WORK PLAN FOR WELL INSTALLATIONS AND IN-SITU CHEMICAL OXIDATION PILOT STUDY

ARCO Facility No. 5300

710 15th Avenue, Longview, Washington

Antea® Group Project No. 05300EA163
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1.0 INTRODUCTION

On behalf of Atlantic Richfield Company (ARC), Antea®Group has prepared this *Work Plan for Well Installations and In-Situ Chemical Oxidation Pilot Study* (work plan) at ARCO Facility No. 5300 located at 710 15th Avenue, Longview, Cowlitz County, Washington (hereinafter referred to as the "Site"). The objective of the investigation is to characterize off-site subsurface conditions, and to evaluate the feasibility of hydrogen peroxide to be an effective in-situ chemical oxidizer capable of reducing the dissolved phase petroleum hydrocarbon concentrations in groundwater to below Washington State Department of Ecology (Ecology) Model Toxics Control Act (MTCA) Method A Cleanup Levels at the Site.

2.0 BACKGROUND

2.1 Site Description

The Site is an operating ARC facility with a convenience store. The Site is located on the northeast corner of the intersection of 15th Avenue and Tennant Way in Longview, Washington. City road 15th Avenue runs along the western border, Tennant Way runs along the southern border, and retail businesses surround the northern and eastern borders of the Site. The nearest surface water body is Lake Sacajawea located approximately 300 feet west across 15th Avenue in Lake Sacajawea Park. According to Google Earth, the Site is approximately 18 feet above mean sea level in reference to the world geodetic system 1984 (WSG84) datum. The Site vicinity is a mix of commercial and residential land uses. A Site Location Map and a Site Aerial Map are presented as Figures 1 and 2.

Site features include a station building, a trash enclosure, and four dispensing islands with eight dispenser pumps under a single canopy. The underground storage tank (UST) complex consisting of four 10,000 gallon double-wall fiberglass USTs and the associated fueling system components are located in the southeastern portion of the Site. The surface of the Site consists mostly of asphalt and concrete with planters along the western and southern borders. A Site Map detailing the structures is presented as Figure 3.

2.2 Previous Investigations

2.2.1 December 2009 – Dispenser Upgrade Activities

In December 2009, Wayne Perry, Inc. (Wayne Perry) of Yelm, Washington was contracted by ARC to complete dispenser upgrade activities. The upgrade activities included the installation of four new dispensers with under dispenser containment (UDC) vaults, installation of new product distribution piping and vapor lines. On December 3, 2009, Delta Consultants (Delta) collected compliance soil samples during the upgrade activities. Field screening indicated a photoionization detector (PID) reading of 1,004 parts per million (ppm) in the soil sample (NW-Disp-W) collected beneath the northwest dispenser. Over-excavation activities were conducted at this sample location, and the area was excavated to a depth of approximately 8 feet below ground surface (bgs). Confirmatory soil sample NW-Disp-8 was collected from the bottom of the excavation. A total of 16 soil samples were collected and submitted to Test America in Tacoma, Washington for quantitative chemical analysis. Laboratory analytical results indicated petroleum hydrocarbon concentrations in excess of the MTCA Method A Cleanup Levels in soil sample NW-Disp-W. The laboratory analytical results of the confirmatory soil sample collected from the over-excavation activities indicated the concentration for total petroleum hydrocarbons as gasoline (TPH-G) was detected slightly above MTCA Method A Cleanup Level at 36 milligrams per kilograms (mg/kg). On behalf of ARC, Belshire Environmental Services, Inc. (Belshire) of Foothills Ranch, California coordinated the disposal of 9.91 tons of soils from the upgrade and over-excavation activities to be transported to Cemex in Everett, Washington. The soil analytical results are summarized in Table 1.

2.2.2 August 2012 – Subsurface Investigation

On August 3 and 4, 2012, Antea Group advanced four borings to a maximum depth of 20 feet bgs and completed them as groundwater monitoring wells (MW-1, MW-2, MW-3, and MW-4). Soil samples were collected at depths ranging from 5 to 12 feet bgs. A total of 11 soil samples were collected and submitted to Pace Analytical (Pace) in Seattle, Washington for quantitative chemical analyses. Laboratory analytical results did not indicate petroleum hydrocarbon concentrations in excess of the MTCA Method A Cleanup Levels in any of the soil samples collected. The soil analytical results are summarized in Table 1. The boring logs are included in Appendix A.

2.2.3 August 2013 – Subsurface Investigation

On August 14 and 15, 2013, Antea Group advanced four soil borings and completed three of the borings as groundwater monitoring wells MW-6, MW-7, and MW-8. One boring, SB-5, was pre-cleared to 6.5 feet bgs but was not advanced due to limitations with the City of Longview right-of-way (ROW) permit. Seven soil samples were collected and submitted to ALS Environmental (ALS) in Kelso, Washington for quantitative chemical analysis. Laboratory analytical results did not indicate petroleum hydrocarbon concentrations in excess of the MTCA Method A Cleanup Levels for any soil samples. The soil analytical results are summarized in Table 1. The boring logs are included in Appendix A.

2.2.4 September 2012 to August 2015 – Groundwater Monitoring and Sampling

In September 2012, Antea Group conducted a groundwater sampling event following the installation of the monitoring wells. The groundwater samples were submitted to Pace for quantitative chemical analyses. Concentrations of benzene and TPH-G were detected in excess of MTCA Method A Cleanup Levels in the groundwater sample collected from MW-4 at 6.1 micrograms per liter (ug/L) and 10,200 ug/L, respectively. Total lead concentrations were detected in excess of the MTCA Method A Cleanup Level in wells MW-1 and MW-2 at 50.6 ug/L and 15.8 ug/L, respectively.

Quarterly and/or semi-annual groundwater monitoring and sampling events have been conducted since September 2012. Concentrations of TPH-G in excess of the MTCA Method A Cleanup Level have been detected in groundwater samples collected from MW-4 ranging from 3,230 ug/L to 10,200 ug/L. A total lead concentration of 15.8 ug/L was detected in MW-4 in December 2012. In April 2014, groundwater data indicated a TPH-G concentration in excess of the MTCA Method A Cleanup Level in MW-6 at 830 ug/L. No other hydrocarbon concentrations were detected in excess of MTCA Method A Cleanup Levels during these events. Depth to water has ranged from 10.5 to 13.0 feet bgs. Groundwater direction is generally to the southwest with a gradient of less than 0.01 feet per linear foot (ft/linear ft). A summary of Groundwater Gauging Data and Groundwater Analytical Data are presented as Tables 2 and 3, respectively.

In April 2014, additional data was collected to evaluate groundwater chemistry in preparation for the ISCO pilot study. Additional analyses included ethane, ethane, methane, total and dissolved iron, nitrate, sulfate, total organic carbon, alkalinity, and chemical oxygen demand. The full list of extended groundwater data is presented on Table 4.

2.3 Current Site Status

The Site was entered into the Ecology Leaking Underground Storage Tank (LUST) database with a LUST ID No. 6485 on December 18, 2009, following analytical results from the dispenser upgrade activities in December 2009. The current unit status on the Ecology Toxics Cleanup Program Web Reporting database is “Awaiting Cleanup”. The Site currently has seven groundwater monitoring wells (MW-1 through MW-4, and MW-6 through MW-8) sampled on a quarterly basis utilizing the low flow groundwater sampling methods.

3.0 SITE GEOLOGY AND HYDROGEOLOGY

Geologic information for the Site was obtained from a Washing State Department of Natural Resources Geological Map of Washington State by J. Eric Schuster, 2005. According to the geological map, the City of Longview is located in an area predominately Quaternary Alluvium that was transported and deposited by the Columbia and Cowlitz Rivers. Alluvium consists of mostly unconsolidated silt, sand, and gravel valley fill with some clay. The

alluvium ranges from loose to medium density and may contain interbeds of marsh, peat, artificial fill, and glacial deposits. This soil description is consistent with the lithology observed during the subsurface investigation.

The groundwater at the Site is typically encountered at relatively shallow depths. Based on previous groundwater sampling events, the depth to groundwater has ranged from 10.5 to 13.0 feet bgs. Groundwater direction is typically southwest or west-southwest, but has been observed in the northwest direction. Groundwater gradient is approximately 0.01 ft/linear ft. The latest Groundwater Elevation Contour Map is presented as Figure 4. A rose diagram indicating groundwater direction is included as Figure 5.

Drinking water from the City of Longview has been typically supplied from the Cowlitz River treated by the Regional Water Treatment Plan (RWTP). Concerns about changing water quality in the Cowlitz River and aging components at the RWTP prompted the development of a new treatment plan, the Mint Farm Regional Water Treatment Plan (MFRWTP). The MFRWTP is located approximately 2.5 miles west of the Site. The Site is located just outside the Mint Farm Wellhead Protection Area (WHPA). A map of the Mint Farm WHPA is presented in Appendix B.

4.0 OBJECTIVE AND SCOPE OF WORK

The objective of the investigation is to characterize off-site subsurface conditions, and to evaluate the feasibility of hydrogen peroxide to be an effective in-situ chemical oxidizer of the petroleum hydrocarbon concentrations in groundwater at the Site. Antea Group is proposing to install one off-site groundwater monitoring well (MW-5) and four onsite injection wells (IW-1, IW-2, IW-3, and IW-4) in the vicinity of monitoring wells MW-4 and MW-6. The injection wells will be installed approximately 5 to 8 feet from the target monitoring wells. Antea Group will use the injections wells to conduct a water injection test to evaluate how the subsurface will accommodate a large volume of solution. Pending the successful completion of the water injection test, Antea Group will proceed with the in-situ chemical oxidation (ISCO) pilot study using hydrogen peroxide. All fieldwork will be implemented and completed in accordance with BP's Control of Work (CoW) Defined Practices and is attached in Appendix C.

To test the feasibility of ISCO injections to treat dissolved phase petroleum hydrocarbons in groundwater at the Site, Antea Group is proposing the following tasks:

- Installation of four injection wells (IW-1, IW-2, IW-3, and IW-4) in the vicinity of the monitoring wells MW-4 and MW-6;
- Conduct a water injection test to evaluate the subsurface intake of water;
- Collection of baseline groundwater samples from all monitoring wells (MW-1 through MW-8);
- Conduct hydrogen peroxide injection events into IW-1 through IW-4 once a week for two weeks;

- Collection of groundwater samples from all monitoring wells (MW-1 through MW-8) one week after each injection event.

4.1 Pre-Drilling and Planning Activities

As part of pre-ISCO pilot study activities, Antea Group will:

- Prepare a work plan for well installations and ISCO pilot study;
- Submit the work plan to Antea Group's Engineering Assurance (EA) team and Ecology;
- Update the Health and Safety Plan (HASP) for the Site. A copy of the HASP will be available at the Site during field activities. Field activities performed by Antea Group at the Site will be conducted in accordance with guidelines established in the HASP;
- Obtain an approved Underground Injection Control (UIC) permit from Ecology;
- Obtain a City of Longview ROW Permit for the proposed work;
- Request a public locate via the One-Call Notification Center;
- Conduct a meeting with subcontractors to develop Level 1 and Level 2 Task Risk Assessment (TRA) with the scope of work described in the work plan;
- Perform a Site visit to evaluate access limitation and other activities as needed; and
- Identify location, depth, and construction materials of subsurface utilities at the Site.

4.2 Utility Locates

The proposed boring locations will be marked and the Utility Underground Location Center will be contacted at least 72 hours before field work is to begin. A Site walk will be conducted to visually inspect for utility markers and indicators. The Site owner and/or tenants will be contacted for their knowledge of utilities. Applied Professional Services, Inc. (APS) of North Bend, Washington will also be utilized to identify subsurface utilities. APS will sweep a search zone 10 feet in all directions surrounding the proposed boring locations. APS uses Metrotech 810 multi-frequency locators to identify conductive subsurface utilities. All utilities will be marked in paint and recorded on a drawing/plot plan. Proposed boring locations that are within two feet of an identified utility it will be relocated three or more feet away from the identified utility.

4.3 Right-of-Way Permit

Prior to conducting any work in the public ROW of 15th Avenue, a City of Longview ROW permit must be obtained. The application to perform work on public ROW must be completed with proposed work and drawing to be reviewed by a City Engineer. Antea Group will submit a Traffic Control Plan for work within the ROW compiled by Altus Traffic (Altus) from SeaTac, Washington. The Traffic Control Plan will be created in compliance with the Manual on Uniform Traffic Control Devices (MUTCD). Based on the requirements of the ROW permit, a City Engineer may be contacted to request an inspection 24 hours before backfilling trenches or repairing pavement

and the Underground Utilities Coordinating Council may be contacted within 2 working days before proceeding with any excavation associated with the permit.

4.4 Underground Injection Control Permit

Prior to conducting the ISCO pilot study, an Underground Injection Control (UIC) Permit will have to be obtained from Ecology. Ecology regulates all fluid discharges into groundwater to protect water quality. The UIC Permit will allow Antea Group to inject hydrogen peroxide into the subsurface of the Site.

5.0 INJECTION WELL AND MONITORING WELL INSTALLATIONS

Antea Group is proposing to install one off-site groundwater monitoring well (MW-5) in the City of Longview ROW at boring location SB-5. Boring SB-5 is located in the ROW of 15th Avenue, in the southbound left-hand turn lane. Boring SB-5 was previously pre-cleared during the subsurface investigation conducted in August 2013. However, due to limitations with the City of Longview ROW permit, a monitoring well was not installed. The proposed groundwater monitoring well MW-5 will be used to characterize the off-site subsurface conditions in soil and groundwater with respect to petroleum hydrocarbons.

