						
70	1760	12/20/10						
71	1770	12/20/10						
72	1820	12/20/10						
73	2030	12/22/10						
74	2070	(15-16 ft)						
75	2105	(1.5 ft.)						
76	2250	12/22/10						
77	2290	(7.5-10 ft)						
78	2520	12/20/10						
79	2620	12/20/10						
80	2650	(0-4 ft)						
81	2700	(7.5-9 ft)						
82	2810	(0-2.5 ft)						
83	2840	12/20/10						
84	2970	12/20/10						
85	3240	12/22/10						
86	3850	(0-4 ft)						
87	4580	12/22/10						
88	4700	12/20/10						
89	9300	(6-8 ft)						
90	10400	(6-7 ft)						

	A	B
2	15	12/20/10
3	18	12/20/10
4	18	(7-8 ft)
5	34	(10-11 ft)
6	37	12/20/10
7	55	(12-16 ft)
8	57	12/16/10
9	58	12/20/10
10	64	(10-11 ft)
11	75	(7-8 ft)
12	91	12/17/10
13	98	12/20/10
14	99	12/20/10
15	124	(2-4 ft)
16	146	12/16/10
17	153	(14-15 ft)
18	179	(11-12 ft)
19	196	(2-3 ft)
20	196	(11-12 ft)
21	197	(0-4 ft)
22	198	(12-13 ft)
23	201	12/20/10
24	216	(4-8 ft)
25	226	12/20/10
26	227	12/20/10
27	254	12/20/10
28	272	12/20/10
29	284	(5-7.5 ft)
30	289	(4-8 ft)
31	300	12/16/10
32	309	(15-16 ft)
33	310	(2-4 ft)
34	360	12/20/10
35	366	12/16/10
36	371	(2-4 ft)
37	380	(3-5 ft)
38	410	12/20/10
39	440	(0-2 ft)
40	442	12/22/10
41	450	(7-8 ft)
42	490	12/20/10
43	524	12/17/10
44	570	12/22/10
45	590	12/17/10
46	600	(6-8 ft)
47	701	(2 ft.)
48	745	(1.5 ft.)
49	800	(7-8 ft)
50	830	12/20/10
51	834	(8-12 ft)
52	850	(2.5-5 ft)
53	985	12/20/10
54	1010	(1-2 ft)
55	1130	(11-12 ft)
56	1170	12/17/10
57	1170	12/16/10
58	1190	(1-2 ft)
59	1260	(2.5-4 ft)
60	1270	(1-2 ft)
61	1310	(11-12 ft)
62	1370	(8-12 ft)
63	1585	(1.5 ft.)
64	1700	12/20/10
65	1724	(3 ft.)
66	1750	12/17/10
67	1760	12/20/10
68	1770	12/20/10
69	1820	12/20/10
70	2030	12/22/10
71	2105	(1.5 ft.)
72	2250	12/22/10
73	2290	(7.5-10 ft)
74	2520	12/20/10
75	2620	12/20/10
76	2650	(0-4 ft)
77	2700	(7.5-9 ft)
78	2810	(0-2.5 ft)
79	2840	12/20/10
80	2970	12/20/10
81	3240	12/22/10
82	3850	(0-4 ft)
83	4580	12/22/10
84	4700	12/20/10
85	9300	(6-8 ft)
86	10400	(6-7 ft)
87		

MTCAStat 97 Site Module

Number of samples		Uncensored values	
Uncensored	85	Mean	1218.547
Censored		Lognormal mean	1508.968
Detection limit or PQL		Std. devn.	1728.280
Method detection limit		Median	570
TOTAL	85	Min.	14.9
ENTER DATA		Max.	10400

Distribution Decision

Probability plot method | W test | D'Agostino's test

Lognormal distribution?		Normal distribution?	
r-squared is:	**0.981**	r-squared is:	**0.633**

Recommendations:

Use lognormal distribution.

Upper Confidence Limit (UCL)

UCL (Land's method) is 2314.85288554698

Paste values

Sort data

Calculate UCL

Lognormal

Normal

Neither

Finished

Exit MTCA*Stat*

Clear messages

Clear all

Histogram

5 10 20

Create report

Sample size

MTCAStat '97 Site Module

Number of samples		Uncensored values	
Uncensored	117	Mean	1876.521
Censored		Lognormal mean	1492.251
Detection limit or PQL		Std. devn.	5928.946
Method detection limit		Median	78
TOTAL	117	Min.	8.4
ENTER DATA		Max.	37000

Paste values

Sort data

Calculate UCL

Lognormal

Normal

Neither

Finished

Exit MTCA*Stat*

Distribution Decision

Probability plot method | W test | D'Agostino's test

Lognormal distribution?		Normal distribution?	
r-squared is:	0.915	r-squared is:	0.332

Recommendations:

Use lognormal distribution

Clear messages

Clear all

Histogram

5 | 10 | 20

Create report

Sample size

Upper Confidence Limit (UCL)

UCL (Land's method) is 3003.79879119008

Row	A	B
2	8.4	12/22/10
3	8.5	12/23/10
4	8.6	3/25/2010
5	8.9	12/22/10
6	9.00	12/22/10
7	10.4	12/22/10
8	10.7	12/22/10
9	11.2	12/22/10
10	11.6	3/25/2010
11	12.1	12/22/10
12	12.1	3/25/2010
13	12.7	12/22/10
14	12.8	12/22/10
15	14.1	12/22/10
16	15	3/25/2010
17	15.5	12/22/10
18	15.9	3/25/2010
19	16.4	12/21/10
20	16.4	12/21/10
21	16.8	3/25/2010
22	19.3	9/22/2009
23	19.4	12/17/10
24	20.3	9/22/2009
25	20.4	12/21/10
26	21.3	12/21/10
27	21.5	3/25/2010
28	22.5	12/21/10
29	25.5	12/17/10
30	25.6	9/22/2009
31	26.1	12/21/10
32	27	9/22/2009
33	27	3/25/2010
34	28.2	12/21/10
35	30	9/22/2009
36	30.1	12/23/10
37	31.0	12/17/10
38	31.5	12/17/10
39	37.6	12/23/10
40	40.0	12/23/10
41	42.0	12/22/10
42	45.4	12/23/10
43	55.5	9/22/2009
44	56.0	12/21/10
45	56.0	12/22/10
46	57.0	12/22/10
47	58.5	9/22/2009
48	62.1	12/22/10
49	62.2	12/22/10
50	64.5	9/22/2009
51	68.0	12/21/10
52	68.0	12/22/10
53	68.3	12/23/10
54	68.5	9/22/2009
55	68.5	9/22/2009
56	75	12/22/10
57	75	9/22/2009
58	75	9/22/2009
59	75	9/22/2009
60	78	3/25/2010
61	80.5	9/22/2009
62	80.5	9/22/2009
63	80.5	9/22/2009
64	80.5	9/22/2009
65	81	9/22/2009
66	81	3/25/2010
67	92.5	3/25/2010
68	93.5	9/22/2009
69	98	9/22/2009
70	103	9/22/2009
71	105	12/17/10
72	106	9/22/2009
73	106	9/22/2009
74	108	12/22/10
75	123	12/17/10
76	127	12/21/10
77	144	12/22/10
78	174	12/21/10
79	182	9/22/2009
80	186	9/22/2009
81	261	9/22/2009
82	284	9/22/2009
83	337	12/22/10
84	366	12/22/10
85	383	12/22/10
86	406	12/17/10
87	413	12/17/10
88	421	12/22/10
89	500	12/22/10
90	520	3/25/2010
91	570	12/22/10
92	770	9/22/2009
93	1,060	12/17/10
94	1200	9/22/2009
95	1,590	12/22/10
96	1680	9/22/2009
97	1,910	12/22/10
98	2,210	12/22/10
99	2310	9/22/2009
100	2,320	12/17/10
101	2,330	12/22/10
102	2,400	12/22/10
103	2,670	12/22/10
104	2950	9/22/2009
105	3,830	12/22/10
106	4,130	12/22/10
107	4240	3/25/2010
108	4650	9/22/2009
109	5,300	12/21/10
110	5,580	12/17/10
111	5600	9/22/2009
112	6,100	12/17/10
113	7,500	12/22/10
114	13,500	12/22/10
115	24,000	12/22/10
116	31,000	12/22/10
117	33,000	12/22/10
118	37,000	12/22/10

MTCAStat '97 Site Module

Number of samples		**Uncensored values**	
Uncensored	94	Mean	2224.638
Censored		Lognormal mean	1902.754
Detection limit or PQL		Std. devn.	6561.372
Method detection limit		Median	80.75
TOTAL	94	Min.	8.6
ENTER DATA		Max.	37000

Paste values | Sort data | Calculate UCL | Lognormal | Normal | Neither | Clear messages | Clear all

Finished

Exit MTCA*Stat*

Distribution Decision

Probability plot method		W test	D'Agostino's test
Lognormal distribution?		Normal distribution?	
r-squared is:	**0.916**	r-squared is:	**0.363**

Recommendations:

Use lognormal distribution.

Histogram 5 | 10 | 20

Upper Confidence Limit (UCL)

UCL (Land's method) is 4332.02481787846

Create report | Sample size

	A	B
2	8.6	3/25/2010
3	8.9	12/22/10
4	9.00	12/22/10
5	10.4	12/22/10
6	11.6	3/25/2010
7	12.1	12/22/10
8	12.7	12/22/10
9	12.8	12/22/10
10	14.1	12/22/10
11	15.5	12/22/10
12	16.4	12/21/10
13	16.4	12/21/10
14	16.8	3/25/2010
15	19.3	9/22/2009
16	19.4	12/17/10
17	20.3	9/22/2009
18	20.4	12/21/10
19	21.5	3/25/2010
20	22.5	12/21/10
21	25.6	9/22/2009
22	26.1	12/21/10
23	27	9/22/2009
24	27	3/25/2010
25	28.2	12/21/10
26	30	9/22/2009
27	30.1	12/23/10
28	31.5	12/17/10
29	37.6	12/23/10
30	40.0	12/23/10
31	42.0	12/22/10
32	45.4	12/23/10
33	55.5	9/22/2009
34	56.0	12/21/10
35	56.0	12/22/10
36	57.0	12/22/10
37	58.5	9/22/2009
38	64.5	9/22/2009
39	68.0	12/21/10
40	68.0	12/22/10
41	68.3	12/23/10
42	68.5	9/22/2009
43	68.5	9/22/2009
44	75	12/22/10
45	75	9/22/2009
46	75	9/22/2009
47	80.5	9/22/2009
48	80.5	9/22/2009
49	81	9/22/2009
50	81	3/25/2010
51	92.5	3/25/2010
52	93.5	9/22/2009
53	98	9/22/2009
54	103	9/22/2009
55	105	12/17/10
56	106	9/22/2009
57	108	12/22/10
58	127	12/21/10
59	144	12/22/10
60	174	12/21/10
61	182	9/22/2009
62	186	9/22/2009
63	261	9/22/2009
64	284	9/22/2009
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66	366	12/22/10
67	383	12/22/10
68	406	12/17/10
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79	2,320	12/17/10
80	2,400	12/22/10
81	2,670	12/22/10
82	3,830	12/22/10
83	4,130	12/22/10
84	4240	3/25/2010
85	4650	9/22/2009
86	5,300	12/21/10
87	5,580	12/17/10
88	5600	9/22/2009
89	6,100	12/17/10
90	7,500	12/22/10
91	13,500	12/22/10
92	24,000	12/22/10
93	31,000	12/22/10
94	33,000	12/22/10
95	37,000	12/22/10

APPENDIX G

Petroleum Biomarker Analysis Results for Groundwater, Million Gallon Tanks Subarea (prepared by Ecology)

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

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May 10, 2010

TO: Lucy McInerney, P.E., TCP-NWRO

FROM: Charles San Juan, LHG, TCP-HQ *Charles San Juan*; Bob Carrell, Ecology Manchester Lab

SUBJECT: GP West Million Gallon Tank Farm – Ground Water Petroleum "Biomarker" Analysis Results

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Executive Summary

This technical memorandum provides the results of a ground water petroleum "biomarker" analysis for the subject site. The biomarker test was used to determine if all of the ground water petroleum (dissolved-phase) north and west of the former GP West Million Gallon Tank Farm is the same oil.

Ground water flow across this site area is primarily north-northeast, with a slight ground water flow divide west of the tank farm (based on Sept 2009 Aspect GW elevation data). However, higher concentrations of ground water petroleum were detected northwest of the tank farm. This raised the question as to whether the tank farm is the source of the ground water dissolved-phase petroleum found to the northwest. Biomarker analysis was used to help answer this question.

Methods - the biomarker analysis is a forensic tool that may be used to match samples from one location to another. This test uses biomarkers (triterpanes and steranes) to "fingerprint" petroleum. The biomarker method that was used is similar to ASTM Method D-5739. This biomarker test was used on 8 ground water samples (from 8 different monitor wells) collected north and west of the tank farm.

Results – of the 8 samples collected, only 2 had a possible match by the biomarker test. Not all the samples had enough NAPL or product for biomarker test positive match. The two sample locations that appeared to match (EMS-16S and MG-MW03) are ~ 100-125 ft. north of the north edge of the tank farm. Both of these samples contained coal tar creosote, which suggests a match. However, the amount of coal tar in EMW-16S was less than MG-MW-03; therefore, a positive match is not possible. Three of the sample locations that did not match (EMW -7S, 8S and CF-MW01) are ~ 500-600 ft. northwest of the tank farm. Sample locations immediately north and east of the tank farm, also did not match (MG-

MW01, EMS-12S). The last sample location that did not match was CF-MW02, which is ~260 ft. north-northwest of the tank farm.

Conclusions – the ground water within the vicinity of million gallon tank farm is highly reduced, with biodegradation of remnant petroleum hydrocarbons. There wasn't enough "NAPL" or product in all samples to positively identify, by biomarker methods, all the oil as one unique or distinct source. According to the historical records, Bunker C fuel oil was stored in the million gallon tank farm. However, the analysis indicates that this remnant petroleum is now highly weathered ("lube oil" or unresolved chromatographic envelope). In other words, this remnant oil could not be conclusively identified (chromatographically) as Bunker C. Nevertheless, it is our belief that this oil is in likely highly weathered Bunker C. Ecology's ground water TPH results (March, 2010) were on average ~ 10X lower than the average of the previous sampling event (Aspect, Sept-09). This is likely an artifact of non-dissolved petroleum (polar compounds), laboratory protocols (silica gel cleanup) and gas chromatography (PAH peaks that elute within the diesel range). The million gallon tank farm is the likely source for the remnant oil immediately north-northeast (MG-MW03). As for the remnant oil to the northwest (CF-MW01), it is possible that petroleum dissolved-phase has migrated in this direction. There is a bit of a ground water flow divide west of the tank farm. However, it is our opinion that the Sept-09 ground water TPH concentrations should be checked. They may be an artifact of analytical methods/gas chromatography (PAH peaks that elute within the diesel range).

Ground Water Petroleum Evaluation

This section provides the results of Ecology's ground water petroleum "biomarker" analysis as well as an evaluation of other issues/conditions that may contribute to the distribution of petroleum at the Million Gallon Tank Farm.

Biomarker Analysis

The biomarker analysis is a forensic tool that may be used to match samples from one location to another. This test uses biomarkers (triterpanes and steranes) to "fingerprint" petroleum. This biomarker test has been modified by Bob Carrell and is similar to ASTM D5739-06 (*Standard Practice for Oil Spill Source Identification by Gas Chromatography and Positive Ion Electron Impact Low Resolution Mass Spectrometry*). The term "biomarker" refers to "molecular fossils" that demonstrate little to no change from their former precursor compounds.

The biomarker method was modified by certain changes to the GC temperature program. The shooting solvent was also changed from cyclohexanes to methylene chloride. Additionally the NWTPH-Dx extracts were used rather than extracts produced specifically for biomarker analyses. These extracts were pre-treated with concentrated sulfuric acid and silica gel as a clean-up procedure (NWTPH-Dx). None of these changes would significantly affect the results of the biomarker analyses.

Analytical Issues

The remnant ground water dissolved-phase petroleum has been quantified as "lube oil". This term may be used for petroleum products which present an unresolved chromatographic envelope of compounds, originating or extending beyond tetracosane (Ecology, 1997). Conversely, heavy fuel oils, e.g. fuel oil #6 or Bunker C, which contain a diesel range component as well as a lube oil (and higher) range may be reported using the collective term, "heavy fuel oil", unless specific identification is possible. Historical records indicate that Bunker C fuel had been stored at the million gallon tank farm. However, the biomarker analysis found that two of the samples contained coal tar creosote. Consequently, it appears that what was Bunker C oil is now actually highly weathered remnant petroleum (hence the use of the term lube oil). In other words, Bunker C oil could not be identified chromatographically. One likely explanation is that over time, the more volatile, water soluble and more easily degraded "cutter" portion of any Bunker C may have been lost through weathering (both biotic and abiotic). "Cutter" is a diesel or diesel-like fuel used to "cut" or change the viscosity of the Bunker fuel to the desired level.

As for the coal tar creosote, the amount was not determined or quantified. Here's why – this material, although hydrocarbon, does not represent petroleum. Coal tar is primarily comprised of unsubstituted PAHs; however, petroleum is comprised of substituted PAHs. In other words, the coal tar that was identified by the biomarker analysis may have been previously misidentified as Bunker C oil. Specifically, peaks that were thought to be petroleum (e.g. elute within the diesel range) were in reality coal tar creosote PAHs.

In conclusion, if this remnant oil was originally Bunker C (as presumed), then it is extremely weathered and it's lost most of its diesel "cutter". Conversely, if it is was "lube oil" initially, then there is no way to tell how weathered it is. The peaks that could be identified were PAHs, some of which could be from petroleum (e.g. naphthalene and methylnaphthalenes). The term "lube oil" was used because that fraction was what could reliably be quantified without the interference from the creosote PAHs. Also, these PAH peaks where significantly higher than the remaining compounds and the unresolved envelope. The small compound peaks in between them were insignificant compared to much higher PAH peaks.

Age Dating Ground Water Diesel

Per the methods described in Galperin and Kaplan (2008), an attempt was made to try and age-date the weathered diesel fuel. This method is based on analysis of the n-C17 (n-heptadecane) / pristane ratios. However, analysis of the chromatograms found that C17/pristine, C18 / phytane and pristane / phytane ratios are obscured by small amounts of a number of unidentified compounds. Therefore, the Galperin and Kaplan (2008) age-dating procedure was not used.

Ground Water Samples

Eight (8) ground water samples were collected from 8 different wells (March, 2010). These 8 wells are north, northwest and east of the tank farm. Samples were collected per Aspect (2009) work plan protocols, e.g. peristaltic pump, low-flow, pre-cleaned tubing, etc. Ground water field parameters (e.g. pH, dissolved oxygen, etc.) were monitored prior to sample collection. Once the samples were collected, they were shipped to Ecology's Manchester Lab for analysis.

Impact of Sample Turbidity and Filtering

A few of the GP West site ground water samples had a distinct "coffee color". This "coffee color" may be the result of lignins (spent liquor from the lignin plant was apparently stored in some of the tanks). This distinct color could not be removed, even after extraction and silica gel cleanup. Key issue – for the Mar-10 sampling event, Ecology's average ground water TPH concentration was 193 ppb (Table 6, p. 111). For Aspect's Sept-09 event, the average ground water TPH concentration was 1,920 ppb - 10 times higher. This seems to imply that the Sept -09 ground water TPH results were high-biased by non-dissolved petroleum.

Zemo (2006) has reported that ground water petroleum samples may be high-biased by "non-dissolved" petroleum. This non-dissolved petroleum may be an artifact of sampling methods (e.g. a bailer) and turbid (muddy) ground water. Specifically, some of the petroleum will adsorb to soil particles within the ground water. In a subsequent study, Zemo (2009) recommended that the possible impacts of non-dissolved petroleum can be reduced or mitigated by both lab and field methods. For field methods, Zemo (2009) recommended: a) re-develop turbid wells, b) use low-flow sampling methods, c) avoid collecting turbid "grab "samples (e.g. direct push temporary wells), and d) if you have to use a grab sample, then use a pre-packed well screens. For lab methods, Zemo (2009) recommends: a) filtering samples prior to extraction (e.g. 0.7 µm), and b) gravity separate samples (Figure 1, p. 7).

However, in a study of weathered diesel, Lang et al. (2009) found that if you only focus on the dissolved-phase petroleum and you ignore the unresolved complex mixture (UCM), then you may underestimate risk. Specifically, as Zemo (2003, 2006, 2009) notes, polar compounds can be captured during extraction, which may high-bias results. Because of their incorporation of nitrogen, sulfur and oxygen atoms, polar compounds are not technically hydrocarbons (Lang, 2009). This is why silica gel cleanup is used to remove polar compounds and other non-petroleum substances (e.g. organic matter) that may interfere with the analysis. Lang's (2009) study found that when weathered diesel fuel was mixed with water, it resulted in concentrations of 96 and 8.6 mg/L, which is well above the effective solubility of diesel fuel (~ 3-5 mg/L). However, Lang's analysis of the weathered fuel water-phase found that polar compounds comprised 98% of the C15-C28 range. Lang's (2009) conclusion: *"These findings highlight the ambiguity of groundwater analyses attempting to characterize the extent of contamination arising from weathered petroleum products, where GC-resolvable components may not be the major analytes."*

Million Gallon Tank Farm – Previous Soil Results

As part of the Phase II (Aspect, 2004) environmental assessment, 9 soil samples were collected from 4 locations. Only one of the 9 soil samples contained petroleum that eluted within or was quantified as Bunker C (MG-MW01, 7.5-9-ft.). The remaining eight samples contained petroleum that was identified as either diesel range or motor oil. Key point – per Ecology Implementation memo #4, unless there's clear reason (analytically) to do so, TPH results should not be "split" into different "pieces" (e.g. motor oil). Specifically, the reported TPH concentration should reflect the sum of all oil types identified and detected.

Table 1 - Soil TPH Results – Million Gallon Tank Farm (Aspect, 2004).

Location	Depth (ft.)	Bunker C (mg/kg)	Diesel (mg/kg)	Motor Oil (mg/kg)	Total TPH (mg/kg)
MG-MW01	2.5-4	--	160	1,100	1,260
	7.5-9	2,700	--	--	2,700
MG-SB01	2-3	--	66	130	196
	0-4	--	250	2,400	2,650
	4-8	--	49	240	289
MG-SB03	0-4	--	17	180	197
	4-8	--	26	190	216
	8-12	--	74	760	834

Spatial Nature and Extent of the Ground Water Dissolved-Phase Hydrocarbons

For the Sept-09 sampling event, ground water petroleum concentrations increased over distance (west) to CF-MW01 (Figure 5, p. 122). This seemed a bit odd as the predominant ground water flow direction for the million gallon tank farm area is north-northeast. However, a check of the 2004 ground water naphthalene data (Aspect, 2004) found that concentrations were higher in the direction of ground water flow (Figure 6, p. 133). Lastly, Ecology ground water petroleum concentrations were higher immediately north of the tank farm (MG-MW03; Figure 7, p. 144). Lower concentrations were detected west of the tank farm (CF-MW01).

Petroleum Hydrocarbon Biodegradation

Results of previous geochemical measurements (Aspect, 2004) were used to cross-check ground water petroleum biodegradation. Geochemical measurements from 3 source area wells were compared to 3 downgradient (north-northeast). Results) were then compared to Robbins (1996; Table 3, p. 6). The average source area dissolved oxygen concentration (0.7 mg/L), was less than 1 mg/L, which is consistent with anaerobic petroleum biodegradation. The average source area electrical conductivity (3,278 µs/cm) was ~3X higher than the average downgradient conductivity (1,173 µs/cm). This is consistent with Robbins (1996) rule of thumb - source area conductivity increase by 2-10X.

Ground Water Flow Direction

Within the vicinity of the million gallon tank farm, the predominant ground water flow direction is north-northeast (Figure 8, p. 155). There appears to be a depression in the water table just northeast of the tank farm @ EMW-16S. This “dip” in the shallow water table may be an artifact of water leakage though the former bulkhead. Also, it appears that there may be slight ground water divide west of the tank farm, within the vicinity of EMW-6S. The flow vectors for this area are more west, in the direction of EMW-8S, EMW-7S and CF-MW01. Higher concentrations of petroleum were detected in these three wells. In others words, this ground water divide may in part explain dissolved-phase petroleum west of the tank farm (CF-MW01).

Table 2 – Ground Water Geochemical Parameters, Million Gallon Tank Farm Area (Aspect, 2004).

Well	Area	Conductivity µs/cm	Dissolved Oxygen (mg/L)	Redox volts	pH
EMW-12S	Source	2,858	0.83	-190	6.6
EMW-16S	Source	5,672	0.67	-225	6.6
MG-MW01	Source	1,303	0.62	-204	6.5
Average		**3,278**	**0.7**	**-206**	**6.5**
EMW-18S	Downgradient	993	0.9	-214	6.7
AP-MW01	Downgradient	1,441	1.3	-168	6.9
EMW-13S	Downgradient	1,085	1.06	-254	7.4
Average		**1,173**	**1.1**	**-212**	**7.0**

Table 3 – Typical Geochemical Conditions – Petroleum Hydrocarbon Biodegradation (Robbins, 1996).

Parameter	Typical Biodegradation Condition
Dissolved Oxygen	Decreased concentration down to less than 1 ppm near source
Platinum Electrode Redox Eh	Decreased; negative values near source
Nitrate	Decreased; very low to non-detection levels near source
Dissolved Iron	Increased from ppb range to 1 to 200 ppm range
Dissolved Manganese	Increased from ppb range to 1 to 100 ppm range
Sulfate	Decreased; very low to non-detection levels near source
Alkalinity	Increased to 100 to 1,000 ppm range
pH	Slightly Increased (within a half of a pH unit)
Electrical Conductivity	Increased by a factor of 2 to over 10 times
Chloride	Increased to several 100 ppm
Dissolved Methane	Increased
Dissolved Carbon	Dioxide Increased

Figure 1 - Gravity Separation of Ground Water Petroleum (Zemo, 2009).

Before **After**

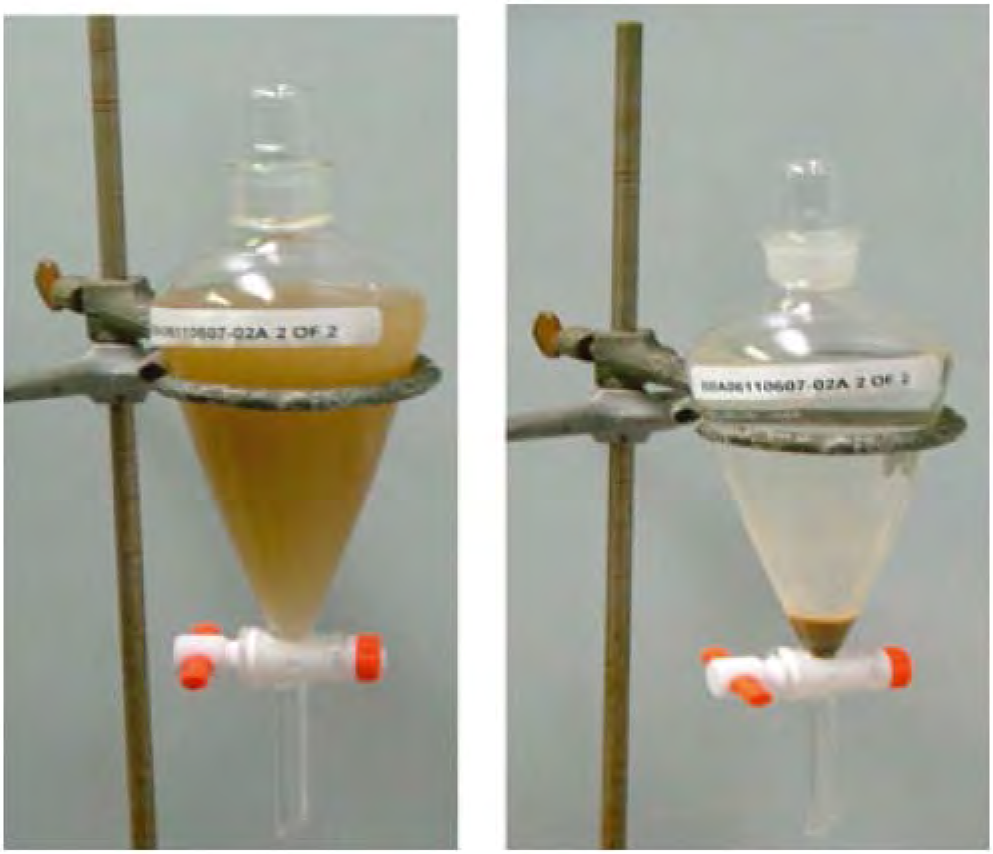


Table 4 - Ground Water TPH Results (Zemo, 2009).

	Conventional TPHd (mg/L)	Gravity Separation TPHd (mg/L)	Reduction (%)
MW-5	254	1.55	-99
MW-6	111	0.57	-99
MW-8	42.8	0.68	-98
MW-10	186	3.53	-98

Figure 2 - GC/FID Chromatogram – Fresh / Weathered Diesel Fuel (Lang, 2009).

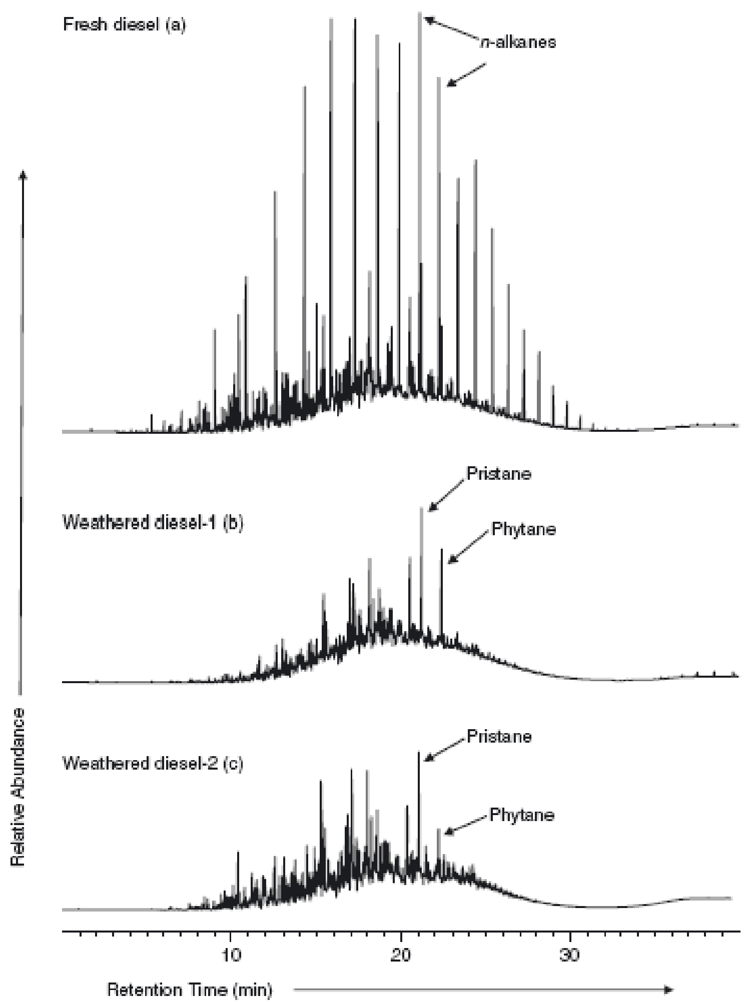
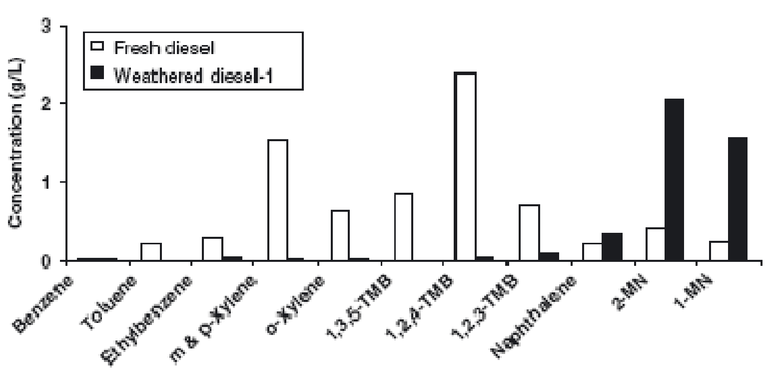


Figure 3 - BTEX and Trimethylbenzene Concentrations, Fresh and Weathered Diesel Fuel (Lang, 2009).



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Zemo, D.A. (2006). Sampling in the Smear Zone: Evaluation of Nondissolved Bias and Associated BTEX, MTBE, and TPH Concentrations in Ground Water Samples. Ground Water Monitoring Remediation (GWMR) Vol. 26, No. 3, Summer, 2006, pp. 125-133.

Zemo, D. A. (2009). Suggested Methods to Mitigate Bias from Nondissolved Petroleum in Ground Water Samples Collected from the Smear Zone. Ground Water Monitoring Remediation (GWMR) Vol. 29, No. 3, Fall, 2009, pp. 77-83.

Figure 4- Biomarker Results.

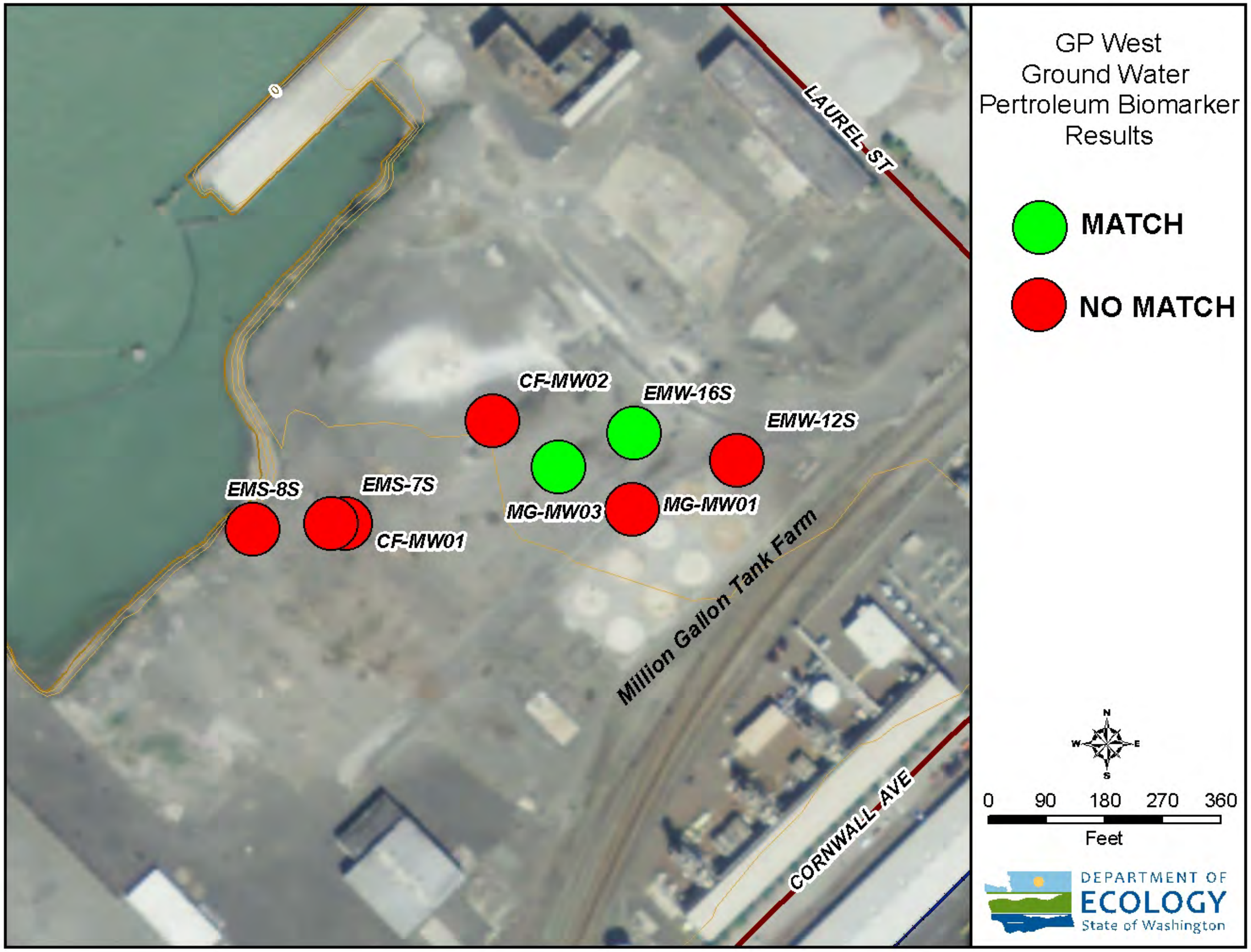


Table 5 - Summary Results.

Well	Ground Water TPH (Aspect, 2009) Diesel Range (by NWTPH-Dx) (ug/L)	Ground Water TPH (Ecology, 2010) Diesel Range (by NWTPH-Dx) (ug/L)	Biomarker Match?
CF-MW01	3,300	120	NO
EMS-7S	--	ND	NO
CF-MW02	1,360	120	NO
EMS-8S	--	ND	NO
EMW-16S	2,520	ND	YES – similar to MG-MW03
EMW-12S	840	ND	NO
MG-MW03	--	340	YES – similar to EMW-16S
MG-MW01	1,580	ND	NO
Average	**1,920**	**193**	

ND = non-detect.

Figure 5 - Ground Water TPH (Aspect, 2010).

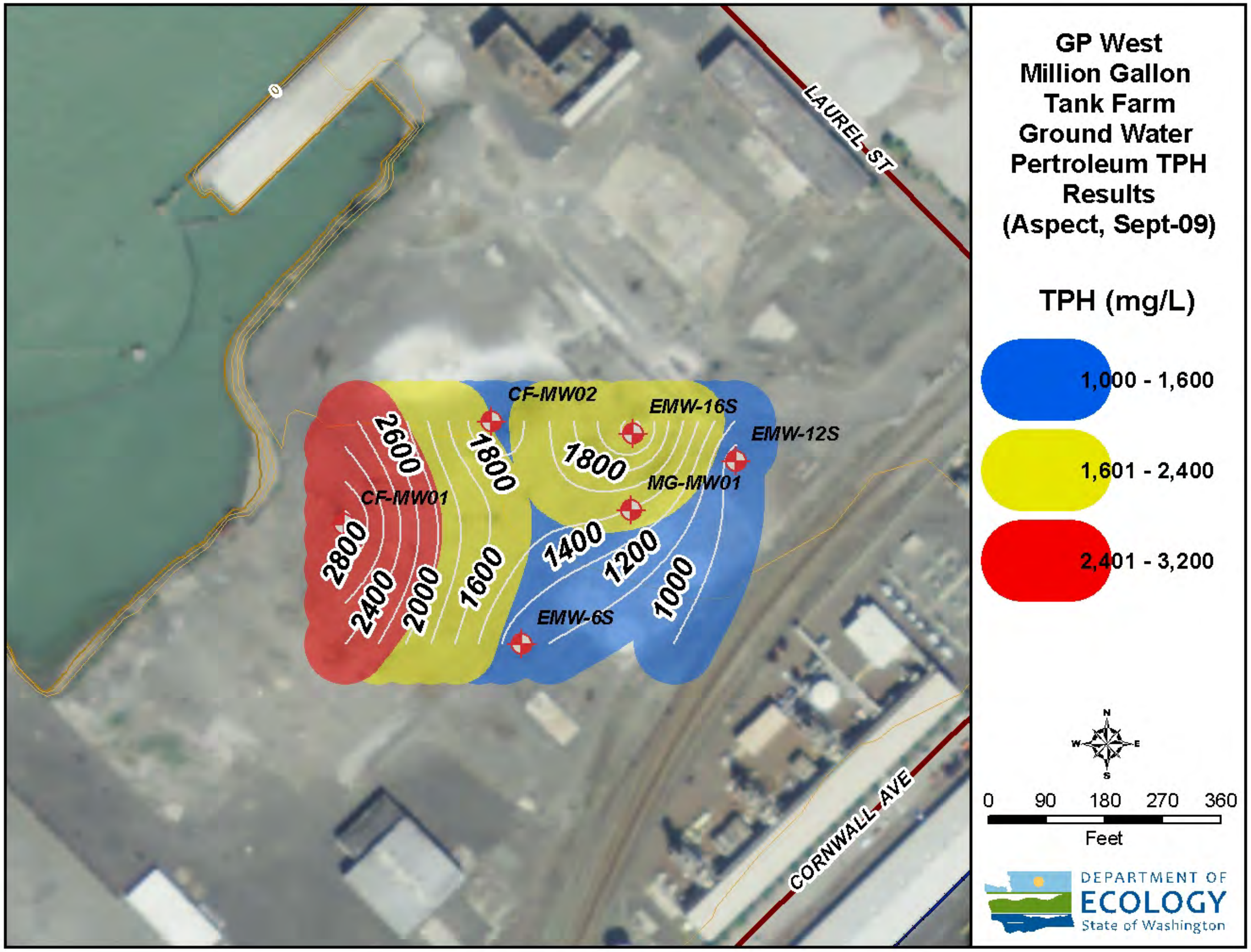


Figure 6 - Ground Water Total Naphthalenes (Aspect, 2004).

