Chevron

Chevron Americas Fuels and Lubricants

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30 May 2024

Oregon Department of Environmental Quality (DEQ)
700 NE Mulnomah St., Suite 14
Portland, OR 97232

RE: Submission of Seismic Vulnerability Assessment

To Whom It May Concern:

On behalf of Chevron, I am submitting the attached Seismic Vulnerability Assessment for the Chevron Willbridge Terminal at 5531 NW Doane Avenue, Portland, OR 97210, in compliance with the DEQ's "Fuel Tank Seismic Stability Rules."

Our consultant SGH prepared this document, and Chevron has reviewed and approved the report.

Please let us know of any comments or questions.

Sincerely,

Gerald Henderson
NW Operations Manager

Enclosures:

SEISMIC VULNERABILITY ASSESSMENT OF THE CHEVRON WILLBRIDGE TERMINAL

Chevron Products Company
Willbridge Terminal
Portland, OR
May 2024

SGH Project 237372

REGISTERED PROFESSIONAL ENGINEER
87981PE
DIGITALLY SIGNED
OREGON
MAR. 12, 2013
GAYLE S. JOHNSON
EXPIRES: 06/30/25

PE Stamp applies to
Report Body and
Appendix C

Gayle S. Johnson

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PREPARED FOR

Chevron Products Company
5531 N.W. Doane Ave.
Portland, OR 97210

PREPARED BY

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EXECUTIVE SUMMARY

Chevron Products Company, a division of Chevron U.S.A., Inc. (Chevron) has contracted Simpson Gumpertz & Heger Inc. (SGH) to perform a Seismic Vulnerability Assessment of the Chevron Willbridge 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

Main Yard Tank Farm	Small (Lube) Tank Farm	MM1 & MM2 Yards	Blending & Slurry Areas	Butane Storage, Offloading, & Dock	Safety Systems & Buildings
Containment Walls	Containment Walls	Containment Walls	(none)	Containment Walls (T-108 Yard)	Water Main
				Piping in Trench under Roadway	Foam System
				Chevron Dock	Fire Pump
				Dock Piping	Deluge System

Table E-2 - Summary of Moderate Risk Items

Main Yard Tank Farm	Small (Lube) Tank Farm	MM1 & MM2 Yards	Blending & Slurry Areas	Butane Storage, Offloading, & Dock	Safety Systems & Buildings
Piping[1]	Piping[1]	Piping[1]	Secondary Containment	Piping[1]	(none)
Oil Water Separator[2]	Tank 29	Tank 33		Trench under Roadway[2]	
Tank 1	Tank 30	Tank 34		Tank 108[2]	
Tank 3	Tank 37	Tank 35		Green plastic tanks[2]	
Tank 45	Tank 38	Tank 36		Additive Totes[2]	
Tank 48	Tank 39	Tank 79		Butane Tank[2]	
Tank 51	Tank 40	Tank 91		Truck Offloading Structure[2]	
Tank 60	Tank 41	Tank 113		Fire Control Room[2]	
Tank 62	Tank 46	Tank 131		Dock Office[2]	
Tank 100	Tank 56	Tank 132		Floating Dock/Boom	
Tank 101	Tank 65				
Tank 109	Tank 72				
Tank 128	Tank 80				
Tank 144	Tank 81				
Tank 145	Tank 83				
Tank 150	Tank 84				

Main Yard Tank Farm	Small (Lube) Tank Farm	MM1 & MM2 Yards	Blending & Slurry Areas	Butane Storage, Offloading, & Dock	Safety Systems & Buildings
Tank 163	Tank 85				
Tank 164	Tank 87				
	Tank 89				
	Tank 92				
	Tank 104				
	Tank 105				
	Tank 106				
	Tank 110				
	Tank 112				
	Tank 114				
	Tank 116				
	Tank 117				
	Tank 118				
	Tank 138				
	Tank 139				
	Tank 147				
	Tank 148				
	Tank 149				
	Tank 151				
	Tank 152				
	Tank 160				

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 lateral ground deformations varies from about 1 ft near the warehouse and lube yard, to over 5 ft at the waterfront. Corresponding vertical displacements vary from 6 in. to over 30 in. at the site, with the potential for higher localized settlements. Our structural and safety assessments considered these potential displacements.

Structural

Many of the tanks in the Main Yard have a Moderate Risk due to their flammable contents and a higher Life Safety severity. Other tanks in the Main Yard are Moderate Risk due to a higher Likelihood of damage driven by an over-constrained condition with stairs or piping, as shown in the example photos of Figure E-1.

Moderate Risk tanks in the MM1 Yard, MM2 Yard, and Lube Yard are generally unanchored and have a high aspect ratio. Some tanks in the Lube Yard also have over-constrained piping.

Pipelines are rated Moderate throughout the Terminal due to differential displacements from ground deformation and the anticipated pipe stresses. At the dock, pipelines are rated High due to a higher consequence of damage and spill directly into the river. Additionally, the dock piping is likely to experience high stresses due to its supported condition on the wharf and the higher soil displacements estimated at the river front. Similarly piping in the trench under the roadway is rated High due to likelihood for high stresses due to differential soil displacements.

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

Figure E-1: Example Over-Constrained Conditions

Left: Short pipe run to anchored pump at Tank 117

Right: Anchored stair handrail at Tank 100

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 for foam distribution. It is highly unlikely municipal water will be available following the DLE considered by the Rules.