Antea Group is also proposing to install three injection wells (IW-1, IW-2, and IW-3) in the vicinity of monitoring well MW-4 and one injection well (IW-4) near monitoring well MW-6. Injection well IW-1 will be installed north, IW-2 will be installed east, and IW-3 will be installed south of MW-4. Injection well IW-4 will be installed northeast of MW-6. The injection wells will be installed approximately 5 to 8 feet from the target monitoring well.

5.1 Well Installations and Construction Details

Per Remediation Management (RM) Defined Practice for Ground Disturbance (RM Ground Disturbance), all borings must be cleared to a minimum of 6.5 feet bgs utilizing a vacuum truck with air-knife and/or hand tools. Once the borings are cleared to 6.5 feet bgs, a licensed driller will advance the borings using a hollow stem auger drill rig. The soil boring SB-5 will be completed as groundwater monitoring well MW-5 constructed of a 2-inch diameter schedule 40 polyvinyl chloride (PVC) casing with 0.010-inch slotted screen. Well MW-5 will be completed to 20 feet bgs with 15 feet of slotted screen. The borings that will completed as injection wells will be constructed of 4-inch diameter schedule 40 PVC casing with 0.020-inch slotted screen. The injection wells will be completed to 15 feet bgs with 5 feet of slotted screen. All wells will be backfilled with sand to 2 feet above the screen, followed by a 1 foot bentonite seal, and bentonite grout to 18-inches bgs. The wells will be completed to ground surface using flush-mounted well lids. Soil borings not completed as wells will be decommissioned by the licensed well driller by backfilling the borings with hydrated bentonite chips.

5.2 Soil Sampling

Soil samples will be collected during well installation activities. Field methods associated with soil samples are described below.

5.2.1 Soil sampling Procedures

The vacuum truck with air-knife will be used to pothole the boring location to a depth of approximately 5 feet bgs or shallower based on depths of historical impacts. A hand auger equipped with a steel soil auger head and 5 foot extension rod or other hand tools deemed feasible will be used to collect an undisturbed soil sample at depths of less than 6.5 feet bgs. The soil auger head is approximately 3 inches in diameter and 12 inches long. Following sample collection, the vacuum truck and air-knife will again be used to advance the pothole to a depth of at least 6.5 feet bgs and soil sampling will continue as detailed below.

Soil samples will be collected approximately every 5 feet bgs to the terminal depth of the boring unless field observations, photoionization detector (PID) readings, or other information indicates that additional samples are necessary. Soil samples will be collected from the borings using an 18 inch split spoon sampler during hollow stem auger drilling. The split spoon samplers and hand auger will be decontaminated between each sample. Soil samples will be obtained from the split spoon sampler and hand auger using a syringe sampler and placed into laboratory-supplied 40-milliliter (mL) VOA vials preserved with methanol and/or sodium bisulfate in accordance with Environmental Protection Agency (EPA) Method 5035A. Additional soil will be placed into 4 to 8-ounce laboratory-supplied glass soil jars. After collection, each soil sample will be field screened for the presence of volatile organic compounds with a PID to aid in the facilitation of selecting representative soil samples for chemical analysis. Clear plastic bags will be filled to one-third to half capacity and then sealed. Soils in the bags will then be gently agitated to facilitate the breakup of any lumps and allowed to sit for approximately ten minutes prior to analyzing the air above the soil in the bag. The maximum vapor concentrations will be recorded for each soil sample collected.

Each boring will be logged in accordance with standard geologic practices for the environmental industry. Boring logs will include detailed descriptions of materials encountered during drilling, including Unified Soil Classification System (USCS) (ASTM Standard D-2488-93) classification and description, field density, moisture content, color, the presence of fill, debris, and contamination (visual or odors).

5.2.2 Soil Sample Designations

Soil samples will be assigned a unique identification code. The sample designation consists of the boring location number and the depth or depth interval. For example, the designation "IW-1-5" identifies a soil sample collected at 5 feet bgs from boring location IW-1.

5.2.3 Equipment Decontamination

Soil sampling equipment will be decontaminated prior to initiating sampling activities, between sampling locations, and upon completion of sampling activities. Field sampling equipment used in the collection of soil samples will be decontaminated by washing with non-phosphate detergent and rinsing with deionized water. Drilling equipment that directly contacts soil samples will be decontaminated after each exploration. Attached soil will be brushed off and any remaining visible soil will be removed using a high-pressure steam cleaner.

5.3 Well Development and Surveying

Following well installations and prior to sampling, the groundwater monitoring well and injection wells will be developed following well installations. Well development is performed to produce representative formation water that is free of drilling fluids, cutting, or other material potentially introduced during drilling and well construction activities. The injection wells will be developed to remove sediment that may have accumulated during well installation to improve hydraulic connection with the aquifer. The location and elevation of MW-5 will be surveyed. Vertical control will be relative to an arbitrary vertical datum or previously identified vertical datum. Elevations will be surveyed to the nearest 0.01 foot.

5.4 Investigation-Derived Waste

Investigation-derived wastes (IDW) in the form of soil cuttings and/or purge water are expected to be generated during field activities. Soil and purge water generated during field activities will be placed in Department of Transportation-approved 55-gallon drums. The drums will be sealed, labeled, and temporarily stored on the Site. Arrangements for proper disposal and/or recycling of IDW will be made upon receipt of final analytical results for soil and groundwater. All IDW will be disposed of by an ARC RM approved contractor.

6.0 WATER INJECTION PILOT STUDY

In order to anticipate how the subsurface will accommodate the volume of hydrogen peroxide solution, a pilot study using water will be conducted. Approximately 500 gallons of water will be gravity fed into injection wells IW-1 through IW-4. In addition to gravity feed, a water injection step test will also be conducted to monitor injections under different pressures. Monitoring wells MW-4, MW-6, and MW-7 will be monitored for mounding groundwater conditions. If groundwater levels in wells MW-4, MW-6, and MW-7 rise in excess of 2 feet, injections will be terminated to allow groundwater levels to equilibrate. Results of the water injection pilot study will be used to determine the practical volume of hydrogen peroxide to be injected in each event.

7.0 BASELINE GROUNDWATER SAMPLING

Following well installation and development, groundwater samples will be collected from existing monitoring wells MW-1 through MW-4, MW-6 through MW-8, and from newly installed monitoring well MW-5.

7.1 Groundwater Sampling Procedures

Groundwater samples will be collected after the monitoring wells have been developed. The depth to water at each monitoring well will be measured and groundwater samples will be collected from the new monitoring wells after development. Samples will be collected using the low flow sampling techniques utilizing a peristaltic pump, and dedicated silicon and polyethylene tubing. The silicon tubing will be used for the section around the rotor head of the peristaltic pump while the dedicated polyethylene tubing will be used in the monitoring well. Field parameters such as dissolved oxygen, oxygen reduction potential, turbidity, temperature, specific conductivity, and pH will be monitored using a Horiba, YSI or equivalent equipment. Each monitoring well will be purged at a slow speed until the field parameters stabilize. The field parameters will be recorded at approximately three to five minute intervals until stabilization is achieved. After stabilization, groundwater will be collected directly from the polyethylene tubing into the appropriate laboratory-supplied containers and placed in a cooler with ice.

8.0 LABORATORY ANALYSIS PLAN

Soil and groundwater samples selected for chemical analysis will be delivered to Test America and analyzed within standard holding times.

8.1 Quantitative Laboratory Analysis

All sample containers will be labeled, placed in a field cooler after collection, and packed with ice pending transport. Standard chain-of-custody procedures will be used for all samples submitted to the laboratory. Samples will be sub-packed by sample location in new zippered plastic bags and stored in the dark at approximately 4°C. A temperature compliance vial will accompany each cooler to verify that proper holding temperatures were maintained during transport.

A chain-of-custody form sealed in a plastic zippered bag will accompany each sample cooler containing laboratory samples. The Antea Group field personnel will retain a copy of the chain-of-custody, and the original will be sent with the samples to the laboratory.

The soil and groundwater samples will be analyzed for constituents listed in Table 830-1, Required Testing for Petroleum Releases, Gasoline Range Organics, of the Ecology MTCA Cleanup Regulation, Chapter 173-340 WAC. Soil and groundwater samples will be analyzed for the following constituents of concern (COCs):

- Benzene, toluene, ethylbenzene, and total xylenes (BTEX) by EPA Method 8260B;
- Methyl tertiary-butyl ether (MTBE) by EPA Method 8260B;
- Total petroleum hydrocarbons as gasoline (TPH-G) by Northwest Method NWTPH-Gx; and
- Total lead and dissolved lead (groundwater) using EPA 6000/7000 Series Methods.

In accordance with the time schedule for this project, all samples will be submitted for regular turn around analyses with Test America. Rush analyses may be requested if field conditions or waste disposal profiling necessitates expedited analyses.

8.2 Field Quality Control and Documentation

Samples will be kept in sight of the sampling crew or in a secure, locked vehicle at all times. Transfer of samples from field personnel to the laboratory will be documented using chain-of-custody procedures. If someone other than the sample collector transports samples to the laboratory, the collector will sign and date the Chain-of-Custody Record and insert the name of the person or firm transporting the samples under "transported by" before sealing the container with a Custody Seal.

Field personnel will record required field information for each sampling location. The person recording the data will review all data and log forms daily, so that any errors or omissions can be corrected. All completed data sheets will be removed daily from the field, photocopied, and stored in the project file.

9.0 IN-SITU CHEMICAL OXIDATION PILOT STUDY

An injection gallery of four wells (IW-1, IW-2, IW-3, and IW-4) will be installed around monitoring wells MW-4 and MW-6. The injection gallery will allow for increased distribution and reduced channeling of the reagent across the width of the petroleum hydrocarbon plume as well as allowing for reagent reapplication to the target area if additional applications are warranted after the initial pilot study. An injection gallery was chosen instead of using direct push to minimize groundwater table mounding that frequently occurs with direct push applications and to limit injection pressure associated with direct push that can lead to unsafe conditions during the field activities.

Commercially available hydrogen peroxide has a concentration of 35% weight per volume. Generally, concentrations of hydrogen peroxide used in water quality applications range from 4% to 20%. Peroxide reactions are exothermic and strong solutions of hydrogen peroxide (>10%) may present problems with heat generation and casing damage in the injection wells. A hydrogen peroxide solution concentration 7% will provide the necessary oxidation strength to decompose contaminants and increase dissolved oxygen while maintaining the integrity of the injection wells.

The target area is predominantly underlain by silt and silty sand with lenses of poorly-graded sand. The size of the treatment zone is approximately 20 feet long by 20 feet wide, with an assumed thickness of approximately 8 feet. Assuming a porosity of 35%, the volume of groundwater in the target area is approximately 4,189 gallons. The soil types in the target area can be relatively permeable. The dosage volume of hydrogen peroxide injected is a function of the mass of contaminant, the amount of organic material in the soil that would react with the peroxide, and the amount of inorganic constituents that could terminate oxidation reactions or form insoluble reaction products (e.g. alkanity, Fe^{+3}); approximately 10 to 50% of the volume of plume. It is anticipated that approximately 2,100 gallons of hydrogen peroxide will be required to address the hydrocarbon plume and ensure that hydrogen peroxide moves out from the injection well into the formation. The Petroleum Hydrocarbon Mass in Groundwater Calculations is included as Table 5.

9.1 Onsite Injection Procedure

Hydrogen peroxide will be transported to the Site in a Department of Transportation (DOT) approved tote by a chemical distribution company and piped directly into the injection wellheads during the pilot study. No solution will be stored or left onsite and the injection process will be continuously monitored by field personnel. The following tasks will be performed during each hydrogen peroxide injection event:

- Delineate the work zones with delineators and reflective safety boards. Setup the work zone area with secondary booms.
- Measure depth to water and water quality parameters (pH, conductivity, oxidation reduction potential, total dissolved solids, temperature, and dissolved oxygen) in wells MW-2, MW-7, and MW-8.
- Setup the injection tote, valve, hose, and stringer attachment. Ensure that the injection equipment is clean. The injection setup must be leak tested with water prior to the injection of hydrogen peroxide.
- Initiate injection at wells IW-1 through IW-4. The hydrogen peroxide will be drained at a flow rate that ensures the well casing does not fill up with hydrogen peroxide and cause surfacing.
- Collect depth to water, water quality parameters, and pressure influence at wells MW-2, MW-7, and MW-8 approximately every 30 minutes during the injection event.
- Upon completion of the injection event, place pressure gauges on injection wells IW-1 through IW-4 to measure the pressure. If there is measureable pressure, allow the wells to vent for a minimum of 30 minutes until the pressure has subsided. Once the pressure has subsided, the wells can be capped.
- Collect a final round of depth to water and water quality parameters from MW-2, MW-7, and MW-8.

9.2 Down-Gradient Continuous Monitoring

Pending the installation of MW-5 and the City of Longview ROW permit, an Aquistar pressure and temperature datalogger will be installed in monitoring well MW-5 prior to the initiation of hydrogen peroxide injection to monitor temperature and pressure down-gradient of the injection gallery through the duration of the pilot study. Peroxide reactions are exothermic and the data collected will assist with monitoring hydrogen peroxide

distribution towards MW-5 and water levels during the injection process. The logger has an accuracy of 0.5 degrees Celsius and a resolution of 0.06 degrees Celsius and will be set to log temperature and pressure every five minutes throughout the pilot study. A specification sheet detailing the datalogger design and performance is included in Appendix D.

9.3 Groundwater Monitoring & Sampling

Depth to groundwater, water quality parameters, and pressure in MW-2, MW-7, and MW-8 will be monitored frequently to assess any groundwater mounding that may occur. If groundwater levels in MW-2, MW-7, and MW-8 rise in excess of 2 feet, injections will cease to prevent hydrogen peroxide from coming into contact with utilities in the treatment area. Similarly, injection will be suspended if any upwelling at the injection wells or leaks in the piping is observed. In addition, if the temperatures in these wells increase by 5 degrees Celsius, injections will cease to allow the reaction time to quell.