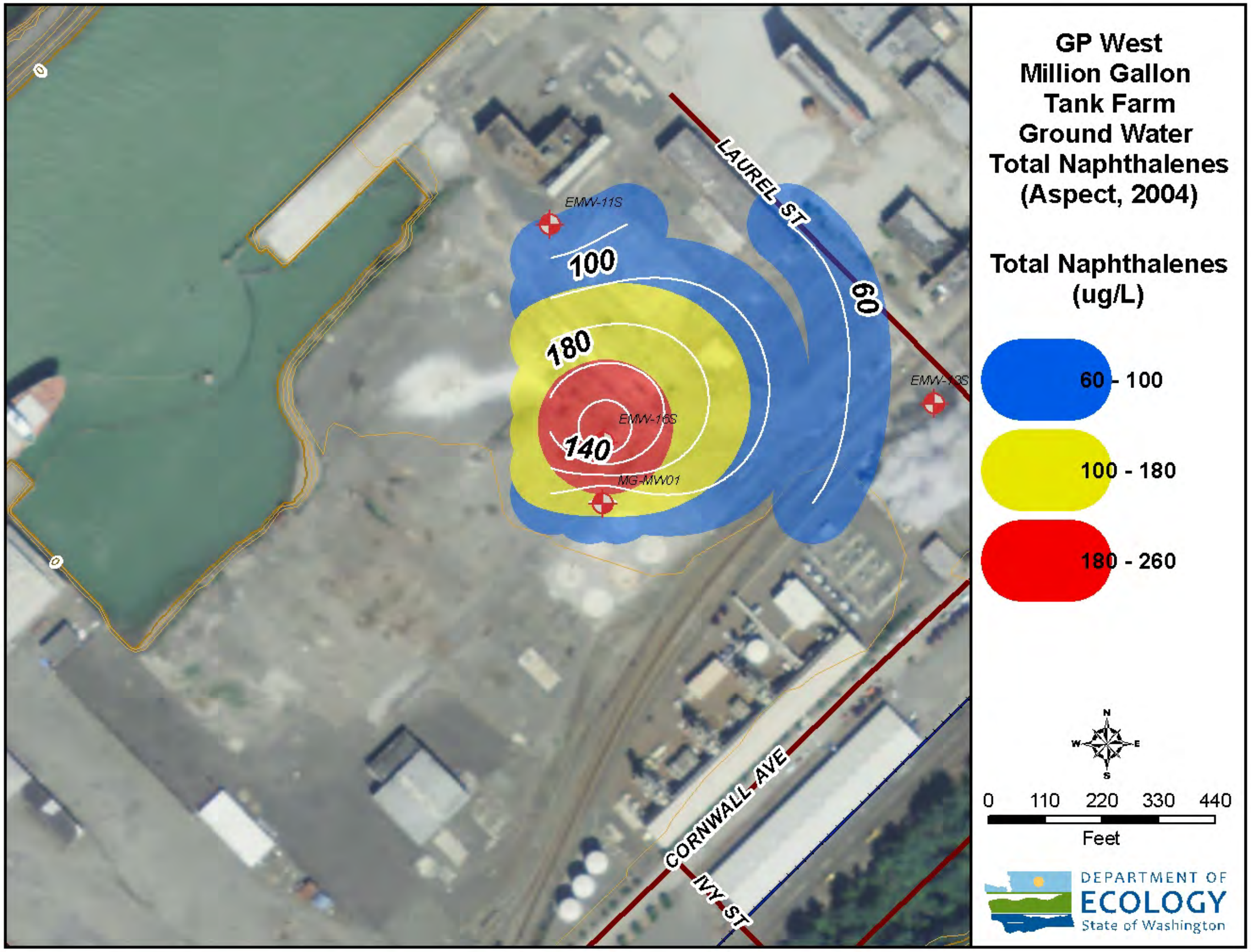


Figure 7 - Ground Water TPH (Ecology, 2010).

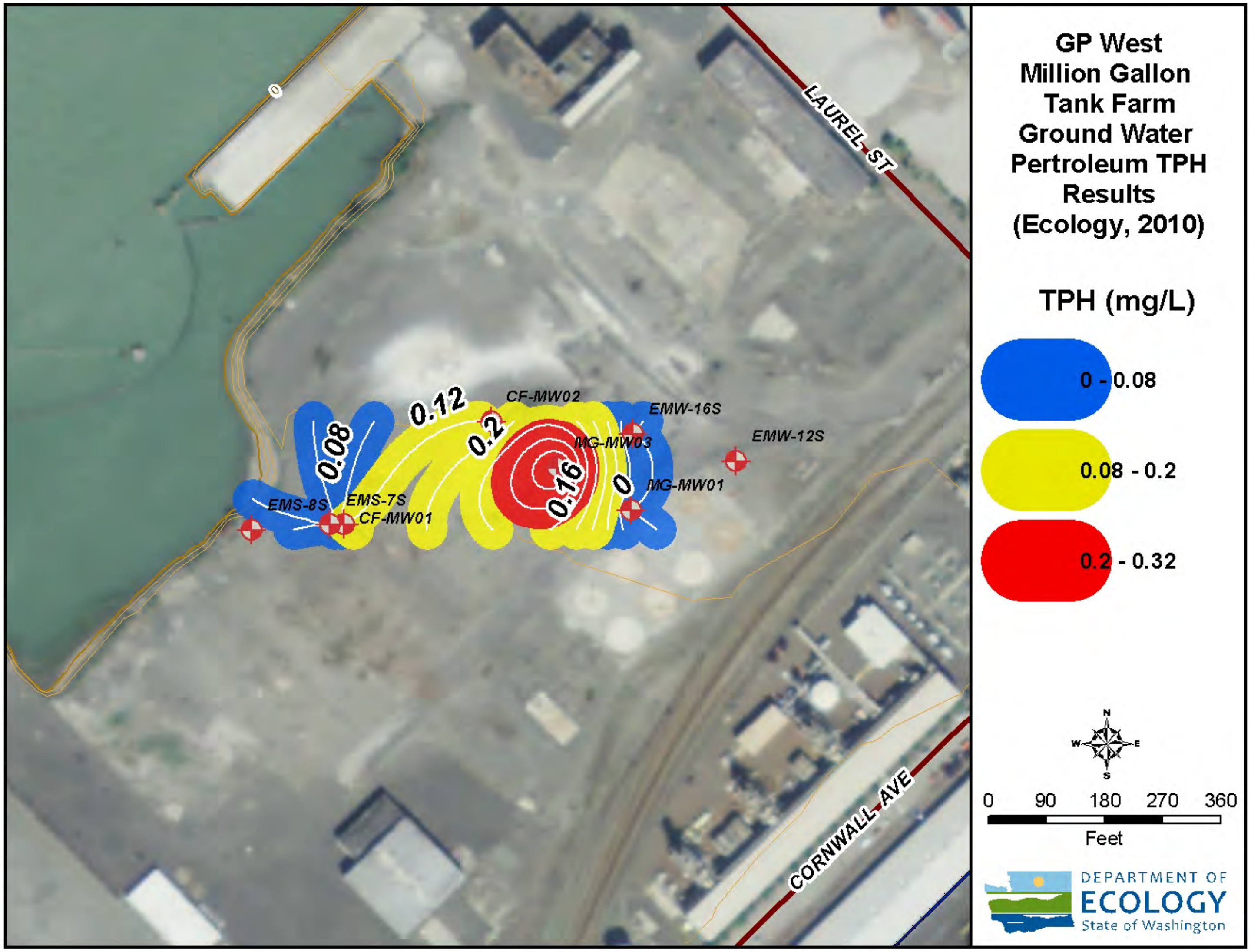
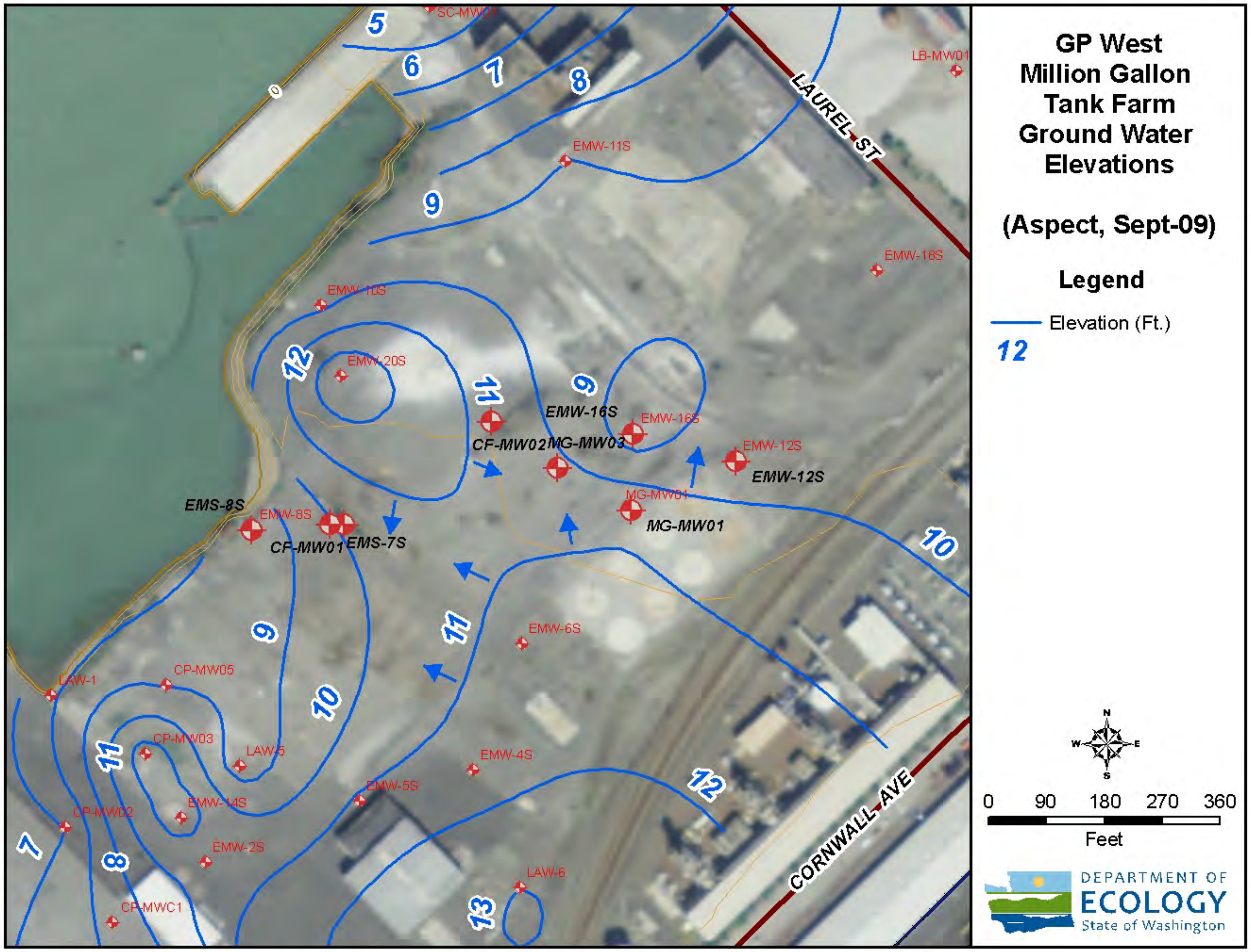


Figure 8 - Ground Water Flow Direction (Aspect, 2010; Sept-09 Elevations).



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PAGE 1 OF 1 COC #

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PROJECT MANAGER: Steve Germiat
COMPANY/ADDRESS: 401 2nd Ave S Suite 201
CITY/STATE/ZIP: Seattle, WA 98104
E-MAIL ADDRESS: sgermiat@aspectconsulting.com
PHONE #: 206-838-5830 FAX #:
SAMPLER'S SIGNATURE:

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐ 8270LL☐	Volatile Organics 624☐ 8260☐ 8021☐	Hydrocarbons (*see below) Gas☐ Diesel☒ Oil☐ BTEX☐ TPHD	Fuel Fingerprint (FIQ) ☐ NW-HCID Screen ☐	Oil & Grease/TRPH 1664 HEM☐ 1664 SGT☐	PCB's Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081A☐ 8141A☐ 8151A☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	PAHS 8310☐ SIM☐	Metals, Total or Dissolved (See list below)	Cyanide☐ Hex-Chrom☐	pH, Cond., Cl, SO4, PO4, F, NO2, NO3, BOD, TSS, TDS (circle)	NH3-N, COD, Total-P, TKN, TOC, DOC (circle) NO2+NO3	TOX 9020☐ AOX 1650☐ 506☐	BIOMARKERS				REMARKS
CF-MW01-033110	3/31/10	1450	01	W	1			X												X				
EMW-7S-033110	3/31/10	1115	02		1			X												X				
CF-MW02-033110	3/31/10	1645	03		1			X												X				
EMW-8S-033110	3/31/10	0955	04		1			X												X				
EMW-16S-033010	3/30/10	1500	05		1			X												X				
EMW-12S-033010	3/30/10	1405	06		1			X												X				
MG-MW03-032910	3/29/10	1445	07		1			X												X				
MG ~~CFE~~-MW01-032910	3/29/10	1520	08	W	1			X												X				

Open Charles Sam Bryan

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required
___ II. Report Dup., MS, MSD as required
___ III. Data Validation Report (includes all raw data)
___ IV. CLP Deliverable Report
___ V. EDD

INVOICE INFORMATION
P.O. # 070188-001-07
Bill To: Aspect Consulting

TURNAROUND REQUIREMENTS
___ 24 hr. ___ 48 hr.
___ 5 Day
X Standard (~~10-15~~ 30 working days)
___ Provide FAX Results

Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORTHWEST OTHER:_______ (CIRCLE ONE)

SPECIAL INSTRUCTIONS/COMMENTS:
Cooler Temp 5°C
ALL Samples arrived over the 7 day hold time. NR
Custody Seal intact - NR

RELINQUISHED BY:		RECEIVED BY:		RELINQUISHED BY:		RECEIVED BY:	
Signature	Date/Time 4/6/10	Signature	Date/Time 04/07/10 13:10	Signature	Date/Time	Signature	Date/Time
Printed Name Amy Tice	Firm Aspect	Printed Name Nancy Rosenbauer	Firm DOE Lab	Printed Name	Firm	Printed Name	Firm

RCOC #1 07/09

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard, Washington 98366

Case Narrative

April 16, 2010

Subject: GP West Site Project

Sample(s): 1003057-01 through 1003057-08

Officer(s): Charles San Juan and Lucy McInerney

Work Order: 1003057

By: Bob Carrell

BIOMARKER ANALYSES

Analytical Method(s)

The samples were extracted with methylene chloride and were then analyzed, along with a method blank and Alaska North Slope crude oil (ANS) standard, by gas chromatography with detection by selected ion monitoring mass spectroscopy (GC/MS-SIM). This is used to determine the biomarker (triterpanes and steranes) "fingerprint" by analyzing for the 191 mass ion (triterpanes) and the 217 and 218 mass ions (steranes) as well as ratios of various other petroleum constituents. This method is similar to ASTM Method D-5739 for biomarker analyses.

Holding Times

The samples were extracted and analyzed within the recommended method holding times.

Calibration

This is not applicable in the traditional sense since only various petroleum products standards are analyzed to establish chromatographic product "fingerprints".

Blanks

No analytically significant levels of any petroleum product or hydrocarbon were detected in the method blank (B10D065-BLK1) associated with these samples.

Comments

The low amount of lube oil range material in most of these samples prevents biomarkers from being determined in all but two of the samples. In those samples (1003057-05 and 1003057-07) there may be a match between them but since the biomarker levels in sample 1003057-05 are fairly low I cannot be certain. Since they both also contain coal tar creosote, a match is more likely.

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Biomarker - Hydrocarbon Identification

Project Name: GP West Site
Work Order: 1003057
Project Officer: San Juan, Charles

Analyte: Hydrocarbon identification
Method: Biomarker
Matrix: Water

Sample #	Sample ID	Collected	Analyzed	Result
1003057-01	**CF-MWO1-033110**	03/31/10	04/12/10	This sample had little in the way of biomarkers.
1003057-02	**EMW-75-033110**	03/31/10	04/12/10	This sample had little in the way of biomarkers.
1003057-03	**CF-MWO2-033110**	03/31/10	04/12/10	This sample had little in the way of biomarkers.
1003057-04	**EMW-85-033110**	03/31/10	04/12/10	This sample had little in the way of biomarkers.
1003057-05	**EMW-165-033010**	03/30/10	04/12/10	This sample may match sample 1003057-07.
1003057-06	**EMW-125-033010**	03/30/10	04/12/10	This sample had little in the way of biomarkers.
1003057-07	**MG-MWO3-032910**	03/29/10	04/12/10	This sample may match sample 1003057-05.
1003057-08	**MG-MWO1-032910**	03/29/10	04/12/10	This sample had little in the way of biomarkers.

QC Results for Batch ID: B10D065
Method Blank

B10D065-BLK1 Blank No detectable petroleum hydrocarbons or products found.

Authorized by: [signature]

Release Date: 4-19-10

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard, Washington 98366

Case Narrative

April 16, 2010

Subject: GP West Site Project

Sample(s): 1003057-01 through 1003057-08

Officer(s): Charles San Juan and Lucy McInerney

Work Order #: 1003057

By: Bob Carrell

NWTPH-Dx Analysis

Analytical Method

The water samples, two laboratory control spike, and a method blank were extracted with methylene chloride and the extracts were analyzed by gas chromatography with flame ionization detection (GC/FID) as outlined in the NWTPH-Dx method.

Holding Times

The samples were extracted and analyzed within the recommended method holding times.

Calibration

An eight point diesel oil and an eight point lube oil calibrations using a linear fit for the diesel and quadratic fit for the lube oil resulted in correlation coefficients of greater than 0.99 with no standard varying from its true value by more than +/-20%. Also the beginning and end of analytical run check standards did not vary from their true values by more than +/-20%.

Blanks

No analytically significant levels of analyte were detected in the method blank B10D065-BLK1 associated with these samples.

Surrogate

The pentacosane surrogate recoveries were acceptable and within the QC limits of 50% to 150%.

Laboratory Control Spike

The results of the diesel oil LCSs (B10D065-BS1and BSD1) were acceptable and within the laboratory QC limits of 70%-130%.

Matrix Spikes

None requested.

Sample Duplicate

None requested.

Comments

None of the oil observed in these samples could be positively identified and what was there appears to elute primarily in the lube oil range. As such it was quantitated as lube oil. Two samples, i.e. 1003057-05 and 1003057-07 contained significant amounts of coal tar creosote which primarily elutes within the diesel range. Because of that the reported value for diesel had to be raised above that which the creosote would produce.

Data Qualifier Codes

U	-	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	-	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ	-	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
REJ	-	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
NAF	-	Not analyzed for.
NC	-	Not Calculated

bold - The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **Field ID: CF-MWO1-033110**

Work Order: 1003057	**Lab ID #: 1003057-01**	**Batch ID: B10D065**
Project Officer: San Juan, Charles	**Collected: 3/31/2010**	**Prepared: 4/8/2010**
Initial Vol: 1025 mL	**Prep Method: SW3535**	**Analyzed: 4/14/2010**
Final Vol: 1 mL	**Analysis Method: NWTPH-DX**	**Matrix: Water**
		Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.05	U	0.05	0.002
NULL	**Lube Oil**	**0.12**		0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.0972		0.137	71	50-150

Authorized by: Barell **Release Date:** 4-19-10 Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **Field ID: EMW-75-033110**

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1010 mL
Final Vol: 1 mL

Lab ID #: 1003057-02
Collected: 3/31/2010
Prep Method: SW3535
Analysis Method: NWTPH-DX

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.05	U	0.05	0.002
NULL	Lube Oil	0.12	U	0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.107		0.139	77	50-150

Authorized by: Barrell **Release Date:** 4-19-10 Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **Field ID: CF-MWO2-033110**

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1025 mL
Final Vol: 1 mL

Lab ID #: 1003057-03
Collected: 3/31/2010
Prep Method: SW3535
Analysis Method: NWTPH-DX

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.05	U	0.05	0.002
NULL	**Lube Oil**	**0.12**		0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.145		0.137	106	50-150

Authorized by: Barl[illegible] **Release Date:** 4-19-10

Printed:
4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **Field ID: EMW-85-033110**

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1025 mL
Final Vol: 1 mL

Lab ID #: 1003057-04
Collected: 3/31/2010
Prep Method: SW3535
Analysis Method: NWTPH-DX

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.05	U	0.05	0.002
NULL	Lube Oil	0.12	U	0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.150		0.137	110	50-150

Authorized by: Barell **Release Date:** 4-19-10 Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **Field ID: EMW-165-033010**

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1030 mL
Final Vol: 1 mL

Lab ID #: 1003057-05
Collected: 3/30/2010
Prep Method: SW3535
Analysis Method: NWTPH-DX

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.34	U	0.34	0.002
NULL	Lube Oil	0.12	U	0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.147		0.136	108	50-150

Authorized by: Bawell **Release Date:** 4-19-10

Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **Field ID: EMW-125-033010**

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1030 mL
Final Vol: 1 mL

Lab ID #: 1003057-06
Collected: 3/30/2010
Prep Method: SW3535
Analysis Method: NWTPH-DX

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.05	U	0.05	0.002
NULL	Lube Oil	0.12	U	0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.116		0.136	85	50-150

Authorized by: Banell **Release Date:** 4-19-10

Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **Field ID: MG-MWO3-032910**

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1025 mL
Final Vol: 1 mL

Lab ID #: 1003057-07
Collected: 3/29/2010
Prep Method: SW3535
Analysis Method: NWTPH-DX

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.20	U	0.20	0.002
NULL	**Lube Oil**	**0.34**		0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.139		0.137	102	50-150

Authorized by: [signature] **Release Date:** 4-19-10 Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **Field ID: MG-MWO1-032910**

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1030 mL
Final Vol: 1 mL

Lab ID #: 1003057-08
Collected: 3/29/2010
Prep Method: SW3535
Analysis Method: NWTPH-DX

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.05	U	0.05	0.002
NULL	Lube Oil	0.12	U	0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.125		0.136	92	50-150

Authorized by: Banell **Release Date:** 4-19-10

Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **QC Type : Method Blank**

Work Order: 1003057	**Lab ID #:** B10D065-BLK1	**Batch ID:** B10D065
Project Officer: San Juan, Charles	**Prep Method:** SW3535	**Prepared:** 4/8/2010
Initial Vol: 1000 mL	**Analysis Method:** NWTPH-DX	**Analyzed:** 4/14/2010
Final Vol: 1 mL	**Source Field ID:** Blank	**Matrix:** Water
		Units: mg/L

CAS#	Analyte	Result	Qualifier	RL	MDL
68476-34-6	#2 Diesel	0.05	U	0.05	0.002
NULL	Lube Oil	0.12	U	0.12	0.004

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.130		0.14	93	50-150

Authorized by: Barrell **Release Date:** 4-19-10 Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site **QC Type : LCS**

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1000 mL
Final Vol: 1 mL

Lab ID #: B10D065-BS1
Prep Method: SW3535
Analysis Method: NWTPH-DX
Source Field ID: LCS

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

Analyte	Spike Result	RL	Spike Level	%Rec	%Rec Limits
#2 Diesel	**0.91**	0.05	1	91	70-130

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.162		0.14	115	50-150

Authorized by: Bmullf **Release Date:** 4-19-10 Printed: 4/19/2010

Washington State Department of Ecology
Manchester Environmental Laboratory
Final Analysis Report for
Semi-volatile petroleum products

Project: GP West Site

QC Type : LCS Dup

Work Order: 1003057
Project Officer: San Juan, Charles
Initial Vol: 1000 mL
Final Vol: 1 mL

Lab ID #: B10D065-BSD1
Prep Method: SW3535
Analysis Method: NWTPH-DX
Source Field ID: LCS Dup

Batch ID: B10D065
Prepared: 4/8/2010
Analyzed: 4/14/2010
Matrix: Water
Units: mg/L

Analyte	Spike Result	RL	Spike Level	%Rec	%Rec Limits	RPD	RPD Limit
#2 Diesel	**0.86**	0.05	1	86	70-130	6	40

Surrogate Recovery:

CAS#	Analyte	Result	Qualifier	Spike Level	% Recovery	%Rec.Limits
629-99-2	Pentacosane	0.138		0.14	98	50-150

Authorized by: Barlell Release Date: 4-19-10 Printed: 4/19/2010

APPENDIX H

RI Data Quality Validation Reports (prepared by Pyron Environmental)

and Attachment H-1: Laboratory Reports (on CD)

Data Validation Report

Port of Bellingham Former GP Mill Property RI/FS
Bellingham, Washington
2009 Soil Sampling

Prepared for:

Aspect Consulting LLC
401 Second Ave South, Suite 201
Seattle, WA 98014

Prepared by:

Pyron Environmental, Inc.
3530 32nd Way, NW
Olympia, WA 98502

December 2, 2009

ACRONYMS

%D	percent difference
%D$_f$	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
AMU	atomic mass unit
BFB	bromofluorobenzene
CAS	Columbia Analytical Services, Inc. – Kelso, Washington
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CDD	chlorinated dibenzo-p-dioxin
CDF	chlorinated dibenzofuran
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
CPS	column performance solution
CS	calibration standard
CVAA	cold vapor atomic absorption spectrometry
DFTPP	decafluorotriphenylphosphine
EDL	estimated detection limit
EMPC	estimated maximum possible concentration
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
Hg	mercury
HRGC	high-resolution gas chromatograph
HRMS	high-resolution mass spectrometer
ICAL	initial calibration
ICB	initial calibration blank
ICP	Inductively coupled plasma
ICSA	ICP interference check sample solution A
ICSAB	ICP interference check sample solution AB

ICV	initial calibration verification
IPR	initial precision and recovery
ISC	isomer specificity check
LCL	laboratory control limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
µg/kg	microgram per kilogram
µg/L	microgram per liter
mg/kg	milligram per kilogram
µg/L	microgram per liter
MDL	method detection limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
m/z	mass-to-charge ratio
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics, EPA 2004 – Inorganics, EPA 2005 - Dioxins and Furans)
ng/kg	nanogram per kilogram
OPR	ongoing precision and recovery
PAH	polycyclic aromatic hydrocarbon
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RF	response factor
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SICP	selected ion current profile
S/N	signal-to-noise ratio
WDM	window defining mixture
SIM	selective ion monitoring
TCLP	toxicity characteristics leaching procedure
TPH	total petroleum hydrocarbon
VOCs	volatile organic compounds
WDOE	Washington State Department of Ecology

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for samples collected during September 2009 for the referenced project. The laboratory reports validated herein were submitted by Columbia Analytical Services, Inc.

A level III data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines Guidelines ([NFGs], EPA 2008 – Organics, EPA 2004 – Inorganics, and EPA 2005 – Dioxins & Furans) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Aspect, 2009) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	pH	Dioxins
PR-SB05-5-7	K0908614-001	09/14/09	Soil			Hg			
PR-SB05-9-10	K0908614-002	09/14/09	Soil			Hg			
PR-SB05-13-14	K0908614-003	09/14/09	Soil			Hg			
PR-SB05-17-18	K0908614-004	09/14/09	Soil			Hg			
PR-SB04-1-3	K0908614-005	09/14/09	Soil			Hg			
PR-SB04-5-7	K0908614-006	09/14/09	Soil			Hg			
PR-SB04-10-12	K0908614-007	09/14/09	Soil			Hg			
PR-MW01-1-3	K0908614-008	09/14/09	Soil			Hg			
PR-MW01-5-7	K0908614-009	09/14/09	Soil			Hg			
PR-MW01-13-14	K0908614-010	09/14/09	Soil			Hg			
PR-MW01-17-18	K0908614-011	09/14/09	Soil			Hg			
PR-SB03-1-3	K0908614-012	09/14/09	Soil			Hg			
PR-SB03-5-7	K0908614-013	09/14/09	Soil			Hg			
PR-SB03-9-10	K0908614-014	09/14/09	Soil			Hg			
PR-SB03-13-14	K0908614-015	09/14/09	Soil			Hg			
PR-SB03-17-18	K0908614-016	09/14/09	Soil			Hg			
PR-SB02-4-5	K0908614-017	09/14/09	Soil			Hg			
PR-SB02-6-7	K0908614-018	09/14/09	Soil			Hg			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	pH	Dioxins
PR-SB02-9-10	K0908614-019	09/14/09	Soil			Hg			
PR-MW01-9-10	K0908614-020	09/14/09	Soil			Hg			
PR-SB02-13-14	K0908614-021	09/14/09	Soil			Hg			
PR-SB02-17-18	K0908614-022	09/14/09	Soil			Hg			
MG-SB07-1-2	K0908615-001	09/14/09	Soil		X		X		
MG-SB07-6-8	K0908615-002	09/14/09	Soil		X		X		
MG-SB07-12-13	K0908615-003	09/14/09	Soil		X		X		
MG-SB07-15-16	K0908615-004	09/14/09	Soil		X		X		
MG-SB08-1-2	K0908615-005	09/14/09	Soil		X		X		
MG-SB08-7-8	K0908615-006	09/14/09	Soil		X		X		
MG-SB08-11-12	K0908615-007	09/14/09	Soil		X		X		
MG-SB08-15-16	K0908615-008	09/14/09	Soil		X		X		
MG-SB10-1-2	K0908615-009	09/14/09	Soil		X		X		
MG-SB10-7-8	K0908615-010	09/14/09	Soil		X		X		
MG-SB10-11-12	K0908615-011	09/14/09	Soil		X		X		
MG-SB10-15-16	K0908615-012	09/14/09	Soil		X		X		
MG-SB09-2-4	K0908615-013	09/14/09	Soil		X		X		
MG-SB09-6-7	K0908615-014	09/14/09	Soil		X		X		
MG-SB09-11-12	K0908615-015	09/14/09	Soil		X		X		
MG-SB09-19-20	K0908615-016	09/14/09	Soil		X		X		
MG-SB04-2-4	K0908615-017	09/14/09	Soil		X		X		
MG-SB04-6-8	K0908615-018	09/14/09	Soil		X		X		
MG-SB04-11-12	K0908615-019	09/14/09	Soil		X		X		
MG-SB04-16-18	K0908615-020	09/14/09	Soil		X		X		
LP-SB12-1-2	K0908616-001	09/15/09	Soil	X					
LP-SB12-4-5	K0908616-002	09/15/09	Soil	X					
LP-SB12-7-8	K0908616-003	09/15/09	Soil	X					
LP-SB13-1-2	K0908616-005	09/15/09	Soil	X					
LP-SB13-4-5	K0908616-006	09/15/09	Soil	X					
LP-SB13-7-8	K0908616-007	09/15/09	Soil	X					
LP-SB14-1-2	K0908616-009	09/15/09	Soil	X					
LP-SB14-5-6	K0908616-010	09/15/09	Soil	X					
LP-SB14-9-10	K0908616-011	09/15/09	Soil	X					
LP-SB09-1-2	K0908616-013	09/15/09	Soil	X					
LP-SB09-3.5-4.5	K0908616-014	09/15/09	Soil	X					

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	pH	Dioxins
LP-SB09-8-9	K0908616-015	09/15/09	Soil	X					
LP-SB10-1-2	K0908616-017	09/15/09	Soil	X					
LP-SB10-4-5	K0908616-018	09/15/09	Soil	X					
LP-SB10-7-8	K0908616-019	09/15/09	Soil	X					
LP-SB11-1-2	K0908616-021	09/15/09	Soil	X					
LP-SB11-4-5	K0908616-022	09/15/09	Soil	X					
LP-SB11-8-9	K0908616-023	09/15/09	Soil	X					
AA-MW04-1-2	K0908616-025	09/15/09	Soil			X		X	
AA-MW04-4-5	K0908616-026	09/15/09	Soil			X		X	
AA-MW04-8.5-9.5	K0908616-027	09/15/09	Soil			X		X	
AA-MW04-11-12	K0908616-028	09/15/09	Soil			X		X	
FD-AA-01	K0908616-029	09/15/09	FD			X			
PR-MW01-5-6	K0908616-031	09/14/09	Soil						X
MG-SB05-2-4	K0908616-032	09/14/09	Soil		X		X		
MG-SB05-7-8	K0908616-033	09/14/09	Soil		X		X		
MG-SB05-10-11	K0908616-034	09/14/09	Soil		X		X		
MG-SB05-14-15	K0908616-035	09/14/09	Soil		X		X		
PR-SB05-1-2	K0908616-036	09/14/09	Soil		X		X		
CP-MWC3-12-14	K0908771-001	09/16/09	Soil			Hg			
CP-MWA3-11-13	K0908771-002	09/16/09	Soil			Hg			
CP-MW03-1.5-2.5	K0908771-003	09/16/09	Soil			Hg			
CP-MW03-4-5	K0908771-004	09/16/09	Soil						X
CP-MW03-13-15	K0908771-005	09/16/09	Soil			Hg			
CP-MW06-1-2	K0908771-006	09/16/09	Soil			Hg			
CP-MW06-13-15	K0908771-007	09/16/09	Soil			Hg			
CP-MW02-1.5-2.5	K0908771-008	09/16/09	Soil			Hg			
CP-MW02-10-12	K0908771-009	09/16/09	Soil			Hg			
FD-CP-1	K0908771-010	09/16/09	FD			Hg			
FD-CP-2	K0908771-011	09/16/09	FD						X
FD-CP-3	K0908771-012	09/16/09	FD			Hg			
CP-MWB3-13-15	K0908771-013	09/17/09	Soil			Hg			
CP-MWC2-2-3	K0908771-014	09/17/09	Soil			Hg			
CP-MWC2-13-15	K0908771-015	09/17/09	Soil			Hg			
CP-MWB2-10-12	K0908771-016	09/17/09	Soil			Hg			
FD-CP-6	K0908771-017	09/17/09	FD			Hg			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	pH	Dioxins
FD-CP-5	K0908771-018	09/17/09	FD			Hg			
CP-MW04-2.5-4	K0908771-019	09/17/09	Soil			Hg			
CP-MW04-5-6.5	K0908771-020	09/17/09	Soil			Hg			
CP-MW04-7.5-9	K0908771-021	09/17/09	Soil			Hg			
CP-MW04-10-11.5	K0908771-022	09/17/09	Soil			Hg			
CP-MW04-12.5-14	K0908771-023	09/17/09	Soil			Hg			
CP-MW04-15-16.5	K0908771-024	09/17/09	Soil			Hg			
CP-MW04-17.5-19	K0908771-025	09/17/09	Soil			Hg			
FD-CP-4	K0908771-026	09/17/09	FD			Hg			
CP-MW05-2.5-4	K0908771-027	09/17/09	Soil			Hg			
CP-MW05-5-6.5	K0908771-028	09/17/09	Soil			Hg			
CP-MW05-7.5-9	K0908771-029	09/17/09	Soil			Hg			
CP-MW05-10-11.5	K0908771-030	09/17/09	Soil			Hg			
CP-MW05-12.5-14	K0908771-031	09/17/09	Soil			Hg			
CP-MW05-15-16.5	K0908771-032	09/17/09	Soil			Hg			
CP-MW05-17.5-19	K0908771-033	09/17/09	Soil			Hg			
CP-MW05-20-21.5	K0908771-034	09/17/09	Soil			Hg			
CP-MWA2-2-3	K0908855-001	09/21/09	Soil			Hg			
CP-MWA2-11-12	K0908855-002	09/21/09	Soil			Hg			
CP-MWA1-2-3	K0908855-003	09/21/09	Soil			Hg			
CP-MWA1-14-15	K0908855-004	09/21/09	Soil			Hg			
CP-MWA1-14-15	K0908855-005	09/21/09	Soil			Hg			
CP-MWB1-2-3	K0908855-006	09/21/09	Soil			Hg			
CP-MWB1-12.5-13.5	K0908855-007	09/21/09	Soil			Hg			
CP-MWC1-2-3	K0908855-008	09/21/09	Soil			Hg			
CP-MWC1-12-13	K0908855-009	09/21/09	Soil			Hg			
CP-MWB2-3-4	K0908855-010	09/21/09	Soil			Hg			
FD-CP-8	K0908855-011	09/21/09	FD			Hg			
CP-MW05-22-23	K0908855-012	09/21/09	Soil			Hg			
CP-MW05-26-27	K0908855-013	09/21/09	Soil			Hg			
CP-MW05-30-31	K0908855-014	09/21/09	Soil			Hg			
CP-MW05-34-35	K0908855-015	09/21/09	Soil			Hg			
CP-MW05-38-39	K0908855-016	09/21/09	Soil			Hg			
CP-MW04-22-23	K0908855-017	09/21/09	Soil			Hg			
CP-MW04-26-27	K0908855-018	09/21/09	Soil			Hg			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	pH	Dioxins
CP-MW04-30-31	K0908855-019	09/21/09	Soil			Hg			
CP-MW04-34-35	K0908855-020	09/21/09	Soil			Hg			
CP-MW04-38-39	K0908855-021	09/21/09	Soil			Hg			
FD-CP-7	K0908855-022	09/21/09	FD			Hg			
CP-MW01-2-3	K0908855-023	09/21/09	Soil			Hg			
CP-MW01-14-15	K0908855-024	09/21/09	Soil			Hg			
MG-SB06-3-5	K0909006-001	09/21/09	Soil		X		X		
MG-SB06-7-8	K0909006-002	09/21/09	Soil		X		X		
MG-SB06-10-11	K0909006-003	09/21/09	Soil		X		X		
BC-SB03-4-5	K0909006-004	09/22/09	Soil		X		X		
BC-SB03-8.5-9.5	K0909006-005	09/22/09	Soil		X		X		
BC-SB03-11.5-12.5	K0909006-006	09/22/09	Soil		X		X		
BC-SB03-14-15	K0909006-007	09/22/09	Soil		X		X		
BC-SB04-1-2	K0909006-008	09/22/09	Soil		X		X		
BC-SB04-7.5-8.5	K0909006-009	09/22/09	Soil		X		X		
BC-SB04-10.5-11.5	K0909006-010	09/22/09	Soil		X		X		
BC-SB04-14-15	K0909006-011	09/22/09	Soil		X		X		
BC-SB05-0.5-1.5	K0909006-012	09/22/09	Soil						X
BC-SB05-7.5-8.5	K0909006-013	09/22/09	Soil		X		X		
BC-SB05-10.5-11.5	K0909006-014	09/22/09	Soil		X		X		
BC-SB05-14-15	K0909006-015	09/22/09	Soil		X		X		
BC-MW03-4-5	K0909006-016	09/22/09	Soil		X		X		
BC-MW03-7.5-9.5	K0909006-017	09/22/09	Soil		X		X		
BC-FD-1	K0909006-018	09/22/09	FD		X		X		
BC-FD-2	K0909006-019	09/22/09	FD		X		X		
BC-FD-3	K0909006-020	09/22/09	FD		X		X		
BC-MW03-13-15	K0909015-001	09/22/09	Soil		X		X		
BC-MW03-18.5-19.5	K0909015-002	09/22/09	Soil		X		X		
BC-SB06-4-5	K0909015-003	09/22/09	Soil		X		X		
BC-SB06-9-10	K0909015-004	09/22/09	Soil		X		X		
BC-SB06-12-14	K0909015-005	09/22/09	Soil		X		X		
BC-SB06-17.5-18.5	K0909015-006	09/22/09	Soil		X		X		
BC-SB06-19-20	K0909015-007	09/22/09	Soil		X		X		
BC-SB07-4-5	K0909015-008	09/22/09	Soil		X		X		
BC-SB07-7.5-9.5	K0909015-009	09/22/09	Soil		X		X		

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	pH	Dioxins
BC-SB07-13-14	K0909015-010	09/22/09	Soil		X		X		
BC-SB07-16-17	K0909015-011	09/22/09	Soil		X		X		
BC-MW02-2-4	K0909015-012	09/22/09	Soil		X		X		
BC-MW02-8-10	K0909015-013	09/22/09	Soil		X		X		
BC-MW02-12-14	K0909015-014	09/22/09	Soil		X		X		
BC-MW02-17-19	K0909015-015	09/22/09	Soil		X		X		
BC-MW02-21-22	K0909015-016	09/22/09	Soil		X		X		
PR-MW02-1-2.5	K0909015-017	09/22/09	Soil			Hg			
PR-MW02-3.5-5	K0909015-018	09/22/09	Soil			Hg			
PR-MW02-9-10	K0909015-019	09/22/09	Soil			Hg			
PR-MW02-13-14	K0909015-020	09/22/09	Soil			Hg			
PR-MW02-17-18	K0909016-001	09/22/09	Soil			Hg			
PR-SB06-0.5-2.5	K0909016-002	09/22/09	Soil			Hg			
PR-SB06-3.5-5	K0909016-003	09/22/09	Soil			Hg			
PR-SB06-5-6.5	K0909016-004	09/22/09	Soil			Hg			
PR-SB06-9-10	K0909016-005	09/22/09	Soil			Hg			
PR-SB06-13-14	K0909016-006	09/22/09	Soil			Hg			
PR-SB06-17-18	K0909016-007	09/22/09	Soil			Hg			
BC-SB08-4-5	K0909016-008	09/22/09	Soil		X		X		
BC-SB08-9-10	K0909016-009	09/22/09	Soil		X		X		
BC-SB08-13-14	K0909016-010	09/22/09	Soil		X		X		
BC-SB08-15.5-16.5	K0909016-011	09/22/09	Soil		X		X		
BC-SB08-18-19	K0909016-012	09/22/09	Soil		X		X		
FD-MG-01	K0909016-013	09/21/09	FD		X		X		
Rinse Blank	K0909031-001	09/24/09	EB		X	X			
PR-SB04-5-7	K0909498-001	09/14/09	Soil			TCLP			
PR-MW01-5-7	K0909498-002	09/14/09	Soil			TCLP			
MG-SB07-6-8	K0909687-001	09/14/09	Soil				EPH		
MG-SB09-6-7	K0909687-002	09/14/09	Soil				EPH		
BC-SB07-4-5	K0909687-003	09/22/09	Soil				EPH		
BC-MW02-8-10	K0909687-004	09/22/09	Soil				EPH		
BC-MW02-17-19	K0909687-005	09/22/09	Soil				EPH		
BC-SB08-15.5-16.5	K0909687-006	09/22/09	Soil				EPH		

Notes:

X - The analysis was requested and performed on the sample
PAHs – Polycyclic aromatic hydrocarbons
Metals – Arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc.
TPH – Diesel and motor oil range total petroleum hydrocarbon
Hg – The sample was analyzed for mercury only
EB – Equipment rinsate blank
FD – Field duplicate
EPH – The sample was analyzed for Extractable Petroleum Hydrocarbon only
TCLP – The sample was extracted with the toxicity characteristics leaching procedure (TCLP) and the leachate analyzed for mercury.

