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May 31, 2024

VIA ELECTRONIC MAIL

Re: Seismic Vulnerability Assessment of Shell Portland Terminal (Triton West LLC)

Dear Oregon Department of Environmental Quality (DEQ),

Shell Trading & Supply (Shell) contracted Simpson Gumpertz & Heger Inc. (SGH) to perform a seismic vulnerability assessment of Shell Portland Terminal (Triton West LLC) to comply with the new "Fuel Tank Seismic Stability Rules" (Rules) recently adopted by the Oregon Department of Environmental Quality (DEQ). Please feel free to reach out with any questions or comments pertaining to the vulnerabilities noted in this report.

Sincerely,

Joshua Lakomiak
PNW Terminal Manager
Shell Trading & Supply

SEISMIC VULNERABILITY ASSESSMENT OF THE SHELL PORTLAND TERMINAL

Shell Trading & Supply
Portland, OR
May 2024

SGH Project 247040

Gayle S. Johnson

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MAR. 12, 2013
GAYLE S. JOHNSON

EXPIRES: 06/30/25

PE Stamp applies to
Report Body and
Appendix C

PREPARED FOR
Shell Trading & Supply
3800 NW St. Helens Road
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PREPARED BY
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EXECUTIVE SUMMARY

Shell Trading & Supply (Shell) has contracted Simpson Gumpertz & Heger Inc. (SGH) to perform a Seismic Vulnerability Assessment of the Shell Portland Terminal to comply with the new "Fuel Tank Seismic Stability Rules" (Rules) recently adopted by the Oregon Department of Environmental Quality (DEQ). This report presents the geotechnical, structural, and safety assessments performed. Key vulnerability findings are summarized below and discussed in further detail in this report.

Items are categorized as Moderate or High Risk based on the full consideration of hazards, including earthquake induced ground deformations. For High Risk items, mitigations should be considered using an As Low As Reasonably Practicable (ALARP) risk reduction philosophy. For Moderate Risk items, further evaluation is recommended to determine if mitigation is necessary. For example, this may include detailed engineering calculations to quantify the seismic capacity of specific, existing components.

Table E-1 - Summary of High Risk Items

North Tank Farm	South Tank Farm	Safety Systems
Containment Walls	Containment Walls	Municipal Power
T-80105	T-55000	Water Main
T-80104		Foam Systems
		Fire Pump

Table E-2 - Summary of Moderate Risk Items

North Tank Farm	South Tank Farm	Safety Systems
T-84200	T-13522	Unstaffed hours
Gasoline piping	T-36002	Communications
	T-13519	UPS
	T-13520	Truck (while loading or unloading)
	T-80103	
	T-13521	
	T-13524	
	Gasoline piping	

Geotechnical

We have determined a peak ground acceleration (PGA_M) of 0.49g for the ASCE 7-16 DLE event. Median estimates of seismically-induced ground deformations are approximately 9 inches horizontally and 8 inches vertically at the site, with the potential for higher localized settlements. Our structural and safety assessments considered these potential displacements.

Structural

Two of the tanks in the North Tank farm have a high Life-Safety severity due to over-constrained piping condition which increase Likelihood and a large volumes of gasoline which increases the Severity. This is also the case for the gasoline tank (T-55000) in the South Tank Farm. Other tanks in the South Tank Farm are rated Moderate primarily due to an over-constrained condition with the stairs anchored to the foundation. An example is shown in Figure E-1.

Figure E-1: Typical Stair Anchorage at South Tank Farm

Gasoline piping systems are listed as Moderate based on life-safety risk due to fire.
The containment walls are rated High due to their importance in containing spills and the uncertainty in their capacity to withstand seismic loads from the DLE due to their age and construction.

Safety

The water supply is rated as a High Risk seismic vulnerability. The facility relies on municipal water as its only source for firewater and foam distribution. It is highly unlikely municipal water will be available following the DLE considered by the Rules.

Power is needed for the fire pump, foam pump, MOVs, and facility lighting. Since it is very likely that power will be lost following an earthquake, we determined that loss of power is a High Risk item.

Personnel use cell phone communication, which may be unreliable immediately following an earthquake, hampering emergency response coordination. This is considered a Moderate risk.

The terminal is normally not staffed from 1 AM to 6 AM. Emergency response can be slowed if an earthquake or spill occurs when the facility is not staffed, thus we consider this item Moderate risk.

Since the foam system is dependent on municipal water, which is unlikely to be available following the DLE, and the consequence of this system being unavailable, this item is deemed a High Risk.

Although terminal communications are protected by a UPS, the system is sized to handle short interruptions of power under an hour and may not provide adequate protection following a large earthquake and extended loss of municipal power. We considered this item a Moderate risk.

Through the workshop and safety advisor review, we identified a potential scenario where a truck at the Truck Rack becomes damaged while loading or unloading product. This could result in a fire. It could also result in the driver being trapped in the vehicle. We considered this item a Moderate risk.

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APPENDIX

1. INTRODUCTION

Shell Trading & Supply (Shell) has contracted Simpson Gumpertz & Heger Inc. (SGH) to perform a Seismic Vulnerability Assessment of the Shell Portland Terminal to comply with the new "Fuel Tank Seismic Stability Rules" (Rules) recently adopted by the Oregon Department of Environmental Quality (DEQ). This report summarizes that assessment.

1.1 Background

The DEQ developed the Rules to address the risks related to a Cascadia Subduction Zone earthquake impacting large capacity fuel handling facilities in Columbia, Lane, and Multnomah counties in Oregon. Rule 340-300-0003 specifies the requirements and timeline to perform a seismic vulnerability assessment. The Seismic Vulnerability Assessment is a detailed, facility-wide, site-specific evaluation of the risk of seismically induced damage and secondary effects to a facility and environment when subjected to a Design Level Earthquake (DLE). The Rules require that, for the purposes of this study, the DLE be determined in accordance with ASCE 7-16. This results in a very large earthquake (with a moment magnitude greater than 9.0) representing the Cascadia Megathrust fault, as described further in Section 3.2.

Rule 340-300-0002(18) defines the "Performance Objective" as limiting structural damage resulting in a spill exceeding the Maximum Allowable Uncontained Spill (MAUS) when the facility experiences DLE ground motions. Rule 340-300-0002 defines the maximum uncontained quantity of spill as one barrel (42 gal) or less for each tank or associated equipment, by reference to the reportable volumes in Oregon Law OAR 340-142.

Rule 340-300-0003 specifies the following elements be included in the Seismic Vulnerability Assessment:

- Description of facility components in terms of construction, age, inspection, maintenance, and operations.
- Summary of currently implemented spill prevention and mitigation measures and their ability to achieve the Performance Objective.
- Definition of the DLE.

- Evaluation of the potential for a spill exceeding the MAUS during the DLE for all components in the facility
- Evaluation of the potential for liquefaction, lateral spreading, and settlement seismically induced
- Evaluation of the safety of operating conditions, safe shutdown procedures, and potential spills
- Evaluation of the availability and integrity of automated sprinkler systems and sufficient supplies of firefighting foam and other emergency response equipment located in seismically resilient locations accessible after an earthquake to mitigate the risk of fire and explosions following an earthquake
- Evaluation of fire control measures such as firewalls surrounding the facility to limit fire spreading into surrounding communities
- Evaluation of the availability of day and night onsite personnel trained in emergency response and able to respond in the event of an earthquake

1.2 Scope of Work

The scope of work consisted of the following assessments consistent with Rule 340-300-0003(6)(a-c):

- Geotechnical Assessment including:
  - Site conditions assessment
  - Seismic hazard evaluation
  - Geotechnical evaluation
- Structural Assessment
- Safety Assessment including:
  - Fire control and suppression systems evaluation
  - Spill containment system evaluation
  - Evaluation of onsite emergency equipment, operational safety measures, and personnel availability

1.3 Assessment Boundaries

The team considered possible scenarios due to earthquakes that may realistically occur and result in an uncontained spill, uncontrolled fire, explosion, or toxic release at the terminal.

The following items were excluded from the scope of this study:

- Failures due to non-earthquake-related causes
- Life-safety considerations that are not directly caused by a spill that occurs due to an earthquake (e.g. life-safety concerns from occupants of a building that collapses)

1.4 Assessment Criteria

Rule 340-300-0002(4) lists codes and standards for use in this assessment. This list includes ASCE 7 for seismic design criteria, building structures, piping and pipe racks, and secondary containment, ASCE 41 for existing buildings, API 650 and API 653 for tanks, and ASCE 61 for piers, wharves, and waterfront structures. As permitted by Rule 340-300-0002(4)(h), the team considers "other applicable standards" to include:

- "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments," prepared for the Unified Program Agency (UPA) Subcommittee of the Region I Local Emergency Planning Committee (LEPC), January 2019, also referred to as the "CalARP Seismic Guidance Document".
- California Building Code (CBC) Chapter 34F, otherwise known as Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), 2022.
- "Seismic Evaluation and Design of Petrochemical and Other Industrial Facilities, 3rd Edition, American Society of Civil Engineers (ASCE), 2020.

The CalARP Seismic Guidance Document has a long history, being widely used within the industry for assessing existing chemical and process facilities that contain hazardous materials. Further, MOTEMS is considered the most appropriate code document for assessment of operational procedures and seismic performance at existing oil terminals. Both of these documents also reference the ASCE document noted above. That document is widely used throughout industry and is frequently accepted by building officials for its interpretation of building code provisions as specifically relevant to typical structures and systems found in petrochemical and industrial facilities.

1.5 Limitations

SGH has performed the professional services for this project using the degree of care and skill ordinarily exercised under similar circumstances by reputable engineers practicing in the structural and earthquake engineering fields in this or similar localities. SGH makes no other warranty, expressed or implied, as to the professional advice included in this report. We have prepared this report for Shell to be used solely for the purposes of satisfying the requirements of the DEQ Rules. We have not prepared the report for use by other parties and the report may not contain sufficient information for purposes of other parties or for other uses. The recommendations resulting from this assessment rely on information provided by Shell to SGH, including soils reports, drawings, and specifications. SGH makes no warranty as to the accuracy and correctness of any information provided by Shell.

Please note that addressing vulnerabilities identified in our report may reduce the risk, but does not guarantee or assure that a release will not occur in an earthquake. All parties should recognize the lack of complete assurance connected with seismic evaluations, especially of existing facilities. Uncertainties exist associated with material properties and structural behavior (uncertainties that are typically larger for existing facilities than new designs), as well as large uncertainties associated with earthquake motion in terms of amplitude, frequency content, direction, and duration. All parties should also recognize that seismic assessments such as those performed in this review require the significant application of professional experience and engineering judgment. Some amount of uncertainty and variation will always exist with respect to the interpretation of data, notwithstanding the exercise of due professional care.

This assessment emphasized identification of vulnerabilities and not conformance to building codes for new design. We further note that conformance to new design codes does not eliminate seismic risk, and industry standards for seismic evaluation of existing facilities consistently have been developed with the intent of reducing risk, and not for compliance with new design codes.

2. FACILITY DESCRIPTION

The Shell Portland Terminal is located at 3800 NW St Helens Road in Portland, Oregon. The terminal is setback from the Willamette River approximately 2,000 ft. The facility consists of two tank farms (North Tank Farm and South Tank Farm), a truck rack, a vapor recovery unit (VRU), and several buildings, including the main office, maintenance garage, shop, storage, truck rack foam system building, and electrical/tank foam system building. See Figure 2-1 for the vicinity plan of the Shell Portland Terminal. See Figure 2-2 for the aerial plan of the facility.

Figure 2-1: Vicinity Plan of Shell Portland Terminal

Figure 2-2: Aerial Plan of Shell Portland Terminal

2.1 North Tank Farm

The North Tank Farm, constructed circa 1920s, consists of three gasoline tanks and one ethanol tank. These tanks are all large-diameter (100 to 120 ft), squat tanks with an aspect ratio (height divided by diameter, H/D) less than 0.5, and supported on shallow, ring-wall foundations. There are also five small (up to 15,000 gallon) additive tanks. Several pumps are located within the containment area. The piping interconnects the tanks and the adjacent truck loading rack. The secondary containment consists of reinforced concrete walls, with a toe and heel foundation with a key. The low point of the North Tank Farm secondary containment is a paved entry ramp at 4.95 ft elevation. Within the main containment, T-84200 has shorter retaining wall and HDPE membrane liner.

An example containment wall cross section is shown in Figure 2-3; more drawings are provided in Appendix A.

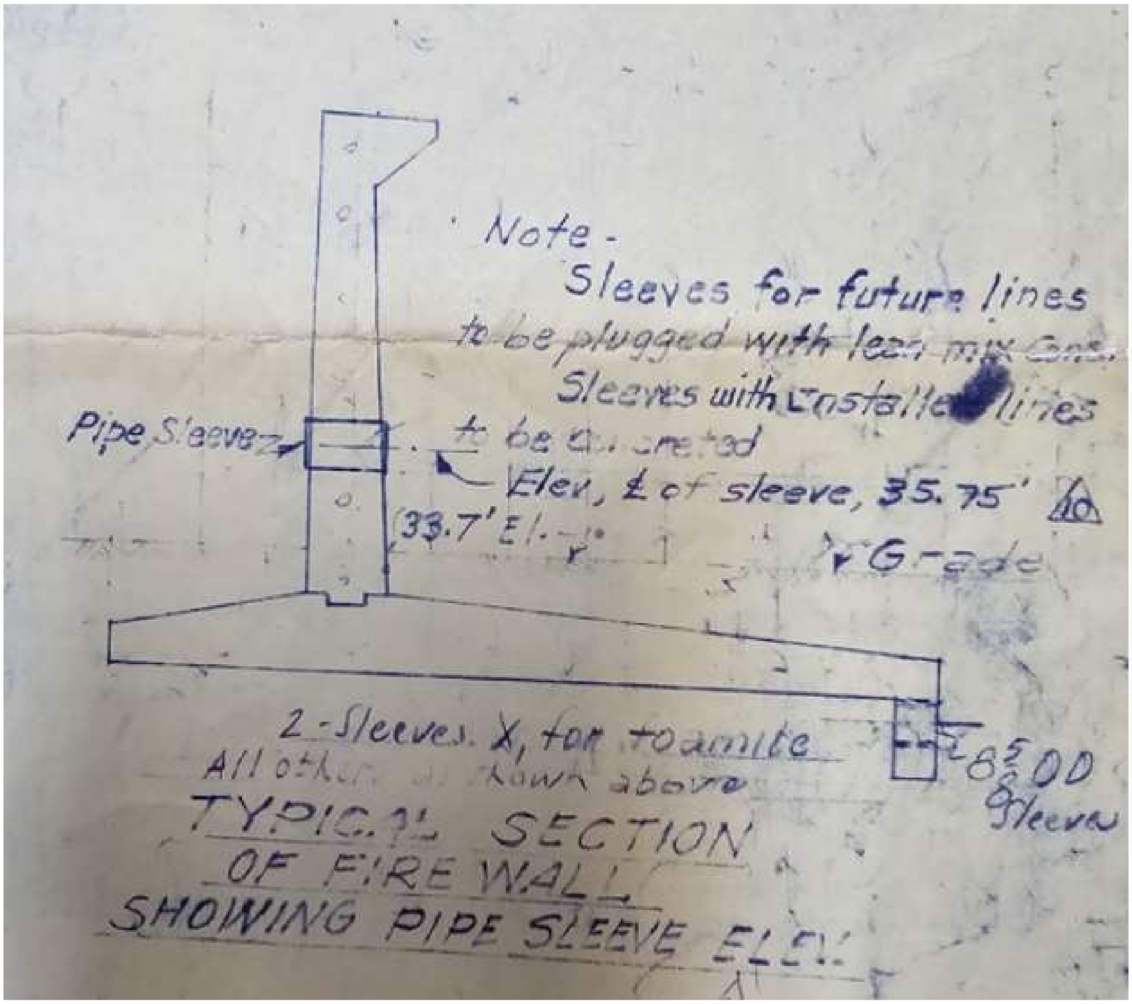


Figure 2-3: Example Tank Farm Containment Wall Cross Section

2.2 South Tank Farm

The South Tank Farm, constructed circa 1920s, consists of one gasoline tank, seven diesel tanks, one contact water tank, and one out-of-service tank. Three of the fuel tanks are large-diameter, squat tanks with a minimum diameter of 95 ft. The remaining fuel tanks have a diameter of 52 ft, with heights varying from 24 ft to 35 ft. Tanks are supported on shallow, ring-wall foundations.

Several pumps and a diesel manifold are located within the containment area. Pipes interconnect the tanks and penetrate the containment wall, leading to the truck loading rack. Like the North Tank Farm, the secondary containment is comprised of reinforced concrete walls and foundations. Although the wall is approximately 10 ft high, containment volume is limited by the low point at the gate approach to an effective height of about 5.39 ft.

An example containment wall cross section is shown in Figure 2-3; more drawings are provided in Appendix A.

2.3 Truck Rack

The truck rack is located on the northwest side of the North Tank farm. The rack consists of three lanes for loading products and one lane for unloading products. Piping from the tank farm runs above the truck rack lanes on pipe bridges. Piping from the tank farm also drops below ground in the tank farm containment area and routes to where it ties in above ground at the truck rack. The truck rack foam system building, transformer shack, and VRU are located south of the truck loading rack.

2.4 Buildings and Structural Canopies

The facility's buildings are grouped together to the south of the North and South Tank Farm. The terminal buildings include an electrical/tank foam system building, a shop building, a maintenance garage, and an office building. The office building is a two-story structure with reinforced concrete shear walls and concrete floor slabs. The maintenance garage, electrical building, and shop building are single-story steel-framed structures. The buildings on site do not contain or store fuels, and therefore, hazardous material release is not an issue.

There is also a structural canopy over the outdoor hazardous waste storage, next to the maintenance building. This area is within a curbed secondary containment.

A plot plan and inventory are provided in Appendix A. See also Figure 2-4.

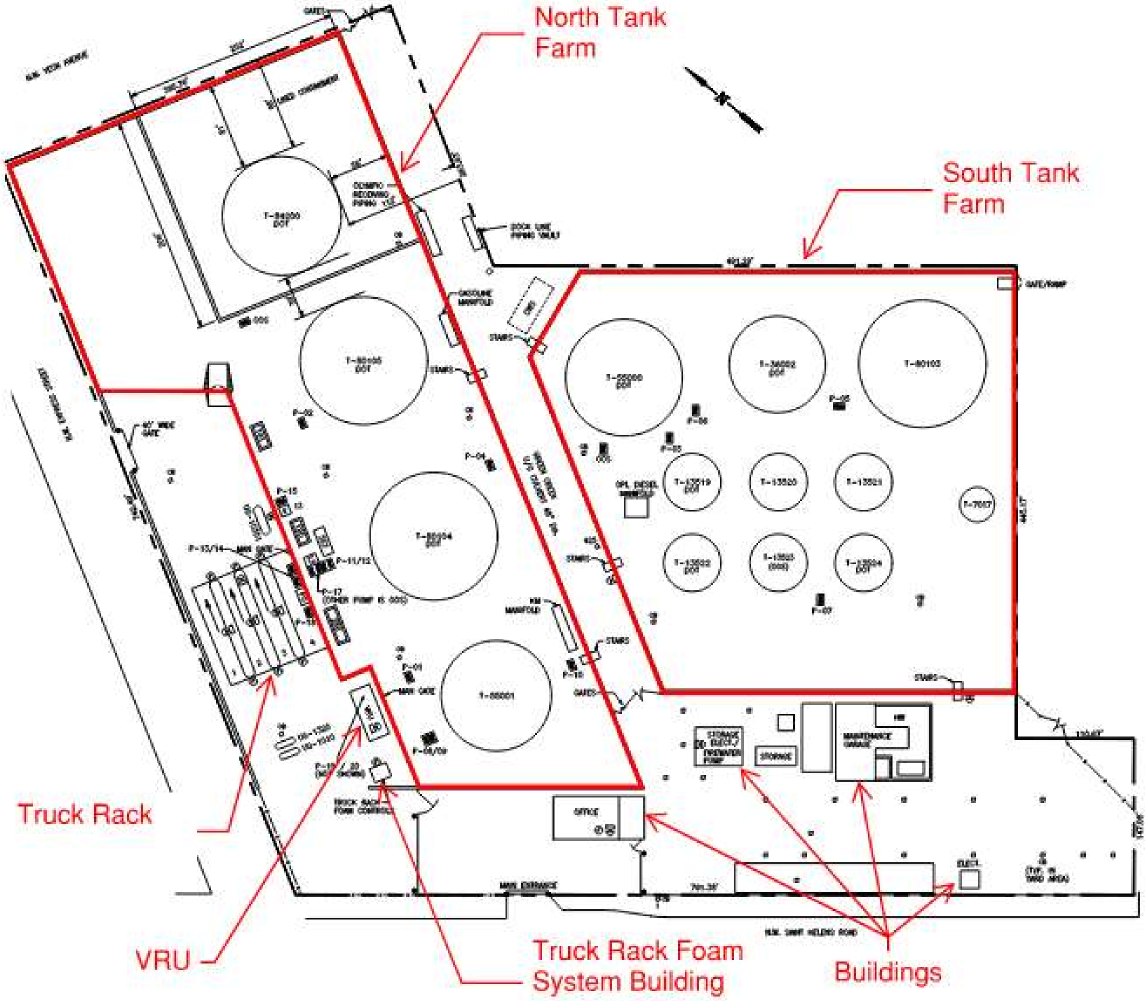


Figure 2-4: Plot Plan of Shell Portland Terminal

3. GEOTECHNICAL ASSESSMENT

A geotechnical assessment was performed to provide input for the Seismic Vulnerability Assessment. The assessment included consideration of existing site-specific geotechnical information and other existing data. The full geotechnical assessment, performed by Gannett Fleming Inc. (Gannett Fleming), is included in Appendix B.