Baseline groundwater samples will be collected from all wells (MW-1 through MW-8) prior to each injection event. One week following each injection event, Antea Group personnel will collect groundwater samples from all wells.

10.0 DATA EVALUATION

Concentrations of petroleum hydrocarbons in groundwater will be compared to the Ecology MTCA Method A Cleanup Levels. Data from the baseline and post injection groundwater sampling events will be plotted on a graph to evaluate concentrations of petroleum hydrocarbons versus time.

11.0 REPORT GENERATION

A written report will be prepared describing the results of field activities, analytical results, and data evaluation results. Conclusions and recommendations regarding the results of field activities and potential future work, if warranted, will be included in the report. The report will include tables, maps, figures, and appendices pertinent to the data collected during field activities.

12.0 SCHEDULE

Field activities outlined in this work plan are scheduled for the second quarter of 2016 pending RM's review and approval of this work plan through the project management framework procedures. Other approvals include the City of Longview ROW permit approval and the UIC permit approval from Ecology. This schedule may be delayed or accelerated by contractor availability, weather, or other factors. All other work plan contingencies are included in Appendix E.

13.0 REFERENCES

Soil Sampling during Dispenser Upgrade Activities, Delta Consultants, April 21, 2010

Subsurface Investigation Report, Antea Group, September 12, 2013

Semi-Annual Groundwater Monitoring Report, Antea Group, February 2, 2016

Subsurface Investigation Report, Antea Group, March 20, 2014

14.0 REMARKS

The recommendations contained in this report represent Antea USA, Inc.'s professional opinions based upon the currently available information and are arrived at in accordance with currently accepted professional standards. This report is based upon a specific scope of work requested by the client. The contract between Antea USA, Inc. and its client outlines the scope of work, and only those tasks specifically authorized by that contract or outlined in this report were performed. This report is intended only for the use of Antea USA, Inc.'s client and anyone else specifically identified in writing by Antea USA, Inc. as a user of this report. Antea USA, Inc. will not and cannot be liable for unauthorized reliance by any other third party. Other than as contained in this paragraph, Antea USA, Inc. makes no express or implied warranty as to the contents of this report.

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c.c. Mr. Aaren Fiedler, Washington Department of Ecology, Southwest Regional Office
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Tables

TABLE 1
SUMMARY OF SOIL ANALYTICAL DATA
ARCO FACILITY NO. 5300
710 15TH AVENUE
LONGVIEW, WASHINGTON

Sample ID	Date Sampled	Sample Depth (feet)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-Benzene (mg/kg)	Total Xylenes (mg/kg)	MTBE (mg/kg)	1,2 Dibromo ethane (mg/kg)	1,2 Dichloro ethane (mg/kg)	TPH-G (mg/kg)	TPH-D (mg/kg)	TPH-O (mg/kg)	Total Lead (mg/kg)	Comments
NC-Line	12/3/2009	3.5	<0.011	<3.3	<3.3	<4.4	<0.0011	<0.0011	<0.0011	<5.9	NA	NA	3.5	
NE-Disp-E	12/3/2009	3.5	<0.011	<3.4	<3.4	<4.5	<0.0011	<0.0011	<0.0011	<5.1	NA	NA	3.8	
NE-Disp-W	12/3/2009	3.5	<0.011	<3.2	<3.2	<4.2	<0.0011	<0.0011	<0.0011	<6.1	NA	NA	3.3	
NE-Line	12/3/2009	3.5	<0.011	<3.2	<3.2	<4.3	<0.0011	<0.0011	<0.0011	<5.6	NA	NA	3.3	
NW-Disp-E	12/3/2009	3.5	<0.012	<3.7	<3.7	<5.0	<0.0012	<0.0012	<0.0012	<6.8	NA	NA	3.1	
NW-Disp-W	12/3/2009	3.5	2.9	550	840	1,200	<0.60	<0.60	<0.60	21,000	NA	NA	4.7	
NW-Disp-8	12/3/2009	8.0	<0.013	<4.0	<4.0	<5.3	<0.0013	<0.0013	<0.0013	36	NA	NA	4.4	
NW-Line	12/3/2009	3.5	<0.011	<3.3	<3.3	<4.4	<0.0011	<0.0011	<0.0011	<4.8	NA	NA	4.4	
SC-Line	12/3/2009	3.5	<0.011	<3.4	<3.4	<4.5	<0.0011	<0.0011	<0.0011	<5.8	NA	NA	3.3	
SE-Disp-E	12/3/2009	3.5	<0.011	<3.3	<3.3	<4.5	<0.0011	<0.0011	<0.0011	<5.5	NA	NA	3.2	
SE-Disp-W	12/3/2009	3.5	<0.011	<3.4	<3.4	<4.5	<0.0011	<0.0011	<0.0011	<6.1	NA	NA	3.2	
SE-Line	12/3/2009	3.5	<0.012	<3.6	<3.6	<4.8	<0.0012	<0.0012	<0.0012	<5.9	NA	NA	3.2	
SW-Disp-E	12/3/2009	3.5	<0.011	<3.3	<3.3	<4.4	<0.0011	<0.0011	<0.0011	<5.2	NA	NA	5.1	
SW-Disp-W	12/3/2009	3.5	<0.011	<3.3	<3.3	<4.5	<0.0011	<0.0011	<0.0011	<5.4	NA	NA	6.4	
SW-Line	12/3/2009	3.5	<0.012	<3.5	<3.5	<4.7	<0.0012	<0.0012	<0.0012	<5.0	NA	NA	14	
SP-1	12/3/2009	NA	0.019	29	23	43	<0.0011	<0.0011	<0.0011	730	NA	NA	4.9	
MW-1-5.0	8/2/2012	5	<0.0036	<0.0036	<0.0036	<0.011	<0.0036	NA	NA	<7.7	NA	NA	3.5	
MW-1-8.0	8/2/2012	8	<0.0035	<0.0035	<0.0035	<0.011	<0.0035	NA	NA	<7.9	NA	NA	5.2	
MW-1-12.0	8/2/2012	12	<0.0036	<0.0036	<0.0036	<0.011	<0.0036	NA	NA	<8.2	NA	NA	3.6	
MW-2-5.0	8/2/2012	5	<0.0039	<0.0039	<0.0039	<0.012	<0.0039	NA	NA	<7.5	NA	NA	3.9	
MW-2-10.0	8/2/2012	10	<0.0041	<0.0041	<0.0041	<0.012	<0.0041	NA	NA	<9.0	NA	NA	4.4	
MW-2-12.0	8/2/2012	12	<0.0035	<0.0035	<0.0035	<0.011	<0.0035	NA	NA	<7.2	NA	NA	2.5	
MW-3-5.0	8/2/2012	5	<0.0038	<0.0038	<0.0038	<0.011	<0.0038	NA	NA	<8.3	NA	NA	2.9	
MW-3-10.0	8/2/2012	10	<0.0036	<0.0036	<0.0036	<0.011	<0.0036	NA	NA	<8.2	NA	NA	5.3	

TABLE 1
SUMMARY OF SOIL ANALYTICAL DATA
ARCO FACILITY NO. 5300
710 15TH AVENUE
LONGVIEW, WASHINGTON

Sample ID	Date Sampled	Sample Depth (feet)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl-Benzene (mg/kg)	Total Xylenes (mg/kg)	MTBE (mg/kg)	1,2 Dibromo ethane (mg/kg)	1,2 Dichloro ethane (mg/kg)	TPH-G (mg/kg)	TPH-D (mg/kg)	TPH-O (mg/kg)	Total Lead (mg/kg)	Comments
MW-4-5.0	8/3/2012	5	<0.0034	<0.0034	<0.0034	<0.010	<0.0034	NA	NA	<6.8	NA	NA	4.1	
MW-4-9.0	8/3/2012	9	<0.0038	<0.0038	<0.0038	<0.011	<0.0038	NA	NA	<8.5	NA	NA	5.0	
MW-4-12.0	8/3/2012	12	<0.0033	<0.0033	0.0079	<0.010	<0.0033	NA	NA	<7.2	NA	NA	4.8	
SB-5-5.0	8/14/2013	5	<0.0054	<0.0054	<0.0054	<0.011	<0.0054	<0.00011	<0.0054	<6.7	NA	NA	3.54	
MW-6-5.0	8/15/2013	5	<0.0061	0.0088	<0.0061	<0.012	<0.0061	<0.00012	<0.0061	<8.5	NA	NA	6.07	
MW-6-9.5	8/15/2013	9.5	<0.0063	0.0064	<0.0063	<0.013	<0.0063	<0.00012	<0.0063	<9.2	NA	NA	4.82	
MW-7-5.0	8/15/2013	5	<0.0054	0.0087	<0.0054	<0.011	<0.0054	<0.00011	<0.0054	<7.3	NA	NA	3.61	
MW-7-9.5	8/15/2013	9.5	<0.0065	<0.0065	<0.0065	<0.013	<0.0065	<0.00013	<0.0065	<7.6	NA	NA	4.25	
MW-8-5.0	8/15/2013	5	<0.0061	0.0081	<0.0061	<0.012	<0.0061	<0.00012	<0.0061	<9.4	NA	NA	3.23	
MW-8-9.5	8/15/2013	9.5	<0.0063	<0.0063	<0.0063	<0.013	<0.0063	<0.00012	<0.0063	<8.6	NA	NA	4.33	
MTCA Method A Cleanup Levels			0.03	7.0	6.0	9.0	0.1	0.005	-	100/30*	2,000	2,000	250	

*100 mg/kg if no detectable levels of Benzene in the sample- otherwise 30 mg/kg.

Notes: Benzene, toluene, ethylbenzene, total xylenes, and methyl tert-butyl ether (MTBE) analyzed by EPA Method 8260.

1,2-Dibromoethane (EDB) and 1,2-Dichloroethane (EDC) analyzed by EPA Method 8260.

TPH-G = Total Petroleum Hydrocarbons as Gasolineanalyzed by the Northwest Method NWTPH-Gx.

Total lead analyzed by EPA Method 6020.

mg/kg = Milligrams per kilogram.

<0.0054 = Concentrations were not detected above the method detection limit and/or method reporting limit.

NA= Not analyzed

TABLE 2

Groundwater Gauging Data

Arco Facility 5300

710 15th Avenue

Longview, WA

Well I.D.	Date	GROUNDWATER ELEVATION DATA					
		TOC Elevation (ft)	Water Level Depth (ft)	LNAPL Depth (ft)	LNAPL Thickness (ft)	Water Level Elevation* (ft)	Qualifiers
MW-1	9/6/2012	99.90	11.57	NP	--	88.33	--
MW-1	12/14/2012	99.90	10.45	NP	--	89.45	--
MW-1	1/9/2013	99.90	10.42	NP	--	89.48	--
MW-1	5/29/2013	99.90	10.68	NP	--	89.22	--
MW-1	8/20/2013	99.90	11.45	NP	--	88.45	--
MW-1	11/13/2013	99.90	11.08	NP	--	88.82	--
MW-1	2/19/2014	99.90	10.54	NP	--	89.36	--
MW-1	4/23/2014	99.90	10.40	NP	--	89.50	--
MW-1	8/7/2014	99.90	11.28	NP	--	88.62	--
MW-1	11/19/2014	99.90	11.12	NP	--	88.78	--
MW-1	2/25/2015	99.90	10.72	NP	--	89.18	--
MW-1	8/11/2015	99.90	11.84	NP	--	88.06	--
MW-2	9/6/2012	99.72	11.43	NP	--	88.29	--
MW-2	12/14/2012	99.72	10.45	NP	--	89.27	--
MW-2	1/9/2013	99.72	10.38	NP	--	89.34	--
MW-2	5/29/2013	99.72	10.66	NP	--	89.06	--
MW-2	8/20/2013	99.72	11.35	NP	--	88.37	--
MW-2	11/13/2013	99.72	11.02	NP	--	88.70	--
MW-2	2/19/2014	99.72	10.49	NP	--	89.23	--
MW-2	4/23/2014	99.72	10.38	NP	--	89.34	--
MW-2	8/7/2014	99.72	11.22	NP	--	88.50	--
MW-2	11/19/2014	99.72	11.03	NP	--	88.69	--
MW-2	2/25/2015	99.72	10.72	NP	--	89.00	--
MW-2	8/11/2015	99.72	11.74	NP	--	87.98	--
MW-3	9/6/2012	99.68	11.63	NP	--	88.05	--
MW-3	12/14/2012	99.68	10.51	NP	--	89.17	--
MW-3	1/9/2013	99.68	10.45	NP	--	89.23	--
MW-3	5/29/2013	99.68	10.81	NP	--	88.87	--
MW-3	8/20/2013	99.68	11.55	NP	--	88.13	--
MW-3	11/13/2013	99.68	11.10	NP	--	88.58	--
MW-3	2/19/2014	99.68	10.01	NP	--	89.67	--
MW-3	4/23/2014	99.68	10.47	NP	--	89.21	--
MW-3	8/7/2014	99.68	11.36	NP	--	88.32	--