Analytical methods in respect to analytical parameters validated herein and the laboratory performing the analyses are summarized below:

Parameter	Analytical Method	Laboratory
V)OCs	SW846 Methods 5035/8260B	Columbia Analytical Services, Inc. Kelso, WA 98626
PAHs	SW846 Method 8270C-SIM	
Polychlorinated Dioxins and Furans	SW846 Method 8290	
Metals	SW846 Methods 6000/7000	
TPH-Diesel and Motor Oil	NWTPH-Dx	
pH	SW846 Method 9045C	
TCLP/Mercury	SW856 Method 1311/7470A	
EPH	WDOE-EPH	Analytical Resources, Inc. Tukwila, WA

Notes:

1. SW846 Methods - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. NWTPH and WDOE Methods - *Analytical Methods for Petroleum Hydrocarbons,* ECY 97-602, Washington State Department of Ecology, June 1997.
3. SIM – Selective ion monitoring

DATA VALIDATION FINDINGS

1. VOCs by GC/MS (EPA Method SW8260B)

1.1 Sample Management and Holding Time

Samples were received in the laboratory intact and in consistence with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport.

Soil samples should be analyzed within 14 days of collection. All samples were analyzed within the required holding time.

1.2 GC/MS Instrument Performance Check

Bromofluorobenzene (BFB) tuning was performed within each 12-hour interval. All required ion abundance ratios met the method requirements.

1.3 Initial Calibration

The National Functional Guidelines (NFGs) require that the percent relative standard deviation (%RSD) be <30% and the average response factor (RF) be > 0.01 for poor response compounds and >0.05 for all other compounds.

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.99. Initial calibration for all target compounds except for the following:

Initial Calibration ID	Analyte	Exceedance	Affected Sample	Data Qualification
Instrument MS05 ICAL: 8816	Acetone Carbon Tetrachloride Styrene Bromoform *n*-Butylbenzene	%RSD >15%	None	No action. The analyte was not detected in any samples at or above the MRL, and the CCVs showed stable response of the analyte, except for those qualified under Section 1.5.
	m-, p-Xylene	%RSD = 20% (>15%)	LP-SB11-4-5 LP-SB13-4-5	**J**

1.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the percent difference (%D) be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verification analyses were performed at the required frequency. The calibration verification %D values either met the criteria for all target compounds or at levels that had no significant effects on data quality (*e.g.,* high recovery where the analyte was not detected).

1.5 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the method detection limits (MDLs), except noted below. Sample result less than five times (10 times for common laboratory contaminants) the detection in method blanks were qualified (U) as non-detects at the MRLs (if detected below the MRL) or the reported concentration (if greater than the MRL).

Method Blank ID (SDG)	Analyte	Detection in Blank (µg/kg)	Affected Sample	Original Result (µg/kg)	Adjusted Results (µg/kg)
KWG0908548-3 KWG0908683-3 (K0908616)	Acetone	5.5 J 4.7 J	LP-SB09-1-2 LP-SB09-3.5-4.5 LP-SB10-1-2 LP-SB10-4-5 LP-SB10-7-8 LP-SB11-1-2 LP-SB11-4-5 LP-SB11-8-9 LP-SB12-4-5 LP-SB12-7-8 LP-SB13-1-2 LP-SB13-4-5 LP-SB14-1-2 LP-SB14-5-6 LP-SB14-9-10	8.4 J 16 J 15 7.3 J 17 J 19 38 17 J 17 11 J 8.6 J 14 J 11 J 8.5 J 6.9 J	**17 U** **17 U** **15 U** **15 U** **17 U** **19 U** **38 U** **20 U** **17 U** **17 U** **16 U** **16 U** **14 U** **17 U** **14 U**
	Methylene Chloride	0.25 J 0.24 J	LP-SB09-1-2 LP-SB09-3.5-4.5 LP-SB09-8-9 LP-SB10-1-2 LP-SB10-4-5 LP-SB10-7-8 LP-SB11-1-2 LP-SB11-4-5 LP-SB11-8-9 LP-SB12-1-2 LP-SB12-4-5 LP-SB12-7-8 LP-SB13-1-2 LP-SB13-4-5 LP-SB13-7-8 LP-SB14-1-2 LP-SB14-5-6 LP-SB14-9-10	5.6 J 11 6 J 0.42 J 0.57 J 0.58 J 5 J 1.6 J 1.9 J 1.6 J 1.1 J 4.6 J 1.7 J 2.8 J 2.2 J 2.4 J 1.7 J 1.8 J	**8.4 U** **11 U** **13 U** **7.0 U** **7.2 U** **8.4 U** **5.7 U** **6.9 U** **9.8 U** **5.8 U** **6.6 U** **8.3 U** **7.6 U** **7.7 U** **13 U** **6.9 U** **8.3 U** **6.7 U**
	Naphthalene	0.47 J 0.47 J	LP-SB10-1-2 LP-SB10-7-8 LP-SB11-1-2 LP-SB11-4-5 LP-SB11-8-9	1 J 5.4 J 2.2 J 5.3 J 25	**14 U** **17 U** **12 U** **14 U** **20 U**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

1.6 Laboratory Control Sample

LCS and LCS duplicate (LCSD) were prepared and analyzed as required by the method. All percent recovery (%R) and relative percent difference (RPD) values met the project control criteria.

1.7 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits.

1.8 Matrix Spike and Matrix Spike Duplicate

MS/MSD analyses were not performed on the project sample in this SDG. Analytical precision and accuracy was evaluated with the LCS and LCSD results (see Section 1.6).

1.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria, except for the following:

SDG	Sample ID	Internal Standard (IS)	IS Recovery (High/Low)	Affected Analyte	Data Qualification
K0908616	LP-SB09-1-2 LP-SB09-8-9 LP-SB10-1-2 LP-SB14-1-2 LP-SB09-3.5-4.5 LP-SB11-1-2 LP-SB11-4-5	Fluorobenzene Chlorobenzene-d_5 1,4-Dichlorobenzene-d_4	Low	All VOCs	**J(+)/UJ(-)**
	LP-SB12-1-2 LP-SB12-4-5	Chlorobenzene-d_5 1,4-Dichlorobenzene-d_4	Low	Associated VOCs	**J(+)/UJ(-)**
	LP-SB13-1-2 LP-SB11-8-9	1,4-Dichlorobenzene-d_4	Low	Associated VOCs	**J(+)/UJ(-)**

Note: All surrogate recovery was within the control limits for these samples; non-detected compounds were therefore not qualified (R) as rejected.

1.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and MRLs were adjusted with sample amount extracted and MRLs were supported with adequate initial calibration concentrations. The project requirements for quantitation limits were achieved.

1.11 Overall Assessment of VOCs Data Usability

VOCs data are of known quality and acceptable for use, as qualified.

2. PAHs by GC/MS - SIM (EPA Method SW8270C)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be extracted within 14 days of collection. Extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

DFTPP tuning was performed within each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The NFGs criteria require that the %RSD be <30% and the average RRF be >0.05 for all target compounds.

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.99. The initial calibration met the criteria, except for the following:

SDG	Initial Calibration ID	Analyte	Exceedance	Affected Sample	Data Qualification
K0909006	Instrument MS11 ICAL: 8903	Pyrene	%RSD >15% (16.0%)	MG-SB06-3-5 MG-SB06-7-8 MG-SB06-10-11 BC-SB03-4-5	**J**
K0909015	Instrument MS11 ICAL: 8903	Pyrene	%RSD >15% (16.0%)	BC-MW02-21-22 BC-MW02-2-4 BC-MW02-8-10 BC-MW03-13-15 BC-SB06-17.5-18.5 BC-SB06-4-5 BC-SB07-13-14 BC-SB07-16-17 BC-SB07-4-5 BC-SB07-7.5-9.5 BC-MW02-12-14 BC-MW02-17-19	**J**

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds. Calibration verification analyses met the criteria.

2.5 Blanks

Method Blank: Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the MDLs in the method blanks or at levels that had no significant effects on associated sample results (sample >10x detects in blank), except for the following:

Method Blank ID (SDG)	Analyte	Blank Detection (µg/kg)	Affected Sample	Original Result (µg/kg)	Adjusted Result (µg/kg)
KWG0908366-5 (K0908615)	Naphthalene	1.9 J	MG-SB04-2-4	9.5	**9.5 U**
KWG0908368-5 (K0908616)	Naphthalene	1.6 J	MG-SB05-7-8 PR-SB05-1-2	14 12	**14 U** **12 U**
	2-Methylnaphthalene	0.44 J	MG-SB05-7-8 PR-SB05-1-2	2.6 J 2.4 J	**2.7 U** **3.1 U**
	Indeno(1,2,3cd)pyrene	0.17 J	MG-SB05-7-8	0.61 J	**2.7 U**
KWG0908921-5 (K0909006)	Naphthalene	0.89 J	BC-SB04-1-2 BC-SB04-7.5-8.5	3.6 J 8.2	**5.0 U** **8.2 U**
	2-Methylnaphthalene	0.72 J	BC-SB04-10.5-11.5 BC-SB04-1-2 BC-SB04-7.5-8.5 BC-SB05-10.5-11.5	0.88 J 1.8 J 3.1 J 3.2 J	**5.0 U** **5.0 U** **5.0 U** **4.9 U**
	Dibenzofuran	0.82 J	BC-SB03-11.5-12.5 BC-SB04-1-2 BC-SB04-14-15 BC-SB04-7.5-8.5 BC-SB05-10.5-11.5	2.5 J 1.3 J 5.9 3 J 1.1 J	**5.0 U** **5.0 U** **5.9 U** **5.0 U** **4.9 U**
	Phenanthrene	2.4 J	BC-SB04-10.5-11.5 BC-SB04-1-2 BC-SB05-10.5-11.5	2.5 J 2.9 J 6.6	**5.0 U** **5.0 U** **6.6 U**
	Pyrene	0.97 J	BC-SB04-10.5-11.5 BC-SB04-1-2 BC-SB05-10.5-11.5	3.5 J 1.6 J 3.4 J	**5.0 U** **5.0 U** **4.9 U**
KWG0908747-4 (K0909031)	Naphthalene	0.0050 J (µg/L)	Rinsate Blank	0.019 J (µg/L)	**0.020 U (µg/L)**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

Equipment Rinsate Blank: One equipment rinsate blank was collected for PAHs analysis. Naphthalene and 2-methylnaphthalene were detected at 0.019 µg/L and 0.0068 µg/L respectively at levels greater than their MDLs, but less than the MRLs. Naphthalene and 2-methylnaphthalene were consistently present in method blanks associated with soil and groundwater samples during the analyses of project samples. The detections of these two compounds in the equipment rinsate blank were more likely a result of laboratory background rather than field procedures. Data qualification was therefore deferred to method blank results rather than the equipment rinsate blank.

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were either within the project control limits or diluted below quantitation limits due to high analyte concentrations.

2.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on project samples at the required frequency. MS/MSD %R and RPD values were within project control criteria for all target compounds, except for the following:

Parent Sample	Analyte	%R MS	%R MSD	Control Limit	RPD	Control Limit	Data Qualifier
MG-SB10-1-2 (K0908615)	Acenaphthylene	68%	340%	32-106%	101%	40%	J
	Anthracene	95%	197%	31-115%	54%		
	Benzo(k)fluoranthene	39%	322%	29-126%	83%		
	Benz(a)anthracene	72%	453%	25-128%	91%		
	Chrysene	97%	315%	25-132%	70%		
	Dibenzo(a,h)anthracene	47%	229%	29-124%	82%		
	Benzo(g,h,i)perylene	NA	482%	24-127%	103%		

Note: NA – Not applicable due to negative recovery.

2.8 Laboratory Control Sample (LCS)

LCS and/or LCSD analyses were performed with each analytical batch. All %R and RPD values were within the project control limits.

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and MRLs were adjusted with sample amount extracted and MRLs were supported with adequate initial calibration concentrations.

Bnezo(b)fluoranthene and benzo(k)fluoranthene in sample BC-SB03-4-5 (Lab ID: K0909006-004) could not be chromatographically separated. The response peaks were integrated into one peak and reported as benzo(b)fluoranthene, where benzo(k)fluoranthene was reported as non-detected. Benzo(b)fluoroanthene and benzo(k)fluoranthene results in sample BC-SB03-4-5 were qualified (J) and (UJ) respectively as estimated.

2.11 Field Duplicates

Four sets of field duplicates were submitted for PAHs analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

2.12 Overall Assessment of PAHs Data Usability

PAHs data are of known quality and acceptable for use, as qualified.

3. Total Metals by ICP and CVAAS (EPA Methods SW6010 and SW7471A)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be analyzed within 180 days for metals and 28 days for mercury. Samples were analyzed within the required holding time.

3.2 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury and atomic absorption spectrometry (AAS) analyses, the methods require that (1) a blank and five calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995. The associated initial calibrations met the method requirements.

A check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The results were within the NFGs criteria of 70-130% or the associated results were greater than the 2x MRLs.

3.3 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) were analyzed at the required frequency. The %R values met the control criteria (90 – 110% for metals, 80 – 120% for mercury).

3.4 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at required frequency. Target analytes were either not detected in ICBs/CCBs at or above the method detection limits (MDLs), or at levels that had no significant effects (sample results > 5x the calibration blank detection) on associated sample results, with the following exceptions:

SDG	Calibration Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result (mg/kg)	Adjusted Results (mg/kg)
K0908616	CCB3 10/02/09,11:49	Arsenic	6.0 J	AA-MW04-4-5	1.3 J	**2.2 U**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were either not detected in the method blanks at or above the MDLs, or at levels that had no significant effects (sample results > 5x the method blank detection) on associated sample results.

Equipment Rinsate Blank: One equipment rinsate blank was collected for total metals analysis. Chromium, lead, manganese, and nickel were detected at levels greater than their MDLs but less than the MRLs. These low-level detections in the rinsate blank had no significant effects on associated soil sample results. Data were not qualified on this basis.

3.5 ICP Interference Check Sample (ICS)

The method requires that (1) an interelement interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several analytes were detected in the ICSA initial analyses at low levels. Since the concentrations in the associated samples were less than 50% of the interferant concentrations in ICSA samples, no action was taken. The %D values for analytes in ICSAB were within ± 20% of the true value or the interferant concentrations in the associated samples were less than 50% of the ICSAB concentrations.

3.6 Laboratory Control Sample (LCS)

LCS analyses were performed at the required frequency. All %R values met the control limits (80 – 120%/20%) for all target analytes.

3.7 Duplicate Sample Analysis

Duplicate sample analyses were performed on project samples at the required frequency. The RPD values (or concentration differences) met the control criteria (20% for detections ≥ 5xRL, ±1xMRL for detections < 5xMRL).

3.8 Matrix Spike (MS)

Matrix spike analyses were performed on project samples as required. All %R values met the laboratory control limits, or native analyte concentrations in the samples were greater than 4x the spiked levels and the %R values were inapplicable for matrix effect evaluation.

3.9 Serial Dilution

Serial dilution analyses were performed on project samples at the required frequency for ICP metals and mercury. All %D values for positive results greater than 50X MDL were within 10%.

3.10 Analyte Quantitation and Reporting Limits

The project requirements for quantitation limits were achieved.

3.11 Field Duplicates

One set of field duplicates were submitted for total metals and seven sets submitted for total mercury analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

3.12 Overall Assessment of Metals Data Usability

Metals data are of known quality and acceptable for use, as qualified.

4. TPH-Diesel & Motor Oil and EPH (Methods NWTPH-Dx & NWTPH-EPH)

4.1 Holding Time

Soil samples should be extracted within 14 days of collection, and extracts be analyzed within 40 days of extraction. All samples were extracted and analyzed within the recommended holding time, except that the extraction of EPH analyses on the six samples in SDG K0909687 was performed six to 14 days past the recommended holding time. EPH results for these samples were qualified (UJ) for non-detects and (J) for detects as estimated.

4.2 Initial Calibration

The methods requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the NWTPH-Dx and NWTPH-EPH ICAL curves were verified with %RSD values of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both diesel and motor oil range total petroleum hydrocarbon (TPH).

4.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value.

Calibration verification was performed at required frequency. The percent drift met the ±15% criterion.

4.4 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the MDLs in the method blanks or at levels that had no significant effects on associated sample results (sample >10x detections in the method blank), except for the following:

SDG	Method Blank ID	Analyte	Detection in Blank (mg/kg)	Affected Sample	Original Result (mg/kg)	Adjusted Result (mg/kg)
K0909006	KWG0908740-4	TPH-Diesel	1.7 J	BC-SB03-11.5-12.5 BC-SB03-14-15 BC-SB04-10.5-11.5 BC-SB04-1-2 BC-SB04-14-15 BC-SB04-7.5-8.5 BC-SB05-10.5-11.5 BC-SB05-14-15 BC-SB05-7.5-8.5 MG-SB06-10-11 BC-FD-1	4.9 J 22 J 2.8 J 2.7 J 20 J 5.5 J 6.1 J 22 J 28 J 29 J 27 J	**32 U** **35 U** **30 U** **26 U** **33 U** **32 U** **33 U** **35 U** **32 U** **30 U** **30 U**
K0909015	KWG0908935-4	TPH-Diesel	2.6 J	BC-MW02-21-22 BC-MW02-2-4 BC-MW03-13-15 BC-MW03-18.5-19.5 BC-SB06-12-14 BC-SB06-19-20 BC-SB06-4-5 BC-SB06-9-10	3.9 J 13 J 6.3 J 2.5 J 19 J 2.9 J 4.4 J 10 J	**31 U** **27 U** **30 U** **31 U** **37 U** **31 U** **29 U** **42 U**
K0909015	KWG0908935-4	TPH-Motor Oil	8.4 J	BC-MW02-21-22 BC-MW02-2-4 BC-MW03-13-15 BC-MW03-18.5-19.5 BC-SB06-12-14 BC-SB06-19-20 BC-SB06-4-5 BC-SB06-9-10 BC-SB07-13-14 BC-SB07-16-17	16 J 98 J 12 J 5.1 J 120 J 10 J 9.7 J 43 J 75 J 110 J	**130 U** **110 U** **120 U** **130 U** **150 U** **130 U** **120 U** **170 U** **130 U** **130 U**
K0909016	KWG0908936-3	TPH-Diesel	2.6 J	BC-SB08-13-14 BC-SB08-18-19 BC-SB08-4-5 BC-SB08-9-10	6.1 J 3.1 J 6.4 J 13 J	**31 U** **30 U** **27 U** **32 U**
K0909016	KWG0908936-3	TPH-Motor Oil	5.4 J	BC-SB08-13-14 BC-SB08-18-19 BC-SB08-4-5 BC-SB08-9-10	33 J 13 J 24 J 79 J	**130 U** **120 U** **110 U** **130 U**

4.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits, outside the control limits due to matrix interference, or diluted below quantitation limits due to high analyte concentrations. In all cases, no data qualification was required.

4.6 Matrix Duplicate

Matrix duplicate analyses were performed on project samples at the required frequency. The RPD values (or concentration differences if sample concentrations are <5xMRL) met the laboratory control limits, except for the following:

4.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required. All %R values met the project control limits.

4.8 Target Compound Identification

Sample extracts were cleaned up with acid and silica gel treatment to minimize the biogenic interference with target compound identification, as required by the project. The laboratory reported results as diesel #2 (C12 - C24) and motor oil (C24 - C38), as required by the method.

4.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations. Sample-specific MDLs and MRLs were adjusted to sample weight and moisture content.

4.10 Field Duplicates

Four sets of field duplicates were submitted for TPH-Diesl and TPH-Motor Oil analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

4.11 Overall Assessment of TPH-Diesel and Motor Oil Data Usability

TPH-Diesel, TPH-Motor Oil, and EPH data are of known quality and acceptable for use as qualified.

5. pH (EPA Method SW9045C)

5.1 Sample Management and Holding Time

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be analyzed within 14 days of collection for pH. All samples were analyzed within the required holding times.

5.2 Instrument Calibration

The initial calibrations were established using three levels of standards as required by the method.

5.3 Calibration Verification

ICV and CCV analyses were performed as required by the methods. All ICV and CCV %R values were within the laboratory control limits (90 – 110%).

5.4 Laboratory Duplicate

A laboratory duplicate analysis was formed on a project sample. The duplicate RPD value was within the project control criterion (20%).

5.5 Laboratory Control Samples (LCS)

LCS analyses were performed as required by the method. All LCS %R values were within the laboratory control limits.

5.6 Overall Assessment of pH Data Usability

pH data are of known quality and acceptable for use.

6. Polychlorinated Dioxins/Furans by HRGC/HRMS (EPA Method SW8290)

6.1 Sample Management and Holding Times

Samples were received at the laboratory intact and were in consistent with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport.

The method recommends a holding time of 30 days for solid samples stored in the dark at < -20°C, and extracts be analyzed within 45 days of extraction. Samples were extracted and analyzed within the recommended holding times.

6.2 HRGC/HRMS Instrument Performance Check

The Method criteria for instrument performance checks are as follows:

Mass Spectrometer Resolution: (1) The resolution check should be performed prior to initial calibration and at the start and end of each 12-hour shift, (2) the resolution should be ≥ 10,000 resolving power at m/z 304.9824, and (3) the deviation between the exact m/z and the theoretical m/z must be less than 5 ppm for monitored isomers.

Window Defining Mixture (WDM) and Column Performance Solution (CPS): (1) WDM and CPS should be analyzed prior to initial calibration and continuing calibration verification, and (2) the 2,3,7,8-TCDD peak and 1,2,3,8-TCDD peak should be resolved with a valley of ≤ 25%.

HRGC/HRMS instrument performance checks met the criteria.

6.3 Initial Calibration

The Method criteria for initial calibration are as follows:

(1) A minimum of five standards should be employed,
(2) The percent relative standard deviation (%RSD) of isomer response should be <20% for native compounds and <30% for labeled compounds,
(3) The absolute RT of the internal standard $^{13}C_{12}$-1,2,3,4-TCDD must be >25 minutes on the DB-5 (or equivalent) column and >15 minutes on the DB-225 (or equivalent) column,
(4) The ion abundance ratios should be within the method control limits, and
(5) The signal-to-noise (S/N) ratio should be >10 for all native and labeled compounds.

Initial calibrations met all acceptance criteria.

6.4 Calibration Verification

The Method requires that:

(1) Continuing calibration verifications should be performed at the beginning of each 12-hour shift,
(2) Ion abundance ratios are within the method control limits,
(3) S/N > 10 for all compounds,
(4) %D values for RRs are within ± 20% for native compounds and ± 30% for labeled compounds.

All calibration verification analyses met the criteria.

6.5 Blanks

Method Blank: A method blank was prepared and analyzed as required for each preparation batch. No target analytes were detected at or above three times (3x) the method reporting limits (MRLs), as required by the NFG. Four target analytes were detected in the method blank at levels greater than their estimated detection limits (EDLs), and the associated data are qualified as follows:

SDG	Method Blank ID	Analyte	Detection in Blank (ng/kg)	Associated Sample	Data Qualification
K0908616	EQ0900391-01	OCDD	3.42 J	PR-MW01-5-6	No action. Sample concentration was > 10x the level in the method blank.
K0908771 **K0909006**	EQ0900401-01	OCDD OCDF	1.06 J 0.371 J	CP-MW03-4-5 FD-CP-2 BCC-SB05-0.5-1.5	

Note: J – The value is greater than the EDL but less than the MRL.

6.6 Initial Precision and Recovery Study (IPR) and Ongoing Precision and Recovery (OPR)

The initial precision and recovery study was performed according to the laboratory, but results were not provided in the data package. A laboratory control sample (LCS) was analyzed in lieu of ongoing precision and recovery (OPR) analysis (see Section 1.8).

6.7 Labeled Compounds

Labeled compounds were added to all field and laboratory QC samples as required by the method. The percent recovery (%R) values met the method requirements, except for the following:

SDG	Sample ID	Labeled Compound	%R	Control Limit	Associated Analytes	Data Qualifier
K0908771	CP-MW03-4-5	^{13}C-1,2,3,4,6,7,8-HpCDD ^{13}C-OCDD ^{13}C-1,2,3,4,7,8-HxCDF ^{13}C-1,2,3,4,6,7,8-HpCDF	36% 35% 33% 35%	40-135%	1,2,3,4,6,7,8-HpCDD OCDD 1,2,3,4,7,8-HxCDF 1,2,3,6,7,8-HxCDF 1,2,3,7,8,9-HxCDF 2,3,4,6,7,8-HxCDF 1,2,3,4,6,7,8-HpCDF 1,2,3,4,7,8,9-HpCDF OCDF	**J** **J** **J** **J** **UJ** **J** **J** **J** **J**
	FD-CP-2	^{13}C-2,3,7,8-TCDD ^{13}C-OCDD	36% 32%	40-135%	2,3,7,8-TCDD OCDD OCDF	**UJ** **J** **J**
K0909006	BCC-SB05-0.5-1.5	^{13}C-OCDD	21	40-135%	OCDD OCDF	**J** **J**

6.8 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required by the method. All %R and relative percent difference (RPD) values met the laboratory control limits.

6.9 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were not performed on the project sample in this SDG. Analytical precision and accuracy was evaluated with the LCS and LCSD results (see Section 6.8) and labeled compound recovery (see Section 6.7).

6.10 Method Reporting Limits (MRLs) and Compound Quantitation

Correct internal standards, quantitation ions, and average RFs were used to quantitate target compound detections. The MRLs were supported with adequate ICAL calibration concentrations. Sample-specific EDLs and MRLs were adjusted with sample weights, internal standard peak height, and noise levels as required by the method.

The concentration of OCDD in sample PR-MW01-5-6 exceeded the instrument calibration ranges. The results were qualified (J) as estimated. Chlorodiphenyl ether interference was observed on 2,3,4,7,8-PeCDF, 1,2,3,6,7,8-HxCDF, and 1,2,3,4,6,7,8-HpCDF for sample PR-MW01-5-6; these results were qualified (J) as estimated.

6.11 Second Column Confirmation

Second-column confirmation is required for samples analyzed on a DB-5 (or equivalent) column in which 2,3,7,8-TCDF is reported at or above the EDL, or where 2,3,7,8-TCDF is reported as an Estimated Maximum Possible Concentration (EMPC). 2,3,7,8-TCDF was detected in samples PR-MW01-5-6, CP-MW03-4-5, and FD-CP-2 on DB-5 column and confirmed on the DB-225 column. The 2,3,7,8-TCDF values were reported from the DB-225 column analyses.

6.12 Field Duplicates

One set of field duplicates were submitted for dioxins and furans analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

6.13 Overall Assessment of Polychlorinated Dioxins/Furans Data Usability

Polychlorinated dioxins and furans data were of known quality and acceptable for use as qualified.

SUMMARY

I. Data qualification are summarized as follows:

SDG	Sample ID	Analyte	Data Qualifier	Reason	Report Section
K0908616	LP-SB11-4-5 LP-SB13-4-5	*m-, p*-Xylenes	J	Initial calibration %RSD value did not meet the linearity criterion of 15%.	**1.3**
K0908616	LP-SB09-1-2 LP-SB09-8-9 LP-SB10-1-2 LP-SB14-1-2 LP-SB09-3.5-4.5 LP-SB11-1-2 LP-SB11-4-5	All VOCs	J(+) UJ(-)	The internal standard recovery was bias low.	**1.9**
K0908616	LP-SB12-1-2 LP-SB12-4-5	Ethylbenzene Styrene trans-1,3-Dichloropropene n-Propylbenzene n-Butylbenzene 4-Chlorotoluene 1,4-Dichlorobenzene 1,2-Dibromoethane (EDB) 1,3,5-Trimethylbenzene Bromobenzene Chlorobenzene 1,2,4-Trichlorobenzene Dibromochloromethane Tetrachloroethene (PCE) sec-Butylbenzene 1,3-Dichloropropane m,p-Xylenes 1,3-Dichlorobenzene 2-Hexanone 1,1,1,2-Tetrachloroethane Bromoform 1,1,2-Trichloroethane 1,1,2,2-Tetrachloroethane 1,2,3-Trichlorobenzene Hexachlorobutadiene Naphthalene o-Xylene 2-Chlorotoluene 1,2-Dichlorobenzene 1,2,4-Trimethylbenzene 1,2-Dibromo-3-chloropropane 1,2,3-Trichloropropane tert-Butylbenzene Isopropylbenzene p-Isopropyltoluene	J(+) UJ(-)	The internal standard recovery was bias low.	**1.9**

SDG	Sample ID	Analyte	Data Qualifier	Reason	Report Section
K0908616	LP-SB13-1-2 LP-SB11-8-9	n-Propylbenzene n-Butylbenzene 4-Chlorotoluene 1,4-Dichlorobenzene 1,3,5-Trimethylbenzene Bromobenzene 1,2,4-Trichlorobenzene sec-Butylbenzene 1,3-Dichlorobenzene 1,1,2,2-Tetrachloroethane 1,2,3-Trichlorobenzene Hexachlorobutadiene Naphthalene 2-Chlorotoluene 1,2-Dichlorobenzene 1,2,4-Trimethylbenzene 1,2-Dibromo-3-chloropropane 1,2,3-Trichloropropane tert-Butylbenzene p-Isopropyltoluene	J(+) UJ(-)	The internal standard recovery was bias low.	**1.9**
K0909006 **K0909015**	MG-SB06-3-5 MG-SB06-7-8 MG-SB06-10-11 BC-SB03-4-5 BC-MW02-21-22 BC-MW02-2-4 BC-MW02-8-10 BC-MW03-13-15 BC-SB06-17.5-18.5 BC-SB06-4-5 BC-SB07-13-14 BC-SB07-16-17 BC-SB07-4-5 BC-SB07-7.5-9.5 BC-MW02-12-14 BC-MW02-17-19	Pyrene	J	Initial calibration %RSD value did not meet the linearity criterion of 15%.	**2.3**
K0908615	MG-SB10-1-2	Acenaphthylene Anthracene Benzo(k)fluoranthene Benz(a)anthracene Chrysene Dibenzo(a,h)anthracene Benzo(g,h,i)perylene	J	The MS/MSD %R value and/or MS/MSD RPD value was outside the control limit.	**2.7**
K0909006	BC-SB03-4-5	Benzo(b)fluoranthene Benzo(k)fluoranthene	J UJ	These analytes could not be chromatographically separated and were reported as benzo(b)fluoranthene.	**2.10**
K0909687	MG-SB07-6-8 MG-SB09-6-7 BC-SB07-4-5 BC-MW02-8-10 BC-MW02-17-19 BC-SB08-15.5-16.5	Aliphatics C8-C10 (EPH) Aliphatics C10-C12 (EPH) Aliphatics C12-C16 (EPH) Aliphatics C16-C21 (EPH) Aliphatics C21-C34 (EPH) Aromatics C8-C10 (EPH) Aromatics C10-C12 (EPH) Aromatics C12-C16 (EPH) Aromatics C16-C21 (EPH) Aromatics C21-C34 (EPH)	J(+) UJ(-)	The extraction of the sample was performed past the recommended holding time.	**4.1**

SDG	Sample ID	Analyte	Data Qualifier	Reason	Report Section
K0908771	CP-MW03-4-5	1,2,3,4,6,7,8-HpCDD OCDD 1,2,3,4,7,8-HxCDF 1,2,3,6,7,8-HxCDF 1,2,3,7,8,9-HxCDF 2,3,4,6,7,8-HxCDF 1,2,3,4,6,7,8-HpCDF 1,2,3,4,7,8,9-HpCDF OCDF	J J J J UJ J J J J	The labeled compound recovery was bias low.	**6.7**
	FD-CP-2	2,3,7,8-TCDD OCDD OCDF	UJ J J	The labeled compound recovery was bias low.	**6.7**
K0909006	BCC-SB05-0.5-1.5	OCDD OCDF	J J	The labeled compound recovery was bias low.	**6.7**
K0908616	PR-MW01-5-6	OCDD	J	The analyte concentration exceeded the instrument calibration range.	**6.10**
	PR-MW01-5-6	2,3,4,7,8-PeCDF 1,2,3,6,7,8-HxCDF 1,2,3,4,6,7,8-HpCDF	J	Chlorodiphenyl ether interference was observed on the analyte quantitation.	**6.10**
K0908771	CP-MW03-4-5 FD-CP-2	Total PeCDF Total HpCDF OCDF Total HxCDF Total TCDF 1,2,3,7,8-PeCDF 1,2,3,4,7,8-HxCDF 2,3,7,8-TCDF	J	Field duplicate results did not meet the field precision evaluation criteria.	**Appendix A**
K0909006	BC-MW03-7.5-9.5 BC-FD-2	Anthracene Pyrene Dibenzofuran Indeno(1,2,3-cd)pyrene Benzo(b)fluoranthene Fluoranthene Benzo(k)fluoranthene Acenaphthylene Chrysene Benzo(a)pyrene Benz(a)anthracene Acenaphthene Phenanthrene Fluorene 2-Methylnaphthalene	J	Field duplicate results did not meet the field precision evaluation criteria.	**Appendix A**
K0909006	BC-SB07-7.5-9.5 BC-FD-3	Benzo(g,h,i)perylene Indeno(1,2,3-cd)pyrene Benzo(k)fluoranthene Benzo(a)pyrene	J	Field duplicate results did not meet the field precision evaluation criteria.	**Appendix A**

Note: J(+) – The detects are qualified (J); UJ(-) – The non-detects are qualified (UJ).

