APPENDIX E

TECHNICAL SPECIFICATIONS FOR DRILLING OPERATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

Prepared by

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1.0 INTRODUCTION

These specifications describe the methods and procedures required for the drilling and sampling of soil borings and constructing monitoring wells. The soil borings will be advanced using GeoProbe™ direct push, or another hydraulically-powered drilling rig. The hollow-stem auger drilling method may be used to drill and install monitoring wells. The proposed boring locations are located at the Astoria Area-Wide Petroleum Site in Astoria, Oregon, as shown on Figure 1. The maximum estimated depth of the soil borings will be approximately 20 feet. Final design of monitoring wells and selection of their locations will be completed after the initial soil characterization phase.

Soil borings will be drilled on behalf of Potentially Responsible Parties (PRPs) involved in conducting a remedial investigation at the Astoria Area-Wide site. Each PRP has retained a consultant to manage the work, as shown below:

PRP	**CONSULTANT**
Chevron Texaco	PNG Environmental, Inc.
Delphia Oil	Maul Foster & Alongi, In.
Harris/Van West	Kleinfelder, Inc.
McCall Oil	Anchor Environmental, LLC
Niemi Oil	GeoEngineers, Inc.
Port of Astoria	*EnviroLogic Resources, Inc.*
Qwest	Tetra Tech EM, Inc.
Shell Oil	Hart Crowser, Inc.

These consultants will be responsible for oversight of soil boring drilling operations conducted at their PRP facility. *EnviroLogic Resources* will provide overall site coordination and oversight on installation of monitoring wells.

1.1 UTILITY LOCATING

No drilling shall take place without approval of the consultant representing the PRP facility to be investigated. The Utility Notification Center at (800)332-2344 will be notified by the consultant to coordinate clearance from utility companies that may have lines in the area. A locating survey will be conducted by a private locating company contracted by the consultant to identify subsurface features. The Contractor shall carefully probe to a depth of 3 feet to avoid damaging undocumented and unidentified utilities. Approval to begin normal drilling operations will be provided by the onsite supervisor for the consultant.

1.2 ACCESS

All drilling locations are in easily accessible areas of the site. Most of the area is paved or has a gravel road base. Some unpaved areas are composed of sandy materials. Care should be taken when accessing areas that could pose traction problems. The presence or absence of overhead power lines shall be noted before rigging up. The consultant will arrange for ingress, egress, and rights-of-way to all drilling locations.

1.3 AVAILABILITY OF WATER AND POWER

The Contractor will provide all electrical power needed for drilling operations and decontamination of equipment. We believe water is available onsite. The Contractor shall be responsible for all fluids produced during drilling operations except samples collected for analytical purposes. Handling of investigation-derived wastes (IDW) is discussed in Section 8.0.

1.4 BEFORE DRILLING

Before drilling, members of the characterization team will familiarize themselves with the Astoria Area-Wide Site Health and Safety Plan and/or applicable site-specific plan (Appendix C of the RI/FS Work Plan). Any necessary tailgate meetings, work zone setup, and air monitoring will be conducted.

Additionally, the location of each proposed borehole will be field checked to locate all underground and aboveground utilities, or other physical limitations that would prevent drilling at the proposed location. The final location for each borehole will be based on the findings of the field check.

1.5 DECONTAMINATION OF EQUIPMENT AND MATERIALS

All drilling rigs, tools, and appropriate sampling materials shall be decontaminated prior to arrival on site. The initial decontamination of the drill rig and downhole tooling shall consist of the following procedures:

- Remove encrusted soil, oil, and grease using high-pressure potable water;
- Wash with detergent and potable water;
- Rinse with potable or distilled water; and
- Steam clean.

Decontamination of drilling equipment will be required between borings in the accordance with the following procedures:

- Steam clean to remove dirt and mud;
- Wash and rinse all sampling equipment such as samplers and extruders with detergent; and
- Rinse sampling equipment with distilled water before use;

- Steam clean tools used downhole.