3.1 Site Conditions

The terminal is located on the east side of NW St. Helens Road just east of the foothills of the Tualatin Mountains and west of the Willamette River as shown in Figure 1. The site is relatively flat at roughly elevation 40 feet (NAVD88). The crest of the river's waterfront slope is roughly 2,000 feet from the east boundary of the site.

Based on regional geologic mapping, the site is underlain by Quaternary alluvium comprised of river and stream deposits of silt, sand, and organic-rich clay with subordinate gravel of mixed lithologies. Site borings conducted by Professional Services Industries, Inc. (PSI) in 2021 indicate subsurface conditions which generally consist of very loose to loose sands and very soft to medium stiff silts, which is generally consistent with published geologic maps. The borings were terminated after encountering SPT sample refusal in dense to very dense gravels at a depth of about 60 feet. Data collected by others near the site indicate bedrock depths of about 50 feet.

Shallow groundwater was encountered in the boring by PSI at depths ranging from about 2 ½ to 7 ½ feet at the time of drilling. Fluctuations in groundwater levels likely occur due to variations in the Willamette River water level, rainfall, underground drainage patterns, regional influence, and other factors.

3.2 Seismic Hazard Evaluation

We have evaluated seismic hazards including ground shaking, liquefaction, lateral spreading, and seismic densification. A summary of our conclusions regarding the potential for liquefaction and lateral spreading is provided below.

As required by the Rules, we developed seismic design parameters in accordance with the 2016 American Society of Civil Engineers (ASCE) Standard 7-16 (ASCE 7-16): Minimum Design Loads for Buildings and Other Structures (ASCE 2016) for the purposes of evaluating liquefaction potential and lateral spreading. Based on the existing geotechnical data, the site can be characterized as Site Class D in conformance with ASCE 7-16. Using the ASCE 7 Hazard Tool, we calculated a maximum considered earthquake geometric mean (MCEG) peak ground acceleration adjusted for site class (PGAM) of 0.49g, corresponding to a moment magnitude (Mw) of 9.3 on the Cascadia Megathrust fault, which governs the seismic hazard at the site.

The results of our evaluation indicate the potential for liquefaction is high during the design earthquake. Related effects include ground surface settlements, sediment ejecta and settlement from ground loss. In addition to settlement from reconsolidation and sediment ejecta, liquefaction-induced foundation settlement can occur when shear-induced deformations driven by cyclic loading occur due to ratcheting and bearing capacity types of movement caused by soil structure interaction (SSI).

Lateral spreading is a phenomenon where a soil mass moves laterally on liquefied soil down a gentle slope or toward a free face, such as the adjacent Willamette River channel. Displacement occurs in response to gravitational and earthquake-induced forces acting on soils within and above the liquefied layer. The magnitudes of lateral displacement are expected to be significant near the Willamette River shoreline, reducing in magnitude with increasing distance from the waterfront slope. To estimate liquefaction-induced lateral displacements, we used a semiempirical approach developed by Zhang, et al. (2004).

During lateral spreading, surface layers commonly break into large blocks, which progressively migrate toward a free face. This development of ground fissures can promote ground loss for sediment ejecta and increase the likelihood of associated settlement.

3.3 Seismically-Induced Ground Deformations

We have developed preliminary estimates of vertical and lateral seismically-induced ground deformations to approximate the range of movements expected at the site.

Lateral deformations due to lateral spreading are estimated at 9 inches. It should be noted that the approach developed by Zhang, et al. (2004) and used to estimate deformations, could underestimate or overestimate lateral displacements by up to a factor of 2. Lateral spreading also results in ground settlement, which can be as much as about one-third to one-half of the magnitude of lateral displacement.

The primary mechanisms of liquefaction-induced settlement are reconsolidation, ejecta-induced, and shear-induced deformation. Reconsolidation settlement estimates range from 2 to 6 inches. Localized, ejecta-induced settlements are estimated as up to 12 inches. Combined with the vertical component of lateral spreading, the total estimated settlement, with free-field conditions, is estimated as 5 to 23 inches with global and local effects.

4. STRUCTURAL ASSESSMENT

Rule 340-300-0003(6)(b) identifies that a structural assessment is to be performed for all onsite structures where damage could result in a potential release of fuel.

The key structural assessment consisted of a walkdown evaluation of the entire facility, supplemented by limited reviews of available drawings and other documentation, such as tank inventory tables.

Our evaluation is based on the "expected" or "most likely" conditions at the time of an earthquake rather than the worst-case or conditions that might be considered for new design. This includes consideration of existing deterioration or damage and any modifications made since construction, as observed during the walkdown.

Considering the variability of tank operation (i.e. tanks are filled or emptied over days, weeks, or months) and input from Shell Operations regarding the likely fill heights based on actual operating procedures, a reasonable assumption for all tanks is that they are half full.

4.1 Walkdown Assessment

The walkdown assessment is a primarily visual review that considers the actual conditions of each installation in a systematic, methodical manner. The engineers performing the review investigate potential seismic vulnerabilities, focusing on proven failure modes from past earthquake experience, basic engineering principles, and engineering judgment. The walkdown review emphasizes the primary seismic load-resisting elements and the potential areas of weakness due to design, construction, modification practices, historical deterioration, or existing damage. A special emphasis is placed on details that may have been designed without consideration of seismic loads.

This walkdown assessment approach is widely used within industry, and in particular is used in California for assessing existing chemical and process facilities that contain hazardous materials. The approach is documented in the CalARP Seismic Guidance Document, which recommends that the walkdown follow the guidance provided by the American Society of Civil Engineers (ASCE) in their document, "*Guidelines for Seismic Evaluation and Design of Petrochemical Facilities*, 2nd Edition", published by ASCE, 2011. We also considered that document, as well as the 3rd Edition, published in 2020.

Our walkdown assessment considered the likely response due to ground shaking (inertial effects), as well as the likely damage due to liquefaction and lateral spreading associated with the DLE.

4.2 Likelihood of Spill from Seismic Structural Damage

We assigned a judgment-based, qualitative likelihood of spill to each structure, tank, and other installation within the terminal based on our walkdown assessment and associated document review.

For storage tanks, we have taken into consideration the historical performance of storage tanks regardless of whether designed to modern code requirements, emphasizing those details that have been proven by experience to increase the likelihood of damage that could lead to a spill. For this assessment, we considered criteria such as tank construction (i.e. riveted versus welded), whether the tank is anchored (anchored tanks historically perform very well), the aspect ratio of the tank (fill height to diameter ratio), and whether any piping, stairs, or other attachments are restrained in a manner that would over-constrain movement of the tank and cause stress concentrations or damage to attached piping.

Although our initial assessment assumes that riveted tanks have a higher vulnerability than welded tanks, we performed limited seismic calculations of representative tanks, which indicated that the riveted tanks do not have a significantly higher risk than welded tanks. This assessment included seismic evaluations per American Petroleum Institute (API) Standard 650, *Welded Tanks for Oil Storage* (API 650) Annex E, “Seismic Design of Storage Tanks”, for one welded and one riveted tank. The tanks had the same 120 ft diameter and 40 ft shell height. We used the joint efficiency factors from API Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction* for the riveted tank. However, because all of the riveted tanks in the south tank farm also have rigidly connected stairs, there is still an increased vulnerability due to the over constrained condition.

For containment walls, the likelihood of structural failure in a seismic event is based on the type of containment (i.e. concrete wall versus soil berm), liner details, depth of wall foundations, geometries (i.e. width and toe), reinforcing details, and era of construction. We also considered the present condition as well as modifications made to containment walls, such as penetrations or reinforcing buttresses, if applicable.

For buildings and other building-like structures, we first considered whether damage to the structure would result directly in an uncontained spill, uncontrolled fire, or explosion or would damage a critical safety or control system, leading to the same effect. Buildings that do not store fuel products (such as the office building) or contain critical safety systems were screened from further assessment. For structures that contain products or critical systems within the scope of these rules, we considered the structure system, visible condition, and era of construction to determine a qualitative likelihood of damage that could lead to a spill.

5. SAFETY ASSESSMENT

We reviewed the fire systems and procedures, oil spill containment systems and procedures, and other emergency systems that would be affected by a major earthquake.

We also performed a walkdown of the site, met with the operator and held discussions, and participated in the risk assessment discussed in Section 6.

We considered realistic general earthquake effects that are likely to occur in a DLE, such as:

- Shaking of the entire facility simultaneously without prior warning.
- Lengthy duration of shaking (15 seconds or longer).
- Loss of grid power.
- Loss of municipal water.
- Multiple alarms triggered.
- Off-site emergency services may not be available due to infrastructure problems (bridges and highways) or regional needs for the general community.
- Unpredictable human response.

5.1 Spill Containment Systems, Equipment and Procedures

This section addresses Rule 340-300-0003(6)(c)(B) and Rule 340-300-0003(1)(d).

Primary Containment and Maintenance Procedures for Bulk Storage

All bulk storage containers (i.e. tanks in the tank farm) at the Shell terminal are made of steel and are designed in accordance with American Petroleum Institute (API) standards. The large vertical storage tanks are inspected per API 653 and the small horizontal additive tanks are inspected per the Steel Tank Institute (STI) standards. All large vertical storage tanks are equipped with a level ATG (Automatic Tank Gauge) and an emergency high level switch which are inspected regularly. The terminal monitors the tank levels continuously and maintains the levels below the Safe Fill Alarm Settings (which are lower than the physical operating limits of the tanks).

As an additional safeguard, tanks are equipped with side gauges, and tank levels are manually gauged at regular intervals to confirm the accuracy of the level sensors.

The terminal is equipped with High level alarms, which initiate visual and audible alarms to alert personnel to possible upset conditions.

Receipt of product into tanks is only conducted with an operator on duty.

Tank bottoms and buried components are protected against corrosion by a cathodic protection system. Cathodic protection rectifier readings are continuously monitored through a remote monitoring unit (RMU) which automatically generates a notification when readings fall outside of acceptable limits. The Corrosion Technician for the site also reviews the Cathodic protection readings on a monthly basis to ensure that the system is providing adequate protection.

The terminal has a formal Tank Integrity Program (TIP), designed to detect corrosion or other potential failures of bulk containment before tanks become compromised. For example, the outside of the tanks are visually inspected monthly for visible signs of deterioration, corrosion, leaks or accumulation of product inside containment areas.

Shell inspects each tank based on age, condition, regulatory status, and service. The inspection policy includes procedures for inspection of:

- Firewall
- Foundation
- Structure
- Appurtenances
- Exterior Coating (paint).

- Internal Coating when tank is periodically taken out of service in accordance with API 653.

The TIP also includes the regular inspection of the floating roof seals, foam chambers and tank level Automatic Tank Gauge (ATG) / emergency level switch.

The inspection of the foam tanks is per NFPA. It is not part of the TIP, but it is part of the overall site maintenance strategy. Pressure Vessel inspections are driven by local regulatory inspection and internal Shell standards. Finally, there is no requirement to inspect the VRU vessels (Adsorber Vessels or Absorber Vessel) beyond a visual inspection which is completed during the quarterly VRU inspection by the manufacturer.

Any drums or totes brought to the site are tested in accordance with the manufacturer, and are all visually inspected monthly.

Maintenance of Terminal Piping

The terminal includes above ground and below ground piping.

The terminal has a formal Facility Integrity Program (FIP), designed to detect corrosion or other failure mechanisms prior to component failure. The FIP for Portland complies with API 2611 RP and includes multiple inspections ranging in frequency from annual to every 10 years. Piping that is regulated by DOT PHMSA is also included in an Atmospheric Corrosion Inspection (ACI) that occurs every 3 years.

All above ground valves and piping are routinely examined for signs of corrosion or coating deterioration during operating personnel rounds. During these examinations, terminal personnel also assess the general condition of:

- Flange joints
- Valve gland and bodies
- Pipe supports

- Metal surfaces
- Catch pans
- Valve locks and/or seals.

All buried piping is coated and cathodically protected.

Secondary Spill Containment Systems and Response Procedures

The terminal provides passive secondary containment for all equipment containing 55 gallons or more of oil.

Both the North and the South tank farms are protected by concrete containment walls and earthen floors. The containment areas are sized to contain the contents of the largest single tank plus an additional safety factor based upon precipitation and deadwood. According to the terminal Spill Prevention Control and Countermeasure (SPCC) Plan, the earthen floors of the containment area are sufficiently impervious to contain a spill provided that the failure of primary containment is detected quickly and clean-up operations begin promptly.

The terminal includes diked and undiked areas. The tank farms and the truck rack are protected by diked areas designed to capture hydrocarbon spills. Areas in between tank farms are undiked and designed to drain surface spills to catch basins that lead to an Oil Water Separator (OWS).

In the event of a hydrocarbon spill, the terminal would activate the Contingency Plan to mitigate the spill. According to the SPCC, any hydrocarbon spills within containment would be recovered by vacuum truck or other similar means.

Both diked and undiked areas in the terminal are visually inspected daily, so that any potential spills are quickly discovered and mitigated.

All terminal personnel are trained on the Facility Response Plan (FRP) and are capable of activating the Contingency Plan in the event of a discharge.

Spill Response Procedures

Initial oil spill response procedures include elimination of sources of ignition, isolating the source of discharge, initiating containment, making internal notifications, making external notifications, activating company resources, and activating response contractors as necessary.

The truck rack is equipped with remotely activated ESD valves that are used to isolate transfers. Elsewhere, the terminal uses a mix of manual and motorized valves for control, but none of the motorized valves (other than the truck rack supply ESD valves) may be closed remotely. All tanks have locally operated block valves that may be used to isolate fuel and mitigate spills in the event of piping or tank failure.

Upon discovery of a spill, the first Shell personnel on scene functions as the Person-In-Charge (PIC) until relieved by an authorized supervisor. Terminal Management will activate the Local Response Team, and external notifications as needed.

Terminal external notifications include the Oil Spill Removal Organization (OSRO), federal, state and local agencies.

Summary of Current Spill Prevention and Mitigation Measures

Tank design and maintenance is in accordance with industry standards. In addition, the terminal provides secondary containment for all product stored on site.

According to the SPCC, the earthen floor of the secondary containment inside the tank farm will contain spilled hydrocarbons inside terminal boundaries long enough to facilitate prompt cleanup operations.

The truck loading rack is equipped with remotely activated ESD valves that are used to isolate transfers. Similarly, all tanks have block valves that are used to isolate fuel and mitigate spills in the event of piping or tank failure.

5.1.1 Seismic Vulnerabilities

Tanks in the tank farms are susceptible to damage in the DLE from shaking or differential displacements. Similarly, piping is susceptible to damage from differential displacements of supports and anchor points.

The concrete containment walls that form part of the secondary containment for the North and South Tank farms are susceptible to damage during an earthquake and might not provide adequate protection following an earthquake and subsequent spill from a tank. From a safety standpoint, loss of containment for a spill would potentially spread the life safety hazards over a larger area, including fire and exposure to hazardous materials.

Loss of power following an earthquake will lead to loss of facility lighting, hampering emergency response and potential spill mitigation measures. The ESD valves are all fail closed, but the other motor operated valves (MOVs) would not be able to be actuated from the local push button at each device. Since the tank foam system relies upon a foam pump that is electrically driven, it would also not function.

5.2 Fire Control and Suppression Systems

This section addresses Rule 340-300-0003(6)(c)(A) and Rule 340-300-0003(1)(i).

Firewater at the terminal is provided by a fire main loop which serves seven fire hydrants. The fire main is charged from a municipal water connection.

In addition, the terminal is equipped with a foam proportioning system that can provide fire fighting foam to the four tanks located in the North Tank Farm and to the eight tanks in the South Tank Farm. The tank foam proportioning system is located inside the electrical/tank foam system building, which is equipped with a 1250 GPM fire pump and a foam pump. The tank foam system includes a 2000-gallon foam tank (normally filled to 1900 gallons).

The truck rack is protected by a dedicated foam deluge system, which includes a 400 gallon bladder tank. The truck rack foam system is activated automatically by the fire wire (a linear heat detection system) at the truck rack or manually from eight pull stations (one located at the office building). The truck rack foam system is also able to be actuated manually from the truck rack foam system building by manually opening the foam deluge valve.

The tank foam system must be activated manually. Foam is then delivered to individual tanks by opening dedicated foam valves located just outside both tank farms. The foam valves for the North Tank farm are motorized and may be opened remotely. The foam valves for the South Tank farm are manual and need to be opened locally in order to deliver foam to the tanks.

The foam systems in the terminal depend on municipal water to function.

Each tank farm area is surrounded by concrete containment walls. The original design drawings for the containment walls indicate that they were designed as firewalls.

5.2.1 Seismic Vulnerabilities

The firewater system and foam distribution system are dependent on municipal water, which might not be available following an earthquake.

The foam distribution system valves for the North Tank farm require municipal power to be actuated remotely. Municipal power might not be available following an earthquake.

The concrete containment walls that provide secondary containment and serve as firewalls are susceptible to damage during an earthquake and might not provide adequate containment of a spill, hindering control of a fire.

5.3 Emergency Response Equipment

This section addresses Rule 340-300-0003(6)(c)(C) and Rule 340-300-0003(1)(h).

Firefighting Foam

The quantity of foam available at the site is detailed in Section 5.2. There is sufficient foam available to meet NFPA 11 requirements.

Activation of the foam system is described in Section 5.2, with a mixture of motorized and manual valves, and partial dependence on municipal power.

The foam systems in the terminal depend on municipal water to function.

Spill Response Kits

Spill response kits are strategically located throughout the terminal including at the North Tank Farm, South Tank Farm, Warehouse and Truck Loading Rack. The Spill Response Kit includes boom, absorbent pads and granular absorbents.

Power and Communications

The terminal is not equipped with an emergency generator to provide power for lights or Motor Operated Valves (MOV)s. The MOVs fail in their last position and may still be closed manually. There is a UPS (Uninterruptible Power Supply) that is capable of powering the communications associated with the Automation/Control Systems for less than 1 HR (i.e. a short upset condition). The UPS does not provide sufficient power to run pumps, MOVs or other higher voltage equipment.

Terminal personnel use intrinsically safe cellphones to communicate during normal operations.

5.3.1 Seismic Vulnerabilities

The firewater system and foam distribution system are dependent on municipal water, which might not be available following an earthquake.