II. Data affected by associated blanks are qualified and results adjusted as follows:

SDG	Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
K0908616	LP-SB09-1-2	Acetone	8.4 J	17 U	µg/kg	1.5
	LP-SB09-3.5-4.5		16 J	17 U		
	LP-SB10-1-2		15	15 U		
	LP-SB10-4-5		7.3 J	15 U		
	LP-SB10-7-8		17 J	17 U		
	LP-SB11-1-2		19	19 U		
	LP-SB11-4-5		38	38 U		
	LP-SB11-8-9		17 J	20 U		
	LP-SB12-4-5		17	17 U		
	LP-SB12-7-8		11 J	17 U		
	LP-SB13-1-2		8.6 J	16 U		
	LP-SB13-4-5		14 J	16 U		
	LP-SB14-1-2		11 J	14 U		
	LP-SB14-5-6		8.5 J	17 U		
	LP-SB14-9-10		6.9 J	14 U		
K0908616	LP-SB09-1-2	Methylene Chloride	5.6 J	8.4 U	µg/kg	1.5
	LP-SB09-3.5-4.5		11	11 U		
	LP-SB09-8-9		6 J	13 U		
	LP-SB10-1-2		0.42 J	7.0 U		
	LP-SB10-4-5		0.57 J	7.2 U		
	LP-SB10-7-8		0.58 J	8.4 U		
	LP-SB11-1-2		5 J	5.7 U		
	LP-SB11-4-5		1.6 J	6.9 U		
	LP-SB11-8-9		1.9 J	9.8 U		
	LP-SB12-1-2		1.6 J	5.8 U		
	LP-SB12-4-5		1.1 J	6.6 U		
	LP-SB12-7-8		4.6 J	8.3 U		
	LP-SB13-1-2		1.7 J	7.6 U		
	LP-SB13-4-5		2.8 J	7.7 U		
	LP-SB13-7-8		2.2 J	13 U		
	LP-SB14-1-2		2.4 J	6.9 U		
	LP-SB14-5-6		1.7 J	8.3 U		
	LP-SB14-9-10		1.8 J	6.7 U		
K0908616	LP-SB10-1-2	Naphthalene	1 J	14 U	µg/kg	1.5
	LP-SB10-7-8		5.4 J	17 U		
	LP-SB11-1-2		2.2 J	12 U		
	LP-SB11-4-5		5.3 J	14 U		
	LP-SB11-8-9		25	20 U		
K0908615	MG-SB04-2-4	Naphthalene	9.5	9.5 U	µg/kg	2.5
K0908616	MG-SB05-7-8	Naphthalene	14	14 U	µg/kg	2.5
	PR-SB05-1-2		12	12 U		
K0908616	MG-SB05-7-8	2-Methylnaphthalene	2.6 J	2.7 U	µg/kg	2.5
	PR-SB05-1-2		2.4 J	3.1 U		
K0908616	MG-SB05-7-8	Indeno(1,2,3cd)pyrene	0.61 J	2.7 U	µg/kg	2.5
K0909006	BC-SB04-1-2	Naphthalene	3.6 J	5.0 U	µg/kg	2.5
	BC-SB04-7.5-8.5		8.2	8.2 U		

SDG	Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
K0909006	BC-SB04-10.5-11.5 BC-SB04-1-2 BC-SB04-7.5-8.5 BC-SB05-10.5-11.5	2-Methylnaphthalene	0.88 J 1.8 J 3.1 J 3.2 J	5.0 U 5.0 U 5.0 U 4.9 U	**µg/kg**	**2.5**
K0909006	BC-SB03-11.5-12.5 BC-SB04-1-2 BC-SB04-14-15 BC-SB04-7.5-8.5 BC-SB05-10.5-11.5	Dibenzofuran	2.5 J 1.3 J 5.9 3 J 1.1 J	5.0 U 5.0 U 5.9 U 5.0 U 4.9 U	**µg/kg**	**2.5**
K0909006	BC-SB04-10.5-11.5 BC-SB04-1-2 BC-SB05-10.5-11.5	Phenanthrene	2.5 J 2.9 J 6.6	5.0 U 5.0 U 6.6 U	**µg/kg**	**2.5**
K0909006	BC-SB04-10.5-11.5 BC-SB04-1-2 BC-SB05-10.5-11.5	Pyrene	3.5 J 1.6 J 3.4 J	5.0 U 5.0 U 4.9 U	**µg/kg**	**2.5**
K0908616	AA-MW04-4-5	Arsenic	1.3 J	2.2 U	**mg/kg**	**3.4**
K0909006	BC-SB03-11.5-12.5 BC-SB03-14-15 BC-SB04-10.5-11.5 BC-SB04-1-2 BC-SB04-14-15 BC-SB04-7.5-8.5 BC-SB05-10.5-11.5 BC-SB05-14-15 BC-SB05-7.5-8.5 MG-SB06-10-11 BC-FD-1	TPH-Diesel	4.9 J 22 J 2.8 J 2.7 J 20 J 5.5 J 6.1 J 22 J 28 J 29 J 27 J	32 U 35 U 30 U 26 U 33 U 32 U 33 U 35 U 32 U 30 U 30 U	**mg/kg**	**4.4**
K0909015	BC-MW02-21-22 BC-MW02-2-4 BC-MW03-13-15 BC-MW03-18.5-19.5 BC-SB06-12-14 BC-SB06-19-20 BC-SB06-4-5 BC-SB06-9-10	TPH-Diesel	3.9 J 13 J 6.3 J 2.5 J 19 J 2.9 J 4.4 J 10 J	31 U 27 U 30 U 31 U 37 U 31 U 29 U 42 U	**mg/kg**	**4.4**
K0909015	BC-MW02-21-22 BC-MW02-2-4 BC-MW03-13-15 BC-MW03-18.5-19.5 BC-SB06-12-14 BC-SB06-19-20 BC-SB06-4-5 BC-SB06-9-10 BC-SB07-13-14 BC-SB07-16-17	TPH-Motor Oil	16 J 98 J 12 J 5.1 J 120 J 10 J 9.7 J 43 J 75 J 110 J	130 U 110 U 120 U 130 U 150 U 130 U 120 U 170 U 130 U 130 U	**mg/kg**	**4.4**
K0909016	BC-SB08-13-14 BC-SB08-18-19 BC-SB08-4-5 BC-SB08-9-10	TPH-Diesel	6.1 J 3.1 J 6.4 J 13 J	31 U 30 U 27 U 32 U	**mg/kg**	**4.4**

SDG	Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
K0909016	BC-SB08-13-14 BC-SB08-18-19 BC-SB08-4-5 BC-SB08-9-10	TPH-Motor Oil	33 J 13 J 24 J 79 J	130 U 120 U 110 U 130 U	**mg/kg**	**4.4**

III. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
R	The result was rejected and could not be used.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: ______________________ Date: ______________

Mingta Lin, Senior Project Chemist

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APPENDIX A

A total of 13 field duplicate samples were collected for various analyses during this sampling event. Field duplicate sample identities and the corresponding parent samples are referenced as follows:

Field Duplicate	Parent Sample ID	SDG	Assigned Analyses
BC-FD-1	BC-SB05-7.5-8.5	K0909006	TPH-Diesel & Motor Oil, PAHs
BC-FD-2	BC-MW03-7.5-9.5	K0909006	TPH-Diesel & Motor Oil, PAHs
BC-FD-3	BC-SB07-7.5-9.5	K0909006	TPH-Diesel & Motor Oil, PAHs
FD-AA-01	AA-MW04-8.5-9.5	K0908616	Metals
FD-CP-04	CP-MW04-17.5-19	K0908771	Mercury
FD-CP-07	CP-MW05-26-27	K0908855	Mercury
FD-CP-1	CP-MWA3-11-13	K0908771	Mercury
FD-CP-2	CP-MW03-4-5	K0908771	Dioxins & Furans
FD-CP-3	CP-MW02-10-12	K0908771	Mercury
FD-CP-5	CP-MW02-13-15	K0908771	Mercury
FD-CP-6	CP-MW02-10-12	K0908771	Mercury
FD-CP-8	CP-MWA1-14-15	K0908855	Mercury
FD-MG-01	MG-SB06-7-8	K0909016	TPH-Diesel & Motor Oil, PAHs

The precision criterion (≤ 50%) was applied to evaluating the relative percent difference (RPD) values of field duplicate results greater than five times the MRL (5xMRL). For results less than 5xMRL, an advisory criterion of 2xMRL was applied to evaluating the concentration differences. The RPD and concentration difference values for detected analytes and data qualification are presented as follows:

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
			AA-MW04-8.5-9.5	**FD-AA-01**			
Iron	mg/kg	2.4	12400	13900	11.4%	-	
Lead	mg/kg	2.4	6.2	5.4	-	0.8	
Manganese	mg/kg	0.24	114	138	19.0%	-	
Nickel	mg/kg	0.48	11.6	10.9	6.2%	-	
Arsenic	mg/kg	2.4	10.1	8.8	-	1.3	
Cadmium	mg/kg	0.12	1.35	1.45	7.1%	-	
Chromium	mg/kg	0.6	21.4	26.1	19.8%	-	
Copper	mg/kg	0.7	603	396	41.4%	-	
Zinc	mg/kg	1.2	17.5	17.9	2.3%	-	
Mercury	mg/kg	0.02	0.58	0.373	43.4%	-	
			CPMWA3-11-13	**FD-CP-1**			
Mercury	mg/kg	0.019	0.02	0.013 J	42.4%	0.007	
			CP-MW03-4-5	**FD-CP-2**			
1,2,3,7,8,9-HxCDD	ng/kg	2.36	0.585 J	ND	-	0.585	

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
Total PeCDF	ng/kg	2.36	25	14.1	55.8%	-	**J/J**
OCDD	ng/kg	4.72	104	88.4	16.2%	-	
Total HxCDD	ng/kg	2.36	7.08	7.12	-	0.04	
1,2,3,4,6,7,8-HpCDD	ng/kg	2.36	12.1	9.92	-	2.18	
Total PeCDD	ng/kg	2.36	2.81	2.83	-	0.02	
Total HpCDD	ng/kg	2.36	27.1	21.2	24.4%	-	
Total HpCDF	ng/kg	2.36	16.7	3.3	-	13.4	**J/J**
OCDF	ng/kg	4.72	22.3	14	-	8.3	**J/J**
Total TCDD	ng/kg	0.944	3.88	3.78	-	0.1	
1,2,3,4,7,8,9-HpCDF	ng/kg	2.36	3.64	0.746 J	-	2.894	
Total HxCDF	ng/kg	2.36	28.1	5.41	-	22.69	**J/J**
Total TCDF	ng/kg	0.944	14.6	5.87	85.3%	-	**J/J**
2,3,4,7,8-PeCDF	ng/kg	2.36	3.34	1.82 J	-	1.52	
1,2,3,7,8-PeCDF	ng/kg	2.36	8.68	2.97	-	5.71	**J/J**
1,2,3,6,7,8-HxCDF	ng/kg	2.36	3.45	1.18	-	2.27	
1,2,3,6,7,8-HxCDD	ng/kg	2.36	1.26 J	1.03 J	-	0.23	
2,3,4,6,7,8-HxCDF	ng/kg	2.36	1.44 J	ND	-	1.44	
1,2,3,4,6,7,8-HpCDF	ng/kg	2.36	6.26	3.3	-	2.96	
1,2,3,4,7,8-HxCDF	ng/kg	2.36	12.9	4.489	-	8.411	**J/J**
2,3,7,8-TCDF	ng/kg	0.944	5.65	2.1	-	3.55	**J/J**
			CP-MW02-10-12	**FD-CP-3**			
Mercury	mg/kg	0.018	0.064	0.077	-	0.013	
			CP-MW04-17.5-19	**FD-CP-04**			
Mercury	mg/kg	0.002	0.737	0.765	3.7%	-	
			CP-MWC2-13-15	**FD-CP-5**			
Mercury	mg/kg	0.019	0.037	0.036	-	0.001	
			CP-MWB2-10-12	**FD-CP-6**			
Mercury	mg/kg	0.019	0.016 J	0.015 J	-	0.001	
			CP-MW05-26-27	**FD-CP-07**			
Mercury	mg/kg	0.02	0.031	0.028	-	0.003	
			CP-MWA1-14-15	**FD-CP-8**			
Mercury	mg/kg	0.019	0.125	0.126	0.8%	-	
			BC-SB05-7.5-8.5	**BC-FD-1**			
TPGH-Diesel	mg/kg	32	28 J	27 J	-	1	
TPH-Motor Oil	mg/kg	130	87 J	83 J	-	4	
Anthracene	µg/kg	5	56	60	6.9%	-	
Pyrene	µg/kg	5	910	1000	9.4%	-	
Dibenzofuran	µg/kg	5	19	24	-	5	
Benzo(g,h,i)perylene	µg/kg	5	520	610	15.9%	-	
Indeno(1,2,3-cd)pyrene	µg/kg	5	510	620	19.5%	-	
Benzo(b)fluoranthene	µg/kg	5	770	970	23.0%	-	
Fluoranthene	µg/kg	5	930	1100	16.7%	-	
Benzo(k)fluoranthene	µg/kg	5	270	330	20.0%	-	

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
Acenaphthylene	µg/kg	5	72	95	27.5%	-	
Chrysene	µg/kg	5	590	730	21.2%	-	
Benzo(a)pyrene	µg/kg	5	630	770	20.0%	-	
Dibenzo(a,h)anthracene	µg/kg	5	89	120	29.7%	-	
Benz(a)anthracene	µg/kg	5	390	490	22.7%	-	
Acenaphthene	µg/kg	5	15	21	-	6	
Phenanthrene	µg/kg	5	570	710	21.9%	-	
Fluorene	µg/kg	5	48	67	33.0%	-	
Naphthalene	µg/kg	5	53	83	44.1%	-	
2-Methylnaphthalene	µg/kg	5	32	48	40.0%	-	
			BC-MW03-7.5-9.5	**BC-FD-2**			
TPH-Diesel	mg/kg	33	42	48	-	6	
TPH-Motor Oil	mg/kg	130	140	150	-	10	
Anthracene	µg/kg	5	45	20	-	25	**J/J**
Pyrene	µg/kg	5	300	150	66.7%	-	**J/J**
Dibenzofuran	µg/kg	5	38	19	-	19	**J/J**
Benzo(g,h,i)perylene	µg/kg	5	110	69	45.8%	-	
Indeno(1,2,3-cd)pyrene	µg/kg	5	96	57	51.0%	-	**J/J**
Benzo(b)fluoranthene	µg/kg	5	140	82	52.3%	-	**J/J**
Fluoranthene	µg/kg	5	270	150	57.1%	-	**J/J**
Benzo(k)fluoranthene	µg/kg	5	42	28	-	14	**J/J**
Acenaphthylene	µg/kg	5	34	13	-	21	**J/J**
Chrysene	µg/kg	5	150	78	63.2%	-	**J/J**
Benzo(a)pyrene	µg/kg	5	130	61	72.3%	-	**J/J**
Dibenzo(a,h)anthracene	µg/kg	5	17	8.2	-	8.8	
Benz(a)anthracene	µg/kg	5	92	40	78.8%	-	**J/J**
Acenaphthene	µg/kg	5	23	13	-	10	**J/J**
Phenanthrene	µg/kg	5	390	150	88.9%	-	**J/J**
Fluorene	µg/kg	5	73	22	-	51	**J/J**
Naphthalene	µg/kg	5	200	130	42.4%	-	
2-Methylnaphthalene	µg/kg	5	100	34	98.5%	-	**J/J**
			BC-SB07-7.5-9.5	**BC-FD-3**			
TPH-Diesel	mg/kg	32	71	60	-	11	
TPH-Motor Oil	mg/kg	130	190	150	-	40	
Anthracene	µg/kg	5	290	270	7.1%	-	
Pyrene	µg/kg	5	700	550	24.0%	-	
Dibenzofuran	µg/kg	5	220	280	24.0%	-	
Benzo(g,h,i)perylene	µg/kg	5	62	37	50.5%	-	**J/J**
Indeno(1,2,3-cd)pyrene	µg/kg	5	64	31	69.5%	-	**J/J**
Benzo(b)fluoranthene	µg/kg	5	170	110	42.9%	-	
Fluoranthene	µg/kg	5	990	760	26.3%	-	
Benzo(k)fluoranthene	µg/kg	5	56	33	51.7%	-	**J/J**
Acenaphthylene	µg/kg	5	29	26	10.9%	-	

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
Chrysene	µg/kg	5	230	170	30.0%	-	
Benzo(a)pyrene	µg/kg	5	100	58	53.2%	-	**J/J**
Dibenzo(a,h)anthracene	µg/kg	5	19	9.6	-	9.4	
Benz(a)anthracene	µg/kg	5	200	140	35.3%	-	
Acenaphthene	µg/kg	5	250	300	18.2%	-	
Phenanthrene	µg/kg	5	1100	1100	0.0%	-	
Fluorene	µg/kg	5	240	310	25.5%	-	
Naphthalene	µg/kg	5	380	490	25.3%	-	
2-Methylnaphthalene	µg/kg	5	210	270	25.0%	-	
			MG-SB06-7-8	**FD-MG-01**			
TPH-Diesel	mg/kg	34	200	280	33.3%	-	
TPH-Motor Oil	mg/kg	140	250	340	-	90	
Anthracene	µg/kg	5	1400	1700	19.4%	-	
Benzo(g,h,i)perylene	µg/kg	5	84	70	18.2%	-	
Indeno(1,2,3-cd)pyrene	µg/kg	5	77	59	26.5%	-	
Benzo(b)fluoranthene	µg/kg	5	220	240	8.7%	-	
Benzo(k)fluoranthene	µg/kg	5	67	68	1.5%	-	
Acenaphthylene	µg/kg	5	34	30	12.5%	-	
Chrysene	µg/kg	5	370	480	25.9%	-	
Benzo(a)pyrene	µg/kg	5	170	150	12.5%	-	
Dibenzo(a,h)anthracene	µg/kg	5	16	13	-	3	
Benz(a)anthracene	µg/kg	5	380	430	12.3%	-	
Pyrene	µg/kg	25	3200	3600	11.8%	-	
Dibenzofuran	µg/kg	25	6500	6700	3.0%	-	
Fluoranthene	µg/kg	25	4900	5400	9.7%	-	
Acenaphthene	µg/kg	25	14000	11000	24.0%	-	
Phenanthrene	µg/kg	25	15000	14000	6.9%	-	
Fluorene	µg/kg	25	7300	8300	12.8%	-	
Naphthalene	µg/kg	25	50000	41000	19.8%	-	
2-Methylnaphthalene	µg/kg	25	10000	7900	23.5%	-	

Data Validation Report

Port of Bellingham Former GP Mill Property RI/FS
Bellingham, Washington
September 2009 Groundwater Sampling

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ACRONYMS

%D	percent difference
%D$_f$	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
AMU	atomic mass unit
BFB	bromofluorobenzene
CAS	Columbia Analytical Services, Inc. – Kelso, Washington
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
Cr (VI)	hexavalent chromium
CVAFS	cold vapor atomic fluorescence spectrometry
DFTPP	decafluorotriphenylphosphine
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
Hg	mercury
ICAL	initial calibration
ICB	initial calibration blank
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometry
ICSA	ICP interference check sample solution A
ICSAB	ICP interference check sample solution AB
ICV	initial calibration verification
LCL	laboratory control limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
µg/L	microgram per liter
MDL	method detection limit
MRL	method reporting limit

MS	matrix spike
MSD	matrix spike duplicate
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics and EPA 2004 – Inorganics)
ng/L	nanogram per liter
OPR	ongoing precision and recovery
PAHs	polycyclic aromatic hydrocarbons
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
QCS	quality control sample
RF	response factor
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SIM	selective ion monitoring
TDS	total dissolved solids
TSS	total suspended solids
TPH	total petroleum hydrocarbon
VOCs	volatile organic compounds

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for samples collected during September and October 2009 for the referenced project. The laboratory reports validated herein were submitted by Columbia Analytical Services, Inc. (CAS).

A level III data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines Guidelines ([NFGs], EPA 2008 – Organics and EPA 2004 – Inorganics) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Aspect, 2009) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

				Analysis					
Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	VOCs	PAHs	Metals	TPH	Inorganics	Cr (VI)
LP-MW-01-090109	K0908191-001	09/01/09	GW	X					
LP-SB12-091509	K0908616-004	09/15/09	GW	X					
LP-SB13-091509	K0908616-008	09/15/09	GW	X					
LP-SB14-091509	K0908616-012	09/15/09	GW	X					
LP-SB09-091509	K0908616-016	09/15/09	GW	X					
LP-SB10-091509	K0908616-020	09/15/09	GW	X					
LP-SB11-091509	K0908616-024	09/15/09	GW	X					
FD-LP-091509	K0908616-030	09/15/09	FD	X					
CP-MWC3-092809	K0909133-001	09/28/09	GW			Hg (D)			
CP-MWB3-092809	K0909133-002	09/28/09	GW			Hg (D)		X	
CP-MWA3-092809	K0909133-003	09/28/09	GW			Hg (D)		X	
CP-MW05-092809	K0909133-004	09/28/09	GW			Hg (D)		X	
CP-MW03-092809	K0909133-005	09/28/09	GW			Hg (D)			
FD-CP-2-092809	K0909133-006	09/28/09	GW			Hg (D)		X	
CP-MW04-092909	K0909199-001	09/29/09	GW			Hg (D)			
EMW-28D-092909	K0909199-002	09/29/09	GW			Hg (D)			
EMW-29D-092909	K0909199-003	09/29/09	GW			Hg (D)			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	Inorganics	Cr (VI)
EMW-8S-092909	K0909199-004	09/29/09	GW			Hg (D)			
LAW-1-092909	K0909199-005	09/29/09	GW			Hg (D)		X	
EMW-20S-092909	K0909199-006	09/29/09	GW			Hg (D)			
EMW-10S-092909	K0909199-007	09/29/09	GW			Hg (D)			
BC-MW03-092809	K0909199-008	09/28/09	GW		X		X		
MG-MW01-092809	K0909199-009	09/28/09	GW		X		X		
EMW-6S-092809	K0909199-010	09/28/09	GW		X		X		
AA-MW01-092909	K0909199-011	09/29/09	GW			D		X	X
GF-MW01-092909	K0909199-012	09/29/09	GW			D		X[(A)]	X
FH-MW01-092909	K0909199-013	09/29/09	GW			D		X	X
AA-MW03-092909	K0909199-014	09/29/09	GW			D		X	X
AA-MW04-092909	K0909199-015	09/29/09	GW			D		X	X
EMW-7S-093009	K0909284-001	09/30/09	GW			Hg (D)			
CF-MW01-093009	K0909284-002	09/30/09	GW		X	Hg (D)	X	TSS	
CF-MW02-093009	K0909284-003	09/30/09	GW		X	Hg (D)	X	TSS	
PR-MW02-093009	K0909284-004	09/30/09	GW			Hg (D)			
PR-MW01-093009	K0909284-005	09/30/09	GW			Hg (D)			
EMW-16S-093009	K0909284-007	09/30/09	GW		X	D	X	TSS	X
EMW-12S-093009	K0909284-008	09/30/09	GW		X	D	X	TSS	X
FD-PR-01-093009	K0909284-009	09/30/09	FD			Hg (D)			
FD-CFMG-1-093009	K0909284-010	09/30/09	FD		X	Hg (D)	X	TSS	
SC-MW02-093009	K0909284-011	09/30/09	GW			D			X
LP-MW01-093009	K0909284-012	09/30/09	GW			D			X
AMW-01-100109	K0909347-001	10/01/09	GW			Hg (D)			
CP-MWC2-100109	K0909347-002	10/01/09	GW			Hg (D)		X	
CP-MWC1-100109	K0909347-003	10/01/09	GW			Hg (D)		X	
CP-MWB1-100109	K0909347-004	10/01/09	GW			Hg (D)		X	
CP-MW02-100109	K0909347-005	10/01/09	GW			Hg (D)			
EMW-2S-100109	K0909347-006	10/01/09	GW			Hg (D)		X	
EMW-14S-100109	K0909347-007	10/01/09	GW			Hg (D)		X	
LW-MW01-100109	K0909347-008	10/01/09	GW			Hg (D)		Cations	X
LB-MW01-100109	K0909347-009	10/01/09	GW			Hg (D)		Cations	X
AA-MW02-100109	K0909347-010	10/01/09	GW			D		X	X
BC-MW02-100109	K0909347-011	10/01/09	GW		X	Hg (D)	X	TSS+Cations	X
TS-MW01-100109	K0909347-012	10/01/09	GW			Hg (D)			X

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	Inorganics	Cr (VI)
FD-AABC-01-100109	K0909347-013	10/01/09	GW		X	Hg (D)	X	TSS	X
FB-01-100109	K0909407-001	10/01/09	FB			D			
EMW-1S-100209	K0909407-003	10/02/09	GW			Hg(D)			
EMW-4S-100209	K0909407-004	10/02/09	GW			Hg(D)			
AMW-03-100209	K0909407-005	10/02/09	GW			Hg(D)		X	
CP-MWB2-100209	K0909407-006	10/02/09	GW			Hg(D)		X	
CP-MWA2-100209	K0909407-007	10/02/09	GW			Hg(D)		X	
CP-MW01-100209	K0909407-008	10/02/09	GW			Hg(D)			
CP-MWA1-100209	K0909407-009	10/02/09	GW			Hg(D)		X	
FD-CP-01-100209	K0909407-010	10/02/09	FD			Hg(D)		X	
EMW-19S-100209	K0909407-011	10/02/09	GW			Hg(D)		X	
AMW-2-100209	K0909407-012	10/02/09	GW			Hg(D)		X	
CP-MW06-100209	K0909407-013	10/02/09	GW			Hg(D)		X	
LW-MW01-100109	K0911134-001	10/01/09	GW			D(B)			
LB-MW01-100109	K0911134-001	10/01/09	GW			D(B)			
AA-MW02-100109	K0911134-001	10/01/09	GW			D(B)			
BC-MW02-100109	K0911134-001	10/01/09	GW			D(B)			
TS-MW01-100109	K0911134-001	10/01/09	GW			D(B)			

Notes:

X - The analysis was requested and performed on the sample
PAHs – Polycyclic aromatic hydrocarbons
Metals – Arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc.
Inorganics – Anions (bromide, chloride, fluoride, nitrate, nitrite, and sulfate), caions (dissolved calcium, iron, magnesium, manganese, potassium, and sodium), alkalinity, total dissolved solids (TDS), and sulfide.
TPH – Diesel and motor oil range total petroleum hydrocarbon
Hg – The sample was analyzed for mercury only
FD – Field duplicate
FB – Filtration blank
Cations – The sample was analyzed for dissolved calcium, iron, magnesium, manganese, potassium, and sodium only
T – Total metals
D – Dissolved metals
(A) – No cations were analyzed for this sample
(B) – The sample was analyzed for manganese and dissolved metals except mercury (analyzed and reported in SDG K0909347).

The analytical parameters requested for the samples, the respective analytical methods, and the analytical laboratories are summarized below:

Parameter	Analytical Method	Analytical Laboratory
Volatile organic compounds (VOCs)	SW846 Method 8260B	Columbia Analytical Services, Inc. Kelso, Washington
Polycyclic aromatic hydrocarbons (PAHs)	SW846 Method 8270C-SIM	
TPH-Diesel & Motor Oil	NWTPH-Dx	
Calcium, iron, magnesium, manganese, potassium, & sodium	SW846 Method 6010B	
Total and dissolved metals	SW846 Method 6020	
Mercury	EPA Method 1631E	
Alkalinity (total, carbonate, bicarbonate, & hydroxide)	SM Method 2320B	
Anions (bromide, fluoride, chloride, nitrate, nitrite, & sulfate)	EPA Method 300.0	
Total dissolved solids (TDS)	SM Method 2540 C	
Total suspended Solids (TSS)	SM Method 2540 D	
Sulfide	SM Method 4500-S2-D	
Hexavalent chromium (Cr [VI])	SW846 Method 7196A	

Notes:
1. SW846 - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. EPA Methods - *USEPA Methods for Chemical Analysis of Water and Wastes,* EPA–600/4-79-020, March 1983 Revision.
3. EPA Method 1631E - *Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry,* Office of Water, U.S. Environmental Protection Agency, August 2002, EPA-821-R-02-019.
4. SM – Standard *Methods for the Examination of Water and Wastewater*, American Public Health Association, 20th Edition, 1995.
5. Cations – Calcium, iron, magnesium, manganese, potassium, and sodium.
6. Total and dissolved metals - Arsenic, cadmium, chromium, copper, lead, nickel, and zinc

DATA VALIDATION FINDINGS

1. VOCs by GC/MS (EPA Method SW8260B)

1.1 Sample Management and Holding Time

Samples were received in the laboratory intact and in consistence with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport.

Soil samples should be analyzed within 14 days of collection. All samples were analyzed within the required holding time.

1.2 GC/MS Instrument Performance Check

Bromofluorobenzene (BFB) tuning was performed within each 12-hour interval. All required ion abundance ratios met the method requirements.

1.3 Initial Calibration

The National Functional Guidelines (NFGs) require that the percent relative standard deviation (%RSD) be <30% and the average response factor (RF) be > 0.01 for poor response compounds and >0.05 for all other compounds.

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.99. Initial calibration for all target compounds except for the following:

Initial Calibration ID	Analyte	Exceedance	Affected Sample	Data Qualification
Instrument MS18 ICAL: 8722	Dichlorodifluoromethane Trichlorofluoromethane Carbon Tetrachloride Bromoform 1,2,3-Tichloropropane	%RSD >15%	None	No action. The analyte was not detected in any samples at or above the MDL.
	Vinyl Chloride 1,1-Dichloroethen	%RSD = 16.4% %RSD = 15.1%	LP-MW-01	**J** **J**

1.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the percent difference (%D) be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verification analyses were performed at the required frequency. The calibration verification %D values either met the criteria for all target compounds or at levels that had no significant effects on data quality (*e.g.,* high recovery where the analyte was not detected).

1.5 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the method detection limits (MDLs) in the method blanks or at levels that had no significant effects on data quality.

1.6 Laboratory Control Sample

LCS and LCS duplicate (LCSD) were prepared and analyzed as required by the method. All percent recovery (%R) and relative percent difference (RPD) values met the project control criteria.

1.7 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits.

1.8 Matrix Spike and Matrix Spike Duplicate

MS/MSD analyses were not performed on the project sample in this SDG. Analytical precision and accuracy was evaluated with the LCS and LCSD results (see Section 1.6).

1.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

1.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and MRLs were adjusted with sample amount extracted and MRLs were supported with adequate initial calibration concentrations. The project requirements for quantitation limits were achieved.

1.11 Field Duplicates

One set of field duplicates were submitted for VOCs analyses. Field duplicate results for detected target compounds, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

1.12 Overall Assessment of VOCs Data Usability

VOCs data are of known quality and acceptable for use, as qualified.

2. PAHs by GC/MS - SIM (EPA Method SW8270C)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be extracted within 14 days of collection. Extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

DFTPP tuning was performed within each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The NFGs criteria require that the %RSD be <30% and the average RRF be >0.05 for all target compounds.

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.99. The initial calibration met the criteria.

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds. Calibration verification analyses met the criteria.

2.5 Blanks

Method Blank: Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the MDLs in the method blanks or at levels that had no significant effects on associated sample results (sample >10x detects in blank), except for the following:

Method Blank ID (SDG)	Analyte	Blank Detection (µg/L)	Affected Sample	Original Result (µg/L)	Adjusted Result (µg/L)
KWG09085-4 (K0909347)	Phenanthrene	0.0051 J	BC-MW02-100109 FD-AABC-01-100109	0.022 0.020 J	**0.022 U** **0.023 U**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were either within the project control limits or appeared to be affected by the sample matrix (high levels of target or non-target compounds).

2.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were not performed on the project sample in this SDG. Analytical precision and accuracy was evaluated with the LCS and LCSD results (see Section 2.8).

2.8 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed with each analytical batch. All %R and RPD values were within the project control limits.

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and MRLs were adjusted with sample amount extracted and MRLs were supported with adequate initial calibration concentrations.

2.11 Field Duplicates

Two sets of field duplicates were submitted for PAHs analyses. Field duplicate results for detected target compounds, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

2.12 Overall Assessment of PAHs Data Usability

PAHs data are of known quality and acceptable for use, as qualified.

3. Metals by ICP, ICP/MS, and CVAFS (EPA Methods SW6010/6020 and 1631)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be analyzed within 180 days for metals and 28 days for mercury. Samples were analyzed within the required holding time.

3.2 ICP/MS Tuning

Instrument tuning was performed at the required frequency. The stability check (%RSD <5%), mass calibration (mass difference <0.1 AMU), and resolution check (peak width <1.0 AMU at 5% peak height) met the method criteria.

3.3 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury (CVAFS) analyses, the methods require that (1) a blank and five calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995 or %RSD ≤15%. The associated initial calibrations met the method requirements.

A check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The results were within the NFGs criteria of 70-130% or the associated results were greater than the 2x MRLs.

3.4 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) or Ongoing Precision Recovery (OPR) samples (for Method 1631E) were analyzed at the required frequency. The %R values met the method control criteria.

3.5 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at required frequency. Target analytes were either not detected in ICBs/CCBs at or above the method detection limits (MDLs), or at levels that had no significant effects (sample results > 5x the calibration blank detection) on associated sample results, with the following exceptions:

SDG	Calibration Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result (µg/L)	Adjusted Results (µg/L)
K0909199	CCB3, 10/27/09, 10:14 CCB4, 10/27/09, 11:04	Dissolved Cadmium	0.013 J 0.003 J	FH-MW01-092909 AA-MW01-092909 AA-MW03-092909	0.039 0.007 J 0.006 J	**0.039 U** **0.02 U** **0.02 U**
K0909347	CCB2, 10/27/09, 09:30 CCB3, 10/27/09, 10:14	Dissolved Cadmium	0.011 J 0.013 J	AA-MW02-100109	0.007 J	**0.02 U**
K0911134	CCB3, 11/19/09, 12:10	Dissolved Arsenic Dissolved Cadmium	0.14 J 0.004 J	LB-MW01-100109	0.45 J 0.013 J	**0.5 U** **0.02 U**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were either not detected in the method blanks at or above the MDLs, or at levels that had no significant effects (sample results > 5x the method blank detection) on associated sample results, except for the following:

SDG	Preparation Blank ID	Analyte	Detection in Blank (ng/L)	Affected Sample	Original Result (ng/L)	Adjusted Results (ng/L)
K0909133	MB1 MB2 MB3	Dissolved Mercury	0.07 J 0.47 J 0.12 J	CP-MWC3-092809 CP-MWA3-092809	1.71 1.03	**1.71 U** **1.03 U**
K0909199	MB3	Dissolved Mercury	0.28 J	GF-MW01-092909 FH-MW01-092909 EMW-8S-092909 AA-MW01-092909 AA-MW03-092909	0.75 J 1.34 0.28 J 0.53 J 0.78 J	**1 U** **1.34 U** **1 U** **1 U** **1 U**
K0909284	MB1 MB3	Dissolved Mercury	0.32 J 0.48 J	PR-MW02-093009 SC-MW02-093009 EMW-12S-093009 EMW-7S-093009	1.36 J 2.42 J 2.68 J 0.84 J	**5 U** **5 U** **5 U** **1 U**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

Filtration Blank: Sample FB-01-100109 was a filtration blank sample collected for the evaluation of the potential of metals contamination being introduced through the filtering procedure. Mercury was detected at 0.1 ng/L, a level between the MDL and MRL, in the filtration blank sample. All groundwater sample result less than the MRLs or 10x the concentration in the filtration blank were considered affected. Most of the affected results were qualified as a consequence of the positive detections in method blanks (see Method Blank above); affected results not yet qualified above are qualified as follows:

SDG	Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result (µg/L)	Adjusted Results (µg/L)
K0909347	FB-01-100109	Dissolved Mercury	0.10 J	BC-MW02-100109 AA-MW02-100109	0.28 J 0.2 J	**1 U** **1 U**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

3.6 ICP Interference Check Sample (ICS)

The method requires that (1) an inter-element interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several analytes were detected in the ICSA initial analyses at low levels. Since the concentrations in the associated samples were less than 50% of the interferant concentrations in ICSA samples, no action was taken. The %D values for analytes in ICSAB were within ± 20% of the true value or the interferant concentrations in the associated samples were less than 50% of the ICSAB concentrations.

3.7 Laboratory Control Sample (LCS) and Quality Control Samples (QCS)

LCS or QCS (as named in Method 1631E) analyses were performed at the required frequency. All %R values met the control limits (80 – 120%/20%) for all target analytes.

3.8 Duplicate Sample Analysis

Duplicate sample (matrix spike duplicates for mercury) analyses were performed on project samples at the required frequency. The RPD values (or concentration differences) met the control criteria (20% for detections ≥ 5xRL, ±1xMRL for detections < 5xMRL).

3.9 Matrix Spike (MS)

Matrix spike analyses were performed on project samples as required. All %R values met the laboratory control limits, or native analyte concentrations in the samples were greater than 4x the spiked levels and the %R values were inapplicable for matrix effect evaluation, except for the following:

SDG	Sample ID	Analyte	%R	Control Limit	Affected Sample	Data Qualification
K0911134	FD-AABC-01-100109	Copper Nickel	78.8% 82.2%	86-113% 86-120%	BC-MW02-100109 FD-AABC-01-100109	**J** **J**

3.10 Serial Dilution

Serial dilution analyses were performed on project samples at the required frequency for ICP metals and mercury. All %D values for positive results greater than 50X MDL were within 10%, except for the following:

SDG	Sample ID	Analyte	%D	Affected Sample	Data Qualification
K0909347	AA-MW02-100109	Magnesium	43.3%	AA-MW02-092909	J
K0911134	LB-MW01-100109	Chromium	11.0%	LB-MW01-100109	J

3.11 Internal Standards

At least three internal standards were added to all samples and QC analyses. All percent relative intensity values were within the Functional Guidelines criterion (60 - 125% of those of the calibration blank).

3.12 Analyte Quantitation and Reporting Limits

The project requirements for quantitation limits were achieved. Samples BC-MW02-100109 and FD-AABC-01-100109 appeared to be brackish, which prevented optimal analytical results of dissolved metals using the ICP/MS technique (EPA Method 6020) as the project planned. The ICP technique (EPA Method 6010B) was applied to analyze the dissolved metals for these samples, and the MRLs were elevated from the project goals.

3.13 Field Duplicates

One set of field duplicate for dissolved metals and five sets of field duplicates for dissolved mercury were submitted for analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

3.14 Overall Assessment of Metals Data Usability

Metals data are of known quality and acceptable for use, as qualified.

4. TPH-Diesel & Motor Oil (Methods NWTPH-Dx)

4.1 Holding Time

Soil samples should be extracted within 14 days of collection, and extracts be analyzed within 40 days of extraction. All samples were extracted and analyzed within the recommended holding time.

4.2 Initial Calibration

The methods requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curves were verified with %RSD values of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both diesel and motor oil range total petroleum hydrocarbon (TPH).

4.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value.

Calibration verification was performed at required frequency. The percent drift met the ±15% criterion.

4.4 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the MDLs in the method blanks or at levels that had no significant effects on associated sample results (sample >10x detections in the method blank), except for the following:

SDG	Method Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result (µg/L)	Adjusted Result (µg/L)
K0909199	KWG0909319-6	TPH-Diesel TPH-Motor Oil	17 J 19 J	BC-MW03-092809	96 J 48 J	**270 U** **530 U**
K0909284	KWG0909319-6	TPH-Motor Oil	19 J	EMW-12S-093009	300 J	**560 J**
K0909347	KWG0908936-3	TPH-Diesel	19 J	BC-MW02-100109 FD-AABC-01-100109	38 J 44 J	**280 U** **280 U**
		TPH-Motor Oil	70 J	BC-MW02-100109 FD-AABC-01-100109	70 J 98 J	**560 J** **560 J**

4.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits, outside the control limits due to matrix interference, or diluted below quantitation limits due to high analyte concentrations. In all cases, no data qualification was required.

4.6 Matrix Duplicate

Matrix duplicate analyses were performed on project samples at the required frequency. The RPD values (or concentration differences if sample concentrations are <5xMRL) met the laboratory control limits, except for the following:

4.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required. All %R values met the project control limits.

4.8 Target Compound Identification

Sample extracts were cleaned up with acid and silica gel treatment to minimize the biogenic interference with target compound identification, as required by the project. The laboratory reported results as diesel #2 (C12 - C24) and motor oil (C24 - C38), as required by the method.

4.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations. Sample-specific MDLs and MRLs were adjusted to sample weight and moisture content.

4.10 Field Duplicates

Two sets of field duplicates were submitted for TPH-Diesl and TPH-Motor Oil analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

4.11 Overall Assessment of TPH-Diesel and Motor Oil Data Usability

TPH-Diesel, TPH-Motor Oil, and EPH data are of known quality and acceptable for use as qualified.

5. Alkalinity, TDS, TSS, Anions, Cr (VI), and Sulfide

5.1 Holding Times

The samples were analyzed within the required holding times of 24 hours for Cr (VI), 48 hours for nitrate and nitrite; seven days for total dissolved solids (TDS) and total suspended solids (TSS), 14 days for alkalinity and sulfide; and 28 days for bromide, chloride, fluoride, and sulfate. All analyses were performed within the required holding times, except for the following:

SDG	Sample ID	Analyte	Date Collected	Date Analyzed	Required Holding Time	Actual Holding Time	Data Qualifier
K0909199	GF-MW01-092909	Cr (VI)	09/29/09	10/01/09	24 hours	48 hours	**J**
K0909347	EMW-14S-100109	Nitrate	10/01/09	10/05/09	48 hours	96 hours	**UJ**[(A)]
K0909407	CP-MWB2-100209 CP-MWA2-100209 FD-CP-01-100209 EMW-19S-100209 AMW-2-100209 CP-MW06-100209	Nitrate	10/02/09	10/05/09 10/05/09 10/06/09 10/06/09 10/06/09 10/06/09	48 hours	72 hours 72 hours 96 hours 96 hours 96 hours 96 hours	**UJ**[(A)] **UJ**[(A)] **UJ**[(A)] **UJ**[(A)] **UJ**[(A)] **UJ**[(A)]

Note: [(A)] – The analysis was initially performed within the required holding time. Multiple dilutions were required due to high levels of chloride and sulfate in the sample; and the final dilution analysis was performed as dated. Unlike nitrite, nitrate is normally stable in water samples if stored cool. The exceedance of recommended holding time for 24 - 48 hours had relatively low effects on data quality. Data were therefore qualified (UJ) as estimated, rather than (R) rejected.

5.2 Initial Calibration

Initial calibration (ICAL) is required for anions (bromide, chloride, fluoride, nitrite, nitrate, and sulfate by EPA Method 300.0), Cr (VI), and sulfide analyses. The initial calibration correlation coefficients were greater than 0.995 and met the method requirements for these parameters.

5.3 Initial and Continuing Calibration Verification

Initial calibration verification (ICV) and continuing calibration verification (CCV) analyses were performed at the required frequency for all inorganic constituents. All percent recovery values were within the control limits of 90 – 110%.