Since the foam system, fire pump, and deluge systems are dependent on municipal water, which is unlikely to be available following the DLE, and the consequence of these systems being unavailable, these items are deemed a High Risk.

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APPENDIX

1. INTRODUCTION

Chevron Products Company, a division of Chevron U.S.A., Inc. (Chevron) has contracted Simpson Gumpertz & Heger Inc. (SGH) to perform a Seismic Vulnerability Assessment of the Chevron Willbridge 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 in California for seismic assessment of existing chemical and process facilities in high seismic zones that contain hazardous materials. Further, MOTEMS is considered the most appropriate code document for assessment of operational procedures and seismic performance at existing marine 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 Chevron 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 Chevron to SGH, including soils reports, drawings, and specifications. SGH makes no warranty as to the accuracy and correctness of any such information.

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 Chevron Willbridge Terminal is located at 5924 NW Front Avenue in Portland, Oregon. The terminal has a 780-foot dock that extends into the Willamette River. The facility consists of four tank farms, the dock, a butane storage area, an offload area, loading racks, and several buildings, including the lubricants building and maintenance building. See Figure 2-1 for the vicinity plan of the Chevron Willbridge Terminal. See Figure 2-2 for the aerial plan of the facility.

Figure 2-1: Vicinity Plan of Chevron Willbridge Terminal

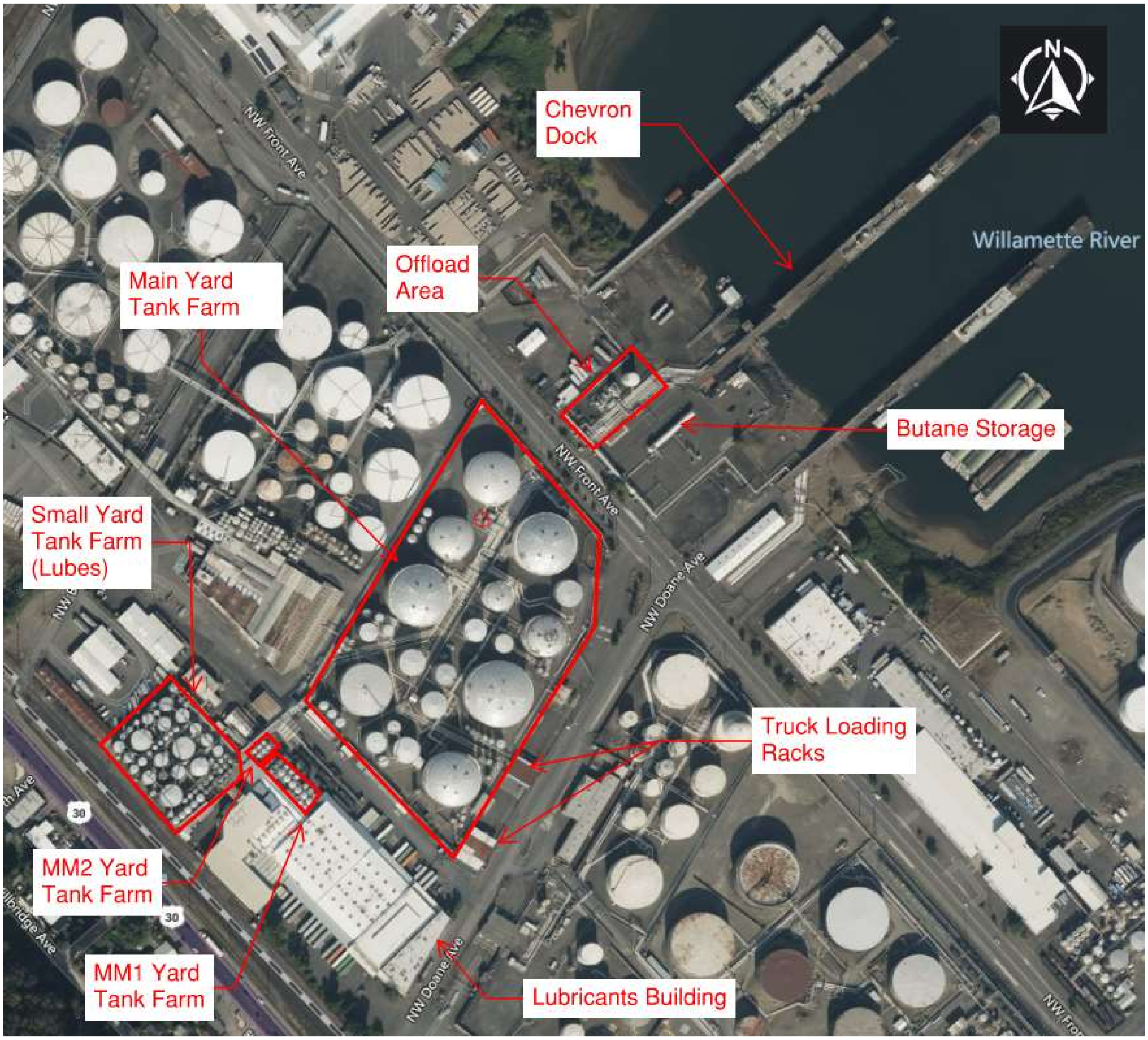


Figure 2-2: Aerial Plan of Chevron Willbridge Terminal

2.1 Main Yard Tank Farm

The Main Yard Tank Farm consists of seven combustible fuel tanks, thirteen flammable fuel tanks, and twenty-three non-combustible petroleum tanks. There are forty-three total tanks in the containment area. There are eight tanks with a diameter larger than 90 feet, while the remainder of tanks have a diameter less than 60 feet. The tanks vary from large-diameter squat tanks to small-diameter tanks with a higher aspect ratio (height divided by diameter, H/D). Several pumps and an oil water separator are located within the tank farm. Pipes interconnect the tanks and penetrate the containment walls, leading to the adjacent truck loading racks. The containment consists primarily of reinforced concrete walls and three earthen ramps from Doane Ave, Front Street, and the lube oil side. The approximate gross area within the containment is 367,500 square feet. Containment volume of the Main Yard, per the SPCC, is about 6,216,300 gallons (about 148,000 barrels). See Figure 2-3 for an aerial view of the Main Yard Tank Farm.