Decontamination areas will be designated for use by the Contractor. The Consultant will inspect the drilling rig, tools, and sampling equipment upon arrival onsite. If the cleanliness of the drilling and sampling equipment does not meet the standards set forth herein, the Contractor shall correct the condition at his own expense. Leaks of hydraulic fluid, oil, or other fluids from vehicles shall be mitigated prior to arrival on site.

2.0 SOIL SAMPLING

Soil samples will be collected during drilling of the soil borings and monitoring wells. Soil samples may be collected for geologic, analytical, and geoenvironmental analyses. The following is a description of the procedures.

2.1 DRILLING PROCEDURES

Drilling of soil borings and monitoring well borings will be performed in accordance with applicable WRD regulations and DEQ guidance. Borings will be drilled using a GeoProbe™ direct push, or another hydraulically-powered drilling rig. Other drilling methods may be used depending on site-specific conditions. Hollow-stem auger methods may be used for the drilling and installation of monitoring wells. Selected borings may be advanced using stainless steel hand augers.

Drilling of shallow soil and monitoring well borings will terminate if a confining layer is encountered below the water table. The drilling of all borings and well installations will be monitored and recorded by a field representative working under the supervision of an Oregon registered geologist, or by an Oregon registered geologist. The consultant shall direct the Contractor as to when to begin drilling, collect soil samples, and verify boring depths, and shall inform the Contractor as to the desired depth of the boring or well. The Contractor shall provide safe access to the consultant to observe soil-sample collection.

2.2 SOIL SAMPLING PROCEDURES

Soil samples will be collected continuously. In borings advanced by GeoProbe™, the soil samples will be obtained by using a macro core soil sampler. Coring will start at the ground surface with a 4 or 5 foot-long (depending on the tool used) core sampler. The piston tip of the soil sampler will be loosened

and the sampler will be advanced into the ground, thereby coring the soil inside the sampler's disposable, single-use plastic liner. The sampler will then be withdrawn to retrieve the liner and the soil sample. The liner will be cut to remove the soil sample. A new liner will be placed inside the core sampler, and the core sampler with the piston tip locked will be advanced to the top of the next sample interval. The piston tip will then be released and the core sampler advanced another 4 or 5 feet to obtain the next sample. This process will be repeated until ground water is encountered. Between samples, the core sampler, including the piston tip and attached rod, will be decontaminated.

In soil borings advanced by hollow-stem auger, brass or stainless steel sample liner tubes and end caps provided by the Contractor shall be required to contain samples.

Soil cuttings will be observed continuously and screened by the consultant for organic vapors using a photoionization detector (PID). A record of the soil and ground-water conditions will be maintained during drilling on a boring log form, an example of which is shown in the Appendix to the Field Sampling Plan (Appendix A) of the Work Plan. The boring log will show sampling depths, sampling methods, sample recoveries, soil types, stratifications, evidence of contamination as indicated through visual observations and the use of appropriate instrumentation (e.g., PID, FID, etc.), ground-water conditions, and other pertinent information. Each log also will contain the names of the drilling company and drillers, the type of drill rig, starting and finishing dates for drilling, borehole diameter, locator identification, and boring/well location.

3.0 POST SAMPLING

The following procedures are to be followed once the soil sampling is complete.

3.1 DRILLING RESIDUALS

Cuttings and formation water produced during drilling shall be contained in such a manner as to prevent spillage onto the ground and to facilitate transfer to appropriate storage media for proper disposal. Plastic sheeting shall be placed below the drilling rig in areas where cuttings or formation water may come into contact with native uncontaminated surface soils. The Contractor shall be responsible for, and take measures to control, dust, mud, and water from the drilling operation to prevent damage and nuisance to persons and property. All drill cuttings and water removed from the borehole during drilling will be managed as IDW.

3.2 DRILLING EQUIPMENT DECONTAMINATION PROCEDURES

Before and between drilling each boring, temporary steel casings, push rods, sampling probes and augers, and all other downhole drilling and sampling equipment will be cleaned using a high-pressure hot water washer, as described in Section 1.5. Before installation of the wells, casing centralizers and screens will be similarly cleaned and inspected for damage.