TABLE 2

Groundwater Gauging Data

Arco Facility 5300

710 15th Avenue

Longview, WA

Well I.D.	Date	GROUNDWATER ELEVATION DATA					
		TOC Elevation (ft)	Water Level Depth (ft)	LNAPL Depth (ft)	LNAPL Thickness (ft)	Water Level Elevation* (ft)	Qualifiers
MW-3	11/19/2014	99.68	11.10	NP	--	88.58	--
MW-3	2/25/2015	99.68	10.92	NP	--	88.76	--
MW-3	8/11/2015	99.68	11.94	NP	--	87.74	--
MW-4	9/6/2012	100.00	12.02	NP	--	87.98	--
MW-4	12/14/2012	100.00	11.03	NP	--	88.97	--
MW-4	1/9/2013	100.00	10.90	NP	--	89.10	--
MW-4	5/29/2013	100.00	11.28	NP	--	88.72	--
MW-4	8/20/2013	100.00	11.95	NP	--	88.05	--
MW-4	11/13/2013	100.00	11.69	NP	--	88.31	--
MW-4	2/19/2014	100.00	10.73	NP	--	89.27	--
MW-4	4/23/2014	100.00	11.14	NP	--	88.86	--
MW-4	8/7/2014	100.00	11.88	NP	--	88.12	--
MW-4	11/19/2014	100.00	11.71	NP	--	88.29	--
MW-4	2/25/2015	100.00	11.43	NP	--	88.57	--
MW-4	8/11/2015	100.00	12.25	NP	--	87.75	--
MW-6	8/20/2013	99.76	11.63	NP	--	88.13	--
MW-6	11/13/2013	99.76	11.43	NP	--	88.33	--
MW-6	2/19/2014	99.76	10.51	NP	--	89.25	--
MW-6	4/23/2014	99.76	10.68	NP	--	89.08	--
MW-6	8/7/2014	99.76	11.60	NP	--	88.16	--
MW-6	11/19/2014	99.73	11.35	NP	--	88.38	--
MW-6	2/25/2015	99.73	11.04	NP	--	88.69	--
MW-6	8/11/2015	99.73	12.00	NP	--	87.73	--
MW-7	8/20/2013	100.27	12.40	NP	--	87.87	--
MW-7	11/13/2013	100.27	12.09	NP	--	88.18	--
MW-7	2/19/2014	100.27	10.91	NP	--	89.36	--
MW-7	4/23/2014	100.27	11.52	NP	--	88.75	--
MW-7	8/7/2014	100.27	12.35	NP	--	87.92	--
MW-7	11/19/2014	100.27	12.09	NP	--	88.18	--
MW-7	2/25/2015	100.27	11.83	NP	--	88.44	--
MW-7	8/11/2015	100.27	12.75	NP	--	87.52	--

TABLE 2

Groundwater Gauging Data

Arco Facility 5300

710 15th Avenue

Longview, WA

Well I.D.	Date	GROUNDWATER ELEVATION DATA					
		TOC Elevation (ft)	Water Level Depth (ft)	LNAPL Depth (ft)	LNAPL Thickness (ft)	Water Level Elevation* (ft)	Qualifiers
MW-8	8/20/2013	100.00	12.04	NP	--	87.96	--
MW-8	11/13/2013	100.00	12.73	NP	--	87.27	--
MW-8	2/19/2014	100.00	10.29	NP	--	89.71	--
MW-8	4/23/2014	100.00	11.14	NP	--	88.86	--
MW-8	8/7/2014	100.00	11.94	NP	--	88.06	--
MW-8	11/19/2014	100.00	11.70	NP	--	88.30	--
MW-8	2/25/2015	100.00	11.50	NP	--	88.50	--
MW-8	8/11/2015	100.00	12.42	NP	--	87.58	--

Notes:

TOC - Top of Casing

ft - feet

NP - No Product

LNAPL - Light Non-Aqueous Phase Liquid

* - Corrected for LNAPL if present (assumes LNAPL specific gravity = 0.75)

-- No Information Available

Dry - Well Dry

TABLE 3
Groundwater Analytical Data
Arco Facility 5300
710 15th Avenue
Longview, WA

CONSTITUENT		B	T	E	X	MTBE	EDB	EDC	TPH-G	Lead (Total)	Lead (Dissolved)
UNIT		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MTCA METHOD A CLEANUP LEVELS		**5**	**1000**	**700**	**1000**	**20**	**0.01**	**5**	***1000/800**	**15**	**NE**
Well ID	Date										
MW-1	9/6/2012	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50.0	**50.6**	--
MW-1	12/14/2012	< 1.0	< 1.0	< 1.0	< 3.0	--	< 0.01	< 1.0	< 100	< 3.0	--
MW-1	1/9/2013	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 1.0	< 1.0	< 80	11	--
MW-1	5/29/2013	< 0.50	< 0.50	< 0.50	< 1.00	< 0.50	< 0.0096	< 0.50	< 50	< 10	--
MW-1	8/20/2013	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50	< 0.0096	< 0.50	< 50	< 10	< 10
MW-1	11/13/2013	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-1	2/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-1	4/23/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-1	8/7/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	8.1	< 2.0
MW-1	11/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-1	2/25/2015	< 2.0*	< 2.0*	< 3.0*	< 3.0	< 1.0	--	--	< 100	< 2.0	< 2.0
MW-1	8/11/2015	< 2.0	< 2.0	< 3.0	< 3.0	< 1.0	--	--	190	< 2.0	< 2.0
MW-2	9/6/2012	< 1.0	< 1.0	< 1.0	< 3.0	2.6	< 0.010	< 1.0	< 50.0	**15.8**	--
MW-2	12/14/2012	< 1.0	< 1.0	< 1.0	< 3.0	--	< 0.01	< 1.0	< 100	< 3.0	--
MW-2	1/9/2013	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 1.0	< 1.0	< 80	< 1.0	--
MW-2	5/29/2013	< 0.50	< 0.50	< 0.50	< 1.00	0.66	< 0.0098	< 0.50	< 50	13.0	--
MW-2	8/20/2013	< 0.50	< 0.50	< 0.50	< 1.0	0.70	< 0.0097	< 0.50	< 50	< 10	< 10
MW-2	11/13/2013	< 1.0	2.8	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	7.8	< 2.0
MW-2	2/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-2	4/23/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-2	8/7/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-2	11/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-2	2/25/2015	< 2.0*	< 2.0*	< 3.0*	< 3.0	< 1.0	--	--	< 100	< 2.0	< 2.0
MW-2	8/11/2015	< 2.0	< 2.0	< 3.0	< 3.0	< 1.0	--	--	65	< 2.0	< 2.0
MW-3	9/6/2012	< 1.0	< 1.0	< 1.0	< 3.0	16.9	< 0.010	< 1.0	< 50.0	< 10.0	--
MW-3	12/14/2012	< 1.0	< 1.0	< 1.0	< 3.0	--	< 0.01	< 1.0	< 100	11.1	--
MW-3	1/9/2013	< 1.0	< 1.0	< 1.0	< 3.0	17	< 1.0	< 1.0	< 80	< 1.0	--
MW-3	5/29/2013	< 0.50	< 0.50	< 0.50	< 1.00	14	< 0.0097	< 0.50	< 50	10.7	--
MW-3	8/20/2013	< 0.50	< 0.50	< 0.50	< 1.0	7.9	< 0.0097	< 0.50	< 50	< 10	< 10
MW-3	11/13/2013	< 1.0	2.3	< 1.0	< 3.0	17	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-3	2/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	11	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-3	4/23/2014	< 1.0	< 1.0	< 1.0	< 3.0	14	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-3	8/7/2014	< 1.0	< 1.0	< 1.0	< 3.0	**25**	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-3	11/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	11	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-3	2/25/2015	< 2.0*	< 2.0*	< 3.0*	< 3.0	8.1	--	--	< 100	< 2.0	< 2.0

TABLE 3
Groundwater Analytical Data
Arco Facility 5300
710 15th Avenue
Longview, WA

CONSTITUENT		B	T	E	X	MTBE	EDB	EDC	TPH-G	Lead (Total)	Lead (Dissolved)
UNIT		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MTCA METHOD A CLEANUP LEVELS		**5**	**1000**	**700**	**1000**	**20**	**0.01**	**5**	***1000/800**	**15**	**NE**
Well ID	Date										
MW-3	8/11/2015	< 2.0	< 2.0	< 3.0	< 3.0	3.8	--	--	54	< 2.0	< 2.0
MW-4	9/6/2012	**6.1**	< 1.0	290	116	3.6	< 0.010	< 1.0	**10200**	< 10.0	--
MW-4	12/14/2012	4.8	< 1.0	208	50.7	--	< 0.01	< 1.0	**3230**	**15.8**	--
MW-4	1/9/2013	< 5.0	< 5.0	250	56	< 5.0	< 5.0	< 5.0	**4500**	6.1	--
MW-4	5/29/2013	2.1	< 0.50	220	48.8	2.6	< 0.0095	< 0.50	**4500**	14.7	--
MW-4	8/20/2013	1.6	< 0.50	240	47	< 2.4	< 0.0098	< 0.50	**4500**	< 10	< 10
MW-4	11/13/2013	1.7	1.9	270	43	1.1	< 0.010	< 1.0	**7100**	8.9	8.2
MW-4	2/19/2014	1.1	< 1.0	180	26	2.0	< 0.010	< 1.0	**5400**	5.6	5.7
MW-4	4/23/2014	< 1.0	< 1.0	130	17	< 1.0	< 0.010	< 1.0	**5800**	8.6	6.1
MW-4	8/7/2014	< 1.0	< 1.0	170	15	< 1.0	< 0.010	< 1.0	**5700**	6.6	6.0
MW-4	11/19/2014	< 1.0	< 1.0	< 1.0	7.6	< 1.0	< 0.010	< 1.0	**4900**	9.0	6.9
MW-4	2/25/2015	< 2.0*	< 2.0*	130	5.5	< 1.0	--	--	< 100	6.1	5.3
MW-4	8/11/2015	< 2.0	< 2.0	46	< 3.0	< 1.0	--	--	**3700**	5.7	5.6
MW-6	8/20/2013	< 0.50	< 0.50	1.9	< 1.0	4.9	< 0.0097	< 0.50	650	< 10	< 10
MW-6	11/13/2013	< 1.0	1.4	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	400	2.1	< 2.0
MW-6	2/19/2014	< 1.0	< 1.0	1.4	< 3.0	1.6	< 0.010	< 1.0	300	< 2.0	< 2.0
MW-6	4/23/2014	< 1.0	< 1.0	1.0	< 3.0	< 1.0	< 0.010	< 1.0	**830**	3.4	< 2.0
MW-6	8/7/2014	< 1.0	< 1.0	3.0	< 3.0	< 1.0	< 0.010	< 1.0	570	< 2.0	< 2.0
MW-6	11/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	220	< 2.0	< 2.0
MW-6	2/25/2015	< 2.0*	< 2.0*	< 3.0*	< 3.0	< 1.0	--	--	370	< 2.0	< 2.0
MW-6	8/11/2015	< 2.0	< 2.0	< 3.0	< 3.0	2.2	--	--	88	< 2.0	< 2.0
MW-7	8/20/2013	< 0.50	< 0.50	< 0.50	< 1.0	2.0	< 0.0096	< 0.50	< 50	< 10	< 10
MW-7	11/13/2013	< 1.0	1.2	< 1.0	< 3.0	2.2	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-7	2/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-7	4/23/2014	< 1.0	< 1.0	< 1.0	< 3.0	2.2	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-7	8/7/2014	< 1.0	< 1.0	< 1.0	< 3.0	2.9	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-7	11/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	3.2	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-7	2/25/2015	< 2.0*	< 2.0*	< 3.0*	< 3.0	1.8	--	--	< 100	< 2.0	< 2.0
MW-7	8/11/2015	< 2.0	< 2.0	< 3.0	< 3.0	2.8	--	--	< 50	< 2.0	< 2.0
MW-8	8/20/2013	< 0.50	< 0.50	< 0.50	< 1.0	2.2	< 0.0097	< 0.50	< 50	< 10	< 10
MW-8	11/13/2013	< 1.0	1.0	< 1.0	< 3.0	2.3	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-8	2/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	< 1.0	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-8	4/23/2014	< 1.0	< 1.0	< 1.0	< 3.0	1.9	< 0.010	< 1.0	< 50	< 2.0	< 2.0

TABLE 3

Groundwater Analytical Data

Arco Facility 5300

710 15th Avenue

Longview, WA

CONSTITUENT		B	T	E	X	MTBE	EDB	EDC	TPH-G	Lead (Total)	Lead (Dissolved)
UNIT		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MTCA METHOD A CLEANUP LEVELS		**5**	**1000**	**700**	**1000**	**20**	**0.01**	**5**	***1000/800**	**15**	**NE**
Well ID	Date										
MW-8	8/7/2014	< 1.0	< 1.0	< 1.0	< 3.0	1.8	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-8	11/19/2014	< 1.0	< 1.0	< 1.0	< 3.0	2.7	< 0.010	< 1.0	< 50	< 2.0	< 2.0
MW-8	2/25/2015	< 2.0*	< 2.0*	< 3.0*	< 3.0	3.0	--	--	< 100	< 2.0	< 2.0
MW-8	8/11/2015	< 2.0	< 2.0	< 3.0	< 3.0	4.6	--	--	200	< 2.0	< 2.0

Notes:

B = Benzene

T = Toluene

E = Ethyl benzene

X = Xylenes, Total

MTBE = Methyl-tertiary-butyl ether

EDB = 1,2-Dibromo-ethane

EDC = 1,2-Dichloro-ethane

TPH-G = Total petroleum hydrocarbons as gasoline by Northwest Method NWTPH-Gx

TPH-D = Total petroleum hydrocarbons as diesel by Northwest Method NWTPH-Dx with silica gel cleanup

TPH-O = Total petroleum hydrocarbons as oil by Northwest Method NWTPH-Dx with silica gel cleanup

*1,000 ug/L if no detectable levels of Benzene in the sample - otherwise 800 ug/L

NE = Not evaluated

<1.0 = Concentrations were not detected above the laboratory method reporting limit.

ug/L = Micrograms per liter (ppb)

ND = Not detected

-- = No value given/Not analyzed/Not applicable

MTCA = Model Toxics Control Act

Results in **bold** indicate concentrations in excess of MTCA Method A Cleanup Levels