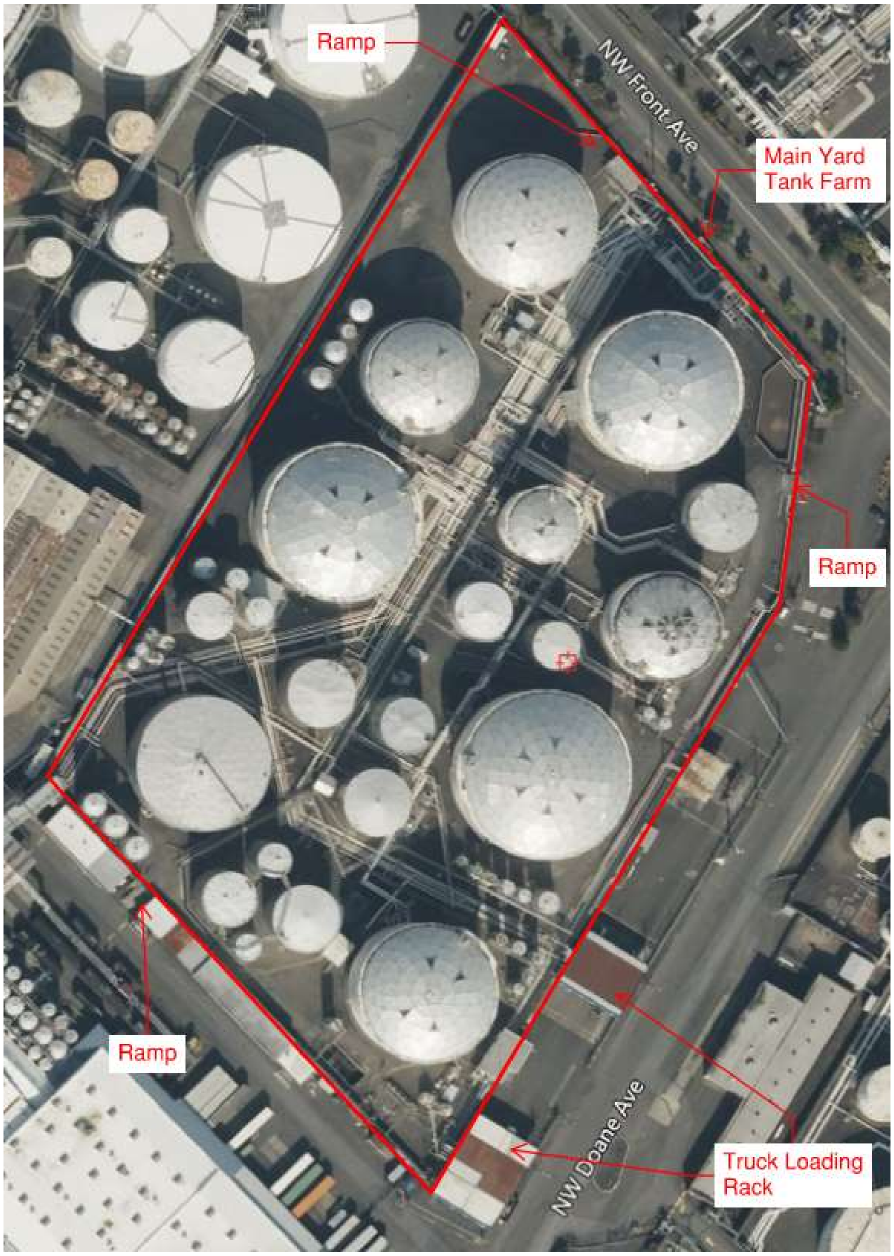


Figure 2-3: Aerial Plan of Main Yard Tank Farm

2.2 Small Yard Tank Farm

The Small Yard Tank Farm, otherwise known as the Lubes Tank Farm, consists of one combustible fuel tank and sixty-five non-combustible petroleum tanks. There are sixty-six total tanks in the containment area. There are sixteen tanks with a diameter larger than 22 feet, while the remainder of the tanks have a diameter of less than 19 feet. Most tanks in this tank farm have a high aspect ratio (height divided by diameter, H/D) of more than 1.0 and up to 3.0. Several pumps and other mechanical equipment are located within the tank farm. Pipes interconnect the tanks and lead out of the tank farm via pipe bridges over the containment walls. The containment consists primarily of reinforced concrete walls. The approximate gross area within the containment is 56,930 square feet. Containment volume of the Small Yard, per the SPCC is 673,649 gallons (16,039 bbl). See Figures 2-4 for an aerial view of the Small Yard Tank Farm.