The foam distribution system valves for the North Tank farm require municipal power to be actuated remotely. Municipal power might not be available following an earthquake.

Loss of power following an earthquake will lead to loss of facility lighting and the ability to electrically actuate the MOVs. The UPS for communications only lasts for one hour. Additionally, cell phone service may be unreliable immediately following an earthquake. These risks may hamper emergency response and potential spill mitigation measures.

5.4 Safety of Operating Conditions

This section addresses Rule 340-300-0003(1)(g).

Terminal operating conditions and procedures are consistent with common industry practices, and no concerns were noted by the audit team.

Activating the Terminal ESD shuts down the Truck Rack Supply Pumps. The KM (KinderMorgan) Pipeline Shipping Pump (P-10), the Diesel Transfer Pump (P-06), and the Gasoline Transfer Pump (P-04) do not automatically shut down during a Terminal ESD. Note that P-04 does shut down if it is lined up as the Spare Truck Rack Supply Pump. Isolating damaged sections of piping or tanks requires manually shutting valves, with the exception of the truck rack (See Section 5.1 for additional details).

Spills are mitigated by the secondary containment system that protects the tank farms and the truck loading rack area.

5.4.1 Seismic Vulnerabilities

The concrete containment walls that form part of the secondary containment for the North and South Tank farms are susceptible to damage during an earthquake and might not provide adequate protection following an earthquake and subsequent spill from a tank.

Pumps P-10, P-04 and P-6 do not shutoff when the ESD is pushed.

5.5 Terminal Staffing, Monitoring, and Response

This section addresses Rule 340-300-0003(1)(j).

The terminal is normally not staffed from 1 AM to 6 AM. If any of the following activities are schedule to occur during hours that are normally not staffed, terminal personnel are scheduled to staff the site:

1. Olympic Pipeline (OPL) Receipt into a Tank
2. Ethanol Offloading into a Tank
3. Biodiesel Offloading into a Tank
4. Additive Offloading into a Tank
5. KM (Kinder Morgan) Pipeline Shipments from a Tank
6. Tank to Tank Transfers (gravity fed or with a transfer pump)

Additionally, the tank levels are monitored 24/7 from the Houston Control Center (HCC). This is helpful since the Tank Idle Deviation Alarm should detect sloshing of product due to the DLE. If sloshing occurs, the HCC is able to contact Local Operations who then mobilize and assess the situation.

Lastly, the HCC is able to detect complete loss of AC power to the site through the AC Power Fail Alarm. When this occurs, the HCC notifies Local Operations who then mobilize and assess the situation.

5.5.1 Seismic Vulnerabilities

There are no Shell personnel present between 1 AM and 6AM. This could slow the detection of a spill and the initiation of spill response procedures.

6. RISK ASSESSMENT

We used a critical systems risk assessment process to identify, prioritize, and assess the seismic vulnerabilities of critical equipment, structures, and procedures during a DLE event. This analysis considered the performance of critical systems during and after the DLE event, and how their seismic vulnerabilities impact the prevention and containment of oil spills.

This risk assessment was in the form of a workshop including terminal operations and safety specialists, along with structural/seismic engineering specialists who understand the historic seismic performance of systems in earthquakes. With this experience we can consider realistic damage and failure scenarios rather than assessing strict conformance to current codes for new design. See Appendix C for a list of attendees.

The team considered possible scenarios due to earthquakes that could realistically occur and result in an uncontained spill, uncontrolled fire, explosion, or toxic release at the terminal. The workshop was used to risk rank and prioritize the criticality of various structures and systems during and following a seismic event in terms of the likelihood and consequences of a potential release of fuel from a spill caused by a DLE event.

The risk ranking was done through a risk matrix approach, using the risk matrices shown in Figures 6-1 and 6-2 for Environmental and Life-Safety risks, respectively.

We assigned structures and equipment a Likelihood of damage in a DLE that could lead to a spill, with ratings of 1 to 5 from "Very Unlikely" to "Very Likely", as defined in Appendix C. During the workshop, we assigned a Severity rating from A to E, from the least severe environmental or life-safety consequences to the most severe.

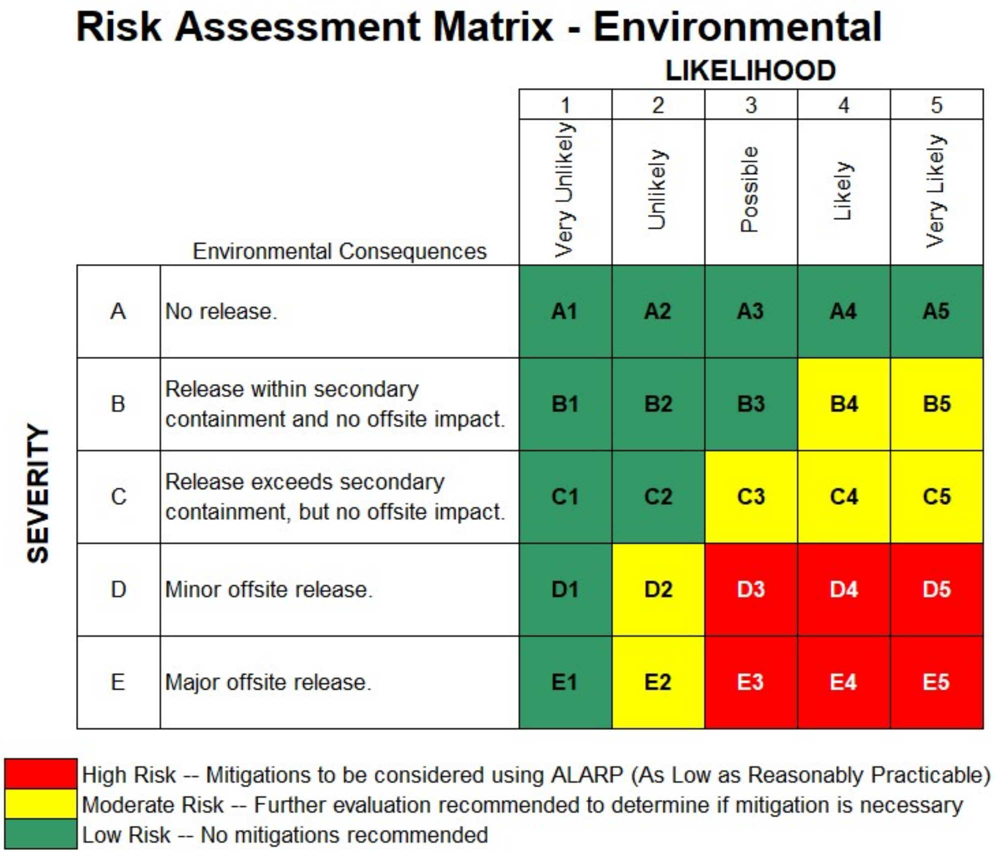
The Severity rating considered potential spill volumes, secondary containment mechanisms, operational or other safeguards that are in place, type of contents (i.e. flammability or combustibility of contents), and criticality of the component in emergency response. The potential impact on public health and safety are also considered within the Life Safety severity.

For example, the spill of a more volatile substance has a higher Life Safety consequence due to its fire potential.

We use the Severity and Likelihood to assign each item two risk ranking matrix scores. The environmental score relates to the quantity of spill and its impact on, or extent into, the neighboring community. The life-safety score relates to life-safety consequences that occur directly as a result of the spill.

For most items, the scores are specific to that item (e.g. based on an individual tank's Likelihood of structural failure and Severity of consequences). For secondary containment walls, the score considers all the tanks, piping, and other fuel storage within that area. If likelihood of structural failure is 'Possible' or more likely, then the severity score is based on the worst of any given tank or piping within that area. If the likelihood of structural failure is considered Very Unlikely or Unlikely, then the severity is based on the volume of potential overtopping using an expected probable volume of spill for tanks within that containment.

We provide the complete risk assessment, including a table of all items and resulting risk assessment scores in Appendix C.

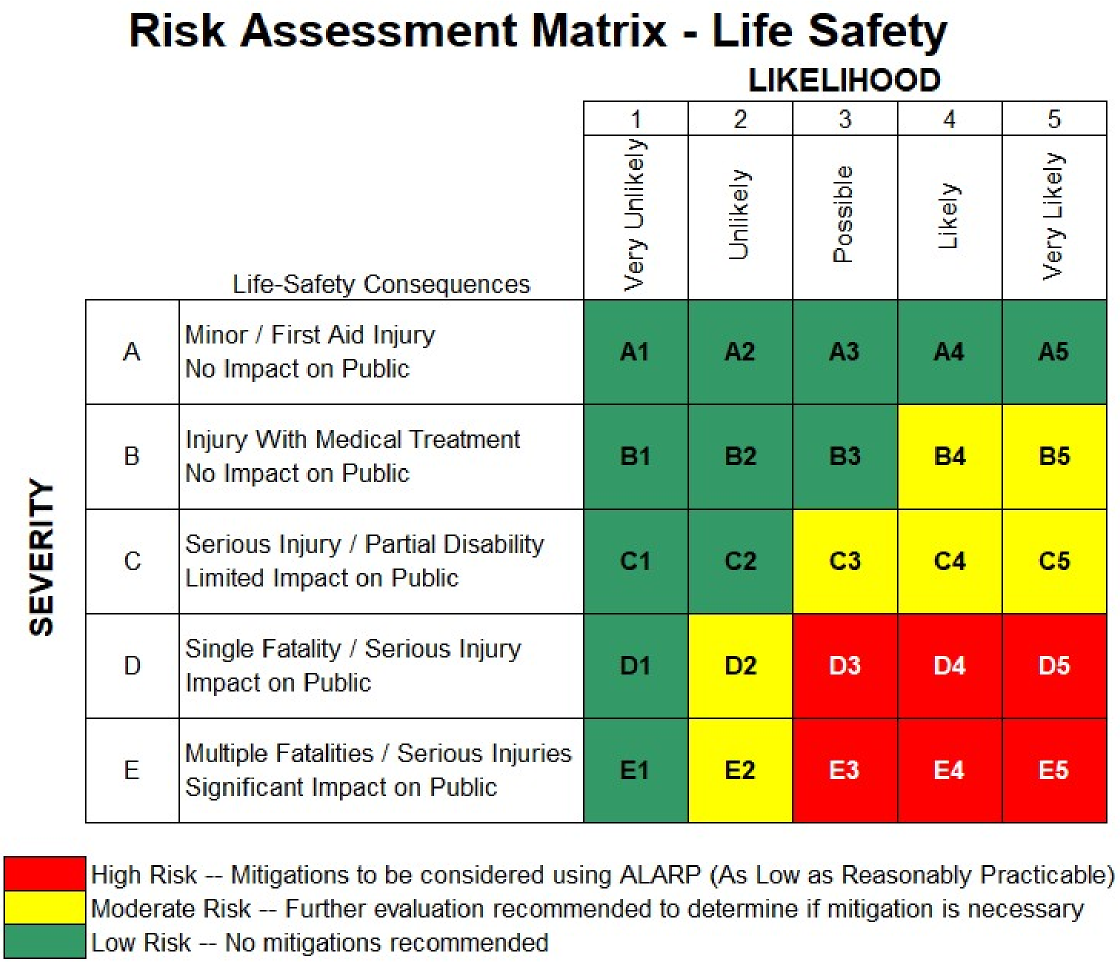


Risk Assessment Matrix - Environmental

			LIKELIHOOD				
			1	2	3	4	5
		Environmental Consequences	Very Unlikely	Unlikely	Possible	Likely	Very Likely
SEVERITY	A	No release.	A1	A2	A3	A4	A5
	B	Release within secondary containment and no offsite impact.	B1	B2	B3	B4	B5
	C	Release exceeds secondary containment, but no offsite impact.	C1	C2	C3	C4	C5
	D	Minor offsite release.	D1	D2	D3	D4	D5
	E	Major offsite release.	E1	E2	E3	E4	E5

🟥 High Risk -- Mitigations to be considered using ALARP (As Low as Reasonably Practicable)
🟨 Moderate Risk -- Further evaluation recommended to determine if mitigation is necessary
🟩 Low Risk -- No mitigations recommended

Figure 6-1 – Environmental Risk Assessment Matrix



Risk Assessment Matrix - Life Safety

			LIKELIHOOD				
			1	2	3	4	5
		Life-Safety Consequences	Very Unlikely	Unlikely	Possible	Likely	Very Likely
SEVERITY	A	Minor / First Aid Injury No Impact on Public	🟩 A1	🟩 A2	🟩 A3	🟩 A4	🟩 A5
	B	Injury With Medical Treatment No Impact on Public	🟩 B1	🟩 B2	🟩 B3	🟨 B4	🟨 B5
	C	Serious Injury / Partial Disability Limited Impact on Public	🟩 C1	🟩 C2	🟨 C3	🟨 C4	🟨 C5
	D	Single Fatality / Serious Injury Impact on Public	🟩 D1	🟨 D2	🟥 D3	🟥 D4	🟥 D5
	E	Multiple Fatalities / Serious Injuries Significant Impact on Public	🟩 E1	🟨 E2	🟥 E3	🟥 E4	🟥 E5

🟥 High Risk -- Mitigations to be considered using ALARP (As Low as Reasonably Practicable)
🟨 Moderate Risk -- Further evaluation recommended to determine if mitigation is necessary
🟩 Low Risk -- No mitigations recommended

Figure 6-2 – Life-Safety Risk Assessment Matrix

7. FINDINGS

Based upon the geotechnical, structural, and safety assessments as described herein, we have identified the key vulnerability findings as summarized below.

Items are categorized as Moderate or High Risk based on the full consideration of hazards, including earthquake induced ground deformations. For High Risk items, mitigations should be considered using an As Low As Reasonably Practicable (ALARP) risk reduction philosophy. For Moderate Risk items, further evaluation is recommended to determine if mitigation is necessary. For example, this may include detailed engineering calculations to quantify the seismic capacity of specific, existing components.

Table 7-1 - Summary of High Risk Items

North Tank Farm	South Tank Farm	Safety Systems
Containment Walls	Containment Walls	Municipal Power
T-80105	T-55000	Water Main
T-80104		Foam Systems
		Fire Pump

Table 7-2 - Summary of Moderate Risk Items

North Tank Farm	South Tank Farm	Safety Systems
T-84200	T-13522	Unstaffed hours
Gasoline piping	T-36002	Communications
	T-13519	UPS
	T-13520	Truck (while loading or unloading)
	T-80103	
	T-13521	
	T-13524	
	Gasoline piping	

7.1 Geotechnical

We have determined a peak ground acceleration (PGA_M) of 0.49g for the ASCE 7-16 DLE event. Median estimates of seismically-induced ground deformations are approximately 9 inches horizontally and 8 inches vertically at the site, with the potential for higher localized settlements. Our structural and safety assessments considered these potential displacements.

7.2 Structural

Two of the tanks in the North Tank farm have a high Life-Safety severity due to over-constrained piping condition which increase Likelihood and a large volumes of gasoline which increases the Severity. This is also the case for the gasoline tank (T-55000) in the South Tank Farm. Other tanks in the South Tank Farm are rated Moderate primarily due to an over-constrained condition with the stairs anchored to the foundation. An example is shown in Figure 7-1.

Figure 7-1: Typical Stair Anchorage at South Tank Farm

Gasoline piping systems are listed as Moderate based on life-safety risk due to fire.

The containment walls are rated High due to their importance in containing spills and the uncertainty in their capacity to withstand seismic loads from the DLE due to their age and construction.

7.3 Safety

The water supply is rated as a High Risk seismic vulnerability. The facility relies on municipal water as its only source for firewater and foam distribution. It is highly unlikely municipal water will be available following the DLE considered by the Rules.

Power is needed for the fire pump, foam pump, MOVs, and facility lighting. Since it is very likely that power will be lost following an earthquake, we determined that loss of power is a High Risk item.

Personnel use cell phone communication, which may be unreliable immediately following an earthquake, hampering emergency response coordination. This is considered a Moderate risk.

The terminal is normally not staffed from 1 AM to 6 AM. Emergency response can be slowed if an earthquake or spill occurs when the facility is not staffed, thus we consider this item Moderate risk.

Since the foam system is dependent on municipal water, which is unlikely to be available following the DLE, and the consequence of this system being unavailable, this item is deemed a High Risk.

Although terminal communications are protected by a UPS, the system is sized to handle short interruptions of power under an hour and may not provide adequate protection following a large earthquake and extended loss of municipal power. We considered this item a Moderate risk.

Through the workshop and safety advisor review, we identified a potential scenario where a truck at the Truck Rack becomes damaged while loading or unloading product. This could result in a fire. It could also result in the driver being trapped in the vehicle. We considered this item a Moderate risk.

8. REFERENCES

1. API Standard 570 "Piping Inspection Code: Inspection, Repair, Alteration and Rerating of In-Service Piping Systems, American Petroleum Institute (API)," 5th Edition, 2024.

2. API Standard 650 "Welded Tanks for Oil Storage, American Petroleum Institute (API)," 13th Edition, 2020.

3. API Standard 653 "Tank Inspection, Repair, Alteration and Reconstruction, American Petroleum Institute (API)," 5th Edition, 2020.

4. ASCE 7-16 "Minimum Design Loads and Associated Criteria for Buildings and Other Structures, American Society of Civil Engineers (ASCE), Structural Engineering Institute (SEI)," 2016.

5. ASCE 41-17 "Seismic Evaluation and Retrofit of Existing Buildings, American Society of Civil Engineers (ASCE), Structural Engineering Institute (SEI)," 2017.

6. ASCE 61-14 "Seismic Design of Piers and Wharves, American Society of Civil Engineers (ASCE), Coasts, Oceans, Ports & Rivers Institute, (COPRI)," 2014.

7. California Building Code (CBC) Chapter 31F, "Marine Oil Terminal Engineering and Maintenance Standards" (MOTEMS), 2022.

8. "Fuel Tank Stability Rules," Division 300, State of Oregon Department of Environmental Quality (DEQ), 2023.

9. "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments." Prepared for the Unified Program Agency (UPA) Subcommittee of the Region I Local Emergency Planning Committee (LEPC) by the CalARP Program Seismic Guidance Committee, January 2019.