5.4 Blanks

Calibration Blanks: ICBs and CCBs were analyzed at the required frequency. Target analytes were either not detected at or above the MDLs in ICBs and CCBs, or at levels that had no significant effects on sample results, except for the following:

SDG	Calibration Blank ID	Analyte	Detection in Blank (mg/L)	Affected Sample	Original Result (mg/L)	Adjusted Result (mg/L)
K0909347	CCB1 CCB2 CCB3	Cr (VI)	0.004 J 0.006 J 0.004 J	AA-MW02-100109 BC-MW02-100109 TS-MW01-100109 FD-AABC-01-100109	0.009 J 0.008 J 0.008 J 0.007 J	**0.05 U** **0.05 U** **0.05 U** **0.05 U**

Method Blanks: Method blanks were analyzed at the required frequency. Target analytes were either not detected at or above the MDLs in method blanks, or at levels that had no significant effects on sample results.

5.5 Duplicate Sample Analysis

Duplicate analyses were performed for all inorganic constituents on project samples. All RPD or concentration difference values met the laboratory control criteria.

5.6 Matrix Spike (MS)

Matrix spike analyses were performed at the required frequency (some on batch QC samples). All %R values were within the laboratory control limits.

5.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required by the methods. All %R values were within the laboratory control limits.

5.8 Field Duplicates

One set of field duplicates were submitted for inorganic constituent analyses. Field duplicate results, RPD or concentration difference values, and data qualification are presented in **Appendix A**.

5.9 Laboratory Reporting Limits

Most groundwater samples contained elevated levels of chloride and, in some cases, sulfate that heavily interfered with the quantitation of other anions, particularly nitrite and nitrate. The MRLs were thus raised for affected anions in these cases.

5.10 Overall Assessment of Inorganic Constituents Data

Inorganic constituents data are of known quality and acceptable for use as qualified.

SUMMARY

I. Data qualification is summarized as follows:

SDG	Sample ID	Analyte	Data Qualifier	Reason	Report Section
K0908191	LP-MW-01	Vinyl Chloride 1,1-Dichloroethene	J	Initial calibration %RSD value did not meet the linearity criterion of 15%.	**1.3**
K0911134	BC-MW02-100109 FD-AABC-01-100109	Dissolved Copper Dissolved Nickel	J	The MS %R value was below the lower control limits.	**3.7**
K0909347	AA-MW02-100109	Magnesium	J	The serial dilution %D value exceeded 10%.	**3.10**
K0911134	LB-MW01-100109	Chromium	J	The serial dilution %D value exceeded 10%.	**3.10**
K0909199	GF-MW01-092909	Cr (VI)	J	The analysis was performed past the recommended holding time.	**5.1**
K0909347	EMW-14S-100109	Nitrate	UJ	The analysis was performed past the recommended holding time.	**5.1**
K0909407	CP-MWB2-100209 CP-MWA2-100209 FD-CP-01-100209 EMW-19S-100209 AMW-2-100209 CP-MW06-100209	Nitrate	UJ	The analysis was performed past the recommended holding time.	**5.1**
K0908616	LP-SB09-091509 FD-LP-091509	Chloromethane	J	The field duplicate result did not meet field precision evaluation criteria.	**Appendix A**
K0909284	CF-MW01-093009 FD-CFMG-1-093009	Dissolved Mercury	J	The field duplicate result did not meet field precision evaluation criteria.	**Appendix A**

Note: J(+) – The detects are qualified (J); UJ(-) – The non-detects are qualified (UJ).

II. Data affected by associated blanks are qualified and results adjusted as follows:

SDG	Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
K0909031	Rinsate Blank	Naphthalene	0.019 J	0.020 U	**µg/L**	**2.5**
K0909347	BC-MW02-100109 FD-AABC-01-100109	Phenanthrene	0.022 0.020 J	0.022 U 0.023 U	**µg/L**	**2.5**
K0909199	FH-MW01-092909 AA-MW01-092909 AA-MW03-092909	Dissolved Cadmium	0.039 0.007 J 0.006 J	0.039 U 0.02 U 0.02 U	**µg/L**	**3.5**
K0909347	AA-MW02-100109	Dissolved Cadmium	0.007 J	0.02 U	**µg/L**	**3.5**
K0909133	CP-MWC3-092809 CP-MWA3-092809	Dissolved Mercury	1.71 1.03	1.71 U 1.03 U	**ng/L**	**3.5**
K0909199	GF-MW01-092909 FH-MW01-092909 EMW-8S-092909 AA-MW01-092909 AA-MW03-092909	Dissolved Mercury	0.75 J 1.34 0.28 J 0.53 J 0.78 J	1 U 1.34 U 1 U 1 U 1 U	**ng/L**	**3.5**
K0909284	PR-MW02-093009 SC-MW02-093009 EMW-12S-093009 EMW-7S-093009	Dissolved Mercury	1.36 J 2.42 J 2.68 J 0.84 J	5 U 5 U 5 U 1 U	**ng/L**	**3.5**
K0909347	BC-MW02-100109 TS-MW01-100109 AMW-01-100109 AA-MW02-100109	Dissolved Mercury	0.28 J 1.08 1.09 0.2 J	1 U 1.08 U 1.09 U 1 U	**ng/L**	**3.5**
K0911134	LB-MW01-100109	Dissolved Arsenic Dissolved Cadmium	0.45 J 0.013 J	0.5 U 0.02 U	**µg/L**	**4.4**
K0909199	BC-MW03-092809	TPH-Diesel TPH-Motor Oil	96 J 48 J	270 U 530 U	**µg/L**	**4.4**
K0909284	EMW-12S-093009	TPH-Motor Oil	300 J	560 J	**µg/L**	**4.4**
K0909347	BC-MW02-100109 FD-AABC-01-100109	TPH-Diesel	38 J 44 J	280 U 280 U	**µg/L**	**4.4**
K0909347	BC-MW02-100109 FD-AABC-01-100109	TPH-Motor Oil	70 J 98 J	560 J 560 J	**µg/L**	**4.4**
K0909347	AA-MW02-100109 BC-MW02-100109 TS-MW01-100109 FD-AABC-01-100109	Hexavalent Chromium	0.009 J 0.008 J 0.008 J 0.007 J	0.05 U 0.05 U 0.05 U 0.05 U	**mg/L**	**5.4**

III. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
R	The result was rejected and could not be used.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: ______________________________ Date: ____________________

Mingta Lin, Senior Project Chemist

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APPENDIX A

A total of six field duplicate samples were collected for various analyses during this sampling event. Field duplicate sample identities and the corresponding parent samples are referenced as follows:

Field Duplicate	Parent Sample ID	SDG	Assigned Analyses
FD-LP-091509	LP-SB11-091509	K0908616	VOCs
FD-CP-2-092809	CP-MW05-092809	K0909133	Dissolved Mercury
FD-CFMG-1-093009	CF-MW01-093009	K0909284	Dissolved Mercury, TSS, TPH-Diesel & Motor Oil, PAHs
FD-PR-01-093009	PR-MW01-093009	K0909284	Dissolved Mercury
FD-AABC-01-100109	BC-MW02-100109	K0909347	Dissolved Metals, Dissolved Mercury, TSS, TPH-Diesel & Motor Oil, PAHs, Cations, Cr (VI)
FD-CP-01-100209	CP-MWA1-100209	K0909407	Dissolved Mercury, Inorganics, Cations

The precision criterion (≤ 35%) was applied to evaluating the relative percent difference (RPD) values of field duplicate results greater than five times the MRL (5xMRL). For results less than 5xMRL, an advisory criterion of 2xMRL was applied to evaluating the concentration differences. The RPD and concentration difference values for detected analytes and data qualification are presented as follows:

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
			LP-SB09-091509	**FD-LP-091509**			
1,1-Dichloroethane	µg/L	0.5	4.1	3.8	7.6%	-	
1,1-Dichloroethene	µg/L	0.5	0.37 J	0.34 J	-	0.03	
1,2,4-Trimethylbenzene	µg/L	2	0.11 J	0.09 J	-	0.02	
Acetone	µg/L	20	5.7 J	13 J	-	7.3	
Benzene	µg/L	0.5	0.32 J	0.34 J	-	0.02	
Carbon disulfide	µg/L	0.5	0.57	0.59	-	0.02	
Chloromethane	µg/L	0.5	1.8	0.67	-	1.13	**J/J**
Methylene chloride	µg/L	2	2.5	ND	-	2.5	
Naphthalene	µg/L	2	4.8	3.2	-	1.6	
Toluene	µg/L	0.5	0.15 J	0.21 J	-	0.06	
Trichloroethene (TCE)	µg/L	0.5	0.11 J	ND	-	0.11	
			CP-MW05-0928-09	**FD-CP-2-092809**			
Dissolved Mercury	ng/L	1	5.99	4.39	-	1.60	
			CF-MW01-093009	**FD-CFMG-1-093009**			
Dissolved Mercury	ng/L	1	4.56	2.39	-	2.17	**J/J**
TPH-Diesel	µg/L	280	1900	1600	15.8%	-	
TPH-Motor Oil	µg/L	560	1400	2000	-	600	
Total Suspended Solids	µg/L	5	247	206	18.1%	-	
Anthracene	µg/L	0.022	0.027 J	ND	-	0.027	
Pyrene	µg/L	0.022	0.069	0.042	-	0.027	

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
Dibenzofuran	µg/L	0.022	0.021 J	0.013 J	-	0.008	
Benzo(g,h,i)perylene	µg/L	0.022	0.0075 J	ND	-	0.0075	
Indeno(1,2,3-cd)pyrene	µg/L	0.022	0.0087 J	ND	-	0.0087	
Benzo(b)fluoranthene	µg/L	0.022	0.017 J	ND	-	0.017	
Fluoranthene	µg/L	0.022	0.096	0.058	-	0.038	
Benzo(k)fluoranthene	µg/L	0.022	0.0096 J	ND	-	0.0096	
Chrysene	µg/L	0.022	0.025	0.014	-	0.011	
Benzo(a)pyrene	µg/L	0.022	0.01 J	ND	-	0.01	
Dibenzo(a,h)anthracene	µg/L	0.022	0.054	ND	-	0.054	
Benz(a)anthracene	µg/L	0.022	0.019 J	0.01 J	-	0.009	
Acenaphthene	µg/L	0.022	0.061	0.049	-	0.012	
Phenanthrene	µg/L	0.022	0.096	0.061	-	0.035	
Fluorene	µg/L	0.022	0.037	0.022 J	-	0.015	
Naphthalene	µg/L	0.022	0.045	0.02 J	-	0.025	
2-Methylnaphthalene	µg/L	0.022	0.016	0.0074 J	-	0.0086	
			PR-MW01-093009	**FD-PR-01-093009**			
Dissolved Mercury	ng/L	1	43.2	34.3	23.0%	-	
			BC-MW02-100109	**FD-AABC-01-100109**			
Dissolved Mercury	ng/L	1	0.28 J	0.44 J	-	0.16	
Dissolved Arsenic	µg/L	10	ND	5.2 J	-	5.2	
Dissolved Cadmium	µg/L	0.5	1.5	1.4	-	0.1	
Dissolved Chromium	µg/L	2.0	1.1 J	0.6 J	-	0.5	
Dissolved Copper	µg/L	4.0	12.7	11.0	-	1.7	
Dissolved Lead	µg/L	10	412	334	20.9%	-	
Dissolved Nickel	µg/L	20	32.4	30.1	-	1.3	
Dissolved Zinc	µg/L	2.0	208	195	6.5%	-	
TPH-Diesel	µg/L	280	38 J	44 J	-	6	
TPH-Motor Oil	µg/L	560	70 J	98 J	-	28	
Total Suspended Solids	mg/L	5	11.5	16.5	-	5	
Dissolved Iron	µg/L	20	554	566	2.1%	-	
Dissolved Manganese	µg/L	5	204	201	1.5%	-	
Dissolved Potassium	µg/L	400	291000	288000	1.0%	-	
Dissolved Calcium	µg/L	50	241000	236000	2.1%	-	
Dissolved Magnesium	µg/L	4000	999000	995000	0.4%	-	
Dissolved Sodium	µg/L	20000	8590000	8550000	0.5%	-	
Hexavalent Chromium	mg/L	0.05	0.008 J	0.007 J	-	0.001	
Anthracene	µg/L	0.022	0.0058 J	0.0053 J	-	0.0005	
Pyrene	µg/L	0.022	0.021 J	0.025	-	0.004	
Dibenzofuran	µg/L	0.022	0.0068 J	0.0079 J	-	0.0011	
Fluoranthene	µg/L	0.022	0.028	0.027	-	0.001	
Benz(a)anthracene	µg/L	0.022	ND	0.0061 J	-	0.0159	
Acenaphthene	µg/L	0.022	0.045	0.037	-	0.008	
Phenanthrene	µg/L	0.022	0.022	0.02 J	-	0.002	

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
Fluorene	µg/L	0.022	0.018 J	0.018 J	-	0	
Naphthalene	µg/L	0.022	0.017 J	0.014 J	-	0.003	
2-Methylnaphthalene	µg/L	0.022	ND	0.0061 J	-	0.0159	
			CP-MWA1-100209	**FD-CP-01-100209**			
Dissolved Mercury	ng/L	100	10800	11300	4.5%	-	
Bromide	mg/L	0.1	ND	ND	-	0	
Nitrate as Nitrogen	mg/L	5	ND	3.95 J	-	1.05	
Nitrite as Nitrogen	mg/L	5	ND	ND	-	0	
Fluoride	mg/L	10	4.34 J	ND	-	4.34	
Sulfate	mg/L	10	65	56	14.9%	-	
Chloride	mg/L	200	1980	1920	3.1%	-	
Alkalinity, Total as CaCO3	mg/L	10	11800	11300	4.3%	-	
Total Dissolved Solids	mg/L	5	23600	23400	0.9%	-	
Sulfide	mg/L	0.05	13.5	14.3	5.8%	-	
Iron	µg/L	100	9840	9740	1.0%	-	
Magnesium	µg/L	100	2610	2440	7.0%	-	
Manganese	µg/L	25	207	192	7.8%	-	
Potassium	µg/L	2000	52300	52300	0.0%	-	
Calcium	µg/L	250	19100	18300	4.4%	-	
Sodium	µg/L	10000	7730000	7570000	2.1%	-	

Note:
mg/L – milligram per liter
µg/L – microgram per liter
ng/L – nanogram per liter
Conc. Difference – Concentration difference between the parent sample and the field duplicate
MRL – Method reporting limit
ND – Not detected at or above the method detection limit
RPD – Relative percent difference

Data Validation Report

Port of Bellingham Former GP Mill Property RI/FS
Bellingham, Washington

March 2010 Soil Sampling

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May 18, 2010

ACRONYMS

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
CAS	Columbia Analytical Services, Inc. – Kelso, Washington
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
CVAA	cold vapor atomic absorption spectrometry
DFTPP	decafluorotriphenylphosphine
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
Hg	mercury
ICAL	initial calibration
ICB	initial calibration blank
ICV	initial calibration verification
LCL	laboratory control limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
µg/kg	microgram per kilogram
mg/kg	milligram per kilogram
MDL	method detection limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics, EPA 2004 – Inorganics)
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RF	response factor

RPD	relative percent difference
SDG	sample delivery group
TPH	total petroleum hydrocarbon
WDOE	Washington State Department of Ecology

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for samples collected during September 2009 for the referenced project. The laboratory reports validated herein were submitted by Columbia Analytical Services, Inc.

A level III data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines ([NFGs], EPA 2008 – Organics, EPA 2004 – Inorganics) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Aspect, 2009) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis	
				Mercury	TPH-Dx
SW-HA01-0-0.5	K1002851-001	03/24/10	Soil	X	
SW-HA01-0.5-1	K1002851-002	03/24/10	Soil	X	
SW-HA04-0-0.5	K1002851-003	03/24/10	Soil	X	
SW-HA04-0.5-1	K1002851-004	03/24/10	Soil	X	
SW-HA03-0-0.5	K1002851-005	03/24/10	Soil	X	
SW-HA03-0.5-1	K1002851-006	03/24/10	Soil	X	
SW-HA02-0-0.5	K1002851-007	03/24/10	Soil	X	
SW-HA02-0.5-1	K1002851-008	03/24/10	Soil	X	
MG-MW02-0-0.5	K1002851-009	03/25/10	Soil	X	
MG-MW02-2-3	K1002851-010	03/25/10	Soil	X	
MG-MW02-0.5-1	K1002851-011	03/25/10	Soil	X	
MG-MW02-5-6	K1002851-012	03/25/10	Soil	X	
MG-MW02-8-9	K1002851-013	03/25/10	Soil	X	
SW-HA05-0-0.5	K1002851-014	03/25/10	Soil	X	
SW-HA05-0.5-1	K1002851-015	03/25/10	Soil	X	
SW-HA06-0-0.5	K1002851-016	03/25/10	Soil	X	
SW-HA06-0.5-1	K1002851-017	03/25/10	Soil	X	
SW-SB02-0-0.5	K1002851-018	03/25/10	Soil	X	
SW-SB02-0.5-1	K1002851-019	03/25/10	Soil	X	

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis	
				Mercury	TPH-Dx
SW-SB02-2-3	K1002851-020	03/25/10	Soil	X	
SW-SB02-5-6	K1002853-001	03/25/10	Soil	X	
SW-SB02-8-9	K1002853-002	03/25/10	Soil	X	
SW-SB02-11-12	K1002853-003	03/25/10	Soil	X	
SW-SB02-14-15	K1002853-004	03/25/10	Soil	X	
SW-SB01-0-0.5	K1002853-005	03/25/10	Soil	X	
SW-SB01-0.5-1	K1002853-006	03/25/10	Soil	X	
SW-SB01-2-3	K1002853-007	03/25/10	Soil	X	
SW-SB01-5-6	K1002853-008	03/25/10	Soil	X	
SW-SB01-8-9	K1002853-009	03/25/10	Soil	X	
PR-MW03-1-2	K1002853-010	03/25/10	Soil	X	
PR-MW03-3-4	K1002853-011	03/25/10	Soil	X	
PR-MW03-7-8	K1002853-012	03/25/10	Soil	X	
PR-MW03-9-10	K1002853-013	03/25/10	Soil	X	
PR-MW03-13-14	K1002853-014	03/25/10	Soil	X	
FD-SW01	K1002853-015	03/25/10	Soil	X	
FD-MG01	K1002853-016	03/25/10	Soil	X	
BC-SB10-5-6	K1002854-001	03/25/10	Soil		X
BC-SB10-9-10	K1002854-002	03/25/10	Soil		X
BC-SB10-13-14	K1002854-003	03/25/10	Soil		X
BC-SB10-15-16	K1002854-004	03/25/10	Soil		X
BC-SB10-16-17	K1002854-005	03/25/10	Soil		X
BC-SB10-18-19	K1002854-006	03/25/10	Soil		X
BC-SB09-1-2	K1002854-007	03/25/10	Soil		X
BC-SB09-3-4	K1002854-008	03/25/10	Soil		X
BC-SB09-5-6	K1002854-009	03/25/10	Soil		X
BC-SB09-7-8	K1002854-010	03/25/10	Soil		X
BC-SB09-9-10	K1002854-011	03/25/10	Soil		X
BC-SB09-13-15	K1002854-012	03/25/10	Soil		X
BC-SB09-18-20	K1002854-013	03/25/10	Soil		X
FD-BC01	K1002854-014	03/25/10	Soil		X

Notes:

X - The analysis was requested and performed on the sample
TPH-Dx – Diesel and motor oil range total petroleum hydrocarbon

Analytical methods in respect to analytical parameters validated herein and the laboratory performing the analyses are summarized below:

Parameter	Analytical Method	Laboratory
Mercury	SW846 Method 7471A	Columbia Analytical Services, Inc. Kelso, WA 98626
TPH-Diesel and Motor Oil	NWTPH-Dx	

Notes:

1. SW846 Methods - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. NWTPH and WDOE Methods - *Analytical Methods for Petroleum Hydrocarbons,* ECY 97-602, Washington State Department of Ecology, June 1997.

DATA VALIDATION FINDINGS

1. Mercury by CVAAS (EPA Method SW7471A)

1.1 Sample Management and Holding Times

Samples were received in the laboratory intact and in consistence with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport.

Soil samples should be analyzed within 28 days of collection for mercury. Samples were analyzed within the required holding time.

1.2 Initial Calibration

For mercury analyses, the method require that (1) a blank and five calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995. The associated initial calibrations met the method requirements.

A check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The results were within the NFGs criteria of 70-130% or the associated results were greater than the two times the method reporting limit (2 x MRL).

1.3 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) were analyzed at the required frequency. The %R values met the control criteria (90 – 110% for mercury).

1.4 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at required frequency. Mercury was not detected in ICBs/CCBs at or above the method detection limit (MDL). Negative detections in ICB/CCBs were evaluated against the associated sample results, and were determined to have no significant effects on sample results.

Preparation Blanks: Method blanks were prepared and analyzed as required. Mercury was not detected in ICBs/CCBs at or above the MDL.

1.5 Laboratory Control Sample (LCS)

LCS analyses were performed at the required frequency. All %R values met the control limits for mercury.

1.6 Duplicate Sample Analysis

Duplicate sample analyses were performed on project samples at the required frequency. The RPD values (or concentration differences) met the control criteria (20% for detections ≥ 5xRL, or ±1xMRL for detections < 5xMRL).

1.7 Matrix Spike (MS)

Matrix spike analyses were performed on project samples as required. All %R values met the project control limits.

1.8 Reporting Limits

The project requirements for quantitation limits were achieved.

1.9 Field Duplicates

Two set of field duplicates were submitted for total mercury analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

1.10 Overall Assessment of Mercury Data Usability

Mercury data are of known quality and acceptable for use, as qualified.

2. TPH-Diesel & Motor Oil (Method NWTPH-Dx)

2.1 Holding Time

Soil samples should be extracted within 14 days of collection, and extracts analyzed within 40 days of extraction. All samples were extracted and analyzed within the recommended holding time.

2.2 Initial Calibration

The methods requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curves were verified with %RSD values of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both diesel and motor oil range total petroleum hydrocarbon (TPH).

2.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift value be within ±15% of the true value.

Calibration verification was performed at required frequency. The percent drift met the ±15% criterion.

2.4 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Motor oil range TPH was not detected at or above the MDLs in the method blank. Diesel range TPH was detected in the method blank at a level less than the method reporting limit (MRL). Sample results less than the MRL or 10x the detection in the method blank were considered affected and qualified as follows:

SDG	Method Blank ID	Analyte	Detection in Blank (mg/kg)	Affected Sample	Original Result (mg/kg)	Adjusted Result (mg/kg)
K1002854	KWG1002742-4	TPH-Diesel	2.2 J	BC-SB09-13-15	9.5 J	**34 U**
				BC-SB09-18-20	3.9 J	**34 U**
				BC-SB09-3-4	5.5 J	**27 U**
				BC-SB09-5-6	11 J	**29 U**
				BC-SB09-7-8	5 J	**33 U**
				BC-SB09-9-10	3.6 J	**31 U**
				BC-SB10-15-16	4.3 J	**32 U**
				BC-SB10-16-17	22 J	**33 U**
				BC-SB10-18-19	5 J	**30 U**
				BC-SB10-5-6	6 J	**27 U**
				BC-SB10-9-10	9.8 J	**31 U**
				FD-BC01	10 J	**35 U**

Note: J – The value is between the MDL and MRL and is an estimated concentration.

2.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits.

2.6 Matrix Duplicate

Matrix duplicate analyses were performed on project samples at the required frequency. The RPD values (or concentration differences if sample concentrations are <5xMRL) met the laboratory control limits.

2.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required. All %R values met the project control limits.

2.8 Target Compound Identification

Sample extracts were cleaned up with acid and silica gel treatment to minimize the biogenic interference with target compound identification, as required by the project. The laboratory reported results as diesel #2 (C12 - C24) and motor oil (C24 - C38), as required by the method. The reported Diesel range TPH were at trace levels (slightly greater than MDLs), except sample BC-SB10-13-14 (mixture of diesel and motor oil range TPH) and sample BC-SB09-1-2 (light-end of motor oil range TPH). The reported motor oil range TPH detections did not resemble the same chromatographic patterns as those of the calibration standards.

2.9 Reporting Limits

The reported MRLs were supported with adequate ICAL concentrations. Sample-specific MDLs and MRLs were adjusted to sample weights and moisture contents. The MDLs for diesel range TPH in most samples were elevated to their MRLs due to the low-level detection in the method blank (see Section 2.4). The sample-specific MRLs remained lower than the project screening level for TPH-Diesel; the project quantitation goals for TPH-diesel and motor oil were achieved.

2.10 Field Duplicates

One set of field duplicates were submitted for TPH-Diesl and TPH-Motor Oil analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

2.11 Overall Assessment of TPH-Diesel and Motor Oil Data Usability

TPH-Diesel and TPH-Motor Oil data are of known quality and acceptable for use as qualified.

SUMMARY

I. Data qualification are summarized as follows:

SDG	Sample ID	Analyte	Data Qualifier	Reason	Report Section
No data qualifiers were assigned to data in this SDG as a result of QC outlier.					

II. Data affected by associated blanks are qualified and results adjusted as follows:

SDG	Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
K1002854	BC-SB09-13-15	TPH-Diesel	9.5 J	**34 U**	**mg/kg**	**2.4**
	BC-SB09-18-20		3.9 J	**34 U**		
	BC-SB09-3-4		5.5 J	**27 U**		
	BC-SB09-5-6		11 J	**29 U**		
	BC-SB09-7-8		5 J	**33 U**		
	BC-SB09-9-10		3.6 J	**31 U**		
	BC-SB10-15-16		4.3 J	**32 U**		
	BC-SB10-16-17		22 J	**33 U**		
	BC-SB10-18-19		5 J	**30 U**		
	BC-SB10-5-6		6 J	**27 U**		
	BC-SB10-9-10		9.8 J	**31 U**		
	FD-BC01		10 J	**35 U**		

III. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.

Approved By: ______________________ Date: ______________

Mingta Lin, Senior Project Chemist

REFERENCES

USEPA Test Methods for Evaluating Solid Waste (SW-846). Third Edition and Revised Update IIIA. Office of Solid Waste and Emergency Response, Washington, D.C. April 1998.

USEPA Analytical Operations/Data Quality Center National Functional Guidelines for Chlorinated Dioxin/Furan Data Review, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, September 2005, EPA 540/R-05-001.

USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, October 2004, EPA 540/R-04/004.

USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, June 2008, EPA-540-R-08-01.

USEPA Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983 and updates.

Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 20th Edition, 1995.

Ecology (Washington State Department of). 1997. Analytical Methods for Petroleum Hydrocarbons. Publication No. ECY 97-602. June 1997.

Aspect Consulting, LLC. Quality Assurance Project Plan, Port of Bellingham Former GP Mill Property RI/FS, Seattle, Washington. September, 2009.

APPENDIX A

A total of three field duplicate samples were collected for various analyses during this sampling event. Field duplicate sample identities and the corresponding parent samples are referenced as follows:

Field Duplicate	Parent Sample ID	SDG	Assigned Analyses
FD-SW01	SW-SB02-0-0.5	K1002853/K1002851	Mercury
FD-MG01	MG-MW02-5-6	K1002853/K1002851	Mercury
FD-BC01	BC-SB09-13-15	K1002854	TPH-Diesel & Motor Oil

The precision criterion (≤ 50%) was applied to evaluating the relative percent difference (RPD) values of field duplicate results greater than five times the MRL (5xMRL). For results less than 5xMRL, an advisory criterion of 2xMRL was applied to evaluating the concentration differences. The RPD and concentration difference values for detected analytes and data qualification are presented as follows:

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
			SW-SB02-0-0.5	**FD-SW01-01**			
Mercury	mg/kg	0.187	3.61	2.32	44%	-	
			MG-MW02-5-6	**FD-MG-01**			
Mercury	mg/kg	0.019	0.482	0.514	6%	-	
			BC-SB09-13-15	**FD-BC-01**			
TPGH-Diesel	mg/kg	34	9.5 J	10 J	-	0.5 mg/kg	
TPH-Motor Oil	mg/kg	140	83 J	120 J	-	37 mg/kg	

Data Validation Report

Port of Bellingham Former GP Mill Property RI/FS
Bellingham, Washington

March & April 2010 Groundwater Sampling

Prepared for:

Aspect Consulting LLC
401 Second Ave South, Suite 201
Seattle, WA 98014

Prepared by:

Pyron Environmental, Inc.
3530 32nd Way, NW
Olympia, WA 98502

June 4, 2010

ACRONYMS

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
AMU	atomic mass unit
BFB	bromofluorobenzene
CAS	Columbia Analytical Services, Inc. – Kelso, Washington
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
Cr (VI)	hexavalent chromium
CVAFS	cold vapor atomic fluorescence spectrometry
DFTPP	decafluorotriphenylphosphine
DOC	dissolved organic carbon
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
Hg	mercury
ICAL	initial calibration
ICB	initial calibration blank
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometry
ICSA	ICP interference check sample solution A
ICSAB	ICP interference check sample solution AB
ICV	initial calibration verification
LCL	laboratory control limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
µg/L	microgram per liter
MDL	method detection limit

MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics and EPA 2004 – Inorganics)
ng/L	nanogram per liter
OPR	ongoing precision and recovery
PAHs	polycyclic aromatic hydrocarbons
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
QCS	quality control sample
RF	response factor
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SIM	selective ion monitoring
TDS	total dissolved solids
TSS	total suspended solids
TPH	total petroleum hydrocarbon
VOCs	volatile organic compounds

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for samples collected during March and April 2010 for the referenced project. The laboratory reports validated herein were submitted by Columbia Analytical Services, Inc. (CAS).

A level III data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines ([NFGs], EPA 2008 – Organics and EPA 2004 – Inorganics) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Aspect, 2009) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	Inorganics	Cr (VI)
EQ Rinse	K1003000-001	03/26/10	EB		X	Hg			
CP-MWB3-032910	K1003000-002	03/29/10	GW			(A)		X	
CP-MWC3-032910	K1003000-003	03/29/10	GW					X	
CP-MWA2-032910	K1003000-004	03/29/10	GW					X	
CP-MWC2-032910	K1003000-005	03/29/10	GW					X	
CP-MWA3-032910	K1003000-006	03/29/10	GW					X	
AMW1-032910	K1003000-007	03/29/10	GW			Hg			
EMW-16S-033010	K1003000-008	03/30/10	GW		X	X	X	TSS	X
EMW-18S-032910	K1003000-009	03/29/10	GW				X	TSS	
MG-MW02-032910	K1003000-010	03/29/10	GW		X		X	TSS	
EMW-6S-032910	K1003000-011	03/29/10	GW				X	TSS	
MG-MW03-032910	K1003000-012	03/29/10	GW		X		X	TSS	
MG-MW01-032910	K1003000-013	03/29/10	GW		X		X	TSS	
LP-MW01-032910	K1003000-014	03/29/10	GW	X					
FD-MW01-032910	K1003000-015	03/29/10	FD	X					
LW-MW01-033010	K1003000-016	03/30/10	GW			X			X
LP-MW01-033010	K1003000-017	03/30/10	GW			X			X
EMW-12S-033010	K1003000-018	03/30/10	GW		X	X	X	TSS	X
GF-MW01-033010	K1003000-019	03/30/10	GW			X(A)			X

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	Inorganics	Cr (VI)
AA-MW01-033010	K1003000-020	03/30/10	GW			X(A)		X	X
FH-MW01-033010	K1003000-021	03/30/10	GW			X(A)		X	X
AA-MW03-033010	K1003000-022	03/30/10	GW			X(A)			X
AA-MW04-033010	K1003000-023	03/30/10	GW			X(A)		X	X
Trip Blank	K1003000-024	03/29/10	TB	X					
CP-MW09-040110	K1003092-001	04/02/10	GW			Hg			
PR-MW01-033010	K1003097-001	03/30/10	GW			Hg			
FD-PR-01-033010	K1003097-002	03/30/10	FD			Hg			
EMW-13S-033010	K1003097-003	03/30/10	GW			Hg			
LAW-1-033110	K1003097-004	03/31/10	GW			Hg		X	
CP-MW03-033110	K1003097-005	03/31/10	GW			Hg		X	
CP-MW05-033110	K1003097-006	03/31/10	GW			Hg			
EMW-7S-033110	K1003097-007	03/31/10	GW			Hg	X	TSS	
EMW-8S-033110	K1003097-008	03/31/10	GW			Hg	X	TSS	
EMW-29D-033110	K1003097-009	03/31/10	GW			Hg			
EMW-6S-033110	K1003097-010	03/31/10	GW		X				
EMW-28D-033110	K1003097-011	03/31/10	GW			Hg			
FD-CP-2-033110	K1003097-012	03/31/10	FD			Hg			
EMW-04S-033110	K1003097-013	03/31/10	GW			Hg			
EMW-1S-033110	K1003097-014	03/31/10	GW			Hg			
CF-MW01-033110	K1003097-015	03/31/10	GW		X	Hg	X	TSS	
FD-CFMG-1-033110	K1003097-016	03/31/10	FD		X	Hg	X	TSS	
CF-MW02-033110	K1003097-017	03/31/10	GW		X	Hg	X	TSS	
PR-MW02-033110	K1003097-018	03/31/10	GW			Hg			
FB-01-040110	K1003097-019	04/01/10	GW			X+Hg(A)			
PR-MW03-040110	K1003097-020	04/01/10	GW			Hg			
BC-MW01-040110	K1003097-021	04/01/10	GW		X	X+Hg(A)	X	TSS	X
BC-MW02-040110	K1003097-022	04/01/10	GW		X	X+Hg(A)	X	TSS	X
FD-AABC-1-040110	K1003097-023	04/01/10	FD		X	X+Hg	X	TSS	X
BC-MW03-040110	K1003097-024	04/01/10	GW		X	X+Hg(A)	X	TSS	X
TS-MW01-040110	K1003097-025	04/01/10	GW			X+Hg(A)			X
LB-MW01-040110	K1003097-026	04/01/10	GW			X+Hg(A)			X
AA-MW02-040110	K1003097-027	04/01/10	GW			X+Hg(A)		X	X
SC-MW02-040110	K1003097-028	04/01/10	GW			X+Hg			X
CP-MW08-040110	K1003097-029	04/01/10	GW			Hg			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis					
				VOCs	PAHs	Metals	TPH	Inorganics	Cr (VI)
EMW-20S-040510	K1003249-001	04/05/10	GW			Hg	X	TSS	
EMW-10S-040510	K1003249-002	04/05/10	GW			Hg			
CP-MW10-040510	K1003249-003	04/05/10	GW			Hg			
CP-MW11-040510	K1003249-004	04/05/10	GW			Hg			
CP-MW02-040510	K1003249-005	04/05/10	GW			Hg			
EMW-14S-040510	K1003249-006	04/05/10	GW			Hg		X	
EMW-02S-040510	K1003249-007	04/05/10	GW			Hg		X	
CP-MW04-040510	K1003249-008	04/05/10	GW			Hg			
CP-MW06-040510	K1003249-009	04/05/10	GW			Hg		X	
EMW-19S-040510	K1003249-010	04/05/10	GW			Hg		X	
CP-MW07-040610	K1003249-011	04/06/10	GW			Hg			
CP-MWB3-040610	K1003249-012	04/06/10	GW			Hg		DOC	
CP-MWC1-040610	K1003249-013	04/06/10	GW			Hg		X	
CP-MWB2-040610	K1003249-014	04/06/10	GW			Hg[(A)]		X+DOC	
CP-MWB1-040610	K1003249-015	04/06/10	GW			Hg[(A)]		X+DOC	
AMW-2-040610	K1003249-016	04/06/10	GW			Hg		X	
CP-MWA1-040610	K1003249-017	04/06/10	GW			Hg[(A)]		X+DOC	
FD-CP-1-040610	K1003249-018	04/06/10	FD			Hg		X+DOC	
CP-MW01-040610	K1003249-019	04/06/10	GW			Hg			
AMW-3-040610	K1003249-020	04/06/10	GW			Hg		X+DOC	
CP-MW12-041310	K1003519-001	04/13/10	GW			Hg		Cond.	

Notes:
X - The analysis was requested and performed on the sample.
PAHs – Polycyclic aromatic hydrocarbons
Metals – Dissolved arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc.
Inorganics – Chloride, sulfate, dissolved calcium, dissolved iron, dissolved magnesium, dissolved potassium, dissolved sodium, alkalinity, total dissolved solids (TDS), and total sulfide.
TSS – Total suspended solids
TPH – Diesel and motor oil range total petroleum hydrocarbon
Hg – The sample was analyzed for dissolved mercury only.
DOC – Dissolved organic carbon
FD – Field duplicate
Cond. – Conductivity
[(A)] – The sample was analyzed for dissolved iron and manganese in addition.

The analytical parameters requested for the samples, the respective analytical methods, and the analytical laboratories are summarized below:

Parameter	**Analytical Method**	**Analytical Laboratory**
Volatile Organic Compounds (VOCs)	SW846 Method 8260B	Columbia Analytical Services, Inc. (CAS) Kelso, Washington
Polycyclic Aromatic Hydrocarbons (PAHs)	SW846 Method 8270C-SIM	
TPH-Diesel & Motor Oil	NWTPH-Dx	
Dissolved Calcium, Iron, Magnesium, Manganese, Potassium, & Sodium	SW846 Method 6010B	
Dissolved Metals	SW846 Method 6020	
Mercury	EPA Method 1631E	
Alkalinity (Total as Carbonate)	SM Method 2320B	
Chloride & Sulfate	EPA Method 300.0	
Total Dissolved Solids (TDS)	SM Method 2540 C	
Total Suspended Solids (TSS)	SM Method 2540 D	
Sulfide	SM Method 4500-S2-D	
Hexavalent Chromium (Cr [VI])	SW846 Method 7196A	
Dissolved Organic Carbon (DOC)	SM Method 5310 C	
Conductivity	SM Method 2510 B	

Notes:

1. SW846 - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. EPA Methods - *USEPA Methods for Chemical Analysis of Water and Wastes,* EPA–600/4-79-020, March 1983 Revision.
3. EPA Method 1631E - *Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry,* Office of Water, U.S. Environmental Protection Agency, August 2002, EPA-821-R-02-019.
4. SM – Standard *Methods for the Examination of Water and Wastewater*, American Public Health Association, 20th Edition, 1995.
5. Dissolved Metals – Dissolved arsenic, cadmium, chromium, copper, lead, nickel, and zinc.

DATA VALIDATION FINDINGS

1. VOCs by GC/MS (EPA Method SW8260B)

1.1 Sample Management and Holding Time

Samples were received in the laboratory intact and in consistence with the accompanying chain-of-custody (COC) documentation. No anomalies were identified in relation to sample preservation, handling, and transport.

Water samples should be analyzed within 14 days of collection. All samples were analyzed within the required holding time.

1.2 GC/MS Instrument Performance Check

Bromofluorobenzene (BFB) tuning was performed within each 12-hour interval. All required ion abundance ratios met the method requirements.

1.3 Initial Calibration

The National Functional Guidelines (NFGs) require that the percent relative standard deviation (%RSD) be <30% and the average response factor (RF) be > 0.01 for poor response compounds and >0.05 for all other compounds.

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.99. Initial calibration for all target compounds except for the following:

SDG	Initial Calibration ID	Analyte	Exceedance	Affected Sample	Data Qualification
K1003000	Instrument MS04 ICAL: 9329	1,2-Dibromo-3-chloropropane 2-Butanone 2-Hexanone 4-Methyl-2-pentanone Naphthalene *p*-Isopropyltoluene Styrene *tert*-Butylbenzene	%RSD >15%	None	No action. The analyte was not detected in any samples at or above the MDL.

1.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the percent difference (%D) be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds.

Calibration verification analyses were performed at the required frequency. The calibration verification %D values either met the criteria for all target compounds or at levels that had no significant effects on data quality (*e.g.,* high recovery where the analyte was not detected).

1.5 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the method detection limits (MDLs) in the method blanks or at levels that had no significant effects on data quality (*e.g.,* sample concentration >10x the level found in method blank).

Trip Blank: Target compounds were not detected at or above MDLs in trip blanks, excerpt for the following:

Trip Blank ID (SDG)	Analyte	Blank Detection (µg/L)	Affected Sample	Original Result (µg/L)	Adjusted Result (µg/L)
Trip Blank (K1003000)	Toluene	0.21 J	FD-MW01-032910 LP-MW01-032910	0.16 J 0.11 J	**0.5 U** **0.5 U**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

1.6 Laboratory Control Sample

LCS and LCS duplicate (LCSD) were prepared and analyzed as required by the method. All percent recovery (%R) and relative percent difference (RPD) values met the project control criteria.