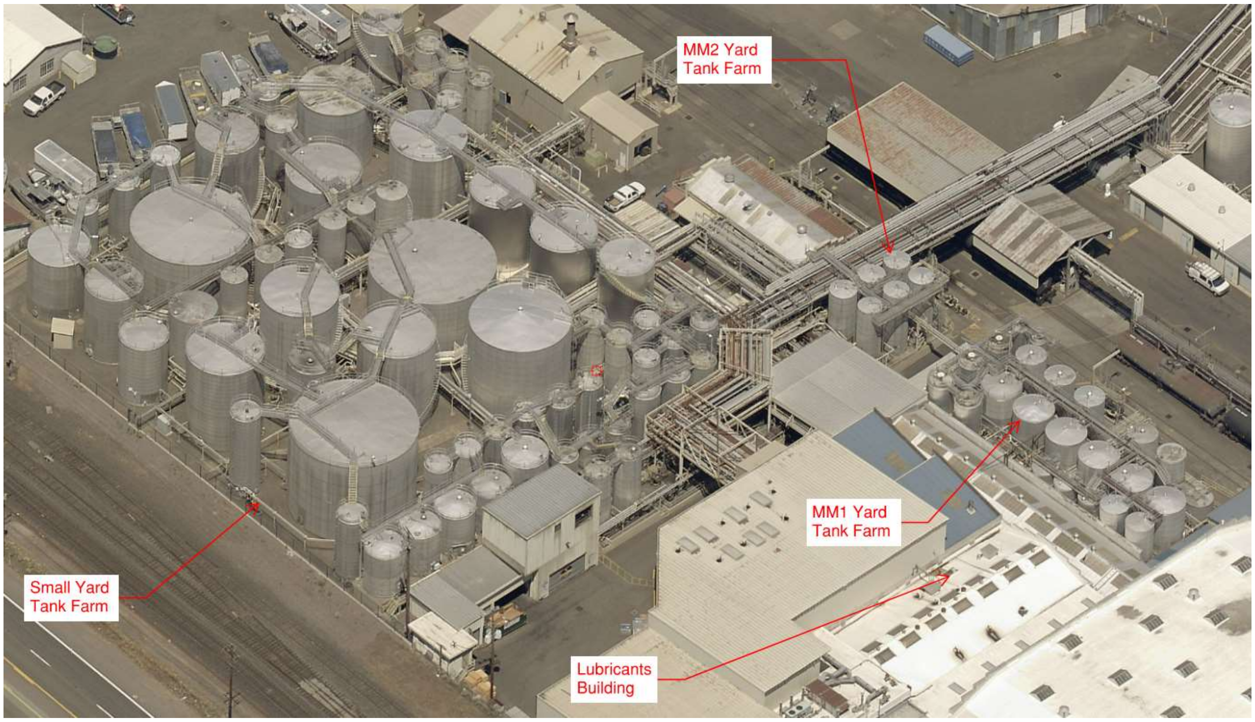


Figure 2-4: Aerial of Small Yard, MM1 and MM2 Tank Farm

2.3 MM1 Yard Tank Farm

The MM1 Yard Tank Farm has twenty-three non-combustible petroleum tanks within the containment area. There are ten tanks with a diameter larger than 12 feet, while the remainder of the tanks have a diameter of less than 11 feet. Several pumps and other mechanical equipment are located within the tank farm. Pipes interconnect the tanks and lead to out of the tank farm via pipe bridges. The containment consists primarily of reinforced concrete curbs and the backwall of the lubricants building. The approximate gross area within the containment is 6,639 square feet. Containment volume of MM1 Yard, per the SPCC, is 42,421 gallons (1010 bbls). See Figures 2-4 for an aerial view of the MM1 Yard Tank Farm.

2.4 MM2 Yard Tank Farm

The MM2 Yard Tank Farm, constructed circa 1946, has six non-combustible petroleum tanks within the containment area. All the tanks have a diameter of 10 feet with a height of 30 feet. Several pumps and other mechanical equipment are located within the tank farm. Pipes interconnect the tanks and lead out of the tank farm via pipe bridges. The containment consists of short masonry walls. The approximate gross area within the containment is 2,107 square feet. Containment volume of MM2 Yard, per the SPCC, is 23,311 gallons (555 bbl). See Figures 2-4 for an aerial view of the MM2 Yard Tank Farm.

2.5 Butane Storage, Offload Area, and Dock

The dock was constructed circa 1928 and extends 780 feet into the Willamette River. The original dock consisted of timber piles, beams, and decking. Improvements were constructed in 1972 and 1995 and included the construction of reinforced concrete berthing platforms with steel plumb and batter piles. Piping runs underneath the timber decking towards shore to the Offload Area.

The Offload Area is located north of the Main Yard Tank Farm. One tank, several pumps, and other equipment are located within the containment area. The containment consists of a 3-ft tall reinforced concrete wall. The approximate gross area within the containment is 15,500 square feet.

The Butane Storage is located southeast of the Offload Area. The Butane Storage is an approximately 138-ft long horizontal tank supported on reinforced concrete piers and constructed circa 2015. Piping from the tank runs to the south to a Butane Truck Offloading structure.

See Figures 2-5 for an aerial view of the dock, Offload Area and Butane Storage.

