

Work Plan

Geotechnical Data Investigation

NW Natural Portland LNG Seismic Assessment

Objective and Scope

The objective of the proposed geotechnical investigation is to collect subsurface data to be used by NW Natural (NWN) and HDR Engineering, Inc. (HDR) to facilitate completion of a seismic assessment of the Gasco liquefied natural gas (LNG) facility located at 7900 NW St. Helens Road, Portland, Oregon. The assessment is being completed in accordance with the Oregon Department of Environmental Quality (DEQ) Fuel Tank Seismic Stability Rules per OAR 340-300-0000 et seq.

The field exploration will include advancing 20 cone penetration test (CPT) borings and four seismic CPT (SCPT) borings to collect continuous geotechnical data across the footprint of the site for seismic analyses. The SCPT borings are installed to determine seismic design category and develop P- and S-wave velocity profiles and other dynamic properties for design. The CPT borings are installed to obtain geotechnical data using a probe consisting of a piezocone tip and side friction sleeve. The CPT probe will take continuous measurements of penetration resistance of the tip, side sleeve, and pore water pressure. The data obtained from the probe will be applied to industry standard correlations to develop geotechnical design parameters of the subsurface. All CPT and SCPT borings will be performed using direct-push equipment that incorporates geotechnical and seismic sensor apparatus into the cone tip. All direct push CPT borings will be continuously advanced to refusal on bedrock or other dense substrate.

The CPT and SCPT borings will be installed at the approximate locations shown on Figure 1, to be adjusted as necessary to avoid buried utilities or other known infrastructure. The planning level coordinates of the CPTs and SCPTs are provided in Table 1 of this document. Also included in Table 1 is an estimated depth range to bedrock in the area of each proposed boring.

All CPTs and SCPT borings are located in areas where soil and groundwater contamination is present, including oil in the form of a dense non-aqueous phase liquid (DNAPL) with the following being a typical suite of contaminants as evaluated by NW Natural across the area of the proposed seismic investigation: cyanide; total petroleum hydrocarbons; polycyclic aromatic hydrocarbons (PAHs); volatile organic compounds (VOCs), including benzene, toluene, ethylbenzene, and xylenes (BTEX); and metals. Levels of contamination and presence of DNAPL are generally the most extensive in the fill or upper portions of the Alluvium and diminish with depth.

All CPT work will be completed in a manner consistent with procedures previously approved by the DEQ for CPT work (e.g., TarGOST borings) completed across the property through zones of known contamination. These previously approved procedures were developed to minimize the risk of exacerbating existing contaminant conditions by ensuring all borehole explorations are fully sealed from bottom to top with a grout mix demonstrated to maintain integrity in the presence of site contaminants, with the grouting to occur as soon as possible after removal of CPT tooling.

CPT Boring Procedures

All CPT/SCPT boring installation work will be performed by an Oregon-bonded and licensed monitoring well constructor. The boring installations will be completed in accordance with the Oregon Groundwater Law (Oregon Revised Statute (ORS) Chapter 537) and the Rules for Construction and Maintenance of Monitoring Wells and Other Holes in Oregon (Oregon Administrative Rules (OAR) Chapter 690, Division 240).

The general field activities for installing the CPT/SCPT borings are as follows:

1. All proposed CPT/SCPT locations will be marked (flag or paint) in the field.
2. All CPT/SCPT locations will be cleared for installation by identifying any public and private underground utilities within the proposed investigation area. An underground utility locating contractor will be retained to perform the borehole clearance activities.
3. Perform CPT/SCPT advancement in accordance with ASTM D5778 at the approximate locations shown on Figure 1 and Table 1.
 - a. All CPT/SCPT borings will be approximately 1.44-inches (3.6 cm) in diameter, which is the diameter of the CPT/SCPT probe tip.
 - b. CPT/SCPT borings will be advanced continuously to total depth.
 - c. No physical samples or soil waste will be generated from the CPT/SCPT soundings; the cone will push vertically and collect data electronically.
 - d. In instances where it is not possible to advance the CPT/SCPT through the fill, the location may be offset adjacent to the original CPT/SCPT location.
 - e. Between all locations, the CPT/SCPT probe and rods will be decontaminated by scrubbing with a detergent based water solution. Decontamination water is anticipated to be approximately 5-gallons per location which will be managed in consistent with the facility's Contaminated Media Management Plan¹, with all decontamination water to be fully treated through the facility Groundwater Treatment System.
4. All proposed CPT/SCPT will be advanced through previously identified zones of subsurface soil and groundwater contamination. Therefore, as soon as possible following removal of CPT/SCPT rods from the borehole, a tremie pipe will be re-advanced to the base of the CPT/SCPT borehole utilizing a direct push rig and a bentonite/organoclay grout blend will then be placed uniformly from the bottom to top of the borehole. The grout mix will consist of approximately nine parts Wyoming sodium bentonite and one-part organoclay by volume and will be mixed to a minimum 20% solids content. The resulting mud weight of the 20% solids solution will be 71.7 pounds per cubic foot (plus or minus 1 pound per cubic foot). The preceding equates to an approximate mud weight of between 9.5 and 9.7 pounds per gallon at a 20% solids content. The grout mix will meet site specific requirements identified by DEQ. Minimum grout volumes to place that completely fill each boring will be calculated and

¹ Anchor QEA, 2021. *Contaminated Media Management Plan, NW Natural Gasco Site, ECSI No. 84*, Portland, Oregon. November 19, 2021.

recorded based on depth and diameter of the borehole. This calculated volume will represent the minimum volume to place at each location. Field measurements of mud weights and volume of grout pumped into each borehole will be recorded and maintained in the project field notes.

5. A containment system will be deployed at all CPT/SCPT locations in order to ensure that all returned grout, decontamination water, or other fluids are at all times fully contained and make no contact with the surrounding ground surface. The Contractor will take precautions to prevent fuel, lubricant, and/or fluid leaks from all equipment onsite. An inspection of the rig will take place prior to work being performed to prevent fuel, lubricant, and/or fluid leaks from all equipment onsite. Plastic sheeting will be placed under all stationary equipment to capture any leaks, drips, or spills. The Contractor will be prepared to immediately clean up spills or leaks of any such materials and to prevent those materials from entering streams or water bodies. An oil absorption or adsorption medium will be onsite for use in the event of a spill.
6. Two proposed boring locations (SC-1 and SC-2) will be installed on the LNG tank platform and will therefore require uncovering, cutting, and subsequent repair of the basin liner. The overlying aggregate will be stockpiled near the work location to reuse at the completion of the repair. NW Natural will directly make arrangements for the repair of the basin liner with the original installation vendor (ACF West/EC Blue). NW Natural has verified with ACF West that the original installation materials are available locally and that a “patch” repair can be completed, including integrity testing of any seam welds on the border of the patched repair. Following the vendors confirmation of satisfactory repairs, including integrity tests, NW Natural will recover the area using the original aggregate back to grade.
7. The data obtained from the above activities will be compiled in a geotechnical data report that will include the geotechnical field details and collected data.