* = LCS or LCSD is outside acceptance limits

TABLE 4
SUMMARY OF GROUNDWATER DATA - EXTENDED
ARCO FACILITY NO. 5300
710 15TH AVENUE
LONGVIEW, WA

					Dissolved Gases			Total and Dissolved Metals			General Chemistry									
Well	TOC (feet)	Date Sampled	Depth to Water (feet)	GW Elevation (feet)	Ethane (µg/L)	Ethene (µg/L)	Methane (FID/TCD) (µg/L)	Total Iron (µg/L)	Total Manganese (µg/L)	Dissolved Iron (µg/L)	Nitrate as N (mg/L)	Sulfate (mg/L)	Total Organic Carbon (mg/L)	Ferrous Iron (µg/L)	Alkalinity (mg/L)	Bicarbonate Alkalinity as CaCO3 (mg/L)	Carbonate Alkalinity as CaCO3 (mg/L)	Hydroxide Alkalinity as CaCO3 (mg/L)	Biochemical Oxygen Demand (mg/L)	Chemical Oxygen Demand (mg/L)
MW-1	99.90	4/23/2014	10.40	89.50	<2.0	<2.8	30	11,000	1,000	6,000	<0.90	40	2.0	15,000	110	110	<5.0	<5.0	<2.0	<15
MW-2	99.72	4/23/2014	10.38	89.34	<2.0	<2.8	240	8,800	1,100	4,200	<0.90	42	2.0	4,000	140	140	<5.0	<5.0	<2.0	<15
MW-3	99.68	4/23/2014	10.47	89.21	<2.0	<2.8	7,300	36,000	3,700	29	<0.90	4.7	8.7	15,000	330	330	<5.0	<5.0	12	25
MW-4	100.00	4/23/2014	11.14	88.86	<2.0	<2.8	6,200	58,000	5,400	47	<0.90	<1.2	5.9	20,000	200	200	<5.0	<5.0	15	20
MW-6	99.76	4/23/2014	10.68	89.08	<2.0	<2.8	1,300	31,000	5,000	16	<0.90	28	4.4	10,000	190	190	<5.0	<5.0	2.0	<15
MW-7	100.27	4/23/2014	11.52	88.75	<2.0	<2.8	6,500	35,000	3,400	23	<0.90	17	4.0	5,000	180	180	<5.0	<5.0	11	<15
MW-8	100.00	4/23/2014	11.14	88.86	<2.0	<2.8	1,400	8,800	1,400	5.0	0.98	5.1	2.4	6,000	200	200	<5.0	<5.0	<2.0	<15

Dissolved gases analyzed by EPA Method RSK-175-Dissolved Gases (GC)
Total and dissolved metals analyzed by EPA Method 6020
General chemistry analyzed by EPA Method SM 5210B
<2.0 = Concentrations were not detected above the laboratory method reporting limit
µg/L = Micrograms per liter
mg/L = Milligrams per liter

TABLE 5
Petroleum Hydrocarbon Mass In Groudnwater Calculations

Constituent		Approximate Area of Plume[1] (ft^2)	Approximate Thickness of Plume[2] (feet)	Estimated Soil Porosity[3]	Approximate Volume of plume[4] (gallons)	Average Concentration[5] (ug/l)	Approximate Mass of Contaminant[6] (pounds)	Constituent Totals
GRO	GRO Impact:Interval 1	200.00	8.00	35%	4,188.80	6,000	**0.210**	**0.210**
	GRO Impact:Interval 2				0.00		**0.000**	
Benzene	Benzene Impact:Interval 1				0.00		**0.000**	**0.000**
	Benzene Impact:Interval 2				0.00		**0.000**	
MTBE	MTBE Impact:Interval 1				0.00		**0.000**	**0.000**
	MTBE Impact:Interval 2				0.00		**0.000**	
Other:_____	_____ Impact:Interval 1				0.00		**0.000**	**0.000**
	_____ Impact:Interval 2				0.00		**0.000**	

Notes and Assumptions

1 Length x Width of the groundwater contour in feet. For an ellipse shapped groundwater plume, the area is Area of an ellipse = (3.14*diameter1 x diameter2)/4 . Note diameters should be in feet. Note that you may need to subtract ellipse areas inside the core zone that are at higher concentrations.

2 The height (in feet) is the interval length that you want to assign an average or maximum groundwater concentration.

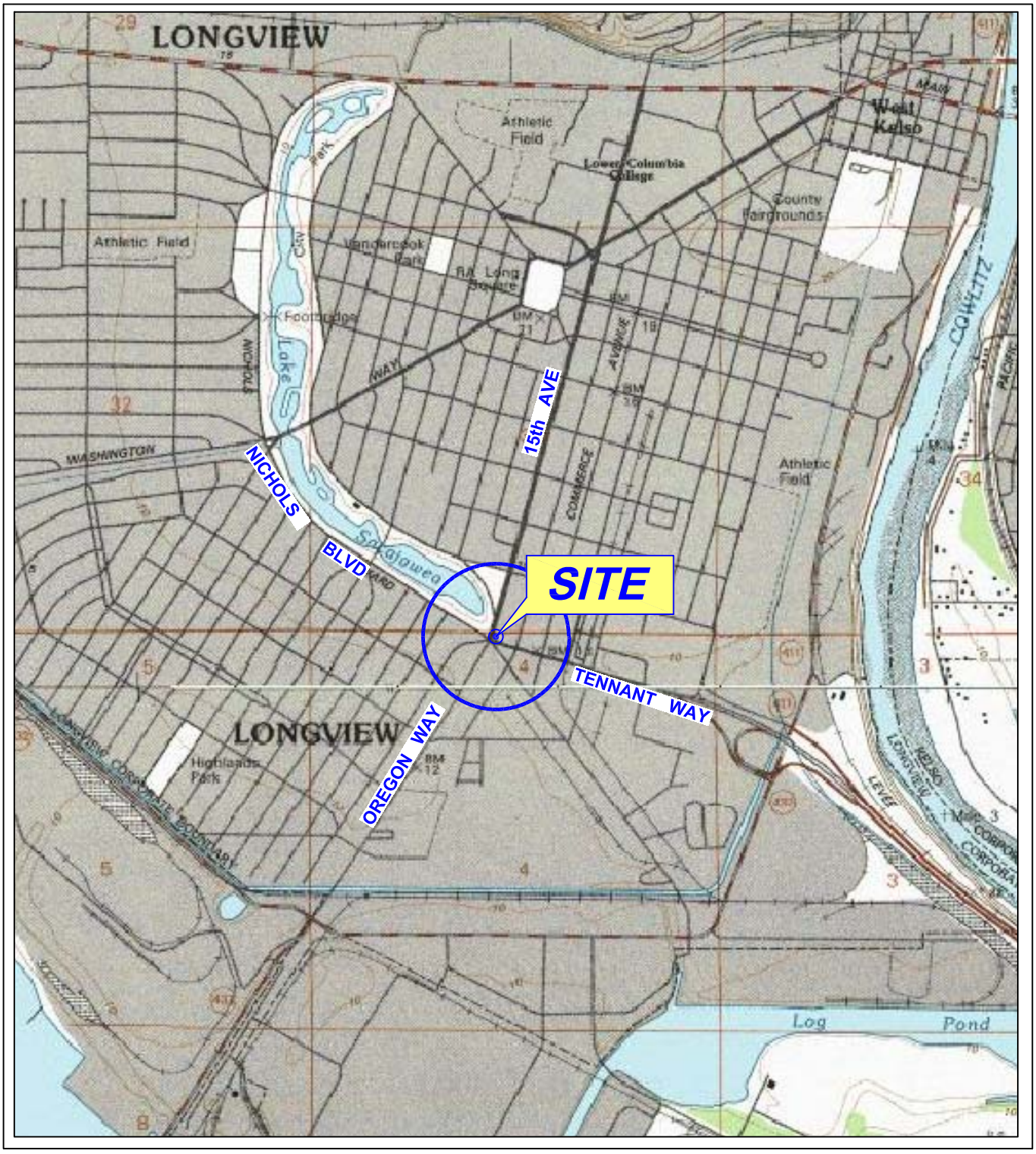
3 Enter as a percentage (ex, 30%). Based on the soil types in the specific depth interval you are calculating, you should estimate the general soil porosity. Consult the project PG.

4 Use estimate depth interval (ie from 5 to 10 feet bgs) would be 5 feet in height. If the aquifer is not separated by any aquicludes or aquitards, you can interval height from the average DTW to the bottom of the most impacted well screen. Calcualtion for groundwater volume is: Soil Volume (ft3) * Soil Porosity (%)* (7.48 gallons/ft3)

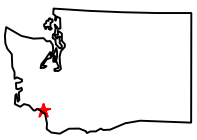
5 Use isoconcentration constituent concentration in the depicted on quarterly groundwater maps.

6 Calculation: Groundwater Volume (gallons) * (3.79 liters/gallon) * Groundwater Concentration (ug/L) * (1 gram/1,000,000 micrograms) * (1 lb/453.6 g)

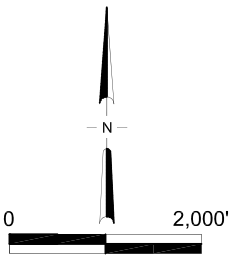
Figures



GENERAL NOTES:
BASE MAP FROM TERRAIN NAVIGATOR PRO
KELSO, WA. QUADRANGLE
7.5 MINUTE TOPOGRAPHIC MAP
1990



QUADRANGLE LOCATION



SCALE

FIGURE 1
SITE LOCATION MAP

ARCO FACILITY NO. 5300
710 15th AVENUE
LONGVIEW, WA.

PROJECT NO. 05300EA131		DRAWN BY K. MARTIN	
FILE NO. 5300-SLM		PREPARED BY M. STOCK	
DATE 04 JUN 13	REV. 0	REVIEWED BY	

antea group

NORTH
0 200'
SCALE

SITE LOCATION

FIGURE 2
SITE AERIAL MAP
ARCO FACILITY NO. 5300
710 15th AVENUE
LONGVIEW, WASHINGTON

PROJECT NO. 5300EA121	DRN KM
FILE NO. 5300G-Sam	PREPARED MS
DATE 04 JUN 13 / REV. 0	REVIEWED

antea group

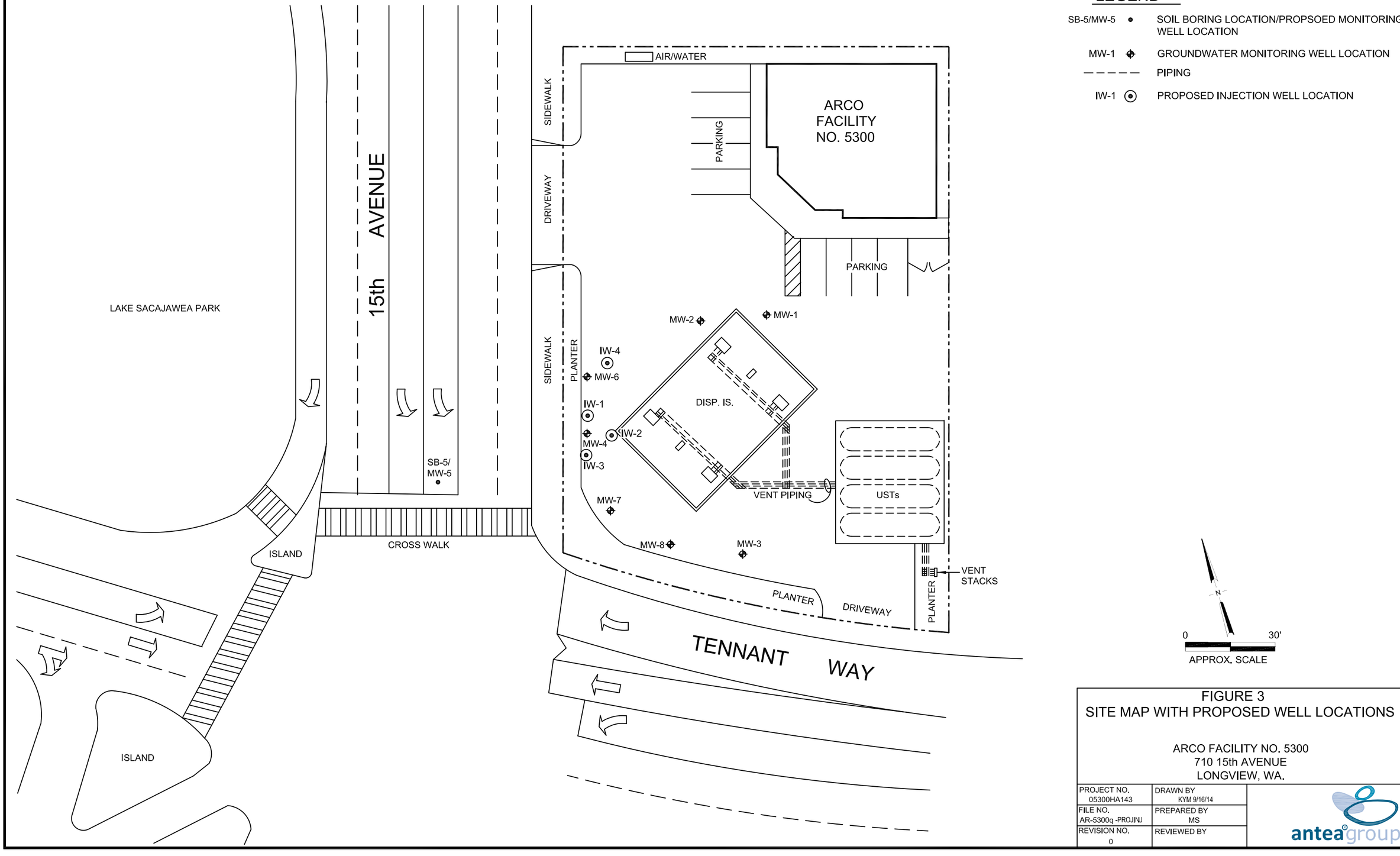
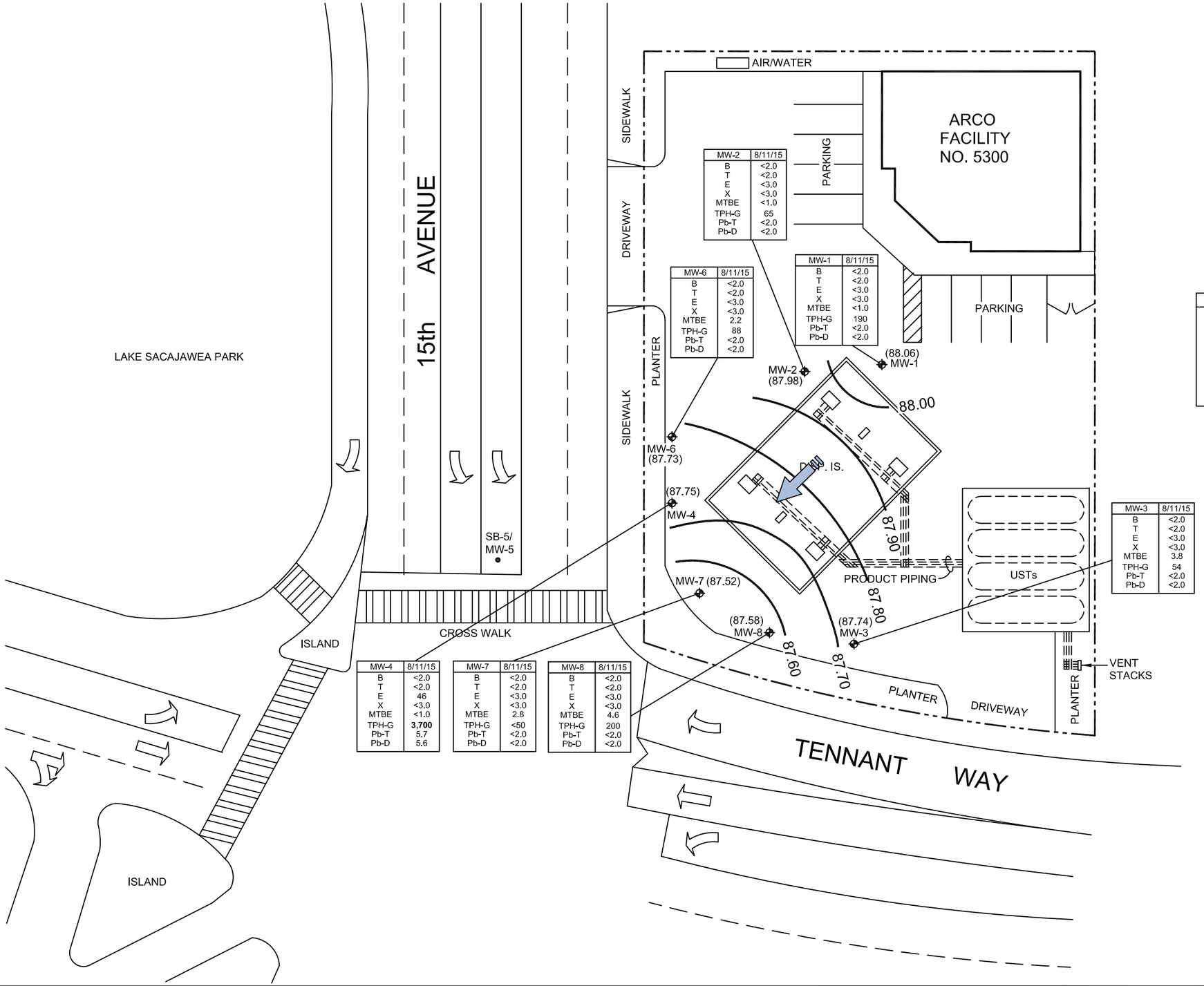