Figure 2-5: Aerial of Offload Area, Butane Storage and Dock

2.6 Loading Racks

The Chevron Willbridge Terminal has seven loading racks. TTLR-1, TTLR-2, and TTLR-3 are located off N.W. Doane Avenue, south of the Main Yard Tank Farm. They are used for loading product onto trucks. TCLR No. 1 through TCLR No. 3 are located between the Main Yard Tank Farm and MM1 Yard Tank Farm and are used to load product onto railcars. Lastly, the Tank Truck Loading Rack is adjacent to the southwest end of the Lubricants Building. The loading racks consist of steel framed construction with corrugated metal deck rooting. See Figures 2-6 for an aerial view of the Loading Racks.

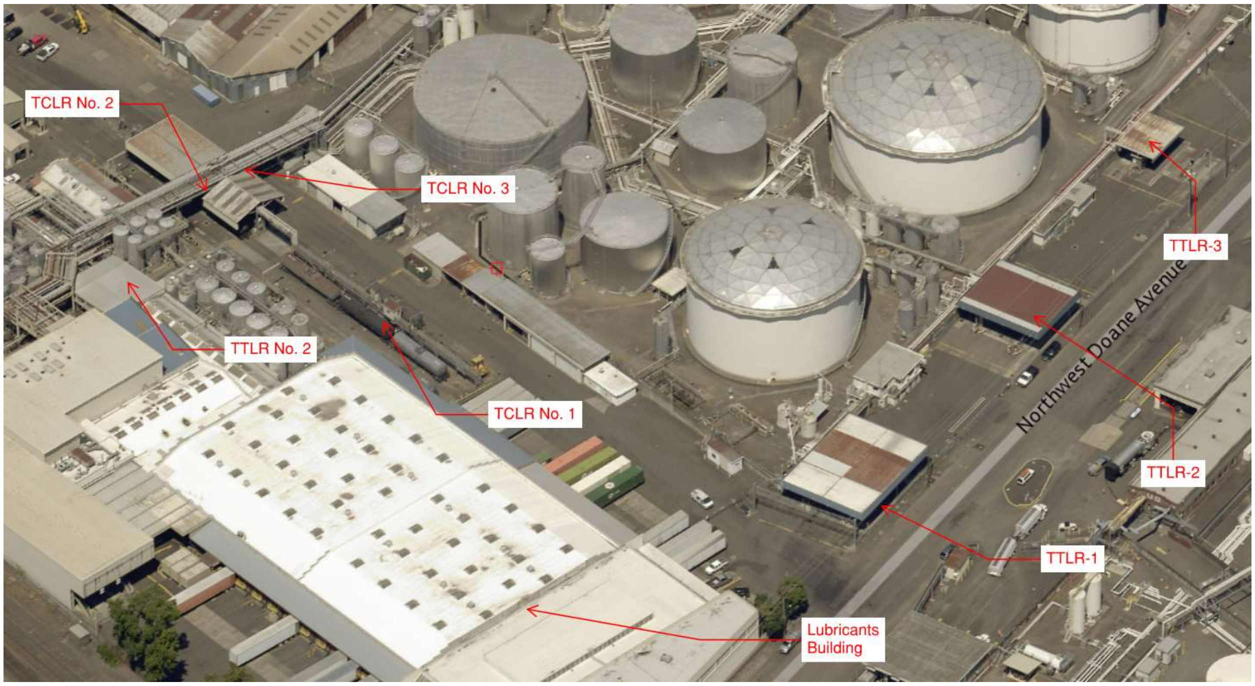


Figure 2-6: Aerial of Truck Loading Racks

2.7 Buildings

The Lubricants building is located off N.W. Doane Avenue, south of the Main Yard Tank Farm. The office portion is a two-story building constructed circa 1952 with reinforced concrete slabs, beams, and columns. The roof consists of a combination of steel bracing and wood diaphragms. The lubricants warehouse is located northwest of the lubricants office portion. The warehouse building lateral system consists of concrete or masonry shear walls with timber roof framing and sheathing. The warehouse stores pallets of packaged oils stacked on storage racks, ranging in size from cases of quart bottles to 55 gallon drums. There are several anchored tanks located within the warehouse, classified as the Blending and Slurry area. The foundation system is unknown.

The Maintenance building is a single-story pre-engineered building with steel framing and corrugated roof metal deck. The Maintenance building does not contain or store fuels. Several smaller building are located in the terminal; although none of them contain or store fuels, they are listed in the risk assessment (Section 6).

See Figures 2-7 for an aerial view of the Lubricants and Maintenance Building.