1.7 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits.

1.8 Matrix Spike and Matrix Spike Duplicate

MS/MSD analyses were not performed on the project sample in this SDG. Analytical precision and accuracy was evaluated with the LCS and LCSD results (see Section 1.6).

1.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

1.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and MRLs were adjusted with sample amount extracted and MRLs were supported with adequate initial calibration concentrations. The project requirements for quantitation limits were achieved.

1.11 Field Duplicates

One set of field duplicates were submitted for VOCs analyses. Field duplicate results for detected target compounds, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

1.12 Overall Assessment of VOCs Data Usability

VOCs data are of known quality and acceptable for use, as qualified.

2. PAHs by GC/MS - SIM (EPA Method SW8270C)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be extracted within 7 days of collection. Extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

DFTPP tuning was performed within each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The NFGs criteria require that the %RSD be <30% and the average RRF be >0.05 for all target compounds.

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.99. The initial calibration met the criteria, except for the following:

SDG	Initial Calibration ID	Analyte	Exceedance	Affected Sample	Data Qualification
K1003097	Instrument MS11 ICAL: 9400	Pyrene	%RSD = 25.9% (>15%)	BC-MW01-040110	**J**

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds. Calibration verification analyses met the criteria or the %D value was at a level that had no adverse effects on data quality (*e.g.,* biased-high recovery for an analyte that was not detected in associated samples).

2.5 Method Blanks

Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the MDLs in the method blanks.

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were either within the project control limits or at levels that had no adverse effects on data quality (*e.g.,* biased-high recovery for analytes that were not detected in samples).

2.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were not performed on the project sample in these SDGs. Analytical precision and accuracy was evaluated with the LCS and LCSD results (see Section 2.8).

2.8 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed with each analytical batch. All %R and RPD values were within the project control limits.

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and MRLs were adjusted with sample amount extracted and MRLs were supported with adequate initial calibration concentrations.

2.11 Field Duplicates

Two sets of field duplicates were submitted for PAHs analyses. Field duplicate results for detected target compounds, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

2.12 Overall Assessment of PAHs Data Usability

PAHs data are of known quality and acceptable for use, as qualified.

3. Metals by ICP, ICP/MS, and CVAFS (EPA Methods SW6010/6020 and 1631)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be analyzed within 180 days for metals and 28 days for mercury. Samples were analyzed within the required holding times.

3.2 ICP/MS Tuning

Instrument tuning was performed at the required frequency. The stability check (%RSD <5%), mass calibration (mass difference <0.1 AMU), and resolution check (peak width <1.0 AMU at 5% peak height) met the method criteria.

3.3 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury (CVAFS) analyses, the methods require that (1) a blank and five calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995 or %RSD ≤15%. The associated initial calibrations met the method requirements.

A check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The results were within the NFGs criteria of 70-130% or the associated results were greater than the 2x MRLs.

3.4 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) or Ongoing Precision Recovery (OPR) samples (for Method 1631E) were analyzed at the required frequency. The %R values met the method control criteria.

3.5 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at required frequency. Target analytes were either not detected in ICBs/CCBs at or above the method detection limits (MDLs), or at levels that had no significant effects (sample results > 5x the calibration blank detection) on associated sample results.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were either not detected in the method blanks at or above the MDLs, or at levels that had no significant effects (sample results >5x the method blank detection) on associated sample results, except for the following:

SDG	Preparation Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result	Adjusted Result	Unit
K1003000	MB1	Dissolved Cadmium	0.12 J	GF-MW01-033010	0.012 J	**0.067 U**	µg/L
K1003000	MB2	Dissolved Copper	0.03 J	EMW-16S-033010	0.042 J	**0.333 U**	µg/L
K1003097	MB1	Dissolved Cadmium	0.011 J	BC-MW02-040110 FD-AABC-1-040110 BC-MW03-040110 FB-01-040110[(A)]	0.012 J 0.016 J 0.014 J 0.013 J	**0.067 U** **0.067 U** **0.067 U** **0.02 U**	µg/L
K1003097	MB1	Dissolved Lead	0.035 J	BC-MW02-040110 SC-MW02-040110 FB-01-040110[(A)]	0.045 J 0.042 J 0.016 J	**0.10 U** **0.10 U** **0.02 U**	µg/L
K1003097	MB2	Dissolved Chromium	0.02 J	FB-01-040110	0.07 J	**0.20 U**	µg/L
K1003097	MB2	Dissolved Copper	0.03 J	FB-01-040110	0.07 J	**0.10 U**	µg/L
K1003097	MB2	Dissolved Iron	12.2 J	LB-MW01-040110	19.0 J	**100 U**	µg/L
K1003097	MB2	Dissolved Nickel	0.03 J	FB-01-040110	0.03 J	**0.20 U**	µg/L
K1003097	MB3	Dissolved Mercury	0.09 J	EMW-8S-033110 EMW-04S-033110	0.46 J 0.94 J	**1.0 U** **1.0 U**	ng/L
K1003249	MB2	Dissolved Mercury	0.19 J	EMW-10S-040510 CP-MW07-040610 FB-01-040110	0.53 J 0.72 J 0.21 J	**1.0 U** **1.0 U** **1.0 U**	ng/L
K1003519	MB1 MB2	Dissolved Mercury	0.17 J 0.18 J	CP-MW12-041310	0.34 J	**1.0 U**	ng/L

Note:
J – The value was at a level between the MDL and MRL, and considered as estimated.
[(A)] – Cadmium and lead detected in sample FB-01-040110 were determined as affected by MB1 (although not associated) based on the trends that these two metals consistently appeared in laboratory blanks.

Filtration Blank: Sample FB-01-040110 was a filtration blank sample used to evaluate if any target metals were introduced via the filtration procedures during dissolved metals sampling. Arsenic, cadmium, chromium, copper, lead, nickel, and zinc were detected in this samples at levels between their MDLs and MRLs. Among which, cadmium, chromium, copper, lead, and nickel were determined as a laboratory background based on the method blank results (see **Preparation Blank** as discussed above). For the remaining detected metals, results for all groundwater samples collected in this sampling event (March and April 2010) were evaluated against the filtration balnk results. Groundwater sample results less than their MRLs or 5x the concentration in the filtration blank were considered affected. Affected results not yet qualified above are qualified as follows:

SDG	Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result (µg/L)	Adjusted Results (µg/L)
K1003000	FB-01-040110	Dissolved Arsenic	0.3 J	AA-MW01-033010 AA-MW03-033010 EMW-16S-033010 LP-MW01-033010	0.3 J 0.4 J 0.17 J 1.1	**0.5 U** **0.5 U** **1.67 U** **1.1 J**
K1003000	FB-01-040110	Dissolved Zinc	0.4 J	AA-MW01-033010 EMW-12S-033010 GF-MW01-033010 LP-MW01-033010	0.5 1 0.32 J 0.5	**0.5 U** **1.0 J** **1.67 U** **0.5 U**
K1003097	FB-01-040110	Dissolved Arsenic	0.3 J	AA-MW02-040110 BC-MW01-040110 BC-MW02-040110 BC-MW03-040110 FB-01-040110 FD-AABC-1-040110 LB-MW01-040110 TS-MW01-040110	0.2 J 1.5 0.66 J 0.15 J 0.3 J 0.61 J 0.4 J 0.5 J	**0.5 U** **1.5 J** **1.67 U** **1.67 U** **0.5 U** **1.67 U** **0.5 U** **0.5 U**
K1003097	FB-01-040110	Dissolved Zinc	0.4 J	AA-MW02-040110 BC-MW01-040110 BC-MW02-040110 BC-MW03-040110 FB-01-040110 FD-AABC-1-040110 LB-MW01-040110 SC-MW02-040110 TS-MW01-040110	0.6 0.9 1.18 J 0.47 J 0.4 J 0.69 J 0.6 0.37 J 0.3 J	**0.6 J** **0.9 J** **1.67 U** **1.67 U** **0.5 U** **1.67 U** **0.6 J** **1.67 U** **0.5 U**

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

3.6 ICP Interference Check Sample (ICS)

The method requires that (1) an inter-element interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several analytes were detected in the ICSA initial analyses at low levels. Since the concentrations in the associated samples were less than 50% of the interferant concentrations in ICSA samples, no action was taken. The %D values for analytes in ICSAB were within ± 20% of the true value or the interferant concentrations in the associated samples were less than 50% of the ICSAB concentrations.

3.7 Laboratory Control Sample (LCS) and Quality Control Samples (QCS)

LCS or QCS (as named in Method 1631E) analyses were performed at the required frequency. All %R values met the control limits (80 – 120%/20%) for all target analytes.

3.8 Duplicate Sample Analysis

Duplicate sample (matrix spike duplicates for mercury) analyses were performed on project samples at the required frequency. The RPD values (or concentration differences) met the control criteria (20% for detections ≥ 5xRL, ±1xMRL for detections < 5xMRL).

3.9 Matrix Spike (MS)

Matrix spike analyses were performed on project samples as required. All %R values met the laboratory control limits, or native analyte concentrations in the samples were greater than 4x the spiked levels and the %R values were inapplicable for matrix effect evaluation.

3.10 Serial Dilution

Serial dilution analyses were performed on project samples at the required frequency for ICP metals and mercury. All %D values for positive results greater than 50X MDL were within 10%.

3.11 Internal Standards

At least three internal standards were added to all samples and QC analyses. All percent relative intensity values were within the Functional Guidelines criterion (60 - 125% of those of the calibration blank).

3.12 Analyte Quantitation and Reporting Limits

The project requirements for quantitation limits were achieved. Six samples, EMW-16S-033010, GF-MW01-033010, BC-MW02-040110, FD-AABC-1-040110, BC-MW03-040110, and SC-MW02-040110, appeared to be brackish (based on the sample conductivity values and laboratory screening), which prevented optimal analytical results of dissolved metals using the ICP/MS technique (EPA Method 6020) as the project planned. A chemical separation procedure (reductive precipitation) was applied to reduce the brackish interference. Dissolved metals MRLs were adjusted with sample volumes available for the procedure (*i.e.,* 300 mL available volume vs. ideal volume of 1000 mL); the MRLs were proportionally raised from the project quantitation goals for these samples.

3.13 Field Duplicates

One set of field duplicate for dissolved metals and five sets for dissolved mercury were submitted for analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

3.14 Overall Assessment of Metals Data Usability

Metals data are of known quality and acceptable for use, as qualified.

4. TPH-Diesel & Motor Oil (Methods NWTPH-Dx)

4.1 Holding Time

Water samples should be extracted within 7 days of collection, and extracts analyzed within 40 days of extraction. All samples were extracted and analyzed within the recommended holding time.

4.2 Initial Calibration

The methods requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curves were verified with %RSD values of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both diesel and motor oil range total petroleum hydrocarbon (TPH).

4.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift (%D_f) value be within ±15% of the true value.

Calibration verification was performed at required frequency. The %D_f values were either within the ±15% criterion or at levels that had no adverse effects on data quality (e.g., high-bias %D_f value where the target compound was not detected in associated sample).

4.4 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the MDLs in the method blanks or at levels that had no significant effects on associated sample results (sample >10x detections in the method blank), except for the following:

SDG	Method Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result (µg/L)	Adjusted Result (µg/L)
K1003000	KWG1003089-3	TPH-Diesel	17 J	EMW-12S-033010 EMW-18S-032910 EMW-6S-032910 MG-MW01-032910 MG-MW02-032910 MG-MW03-032910	29 J 21 J 25 J 46 J 26 J 200 J	**250 U** **250 U** **260 U** **260 U** **260 U** **320 U**
K1003249	KWG1003089-3	TPH-Diesel	17 J	EMW-20S-040510	26 J	**250 U**

4.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits, outside the control limits due to matrix interference, or diluted below quantitation limits due to high analyte concentrations. In all cases, no data qualification was required.

4.6 Matrix Duplicate

Matrix duplicate analyses were performed on project samples at the required frequency. The RPD values (or concentration differences if sample concentrations are <5xMRL) met the laboratory control limits, except for the following:

4.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required. All %R values met the project control limits.

4.8 Target Compound Identification

Sample extracts were cleaned up with acid and silica gel treatment to minimize the biogenic interference with target compound identification, as required by the project. The laboratory reported results as diesel #2 (C12 - C24) and motor oil (C24 - C38), as required by the method.

4.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations. Sample-specific MDLs and MRLs were adjusted to sample weight and moisture content.

4.10 Field Duplicates

Two sets of field duplicates were submitted for TPH-Diesl and TPH-Motor Oil analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

4.11 Overall Assessment of TPH-Diesel and Motor Oil Data Usability

TPH-Diesel and TPH-Motor Oil data are of known quality and acceptable for use as qualified.

5. Alkalinity, TDS, TSS, Chloride, Sulfate, Cr (VI), Conductivity, DOC, and Sulfide

5.1 Holding Times

The samples were analyzed within the required holding times of 24 hours for conductivity and Cr (VI); seven days for total dissolved solids (TDS) and total suspended solids (TSS); 14 days for alkalinity, sulfide, and dissolved organic carbon (DOC); and 28 days for chloride and sulfate. All analyses were performed within the required holding times.

5.2 Initial Calibration

Initial calibration (ICAL) is required for chloride, sulfate, Cr (VI), and sulfide analyses. The initial calibration correlation coefficients were ≥0.995 and met the method requirements for these parameters.

5.3 Initial and Continuing Calibration Verification

Initial calibration verification (ICV) and continuing calibration verification (CCV) analyses were performed at the required frequency for all inorganic constituents. All percent recovery values were within the control limits of 90 – 110%.

5.4 Blanks

Calibration Blanks: ICBs and CCBs were analyzed at the required frequency. Target analytes were either not detected at or above the MDLs in ICBs and CCBs, or at levels that had no significant effects on sample results.

Method Blanks: Method blanks were analyzed at the required frequency. Target analytes were either not detected at or above the MDLs in method blanks, or at levels that had no significant effects on sample results.

5.5 Duplicate Sample Analysis

Duplicate analyses were performed for all inorganic constituents on project samples. All RPD or concentration difference values met the laboratory control criteria.

5.6 Matrix Spike (MS)

Matrix spike analyses were performed at the required frequency (some on batch QC samples). All %R values were within the laboratory control limits.

5.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required by the methods. All %R values were within the laboratory control limits.

5.8 Field Duplicates

One set of field duplicates were submitted for inorganic constituent analyses. Field duplicate results, RPD or concentration difference values, and data qualification are presented in **Appendix A**.

5.9 Laboratory Reporting Limits

Most groundwater samples contained elevated levels of chloride and, in some cases, sulfate that heavily interfered with the quantitation of other anions, particularly nitrite and nitrate. The MRLs were thus raised for affected anions in these cases.

5.10 Overall Assessment of Inorganic Constituents Data

Inorganic constituents data are of known quality and acceptable for use as qualified.

SUMMARY

I. Data qualification is summarized as follows:

SDG	Sample ID	Analyte	Data Qualifier	Reason	Report Section
K1003097	BC-MW01-040110	Pyrene	J	Initial calibration %RSD value did not meet the linearity criterion of 15%.	**2.3**
K1003000	FD-CFMG-1-033110 CF-MW01-033110	Dissolved Mercury TSS	J	The field duplicate result did not meet field precision evaluation criteria.	**Appendix A**
K1003249	FD-CP-1-040610 CP-MWA1-040610	Dissolved Mercury	J	The field duplicate result did not meet field precision evaluation criteria.	**Appendix A**

II. Data affected by associated blanks are qualified and results adjusted as follows:

SDG	Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
K1003000	FD-MW01-032910 LP-MW01-032910	Toluene	0.16 J 0.11 J	**0.5 U** **0.5 U**	**µg/L**	**1.5 TB**
K1003000	GF-MW01-033010	Dissolved Cadmium	0.012 J	**0.067 U**	µg/L	**3.5 MB**
K1003000	EMW-16S-033010	Dissolved Copper	0.042 J	**0.333 U**	µg/L	**3.5 MB**
K1003097	BC-MW02-040110 FD-AABC-1-040110 BC-MW03-040110 FB-01-040110	Dissolved Cadmium	0.012 J 0.016 J 0.014 J 0.013 J	**0.067 U** **0.067 U** **0.067 U** **0.02 U**	µg/L	**3.5 MB**
K1003097	BC-MW02-040110 SC-MW02-040110 FB-01-040110	Dissolved Lead	0.045 J 0.042 J 0.016 J	**0.10 U** **0.10 U** **0.02 U**	µg/L	**3.5 MB**
K1003097	FB-01-040110	Dissolved Chromium	0.07 J	**0.20 U**	µg/L	**3.5 MB**
K1003097	FB-01-040110	Dissolved Copper	0.07 J	**0.10 U**	µg/L	**3.5 MB**
K1003097	LB-MW01-040110	Dissolved Iron	19.0 J	**100 U**	µg/L	**3.5 MB**
K1003097	FB-01-040110	Dissolved Nickel	0.03 J	**0.20 U**	µg/L	**3.5 MB**

SDG	Sample ID	Analyte	Original Result	Adjusted Result	Unit	Report Section
K1003097	EMW-8S-033110 EMW-04S-033110	Dissolved Mercury	0.46 J 0.94 J	**1.0 U** **1.0 U**	ng/L	**3.5** **MB**
K1003249	EMW-10S-040510 CP-MW07-040610 FB-01-040110	Dissolved Mercury	0.53 J 0.72 J 0.21 J	**1.0 U** **1.0 U** **1.0 U**	ng/L	**3.5** **MB**
K1003519	CP-MW12-041310	Dissolved Mercury	0.34 J	**1.0 U**	ng/L	**3.5** **MB**
K1003000	AA-MW01-033010 AA-MW03-033010 EMW-16S-033010 LP-MW01-033010	Dissolved Arsenic	0.3 J 0.4 J 0.17 J 1.1	**0.5 U** **0.5 U** **1.67 U** **1.1 J**	µg/L	**3.5** **FB**
K1003000	AA-MW01-033010 EMW-12S-033010 GF-MW01-033010 LP-MW01-033010	Dissolved Zinc	0.5 1 0.32 J 0.5	**0.5 U** **1.0 J** **1.67 U** **0.5 U**	µg/L	**3.5** **FB**
K1003097	AA-MW02-040110 BC-MW01-040110 BC-MW02-040110 BC-MW03-040110 FB-01-040110 FD-AABC-1-040110 LB-MW01-040110 TS-MW01-040110	Dissolved Arsenic	0.2 J 1.5 0.66 J 0.15 J 0.3 J 0.61 J 0.4 J 0.5 J	**0.5 U** **1.5 J** **1.67 U** **1.67 U** **0.5 U** **1.67 U** **0.5 U** **0.5 U**	µg/L	**3.5** **FB**
K1003097	AA-MW02-040110 BC-MW01-040110 BC-MW02-040110 BC-MW03-040110 FB-01-040110 FD-AABC-1-040110 LB-MW01-040110 SC-MW02-040110 TS-MW01-040110	Dissolved Zinc	0.6 0.9 1.18 J 0.47 J 0.4 J 0.69 J 0.6 0.37 J 0.3 J	**0.6 J** **0.9 J** **1.67 U** **1.67 U** **0.5 U** **1.67 U** **0.6 J** **1.67 U** **0.5 U**	µg/L	**3.5** **FB**
K1003000	EMW-12S-033010 EMW-18S-032910 EMW-6S-032910 MG-MW01-032910 MG-MW02-032910 MG-MW03-032910	TPH-Diesel	29 J 21 J 25 J 46 J 26 J 200 J	**250 U** **250 U** **260 U** **260 U** **260 U** **320 U**	µg/L	**4.4** **MB**
K1003249	EMW-20S-040510	TPH-Diesel	26 J	**250 U**	µg/L	**4.4** **MB**

III. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: ______________________________ Date: ____________________

Mingta Lin, Senior Project Chemist

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APPENDIX A

A total of six field duplicate samples were collected for various analyses during this sampling event. Field duplicate sample identities and the corresponding parent samples are referenced as follows:

Field Duplicate	Parent Sample ID	SDG	Assigned Analyses
FD-MW01-032910	LP-MW01-032910	K1003000	VOCs
FD-PR-01-033010	PR-MW01-033010	K1003097	Dissolved Mercury
FD-CP-2-033110	EMW-28D-033110	K1003097	Dissolved Mercury
FD-CFMG-1-033110	CF-MW01-033110	K1003097	Dissolved Mercury, TSS, TPH-Diesel & Motor Oil, PAHs
FD-AABC-1-040110	BC-MW02-040110	K1003097	Dissolved Mercury, TSS, TPH-Diesel & Motor Oil, PAHs Dissolved Metals, Cr (VI)
FD-CP-1-040610	CP-MWA1-040610	K1003249	Dissolved Mercury, Inorganics, DOC

The precision criterion (≤ 35%) was applied to evaluating the relative percent difference (RPD) values of field duplicate results greater than five times the MRL (5xMRL). For results less than 5xMRL, an advisory criterion of 2xMRL was applied to evaluating the concentration differences. The RPD and concentration difference values for detected analytes and data qualification are presented as follows:

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
			FD-MW01-032910	**LP-MW01-032910**			
1,1-Dichloroethane	µg/L	0.5	0.24	0.34	-	0.1	
Chloroform	µg/L	0.5	0.2	0.2	-	0	
Chloromethane	µg/L	0.5	0.07	0.08	-	0.01	
cis-1,2-Dichloroethene	µg/L	0.5	0.17	0.27	-	0.1	
Tetrachloroethene (PCE)	µg/L	0.5	6.2	6.5	5%	-	
Toluene	µg/L	0.5	0.16	0.11	-	0.05	
Trichloroethene (TCE)	µg/L	0.5	0.28	0.33	-	0.05	
Vinyl chloride	µg/L	0.5	0.5	0.11	-	0.39	
			FD-PR-01-033010	**PR-MW01-033010**			
Dissolved Mercury	ng/L	1.0	11.8	14.3	19%	-	
			FD-CP-2-033110	**EMW-28D-033110**			
Dissolved Mercury	ng/L	1	3.74	1.99	-	1.75	
			FD-CFMG-1-033110	**CF-MW01-033110**			
Dissolved Mercury	ng/L	1	4.9	2.21	-	2.69	**J/J**
TPH-Diesel	µg/l	260	30 J	29 J	-	1	
Total Suspended Solids	mg/l	5	242	129	61%	-	**J/J**
2-Methylnaphthalene	µg/L	0.02	0.0062 J	0.02 J	-	0.0138	
Acenaphthene	µg/L	0.02	0.039	0.038	-	0.001	

Detected Analyte	Unit	MRL	Field Duplicate ID & Concentration		RPD (%)	Conc. Difference	Data Qualifier
Fluoranthene	µg/L	0.02	0.046	0.042	-	0.004	
Fluorene	µg/L	0.02	0.018 J	0.018 J	-	0	
Naphthalene	µg/L	0.02	0.027	0.062	-	0.035	
Phenanthrene	µg/L	0.02	0.049	0.045	-	0.004	
Pyrene	µg/L	0.02	0.027	0.022	-	0.005	
			FD-AABC-1-040110	**BC-MW02-040110**			
Dissolved Mercury	ng/L	1	0.36 J	0.58 J	-	0.22	
TPH-Diesel	µg/L	250	30 J	28 J	-	2	
TPH-Motor Oil	µg/L	500	32 J	21 J	-	11	
Total Suspended Solids	mg/L	5	11.5	14	-	2.5	
Arsenic	µg/L	1.67	0.61 J	0.66 J	-	0.05	
Cadmium	µg/L	0.067	0.016 J	0.012 J	-	0.004	
Chromium	µg/L	0.67	2.3	3.03	27%	-	
Copper	µg/L	0.333	0.121 J	0.232 J	-	0.111	
Lead	µg/L	0.1	ND	0.045 J	-	0.045	
Nickel	µg/L	1.67	0.47 J	0.1 J	-	0.37	
Zinc	µg/L	1.67	0.69 J	1.18 J	-	0.49	
Chromium (VI)	µg/L	0.05	ND	ND	-	0	
Acenaphthene	µg/L	0.095	11	10	10%	-	
Benz(a)anthracene	µg/L	0.019	0.013 J	0.011 J	-	0.002	
Benzo(b)fluoranthene	µg/L	0.019	0.014 J	ND	-	0.005	
Benzo(g,h,i)perylene	µg/L	0.019	0.0075 J	ND	-	0.0075	
Chrysene	µg/L	0.019	0.0069 J	0.0065 J	-	0.0004	
Dibenzo(a,h)anthracene	µg/L	0.019	ND	ND	-	0	
Dibenzofuran	µg/L	0.019	0.019	0.017	-	0.002	
Fluoranthene	µg/L	0.019	0.077	0.068	-	0.009	
Indeno(1,2,3-cd)pyrene	µg/L	0.019	0.006 J	ND	-	0.006	
Naphthalene	µg/L	0.019	0.028	0.032	-	0.004	
Pyrene	µg/L	0.019	0.11	0.1	-	0.01	
			FD-CP-1-040610	**CP-MWA1-040610**			
Dissolved Mercury	ng/L	2000	9610	14300	-	4690	**J/J**
Chloride	mg/l	100	1780	2160	19%	-	
Sulfate	mg/l	10	51	62	19%	-	
Alkalinity, Total as CaCO3	mg/l	50	11800	13400	13%	-	
Total Dissolved Solids	mg/l	5	24100	27700	14%	-	
Sulfide	mg/L	10	269	296	10%	-	
Dissolved Organic Carbon	mg/L	50	2320	2270	2%	-	
Calcium	µg/L	250	6520	6110	6%	-	
Magnesium	µg/L	100	132	135	-	3	
Potassium	µg/L	2000	64600	61000	6%	-	
Sodium	µg/L	10000	8070000	7740000	4%	-	

Note:
mg/L – milligram per liter
µg/L – microgram per liter
ng/L – nanogram per liter
Conc. Difference – Concentration difference between the parent sample and the field duplicate
MRL – Method reporting limit
ND – Not detected at or above the method detection limit
RPD – Relative percent difference

Data Validation Report

Port of Bellingham Former GP Mill Property RI/FS
Bellingham, Washington

December 2010 Soil Sampling

Prepared for:

Aspect Consulting LLC
401 Second Ave South, Suite 201
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Prepared by:

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March 21, 2011

ACRONYMS

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
CAS	Columbia Analytical Services, Inc. – Kelso, Washington
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
CVAA	cold vapor atomic absorption
CVAFS	cold vapor atomic fluorescence spectrometry
DFTPP	decafluorotriphenylphosphine
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
Hg	mercury
ICAL	initial calibration
ICB	initial calibration blank
ICP	inductively coupled plasma
ICSA	ICP interference check sample solution A
ICSAB	ICP interference check sample solution AB
ICV	initial calibration verification
LCL	laboratory control limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
µg/kg	microgram per kilogram
MDL	method detection limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate

NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics and EPA 2004 – Inorganics)
ng/g	nanogram per gram
OPR	ongoing precision and recovery
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyl
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
QCS	quality control sample
RF	response factor
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SIM	selective ion monitoring
TCLP	toxicity characteristics leaching procedure
TOC	total organic carbon
TPH	total petroleum hydrocarbon

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for samples collected during December 2010 for the referenced project. The laboratory reports validated herein were submitted by Columbia Analytical Services, Inc. (CAS).

A level III data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines ([NFGs], EPA 2008 – Organics and EPA 2004 – Inorganics) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Aspect, 2009) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Hg	TPH	TOC	EPH
L1-MW03-4-5	K1014096-001	12/15/10	Soil		X			
L1-MW03-7-9	K1014096-002	12/15/10	Soil		X			
L1-MW03-11-12	K1014096-003	12/15/10	Soil		X			
L1-MW03-13-14	K1014096-004	12/15/10	Soil		X			
L1-MW03-15-16	K1014096-005	12/15/10	Soil		X			
FD-L1-1	K1014096-006	12/15/10	FD		X			
L1-MW05-3-5	K1014096-007	12/15/10	Soil		X			
L1-MW05-7-9	K1014096-008	12/15/10	Soil		X			
L1-MW05-11-12	K1014096-009	12/15/10	Soil		X			
L1-MW05-13-14	K1014096-010	12/15/10	Soil		X			
L1-MW05-16-18	K1014096-011	12/15/10	Soil		X			
L1-MW01-3-4	K1014096-012	12/16/10	Soil		X			
L1-MW01-7-9	K1014096-013	12/16/10	Soil		X			
L1-MW01-11-13	K1014096-014	12/16/10	Soil		X			
L1-MW01-14-15	K1014096-015	12/16/10	Soil		X			
FD-L1-2	K1014096-016	12/16/10	FD		X			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Hg	TPH	TOC	EPH
L1-MW04-3-4	K1014096-017	12/16/10	Soil		X			
L1-MW04-5-7	K1014096-018	12/16/10	Soil		X			
L1-MW04-8-10	K1014096-019	12/16/10	Soil		X			
L1-MW04-10-12	K1014096-020	12/16/10	Soil		X			
L1-MW04-13-15	K1014098-001	12/16/10	Soil		X			
CP-MW13-1-2	K1014098-002	12/16/10	Soil		X			
CP-MW13-2-3	K1014098-003	12/16/10	Soil		X			
CP-MW13-4-5	K1014098-004	12/16/10	Soil		X			
CP-MW13-8-9	K1014098-005	12/16/10	Soil		X			
CP-MW13-12-14	K1014098-006	12/16/10	Soil		X			
CP-MW13-15-16	K1014098-007	12/16/10	Soil		X			
L1-MW02-4-5	K1014098-008	12/17/10	Soil		X			
L1-MW02-7-9	K1014098-009	12/17/10	Soil		X			
L1-MW02-11-12	K1014098-010	12/17/10	Soil		X			
L1-MW02-13-14	K1014098-011	12/17/10	Soil		X			
L1-MW02-16-17	K1014098-012	12/17/10	Soil		X			
FD-L1-3	K1014098-013	12/17/10	FD		X			
BC-MW05-15-16	K1014099-001	12/17/10	Soil	X		X		
BC-MW05-18-19	K1014099-002	12/17/10	Soil			X		
BC-MW04-3-4	K1014099-003	12/17/10	Soil			X		
BC-MW04-6-7	K1014099-004	12/17/10	Soil	X		X		
BC-MW04-9-10	K1014099-005	12/17/10	Soil			X		
BC-MW04-11-12	K1014099-006	12/17/10	Soil			X	X	
BC-MW04-15-16	K1014099-007	12/17/10	Soil	X		X		
BC-MW04-18-19	K1014099-008	12/17/10	Soil			X		
FD-MW04-10	K1014099-009	12/17/10	FD	X		X		
MG-MW05-2-3	K1014099-010	12/16/10	Soil	X		X		
MG-MW05-5-6	K1014099-011	12/16/10	Soil			X	X	
MG-MW05-7-8	K1014099-012	12/16/10	Soil			X		
MG-MW05-9-10	K1014099-013	12/16/10	Soil	X		X		
MG-MW05-11-12	K1014099-014	12/16/10	Soil			X		
FD-MG-10	K1014099-015	12/16/10	FD	X		X		
BC-MW05-3-4	K1014099-016	12/17/10	Soil			X		
BC-MW05-7-8	K1014099-017	12/17/10	Soil	X		X		

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Hg	TPH	TOC	EPH
BC-MW05-9-10	K1014099-018	12/17/10	Soil			X		
BC-MW05-12-13	K1014099-019	12/17/10	Soil			X		
CP-MW14-3-4	K1014260-001	12/21/10	Soil		X			
CP-MW14-5-6	K1014260-002	12/21/10	Soil		X			
CP-MW14-8-9	K1014260-003	12/21/10	Soil		X			
CP-MW14-14-15	K1014260-004	12/21/10	Soil		X			
CP-MW14-17-18	K1014260-005	12/21/10	Soil		X			
CP-SB09-2-3	K1014260-006	12/21/10	Soil		X			
CP-SB09-4-5	K1014260-007	12/21/10	Soil		X			
CP-SB09-5-6	K1014260-008	12/21/10	Soil		X			
CP-SB09-8-9	K1014260-009	12/21/10	Soil		X			
CP-SB09-12-14	K1014260-010	12/21/10	Soil		X			
CP-SB02-1-2	K1014260-011	12/21/10	Soil		X			
CP-SB02-3-4	K1014260-012	12/21/10	Soil		X			
CP-SB02-5-6	K1014260-013	12/21/10	Soil		X			
CP-SB02-9-10	K1014260-014	12/21/10	Soil		X			
CP-SB02-17-18	K1014260-015	12/21/10	Soil		X			
CP-SB11-3-5	K1014260-016	12/21/10	Soil		X			
CP-SB11-5-6	K1014260-017	12/21/10	Soil		X			
CP-SB11-7-9	K1014260-018	12/21/10	Soil		X			
CP-SB11-12-14	K1014261-001	12/21/10	Soil		X			
CP-SB11-15-16	K1014261-002	12/21/10	Soil		X			
CP-SB13-2-4	K1014261-003	12/21/10	Soil		X			
CP-SB13-5-6	K1014261-004	12/21/10	Soil		X			
CP-SB13-8-9	K1014261-005	12/21/10	Soil		X			
CP-SB13-12-13	K1014261-006	12/21/10	Soil		X			
CP-SB13-15-16	K1014261-007	12/21/10	Soil		X			
CP-SB06-2-3	K1014261-008	12/21/10	Soil		X			
CP-SB06-4-5	K1014261-009	12/21/10	Soil		X			
CP-SB06-5-6	K1014261-010	12/21/10	Soil		X			
CP-SB06-6-8	K1014261-011	12/21/10	Soil		X			
CP-SB06-19-20	K1014261-012	12/21/10	Soil		X			
CP-SB05-1-2	K1014261-013	12/21/10	Soil		X			
CP-SB05-3-4	K1014261-014	12/21/10	Soil		X			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Hg	TPH	TOC	EPH
CP-SB05-4-5	K1014261-015	12/21/10	Soil		X			
CP-SB05-8-9	K1014261-016	12/21/10	Soil		X			
CP-SB05-12-14	K1014261-017	12/21/10	Soil		X			
CP-MW15-4-5	K1014261-018	12/20/10	Soil		X			
CP-MW15-5-6	K1014261-019	12/20/10	Soil		X			
CP-MW15-6-8	K1014261-020	12/20/10	Soil		X			
FD-CP-14	K1014262-001	12/20/10	FD		X			
FD-CP-16	K1014262-002	12/21/10	FD		X			
FD-CP-17	K1014262-003	12/21/10	FD		X			
FD-CP-18	K1014262-004	12/21/10	FD		X			
FD-CP-19	K1014262-005	12/21/10	FD		X			
FD-CP-20	K1014262-006	12/21/10	FD		X			
FD-CP-31	K1014262-007	12/21/10	FD		X			
MG-SB11-9-10	K1014263-001	12/20/10	Soil	X		X		
MG-SB11-12-13	K1014263-002	12/20/10	Soil			X		
MG-SB13-2-3	K1014263-003	12/20/10	Soil			X	X	
MG-SB13-5-6	K1014263-004	12/20/10	Soil	X		X		
MG-SB13-7-8	K1014263-005	12/20/10	Soil			X		X
MG-SB13-9-10	K1014263-006	12/20/10	Soil	X		X		
MG-SB13-12-13	K1014263-007	12/20/10	Soil			X		
MG-SB14-2-3	K1014263-008	12/20/10	Soil			X	X	
MG-SB14-5-6	K1014263-009	12/20/10	Soil			X		
MG-SB14-7-8	K1014263-010	12/20/10	Soil			X		
MG-SB14-9-10	K1014263-011	12/20/10	Soil	X		X		
MG-SB14-12-13	K1014263-012	12/20/10	Soil	X		X		X
MG-SB15-3-4	K1014263-013	12/20/10	Soil			X	X	
MG-SB15-5-6	K1014263-014	12/20/10	Soil			X		
MG-SB15-7-8	K1014263-015	12/20/10	Soil	X		X		
MG-SB15-9-10	K1014263-016	12/20/10	Soil			X		X
MG-SB15-12-13	K1014263-017	12/20/10	Soil			X		
MG-SB16-2-3	K1014263-018	12/20/10	Soil			X		
MG-SB16-5-6	K1014263-019	12/20/10	Soil			X		
MG-SB16-7-8	K1014263-020	12/20/10	Soil	X		X	X	
MG-SB16-9-10	K1014264-001	12/20/10	Soil	X		X		

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Hg	TPH	TOC	EPH
MG-SB16-12-13	K1014264-002	12/20/10	Soil			X	X	
FD-BC-23	K1014264-003	12/21/10	FD			X		
FD-BC-24	K1014264-004	12/21/10	FD			X		
FD-MG-21	K1014264-005	12/20/10	FD			X		
FD-MG-22	K1014264-006	12/20/10	FD			X		
FD-MG-25	K1014264-007	12/20/10	FD			X		
FD-CP-11	K1014264-008	12/20/10	FD		X			
FD-CP-12	K1014264-009	12/20/10	FD		X			
FD-CP-13	K1014264-010	12/20/10	FD		X			
MG-SB12-6-7	K1014264-012	12/22/10	Soil	X		X		X
MG-SB12-8-9	K1014264-013	12/22/10	Soil			X		
MG-SB12-10-11	K1014264-014	12/22/10	Soil	X		X		
MG-SB12-12-13	K1014264-015	12/22/10	Soil			X		
MG-SB12-13-14	K1014264-016	12/22/10	Soil			X		
FD-MG-26	K1014264-017	12/22/10	FD	X		X		
BC-SB13-3-4	K1014265-001	12/21/10	Soil			X		
BC-SB13-6-7	K1014265-002	12/21/10	Soil	X		X		
BC-SB13-9-10	K1014265-003	12/21/10	Soil	X		X		
BC-SB13-12-13	K1014265-004	12/21/10	Soil			X	X	
BC-SB13-14-15	K1014265-005	12/21/10	Soil			X		
BC-SB13-16-17	K1014265-006	12/21/10	Soil			X		
BC-SB12-3-4	K1014265-007	12/21/10	Soil			X		
BC-SB12-6-7	K1014265-008	12/21/10	Soil			X		
BC-SB12-9-10	K1014265-009	12/21/10	Soil	X		X		
BC-SB12-12-13	K1014265-010	12/21/10	Soil	X		X		
BC-SB12-14-15	K1014265-011	12/21/10	Soil			X		
BC-SB12-16-17	K1014265-012	12/21/10	Soil			X		
CP-MW15-10-11	K1014265-013	12/20/10	Soil		X	X		
CP-MW15-12-14	K1014265-014	12/20/10	Soil		X	X		
MG-MW04-2-3	K1014265-015	12/17/10	Soil			X		
MG-MW04-6-7	K1014265-016	12/17/10	Soil			X	X	
MG-MW04-7-8	K1014265-017	12/17/10	Soil	X		X		
MG-MW04-9-10	K1014265-018	12/17/10	Soil			X		
MG-MW04-11-12	K1014265-019	12/17/10	Soil	X		X		