FIGURE 3
SITE MAP WITH PROPOSED WELL LOCATIONS

ARCO FACILITY NO. 5300
710 15th AVENUE
LONGVIEW, WA.

PROJECT NO. 05300HA143	DRAWN BY KYM 9/16/14
FILE NO. AR-5300q -PROJINJ	PREPARED BY MS
REVISION NO. 0	REVIEWED BY

antea group



LEGEND

- SB-5/MW-5 ● — SOIL BORING LOCATION/PROPSOED MONITORING WELL LOCATION
- MW-1 ⌖ — GROUNDWATER MONITORING WELL LOCATION
- – – – – — PIPING
- (87.98) — GROUNDWATER ELEVATION IN FEET RELATIVE TO AN ARBITRARY SITE DATUM
- — 88.00 — INFERRED WATER TABLE CONTOUR IN FEET RELATIVE TO AN ARBITRARY SITE DATUM (CONTOUR INTERVAL: 0.10 ft)
- INFERRED GROUNDWATER FLOW DIRECTION: W GROUNDWATER GRADIENT: 0.006 ft/LINEAR ft

MW-2	8/11/15	
B	<2.0	BENZENE IN MICROGRAMS PER LITER (µg/L)
T	<2.0	TOLUENE IN µg/L
E	<3.0	ETHYLBENZENE IN µg/L
X	<3.0	TOTAL XYLENES IN µg/L
MTBE	<1.0	METHYL TERT-BUTYL ETHER IN µg/L
TPH-G	65	TOTAL PETROLEUM HYDROCARBONS AS GASOLINE IN µg/L
Pb-T	<2.0	TOTAL LEAD IN µg/L
Pb-D	<2.0	DISSOLVED LEAD IN µg/L

NA — NOT ANALYZED

NOTE: **BOLD** TEXT INDICATES CONCENTRATIONS IN EXCESS OF WASHINGTON STATE DEPARTMENT OF ECOLOGY'S MODEL TOXICS CONTROL ACT (MTCA) METHOD A CLEANUP LEVELS.

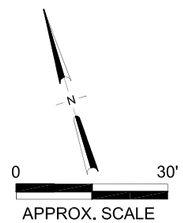


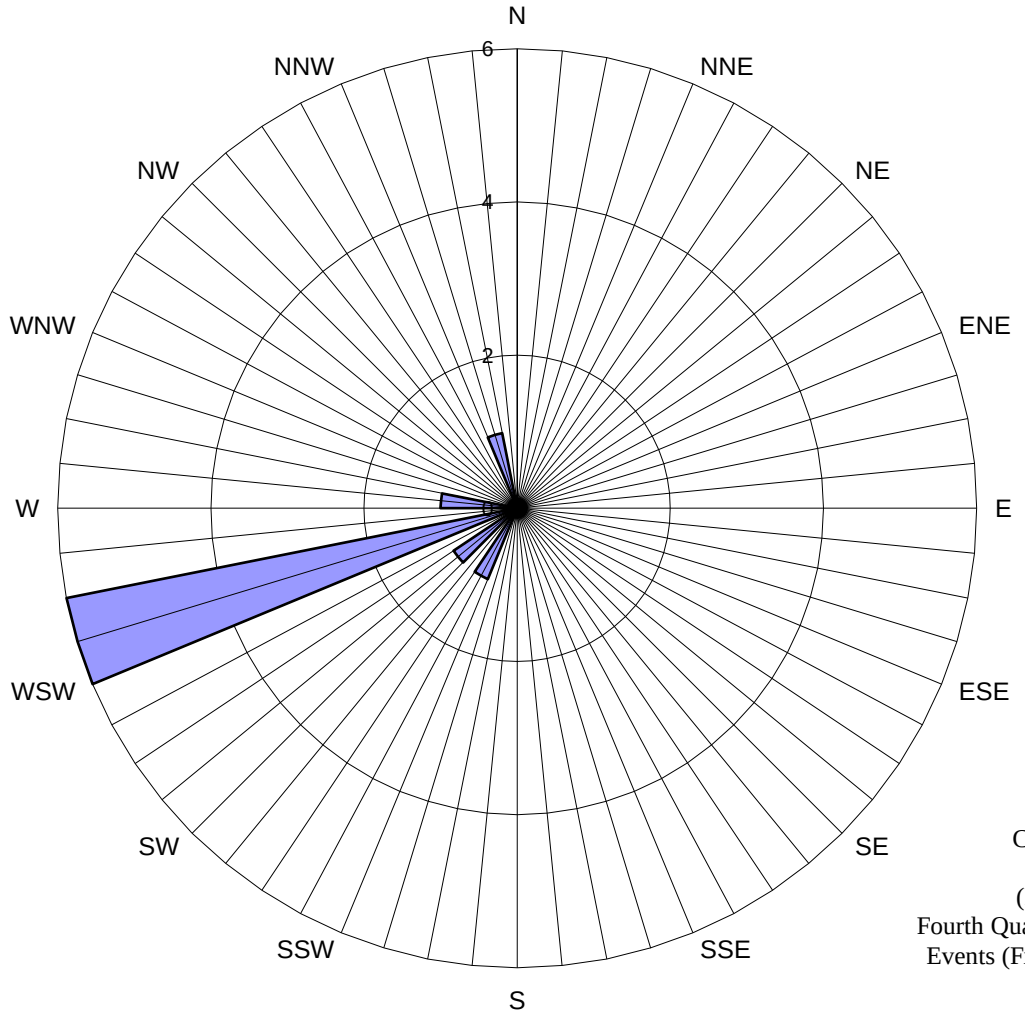
FIGURE 4
GROUNDWATER ANALYTICAL AND ELEVATION CONTOUR MAP - 8/11/2015

ARCO FACILITY NO. 5300
710 15th AVENUE
LONGVIEW, WA.

PROJECT NO. 05300HA151	DRAWN BY KYM 1/21/2016
FILE NO. AR-5300q -3Q15	PREPARED BY LH
REVISION NO. 0	REVIEWED BY

antea group

Figure 5
Groundwater Flow Direction Rose Diagram
ARCO Facility No.: 5300
710 15th Avenue
Longview, Washington



Legend
Concentric Circles represent Quarterly Montoring Events (First Quarter 2013 through Fourth Quarter 2014) and Biannual Monitoring Events (First Quarter 2015 and Third Quarter 2015)
10 Events Shown

Groundwater Flow Direction

Appendix A

Boring Logs

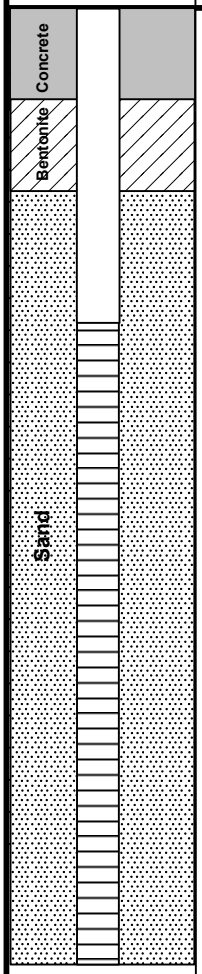
Antea Group

WELL/BORING: MW-1

INSTALLATION DATE: 8/2/2012	DRILLING METHOD: Geoprobe
PROJECT: ARCO 5300	SAMPLING METHOD: Acetate Liner
CLIENT: Atlantic Richfield Company	BORING DIAMETER: 3.5"
LOCATION: 710 15th Avenue	BORING DEPTH: 15'
CITY: Longview	WELL CASING: SCH 40 PVC 2"
STATE: WA	WELL SCREEN: 5' - 15' (0.010")
DRILLER: Cascade Drilling, Inc.	SAND PACK: 3' - 15' (2X12)

CASING ELEVATION	99.90
SURVEY DATE:	8/10/2012
DTW:	11.57 (9/6/2012)

DESCRIPTION/LOGGED BY: Brandon Bickler



DEPTH (FEET)	FIRST	STABILIZED	MOISTURE	PID (ppm)	DENSITY BLOWS / 6"	USCS SYMBOL	DESCRIPTION
5			MST	6.4	-	SP	SAND: brown; poorly-graded very fine sand.
6							
7						SP	Same as Above.
						ML	SILT: brown and gray; trace organics.
8			MST	3.5	-		
9							
10						ML	SILT: reddish brown and gray; trace organics; iron staining.
11							
12			WET	3.7	-		
13						SP	SAND: brown to gray; poorly-graded fine sand.
14						ML	SILT: gray.
15							
16							
17							
18							
19							
20							
21							
22							

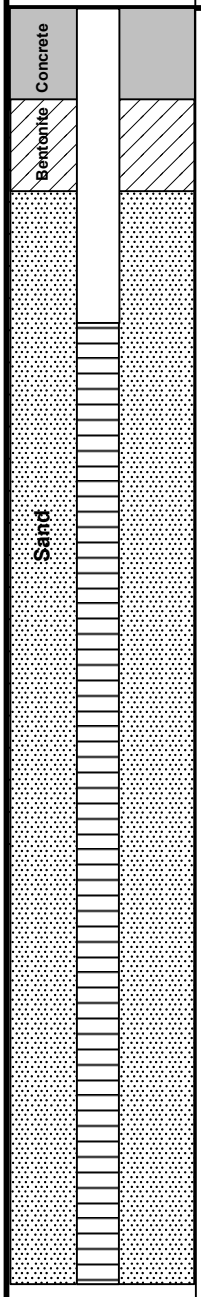
Antea Group

WELL/BORING: MW-2

INSTALLATION DATE: 8/2/2012	DRILLING METHOD: Geoprobe
PROJECT: ARCO 5300	SAMPLING METHOD: Acetate Liner
CLIENT: Atlantic Richfield Company	BORING DIAMETER: 3.5"
LOCATION: 710 15th Avenue	BORING DEPTH: 20'
CITY: Longview	WELL CASING: SCH 40 PVC 2"
STATE: WA	WELL SCREEN: 5' - 20' (0.010")
DRILLER: Cascade Drilling, Inc.	SAND PACK: 3' - 20' (2X12)

CASING ELEVATION	99.72
SURVEY DATE:	8/10/2012
DTW:	11.43 (9/6/2012)

DESCRIPTION/LOGGED BY: Brandon Bickler



DEPTH (FEET)	MOISTURE	PID (ppm)	DENSITY BLOWS / 6"	USCS SYMBOL	DESCRIPTION
5	DMP	10.8	-	SP	SAND: brown; poorly-graded very fine sand.
8					No Recovery.
10	MST	12.6	-	ML	SILT: brown; trace sand; iron staining.
13	WET	154	-	SP	SAND: brown and gray; poorly-graded sand.
14				SP	Same as Above; turns gray.
15				ML	SILT: gray.
16				SP	SAND: gray; poorly-graded sand.
18				ML	SILT: gray.