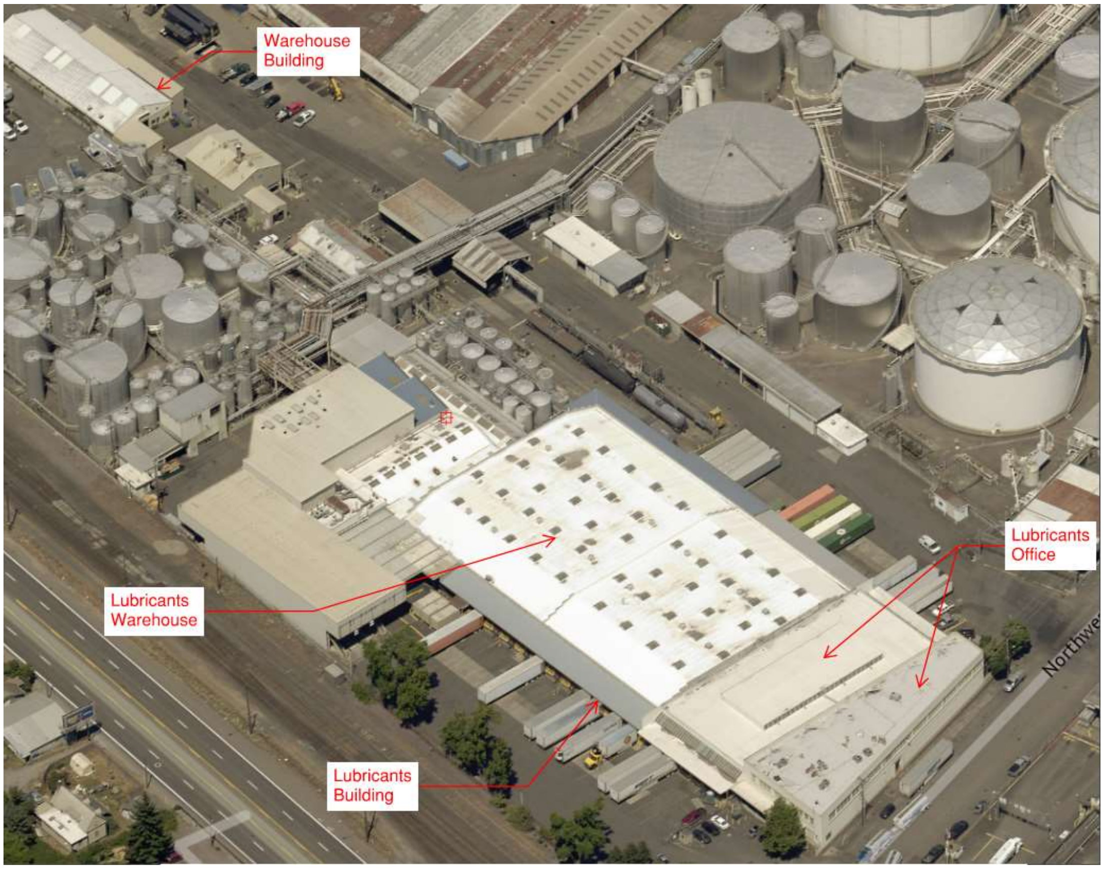


Figure 2-7: Aerial view of Lubricants and Maintenance Building

A plot plan and inventory are provided in Appendix A.

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 east of the foothills of the Tualatin Mountains along the shoreline of the Willamette River as shown in Figure 2-1. The site is relatively flat at roughly elevation 40 feet (NAVD88). Bathymetric survey data collected by the United States Army Corps of Engineers indicate the waterfront slope is roughly 70 feet high.

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. Review of existing geotechnical information included borings from reports dated between 1973 and 2008. Additionally, there is a report which summarizes a geotechnical investigation including two Cone Penetration Tests completed at the site in April 2015.

The previous borings by others indicate subsurface conditions which generally consist of fill, alluvial deposits, and bedrock, consistent with published geologic maps. The fill primarily consists of very loose to medium dense sands with varying amounts of silt and gravel. Alluvial deposits underlying the fill are comprised of fine-grained and sandy soils. Basalt bedrock was encountered at depths ranging from about 40 feet to 45 feet below the ground surface.

The logs indicate subsurface soils in the area of the dock are comprised of fine-grained and sandy alluvial deposits (very soft to stiff silts and loose to medium dense sands) underlain by bedrock. The depth to bedrock encountered in these borings was relatively thin offshore (as little as about 10 feet thick) and increased with distance from the shoreline, with top of rock elevations ranging from about Elevation -48 to -74 feet (NAVD88).

Shallow groundwater was generally encountered in the onshore borings at depths ranging from about 2 to 17 feet. 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 depicted as geographic contours in Figure 3-1. These estimates consider the proximity of the site to the free face slope of the waterfront along the Willamette River and a slope height of 70 feet. As shown in Figure 3-1, the estimated lateral spread deformations range from about 3 feet on the east side of NW Front Avenue (in the area of the dock, T-108 yard, and butane storage and offload area) to about 1 to 2 ½ feet on the west side of NW Front Avenue (in the area of the Main Yard, MM1 Yard, MM2 Yard, and Small Yard). 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.