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Hg	TPH	TOC	EPH
MG-SB11-2-3	K1014265-020	12/20/10	Soil			X		
MG-SB11-5-6	K1014265-021	12/20/10	Soil			X		
MG-SB11-7-8	K1014265-022	12/20/10	Soil	X		X	X	
BC-SB11-3-4	K1014322-001	12/22/10	Soil	X		X		
BC-SB11-6-7	K1014322-002	12/22/10	Soil	X		X		
BC-SB11-9-10	K1014322-003	12/22/10	Soil			X		
BC-SB11-12-13	K1014322-004	12/22/10	Soil			X		
BC-SB11-15-16	K1014322-005	12/22/10	Soil			X		
BC-SB11-18-19	K1014322-006	12/22/10	Soil			X		
BC-SB14-2-3	K1014322-007	12/22/10	Soil			X		
BC-SB14-6.5-7.5	K1014322-008	12/22/10	Soil			X		
BC-SB14-8-9	K1014322-009	12/22/10	Soil			X		
BC-SB14-9-10	K1014322-010	12/22/10	Soil	X		X		
BC-SB14-12-13	K1014322-011	12/22/10	Soil	X		X		
BC-SB14-15-16	K1014322-012	12/22/10	Soil			X		
BC-SB14-18-19	K1014322-013	12/22/10	Soil			X		
BC-SB15-2-3	K1014322-014	12/23/10	Soil			X		
BC-SB15-6.5-7.5	K1014322-015	12/23/10	Soil	X		X		
BC-SB15-9-10	K1014322-016	12/23/10	Soil	X		X		
BC-SB15-12-13	K1014322-017	12/23/10	Soil			X		
BC-SB15-15-16	K1014322-018	12/23/10	Soil			X		
BC-SB15-18-19	K1014322-019	12/23/10	Soil			X		
BC-SB16-3-4	K1014322-020	12/22/10	Soil			X	X	
BC-SB16-6-7	K1014322-021	12/22/10	Soil	X		X		
BC-SB16-9-10	K1014322-022	12/22/10	Soil	X		X		
BC-SB16-10-11	K1014322-023	12/22/10	Soil			X		
BC-SB16-12-13	K1014322-024	12/22/10	Soil			X		
BC-SB16-14-15	K1014322-025	12/22/10	Soil			X		
BC-SB17-3-4	K1014322-026	12/22/10	Soil			X	X	
BC-SB17-4-5	K1014322-027	12/22/10	Soil			X		
BC-SB17-6-7	K1014322-028	12/22/10	Soil			X		
BC-SB17-8-9	K1014322-029	12/22/10	Soil	X		X		X
BC-SB17-9-10	K1014322-030	12/22/10	Soil	X		X		
BC-SB18-3-4	K1014322-031	12/22/10	Soil			X		

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Hg	TPH	TOC	EPH
BC-SB18-6-7	K1014322-032	12/22/10	Soil			X	X	
BC-SB18-9-10	K1014322-033	12/22/10	Soil	X		X		X
BC-SB18-12-13	K1014322-034	12/22/10	Soil			X		
BC-SB18-14-15	K1014322-035	12/22/10	Soil	X		X		
BC-SB18-18-19	K1014322-036	12/22/10	Soil			X		
BC-SB19-3-4	K1014322-037	12/22/10	Soil			X	X	
BC-SB19-6-7	K1014322-038	12/22/10	Soil	X		X		
BC-SB19-9-10	K1014322-039	12/22/10	Soil			X		
BC-SB19-12-13	K1014322-040	12/22/10	Soil	X		X		
BC-SB19-17-18	K1014322-041	12/22/10	Soil			X		
BC-SB19-18-19	K1014322-042	12/22/10	Soil			X		
BC-SB20-7-8	K1014322-043	12/22/10	Soil	X		X		
BC-SB20-14.5-15	K1014322-044	12/22/10	Soil			X		
BC-SB20-19-20	K1014322-045	12/22/10	Soil	X		X		
FD-CP39	K1014323-001	12/22/10	FD		X			
FD-CP15	K1014323-002	12/22/10	FD		X			
FD-CP30	K1014323-003	12/22/10	FD		X			
FD-BC35	K1014323-004	12/22/10	FD			X		
FD-BC36	K1014323-005	12/22/10	FD			X		
FD-BC37	K1014323-006	12/22/10	FD			X		
FD-BC38	K1014323-007	12/22/10	FD			X		
FD-BC39	K1014323-008	12/22/10	FD			X		
FD-BC40	K1014323-009	12/22/10	FD			X		
FD-BC41	K1014323-010	12/22/10	FD			X		
CP-SB08-1-2	K1014323-011	12/23/10	Soil		X			
CP-SB08-2-3	K1014323-012	12/23/10	Soil		X			
CP-SB08-4-5	K1014323-013	12/23/10	Soil		X			
CP-SB08-8-9	K1014323-014	12/23/10	Soil		X			
CP-SB08-12-14	K1014323-015	12/23/10	Soil		X			
CP-SB10-5-6	K1014323-016	12/22/10	Soil		X			
CP-SB10-6-7	K1014323-017	12/22/10	Soil		X			
CP-SB10-8-9	K1014323-018	12/22/10	Soil		X			
CP-SB10-12-13	K1014323-019	12/22/10	Soil		X			
CP-SB10-14-15	K1014323-020	12/22/10	Soil		X			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Hg	TPH	TOC	EPH
CP-SB12-0.5-1	K1014323-021	12/23/10	Soil		X			
CP-SB12-5-6	K1014323-022	12/23/10	Soil		X			
CP-SB12-9-10	K1014323-023	12/23/10	Soil		X			
CP-SB12-12-13	K1014323-024	12/23/10	Soil		X			
CP-SB12-15-16	K1014323-025	12/23/10	Soil		X			
CP-SB09-5-6	K1014323-026	12/21/10	Soil					
CP-SB02-5-6	K1014323-027	12/21/10	Soil					
CP-SB13-15-16	K1014323-028	12/21/10	Soil					
Concrete Cutting Slurry	K1014323-031	12/23/10	Solid		1631			
Cuttings-MG-BC Areas	K1014323-032	12/23/10	Solid	X	**A**	X		
Cuttings-CP Area	K1014323-033	12/23/10	Soil	X	**A**	X		
CP-SB03-2-3	K1014323-034	12/22/10	Soil		X			
CP-SB03-4-5	K1014323-035	12/22/10	Soil		X			
CP-SB03-8-9	K1014323-036	12/22/10	Soil		X			
CP-SB03-11.5-12	K1014323-037	12/22/10	Soil		X			
CP-SB04-2-3	K1014323-038	12/22/10	Soil		X			
CP-SB04-4-5	K1014323-039	12/22/10	Soil		X			
CP-SB04-5-6	K1014323-040	12/22/10	Soil		X			
CP-SB07-3-4	K1014323-041	12/22/10	Soil		X			
CP-SB07-4-5	K1014323-042	12/22/10	Soil		X			
CP-SB07-6.5-7.5	K1014323-043	12/22/10	Soil		X			
CP-SB07-8-9	K1014323-044	12/22/10	Soil		X			
MG-SB12-2-3	K1014323-045	12/22/10	Soil			X		

Notes:
X - The analysis was requested and performed on the sample.
A – The sample was analyzed for total and toxicity characteristics leaching procedure (TCLP) metals (arsenic, barium, cadmium, chromium, mercury, lead, selenium, and silver), PCB Aroclors, and PCB Congeners.
TPH – Diesel and motor oil range total petroleum hydrocarbon
PAHs – Polycyclic aromatic hydrocarbons
Hg – Mercury
FD – Field duplicate
EPH – Extractable petroleum hydrocarbon
1631 – The sample was analyzed for mercury with EPA Method 1631 (as opposed to SW846 Method 7471A).

The analytical parameters requested for the samples, the respective analytical methods, and the analytical laboratories are summarized below:

Parameter	Analytical Method	Analytical Laboratory
Polycyclic Aromatic Hydrocarbons (PAHs)	SW846 Method 8270C-SIM	Columbia Analytical Services, Inc. Kelso, WA
TPH-Diesel & Motor Oil	NWTPH-Dx	
Total Metals	SW846 Methods 6010B/7471A	
TCLP Metals	SW846 Methods 1311/6010B/7470A	
Mercury (one solid sample)	EPA Method 1631E	
Mercury	SW846 Method 7471A	
PCB Aroclors	SW846 Method 8082A	
PCB Congeners	SW846 Method 8082	
Total Organic Carbon (TOC)	ASTM D4129-82M	
EPH	NWTPH-EPH	Analytical Resources, Inc. Tukwila, WA

Notes:

1. SW846 - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. EPA Methods - *USEPA Methods for Chemical Analysis of Water and Wastes,* EPA–600/4-79-020, March 1983 Revision.
3. EPA Method 1631E - *Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry,* Office of Water, U.S. Environmental Protection Agency, August 2002, EPA-821-R-02-019.
4. ASTM – American Society of Testing and Materials

DATA VALIDATION FINDINGS

1. EPH by GC/FID-PID (Method NWTPH-EPH)

1.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport. Soil samples should be extracted within 14 days and extracts analyzed within 40 days. All samples were extracted and analyzed within the required holding times.

1.2 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 20% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.990. Initial calibration met the criteria for all target compounds.

An initial calibration verification (ICV) analysis was performed immediately after the initial calibrations and before any analyses of samples. The %D value for the ICV met the method control limit of 80 – 120%.

1.3 Calibration Verification

Continuing calibration verification (CCV) analyses were performed at the required frequency for all analytical sequences as required by the method. The %D values for all CCVs met the method criterion (±20%).

1.4 Method Blanks

Method blanks were prepared and analyzed as required. No target compounds were detected at or above the method detection limits (MDLs) in the method blanks.

1.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits.

1.6 Matrix Spike and Matrix Spike Duplicate

MS/MSD analyses were performed on project samples in these SDGs. Analytical precision and accuracy was evaluated based on the LCS/LCSD results.

1.7 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required by the method. All %R and RPD values met the laboratory control limits.

1.8 Method Reporting Limits (MRLs)

The reported sample-specific MRLs met the project requirements.

1.9 Field Duplicates

No field duplicates were submitted for EPH analysis in these SDGs.

1.10 Overall Assessment of EPH Data Usability

EPH data are of known quality and acceptable for use, as qualified.

2. PAHs by GC/MS - SIM (EPA Method SW8270C)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be extracted within 7 days of collection. Extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

DFTPP tuning was performed within each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The NFGs criteria require that the %RSD be <30% and the average RRF be >0.05 for all target compounds.

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.99. The initial calibration met the criteria.

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds. Calibration verification analyses met the criteria or the %D value was at a level that had no adverse effects on data quality (*e.g.,* biased-high recovery for an analyte that was not detected in associated samples).

2.5 Method Blanks

Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the MDLs in the method blanks, or sample results were greater than five times the detection in the method blank, except for the following:

Method Blank ID	Target Compound	Detect in Blank	Affected Sample	Original Result	Adjusted Result	Unit
KWG1013923-5	Dibenzo(a,h)anthracene	0.81 J	BC-MW04-15-16 MG-MW05-9-10	1.7 J 3.5 J	**4.2 U** **3.6 U**	µg/kg
KWG1013923-5	Naphthalene	1.5 J	BC-MW05-7-8	3 J	**3.5 U**	µg/kg
KWG1014160-5	Naphthalene	0.84 J	BC-SB13-6-7	1.4 J	**2.8 U**	µg/kg

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were either within the project control limits or at levels that had no adverse effects on data quality (*e.g.,* biased-high recovery for analytes that were not detected in samples). In some cases surrogate spike %R values were inapplicable for data evaluation because the samples contained high levels of target PAHs; no data were qualified on this basis.

2.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample BC-SB20-19-20. All %R and RPD values were within laboratory control limits, except that the MSD %R (133%) and RPD value (42%) were outside the control limits for phenanthrene. The phenanthrene result for sample BC-SB20-19-20 was qualified (J) as estimated.

2.8 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed with each analytical batch. All %R and RPD values were within the project control limits.

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and MRLs were adjusted with sample amount extracted and MRLs were supported with adequate initial calibration concentrations.

2.11 Field Duplicates

Three sets of field duplicates were submitted for PAHs analyses. Field duplicate results for detected target compounds, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

2.12 Overall Assessment of PAHs Data Usability

PAHs data are of known quality and acceptable for use, as qualified.

3. Total & TCLP Metals by ICP; Mercury by CVAFS & CVAA (SW846 Methods 6010B & SW1311/6010B, 1631, 7470, & 7471A)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Soil samples should be analyzed within 180 days for total ICP metals and 28 days for mercury. TCLP samples should be extracted and analyzed within 180 days for ICP metals and 28 days for mercury. Samples were analyzed within the required holding times.

3.2 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury (CVAFS) analyses, the methods require that (1) a blank and five calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995 or %RSD ≤15%. The associated initial calibrations met the method requirements.

A check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The results were within the NFGs criteria of 70-130% or the associated results were greater than the 2x MRLs.

3.3 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) or Ongoing Precision Recovery (OPR) samples (for Method 1631E) were analyzed at the required frequency. The %R values met the method control criteria.

3.4 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at required frequency. Target analytes were either not detected in ICBs/CCBs at or above the method detection limits (MDLs), or at levels that had no significant effects (sample results > 10x the calibration blank detection) on associated sample results, except for the following:

Blank ID	Analyte	Detect in Blank	Affected Sample	Original Result	Adjusted Result	Unit
CCB	TCLP/Arsenic	0.01 J	Cuttings-MG-BC Areas Cuttings-CP Area	0.01 J 0.03 J	**0.1 U** **0.1 U**	mg/L

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were either not detected in the method blanks at or above the MDLs, or at levels that had no significant effects (sample results >10x the method blank detection) on associated sample results.

Blank ID	Analyte	Detect in Blank	Affected Sample	Original Result	Adjusted Result	Unit
K1014323-MB1	TCLP/Barium	0.3 J	Cuttings-CP Area Cuttings-MG-BC Areas	0.46 J 0.71 J	**1 U** **1 U**	mg/L

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

3.5 ICP Interference Check Sample (ICS)

The method requires that (1) an inter-element interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several analytes were detected in the ICSA initial analyses at low levels. Since the concentrations in the associated samples were less than 50% of the interferant concentrations in ICSA samples, no action was taken. The %D values for analytes in ICSAB were within ± 20% of the true value or the interferant concentrations in the associated samples were less than 50% of the ICSAB concentrations.

3.6 Laboratory Control Sample (LCS) and Quality Control Samples (QCS)

LCS or QCS (as named in Method 1631E) analyses were performed at the required frequency. All %R values met the control limits (80 – 120%/20%) for all target analytes.

3.7 Duplicate Sample Analysis

Duplicate sample (matrix spike duplicates for mercury) analyses were performed on project samples at the required frequency. Triplicate analyses for mercury were performed selected samples. The RPD values (or concentration differences) met the control criteria (20% for detections ≥ 5xRL, ±1xMRL for detections < 5xMRL) for duplicate ,analyses and %RSD <20% for triplicate analyses, except for the following:

Parent Sample ID	Analyte	RPD %RSD	Control Limit	Affected Sample	Data Qualification
FD-CP-17	Mercury	RPD = 54.4% %RSD = 39%	RPD = 30% %RSD = 20%	FD-CP-17	**J**
CP-SB06-6-8	Mercury	%RSD = 39%	%RSD = 20%	CP-SB06-6-8	**J**
FD-CP-11	Mercury	RPD = 45.2%	RPD = 30%	FD-CP-11	**J**

3.8 Matrix Spike (MS)

Matrix spike analyses were performed on project samples as required. All %R values met the laboratory control limits, or native analyte concentrations in the samples were greater than 4x the spiked levels and the %R values were inapplicable for matrix effect evaluation, except for the following:

Parent Sample ID	Analyte	MS %R	Control Limit	Affected Sample	Data Qualification
Cuttings-CP Area	Total Chromium	205.5%	75-125%	Cuttings-CP Area Cuttings-MG-BC Areas	J

3.9 Serial Dilution

Serial dilution analyses were performed on project samples at the required frequency for ICP metals and mercury. All %D values for positive results greater than 50X MDL were within 10%.

3.10 Analyte Quantitation and Reporting Limits

Reported sample-specific MRLs met the project requirements.

3.11 Field Duplicates

One set of field duplicate for dissolved metals and five sets for dissolved mercury were submitted for analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

3.12 Overall Assessment of Metals Data Usability

Metals data are of known quality and acceptable for use, as qualified.

4. TPH-Diesel & Motor Oil (Methods NWTPH-Dx)

4.1 Holding Time

Soil samples should be extracted within 14 days of collection, and extracts analyzed within 40 days of extraction. All samples were extracted and analyzed within the recommended holding time.

4.2 Initial Calibration

The methods requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curves were verified with %RSD values of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both TPH-Diesel and TPH-Motor Oil.

4.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift (%D_f) value be within ±15% of the true value.

Calibration verification was performed at required frequency. The %D_f values were either within the ±15% criterion or at levels that had no adverse effects on data quality (e.g., high-bias %D_f value where the target compound was not detected in associated sample).

4.4 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. TPH-Diesel and TPH-Oil were consistently present in method blanks at levels greater than their MDLs but less than MRLs. Associated sample results that were greater than MDLs but less than their MRLs were qualified (U) as non-detects at their MRLs. Qualified data are summarized in **SUMMARY** section.

4.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits, outside the control limits due to matrix interference, or diluted below quantitation limits due to high analyte concentrations. No data qualifying actions were taken in these cases.

4.6 Matrix Duplicate

Matrix duplicate analyses were performed on project samples at the required frequency. The RPD values (or concentration differences if sample concentrations are <5xMRL) met the laboratory control limits, except that the TPH-Oil RPD value (78%) for the duplicate analyses performed on sample BC-SB19-17-18 was outside the control criteria. The TPH-Oil result for sample BC-SB19-17-18 was qualified (J) as estimated.

4.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required. All %R values met the project control limits.

4.8 Target Compound Identification

Sample extracts were cleaned up with acid and silica gel treatment to minimize the biogenic interference with target compound identification, as required by the project. The laboratory reported results as diesel #2 (C12 - C24) and motor oil (C24 - C38), as required by the method.

4.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations. Sample-specific MDLs and MRLs were adjusted to sample weight and moisture content.

4.10 Field Duplicates

Two sets of field duplicates were submitted for TPH-Diesel and TPH-Motor Oil analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

4.11 Overall Assessment of TPH-Diesel and Motor Oil Data Usability

TPH-Diesel and TPH-Motor Oil data are of known quality and acceptable for use as qualified.

5. Total Organic Carbon (TOC)

5.1 Holding Times

Soil samples should be analyzed within 28 days of collection. All samples were analyzed within the required holding time.

5.2 Initial Calibration

Initial calibration (ICAL) was performed as required. The initial calibration correlation coefficients were ≥0.995 and met the method requirements.

5.3 Initial and Continuing Calibration Verification

Initial calibration verification (ICV) and continuing calibration verification (CCV) analyses were performed at the required frequency. All percent recovery values were within the control limits of 90 – 110%.

5.4 Blanks

Calibration Blanks: ICBs and CCBs were analyzed at the required frequency. TOC was not detected at or above the MDLs in ICBs and CCBs.

Method Blanks: Method blanks were analyzed at the required frequency. TOC was not detected at or above the MDLs in method blanks.

5.5 Duplicate Sample Analysis

Duplicate analyses were performed for all inorganic constituents on project samples. All RPD or concentration difference values met the laboratory control criteria.

5.6 Matrix Spike (MS)

Matrix spike analyses were performed at the required frequency (some on batch QC samples). All %R values were within the laboratory control limits.

5.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required by the methods. All %R values were within the laboratory control limits.

5.8 Field Duplicates

Field duplicates were not submitted for TOC analyses in these SDGs.

5.9 Laboratory Reporting Limits

The MRLs met the project requirements.

5.10 Overall Assessment of TOC Data

TOC data are of known quality and acceptable for use.

6. Polychlorinated Biphenyl (PCB) Aroclors and Congeners (EPA Method 8082)

6.1 Holding Times

Soil samples should be extracted within 14 days of collection, and extracts analyzed within 40 days of extraction for PCB Aroclors and Congeners analyses. All samples were extracted and analyzed within the required holding times.

6.2 Initial Calibration

For PCB Aroclors, the method requires that (1) a minimum of 5-point calibration be performed using the mixture of Aroclor 1016 and 1260, (2) a single-point calibration be performed for the other five Aroclors to establish calibration factors (CFs) and for Aroclor pattern recognition, (3) at least 3 peaks (preferably 5 peaks) must be chosen for each Aroclor for characterization, (4) %RSD values of Aroclor 1016 and 1260 CFs must be ≤ 20%, and (5) if dual column analysis is chosen, both columns should meet the requirements. For PCB congeners, the method requirements for individual Aroclor 1016 or Aroclor 1260 peaks apply to individual congener.

The laboratory chose internal calibration approach to establishing initial calibration curve; all %RSD values were ≤20%. The initial calibrations met the method requirements.

6.3 Calibration Verification

The method requires that (1) the initial calibration be verified prior to any analysis for each 12-hour analysis sequence, and (2) the percent drift (%D_f) be within ±15% to demonstrate the linearity of the initial calibration.

Calibration verification analyses were performed at the required frequency. The %D values either met the criteria or the outliers had no effects on associated data (*e.g.,* biased-high %D value for a compound not detected in the samples).

6.4 Method Blanks

Method blanks were prepared and analyzed as required. No target analytes were detected at or above their respective MDLs in the method blank.

6.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits.

6.6 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were performed on sample Cuttings-CP Area. The %R values for selected PCB congeners were greater than the upper control limits in the MS/MSD analyses, indicating potential high bias of results for these compounds. These congeners were not detected in the parent sample; data qualifying action was not required.

6.7 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed as required by the method. The %R values met the laboratory control limits.

6.8 Reporting Limits

The MRLs met the project requirements.

6.9 Internal Standards

The laboratory chose internal calibration approach to quantitating target compounds. According to SW846 Method 8000, internal standard retention times were to be within the ±0.5 minute window of the associated standard in all samples. All internal standard intensity was to be within –50% to +100% of the associated standard. No anomalies were found in relation to internal standards.

6.10 Target Compound Identification

Dual column RPD values for selected compounds in samples Cuttings-CP Area and Cuttings-MG-BC Areas were greater than 40%, indicating a significant variability on the reported values; these results were qualified (J) as estimated.

6.11 Overall Assessment of PCB Aroclors Data Usability

Based on the information submitted by the laboratory, PCB Aroclors data are of known quality and acceptable for use, as qualified.

SUMMARY

I. Data qualification is summarized as follows:

Laboratory ID	Sample ID	Analyte	Adjusted Result	Qualifier	Qualified Reason
K1014323-033	Cuttings-CP Area	PCB 105		J	Dual Column RPD>40%
K1014323-032	Cuttings-MG-BC Areas	PCB 151		J	Dual Column RPD>40%
K1014323-032	Cuttings-MG-BC Areas	PCB 153		J	Dual Column RPD>40%
K1014323-032	Cuttings-MG-BC Areas	PCB 18		J	Dual Column RPD>40%
K1014323-032	Cuttings-MG-BC Areas	PCB 206		J	Dual Column RPD>40%
K1014323-032	Cuttings-MG-BC Areas	PCB 37		J	Dual Column RPD>40%
K1014323-032	Cuttings-MG-BC Areas	PCB 66		J	Dual Column RPD>40%
K1014323-033	Cuttings-CP Area	PCB 153		J	Dual Column RPD>40%
K1014323-033	Cuttings-CP Area	PCB 156		J	Dual Column RPD>40%
K1014323-033	Cuttings-CP Area	PCB 169		J	Dual Column RPD>40%
K1014323-033	Cuttings-CP Area	PCB 177		J	Dual Column RPD>40%
K1014323-033	Cuttings-CP Area	PCB 18		J	Dual Column RPD>40%
K1014323-033	Cuttings-CP Area	PCB 37		J	Dual Column RPD>40%
K1014323-033	Cuttings-CP Area	PCB 44		J	Dual Column RPD>40%
K1014323-033	Cuttings-CP Area	PCB 66		J	Dual Column RPD>40%
K1014322-041	BC-SB19-17-18	TPH-Oil		J	Laboratory duplicate analyses RPD >35%
K1014322-001	BC-SB11-3-4	TPH-Oil		J	Field duplicate imprecision
K1014322-039	BC-SB19-9-10	TPH-Oil		J	Field duplicate imprecision
K1014323-007	FD-BC38	TPH-Oil		J	Field duplicate imprecision
K1014323-008	FD-BC39	TPH-Oil		J	Field duplicate imprecision
K1014261-011	CP-SB06-6-8	Mercury		J	Field duplicate imprecision
K1014262-003	FD-CP-17	Mercury		J	Field duplicate imprecision
K1014323-003	FD-CP30	Mercury		J	Field duplicate imprecision
K1014323-034	CP-SB03-2-3	Mercury		J	Field duplicate imprecision
K1014099-010	MG-MW05-2-3	Acenaphthene		J	Field duplicate imprecision
K1014099-015	FD-MG-10	Acenaphthene		J	Field duplicate imprecision
K1014099-010	MG-MW05-2-3	Dibenzofuran		J	Field duplicate imprecision
K1014099-015	FD-MG-10	Dibenzofuran		J	Field duplicate imprecision
K1014099-010	MG-MW05-2-3	Fluorene		J	Field duplicate imprecision
K1014099-015	FD-MG-10	Fluorene		J	Field duplicate imprecision
K1014261-018	CP-MW15-4-5	Mercury		J	Laboratory duplicate analyses RPD >30% & field duplicate imprecision
K1014264-008	FD-CP-11	Mercury		J	Laboratory duplicate analyses RPD >30% & field duplicate imprecision
K1014323-032	Cuttings-MG-BC Areas	Arsenic	0.1 mg/L	U	Analyte was detected in CCB

Laboratory ID	Sample ID	Analyte	Adjusted Result	Qualifier	Qualified Reason
K1014323-033	Cuttings-CP Area	Arsenic	0.1 mg/L	U	Analyte was detected in CCB
K1014099-002	BC-MW05-18-19	TPH-Diesel	32 mg/kg	U	Analyte was detected in method blank
K1014099-007	BC-MW04-15-16	TPH-Diesel	42 mg/kg	U	Analyte was detected in method blank
K1014099-008	BC-MW04-18-19	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014099-013	MG-MW05-9-10	TPH-Diesel	36 mg/kg	U	Analyte was detected in method blank
K1014099-017	BC-MW05-7-8	TPH-Diesel	35 mg/kg	U	Analyte was detected in method blank
K1014099-018	BC-MW05-9-10	TPH-Diesel	37 mg/kg	U	Analyte was detected in method blank
K1014099-019	BC-MW05-12-13	TPH-Diesel	34 mg/kg	U	Analyte was detected in method blank
K1014263-001	MG-SB11-9-10	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014263-004	MG-SB13-5-6	TPH-Diesel	270 mg/kg	U	Analyte was detected in method blank
K1014263-009	MG-SB14-5-6	TPH-Diesel	290 mg/kg	U	Analyte was detected in method blank
K1014263-011	MG-SB14-9-10	TPH-Diesel	29 mg/kg	U	Analyte was detected in method blank
K1014263-015	MG-SB15-7-8	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014263-016	MG-SB15-9-10	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014263-018	MG-SB16-2-3	TPH-Diesel	140 mg/kg	U	Analyte was detected in method blank
K1014263-019	MG-SB16-5-6	TPH-Diesel	160 mg/kg	U	Analyte was detected in method blank
K1014263-020	MG-SB16-7-8	TPH-Diesel	34 mg/kg	U	Analyte was detected in method blank
K1014264-002	MG-SB16-12-13	TPH-Diesel	32 mg/kg	U	Analyte was detected in method blank
K1014264-003	FD-BC-23	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014264-004	FD-BC-24	TPH-Diesel	31 mg/kg	U	Analyte was detected in method blank
K1014265-001	BC-SB13-3-4	TPH-Diesel	27 mg/kg	U	Analyte was detected in method blank
K1014265-002	BC-SB13-6-7	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014265-004	BC-SB13-12-13	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014265-006	BC-SB13-16-17	TPH-Diesel	29 mg/kg	U	Analyte was detected in method blank
K1014265-007	BC-SB12-3-4	TPH-Diesel	27 mg/kg	U	Analyte was detected in method blank
K1014265-008	BC-SB12-6-7	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014265-010	BC-SB12-12-13	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014265-011	BC-SB12-14-15	TPH-Diesel	36 mg/kg	U	Analyte was detected in method blank
K1014265-012	BC-SB12-16-17	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014265-016	MG-MW04-6-7	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014265-020	MG-SB11-2-3	TPH-Diesel	220 mg/kg	U	Analyte was detected in method blank
K1014265-021	MG-SB11-5-6	TPH-Diesel	170 mg/kg	U	Analyte was detected in method blank
K1014322-003	BC-SB11-9-10	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014322-004	BC-SB11-12-13	TPH-Diesel	33 mg/kg	U	Analyte was detected in method blank
K1014322-005	BC-SB11-15-16	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014322-006	BC-SB11-18-19	TPH-Diesel	29 mg/kg	U	Analyte was detected in method blank
K1014322-010	BC-SB14-9-10	TPH-Diesel	32 mg/kg	U	Analyte was detected in method blank
K1014322-011	BC-SB14-12-13	TPH-Diesel	32 mg/kg	U	Analyte was detected in method blank
K1014322-012	BC-SB14-15-16	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014322-013	BC-SB14-18-19	TPH-Diesel	29 mg/kg	U	Analyte was detected in method blank

Laboratory ID	Sample ID	Analyte	Adjusted Result	Qualifier	Qualified Reason
K1014322-014	BC-SB15-2-3	TPH-Diesel	27 mg/kg	U	Analyte was detected in method blank
K1014322-015	BC-SB15-6.5-7.5	TPH-Diesel	31 mg/kg	U	Analyte was detected in method blank
K1014322-016	BC-SB15-9-10	TPH-Diesel	32 mg/kg	U	Analyte was detected in method blank
K1014322-017	BC-SB15-12-13	TPH-Diesel	33 mg/kg	U	Analyte was detected in method blank
K1014322-018	BC-SB15-15-16	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014322-019	BC-SB15-18-19	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014322-022	BC-SB16-9-10	TPH-Diesel	31 mg/kg	U	Analyte was detected in method blank
K1014322-023	BC-SB16-10-11	TPH-Diesel	59 mg/kg	U	Analyte was detected in method blank
K1014322-024	BC-SB16-12-13	TPH-Diesel	34 mg/kg	U	Analyte was detected in method blank
K1014322-025	BC-SB16-14-15	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014322-027	BC-SB17-4-5	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014322-028	BC-SB17-6-7	TPH-Diesel	29 mg/kg	U	Analyte was detected in method blank
K1014322-031	BC-SB18-3-4	TPH-Diesel	27 mg/kg	U	Analyte was detected in method blank
K1014322-032	BC-SB18-6-7	TPH-Diesel	28 mg/kg	U	Analyte was detected in method blank
K1014322-035	BC-SB18-14-15	TPH-Diesel	31 mg/kg	U	Analyte was detected in method blank
K1014322-036	BC-SB18-18-19	TPH-Diesel	31 mg/kg	U	Analyte was detected in method blank
K1014322-043	BC-SB20-7-8	TPH-Diesel	30 mg/kg	U	Analyte was detected in method blank
K1014323-009	FD-BC40	TPH-Diesel	31 mg/kg	U	Analyte was detected in method blank
K1014323-010	FD-BC41	TPH-Diesel	32 mg/kg	U	Analyte was detected in method blank
K1014099-002	BC-MW05-18-19	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014099-007	BC-MW04-15-16	TPH-Oil	170 mg/kg	U	Analyte was detected in method blank
K1014099-008	BC-MW04-18-19	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014099-011	MG-MW05-5-6	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014099-013	MG-MW05-9-10	TPH-Oil	150 mg/kg	U	Analyte was detected in method blank
K1014099-017	BC-MW05-7-8	TPH-Oil	140 mg/kg	U	Analyte was detected in method blank
K1014099-018	BC-MW05-9-10	TPH-Oil	150 mg/kg	U	Analyte was detected in method blank
K1014099-019	BC-MW05-12-13	TPH-Oil	140 mg/kg	U	Analyte was detected in method blank
K1014263-001	MG-SB11-9-10	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014263-011	MG-SB14-9-10	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014263-015	MG-SB15-7-8	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014263-016	MG-SB15-9-10	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014263-020	MG-SB16-7-8	TPH-Oil	140 mg/kg	U	Analyte was detected in method blank
K1014264-002	MG-SB16-12-13	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014264-003	FD-BC-23	TPH-Oil	110 mg/kg	U	Analyte was detected in method blank
K1014264-004	FD-BC-24	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014265-001	BC-SB13-3-4	TPH-Oil	110 mg/kg	U	Analyte was detected in method blank
K1014265-002	BC-SB13-6-7	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014265-003	BC-SB13-9-10	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014265-004	BC-SB13-12-13	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014265-005	BC-SB13-14-15	TPH-Oil	140 mg/kg	U	Analyte was detected in method blank

Laboratory ID	Sample ID	Analyte	Adjusted Result	Qualifier	Qualified Reason
K1014265-006	BC-SB13-16-17	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014265-007	BC-SB12-3-4	TPH-Oil	110 mg/kg	U	Analyte was detected in method blank
K1014265-008	BC-SB12-6-7	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014265-010	BC-SB12-12-13	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014265-011	BC-SB12-14-15	TPH-Oil	150 mg/kg	U	Analyte was detected in method blank
K1014265-012	BC-SB12-16-17	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014265-016	MG-MW04-6-7	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014322-003	BC-SB11-9-10	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014322-004	BC-SB11-12-13	TPH-Oil	140 mg/kg	U	Analyte was detected in method blank
K1014322-005	BC-SB11-15-16	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014322-010	BC-SB14-9-10	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014322-011	BC-SB14-12-13	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014322-012	BC-SB14-15-16	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014322-014	BC-SB15-2-3	TPH-Oil	110 mg/kg	U	Analyte was detected in method blank
K1014322-015	BC-SB15-6.5-7.5	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014322-017	BC-SB15-12-13	TPH-Oil	140 mg/kg	U	Analyte was detected in method blank
K1014322-018	BC-SB15-15-16	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014322-019	BC-SB15-18-19	TPH-Oil	110 mg/kg	U	Analyte was detected in method blank
K1014322-022	BC-SB16-9-10	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014322-024	BC-SB16-12-13	TPH-Oil	140 mg/kg	U	Analyte was detected in method blank
K1014322-025	BC-SB16-14-15	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014322-027	BC-SB17-4-5	TPH-Oil	110 mg/kg	U	Analyte was detected in method blank
K1014322-028	BC-SB17-6-7	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014322-031	BC-SB18-3-4	TPH-Oil	110 mg/kg	U	Analyte was detected in method blank
K1014322-032	BC-SB18-6-7	TPH-Oil	110 mg/kg	U	Analyte was detected in method blank
K1014322-035	BC-SB18-14-15	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014322-036	BC-SB18-18-19	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014322-043	BC-SB20-7-8	TPH-Oil	120 mg/kg	U	Analyte was detected in method blank
K1014322-044	BC-SB20-14.5-15	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014323-009	FD-BC40	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014323-010	FD-BC41	TPH-Oil	130 mg/kg	U	Analyte was detected in method blank
K1014323-032	Cuttings-MG-BC Areas	Barium	1 mg/L	U	Analyte was detected in method blank
K1014323-033	Cuttings-CP Area	Barium	1 mg/L	U	Analyte was detected in method blank
K1014099-007	BC-MW04-15-16	Dibenzo(a,h)anthracene	4.2 µg/kg	U	Analyte was detected in method blank
K1014099-013	MG-MW05-9-10	Dibenzo(a,h)anthracene	3.6 µg/kg	U	Analyte was detected in method blank
K1014099-017	BC-MW05-7-8	Naphthalene	3.5 µg/kg	U	Analyte was detected in method blank
K1014265-002	BC-SB13-6-7	Naphthalene	1.4 µg/kg	U	Analyte was detected in method blank
K1014323-032	Cuttings-MG-BC Areas	Chromium		J	Matrix spike %R value biased high
K1014323-033	Cuttings-CP Area	Chromium		J	Matrix spike %R value biased high

Laboratory ID	Sample ID	Analyte	Adjusted Result	Qualifier	Qualified Reason
K1014322-045	BC-SB20-19-20	Phenanthrene		J	MSD %R and MS/MSD RPD value outside control criteria

III. Data Qualifiers are defined as follows:

Data Qualifier	Definition
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: Mingta Lin Date: ***03/21/2011***

Mingta Lin, Senior Project Chemist

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APPENDIX A

The precision criterion (≤ 35%) was applied to evaluating the relative percent difference (RPD) values of field duplicate results greater than five times the MRL (5xMRL). For results less than 5xMRL, an advisory criterion of 2xMRL was applied to evaluating the concentration differences.