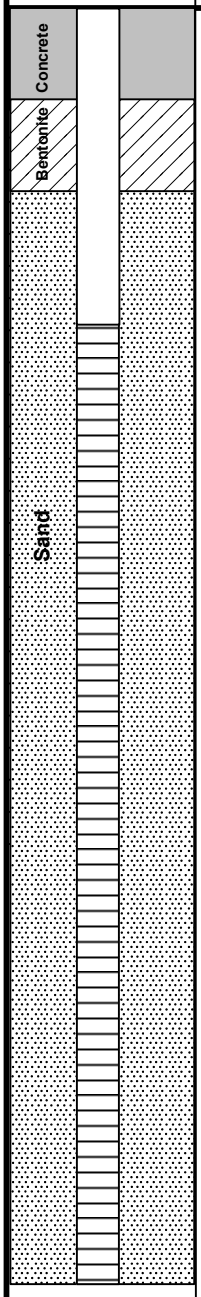
Antea Group

WELL/BORING: MW-3

INSTALLATION DATE: 8/2/2012	DRILLING METHOD: Geoprobe
PROJECT: ARCO 5300	SAMPLING METHOD: Acetate Liner
CLIENT: Atlantic Richfield Company	BORING DIAMETER: 3.5"
LOCATION: 710 15th Avenue	BORING DEPTH: 20'
CITY: Longview	WELL CASING: SCH 40 PVC 2"
STATE: WA	WELL SCREEN: 5' - 20' (0.010")
DRILLER: Cascade Drilling, Inc.	SAND PACK: 3' - 20' (2X12)

CASING ELEVATION	99.68
SURVEY DATE:	8/10/2012
DTW:	11.63 (9/6/2012)

DESCRIPTION/LOGGED BY: Brandon Bickler

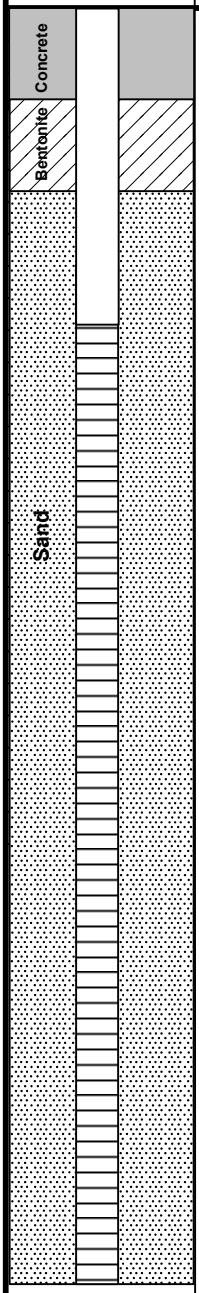


DEPTH (FEET)	MOISTURE	PID (ppm)	DENSITY BLOWS / 6"	USCS SYMBOL	Description
5	DMP	33.9	-	SM	Silty SAND: brown; ~20% silt; ~80% fine sand.
6				SW	Gravelly SAND: brown; ~10% silt; ~60% sand; ~30% subrounded fine gravel.
7	MST	-	-	SP	SAND: brown; poorly-graded sand.
8				ML	SILT: reddish brown; iron staining.
10	MST	12.7	-		
11				SP	SAND: brown; trace gravel.
12				ML	SILT: gray; sand lens; iron staining.
13	WET	-	-		
16				SM	Silty SAND: brown; ~30% silt; 70% sand.
18				ML	SILT: gray; iron staining.
19				ML	Same as Above: no iron staining.

antea group	**Antea Group**	WELL/BORING: MW-4
	INSTALLATION DATE: 8/3/2012	DRILLING METHOD: Geoprobe
	PROJECT: ARCO 5300	SAMPLING METHOD: Acetate Liner
	CLIENT: Atlantic Richfield Company	BORING DIAMETER: 3.5"
	LOCATION: 710 15th Avenue	BORING DEPTH: 20'
	CITY: Longview	WELL CASING: SCH 40 PVC 2"
	STATE: WA	WELL SCREEN: 5' - 20' (0.010")
	DRILLER: Cascade Drilling, Inc.	SAND PACK: 3' - 20' (2X12)

CASING ELEVATION	100.00
SURVEY DATE:	8/10/2012
DTW:	12.02 (9/6/2012)

DESCRIPTION/LOGGED BY: Brandon Bickler



DEPTH (FEET)	FIRST	STABILIZED	MOISTURE	PID (ppm)	DENSITY BLOWS / 6"	USCS SYMBOL	DESCRIPTION
5			MST	14.1	-	SM	Silty SAND: brown; ~10% silt; ~90% poorly-graded fine sand; iron staining.
9			MST	4.9	-	ML	SILT: gray.
12		▼	MST	295.3	-	ML	Same as Above; iron staining.
13	▽		WET	-	-	SP	SAND: gray; poorly-graded fine sand; odor.
15			WET	-	-	ML	SILT: gray; iron staining; odor.
16			WET	-	-	ML	Same as Above: no iron staining from 18.5' to 20.0' bgs.

	Antea Group	WELL/BORING: MW-5
	INSTALLATION DATE: 8/14/2013	DRILLING METHOD: Air Knife / Vac
	PROJECT: ARCO 5300	SAMPLING METHOD: Hand Auger
	CLIENT: Atlantic Richfield Company	BORING DIAMETER: 4"
	LOCATION: 710 15th Avenue	BORING DEPTH: 6.5'
	CITY: Longview	WELL CASING: NA
	STATE: WA	WELL SCREEN: NA
	DRILLER: Cascade Drilling, Inc.	SAND PACK: NA

WELL/BORING COMPLETION	FIRST ▽	STABILIZED ▼	MOISTURE	PID (ppm)	DENSITY BLOWS / 6"	DEPTH (FEET)	RECOVERY	SAMPLE INTERVAL	USCS SYMBOL	GRAPHIC	CASING ELEVATION: -
											SURVEY DATE: -
											DTW: -
											DESCRIPTION/LOGGED BY: Mackie Stock
Concrete						1					0" - 7" Asphalt 7" - 18" Concrete
Backfill						2					
						3					
						4					
			DMP	17.1	-	5			SP		SAND: gray; trace silt; poorly-graded fine sand.
						6					
						7					
						8					
						9					
						10					
						11					
						12					
						13					
						14					
						15					
						16					
						17					
						18					
						19					
						20					
						21					
						22					

Antea Group

WELL/BORING: MW-6

INSTALLATION DATE: 8/15/2013	DRILLING METHOD: Geoprobe
PROJECT: ARCO 5300	SAMPLING METHOD: Acetate Liner
CLIENT: Atlantic Richfield Company	BORING DIAMETER: 4"
LOCATION: 710 15th Avenue	BORING DEPTH: 20'
CITY: Longview	WELL CASING: SCH 40 PVC 2"
STATE: WA	WELL SCREEN: 5' - 20' (0.010")
DRILLER: Cascade Drilling, Inc.	SAND PACK: 3' - 20' (2X12)

CASING ELEVATION	99.76
SURVEY DATE:	8/20/2013
DTW:	11.63

DESCRIPTION/LOGGED BY: Mackie Stock

DEPTH (FEET)	WELL/BORING COMPLETION	FIRST	STABILIZED	MOISTURE	PID (ppm)	DENSITY BLOWS / 6"	RECOVERY	SAMPLE INTERVAL	USCS SYMBOL	GRAPHIC	DESCRIPTION
0	Concrete										Asphalt
1	Bentonite										
2											
3											
4											
5				DMP	0.0	-			SP		SAND: brown; silt lens; 80% poorly-graded fine to medium sand; 10% fine subrounded gravel.
6											
7									ML		SILT: gray.
8											
9											
10				DMP	1.8	-					
11	Sand										
12		▽	▼	MST WET	34.8	-					
13									SP		SAND: gray; trace silt; 95% poorly-graded fine sand; odor.
14											
15				WET	0.7	-			MH		SILT: gray.
16									SP		SAND: gray; poorly-graded fine sand.
17											
18											
19									MH		SILT: gray.
20				WET	0.3	-					
21											
22											

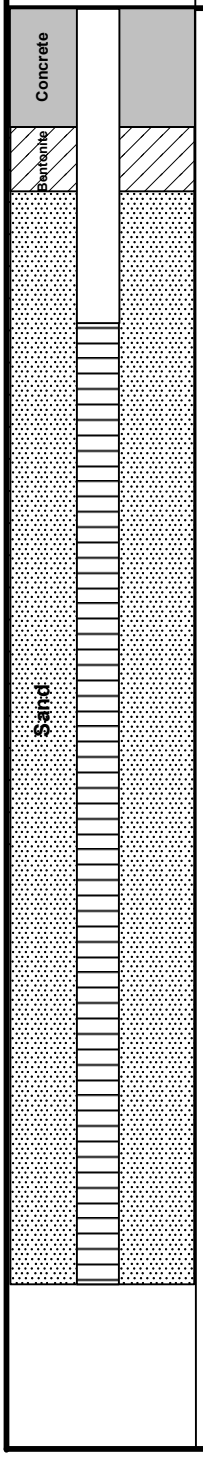
Antea Group

WELL/BORING: MW-7

INSTALLATION DATE: 8/15/2013	DRILLING METHOD: Geoprobe
PROJECT: ARCO 5300	SAMPLING METHOD: Acetate Liner
CLIENT: Atlantic Richfield Company	BORING DIAMETER: 4"
LOCATION: 710 15th Avenue	BORING DEPTH: 20'
CITY: Longview	WELL CASING: SCH 40 PVC 2"
STATE: WA	WELL SCREEN: 5' - 20' (0.010")
DRILLER: Cascade Drilling, Inc.	SAND PACK: 3' - 20' (2X12)

CASING ELEVATION	100.27
SURVEY DATE:	8/20/2013
DTW:	12.40

DESCRIPTION/LOGGED BY: Mackie Stock



DEPTH (FEET)	FIRST	STABILIZED	MOISTURE	PID (ppm)	DENSITY BLOWS / 6"	USCS SYMBOL	DESCRIPTION
0							Asphalt
5			DMP	0.0	-	SM	Silty SAND: brown; 45% silt; 50% fine sand; trace fine gravel.
9						ML	SILT: brown; some iron staining.
10			DMP	0.2	-	ML	SILT: gray; some iron staining.
11						ML	SILT: gray; iron staining.
12	▽	▼	MST WET	0.0	-		
13						SP	SAND: gray; poorly-graded very fine to fine sand; no iron staining.
15			WET	0.0	-		
16						SP	Same as Above.
17						MH	SILT: gray.
20			WET	0.0	-		

10/7/2013

Antea Group	WELL/BORING: MW-8
INSTALLATION DATE: 8/15/2013	DRILLING METHOD: Geoprobe
PROJECT: ARCO 5300	SAMPLING METHOD: Acetate Liner
CLIENT: Atlantic Richfield Company	BORING DIAMETER: 4"
LOCATION: 710 15th Avenue	BORING DEPTH: 20'
CITY: Longview	WELL CASING: SCH 40 PVC 2"
STATE: WA	WELL SCREEN: 5' - 20' (0.010")
DRILLER: Cascade Drilling, Inc.	SAND PACK: 3' - 20' (2X12)