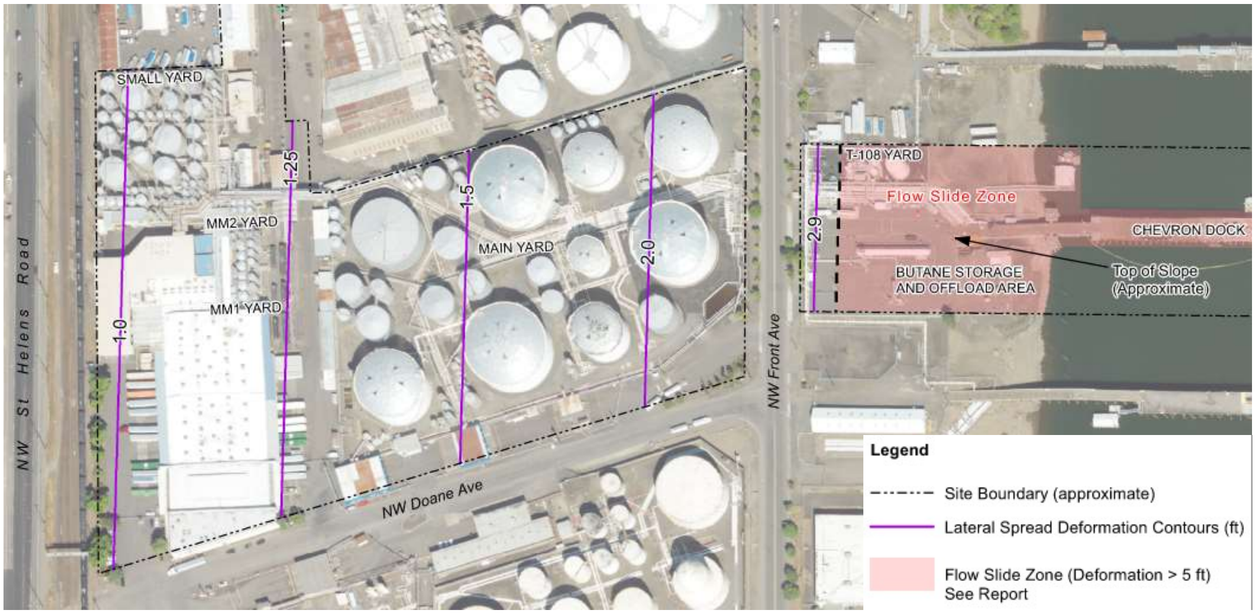


Figure 3-1: Estimated Lateral Spread Deformations

The primary mechanisms of liquefaction-induced settlement are reconsolidation (estimated as 2 to 6 inches), localized ejecta-induced settlements (up to 12 inches), and shear-induced foundation settlement (not estimated). Combined with the vertical component of lateral spreading, the total estimated settlement, with free-field conditions, ranges from 6 to over 30 inches.

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.

For tanks, we also discussed with Chevron to identify likely fill heights of tanks based on actual operating procedures, recognizing that tanks are regularly filled and emptied over days, weeks, or months. Based on these discussions, and review of available fill volume records, wea concluded that a reasonably conservative assumption is that all tanks are half full for the risk evaluation. .

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.

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.

We first determined a likelihood of spill due to earthquake-induced structural damage, without any consideration of the geotechnical ground displacements associated with liquefaction and lateral spreading. We then adjusted likelihood scores for individual elements, considering the estimated ground displacements within the geographic area where the equipment is located and the specifics of that structure (such as aspect ratio and foundation type). For example, significant ground displacement will increase the likelihood for overturning on unanchored tanks with a high aspect ratio, so we increased the Likelihood category accordingly.

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

Terminal tanks are constructed of carbon steel in accordance with API or Underwriter Laboratories specifications.

Terminal Aboveground Storage Tank (AST) inspection and testing is carried out in accordance with American Petroleum Institute (API) Standard 653 as well as the Steel Tank Institute (STI) Standard SP001 for horizontal, vertical and portable ASTs as applicable. This maintenance includes non-destructive test and inspection methods for all tanks shell plates, roof plates and tank nozzles in accordance with industry standards and applies to all aboveground bulk storage tanks holding hydrocarbons greater than 55 gallons.

Tank inspections at the Chevron Terminal include daily monthly, semi-annual and annual inspections to detect evidence of deterioration. The Lubricants Plant also records daily and monthly SPCC Walkthrough inspections.

In addition, the terminal carries out special inspections for all above-ground tanks greater than 15 feet in diameter, described in the Terminal Engineering Standard Inspecting Large Aboveground Storage Tanks (ILAST) in accordance with API 653.

Finally, hydrostatic testing is regularly conducted on terminal tanks, following tank inspection and repair in accordance with API 653.

Terminal tanks are equipped with Liquid Level Tank Gauging Systems and level alarms which are tested on a regular basis according to Standard Operating Procedures (SOPs) and site-specific procedures, including:

- SOP 102 Terminal Tank Alarm Testing
- SOP T01 Gauging Bulk Storage Tanks
- SOP T01A Manual Gauging of Horizontal Storage Tanks, Tank Trucks and Rail Cars
- SOP 10.10.4.3 Field Verification or Calibration of Measurement Instruments

High level alarm equipment for Tanks is installed in accordance with Terminal Engineering Standard Tank Gauging and Alarm Equipment Standard and I-WS570 Spill Prevention Control and Countermeasure.

Drums, totes and other containers containing oil are inspected on a regular basis to detect evidence of deterioration and to implement corrective measures in accordance with terminal SOP I01 Terminal Yard inspections.

A record of all inspections and testing maintenance reports are maintained in accordance with internal company standards and industry standards.

Maintenance of Terminal Piping

The terminal inspects and tests piping in accordance with the T&O Engineering Pipeline Integrity Management (PIM). This standard is in accordance with API 570, and provides guidelines for inspection and testing intervals and methods, documentation of findings and corrective actions for terminal piping.

Most of the piping at the terminal is aboveground, with no new underground piping installed or replaced at the facility since August 2002. Underground piping requiring maintenance is often replace with aboveground piping.

Above ground piping, valves and appurtenances are inspected on a regular basis and in accordance with SOP I01 Terminal Yard Inspections and SOP I18 Pressure Testing Pipelines. In addition, marine pipelines are hydrotested regularly in accordance with United States Coast Guard (USCG) requirements. All underground piping is pressure tested when installed, modified, relocated or replaced.

Terminal and Lubricant Plant piping is inspected daily, including valves and appurtenances. Special attention is placed on flange joints, expansion joints, valves, supports and the locking of valves. In addition, all Terminal and Lubricants Plant piping is under an umbrella program of API 570 inspections carried out by certified API 570 inspectors.