Figure 1. Proposed Exploration Layout

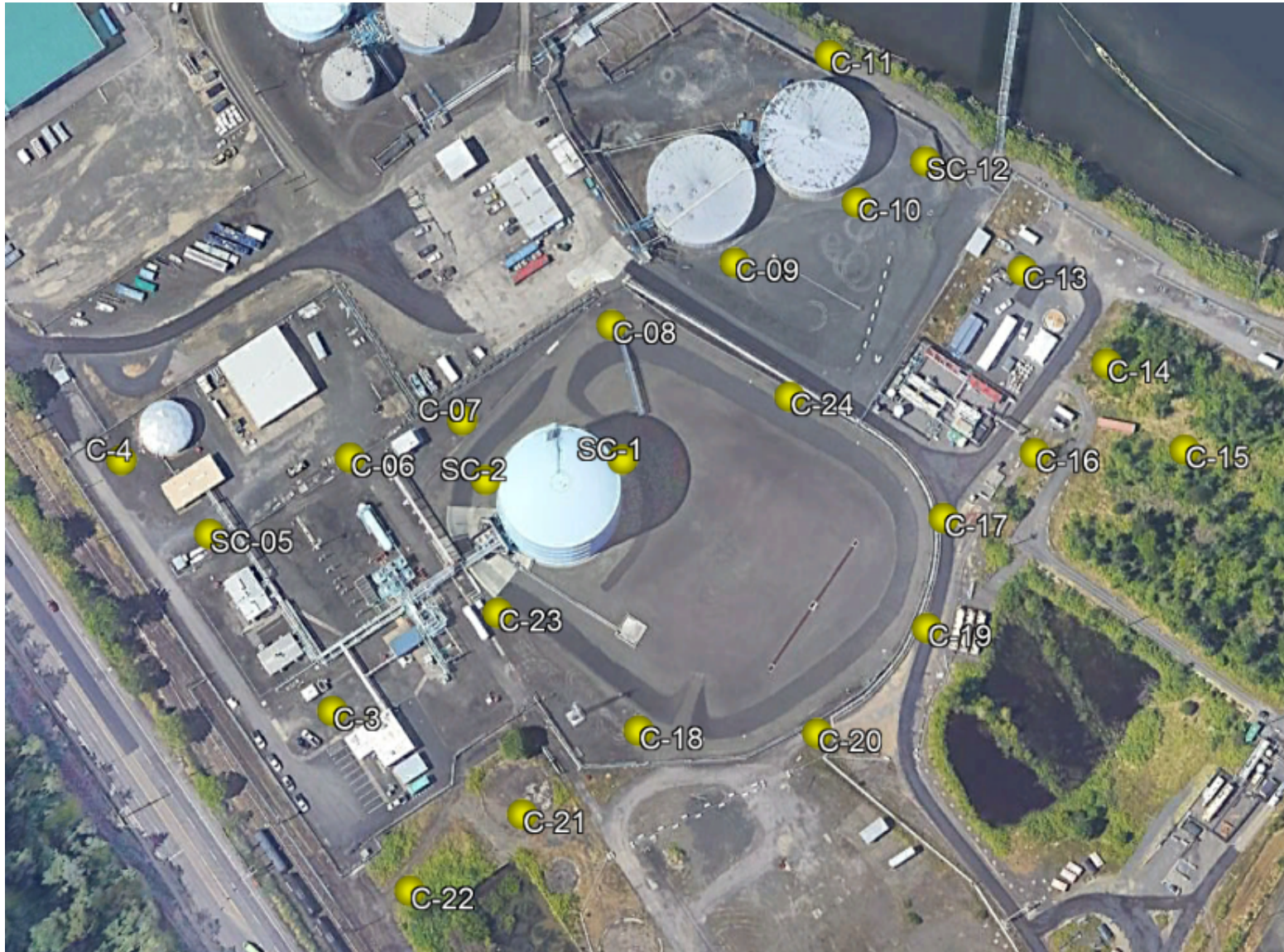


Table 1. Proposed Schedule of Explorations (CPTs/SCPTs)

CPT	Latitude	Longitude	Estimated Depth to Bedrock (ft)
SC-1	45.57880676	-122.7601498	70 to 90
SC-2	45.57874749	-122.7607138	50 to 70
C-3	45.57808267	-122.7613389	40 to 50
C-4	45.5788047	-122.7622076	40 to 50
SC-05	45.57859245	-122.761846	40 to 50
C-06	45.57881153	-122.7612673	50 to 60
C-07	45.57891954	-122.7608063	50 to 70
C-08	45.57919428	-122.7601927	90 to 110
C-09	45.57937777	-122.7596861	120 to 140
C-10	45.5795518	-122.7591799	170 to 190
C-11	45.57997793	-122.7592939	190 to 210
SC-12	45.57967148	-122.7588965	210 to 220
C-13	45.57935105	-122.7585009	220 to 230
C-14	45.57908332	-122.7581561	190 to 210
C-15	45.57883512	-122.7578371	190 to 210
C-16	45.57882478	-122.7584516	160 to 180
C-17	45.57863805	-122.7588273	110 to 120
C-18	45.57802554	-122.7600809	70 to 80
C-19	45.57832062	-122.7588953	120 to 130
C-20	45.57801796	-122.7593464	100 to 120
C-21	45.57778434	-122.7605601	40 to 50
C-22	45.57756612	-122.761021	30 to 40
C-23	45.57836524	-122.7606603	60 to 70
C-24	45.57898761	-122.7594605	120 to 145
1. SC = Seismic CPT			