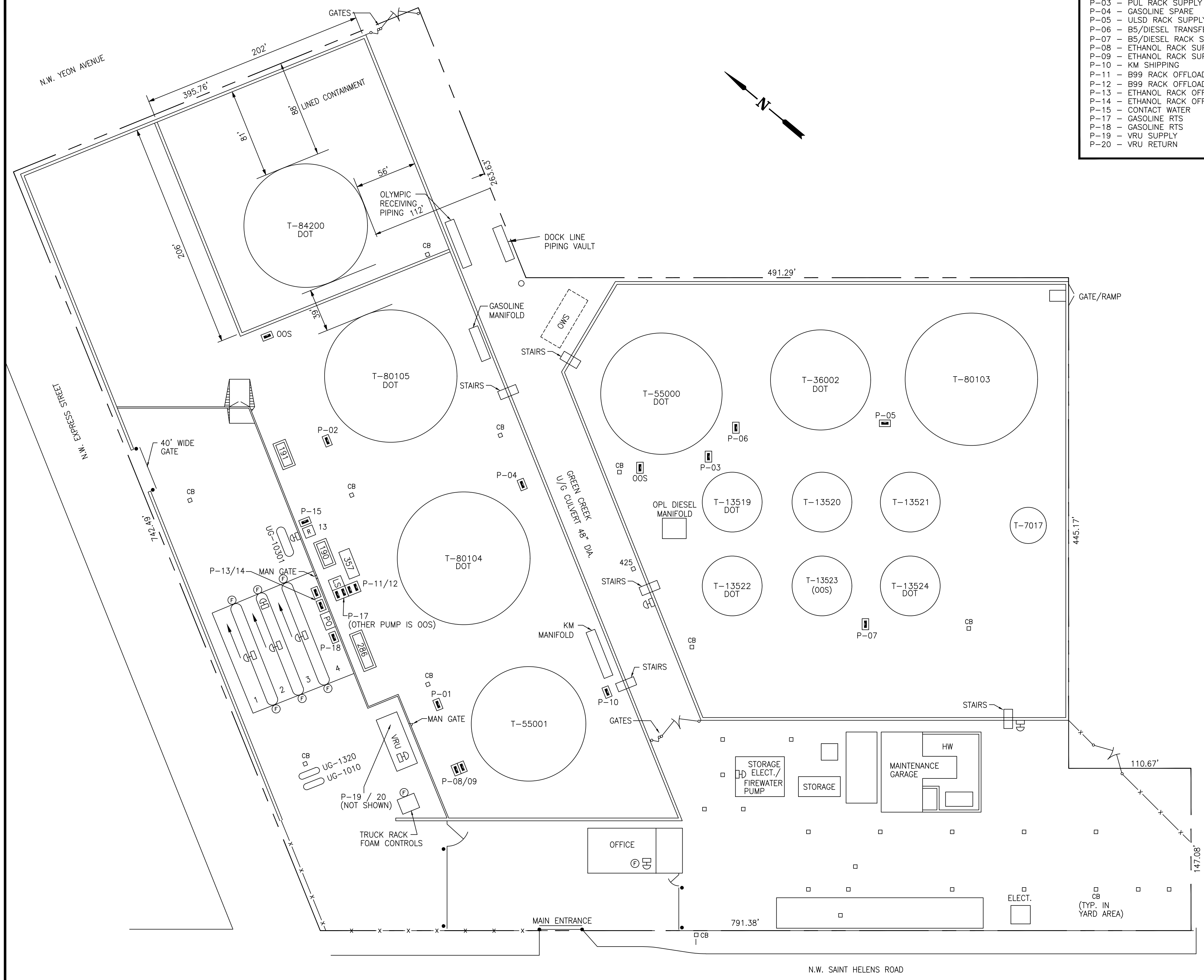
10. "Guidelines for Seismic Evaluation and Design of Petrochemical Facilities," Task Committee on Seismic Evaluation and Design of Petrochemical Facilities, American Society of Civil Engineers (ASCE), 1997, 2nd Edition, 2011, and 3rd Edition, 2020.

11. STI Standard SP001 "Standard for the Inspection of Aboveground Storage Tanks, Steel Tank Institute (STI)," 6th Edition, 2018.

12. Zhang, G., Robertson, P.K., and Brachman, R.W.I., 2004, Estimating Liquefaction-Induced Lateral Displacements Using the Standard Penetration Test or Cone Penetration Test, Journal of Geotechnical and Geoenvironmental Engineering, Volume 130, No. 8, 2004.

Appendix A

Site Plan & Inventory



PUMPS:

P-01 – RUL RACK SUPPLY
P-02 – RUL RACK SUPPLY
P-03 – PUL RACK SUPPLY
P-04 – GASOLINE SPARE
P-05 – ULSD RACK SUPPLY
P-06 – B5/DIESEL TRANSFER PUMP
P-07 – B5/DIESEL RACK SUPPLY
P-08 – ETHANOL RACK SUPPLY
P-09 – ETHANOL RACK SUPPLY
P-10 – KM SHIPPING
P-11 – B99 RACK OFFLOAD/DIESEL RTS
P-12 – B99 RACK OFFLOAD/DIESEL RTS
P-13 – ETHANOL RACK OFFLOAD
P-14 – ETHANOL RACK OFFLOAD
P-15 – CONTACT WATER
P-17 – GASOLINE RTS
P-18 – GASOLINE RTS
P-19 – VRU SUPPLY
P-20 – VRU RETURN

SUMMARY OF STORAGE TANKS

(NOTE: TANK CAPACITIES ARE NOMINAL, WITH CAPACITY IN BBLS FOR 42,000 GALS OR GREATER.)

TANK ID NUMBER	SIZE(NOTE 1)	DIA. & HEIGHT	TYPE	COMMODITY
13519 (DOT)	13326.51 BBL (34.66')	52.552' x 34.755'	CONE	B50 DIESEL
13520	13261.54 BBL (34.25')	52.538' x 34.390'	CONE	B5/ULSD
13521	13287.16 BBL (34.33')	52.544' x 34.370'	CONE	B5/ULSD
13522 (DOT)	13257.78 BBL (34.5')	52.571' x 34.660'	CONE	B5 DIESEL
13523	13445.43 BBL (35')	52.604' x 35.000'	CONE	OOS
13524 (DOT)	13313.33 BBL (34.66')	52.553' x 34.630'	CONE	B5 DIESEL
36002 (DOT)	36306.73 BBL (34.33')	95.047' x 28.660'	CONE	B5 DIESEL
55000 (DOT)	46930.80 BBL (25.75')	114.559' x 28.855'	IFR	PUL GASOLINE
55001	55422.11 BBL (39.83')	100.013' x 39.950'	GEO/IFR	ETHANOL
80103	81037.04 BBL (40.23')	120.063' x 40.230'	CONE	ULSD
80104 (DOT)	79386.53 BBL (39.75')	119.974' x 39.930'	GEO/IFR	RUL GASOLINE
80105 (DOT)	78907.10 BBL (39.46')	119.958' x 39.460'	GEO/IFR	RUL GASOLINE
84200 (DOT)	83450.28 BBL (47.67')	112.059' x 47.685'	GEO/IFR	RUL GASOLINE
7017	7070.98 BBL (39.41')	36.006' x 39.410'	EFR	CONTACT WATER
190	8,000 GAL	8' x 21'	HORIZONTAL	SHELL ADDITIVE
191	8,000 GAL	8' x 21'	HORIZONTAL	LUBRICITY ADDITIVE
286	12,000 GAL	8' x 32'	HORIZONTAL	GENERIC ADDITIVE
357	15,000 GAL	10' x 26'	HORIZONTAL	SHELL ADDITIVE
UG-1320	1,000 GAL	4' x 12'	DW F/GLASS	VAPOR KNOCKOUT
UG-1010	1,000 GAL	4' x 12'	DW F/GLASS	HYDROCARBON SLOP
UG-10301	10,000 GAL	8' x 32'	DW F/GLASS	CONTACT WATER
425	–	–	–	ANTI-STATIC ADDITIVE
13	550 GAL	–	TOTE (SS)	RED DYE ADDTIVE

GENERAL NOTES:

1. SIZE (I.E. VOLUME CAPACITY) OF TANK THAT IS LISTED IS THE NOMINAL CAPACITY. THE MAX FILL HEIGHT (MFH) USED TO CALCULATE ALARM SETTINGS MAY BE LESS.

LEGEND:

OWS	OIL–WATER SEPARATOR (UNDERGROUND)
LS	LIFT STATION (OOS)
	UNDERGROUND STORAGE TANK
VRU	VAPOR RECOVERY UNIT
☐ CB	CATCH BASIN
	SLIDING GATE
	TRUCK LOADING RACK
▮	PRIMARY PRODUCT PUMP(S) – LOCATION APPROXIMATE
—×—×—×—	CHAIN LINK FENCING
	CONCRETE WALL OR CURBING
	EARTHEN OR COATED DIKE WALL
ELEC	ELECTRICAL SWITCHGEAR
○ RW, MW, IW	RECOVERY OR MONITORING WELL, INJECTION WELL.
PO	PUMP OFF AREA
②	TANK NO. 2 (ETC...)
	SWING GATE
HW	HAZARDOUS WASTE DRUM STORAGE
(8)	EMERGENCY PUSHBUTTON/PULL RING
(8) Ⓕ	FIRE ALARM PULL STATION
R	RED DYE TOTE AND PUMP

50' 0' 50' 100'

(IN FEET)

REV NO	DATE	DESCRIPTION OF REVISION	ES NO.	BY	ELEC ENGR	MECH ENGR	APP
9	9/30/20	UPDATED PER SPILL PREVENTION & CONTROL PLAN REVIEW	–	JJV	–	DWB	DWB
8	9/17/20	REMOVAL OF AG–1/AG–2 (MOC–15154)	–	JJV	–	DWB	DWB
7	10/2/18	AS–BUILT PER MOC 11034		IP		AJT	DT
6	2/2/17	AS–BUILT PER MOC 8052 BY SUN ENGINEERING (NO CHANGES)		MW	YST	AT	DT
5	8/1/16	AS–BUILT PER MOC 6858 BY SUN ENGINEERING		MW	YST	WRM	DT

REV NO	DATE	DESCRIPTION OF REVISION	ES NO.	BY	ELEC ENGR	MECH ENGR	APP
4	12/21/15	ADDED GATE, STAIRS, MANIFOLDS, REVISE TANK DATA, R&I REVIEW		CIF	WRM		WRM
3	2/27/15	REMOVED TANKS 45 AND 145		CIF			
2	11/13/14	UPDATED AS PER RESPONSE PLANS		JAL	DGT		DGT
1	9/13/00	REV'D PER FIELD CHECK/AS–BUILT/ADD MARINE DOCK FACILITY		CEF	RPK		RPK
10	2/1/21	ADDED PRIMARY PRODUCT PUMP LABELS / ACTUAL TANK NOMINAL CAPACITY (PER STRAPPING TABLES)		JEA		DWB	DWB

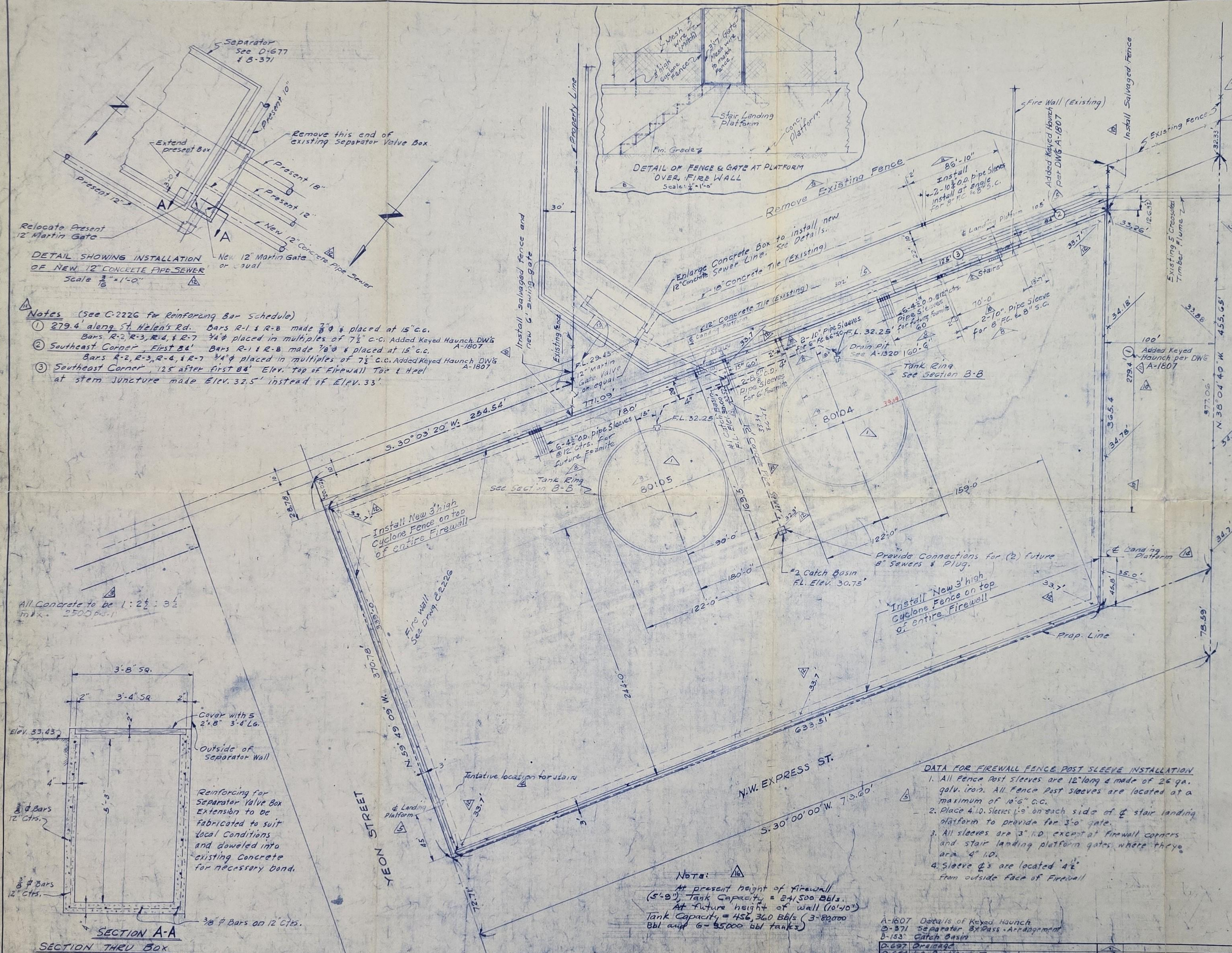
TRANSPORTATION TERMINALS
PORTLAND TERMINAL

GENERAL PLOT PLAN

SCALE 1" = 50'–0"
DATE 10/28/99
DRAWN DTT
P-10196
REVISION **10**

2/21/2023 Jamado 8:29 AM

Tank Number	Service Status	Diameter (ft)	Height (ft)	Design Liquid Level (ft)	Shell Capacity (bbl)	Shell capacity gallons	Product Group Name	Location	Anchored?	Date of Walkdown	Shell Construction	Rigid attachments (Y/N)
V-1	In service						Vapor	VRU	Anchored	2/28/2024	Welded	Y
V-2	In service						Vapor	VRU	Anchored	2/28/2024	Welded	Y
V-3	In service						Gasoline	VRU	Anchored	2/28/2024	Welded	Y
T-84200	In service	112.0	48.0	45.5	83,450		Gasoline	North	Unanchored	2/28/2024	Welded	N
T-80105	In service	120.0	39.6	32.8	78,907		Gasoline	North	Unanchored	2/28/2024	Welded	Y
T-80104	In service	120.0	40.0	40.0	79,387		Gasoline	North	Unanchored	2/28/2024	Welded	Y
T-55001	In service	100.0	40.1	40.1	55,422		Ethanol	North	Unanchored	2/28/2024	Welded	N
190	In service				190	8,000	Shell Additive	North	Anchored	2/28/2024	-	N
357	In service				357	15,000	Shell Additive	North	Unanchored	2/28/2024	Welded	N
13	In service				13	550	Red Dye Additive	North	Anchored	2/28/2024	-	N
191	In service				190	8,000	Lubricity Additive	North	Anchored	2/28/2024	-	N
286	In service				286	12,000	Generic gasoline additive	North	Anchored	2/28/2024	-	N
T-13522	In service	52.6	34.4	33.6	13,258		B5 Diesel	South	Unanchored	2/28/2024	Riveted	Y
T-55000	In service	114.7	28.1	28.1	46,931		Gasoline	South	Unanchored	2/28/2024	Riveted	Y
T-36002	In service	94.8	28.7	24.9	36,307		B5 Diesel	South	Unanchored	2/28/2024	Riveted	Y
T-13519	In service	52.5	34.7	23.5	13,327		B50 diesel	South	Unanchored	2/28/2024	Riveted	Y
T-13520	In service	52.0	34.4	34.4	13,262		B5/ULSD	South	Unanchored	2/28/2024	Riveted	Y
T-80103	In service	120.0	40.1	38.3	81,037		ULSD	South	Unanchored	2/28/2024	Riveted	Y
T-13521	In service	52.0	34.3	29.1	13,287		B5/ULSD	South	Unanchored	2/28/2024	Riveted	Y
T-13524	In service	52.0	34.5	33.8	13,313		B5 Diesel	South	Unanchored	2/28/2024	Riveted	Y
T-7017	In service	36.0	39.5	35.0	7,071		Water w hydrocarbons	South	Unanchored	2/28/2024	Welded	Y
T-13523	Out of Service	52.0	34.5	33.8	13,445		OOS	South	Unanchored	2/28/2024	Riveted	Y

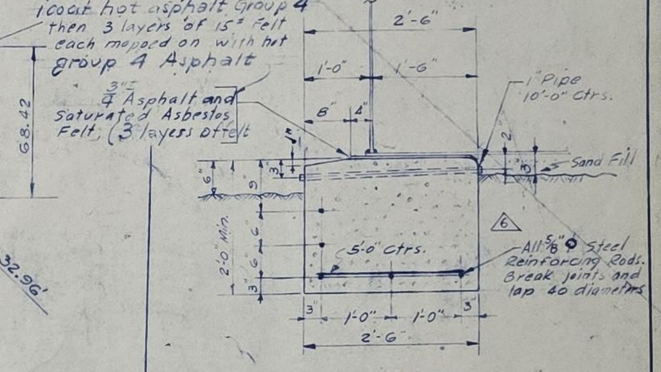


Notes (See C-2226 for Reinforcing Bar Schedule)

① 279.4' along St. Helen's Rd. Bars R-1 & R-8 made 7/8" ∅ & placed at 15" c.c.
Bars R-2, R-3, R-4, & R-7 3/4" ∅ placed in multiples of 7 1/2" c.c. Added Keyed Haunch DWG A-1807

② Southeast Corner, First 84' Bars R-1 & R-8 made 7/8" ∅ & placed at 15" c.c.
Bars R-2, R-3, R-4, & R-7 3/4" ∅ placed in multiples of 7 1/2" c.c. Added Keyed Haunch DWG A-1807

③ Southeast Corner, 125' after first 84' Elev. top of Firewall Toe & Heel at stem juncture made Elev. 32.5' instead of Elev. 33'.



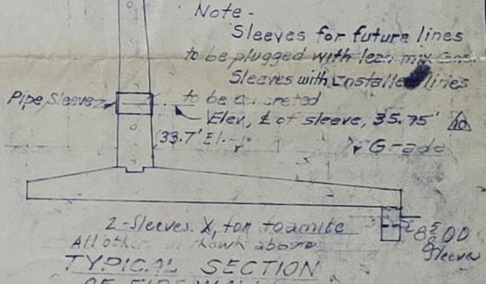
SECTION B-B

DETAIL OF TANK RING

Scale: 3/4" = 1'-0"

NOTE: Sand Fill to be placed by Grading Contractor

All concrete to be 1:2 1/2:3 1/2 mix 2500 p.s.i



Note - Sleeves for future lines to be plugged with lean mix Conc. Sleeves with installed lines to be concreted

Elev. ℄ of sleeve, 35.75'

TYPICAL SECTION OF FIRE WALL SHOWING PIPE SLEEVE ELEV.

GENERAL NOTES:

1. Elevation of Grade at Firewall is 33.7'
2. Elevation of Top of Firewall is 39.21'
3. All Tank Rings have a Top Elevation of 34.0'
4. 139.0 ± cu.yds. Concrete in both foundation Rings
5. All Catch Basins are 4'-0" square and are installed per Dwg Nº B-153
7. Elevations shown on this drawing referred to the same datum as indicated on dwg. D-697 which is the U.S. Eng. Datum
8. Ground to be graded to slope to Catch Basins.