3.3 BOREHOLE COMPLETION

Each borehole will be completed by backfilling with bentonite chips or installation of a monitoring well after drilling and soil sample collection is completed. Bentonite chips will be used to backfill the borehole to within 1 ft of the ground surface as temporary casing or augers are slowly withdrawn or after the removal of the push probe and hydrated. Hydration should occur in stages as the borehole is filled to allow water to contact the bentonite from bottom to the top of the borehole. From 1 ft below

ground surface to the ground surface, the borehole will be filled with a bentonite or cement grout or suitable ground completion surface (asphalt, clean soil). The Contractor shall abandon the boreholes using methods and materials approved by the consultant and consistent with Oregon regulations.

3.4 ABANDONED BOREHOLES

Boreholes completed deeper than the well to be constructed in the borehole will be sealed to within one foot of the bottom of the well. The temporary casing or auger flights (as appropriate) will remain in the borehole to prevent caving while grouting. The temporary casing or auger flights will be slowly withdrawn, as the grout material is backfilled into the borehole. The top of the seal will then be sounded to verify property placement. The seal will require one to two hours (bentonite chip) or twelve (12) to twenty-four (24) hours (cement/bentonite grout) to properly set or hydrate prior to the construction of the well in the borehole.

Upon termination of the drilling at each borehole that is not completed as a monitoring well, the Contractor shall withdraw his equipment out of the boring. The borehole will be sealed immediately with a bentonite-based sealing material from the total drilled depth to the land surface. If the borehole is located on pavement or cement, the Contractor shall install a surface patch of similar substance and quality as the original. Test borings will be decommissioned consistent with OAR 690-240. As above, the borehole will be abandoned by filling the borehole with bentonite chips and properly hydrating the bentonite. The volume of the borehole and the amount of bentonite chips added will be recorded on the exploratory boring log. The temporary casing or auger flights (as appropriate) will remain in the borehole to prevent caving and vertical contaminant migration within the borehole while grout or chipped bentonite is placed. The temporary casing or auger flights will be slowly withdrawn as the grout backfill level rises in the borehole.

4.0 MONITORING WELL CONSTRUCTION

The monitoring wells will be installed in accordance with WRD regulations (OAR 690-240) and DEQ guidance (DEQ, 1992). The final design for each monitoring well will be determined following the initial soil characterization. An *EnviroLogic Resources* field representative under the supervision of a registered Oregon geologist will monitor each monitoring-well installation. This field representative will complete an as-built well completion form showing well construction details.

4.1 MONITORING WELL CASING MATERIALS

The contractor shall arrange for the screen and filter pack to be delivered in such time so as not to delay well installation. Casing will generally be constructed of new 2 to 4-inch diameter flush-threaded Schedule 40 PVC (NSF approved). The slotted casing will be new 2 to 4-inch diameter flush-threaded Schedule 40 PVC well screen with a 0.010-inch slot size. Each well will have 10 feet of well screen. All well screen and blank casing will be boxed or sealed in plastic from the distributor to minimize damage or contamination and/or be thoroughly cleaned on-site prior to installation in the well by steam cleaning, high-pressure hot water washing, detergent washing following by thorough rinsing before well construction activities begin.

4.2 WELL INSTALLATION

The assembling of the casing and screen will occur above ground in the presence of the consultant. Once assembled, the well casing and screen will be lowered into and centered inside the boring, to the depth specified by the Consultant. The casing and screen will be fully supported from the top, as much as practical, during filter-pack installation and sealing operations to ensure the well casing and screen are plumb to the borehole.

The well casing will be installed to the target depth through the auger stem or temporary steel casing. Once the well casing and the screen are installed, the total length of the well will be verified and documented by lowering a weighted tape to the bottom of the inside of the well. All materials inserted into the well should be verified clean; if necessary, well installation tools should be subjected to the decontamination process as described above in Section 1.5.

4.3 SCREEN INTERVAL AND LOCATION

Wells installed in the shallow water-bearing zone will be screened over a 10-ft interval starting at a level above or approximately equaling the expected seasonal high water level. The well screen slot size will be 0.010 inch based on currently available site information (the screen slot size may be modified based on initial field observations and grain size analysis).