The RPD and concentration difference values for detected analytes and data qualification are presented as follows:

SDG No.	Sample ID		Analyte	Unit	MRL	Result		RPD	Conc. Difference	Data Qualifier
	Parent Sample	Field Duplicate				Parent Sample	Field Duplicate			
K1014096	L1-MW01-7-9	FD-L1-2	Mercury	mg/kg	0.064	1.02	1.22	18%		
K1014096	L1-MW03-7-9	FD-L1-1	Mercury	mg/kg	0.019	0.121	0.12	1%		
K1014098	L1-MW02-7-9	FD-L1-3	Mercury	mg/kg	0.36	6.49	7.57	15%		
K1014261	CP-MW15-4-5	FD-CP-11	Mercury	mg/kg	1450	14500	25500	55%		J
K1014261	CP-MW15-5-6	FD-CP-12	Mercury	mg/kg	305	7180	5390	28%		
K1014261	CP-MW15-5-6	FD-CP-12T	Mercury	mg/kg	305	7180	6460	11%		
K1014261	CP-MW15-6-8	FD-CP-13	Mercury	mg/kg	330	7760	10300	28%		
K1014261	CP-MW15-6-8	FD-CP-13T	Mercury	mg/kg	330	7760	10800	33%		
K1014265	CP-MW15-10-11	FD-CP-14	Mercury	mg/kg	2.09	26.1	26.4	1%		
K1014261	CP-SB05-12-14	FD-CP-16	Mercury	mg/kg	0.297	6.09	7.71	23%		
K1014261	CP-SB06-6-8	FD-CP-17	Mercury	mg/kg	1580	38700	51000	27%		J
K1014261	CP-SB13-8-9	FD-CP-18	Mercury	mg/kg	0.019	0.262	0.216	19%		
K1014260	CP-SB11-7-9	FD-CP-19	Mercury	mg/kg	0.014	0.258	0.262	2%		
K1014260	CP-SB09-12-14	FD-CP-20	Mercury	mg/kg	0.023	0.126	0.128	2%		
K1014260	CP-MW14-5-6	FD-CP-31	Mercury	mg/kg	0.366	4.76	4.74	0%		
K1014265	CP-MW15-12-14	FD-CP15	Mercury	mg/kg	0.338	2.03	2.63	26%		
K1014323	CP-SB03-2-3	FD-CP30	Mercury	mg/kg	0.081	1.14	2.35	69%		J
K1014323	CP-SB12-12-13	FD-CP39	Mercury	mg/kg	0.24	2.4	2.68	11%		
K1014099	BC-MW04-6-7	FD-MW04-10	TPH-Diesel	mg/kg	270	800	710		90	

SDG No.	Sample ID		Analyte	Unit	MRL	Result		RPD	Conc. Difference	Data Qualifier
	Parent Sample	Field Duplicate				Parent Sample	Field Duplicate			
K1014099	BC-MW04-6-7	FD-MW04-10	TPH-Oil	mg/kg	1100	5300	4600		700	
K1014099	MG-MW05-2-3	FD-MG-10	TPH-Diesel	mg/kg	28	66	71		5	
K1014099	MG-MW05-2-3	FD-MG-10	TPH-Oil	mg/kg	110	300	290		10	
K1014263	MG-SB14-7-8	FD-MG-21	TPH-Diesel	mg/kg	35	820	610	29%		
K1014263	MG-SB14-7-8	FD-MG-21	TPH-Oil	mg/kg	140	880	870	1%		
K1014263	MG-SB11-12-13	FD-MG-22	TPH-Diesel	mg/kg	32	110	110		0	
K1014263	MG-SB11-12-13	FD-MG-22	TPH-Oil	mg/kg	130	250	240		10	
K1014263	MG-SB13-7-8	FD-MG-25	TPH-Diesel	mg/kg	38	920	620	39%		
K1014263	MG-SB13-7-8	FD-MG-25	TPH-Oil	mg/kg	160	1700	1400	19%		
K1014264	MG-SB12-10-11	FD-MG-26	TPH-Diesel	mg/kg	31	370	390	5%		
K1014264	MG-SB12-10-11	FD-MG-26	TPH-Oil	mg/kg	130	200	200		0	
K1014265	BC-SB12-6-7	FD-BC-24	TPH-Diesel	mg/kg	30	5.4	4.1		1.3	
K1014265	BC-SB12-6-7	FD-BC-24	TPH-Oil	mg/kg	120	15	13		2	
K1014265	BC-SB13-6-7	FD-BC-23	TPH-Diesel	mg/kg	28	5.2	3.6		1.6	
K1014265	BC-SB13-6-7	FD-BC-23	TPH-Oil	mg/kg	120	23	18		5	
K1014322	BC-SB17-8-9	FD-BC35	TPH-Diesel	mg/kg	560	16000	15000	6%	1000	
K1014322	BC-SB17-8-9	FD-BC35	TPH-Oil	mg/kg	2300	15000	15000	0%		
K1014322	BC-SB16-6-7	FD-BC36	TPH-Diesel	mg/kg	55	87	96		9	
K1014322	BC-SB16-6-7	FD-BC36	TPH-Oil	mg/kg	220	250	270		20	
K1014322	BC-SB18-9-10	FD-BC37	TPH-Diesel	mg/kg	650	16000	15000	6%		
K1014322	BC-SB18-9-10	FD-BC37	TPH-Oil	mg/kg	2600	17000	15000	13%		
K1014322	BC-SB19-9-10	FD-BC38	TPH-Diesel	mg/kg	30	130	190		60	
K1014322	BC-SB19-9-10	FD-BC38	TPH-Oil	mg/kg	120	440	970		530	**J**
K1014322	BC-SB11-3-4	FD-BC39	TPH-Diesel	mg/kg	57	310	200		110	
K1014322	BC-SB11-3-4	FD-BC39	TPH-Oil	mg/kg	230	1600	1000		600	**J**
K1014322	BC-SB14-12-13	FD-BC40	TPH-Diesel	mg/kg	32	29	7.5		21.5	
K1014322	BC-SB14-12-13	FD-BC40	TPH-Oil	mg/kg	130	39	26		13	

SDG No.	Sample ID		Analyte	Unit	MRL	Result		RPD	Conc. Difference	Data Qualifier
	Parent Sample	Field Duplicate				Parent Sample	Field Duplicate			
K1014322	BC-SB15-6.5-7.5	FD-BC41	TPH-Diesel	mg/kg	31	7.6	23		15.4	
K1014322	BC-SB15-6.5-7.5	FD-BC41	TPH-Oil	mg/kg	130	30	33		3	
K1014099	BC-MW04-6-7	FD-MW04-10	2-Methylnaphthalene	µg/kg	27	520	480	8%		
K1014099	BC-MW04-6-7	FD-MW04-10	Acenaphthene	µg/kg	27	61	60		1	
K1014099	BC-MW04-6-7	FD-MW04-10	Acenaphthylene	µg/kg	27	59	61		2	
K1014099	BC-MW04-6-7	FD-MW04-10	Anthracene	µg/kg	27	140	110		30	
K1014099	BC-MW04-6-7	FD-MW04-10	Benz(a)anthracene	µg/kg	27	91	74		17	
K1014099	BC-MW04-6-7	FD-MW04-10	Benzo(a)pyrene	µg/kg	27	66	67		1	
K1014099	BC-MW04-6-7	FD-MW04-10	Benzo(b)fluoranthene	µg/kg	27	100	94		6	
K1014099	BC-MW04-6-7	FD-MW04-10	Benzo(g,h,i)perylene	µg/kg	27	110	110		0	
K1014099	BC-MW04-6-7	FD-MW04-10	Benzo(k)fluoranthene	µg/kg	27	19	24		5	
K1014099	BC-MW04-6-7	FD-MW04-10	Chrysene	µg/kg	27	160	150		10	
K1014099	BC-MW04-6-7	FD-MW04-10	Dibenzo(a,h)anthracene	µg/kg	27	53	51		2	
K1014099	BC-MW04-6-7	FD-MW04-10	Dibenzofuran	µg/kg	27	110	110		0	
K1014099	BC-MW04-6-7	FD-MW04-10	Fluoranthene	µg/kg	27	340	290	16%		
K1014099	BC-MW04-6-7	FD-MW04-10	Fluorene	µg/kg	27	130	110	17%		
K1014099	BC-MW04-6-7	FD-MW04-10	Indeno(1,2,3-cd)pyrene	µg/kg	27	53	58		5	
K1014099	BC-MW04-6-7	FD-MW04-10	Naphthalene	µg/kg	27	510	540	6%		
K1014099	BC-MW04-6-7	FD-MW04-10	Phenanthrene	µg/kg	27	1200	1000	18%		
K1014099	BC-MW04-6-7	FD-MW04-10	Pyrene	µg/kg	27	420	360	15%		
K1014099	BC-MW04-6-7	FD-MW04-10	Total cPAHs TEF	µg/kg	27	99.2	98.6	1%		
K1014099	MG-MW05-2-3	FD-MG-10	2-Methylnaphthalene	µg/kg	2.8	92	140	41%		
K1014099	MG-MW05-2-3	FD-MG-10	Acenaphthene	µg/kg	2.8	350	610	54%		J
K1014099	MG-MW05-2-3	FD-MG-10	Acenaphthylene	µg/kg	2.8	6.6	8.5	25%		
K1014099	MG-MW05-2-3	FD-MG-10	Anthracene	µg/kg	2.8	92	130	34%		
K1014099	MG-MW05-2-3	FD-MG-10	Benz(a)anthracene	µg/kg	2.8	98	98	0%		
K1014099	MG-MW05-2-3	FD-MG-10	Benzo(a)pyrene	µg/kg	2.8	57	57	0%		

	Sample ID					Result				
SDG No.	**Parent Sample**	**Field Duplicate**	**Analyte**	**Unit**	**MRL**	**Parent Sample**	**Field Duplicate**	**RPD**	**Conc. Difference**	**Data Qualifier**
K1014099	MG-MW05-2-3	FD-MG-10	Benzo(b)fluoranthene	µg/kg	2.8	99	100	1%		
K1014099	MG-MW05-2-3	FD-MG-10	Benzo(g,h,i)perylene	µg/kg	2.8	37	40	8%		
K1014099	MG-MW05-2-3	FD-MG-10	Benzo(k)fluoranthene	µg/kg	2.8	30	34	13%		
K1014099	MG-MW05-2-3	FD-MG-10	Chrysene	µg/kg	2.8	93	130	33%		
K1014099	MG-MW05-2-3	FD-MG-10	Dibenzo(a,h)anthracene	µg/kg	2.8	8.4	8.4		0	
K1014099	MG-MW05-2-3	FD-MG-10	Dibenzofuran	µg/kg	2.8	220	400	58%		**J**
K1014099	MG-MW05-2-3	FD-MG-10	Fluoranthene	µg/kg	2.8	470	570	19%		
K1014099	MG-MW05-2-3	FD-MG-10	Fluorene	µg/kg	2.8	390	670	53%		**J**
K1014099	MG-MW05-2-3	FD-MG-10	Indeno(1,2,3-cd)pyrene	µg/kg	2.8	32	34	6%		
K1014099	MG-MW05-2-3	FD-MG-10	Naphthalene	µg/kg	2.8	120	150	22%		
K1014099	MG-MW05-2-3	FD-MG-10	Phenanthrene	µg/kg	2.8	840	1200	35%		
K1014099	MG-MW05-2-3	FD-MG-10	Pyrene	µg/kg	2.8	380	410	8%		
K1014099	MG-MW05-2-3	FD-MG-10	Total cPAHs TEF	µg/kg	2.8	84.7	85.7	1%		
K1014264	MG-SB12-10-11	FD-MG-26	2-Methylnaphthalene	µg/kg	31	8100	6700	19%		
K1014264	MG-SB12-10-11	FD-MG-26	Acenaphthene	µg/kg	160	16000	13000	21%		
K1014264	MG-SB12-10-11	FD-MG-26	Acenaphthylene	µg/kg	3.1	70	58	19%		
K1014264	MG-SB12-10-11	FD-MG-26	Anthracene	µg/kg	31	4800	4100	16%		
K1014264	MG-SB12-10-11	FD-MG-26	Benz(a)anthracene	µg/kg	31	5300	4100	26%		
K1014264	MG-SB12-10-11	FD-MG-26	Benzo(a)pyrene	µg/kg	31	1800	1400	25%		
K1014264	MG-SB12-10-11	FD-MG-26	Benzo(b)fluoranthene	µg/kg	31	3200	2700	17%		
K1014264	MG-SB12-10-11	FD-MG-26	Benzo(g,h,i)perylene	µg/kg	3.1	440	330	29%		
K1014264	MG-SB12-10-11	FD-MG-26	Benzo(k)fluoranthene	µg/kg	3.1	910	790	14%		
K1014264	MG-SB12-10-11	FD-MG-26	Chrysene	µg/kg	31	3700	3200	14%		
K1014264	MG-SB12-10-11	FD-MG-26	Dibenzo(a,h)anthracene	µg/kg	3.1	160	120	29%		
K1014264	MG-SB12-10-11	FD-MG-26	Dibenzofuran	µg/kg	31	11000	9400	16%		
K1014264	MG-SB12-10-11	FD-MG-26	Fluoranthene	µg/kg	160	27000	21000	25%		
K1014264	MG-SB12-10-11	FD-MG-26	Fluorene	µg/kg	160	16000	14000	13%		

SDG No.	Sample ID		Analyte	Unit	MRL	Result		RPD	Conc. Difference	Data Qualifier
	Parent Sample	Field Duplicate				Parent Sample	Field Duplicate			
K1014264	MG-SB12-10-11	FD-MG-26	Indeno(1,2,3-cd)pyrene	µg/kg	3.1	490	400	20%		
K1014264	MG-SB12-10-11	FD-MG-26	Naphthalene	µg/kg	160	13000	9300	33%		
K1014264	MG-SB12-10-11	FD-MG-26	Phenanthrene	µg/kg	160	48000	41000	16%		
K1014264	MG-SB12-10-11	FD-MG-26	Pyrene	µg/kg	160	17000	14000	19%		
K1014264	MG-SB12-10-11	FD-MG-26	Total cPAHs TEF	µg/kg	3.1	156	131	17%		
K1014264	MG-SB12-10-11	FD-MG-26	Total cPAHs TEF	µg/kg	31	2690	2110	24%		

Note:
mg/kg – milligram per kilogram
µg/kg – microgram per kilogram
Conc. Difference – Concentration difference between the parent sample and the field duplicate
MRL – Method reporting limit
ND – Not detected at or above the method detection limit
RPD – Relative percent difference

Data Validation Report

Port of Bellingham Former GP Mill Property RI/FS
Bellingham, Washington

December 2010 & January 2011 Groundwater Sampling

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March 21, 2011

ACRONYMS

%D	percent difference
%D_f	percent drift
%R	percent recovery
%RSD	percent relative standard deviation
CAS	Columbia Analytical Services, Inc. – Kelso, Washington
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CF	calibration factor
CLP	U.S. EPA Contract Laboratory Program
COC	chain-of-custody
CVAFS	cold vapor atomic fluorescence spectrometry
DFTPP	decafluorotriphenylphosphine
DOC	dissolved organic carbon
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
FID	flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
Hg	mercury
ICAL	initial calibration
ICB	initial calibration blank
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometry
ICSA	ICP interference check sample solution A
ICSAB	ICP interference check sample solution AB
ICV	initial calibration verification
LCL	laboratory control limit
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
µg/L	microgram per liter
MDL	method detection limit
MRL	method reporting limit

MS	matrix spike
MSD	matrix spike duplicate
NFGs	CLP National Functional Guidelines for Data Review (EPA 2008 – Organics and EPA 2004 – Inorganics)
ng/L	nanogram per liter
OPR	ongoing precision and recovery
PAHs	polycyclic aromatic hydrocarbons
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
QCS	quality control sample
RF	response factor
RPD	relative percent difference
RRT	relative retention time
SDG	sample delivery group
SIM	selective ion monitoring
TDS	total dissolved solids
TSS	total suspended solids
TPH	total petroleum hydrocarbon

INTRODUCTION

This report presents and discusses findings of the data validation performed on analytical data for samples collected during December 2010 and January 2011 for the referenced project. The laboratory reports validated herein were submitted by Columbia Analytical Services, Inc. (CAS).

A level III data validation was performed on this laboratory report. The validation followed the procedures specified in USEPA CLP Functional Guidelines ([NFGs], EPA 2008 – Organics and EPA 2004 – Inorganics) with modifications to accommodate project and analytical method requirements. The numerical quality assurance/quality control (QA/QC) criteria applied to the validation were in accordance with those specified in the quality assurance project plans ([QAPPs], Aspect, 2009) and the current performance-based control limits established by the laboratory (laboratory control limits). Instrument calibration, frequency of QC analyses, and analytical sequence requirements were evaluated against the respective analytical methods.

Validation findings are discussed in each section pertinent to the QC parameter for each type of analysis. Qualified data with applied data qualifiers are summarized in the **Summary** section at the end of this report.

Samples and the associated analyses validated herein are summarized as follows:

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Diss. Hg	TPH	Inorganics	EPH
MG-MW03-121610	K1014093-001	12/16/2010	GW	X		X	TSS	X
MG-MW01-121610	K1014093-002	12/16/2010	GW	X		X	TSS	X
BC-MW03-121610	K1014093-003	12/16/2010	GW	X		X	Conc.+ TSS	X
EMW-16S-121610	K1014093-004	12/16/2010	GW	X		X	Conc.+ TSS	X
BC-MW01-121510	K1014093-005	12/15/2010	GW	X		X	Conc.+ TSS	X
BC-MW02-121510	K1014093-006	12/15/2010	GW	X		X	Conc.+ TSS	X
L1-MW05-121610	K1014093-007	12/16/2010	GW		X		X	
L1-MW03-121610	K1014093-008	12/16/2010	GW		X		X	
LAW-1-121610	K1014093-009	12/16/2010	GW		X		X	
CP-MW03-121710	K1014093-010	12/17/2010	GW		X		X	
CP-MW13-121710	K1014093-011	12/17/2010	GW		X		X	
AMW-01-121610	K1014093-012	12/16/2010	GW		X		X	
L1-WP1-121610	K1014093-013	12/16/2010	GW		X		X	
CP-MW10-121610	K1014093-014	12/16/2010	GW		X		X	
FD-CP1-121710	K1014093-015	12/17/2010	FD		X			
FD-L1-121610	K1014093-016	12/16/2010	FD		X			

Field Sample ID	Laboratory Sample ID	Sampling Date	Sample Type	Analysis				
				PAHs	Diss. Hg	TPH	Inorganics	EPH
BC-MW05-121910	K1014259-001	12/21/2010	GW	X		X	Conc.+ TSS	X
MG-MW04-122110	K1014259-002	12/21/2010	GW	X		X	TSS	X
MG-MW05-122010	K1014259-003	12/20/2010	GW	X		X	TSS	X
FD-MG-11	K1014259-004	12/20/2010	FD	X		X	TSS	X
BC-MW04-122110	K1014259-005	12/21/2010	GW	X		X	Conc.+ TSS	X
CP-MW15-122110	K1014259-006	12/21/2010	GW		X		X	
L1-MW02-121910	K1014259-007	12/21/2010	GW		X		X	
L1-MW01-121910	K1014259-008	12/21/2010	GW		X		X	
CP-MW14-122310	K1014323-029	12/23/2010	GW		X		X	
Concrete Core Slurry Water	K1014323-030	12/23/2010	GW		T/Hg			
L1-MW04-010611	K1100217-001	01/06/2011	GW		X		X + pH	

Notes:
X - The analysis was requested and performed on the sample.
PAHs – Polycyclic aromatic hydrocarbons
Inorganics – Chloride, sulfate, dissolved iron, dissolved manganese, alkalinity, total dissolved solids (TDS), dissolved organic carbon (DOC) and total sulfide.
TSS – Total suspended solids
TPH – Diesel and motor oil range total petroleum hydrocarbon
Diss. Hg – Dissolved mercury.
FD – Field duplicate
Cond. – Conductivity
T/Hg – Total mercury
EPH – Extractable petroleum hydrocarbon

The analytical parameters requested for the samples, the respective analytical methods, and the analytical laboratories are summarized below:

Parameter	Analytical Method	Analytical Laboratory
Polycyclic Aromatic Hydrocarbons (PAHs)	SW846 Method 8270C-SIM	Columbia Analytical Services, Inc. Kelso, WA
TPH-Diesel & Motor Oil	NWTPH-Dx	
Dissolved Iron and Manganese	SW846 Method 6010B	
Mercury	EPA Method 1631E	
Alkalinity (Total as Carbonate)	SM Method 2320B	
Sulfate	EPA Method 300.0	
Total Dissolved Solids (TDS)	SM Method 2540 C	
Total Suspended Solids (TSS)	SM Method 2540 D	
Total Sulfide	SM Method 4500-S2-D	
Dissolved Organic Carbon (DOC)	SM Method 5310 C	
Conductivity	SM Method 2510 B	
EPH	NWTPH-EPH	Analytical Resources, Inc. Tukwila, WA

Notes:

1. SW846 - *USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, Third Edition, December 1996.
2. EPA Methods - *USEPA Methods for Chemical Analysis of Water and Wastes,* EPA–600/4-79-020, March 1983 Revision.
3. EPA Method 1631E - *Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry,* Office of Water, U.S. Environmental Protection Agency, August 2002, EPA-821-R-02-019.
4. SM – Standard *Methods for the Examination of Water and Wastewater*, American Public Health Association, 20th Edition, 1995.

DATA VALIDATION FINDINGS

1. EPH by GC/FID-PID (Method NWTPH-EPH)

1.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport. Water samples should be extracted within 14 days and extracts analyzed within 40 days. All samples were extracted and analyzed within the required holding times.

1.2 Initial Calibration

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 20% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.990. Initial calibration met the criteria for all target compounds.

An initial calibration verification (ICV) analysis was performed immediately after the initial calibrations and before any analyses of samples. The %D value for the ICV met the method control limit of 80 – 120%.

1.3 Calibration Verification

Continuing calibration verification (CCV) analyses were performed at the required frequency for all analytical sequences as required by the method. The %D values for all CCVs met the method criterion (±20%).

1.4 Method Blanks

Method blanks were prepared and analyzed as required. No target compounds were detected at or above the method detection limits (MDLs) in the method blanks.

1.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the laboratory control limits, except that the %R values for both surrogates in sample EMW-165-121610 were less than the lower control limit. EPH results were qualified (UJ) for non-detects and (J) for detects as estimated.

1.6 Matrix Spike and Matrix Spike Duplicate

MS/MSD analyses were performed on project samples at the adequate frequency. The percent recovery (%R) and relative percent difference (RPD) values were within the control limits.

1.7 Laboratory Control Sample

LCS analyses were performed as required by the method. All %R values met the laboratory control limits.

1.8 Method Reporting Limits (MRLs)

The reported sample-specific MRLs met the project requirements.

1.9 Field Duplicates

One set of field duplicates were submitted for EPH analyses in this SDG. The RPD (or concentration difference) values met the project control limits.

1.10 Overall Assessment of EPH Data Usability

EPH data are of known quality and acceptable for use, as qualified.

2. PAHs by GC/MS - SIM (EPA Method SW8270C)

2.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be extracted within 7 days of collection. Extracts should be analyzed within 40 days of extraction. All samples were extracted and analyzed within the required holding times.

2.2 GC/MS Instrument Performance Check

DFTPP tuning was performed within each 12-hour interval. All required ion abundance ratios met the method requirements.

2.3 Initial Calibration

The NFGs criteria require that the %RSD be <30% and the average RRF be >0.05 for all target compounds.

The method linearity criteria require that (1) if linear average RFs is chosen as the quantitation option, the %RSD of RFs be < 15% for the analyte, (2) if least-square linear regression is chosen for quantitation, the correlation coefficient (r) be >0.995, and (3) if six-point non-linear (quadratic) curve is chosen for quantitation, the coefficient of determination (r^2) be >0.99. The initial calibration met the criteria.

2.4 Calibration Verification

The analytical method and NFGs criteria require that (1) continuing calibrations be analyzed at the beginning of each 12-hour analysis period prior to the analysis of method blank and samples, (2) the %D be within ±20%, and (3) the RF be > 0.01 for poor response compounds and >0.05 for all other compounds. Calibration verification analyses met the criteria or the %D value was at a level that had no adverse effects on data quality (*e.g.,* biased-high recovery for an analyte that was not detected in associated samples).

2.5 Method Blanks

Method blanks were prepared and analyzed as required. Target compounds were not detected at or above the MDLs in the method blanks, except that naphthalene was detected in method blank KWG1013897-4 at 0.019 µg/L. Associated sample results above the MDLs but less than MRLs or 5x the detection in this blank were qualified (U) as non-detects at their MRLs (or reported values), as summarized in **SUMMARY, Table I.**

2.6 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were either within the project control limits or at levels that had no adverse effects on data quality (*e.g.,* biased-high recovery for analytes that were not detected in samples).

2.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were not performed on the project sample in these SDGs. Analytical precision and accuracy was evaluated with the LCS and LCSD results (see Section 2.8).

2.8 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

LCS and LCSD analyses were performed with each analytical batch. All %R and RPD values were within the project control limits.

2.9 Internal Standards

The method requires that (1) internal standard retention time be within ±30 seconds from that of the associated 12-hour calibration standard, and (2) the area counts of all internal standards be within –50% to +100% of the associated 12-hour calibration standard. All internal standards in the sample and associated QC analyses met the criteria.

2.10 Reporting Limits and Target Compound Quantitation

The sample-specific MDLs and MRLs were adjusted with sample amount extracted and MRLs were supported with adequate initial calibration concentrations.

2.11 Field Duplicates

One set of field duplicates were submitted for PAHs analyses. Field duplicate results for detected target compounds, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

2.12 Overall Assessment of PAHs Data Usability

PAHs data are of known quality and acceptable for use, as qualified.

3. Iron and Manganese by ICP; Mercury by CVAFS (EPA Methods SW6010 and 1631)

3.1 Sample Management and Holding Times

No anomalies were identified in relation to sample preservation, handling, and transport, as discussed in Section 1.1.

Water samples should be analyzed within 180 days for metals and 28 days for mercury. Samples were analyzed within the required holding times.

3.2 Initial Calibration

The ICP methods requires that (1) a blank and one calibration standard be used in establishing the analytical curve, and (2) the average of replicate exposures be reported for all standards, QC, and sample analyses.

For mercury (CVAFS) analyses, the methods require that (1) a blank and five calibration standards be employed to establish the analytical curve, and (2) the linearity of the calibration curve should meet the criteria of correlation coefficient ≥ 0.995 or %RSD ≤15%. The associated initial calibrations met the method requirements.

A check standard containing target analytes at the reporting limit levels was analyzed at the beginning of each analytical run. The results were within the NFGs criteria of 70-130% or the associated results were greater than the 2x MRLs.

3.3 Calibration Verification (ICV and CCV)

Initial calibration verifications (ICVs) and continuing calibration verifications (CCVs) or Ongoing Precision Recovery (OPR) samples (for Method 1631E) were analyzed at the required frequency. The %R values met the method control criteria.

3.4 Blanks

Calibration Blanks: Initial calibration blanks (ICBs) and continuing calibration blanks (CCBs) were analyzed at required frequency. Target analytes were either not detected in ICBs/CCBs at or above the method detection limits (MDLs), or at levels that had no significant effects (sample results > 5x the calibration blank detection) on associated sample results, except for the following:

SDG	Preparation Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result	Adjusted Result	Unit
K1014259	ICB/CCB	Manganese	20.1 J	CP-MW15-122110	20.1 J	**25.0 U**	µg/L

Note: J – The value was at a level between the MDL and MRL, and considered as estimated.

Preparation Blanks: Method blanks were prepared and analyzed as required. Target analytes were either not detected in the method blanks at or above the MDLs, or at levels that had no significant effects (sample results >5x the method blank detection) on associated sample results.

3.5 ICP Interference Check Sample (ICS)

The method requires that (1) an inter-element interference check sample be analyzed at the beginning of each analytical run, and (2) the results should be within ± 20% of the true value. ICP interference check sample analyses met the requirements.

Several analytes were detected in the ICSA initial analyses at low levels. Since the concentrations in the associated samples were less than 50% of the interferant concentrations in ICSA samples, no action was taken. The %D values for analytes in ICSAB were within ± 20% of the true value or the interferant concentrations in the associated samples were less than 50% of the ICSAB concentrations.

3.6 Laboratory Control Sample (LCS) and Quality Control Samples (QCS)

LCS or QCS (as named in Method 1631E) analyses were performed at the required frequency. All %R values met the control limits (80 – 120%/20%) for all target analytes.

3.7 Duplicate Sample Analysis

Duplicate sample (matrix spike duplicates for mercury) analyses were performed on project samples at the required frequency. The RPD values (or concentration differences) met the control criteria (20% for detections ≥ 5xRL, ±1xMRL for detections < 5xMRL).

3.8 Matrix Spike (MS)

Matrix spike analyses were performed on project samples as required. All %R values met the laboratory control limits, or native analyte concentrations in the samples were greater than 4x the spiked levels and the %R values were inapplicable for matrix effect evaluation.

3.9 Serial Dilution

Serial dilution analyses were performed on project samples at the required frequency for ICP metals and mercury. All %D values for positive results greater than 50X MDL were within 10%.

3.10 Analyte Quantitation and Reporting Limits

Reported sample-specific MRLs met the project requirements.

3.11 Field Duplicates

One set of field duplicate for dissolved metals and five sets for dissolved mercury were submitted for analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

3.12 Overall Assessment of Metals Data Usability

Metals data are of known quality and acceptable for use, as qualified.

4. TPH-Diesel & Motor Oil (Methods NWTPH-Dx)

4.1 Holding Time

Water samples should be extracted within 7 days of collection, and extracts analyzed within 40 days of extraction. All samples were extracted and analyzed within the recommended holding time.

4.2 Initial Calibration

The methods requires that (1) a minimum of 5-point calibration be performed using individual petroleum product reference standards to ensure the proper identification and quantitation of petroleum hydrocarbons in samples, (2) the calibration curve includes a sufficiently low standard to provide the necessary reporting limits, and (3) the linear working range of the instrument be defined.

The ICAL met the method requirements. The linearity of the ICAL curves were verified with %RSD values of RFs (%RSD ≤ 20%, according to EPA SW 846 Method 8000), and was acceptable for both diesel and motor oil range total petroleum hydrocarbon (TPH).

4.3 Calibration Verification

The method requires that (1) a mid-range check standard be analyzed prior to and after each analytical batch, and (2) the percent drift (%D_f) value be within ±15% of the true value.

Calibration verification was performed at required frequency. The %D_f values were either within the ±15% criterion or at levels that had no adverse effects on data quality (e.g., high-bias %D_f value where the target compound was not detected in associated sample).

4.4 Blanks

Method Blanks: Method blanks were prepared and analyzed as required. Target compounds were either not detected at or above the MDLs in the method blanks or at levels that had no significant effects on associated sample results (sample >10x detections in the method blank), except for the following:

SDG	Method Blank ID	Analyte	Detection in Blank (µg/L)	Affected Sample	Original Result (µg/L)	Adjusted Result (µg/L)
K1014259	KWG1014208-3	TPH-Diesel	50 J	BC-MW04-122110 BC-MW05-121910 FD-MG-11 MG-MW04-122110 MG-MW05-122010	77 J 35 J 120 J 110 J 180 J	**260 U** **260 U** **290 U** **270 U** **280 U**
K1014259	KWG1014208-3	TPH-Oil	52 J	BC-MW04-122110 BC-MW05-121910 FD-MG-11 MG-MW04-122110 MG-MW05-122010	84 J 53 J 81 J 190 J 56 J	520 U 520 U 570 U 540 U 550 U

4.5 Surrogate Spikes

Surrogate spikes were added to all samples as required by the method. All surrogate spike %R values were within the project control limits, outside the control limits due to matrix interference, or diluted below quantitation limits due to high analyte concentrations, except for the following:

Sample ID	Surrogate	Surrogate Spike %R	Control Limit	Affected Analyte	Data Qualification
EMW-16S-121610 MG-MW01-121610 MG-MW03-121610	*o*-Terphenyl	5% 11% 7%	50-150%	TPH-Diesel	**J** **UJ** **J**
EMW-16S-121610 MG-MW01-121610 MG-MW03-121610	*n*-Triancotane	6% 12% 7%	50-150%	TPH-Oil	**J** **UJ** **J**

4.6 Matrix Duplicate

Matrix duplicate analyses were performed on project samples at the required frequency. The RPD values (or concentration differences if sample concentrations are <5xMRL) met the laboratory control limits.

4.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required. All %R values met the project control limits.

4.8 Target Compound Identification

Sample extracts were cleaned up with acid and silica gel treatment to minimize the biogenic interference with target compound identification, as required by the project. The laboratory reported results as diesel #2 (C12 - C24) and motor oil (C24 - C38), as required by the method.

4.9 Reporting Limits and Target Compound Quantitation

The reported RLs were supported with adequate ICAL concentrations. Sample-specific MDLs and MRLs were adjusted to sample weight and moisture content.

4.10 Field Duplicates

Two sets of field duplicates were submitted for TPH-Diesl and TPH-Motor Oil analyses. Field duplicate results, RPD (or concentration difference) values, and data qualification were presented in **Appendix A**.

4.11 Overall Assessment of TPH-Diesel and Motor Oil Data Usability

TPH-Diesel and TPH-Motor Oil data are of known quality and acceptable for use as qualified.

5. Alkalinity, TDS, TSS, Chloride, Sulfate, Cr (VI), Conductivity, DOC, and Sulfide

5.1 Holding Times

The samples were analyzed within the required holding times of 24 hours for conductivity and Cr (VI); seven days for total dissolved solids (TDS) and total suspended solids (TSS); 14 days for alkalinity, sulfide, and dissolved organic carbon (DOC); and 28 days for chloride and sulfate. All analyses were performed within the required holding times.

5.2 Initial Calibration

Initial calibration (ICAL) is required for chloride, sulfate, Cr (VI), and sulfide analyses. The initial calibration correlation coefficients were ≥0.995 and met the method requirements for these parameters.

5.3 Initial and Continuing Calibration Verification

Initial calibration verification (ICV) and continuing calibration verification (CCV) analyses were performed at the required frequency for all inorganic constituents. All percent recovery values were within the control limits of 90 – 110%.

5.4 Blanks

Calibration Blanks: ICBs and CCBs were analyzed at the required frequency. Target analytes were either not detected at or above the MDLs in ICBs and CCBs, or at levels that had no significant effects on sample results.

Method Blanks: Method blanks were analyzed at the required frequency. Target analytes were either not detected at or above the MDLs in method blanks, or at levels that had no significant effects on sample results.

5.5 Duplicate Sample Analysis

Duplicate analyses were performed for all inorganic constituents on project samples. All RPD or concentration difference values met the laboratory control criteria.

5.6 Matrix Spike (MS)

Matrix spike analyses were performed at the required frequency (some on batch QC samples). All %R values were within the laboratory control limits.

5.7 Laboratory Control Sample (LCS)

LCS analyses were performed as required by the methods. All %R values were within the laboratory control limits.

5.8 Field Duplicates

One set of field duplicates were submitted for inorganic constituent analyses. Field duplicate results, RPD or concentration difference values, and data qualification are presented in **Appendix A**.

5.9 Laboratory Reporting Limits

Most groundwater samples contained elevated levels of chloride and, in some cases, sulfate that heavily interfered with the quantitation of other anions, particularly nitrite and nitrate. The MRLs were thus raised for affected anions in these cases.

5.10 Overall Assessment of Inorganic Constituents Data

Inorganic constituents data are of known quality and acceptable for use as qualified.

SUMMARY

I. Data qualification is summarized as follows:

K1014323-032	Cuttings-MG-BC Areas	Arsenic	0.1 mg/L	U	Analyte was detected in CCB.
K1014323-033	Cuttings-CP Area	Arsenic	0.1 mg/L	U	Analyte was detected in CCB.
K1014259-006DISS	CP-MW15-122110	Manganese	25 µg/L	U	Analyte was detected in ICB and CCB.
K1014259-001	BC-MW05-121910	TPH-Diesel	260 µg/L	U	Analyte was detected in method blank
K1014259-002	MG-MW04-122110	TPH-Diesel	270 µg/L	U	Analyte was detected in method blank
K1014259-003	MG-MW05-122010	TPH-Diesel	280 µg/L	U	Analyte was detected in method blank
K1014259-004	FD-MG-11	TPH-Diesel	290 µg/L	U	Analyte was detected in method blank
K1014259-005	BC-MW04-122110	TPH-Diesel	260 µg/L	U	Analyte was detected in method blank
K1014259-001	BC-MW05-121910	TPH-Oil	520 µg/L	U	Analyte was detected in method blank
K1014259-002	MG-MW04-122110	TPH-Oil	540 µg/L	U	Analyte was detected in method blank
K1014259-003	MG-MW05-122010	TPH-Oil	550 µg/L	U	Analyte was detected in method blank
K1014259-004	FD-MG-11	TPH-Oil	570 µg/L	U	Analyte was detected in method blank
K1014259-005	BC-MW04-122110	TPH-Oil	520 µg/L	U	Analyte was detected in method blank
K1014323-032	Cuttings-MG-BC Areas	Barium	1.0 mg/L	U	Analyte was detected in method blank
K1014323-033	Cuttings-CP Area	Barium	1.0 mg/L	U	Analyte was detected in method blank
K1014093-002	MG-MW01-121610	Naphthalene	0.31 µg/L	U	Analyte was detected in method blank
K1014093-003	BC-MW03-121610	Naphthalene	0.026 µg/L	U	Analyte was detected in method blank
K1014093-005	BC-MW01-121510	Naphthalene	0.027 µg/L	U	Analyte was detected in method blank
K1014093-001	MG-MW03-121610	TPH-Diesel		J	Surrogate recovery biased low
K1014093-002	MG-MW01-121610	TPH-Diesel		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	TPH-Diesel		J	Surrogate recovery biased low
K1014093-001	MG-MW03-121610	TPH-Oil		UJ	Surrogate recovery biased low
K1014093-002	MG-MW01-121610	TPH-Oil		J	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	TPH-Oil		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aliphatics C10-C12		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aliphatics C12-C16		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aliphatics C16-C21		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aliphatics C21-C34		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aliphatics C8-C10		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aromatics C10-C12		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aromatics C12-C16		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aromatics C16-C21		J	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aromatics C21-C34		UJ	Surrogate recovery biased low
K1014093-004	EMW-16S-121610	Aromatics C8-C10		UJ	Surrogate recovery biased low
K1014093-011	CP-MW13-121710	Alkalinity (Total)		J	Field duplicate imprecision
K1014093-015	FD-CP1-121710	Alkalinity (Total)		J	Field duplicate imprecision
K1014093-007DISS	L1-MW05-121610	Iron		J	Field duplicate imprecision

K1014093-016DISS	FD-L1-121610	Iron		J	Field duplicate imprecision
K1014093-007DISS	L1-MW05-121610	Manganese		J	Field duplicate imprecision
K1014093-016DISS	FD-L1-121610	Manganese		J	Field duplicate imprecision

III. Data Qualifiers are defined as follows:

Data Qualifier	**Definition**
J	The analyte was detected above the reported quantitation limit, and the reported concentration was an estimated value.
U	The analyte was analyzed for, but was considered not detected at the reporting limit or reported value.
UJ	The analyte was analyzed for, and the associated quantitation limit was an estimated value.

Approved By: ______________________ Date*:* ***03/21/2011***

Mingta Lin, Senior Project Chemist

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APPENDIX A

The precision criterion (≤ 35%) was applied to evaluating the relative percent difference (RPD) values of field duplicate results greater than five times the MRL (5xMRL). For results less than 5xMRL, an advisory criterion of 2xMRL was applied to evaluating the concentration differences.

The RPD and concentration difference values for detected analytes and data qualification are presented as follows:

SDG No.	Sample ID		Analyte	Unit	MRL	Result		RPD	Conc. Difference	Data Qualifier
	Parent Sample	Field Duplicate				Parent Sample	Field Duplicate			
K1014093	CP-MW13-121710	FD-CP1-121710	Mercury	ng/L	20	406	399	2%	7	
K1014093	CP-MW13-121710	FD-CP1-121710	Sulfate	mg/L	0.4	0.64	0.67		0.03	
K1014093	CP-MW13-121710	FD-CP1-121710	Alkalinity (Total)	mg/L	9	241	680	95%		**J**
K1014093	CP-MW13-121710	FD-CP1-121710	Total Dissolved Solids	mg/L	14	1590	1610	1%		
K1014093	CP-MW13-121710	FD-CP1-121710	Sulfide	mg/L	0.02	0.4	0.37	8%		
K1014093	CP-MW13-121710	FD-CP1-121710	DOC	mg/L	1	11.6	10.9	6%		
K1014093	CP-MW13-121710	FD-CP1-121710	Iron	µg/L	20	102	92.7		9.3	
K1014093	CP-MW13-121710	FD-CP1-121710	Manganese, Diss.	µg/L	5	14	13.2		0.8	
K1014093	L1-MW05-121610	FD-L1-121610	Mercury	ng/L	200	4060	3970	2%		
K1014093	L1-MW05-121610	FD-L1-121610	Sulfate	mg/L	20	112	112	0%		
K1014093	L1-MW05-121610	FD-L1-121610	Alkalinity (Total)	mg/L	9	1020	1020	0%		
K1014093	L1-MW05-121610	FD-L1-121610	Total Dissolved Solids	mg/L	14	2780	3040	9%		
K1014093	L1-MW05-121610	FD-L1-121610	Sulfide	mg/L	0.2	1.98	2.1	6%		
K1014093	L1-MW05-121610	FD-L1-121610	DOC	mg/L	25	102	98		4	
K1014093	L1-MW05-121610	FD-L1-121610	Iron	µg/L	20	30700	2890	166%		**J**
K1014093	L1-MW05-121610	FD-L1-121610	Manganese	µg/L	5	733	142	135%		**J**
K1014259	MG-MW05-122010	FD-MG-11	Total Suspended Solids	mg/L	5	6.5	8.5		2	
K1014259	MG-MW05-122010	FD-MG-11	Anthracene	µg/L	0.02	3	3.6	18%		
K1014259	MG-MW05-122010	FD-MG-11	Benz(a)anthracene	µg/L	0.02	2.1	2.3	9%		

SDG No.	Sample ID: Parent Sample	Sample ID: Field Duplicate	Analyte	Unit	MRL	Result: Parent Sample	Result: Field Duplicate	RPD	Conc. Difference	Data Qualifier
K1014259	MG-MW05-122010	FD-MG-11	Benzo(a)pyrene	µg/L	0.02	1.2	1.3	8%		
K1014259	MG-MW05-122010	FD-MG-11	Benzo(b)fluoranthene	µg/L	0.02	1.3	1.4	7%		
K1014259	MG-MW05-122010	FD-MG-11	Benzo(g,h,i)perylene	µg/L	0.02	0.34	0.39	14%		
K1014259	MG-MW05-122010	FD-MG-11	Benzo(k)fluoranthene	µg/L	0.02	0.36	0.4	11%		
K1014259	MG-MW05-122010	FD-MG-11	Chrysene	µg/L	0.02	2.8	3.1	10%		
K1014259	MG-MW05-122010	FD-MG-11	Dibenzo(a,h)anthracene	µg/L	0.02	0.11	0.14	24%		
K1014259	MG-MW05-122010	FD-MG-11	Indeno(1,2,3-cd)pyrene	µg/L	0.02	0.23	0.25	8%		
K1014259	MG-MW05-122010	FD-MG-11	Total cPAHs TEF	µg/L	0.02	1.64	1.78	8%		
K1014259	MG-MW05-122010	FD-MG-11	Aromatics C10-C12 (EPH)	µg/L	40	250	270	8%		
K1014259	MG-MW05-122010	FD-MG-11	Aromatics C12-C16 (EPH)	µg/L	40	160	180		20	
K1014259	MG-MW05-122010	FD-MG-11	Aromatics C16-C21 (EPH)	µg/L	40	230	240	4%		
K1014259	MG-MW05-122010	FD-MG-11	Aromatics C21-C34 (EPH)	µg/L	40	78	120		42	

Note:
mg/L – milligram per liter
µg/L – microgram per liter
ng/L – nanogram per liter
Conc. Difference – Concentration difference between the parent sample and the field duplicate
MRL – Method reporting limit
ND – Not detected at or above the method detection limit
RPD – Relative percent difference