Est. # 1195

DATA FOR FIREWALL FENCE POST SLEEVE INSTALLATION

1. All Fence Post sleeves are 12" long & made of 26 ga. galv. iron. All Fence Post sleeves are located at a maximum of 10'-6" c.c.
2. Place 4" I.D. Sleeves 1'-9" on each side of ℄ stair landing platform to provide for 3'-0" gate.
3. All sleeves are 3" I.D. except at Firewall corners and stair landing platform gates where they are 4" I.D.
4. Sleeve ℄'s are located 4 1/2" from outside face of Firewall

NOTE:

At present height of firewall (5'-9"), Tank Capacity = 241,500 Bbls.
At future height of wall (10'-10") Tank Capacity = 456,360 Bbls (3-80,000 Bbl and 6-35,000 bbl tanks)

A-1807 Details of Keyed Haunch
B-371 Separator By Pass - Arrangement
B-153 Catch Basin

D-697	Drainage
D-654	L.O. Portland Terminal
D-677	Water Separator
C-2226	Fire Wall
A-1320	Drain Pit
C-2221	Tank Trimming
D-1862	Additional Facilities

REFERENCE DRAWINGS

MARK	REVISIONS	BY	DATE	APPV'D
	Added note re: Firewall Capacity	GET	10-18-50	

REVISED - DESTROY ALL PRINTS BEARING EARLIER DATE

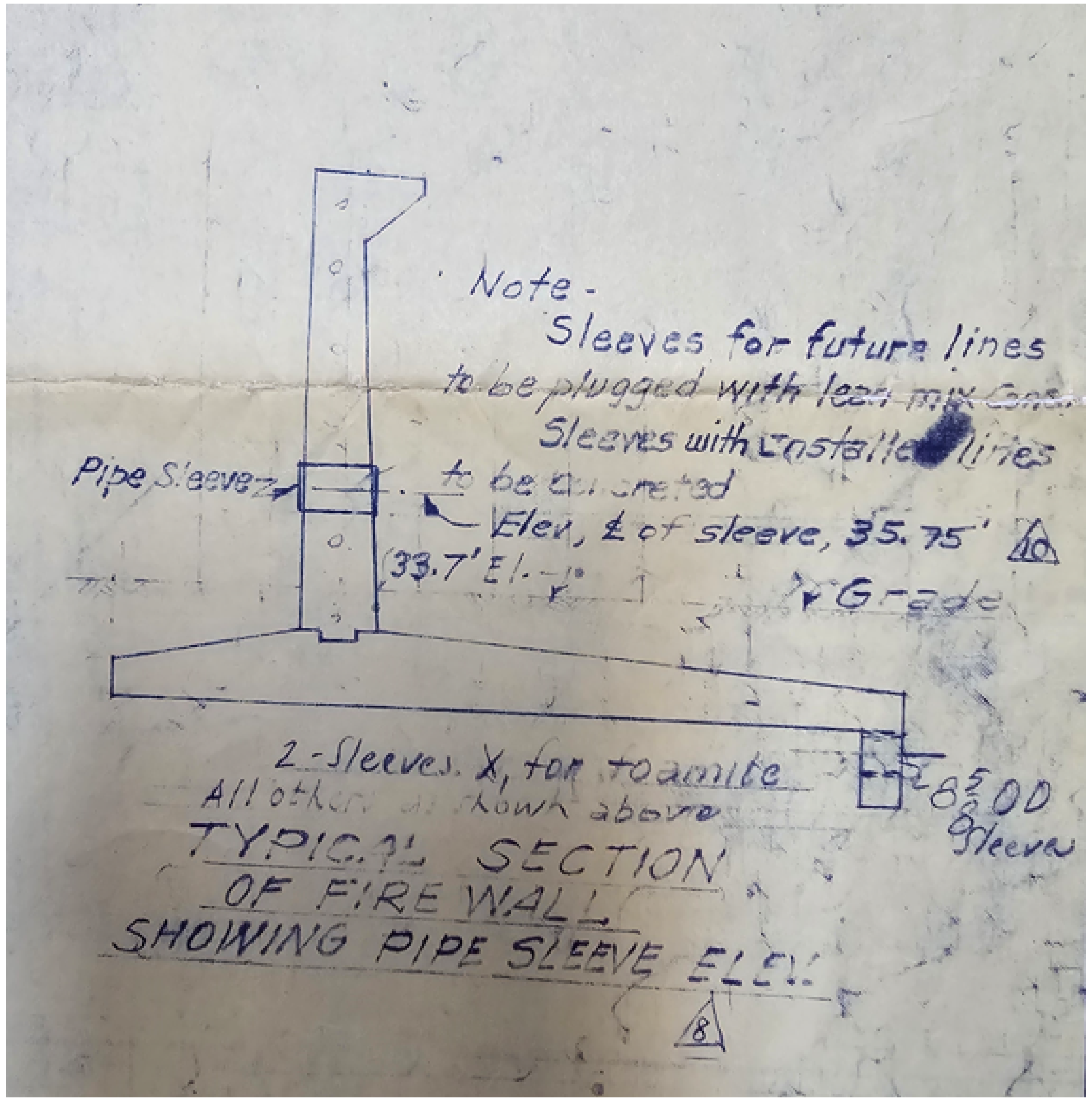
File I Sec III

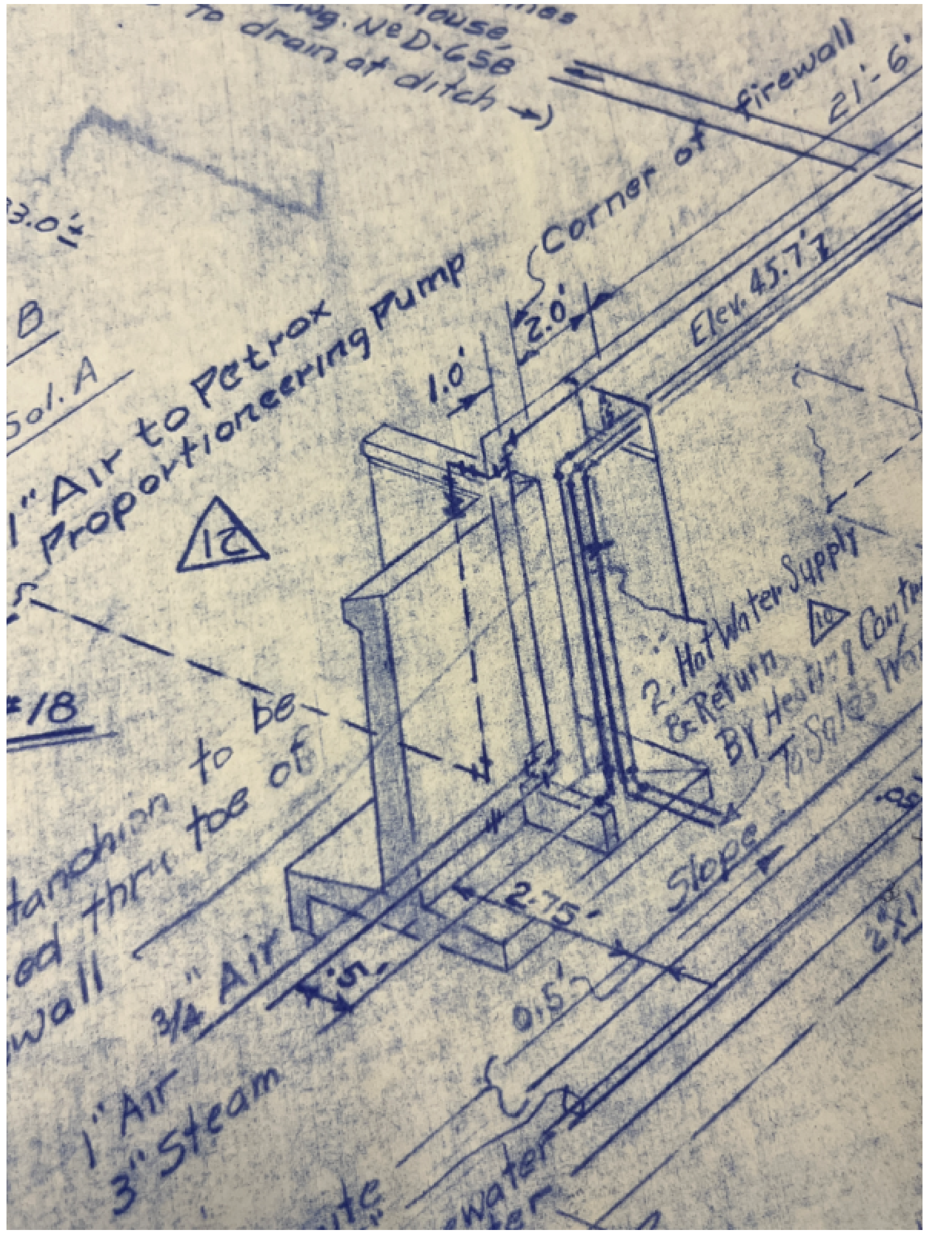
THE TEXAS COMPANY
LOS ANGELES, CALIFORNIA
ENGINEERING DIVISION - REFINING DEPARTMENT

ELEVATIONS FOR GRADING
TANK FOUNDATIONS & FIREWALL
PORTLAND, OREGON TERMINAL

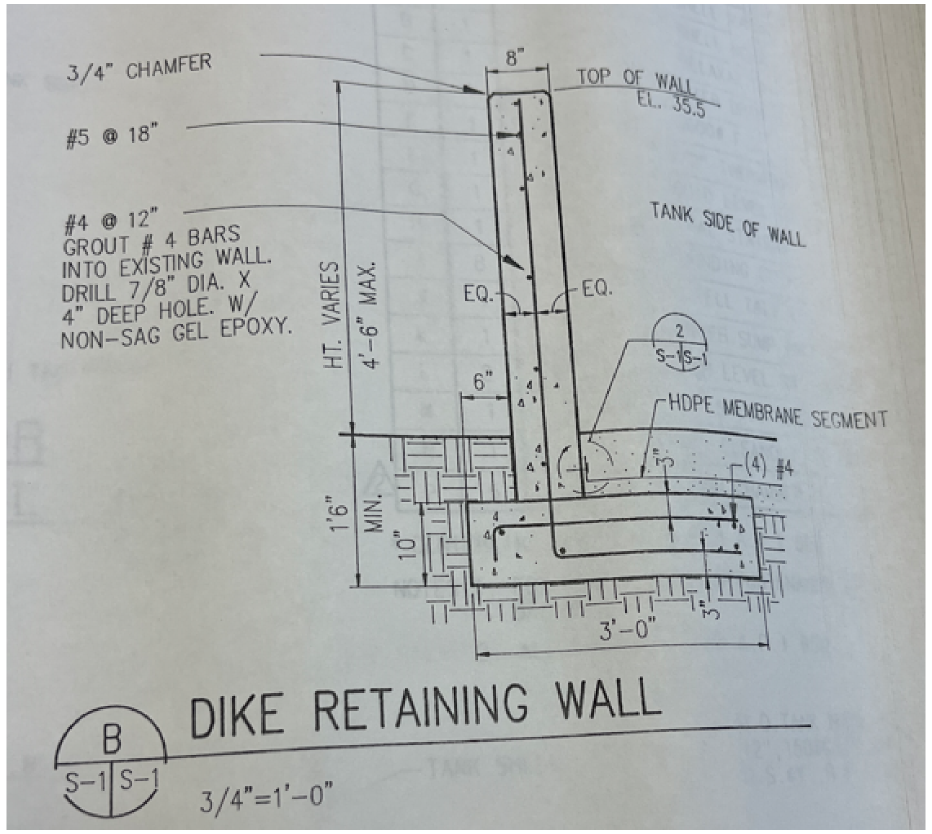
SCALE 1" = 40'-0" & Noted
DRAWN BY C.L. DeSulima DATE 7-24-46
TRACED BY DATE
CHECKED BY Howell DATE 6-9-46
APPROVED
PRINT NO.
D-246

Example Containment Wall Drawings:





Specific to TK-84200 liner:



Appendix B

Geotechnical Assessment

GANNETT FLEMING

155 Grand Avenue
Suite 504
Oakland, CA 94612
P 510.701.2266

gannettfleming.com

Revised May 30, 2024

SGH Project No. 247040.00-SHPO / Gannett Fleming Project No. 078230

Julie A. Galbraith
Senior Project Manager
Simpson Gumpertz & Heger Inc.
1999 Harrison Street, Suite 2400
Oakland, CA 94612

Re: **Technical Memorandum**
Preliminary Geotechnical Assessment
Shell Portland Terminal – Seismic Vulnerability Assessment
Portland, Oregon

Dear Ms. Galbraith:

At your request, Gannett Fleming, Inc. (Gannett Fleming) has prepared this technical memorandum summarizing our preliminary geotechnical assessment in support of the Seismic Vulnerability Assessment of the Shell Oil Products (Shell) Portland Terminal located at 3800 NW St. Helens Road in Portland, Oregon. We performed our assessment in general accordance with the scope of services per our agreement with Simpson Gumpertz & Heger Inc. (SGH) dated March 19, 2024. The following provides a summary of the results of our assessment based on an evaluation of existing geotechnical data for the site.

PROJECT BACKGROUND

The primary improvements at the terminal consist of 13 fuel storage tanks, 1 contact water tank, secondary containment structures, pipelines for product transfer, and associated facilities. A Seismic Vulnerability Assessment of the terminal will be required in accordance with the State of Oregon Department of Environmental Quality (DEQ) Division 300 Fuel Tank Seismic Stability Rules, Oregon Administrative Rules 340-300-0000 (Rules). The Rules require a Seismic Vulnerability Assessment be performed to evaluate the risk of seismically-induced impacts including liquefaction, settlement, lateral spreading, and ground failures. The objective of such an assessment is to identify any risk mitigation measures that may be necessary. SGH is leading the Seismic Vulnerability Assessment with geotechnical input provided by Gannett Fleming.

OBJECTIVE AND SCOPE OF SERVICES

The purpose of our geotechnical assessment is to provide input in support of the Seismic Vulnerability Assessment. In accordance with our agreement with SGH dated March 19, 2024, our assessment considers existing site-specific geotechnical information and other existing data. The scope of our services included the following.

- Review of existing information and subsurface characterization considering geotechnical data for the site.
- Preliminary seismic hazards evaluation considering liquefaction triggering/cyclic degradation based on existing geotechnical data.
- Preliminary assessment of mechanisms contributing to vertical and lateral ground surface deformations.
- Qualitative evaluation of the potential effects of ground deformations on fuel storage tanks and associated facilities.
- Preparation of this memorandum.

SITE CONDITIONS

The terminal is located on the east side of NW St. Helens Road just east of the foothills of the Tualatin Mountains and west of the Willamette River as shown in Figure 1. The site is relatively flat at roughly elevation 40 feet (NAVD88) and the ground surface east of the site slopes downward gently toward the Willamette River with the waterfront slope adjacent to the Willamette River roughly 2,000 feet from the east boundary of the site. Bathymetric survey data collected by the United States Army Corps of Engineers indicate the waterfront slope is roughly 70 feet high. There is no associated marine terminal. Terminal improvements include steel fuel storage tanks about 50 to 120 feet in diameter, a steel contact water tank, pumps, pipelines, secondary containment walls, a truck loading rack, underground storage tanks, vaults, and associated facilities. We understand the tanks are supported on shallow foundations. In addition, a 48-inch diameter underground culvert for Green Creek bisects the site parallel to NW Express Avenue and is situated south of the four fuel storage tanks located on the north side of the site. An aerial image of the terminal is presented in Figure 2.

EXISTING DATA

A previous geotechnical investigation was performed at the site as summarized in a report prepared by Professional Services Industries, Inc. (PSI) dated May 26, 2021 (PSI 2021). The investigation included two geotechnical test borings drilled using mud rotary methods to depths of about 60 feet. Soil samples were collected in the borings using a Standard Penetration Test (SPT) sampler advanced under the impact of an automatic 140-pund hammer free-falling 30 inches. The data from the PSI geotechnical investigation presented in Appendix A were considered as part of our geotechnical assessment.

SUBSURFACE CONDITIONS

Regional geologic mapping indicates the site is underlain by Quaternary alluvium comprised of river and stream deposits of silt, sand, and organic-rich clay with subordinate gravel of mixed lithologies (Beeson, et al. 1991). The material is described by Beeson (1991) as largely confined to the ancient incised Willamette River channel, which includes the current channel and the adjacent floodplains. The mapping suggests the alluvium is underlain by the fine-grained facies of Pleistocene flood deposits and basalt of the Grande Ronde formation at depth.

The previous borings by PSI were completed on April 29, 2021, and indicate subsurface conditions encountered that are generally consistent with regional geology. The borings indicate subsurface soils are primarily comprised of alluvial deposits, which are comprised of sandy soils and fine-grained soils. The sandy alluvium encountered generally consist of very loose to loose sands interlayered with silts. Fine-grained alluvium underlying the sandy alluvium primarily consists of very soft to medium stiff silts deposited by successive historic flood events. The borings were terminated after encountering SPT sample refusal in what is described as dense to very dense gravels at a depth of about 60 feet, which we interpret as weathered bedrock consistent with data collected by others near the site indicating bedrock depths of about 50 feet.

Groundwater

Shallow groundwater was encountered in the borings by PSI at depths ranging from about 2 ½ to 7 ½ feet at the time of drilling. Fluctuations in groundwater levels likely occur due to variations in the Willamette River water level, rainfall, underground drainage patterns, regional influence, and other factors.

SEISMIC HAZARDS ASSESSMENT

We have evaluated seismic hazards including liquefaction, lateral spreading, and seismic densification. As part of this, we have developed design earthquake ground motions for the purposes of our assessment. A summary of design earthquake ground motions and our conclusions regarding the potential for liquefaction, lateral spreading, and seismic densification is provided below.

Design Earthquake Ground Motions

We developed seismic design parameters in accordance with the 2016 American Society of Civil Engineers (ASCE) Standard 7-16 (ASCE 7-16): Minimum Design Loads for Buildings and Other Structures (ASCE 2016) for the purposes of evaluating liquefaction potential and lateral spreading. Considering the existing geotechnical data and depth to bedrock, the site can be characterized as Site Class D. Using the ASCE 7 Hazard Tool, we calculated a maximum considered earthquake geometric mean (MCE_G) peak ground acceleration adjusted for site class (PGA_M) of 0.49g, corresponding to a moment magnitude (M_w) of 9.3 on the Cascadia Megathrust fault, which governs the seismic hazard at the site. Note that this dominant magnitude is slightly more conservative than the M_w 9.0 scenario noted in Chapter 99 of the Oregon Laws; however, we expect the difference in results of our liquefaction and lateral spread assessment to not vary significantly given the high magnitude of either event.

Liquefaction

Using the empirical procedure developed by Boulanger and Idriss (2014), we evaluated the potential for saturated soil deposits to undergo liquefaction or cyclic softening, which are referred to herein as liquefaction. The range of field (uncorrected) SPT sampler blow counts (N-values) for the primary geologic units are summarized in Table 1 below. Our analysis accounts for the liquefaction potential of sands and post-cyclic behavior of silt-rich soil with consideration to data from published studies of Willamette River Silt (Dickenson, et al. 2022) as well as the potential for seismic densification (seismic settlement of sands above the groundwater table). We considered a PGA_M of 0.49g and a moment magnitude (M_w) of 9.3.

Table 1: Primary Geologic Units

Geologic Unit	SPT N-Values
Sandy Alluvium	1 - 11
Fine-Grained Alluvium	0 - 21

The results of our evaluation indicate the potential for liquefaction is high considering the design earthquake. Excess pore-water pressures generated during liquefaction will cause ground settlement as the pore pressures dissipate within saturated soils (referred to as reconsolidation). In addition, excess pore pressures will result in strength loss, which can lead to lateral spreading and other effects such as floatation of underground structures. The primary mechanisms of seismically-induced ground settlement are reconsolidation (seismic settlement of soils below the groundwater table), ejecta-induced, and shear-induced deformation. In addition, sands above the groundwater table can undergo seismic densification resulting in ground settlement. We summarize our assessment of seismic densification and the effects of liquefaction and cyclic degradation including ground settlement and floatation of underground structures below, which is followed by our evaluation of lateral spreading in a subsequent section of this memorandum.

Seismic Densification and Reconsolidation Settlement

Considering the generally shallow groundwater conditions at the site, the risk of seismically-induced settlement resulting from the densification of sands above the groundwater table is low. However, a considerable amount of liquefaction-induced settlement from reconsolidation can occur. The seismically-induced ground deformations summarized in a subsequent section of this memorandum are based on the approaches developed by Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992).

Ejecta-Induced Settlement

Based on our evaluation of the potential for surface effects, we conclude there is a high likelihood of ground surface disruption following liquefaction given the relatively thin non-liquefiable soil (crust) overlying relatively thick liquefiable soil. Surface effects can occur as water is forced to the ground surface when the dissipation of excess pore-water pressures in the liquefied soil exceeds the resistance of the overlying non-liquefiable crust. This can lead to sediment ejecta and settlement from ground loss as the expelled pore-water carries sand particles to the ground surface through volcano-like vents (referred to as sand boils). Ground surface disruption associated with lateral spreading tends to increase the likelihood of sediment ejecta. Our assessment of ejecta-induced settlement considers a review of case histories, such as those summarized by Mijic, et al. (2002), and professional experience including post-earthquake observations.