4.4 ANNULAR SAND PACK

The delivery of the filter pack will be arranged by the contractor. A filter pack will be installed around the screen, extending from the bottom of the end cap to a maximum of 3 ft above the screen. Filter pack material will be commercially prepared, presized, prewashed Lone Star #30, or equivalent for a well screen with 0.010-inch slot size. (The filter pack size may be modified if necessary to correspond with slot size modifications). The filter pack will be installed through a tremie pipe or carefully poured down the annulus between the well casing and the temporary casing, as the temporary casing is slowly withdrawn. During filter pack placement, the distribution and depth of the filter pack will be monitored with a weighted tape. A 2-ft layer of fine sand (No. 20-40 or finer) or bentonite chip seal will be placed above the sand pack.

The filter pack will be placed starting at the bottom of the borehole using a tremie pipe or other method approved by the consultant. The Contractor will measure the depth to the top of the filter-pack material at intervals directed by the consultant. This procedure will continue until the filter pack is brought up to

the depth specified. The top of the filter pack will be within the drill pipe during emplacement to prevent collapse of the borehole during construction operations. After the emplacement of the filter pack, the well will be surged with a surge block until the filter pack is settled. Sounding of the filter pack will occur after each episode of surging and, if necessary, filter-pack material will be added to bring the level up to the depth specified by the Consultant. The well casing and screen will be checked for plumbness during development as specified in Section 4.6. Volumes of filter pack and annular seal material will be recorded on the as-built well completion form for each monitoring well constructed.

4.5 ANNULAR SEAL

The annular space above the filter pack will be filled with bentonite chips to within three (3) feet of the surface (for wells no deeper than fifty (50) feet, otherwise a tremie pipe will be used to grout annular seal with a high-solids bentonite grout. For all well installations, the tremie pipe will be sealed at the lower end and have side discharges to prevent grout from getting into the sand pack. Temporary casing and auger flights will remain in the borehole during seal setting to prevent caving and vertical migration of contaminants within the borehole. The temporary casing or auger flights will be withdrawn slowly as the well is backfilled with grout. The annular seal will be allowed to set for 12 or hours prior to completing the surface seal.

4.6 CASING ALIGNMENT CHECK

Following grouting, well alignment will be determined by lowering a 3-ft long, 1.5-inch outside diameter (OD) or larger bailer into the well without obstruction or resistence.

4.7 CEMENT SURFACE SEAL AND SECURITY MEASURES

Surface completions may be either flush-mounted traffic-rated well vault or aboveground monument.

4.7.1 Above-Ground Monument

The surface of each well will be finished with a concrete surface seal no less than three (3) feet in depth. Heavy gauge metal casing at least six (6) inches in diameter (four inches in diameter large than the nominal diameter of the well casing) will be used as the security casing. This security casing will be installed in a hole at least 10 inches in diameter (four inches in diameter large than the nominal diameter of the security casing). The security casing will be extended a minimum of 24 to a maximum of 36 inches above the land surface (no more than six (6) inches above the well casing). A locking cap on the security casing will be installed that fully encloses the casing collar and the security casing will be permanently marked with well identification information and the words "Monitoring Well." The annulus between the security casing and the well casing will be filled with bentonite (not cement to prevent damage from expansion and shrinkage). The well will be completed with a three feet by three feet (3x3-ft) or three (3) foot diameter concrete pad, a minimum of four (4) inches in thickness and wire-mesh or steel rod reinforced and sloped to allow water to drain away from the well in all directions. Unless watertight construction is required, a drain-hole will be installed near the base of the exposed security casing. The well shall be protected from damage by three metal posts at least three inches in diameter, set in and filled with concrete. The protective posts shall be installed in a triangular array around the casing and at least two feet from it. Each post shall extend at least three feet above and three feet below the ground surface.