CASING ELEVATION	100.00
SURVEY DATE:	8/20/2013
DTW:	12.04

DESCRIPTION/LOGGED BY: Mackie Stock

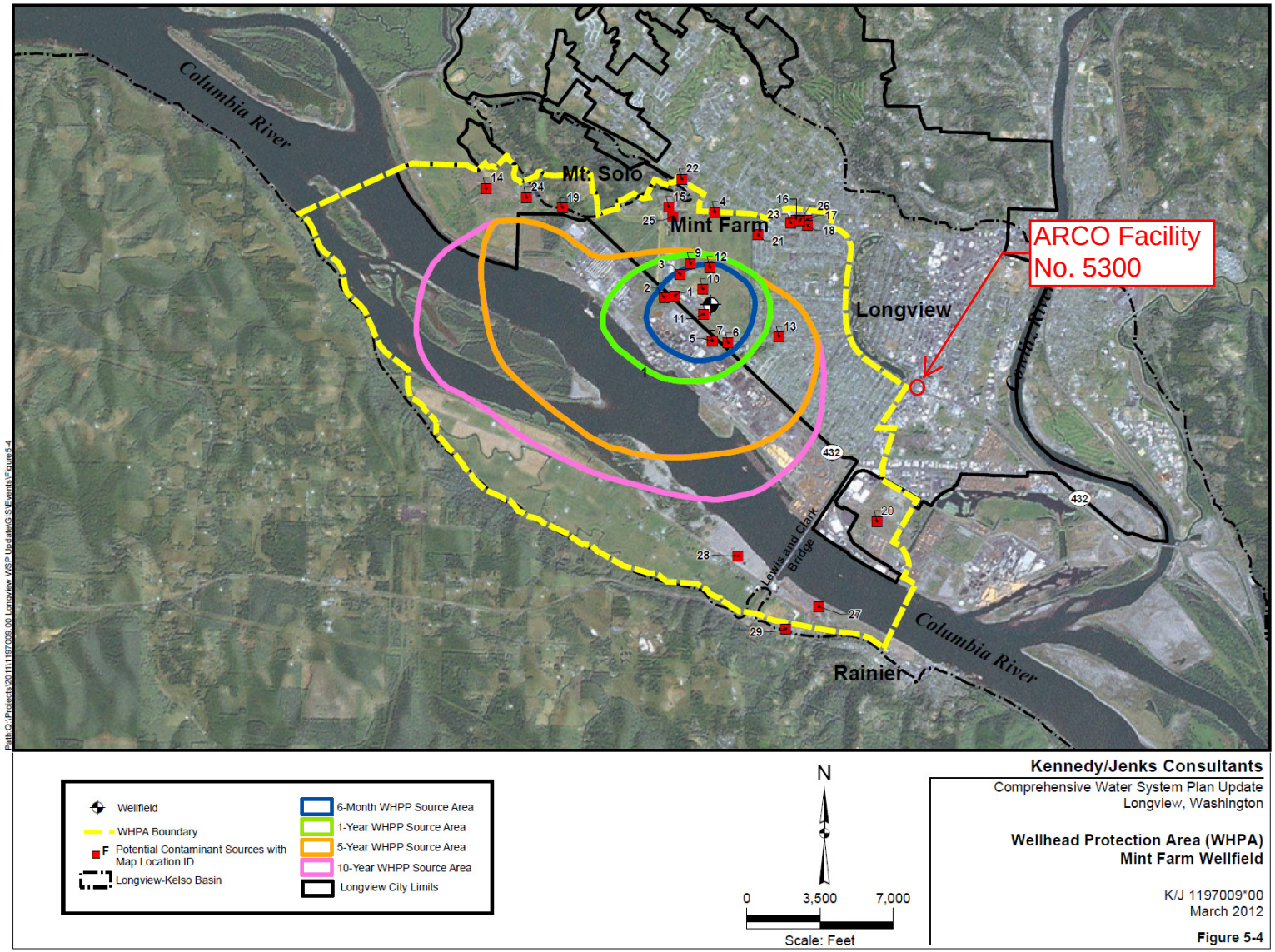
DEPTH (FEET)	FIRST ▽	STABILIZED ▼	MOISTURE	PID (ppm)	DENSITY BLOWS / 6"	USCS SYMBOL	DESCRIPTION
0							Asphalt
5			DMP	0.0	-	ML	SILT: brown; trace fine sand; trace fine subrounded gravel.
8						ML	SILT: brown; trace sand; iron staining.
10			DMP	0.0	-		
11						ML	Same as Above.
12		▼	MST	0.0	-		
13	▽					SP	SAND: brown; poorly-graded fine sand.
14						SP	SAND: gray; poorly-graded very fine to fine sand.
15			WET	0.0	-	MH	SILT: gray.
						SP	SAND: gray; poorly-graded fine sand.
17						MH	SILT: gray; no iron staining.
20			WET	0.0	-		

Concrete; Bentonite; Sand

Appendix B

Mint Farm Wellhead Protection Area

Figure 5-4: Mint Farm Wellhead Protection Area



Appendix C

Control of Work Protocol

CONTROL OF WORK (COW) PROTOCOL

All field work will be implemented and completed in accordance with BP's Control of Work (CoW) Defined Practices. All Antea Group personnel conducting field work during this investigation and all subcontractors (drilling and private utility locators) will be in compliance with CoW requirements. All staff and subcontractors will document training compliance with CoW protocol and provide training compliance certificates to Antea Group prior to field activities. A Level 2 Task Risk Assessment (TRA) Form will be developed and reviewed with representatives from all participating companies to identify, document, and mitigate any risks for this job prior to field activities.

Prior to starting field work, a daily safety meeting will be conducted and the Level 2 TRA will be reviewed. Any additional hazards and risks and the respective mitigation controls that are identified with the planned field activities will be documented in the Level 2 TRA Form. Work activities will be stopped and a safety meeting will be convened if any new risks are identified during site activities. All safety meeting discussions will be documented in the Field Authorization Form prior to any field work. The site Health and Safety Plan (HASP) which includes the Level 2 TRA, the Emergency Response Plan (ERP), and the Simultaneous Operations Plan (SIMOP) will be present at the work site.

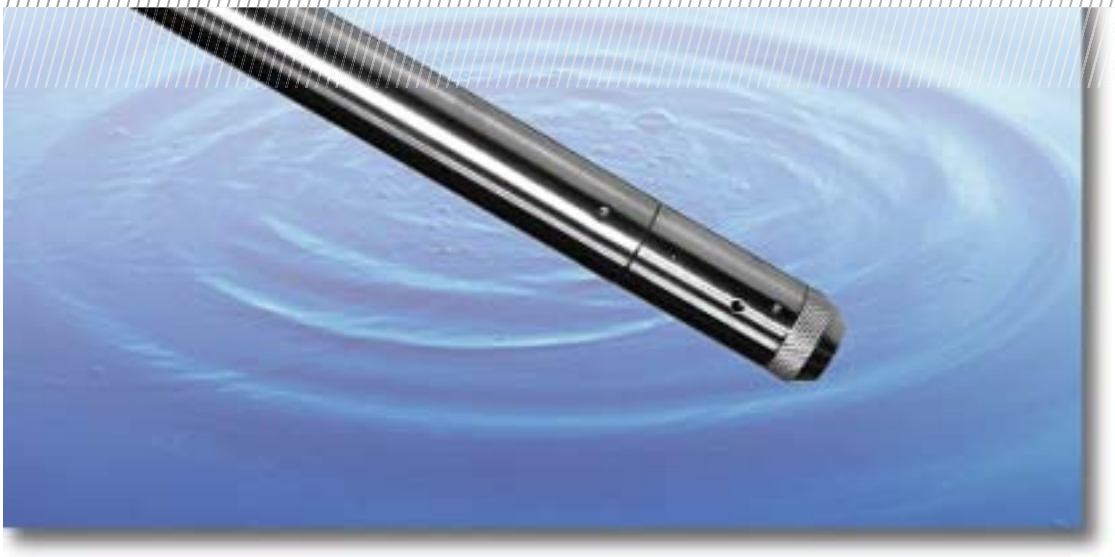
Appendix D

Aquistar Datalogger Specification Sheet

PT2X Submersible Pressure/Temperature Smart Sensor

WITH DATA LOGGING

AquiStar™
Data Collection Systems



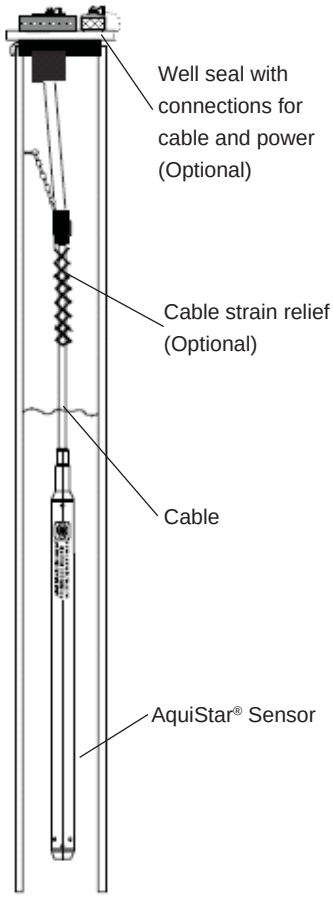
APPLICATIONS

- Pump and slug tests
- Stormwater runoff monitoring
- Well, tank, tidal levels
- River, stream, reservoir gauging
- Wetland monitoring
- Resource administration

Great almost anywhere you need to measure level and temperature – whether it be in a lake, a tank, or a well

Features

- Measures and records pressure/level, temperature, and time
- Low power — *field replaceable AA batteries*
- Modbus® RTU (RS485) and SDI-12 interface — *great flexibility*
- Thermally compensated — *great where water temperatures vary, such as in streams or in industrial tank applications*
- ± 0.05% FSO typical accuracy
- Small diameter — 0.75" (1.9 cm)
- 520,000 record non-volatile memory — *no data loss in the event of a power failure*
- Wireless connectivity — *radios and/or cellular*
- Barometric compensation utility for use with absolute sensors
- Free, easy-to-use software



TYPICAL INSTALLATION

INW™

True data, measure by measure

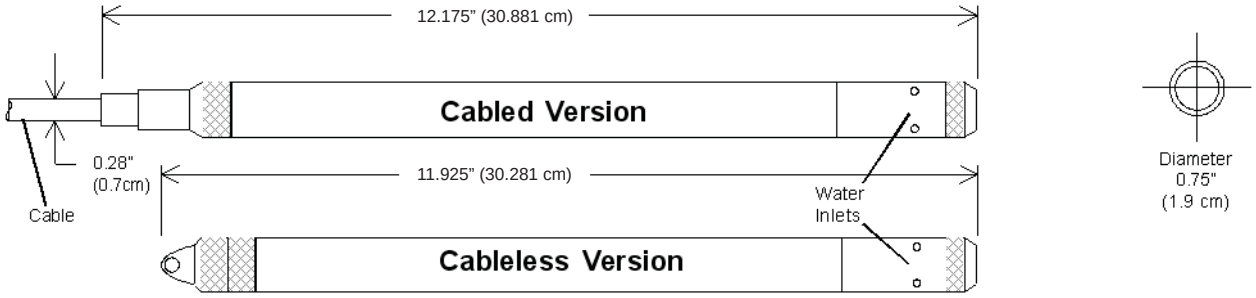
ISO 9001:2008 CERTIFIED

1-800-PRO-WELL
WWW.INWUSA.COM

CE

PT2X Submersible Pressure/ Temperature Smart Sensor with Data Logging

AquiStar™ Data Collection Systems



GENERAL

Length	12.175" (30.881 cm) cabled 11.925" (30.281 cm) cableless
Diameter	0.75" (1.9 cm)
Weight	0.8 lb. (0.4 kg)
Body Material	Acetal & 316 stainless steel *or* titanium
Wire Seal Material	Fluoropolymer and PTFE
Submersible Cable	Polyurethane, polyethylene, *or* FEP available
Protection Rating	IP68, NEMA 6P
Desiccant	1-3 mm indicating silica gel *(high or standard capacity)*
Terminating Connector	Available
Communication	RS485 Modbus® RTU SDI-12 (ver.1.3)
Direct Modbus Read Output	32-bit IEEE floating point
SDI-12 Output	ASCII
Internal Math	32-bit floating point
Operating Temp. Range[3]	-15° C to 55° C
Storage Temp. Range[1]	-40° C to 80° C

LOGGING

Memory	4MB - 520,000 records
Log Types	Variable, user-defined, logarithmic, profiled
Programmable Baud Rate	9600, 19200, 38400
Logging Rate	8x/sec maximum
Software	Complimentary Aqua4Plus or Aqua4Push
Networking	32 available addresses per junction w/ batching capabilities (up to 255)
File Formats	.xls / .csv / .a4d

POWER

Internal Battery	2x1.5V AA alkaline[2]
Auxiliary Power	12 VDC - Nominal 6-15VDC - Range
Exp. Alkaline Battery Life	18 months at 15m polling interval[6]

TEMPERATURE

Element Type	Digital IC on board
Accuracy	± 0.5° C
Resolution	0.1° C
Range	-40° C to 80° C
Units	Celsius, Fahrenheit, Kelvin

PRESSURE

Transducer Type	Silicon strain gauge
Transducer Material	316 stainless steel *or* titanium
Pressure Ranges[5]	
Gauge	
FtH_2O	2.3, 5.8, 12, 35, 69, 115, 231, 692
mH_2O	0.7, 1.75, 3.5, 10.5, 21, 35, 70, 210
Absolute[7]	
FtH_2O	12, 35, 81, 196, 658
mH_2O	3.5, 10, 24, 59, 200
Units	PSI, FtH_2O, inH_2O, cmH_2O, mmH_2O, mH_2O, inHg, cmHg, mmHg, Bars, mBars, kPa
Static Accuracy	± 0.05% FSO (typical) ± 0.1% FSO (maximum) *(B.F.S.L. 20° C)*
Resolution	0.0034% FS (typical)
Maximum Operating Pressure	1.1 x FS
Burst Pressure[4]	3.0 x FS
Compensated Range	0° C to 40° C

1 Storage without batteries
2 Lithium available upon request
3 Requires freeze protection kit if in water below freezing
4 Burst reduced at PSI>300
5 Higher pressure ratings available upon request
6 May vary due to environmental factors
7 Depth range for absolute sensors has 14.7 PSI subtracted to give actual depth allowed.

SALES & SERVICE

8902 122nd Avenue NE
Kirkland, WA 98033 USA
425-822-4434
FAX 425-822-8384 / info@inwusa.com

1-800-PRO-WELL
WWW.INWUSA.COM

INW™

Appendix E

Field and Work Plan Contingencies

FIELD AND WORK PLAN CONTINGENCIES

Preparations for varying field conditions and potential change-in-conditions during field activities have been reviewed and planned for as referenced below:

- Boring locations may need to be moved or relocated based on identified subsurface utilities or surface structures in the immediate area of planned borings, and borings may be terminated at shallower or deeper depths than designated in this work plan based on field conditions;
- Soil sample collection techniques, depths, and locations may be altered based on field conditions, and soil samples within the first 6.5 feet bgs may be collected directly from the boring cleared with the vacuum truck and air knife;
- Groundwater sample collection techniques may be varied based on field conditions;
- Soil borings may be added, eliminated or increased in depth and completed as temporary or permanent monitoring wells based on field conditions or RM guidance;
- Scope changes to this work plan have been reviewed and have been planned for based on field conditions and typical drilling conditions. If site work is terminated based on unpredicted field conditions, a management of change (MOC) will be required prior to rescheduling site work or new site work will be addressed as a new project with a modified work plan.