Shear-Induced Settlement

In addition to settlement from reconsolidation and sediment ejecta, liquefaction-induced foundation settlement can occur when shear-induced deformations driven by cyclic loading occur due to ratcheting and bearing capacity types of movement caused by soil structure interaction (SSI). The amount of foundation settlement depends on the seismic bearing pressures imposed by the structure, foundation dimensions, and liquefied soil strengths. We anticipate settlement would be most significant where the thickness of non-liquefiable crust beneath the foundation is the lowest. While shear-induced foundation settlement is difficult to predict and would need to be evaluated on a case-by-case basis, we expect that up to about 1 foot or more of shear-induced foundation settlement could occur.

Floatation of Underground Structures

Underground structures including underground tanks, vaults, culverts, and manholes may be susceptible to floatation due to liquefaction. This can occur as the soil liquefies and loses shear resistance against the uplift force from the buoyancy of the underground structure. The magnitude of uplift displacement depends on the depth of the structure as well as the duration and intensity of earthquake ground motions and is difficult to predict. This would need to be further evaluated for specific underground structures if needed.

Lateral Spreading

Lateral spreading is a phenomenon where a soil mass moves laterally on liquefied soil down a gentle slope or toward a free face, such as the adjacent Willamette River channel, due to reduced soil strengths and earthquake-induced forces (seismic inertial loading) acting on soils within and above the liquefied layer. The magnitudes of lateral displacement are expected to be significant near the Willamette River shoreline, reducing in magnitude with increasing distance from the waterfront slope. To estimate liquefaction-induced lateral displacements, we used a semiempirical approach developed by Zhang, et al. (2004). The approach uses SPT- and CPT-based methods to evaluate liquefaction potential to estimate potential maximum cyclic shear strains for saturated soils under seismic loading. A lateral displacement index is obtained by integrating the maximum cyclic shear strains with depth considering empirical correlations from case history data developed relating actual lateral displacement, lateral displacement index, and geometric parameters characterizing ground geometry including level ground with a free face (Zhang, et al. 2004). We used this approach to obtain preliminary estimates of seismically-induced ground deformations associated with lateral spreading, which is discussed further below.

During lateral spreading, surface layers commonly break into large blocks, which progressively migrate toward a free face as depicted in Exhibit 1 below. Lateral spreading creates a zone of extension near the head of the spread, which can result in large open ground fissures, with compressional features occurring near the toe. Zones of compression are usually expressed as buckled soil, pavements, or structures. Accordingly, the ground can break into discrete blocks that will move horizontally relative to each other, with the potential for some blocks overriding each other, resulting in heave or settlement. In addition, the development of ground fissures can promote ground loss from sediment ejecta and increase the likelihood of surface effects and associated settlement.

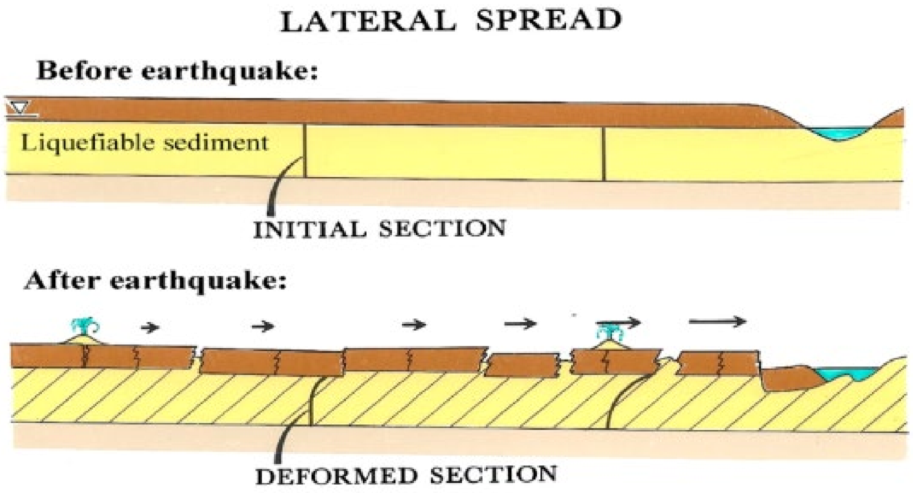


Exhibit 1: Schematic of Lateral Spread Characteristics (Youd 2018)

Seismically-Induced Ground Deformations
We have developed preliminary estimates of vertical and lateral seismically-induced ground deformations to approximate the range of movements expected at the site. An estimate of seismically-induced lateral ground deformation based on the approach developed by Zhang, et al. (2004) is summarized in Table 2 below. This considers the proximity of the site to the free face slope of the waterfront along the Willamette River located about 2,000 feet from the site and a slope height of about 70 feet. It should be noted that there is considerable uncertainty in deformation estimates using the approach developed by Zhang, et al. (2004) and actual deformations may vary significantly.

Table 2: Seismically-Induced Lateral Ground Deformation

Mechanism	Probable Approximate Lateral Deformation (inches)
Lateral Spreading	9 or less

As indicated previously, the primary mechanisms of liquefaction-induced settlement are reconsolidation, ejecta-induced, and shear-induced deformation. Lateral spreading also results in ground settlement, which can be as much as about one-third to one-half of the magnitude of lateral displacement. We summarize our preliminary estimates of vertical settlement from densification, reconsolidation, sediment ejecta, and lateral spreading in Table 3 below. These estimates do not consider shear-induced foundation settlements discussed previously.

Table 3: Seismically-Induced Vertical Settlement

Mechanism	Probable Approximate Vertical Settlement Range[1] (inches)
Densification	< ½
Reconsolidation	2 to 6
Ejecta-Induced[2]	Up to 12 (locally near ejecta)
Vertical Component of Lateral Spreading	3 to 5
All the Above	5 to 23

1. The estimated vertical ground deformations consider free-field conditions. Additional settlement of tanks and other structures may occur due to shear-induced foundation settlement as discussed previously.
2. Ground loss from sediment ejecta is highly variable and difficult to estimate.

CONCLUSIONS

As discussed herein, there are various liquefaction-induced mechanisms that could impact the terminal infrastructure. The most significant risk is related to vertical settlement. While the potential for significant lateral displacements is high near the shoreline of the Willamette River, considering the distance from the site to the shoreline, the risk of lateral spreading at the site is significantly reduced. Where seismically-induced vertical and lateral ground deformations are not acceptable, mitigation measures could be considered. Settlement and other foundation impacts could be mitigated by structural improvements/strengthening of shallow foundations, deep foundations, and/or ground improvement to make them less susceptible to vertical ground deformations.

Any future investigations should be focused on the collection of data in support of developing remedial measures or further evaluating the performance of specific structures. While additional investigations will provide data for further subsurface characterization and assessment, this information will not likely change the conclusions regarding the seismically-induced vertical ground deformations. However, we expect that future studies would exclude the risk of seismically-induced lateral ground deformations.

LIMITATIONS

This report has been prepared for the sole use of SGH and Shell, and is specific to the conditions at the site as described herein. The opinions, conclusions, and recommendations contained in this report are based upon information obtained from existing geotechnical data, experience, and engineering judgment, and have been formulated in accordance with generally accepted geotechnical practices at the time this report was prepared; no other warranty is expressed or implied. In addition, the conclusions and recommendations presented in this report are based on interpretations of the subsurface conditions encountered in widely spaced explorations. Actual conditions may vary. If subsurface conditions encountered in the field differ from those described in this report, Gannett Fleming should be consulted to determine if changes to the conclusions presented herein or supplemental recommendations are required.

The opinions presented in this report are valid as of the date of this report. Changes in the condition of a site can occur with the passage of time, whether due to natural processes or the works of man. In addition, changes in applicable standard of practice can occur, whether from legislation or the broadening of knowledge. Accordingly, this report may be invalidated, wholly or partially, by changes outside of Gannett Fleming's control. In any case, this report should not be relied upon after a period of three years without prior review and approval by Gannett Fleming.

CLOSING

We appreciate the opportunity to collaborate with you on this important project. Please contact us if you have any questions.

Sincerely,

Gannett Fleming, Inc.

REGISTERED PROFESSIONAL ENGINEER
104139PE
OREGON
MAY 14, 2024
BENJAMIN SERNA
05/30/2024
EXPIRES: 06/30/2026

R. William Rudolph

Benjamin Serna, PE
Principal Engineer

R. William Rudolph
Senior Consultant

Attachments: Figures
Appendix A – Existing Data

REFERENCES

ASCE, 2016, ASCE Standard (7-16), Minimum Design Loads and Associated Criteria for Buildings and Other Structures, 2016.

Beeson, M.H., Tolan, T.L., and Madin, I.P., 1991, Geologic Map of the Portland Quadrangle, Multnomah and Washington Counties, Oregon, and Clark County, Washington, Geological Map Series 75, 1:24,000.

Boulanger, R.W., and Idriss, I.M., 2014, CPT and SPT Based Liquefaction Triggering Procedures, Report No. UCD/CGM-14/01, Department of Civil and Environmental Engineering, University of California, Davis, USA.

Dickenson, S.E., Khosravifar, A., Beaty, M., Bock, J., Moug, D., Schlechter, S., and Six, J., 2022, Cyclic and Post-Cyclic Behavior of Silt-Rich, Transitional Soils of the Pacific Northwest: A Database for Geo-professionals in Practice and Research, August 2022.

Ishihara, K., and Yoshimine, M., 1992, Evaluation of Settlements in Sand Deposits Following Liquefaction During Earthquakes, *Soils and Foundations*, Volume 32, No. 1.

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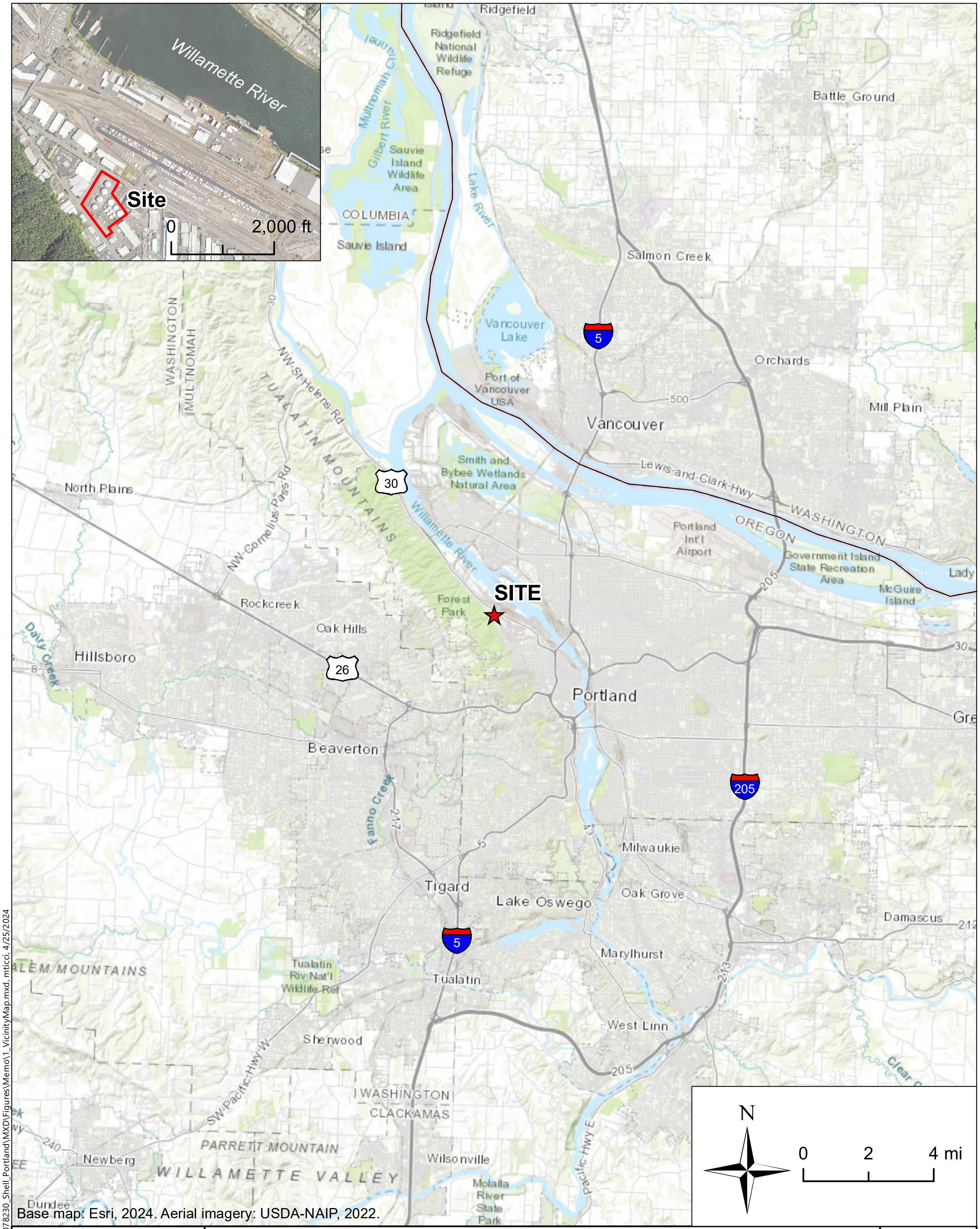
Tokimatsu, K., and Seed, H.B., 1987, Evaluation of Settlements in Sands due to Earthquake Shaking, *Journal of Geotechnical Engineering*, Volume 113, No. 8.

Youd, T.L., 2018, Application of MLR Procedure for Prediction of Liquefaction-Induced Lateral Spread Displacement, *Journal of Geotechnical and Geoenvironmental Engineering*, Volume 144, No. 6.

Zhang, G., Robertson, P.K., and Brachman, R.W.I., 2004, Estimating Liquefaction-Induced Lateral Displacements Using the Standard Penetration Test or Cone Penetration Test, *Journal of Geotechnical and Geoenvironmental Engineering*, Volume 130, No. 8.

FIGURES



Base map: Esri, 2024. Aerial imagery: USDA-NAIP, 2022.

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GANNETT FLEMING

SITE VICINITY PLAN

Shell Portland Terminal
Preliminary Geotechnical Assessment
Portland, Oregon

FIGURE
1

Date: 4/25/2024
By: M. Ticci
Scale: 1:250,000
Project No: 078230

\\cphfs23\EnvSciLI\Projects\07\078230_Shell_Portland\MXD\Figures\Memo\2_SitePlan.mxd, mticci, 4/23/2024

GANNETT FLEMING

SITE PLAN

Shell Portland Terminal
Preliminary Geotechnical Assessment
Portland, Oregon

FIGURE

2

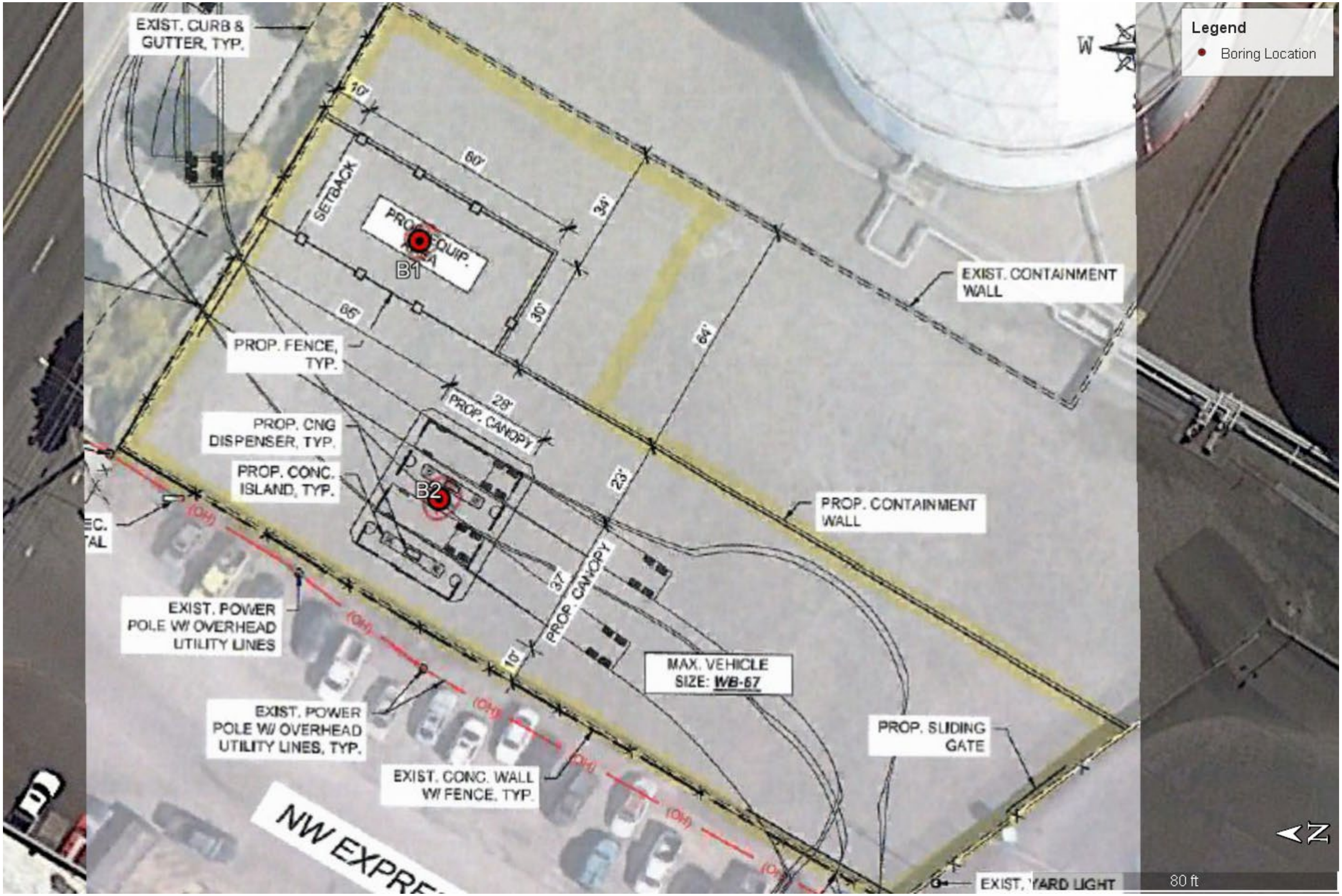
Date: 4/23/2024

By: M. Ticci

Scale: 1:2,400

Project No: 078230

APPENDIX A – EXISTING DATA



Google Earth Imagery	Proposed Shell Fueling Facility (Portland, OR)	JOB NO.	07041373
	Investigation Location Map	FIGURE NO.	2

APPENDIX A

FIELD EXPLORATION DISCUSSION AND LOGS

FIELD EXPLORATION PROGRAM

PSI explored subsurface conditions on April 29, 2021. The field exploration consisted of advancing two mud rotary borings. One mud rotary boring was advanced in the footprint of the proposed fuel island, and one mud rotary boring was advanced in the footprint of the proposed equipment area. Each boring extended to a depth of approximately 60 feet below ground surface (bgs).

Approximate exploration locations are shown on Figure 2, Investigation Location Map. PSI notified the Oregon Utility Notification Center and private utility locators to indicate the approximate location of underground utilities in the vicinity of the proposed exploration locations prior to commencing field activities.

A representative from PSI's office observed the drilling and prepared borings logs of the conditions encountered. It should be noted that the subsurface conditions presented on the boring logs are representative of the conditions at the specific locations drilled. Variations may occur and should be expected across the site. The soil morphology represents the approximate boundary between subsurface materials and the transitions may be gradual and indistinct.

Boring Location Selection and Staking

The boring plan was prepared by PSI and approved by FASTECH prior to drilling. The approved boring plan was superimposed onto Google Earth™ Imagery and the latitude and longitude were recorded. The approved boring locations were also superimposed onto The National Map developed by USGS, which uses the North American Vertical Datum of 1988 (NAVD88), and the elevations of the boring locations were recorded. The location of the borings in the field were established by hand-held GPS using the coordinates from Google Earth™. The latitude, longitude and elevation are noted on each boring log with the perceived accuracy unknown. If accurate locations and elevations are needed, PSI recommends the client/owner have boring locations and elevations determined by survey methods.