4.7.2 Flush-Mount Monument

Flush mounted well installation will only be installed at high-traffic areas not prone to flooding or ponding conditions. The concrete surface seal shall be no less than three (3) feet in depth. Heavy gauge metal casing at least six (6) inches in diameter (four inches in diameter large than the nominal diameter of the well casing) will be used as the security casing. This security casing will be cemented in a hole at least 10 inches in diameter (four inches in diameter large than the nominal diameter of the security casing) and will be of one-piece construction. The security casing will be permanently marked with the monitoring

well information and the cover of the security casing will bear the words "Monitoring Well." All flush mounted security casings will be installed through an impervious surface (i.e., asphalt, concrete). If an impervious surface does not exist, one will be constructed with re-compacted sub-grade that will support maximum traffic loads in the area, and sloped to allow water to drain away from the well in all directions.

4.8 WELL CONSTRUCTION REPORTING

An as-built well completion form will be completed by the consultant for each monitoring well constructed. The following information will be recorded on this form:

- Data of drilling and well installation, driller's name and affiliation, site geologist's name and affiliation;
- Type of drilling equipment used, method of drilling, volume of water used, and type and volume of drilling fluids or additives used;
- The size (diameter) and total depth of the completed well;
- Method of disposal for drill cuttings;
- Screened interval; screen composition, diameter, slot size and open area; and installation procedure;
- Casing composition, diameter and installation procedure;
- Method of joining used to assemble screen and casing; type and location of all casing centralizers used;
- Type of filter pack material, placement interval and method of placement of filter pack, volume of filter pack material used, sieve analysis of filter pack material (if applicable);
- Type of annular sealant, placement interval and method of placement of annular sealant, and calculated and actual volume of sealant used;
- Surface seal and security casing design and construction;

- Well construction diagram;
- Development method(s), time spend on development, pumping rate and volume of water produced during development, clarity of water before and after development, record of field measurements of water quality made during development, method of disposal of development water;
- Results of location and elevation survey;
- Static water level measured to the nearest 0.01 foot, with the date and time of measurement; and
- Results of hydraulic conductivity tests, including raw data, test methods, analytical procedures and data plots.

Additionally, a geologic log will be developed by the consultant, including information on the location of the well, penetration rate or standard penetration resistance, sampled intervals and percent recovery, stratigraphic and lithologic information, aquifers, water-bearing zones and zones of high permeability or fracture encountered, contamination observed, and any other drilling observations including lost circulation zones or other difficulties encountered during drilling. Unconsolidated deposits will be classified on the log according to ASTM D-2488-00 as with subsurface boring logs. Rock will be described by recording lithology, mineralogy, color, grain-size, degree of cementation, degree of weathering, density and orientation of fractures, other primary and secondary features and physical characteristics of the rock, and the rock quality designation.

4.9 MONITORING WELL ABANDONMENT

The wells will be abandoned by first removing the well monument and surface seal material from the wells. The PVC well casing will be removed by overdrilling around the casing, pulling the casing, and drilling the casing out completely. All casing, annular seal, and filter pack material will be removed by overdrilling the well to the original total depth and borehole diameter prior to sealing. The overdrilled borehole will be filled with a sealing material (grout or bentonite) by piping the sealing material directly to

the bottom of the borehole using a tremie pipe and filling the annular space upward from that point. The discharge end of the tremie pipe will be kept submerged below the surface of the grout while it is being applied. If the casing is pulled, the sealing material will be added to the borehole using a tremie pipe as the casing is slowly withdrawn.

The abandonment procedures will be recorded on the appropriate WRD form and provided to WRD within 30 days.

5.0 WELL DEVELOPMENT AND REDEVELOPMENT

Development will remove soil introduced during installation activities and establish hydraulic continuity between the filter pack and the formation. The new monitoring wells will be developed after the final grout has set in the well annulus for a minimum of 24 hrs. Based on anticipated soil and ground-water conditions, the wells will be developed by combination of swabbing, surging, bailing, and purging with a centrifugal pump. The outside diameter of the surge tool (vented surge block) will be 1.8 inches and be constructed as to not damage the screen or casing during its use.

The entire length of the screened interval will be swabbed starting from the bottom of the screened zone at five-foot intervals to the top of the screened zone. Measurements of the quantity of sediment entering the well will be performed after each swabbing. Formation water and sediment will be bailed from the well following surging. Surging and bailing will continue until the produced water is free of visible sediment (to the satisfaction of the consultant) and the pH, temperature, and specific conductance of the produced water have stabilized. Air lifting may be required to remove sediment from the bottom of the well. Samples of produced sediment will be available for examination by the Consultant.