Mud Rotary Borings

Mud rotary borings were advanced using a Mobile Drill B-58 truck-mounted drill rig owned and operated by Holt Services, Inc. of Vancouver, Washington. Soil samples were recovered at selected depths during drilling using a standard Split Spoon Sampler (outside diameter - 2.0 inches; inside diameter – 1.42 inches) driven by a 140-lb weight free falling 30 inches. The number of blows required to drive the sampler 12 inches is designated as the penetration resistance (N-value, blows per foot) and provides an indication of the consistency of cohesive soils and the relative density of granular materials.

Field Classification

Soil samples were initially classified visually in the field. Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the soil samples were noted. The terminology used in the soil classifications and other modifiers are depicted in the General Notes and Soil Classification Chart.

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

⊠ SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
■ ST: Shelby Tube - 3" O.D., except where noted.
▯ RC: Rock Core
⬇ TC: Texas Cone
✋ BS: Bulk Sample
⁙ PM: Pressuremeter
CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
N_{60}: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
Q_u: Unconfined compressive strength, TSF
Q_p: Pocket penetrometer value, unconfined compressive strength, TSF
w%: Moisture/water content, %
LL: Liquid Limit, %
PL: Plastic Limit, %
PI: Plasticity Index = (LL-PL),%
DD: Dry unit weight, pcf
▼, ▽, ▼: Apparent groundwater level at time noted

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	N - Blows/foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50 - 80
Extremely Dense	80+

ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
Angular:	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular:	Particles are similar to angular description, but have rounded edges
Subrounded:	Particles have nearly plane sides, but have well-rounded corners and edges
Rounded:	Particles have smoothly curved sides and no edges

GRAIN-SIZE TERMINOLOGY

Component	Size Range
Boulders:	Over 300 mm (>12 in.)
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to ¾ in.)
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.40)
Silt:	0.005 mm to 0.075 mm
Clay:	<0.005 mm

PARTICLE SHAPE

Description	Criteria
Flat:	Particles with width/thickness ratio > 3
Elongated:	Particles with length/width ratio > 3
Flat & Elongated:	Particles meet criteria for both flat and elongated

RELATIVE PROPORTIONS OF FINES

Descriptive Term	% Dry Weight
Trace:	< 5%
With:	5% to 12%
Modifier:	>12%

GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

Q_U - TSF	N - Blows/foot	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

MOISTURE CONDITION DESCRIPTION

Description	Criteria
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term	% Dry Weight
Trace:	< 15%
With:	15% to 30%
Modifier:	>30%

STRUCTURE DESCRIPTION

Description	Criteria
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided:	Fracture planes appear polished or glossy, sometimes striated

Description	Criteria
Blocky:	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed:	Inclusion of small pockets of different soils
Layer:	Inclusion greater than 3 inches thick (75 mm)
Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample
Parting:	Inclusion less than 1/8-inch (3 mm) thick

SCALE OF RELATIVE ROCK HARDNESS

Q_U - TSF	Consistency
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

ROCK BEDDING THICKNESSES

Description	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

Voids	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

Component	Size Range
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

ROCK QUALITY DESCRIPTION

Rock Mass Description	RQD Value
Excellent	90 -100
Good	75 - 90
Fair	50 - 75
Poor	25 -50
Very Poor	Less than 25

DEGREE OF WEATHERING

Slightly Weathered:	Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered:	Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
Highly Weathered:	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	●	GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
			○	GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	○	GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
			▨	GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	⁘	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			░	SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	░	SM	SILTY SANDS, SAND - SILT MIXTURES
			▨	SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	▥	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			▨	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			☰	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	▥	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			▨	CH	INORGANIC CLAYS OF HIGH PLASTICITY
			〰	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			⺌	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

BORING B1

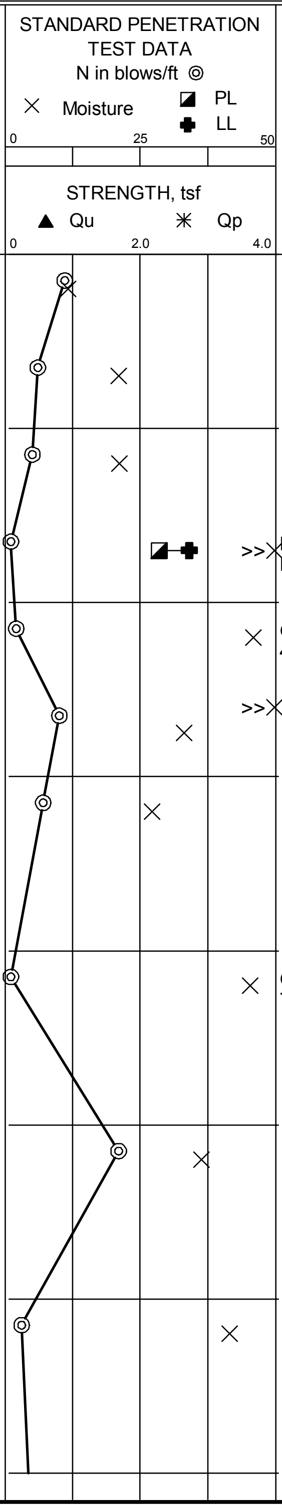
DATE STARTED: 4/29/21
DATE COMPLETED: 4/29/21
COMPLETION DEPTH 60.0 ft
BENCHMARK: N/A
ELEVATION: 39 ft
LATITUDE: 45.5519°
LONGITUDE: -122.7265°
STATION: N/A **OFFSET:** N/A
REMARKS:

DRILL COMPANY: Holt Services, Inc.
DRILLER: Sam Heuser **LOGGED BY:** Helen Russell
DRILL RIG: Mobile Drill B58
DRILLING METHOD: Mud Rotary
SAMPLING METHOD: 2-in SS
HAMMER TYPE: Automatic
EFFICIENCY 86%
REVIEWED BY: Steve Bryant

Water		
▽	While Drilling	7.5 feet
▼	Upon Completion	N/A feet
▽	Delay	N/A feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0	1	15	2 inches of **GRAVEL FILL**, gray, dry **SAND** with Silt, SP, brown, moist, medium dense to loose, poorly graded medium sand		2-5-6 N=11	12	
35		2	18		SP	3-3-3 N=6	21	
	5	3	18			3-2-3 N=5	21	
30		4	16	**Silty SAND**, SM, gray, wet, very loose		0-0-1 N=1	51	LL = 34 PL = 28
	10	5	18		SM	0-1-1 N=2	46	Gradation: Fines = 45.6%
25		6	18			0-4-6 N=10	64 33	
	15	7	16	**SAND**, SP, gray, wet, medium dense to loose, poorly graded medium sand	SP	3-4-3 N=7	27	
20	20	8	18	**SILT** with Sand, ML, brown and gray, wet, very soft to medium stiff		0-0-1 N=1	45	Gradation: Fines = 77.9%
15	25	9	18		ML	2-8-13 N=21	36	
10	30	10	18			1-1-2 N=3	42	
5	35			*Continued Next Page*				



Professional Service Industries, Inc.
6032 N. Cutter Circle, Suite 480
Portland, OR 97219
Telephone: (503) 289-1778

PROJECT NO.: 07041373
PROJECT: Proposed Shell Fueling Facility
LOCATION: 3800 NW Saint Helens Road
Portland
Oregon

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED: 4/29/21
DATE COMPLETED: 4/29/21
COMPLETION DEPTH 60.0 ft
BENCHMARK: N/A
ELEVATION: 39 ft
LATITUDE: 45.5519°
LONGITUDE: -122.7265°
STATION: N/A **OFFSET:** N/A
REMARKS:

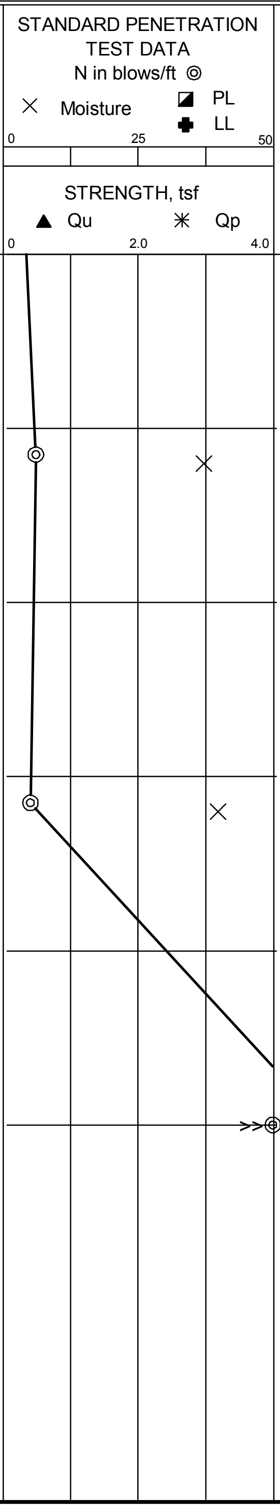
DRILL COMPANY: Holt Services, Inc.
DRILLER: Sam Heuser **LOGGED BY:** Helen Russell
DRILL RIG: Mobile Drill B58
DRILLING METHOD: Mud Rotary
SAMPLING METHOD: 2-in SS
HAMMER TYPE: Automatic
EFFICIENCY 86%
REVIEWED BY: Steve Bryant

BORING B1

Water		
▽	While Drilling	7.5 feet
▼	Upon Completion	N/A feet
▼	Delay	N/A feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	35				**SILT** with Sand, ML, brown and gray, wet, very soft to medium stiff	ML			
0									
	40	⊠	11	18			2-2-4 N=6	37	
-5									
	45								
-10									
	50	⊠	12	18			3-2-3 N=5	40	
-15									
	55								
					GRAVEL with Sand, GW, brown and gray, wet, very dense	GW			
-20									
	60		13	0			50/0"		
					Boring terminated at 60 feet due to SPT sampler refusal				



Professional Service Industries, Inc.
6032 N. Cutter Circle, Suite 480
Portland, OR 97219
Telephone: (503) 289-1778

PROJECT NO.: 07041373
PROJECT: Proposed Shell Fueling Facility
LOCATION: 3800 NW Saint Helens Road
Portland
Oregon

The stratification lines represent approximate boundaries. The transition may be gradual.

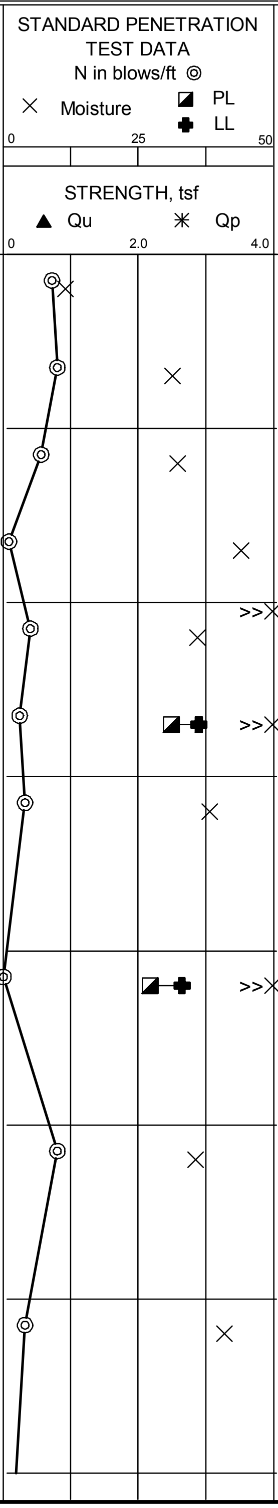
BORING B2

DATE STARTED: 4/29/21
DATE COMPLETED: 4/29/21
COMPLETION DEPTH 61.5 ft
BENCHMARK: N/A
ELEVATION: 39 ft
LATITUDE: 45.5518°
LONGITUDE: -122.7268°
STATION: N/A **OFFSET:** N/A
REMARKS:

DRILL COMPANY: Holt Services, Inc.
DRILLER: Sam Heuser **LOGGED BY:** Helen Russell
DRILL RIG: Mobile Drill B58
DRILLING METHOD: Mud Rotary
SAMPLING METHOD: 2-in SS
HAMMER TYPE: Automatic
EFFICIENCY: 86%
REVIEWED BY: Steve Bryant

Water		
▽	While Drilling	2.5 feet
▼	Upon Completion	N/A feet
▼	Delay	N/A feet

BORING LOCATION:



Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0					2 inches of **GRAVEL FILL**, gray, dry				
				1	17	**SAND** with Silt, SP, brown, moist to wet at 2.5 feet, loose, poorly graded medium sand	SP	2-5-4 N=9	12	
35				2	16			3-4-6 N=10	31	
	5			3	12			4-3-4 N=7	32	Gradation: Fines = 11.6%
30				4	17	**SILT** with Sand, ML, brown and gray, wet, very soft	ML	0-0-1 N=1	44	
	10			5	17	NOTE: 6 inches of white silt at 10 feet bgs **SAND** with Silt, SP, gray, wet, loose, poorly graded medium sand	SP	2-3-2 N=5	81 36	Gradation: Fines = 8.5%
25				6	18	**SILT** with Sand, ML, gray, wet, soft	ML	0-1-2 N=3	68	LL = 36 PL = 31
	15					**SAND** with Silt, SP, gray, wet, loose, poorly graded medium sand				
				7	18		SP	2-2-2 N=4	38	
20	20									
				8	16	**SILT** with Sand, ML, brown and gray, wet, very soft to stiff	ML	1-0-0 N=0	66	LL = 33 PL = 27
15	25			9	16			3-4-6 N=10	36	
10	30			10	18			0-0-4 N=4	41	
5	35									

Continued Next Page

BORING B2

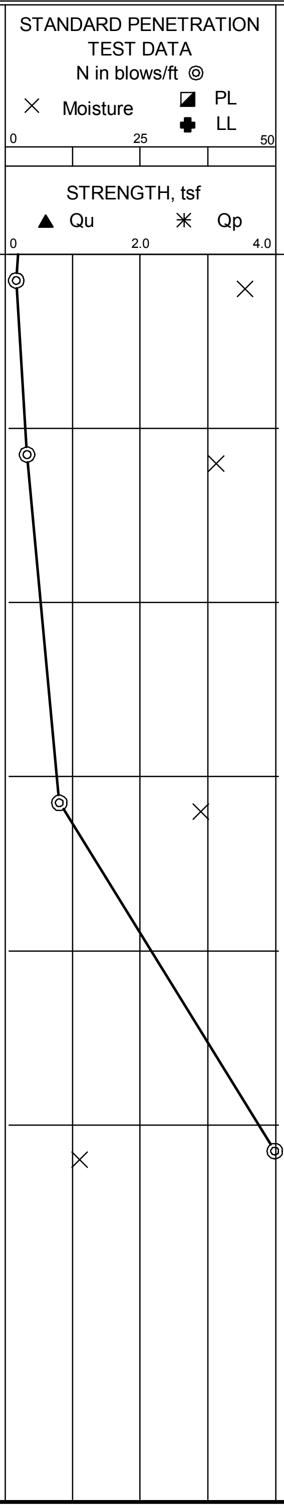
DATE STARTED: 4/29/21
DATE COMPLETED: 4/29/21
COMPLETION DEPTH 61.5 ft
BENCHMARK: N/A
ELEVATION: 39 ft
LATITUDE: 45.5518°
LONGITUDE: -122.7268°
STATION: N/A **OFFSET:** N/A
REMARKS:

DRILL COMPANY: Holt Services, Inc.
DRILLER: Sam Heuser **LOGGED BY:** Helen Russell
DRILL RIG: Mobile Drill B58
DRILLING METHOD: Mud Rotary
SAMPLING METHOD: 2-in SS
HAMMER TYPE: Automatic
EFFICIENCY 86%
REVIEWED BY: Steve Bryant

Water		
▽	While Drilling	2.5 feet
▼	Upon Completion	N/A feet
▽	Delay	N/A feet

BORING LOCATION:

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	35	11	18	**SILT** with Sand, ML, brown and gray, wet, very soft to stiff	ML	0-0-2 N=2	45	
0								
	40	12	18			2-1-3 N=4	39	
-5								
	45							
-10								
	50	13	14			3-4-6 N=10	36	
-15								
	55							
				GRAVEL with Sand, GW, brown and gray, wet, dense	GW			
-20								
	60	14	9			19-17-33 N=50	14	
				Boring terminated at 61.5 feet due to SPT sampler refusal				



Professional Service Industries, Inc.
6032 N. Cutter Circle, Suite 480
Portland, OR 97219
Telephone: (503) 289-1778

PROJECT NO.: 07041373
PROJECT: Proposed Shell Fueling Facility
LOCATION: 3800 NW Saint Helens Road
Portland
Oregon

The stratification lines represent approximate boundaries. The transition may be gradual.

APPENDIX B

LABORATORY TESTING PROGRAM

LABORATORY TESTING PROGRAM AND PROCEDURES

Soil samples obtained during the field explorations were examined in our laboratory. The physical characteristics of the samples were noted, and the field classifications were modified, where necessary. Representative samples were selected during the course of the examination for further testing.

Moisture Content

Natural moisture content determinations were made on selected soil samples in general accordance with ASTM D2216. The natural moisture content is defined as the ratio of the weight of water to the dry weight of soil, expressed as a percentage. Results are shown on the exploration logs.

Visual-Manual Classification

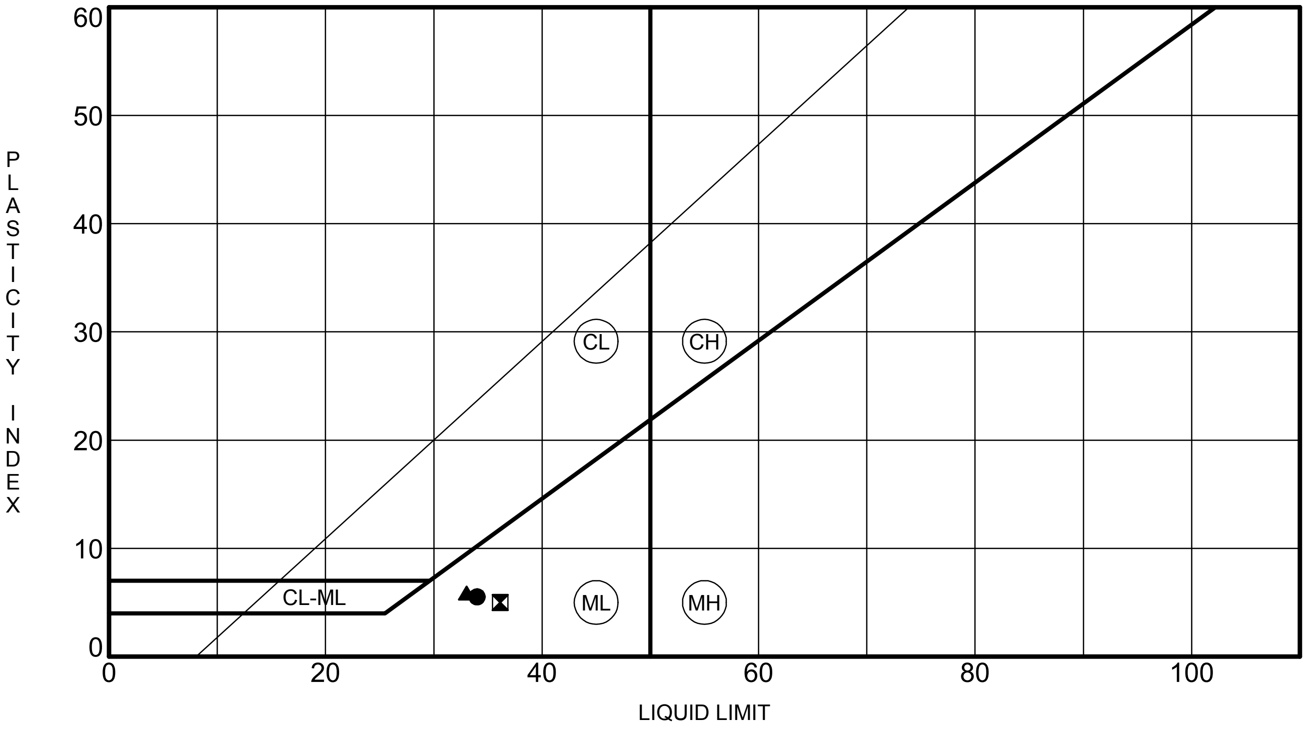
The soil samples were classified in general accordance with guidelines presented in ASTM D2487. Certain terminology incorporating current local engineering practice, as provided in the Soil Classification Chart, is included with, or in lieu of, ASTM terminology. The term which best described the major portion of the sample was used in determining the soil type (i.e., gravel, sand, silt or clay). Results are shown on the exploration logs.

Sieve Analysis

The determination of the amount of material finer than the U.S. Standard No. 200 (75-µm) sieve was made on selected soil sample in general accordance with ASTM D1140. In general, the sample was dried in an oven and then washed with water over the No. 200 sieve. The mass retained on the No. 200 sieve was dried in an oven, and the dry weight recorded. Results from this test procedure assist in determining the fraction, by weight, of coarse-grained and fine-grained soils in the sample. Results are shown on the exploration logs.

Atterberg Limits

The Atterberg Limits are defined by the liquid limit (LL) and plastic limit (PL) states of a given soil. These tests are performed in general accordance with ASTM D4318. These limits are used to determine the moisture content limits where the soil characteristics change from behaving more like a fluid on the liquid limit end to where the soil behaves more like individual soil particles on the plastic limit end. The plasticity index (PI) is the difference between the liquid limit and the plastic limit. The plasticity index is used in conjunction with the liquid limit to assess if the material will behave like a silt or clay. Results are shown on the exploration logs and on the Atterberg Limit Results below.



	Boring	Depth (ft)	LL	PL	PI	Fines	Classification (*Visual)
●	**B1**	**8.5**	**34**	**28**	**6**		
⧗	**B2**	**13.5**	**36**	**31**	**5**		
▲	**B2**	**21.0**	**33**	**27**	**6**		

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6032 N. Cutter Circle, Suite 480
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Fax: (503) 289-1918

ATTERBERG LIMIT RESULTS

PSI Job No.: 07041373
Project: Shell CNG Fueling Facility
Location: Portland
Oregon

Appendix C

Risk Assessment

CRITICAL SYSTEMS RISK ASSESSMENT

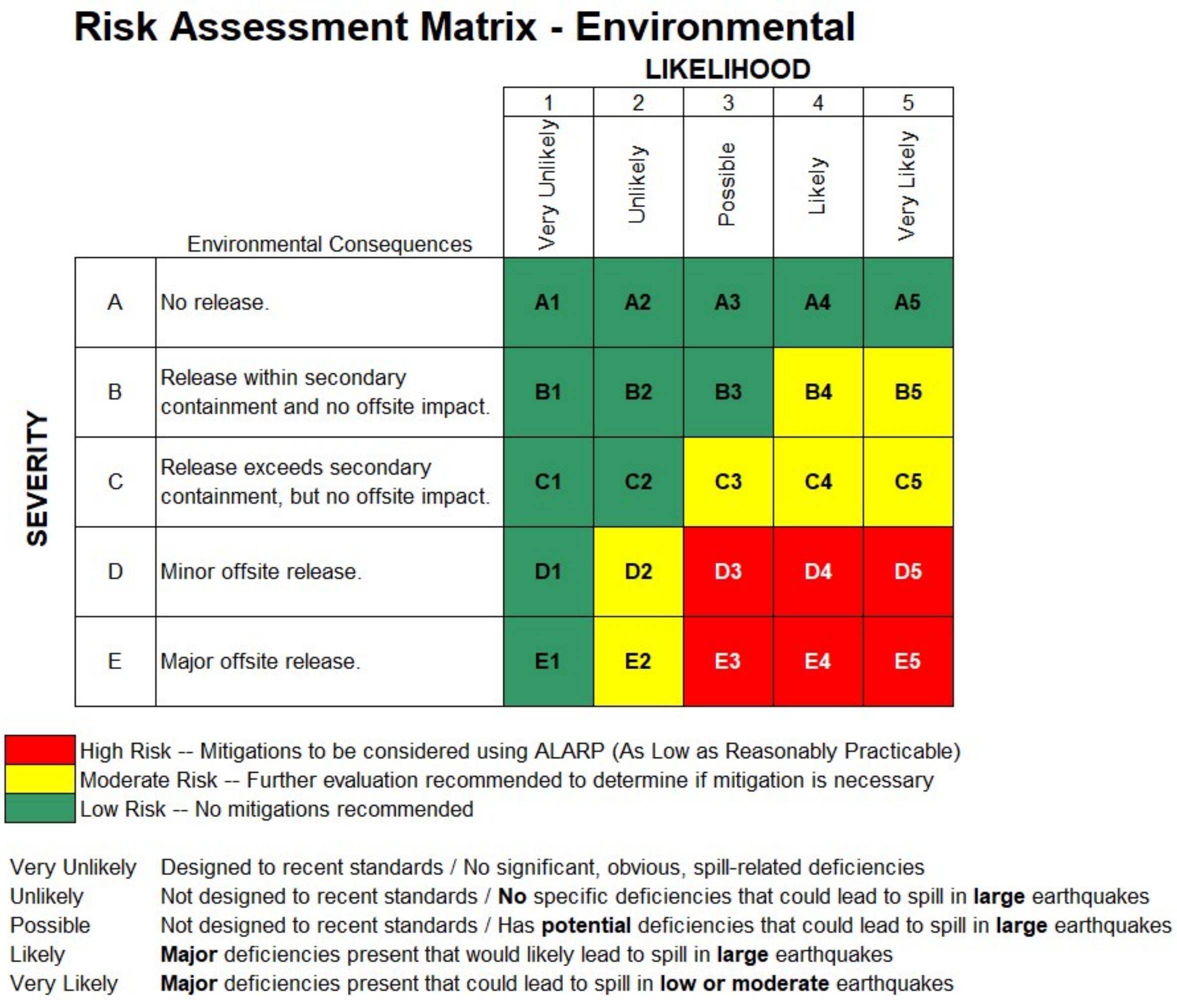
Purpose:	To identify and prioritize critical structures, equipment, tanks, and systems and the performance requirements during and following an earthquake with regards to prevention and containment of oil spills.
Scope:	This study will address all facility components covered by the Rules.
Boundaries:	The team will consider possible scenarios due to earthquakes that may realistically occur and result in an uncontained spill, uncontrolled fire, explosion, or toxic release at the terminal. The following items will be excluded from the scope of this study: • Failures due to non-earthquake related causes • Life-safety considerations that are not directly caused by a spill that occurs due to an earthquake (e.g. life-safety concerns from occupants of a building that collapses)
Process:	***Before the Risk Assessment Session*** • Prepare the charter for the risk assessment. • Prepare a draft assessment based on known industry and terminal practice and knowledge of this specific terminal gained through review of terminal documentation • SGH engineers will perform a structural "walkdown" review of the facility • SGH will prepopulate the risk matrix based on the walkdown review, preliminary geotechnical review, and other factors ***During the Risk Assessment Session*** • Review the risk assessment process and techniques to be used. • Present an overview of the risk assessment matrix. • Review the pre-developed list of systems and components

- Identify additional systems and components
- For each physical area of the terminal, identify the following:
    - Key components or systems that require documentation according to the Rules
    - Which components or systems contain hydrocarbons covered by the rules where spill is a concern
    - Safety systems that are being relied on for mitigation or response following an earthquake as related to the scope of the Rules
- For each critical system, identify key components of that system and for each component perform the following:
    - Identify the possible nature of earthquake performance as related to the Rules (e.g. collapse, damage resulting in spill, functional failure)
    - Identify the **likelihood** of possible failure / unacceptable performance, consistent with the risk matrix, based on known properties of the system and visual reviews. (Note: this is subject to revision based on more detailed evaluation or additional data)
    - Identify the **severity** of possible safety or environmental consequences, consistent with the risk matrix
    - Assign a risk level consistent with the risk matrix
- Document team findings

After the Risk Assessment Session

- Update the findings of the risk assessment as appropriate based on further evaluation or additional data
- Use the risk assessment results as needed in development of the facilities mitigation plan, as required by the Rules

Risk Assessment Matrices



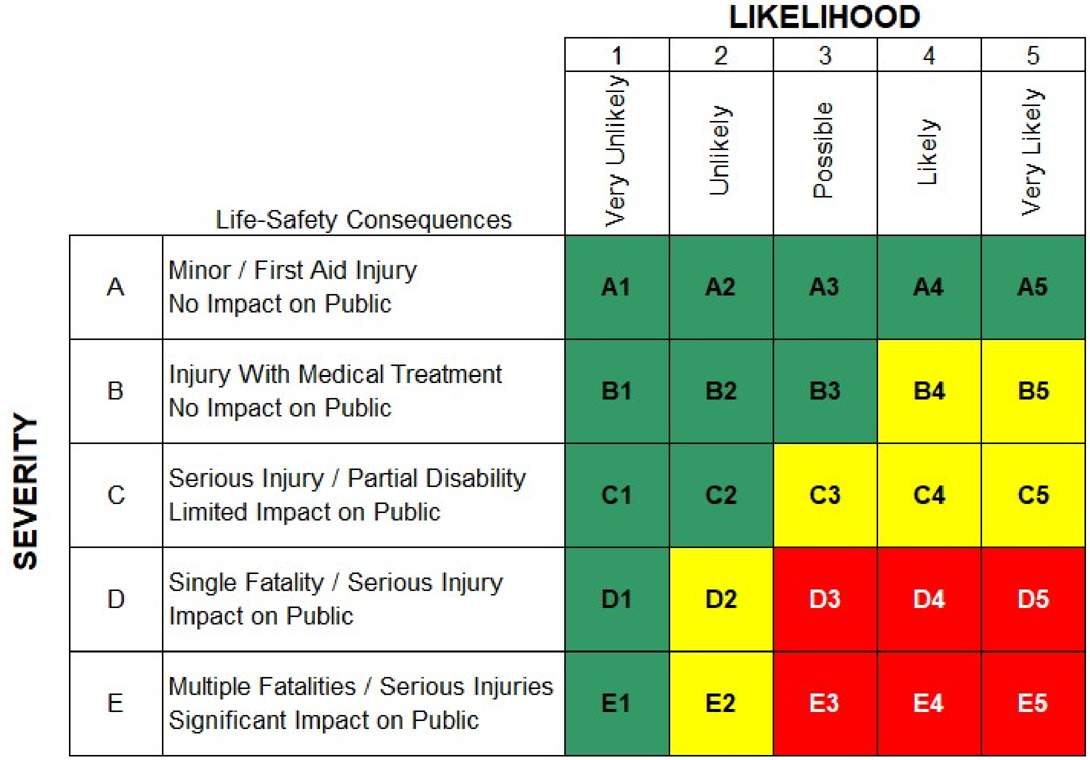
Risk Assessment Matrix - Environmental

			LIKELIHOOD				
			1	2	3	4	5
		Environmental Consequences	Very Unlikely	Unlikely	Possible	Likely	Very Likely
SEVERITY	A	No release.	🟩 A1	🟩 A2	🟩 A3	🟩 A4	🟩 A5
	B	Release within secondary containment and no offsite impact.	🟩 B1	🟩 B2	🟩 B3	🟨 B4	🟨 B5
	C	Release exceeds secondary containment, but no offsite impact.	🟩 C1	🟩 C2	🟨 C3	🟨 C4	🟨 C5
	D	Minor offsite release.	🟩 D1	🟨 D2	🟥 D3	🟥 D4	🟥 D5
	E	Major offsite release.	🟩 E1	🟨 E2	🟥 E3	🟥 E4	🟥 E5

🟥 High Risk -- Mitigations to be considered using ALARP (As Low as Reasonably Practicable)
🟨 Moderate Risk -- Further evaluation recommended to determine if mitigation is necessary
🟩 Low Risk -- No mitigations recommended

Very Unlikely	Designed to recent standards / No significant, obvious, spill-related deficiencies
Unlikely	Not designed to recent standards / **No** specific deficiencies that could lead to spill in **large** earthquakes
Possible	Not designed to recent standards / Has **potential** deficiencies that could lead to spill in **large** earthquakes
Likely	**Major** deficiencies present that would likely lead to spill in **large** earthquakes
Very Likely	**Major** deficiencies present that could lead to spill in **low or moderate** earthquakes

Risk Assessment Matrix - Life Safety



			LIKELIHOOD				
			1	2	3	4	5
		Life-Safety Consequences	Very Unlikely	Unlikely	Possible	Likely	Very Likely
SEVERITY	A	Minor / First Aid Injury No Impact on Public	A1	A2	A3	A4	A5
	B	Injury With Medical Treatment No Impact on Public	B1	B2	B3	B4	B5
	C	Serious Injury / Partial Disability Limited Impact on Public	C1	C2	C3	C4	C5
	D	Single Fatality / Serious Injury Impact on Public	D1	D2	D3	D4	D5
	E	Multiple Fatalities / Serious Injuries Significant Impact on Public	E1	E2	E3	E4	E5

🟥 High Risk -- Mitigations to be considered using ALARP (As Low as Reasonably Practicable)
🟨 Moderate Risk -- Further evaluation recommended to determine if mitigation is necessary
🟩 Low Risk -- No mitigations recommended

Very Unlikely	Designed to recent standards / No significant, obvious, spill-related, life-safety deficiencies
Unlikely	Not designed to recent standards / **No** specific deficiencies that could lead to spill-related, life-safety concerns in **large** earthquakes
Possible	Not designed to recent standards / Has **potential** deficiencies that could lead to spill-related, life-safety concerns in **large** earthquakes
Likely	**Major** deficiencies present that would likely lead to spill-related, life-safety concerns in **large** earthquakes
Very Likely	**Major** deficiencies present that could lead to spill-related, life-safety concerns in **low or moderate** earthquakes

Risk Assessment Report

Date:
April 9, 2024

Location:
Virtual

Attendees:

Gayle S. Johnson, P.E., SGH, Senior Principal (Facilitator)
William M. Bruin, P.E., SGH, Senior Principal
Julie A. Galbraith, P.E., SGH, Senior Project Manager
Luis H. Palacios, P.E., SGH, Senior Technical Manager
Justin D. Reynolds, P.E., SGH, Senior Project Manager
Jun O. Tucay, P.E., S.E., SGH, Senior Consulting Engineer
David Baker, Shell, Senior Facility Engineer (PacNW)
Jay Fitzsimmons, Shell, Terminal Operations Supervisor
John Nguyen, Shell, Mechanical Technician (PacNW)
Gotxon Guereca, Shell, Tank Facility Engineer (West Coast)
Joe Ramos, Shell, Console Supervisor, Control Center
Clinton Linder, Shell, ER Coordinator
Venkit Gopalakrishnan, Shell, R&I Lead (Americas)
Reid Collier, Shell, Tank Lead (Americas)

			Risk Assessment Rankings				
				Severity			
Location	**Item Type**	**Identification**	**Likelihood**	**Environment**	**Safety**	**Risk Score**	**Item or Score Notes**
North Tank Farm							
	Tank	T-84200	2. Unlikely	B. Release within secondary containment	D. Single Fatality / Impact on Public	D2	gasoline increases severity
	Tank	T-80105	3. Possible	B. Release within secondary containment	D. Single Fatality / Impact on Public	D3	rigid connection; gasoline increases severity
	Tank	T-80104	3. Possible	B. Release within secondary containment	D. Single Fatality / Impact on Public	D3	rigid connection; gasoline increases severity
	Tank	T-55001	2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	
	Tank	190	1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	
	Tank	357	2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	
	Tank	13	1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	
	Tank	191	1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	
	Tank	286	1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	
	Piping	Gasoline	3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Publ	C3	gasoline increases severity
	Piping	Ethanol	3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	
	Piping	Additives	3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	
	Secondary Containment Wall	N/A	3. Possible	D. Minor offsite release	C. Serious Injury / Limited Impact on Publ	D3	damage possible with offsite release
South Tank Farm							
	Tank	T-13522	4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	riveted; rigid connection
	Tank	T-55000	4. Likely	B. Release within secondary containment	D. Single Fatality / Impact on Public	D4	riveted; rigid connection; gasoline
	Tank	T-36002	4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	riveted; rigid connection
	Tank	T-13519	4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	riveted; rigid connection
	Tank	T-13520	4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	riveted; rigid connection
	Tank	T-80103	4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	riveted; rigid connection
	Tank	T-13521	4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	riveted; rigid connection
	Tank	T-13524	4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	riveted; rigid connection
	Tank	T-7017	3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	
	Tank	T-13523	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	Out of service
	Piping	Diesel	3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	
	Piping	Gasoline	3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Publ	C3	gasoline increases severity
	Piping	Contact Water	3. Possible	B. Release within secondary containment	A. Minor / First Aid Injury	B3	
	Secondary Containment Wall	N/A	3. Possible	D. Minor offsite release	C. Serious Injury / Limited Impact on Publ	D3	damage possible with offsite release

			Risk Assessment Rankings				
				Severity			
Location	**Item Type**	**Identification**	**Likelihood**	**Environment**	**Safety**	**Risk Score**	**Item or Score Notes**
VRU							
	Tank	V-1	1. Very Unlikely	A. No Release	B. Injury With Medical Treatment	B1	vapor unit; no significant product
	Tank	V-2	1. Very Unlikely	A. No Release	B. Injury With Medical Treatment	B1	vapor unit; no significant product
	Tank	V-3	1. Very Unlikely	A. No Release	B. Injury With Medical Treatment	B1	vapor unit; no significant product
	Piping	Vapor / Slop	3. Possible	A. No Release	A. Minor / First Aid Injury	A3	vapor unit; no significant product
Truck Loading Rack							
	Truck Loading Rack	N/A	3. Possible	B. Release within secondary containment	A. Minor / First Aid Injury	B3	
	Underground Tank	UG-1320	3. Possible	B. Release within secondary containment	A. Minor / First Aid Injury	B3	vapor knockout
	Underground Tank	UG-1010	3. Possible	B. Release within secondary containment	A. Minor / First Aid Injury	B3	hydrocarbon
	Underground Tank	UG-10301	3. Possible	B. Release within secondary containment	A. Minor / First Aid Injury	B3	contact water
	Truck (while loading or unloading)	N/A	2. Unlikely	B. Release within secondary containment	D. Single Fatality / Impact on Public	D2	damage to truck (rolls and/or fire)
Buildings and Structural Canopies							
	Building	Elect.	2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	No matl to spill within building
	Building	Shop	2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	No matl to spill within building
	Building	Maintenance Garage	2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	No matl to spill within building
	Building	Storage	2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	No matl to spill within building
	Building	Electrical/Tank Foam System	2. Unlikely	A. No Release	C. Serious Injury / Limited Impact on Publ	C2	
	Building	Office	2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	No matl to spill within building
	Building	Truck Rack Foam Building	2. Unlikely	A. No Release	C. Serious Injury / Limited Impact on Publ	C2	
	Open Canopy Structure	Hazardous Waste Storage	2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	
Overall Terminal							
	Emergency Response	Unstaffed hours	3. Possible	A. No Release	C. Serious Injury / Limited Impact on Publ	C3	response hindered if during unstaffed hours
		Communications	3. Possible	A. No Release	C. Serious Injury / Limited Impact on Publ	C3	cell phone communication ; no radios
		Municipal Power	5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	no backup power sources
		UPS	4. Likely	A. No Release	B. Injury With Medical Treatment	B4	UPS for only 1 hour
	Fire System	Water Main	5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	no backup water sources
		Foam System (Truck Rack)	5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	unavailable due to no water supply
		Foam System (Tanks)	5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	unavailable due to no water supply
		Fire Pump	5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	no water supply; equipment damage unlikely