Development will continue until at least 5 to 10 casing volumes are removed, soil is reasonably cleared from the well, and the turbidity of the development water is low. Development water will be contained in a temporary staging area at the facility, as discussed in Section 8.0. No groundwater sampling of monitoring wells will be performed for at least 5 to 7 days following development. Well development information will be recorded on the development record form (Figure A-8). A record of the amount and a description of the materials removed will be kept by the Contractor. The Contractor will handle and dispose of produced water.

Redevelopment of existing monitoring wells will be conducted before sampling for the initial ground-water screening event or quarterly ground-water event. Redevelopment procedures will follow the development procedures discussed above for new monitoring wells.

The Contractor will be responsible for any damage to the screen during development. The plumbness of the well shall be verified during development by lowering the development tools and attached piping to the bottom of the well without obstruction or resistance. If it is determined by the consultant that any monitoring wells installed by the Contractor are to be abandoned due to negligence of Contractor and/or his subcontractors (including, but not limited to, non-plumb casing and screen and breached screen or casing), the Contractor shall abandon the unsatisfactory well using methods approved by the consultant and consistent with WRD rules.

6.0 DRILLING SCHEDULE

The drilling for the Astoria Area-Wide investigation is expected to take longer than two weeks to complete. A complete schedule for the RI/FS is presented in the RI/FS Work Plan. The sequence of tasks to be performed by the Contractor at each location shall be as follows:

- Decontamination and mobilization;
- Location safety check;
- Drilling and sampling;
- Well construction, if applicable
- Borehole abandonment, if applicable;
- Decontamination; and
- Demobilization and site cleanup.

7.0 HEALTH AND SAFETY

The Contractor shall be responsible for the health and safety of any and all of his employees who are under his direction during this project, including his subcontractors. The Contractor shall become familiar with, and abide by, the site-specific Health and Safety Plan (Appendix C). The Contractor shall be responsible for fitting his employees and his subcontractor's employees for half-faced respirators prior to commencement of field work and shall be responsible for having properly fitted respirators available throughout the project. The Contractor shall be responsible for health and safety training of his employees and his subcontractor's employees as specified in Occupational Safety and Health Administration, 29 CFR Part 1910.120, Hazardous Waste Operations and Emergency Response, Final Rule.

Contractor and subcontractor employees shall, whenever directed by the consultant, wear face-fitted respirators. Refusal to wear respirators at the direction of the consultant shall constitute grounds for dismissal of subcontractors by the consultant and/or termination of the Contractor.

8.0 WASTE HANDLING

This section addresses the issues of handling of cuttings and residual water and site cleanup. Each of these issues is discussed below.

8.1 HANDLING OF CUTTINGS AND RESIDUAL WATER

The Contractor shall be responsible for depositing all cuttings, formation water, sediment, and drilling fluid produced by drilling and decontamination operations into appropriate receptacles provided by the Contractor. The Contractor shall be responsible for cleanup of any spilled water or cuttings, and any damage caused by such spillage. Handling of IDW will be conducted as described in the RI/FS Work Plan.

8.2 SITE CLEANUP

Upon completion of the work at each drilling location or in case of any earlier termination of the contract, the Contractor shall remove from the vicinity of each drilling location, at the Contractor's sole cost and expense, all unused materials belonging to the Contractor or used under the Contractor's direction during construction and all temporary structures, rubbish, and solid waste materials resulting from their drilling operation. The Contractor shall leave the premises in a neat and clean condition without stains on paved areas, holes, or pitfalls. In the event of the Contractor's failure to perform his obligations under this paragraph, the Consultant may cause the same to be performed at the expense of the Contractor.

The Contractor shall regularly and daily clean up the work site to maintain safety, access, and to avoid fire hazard. All scrap lumber, scrap metal, wire, or other scrap building and/or drilling materials shall be regularly hauled away at the Contractor's expense. The Contractor shall keep the construction site neat

at all times. The Contractor shall also be responsible for the cleanup of all access routes to the drilling locations including public streets, if warranted.