Secondary Spill Containment Systems and Response Procedures

There are five containment areas for aboveground storage tanks in the Chevron terminal, including the Light Products Main Tank Yards, the Small Tank Yard, MM1, MM2, and the MTD Yard. The Small Tank Yard, MM1 and MM2 are equipped with drains that flow to the Oil Water Separator (OWS) located in the Main Tank Yard. Oil from the OWS drains to Slop Oil Tank 89 while treated water is discharged, under permit, to the City of Portland Water Sewage system.

In addition, undiked areas in the facility that contain oil containers or storage have been designed to retain oil releases and to drain to the OWS in the Main Tank Yard.

The OWS is located within the Main Tank Yard and is equipped with automatic shutoff valves to prevent discharge to the City of Portland Water Sewage System during an upset condition. The OWS is equipped with backup air supply and protected by a power generator so that the automatic shutoff valves continue to operate even during loss of municipal power.

The Main Tank Yard drains rainwater through a storm water outfall (Discharge Point 001) that is normally closed and locked, providing emergency secondary containment and securing spills during upset conditions. Impounded rainwater is inspected before discharging, under permit, via Discharge Pont 001 to the City of Portland Water Sewage System.

Similarly, the Lubricant Warehouse Loading Docks drain through two storm water outfalls (Discharge Point 002 and 003) that are normally closed and locked, providing emergency secondary containment and securing spills during upset conditions. The butane storage area drains through Discharge Point 004, which is normally open but can be closed during an incident. Impounded rainwater is inspected prior to discharge.

According to the SPCC, secondary containment at the Main Tank Yard is sized to accommodate the worst-case discharge (failure of the largest tank in the yard) plus a 25-year, 24-hour storm event.

Secondary containment for the Small Tank Yard (STY) can accommodate the worst-case discharge of the largest tank inside the yard with an additional 10% of the largest tank's volume.

Secondary containment for the MM1, MM2 and MTD tank yards can accommodate the worst-case discharge of the largest tank inside the yard simultaneously with a 25-year, 24 hour storm.

Lubricants Warehouse, Blending Area and the Marine Transfer Pipeline Area have secondary containment sized to contain the estimated most likely discharge.

In addition, the terminal has several areas protected by impermeable barriers or drains that lead to the Oil Water Separator, which is sized to contain the most likely discharge from all of the following locations:

- Incoming Pipeline Receipts
- Product Piping Pad
- Vapor Recovery Unit (VRU)
- Absorber and Marine Vapor Recovery Unit (MVRU)
- Terminal Truck Loading Racks
- Railcar Loading Racks
- Biodiesel and Fuel Truck Offloading Area
- Totes Located throughout the Main Tank Yard, Lubricants Plant Alley and TCLR containment area.
- Lubricants Plat Warehouse

Analysis of the soils at the terminal, documented in the SPCC, indicate that the ground is sufficiently impervious to provide adequate secondary containment.

Finally, according to the SPCC, the terminal provides secondary containment for all portable containers, drums, totes, etc. Secondary containment is designed to capture the full contents of the container. This secondary containment includes all oil-filled equipment, including transformers. Equipment owned by a third party is inspected regularly for signs of leaks, corrosion, discoloration, etc. Any maintenance issues found with third party equipment is reported to the owners for mitigation.

Spill Response Procedures

All personnel involved in the handling of oil are trained in general operations and in the proper operation and maintenance of facility equipment to prevent discharges, following standard operating procedures. This training includes an Annual SPCC Plan and Discharge Prevention Briefing, which includes a review of the applicable pollution control laws, rules and regulations as well as the site-specific SPCC Plan

Product transfers do not occur unless they are monitored at all times by a Person-In-Charge (PIC). Any spills detected by the PIC results in the immediate shutdown of the product transfer and the initiation of emergency response procedures.

Visible oil leaks detected during daily inspections or during other operator duties are reported to Operations Management and mitigated as soon as possible. Terminal and Lubricants Plant Tank Yard inspections are conducted in accordance with SOP I01 Terminal Yard Inspections and IWS-570 Spill Prevention Control and Countermeasure.

According to the Facility Response Plan (FRP) Spill / Release Response Action Checklist, the first person to discover a spill:

- Immediately notifies Supervisory Personnel.
- Takes appropriate action to protect life and ensure safety of personnel.
- Contact the appropriate local emergency responders.
- Shut down terminal operations (if applicable).
- Close any remotely controlled valves as soon as leak is detected.
- Secure scene, isolate the area an ensure the safety of people and the environment.

Procedures for Supervisory Personnel include:

- Assume role of Incident Commander
- Conduct assessment of health and safety hazards
- Evacuate non-essential personnel.
- Notify emergency response agencies to provide security and evacuate surround area if needed.
- Call spill response contractors.
- If safe to do so, direct facility responders to shut down potential ignition sources in the vicinity of the spill (motors, pumps, electrical power, etc.)
- Keep drivers away from truck rack if spill occurs in that area.
- If safe to do so, direct facility responders to shut down and control the source of the spill.
- If safe to do so, direct facility responders to stabilize and contain the situation, which may include berming or deployment of containment and/or sorbent boom.
- For low-flash oil (< 100F) consider applying foam over the oil, using water to spray to reduce vapors, grounding all equipment handling the oil and using non-sparking tools.
- Consider lining shoreline with sorbent or diversion boom if there is a potential to impact shorelines.
- Notify local emergency responders, and other appropriate notifications (National Response Center, External Regulatory notifications, etc.)

Summary of Current Spill Prevention and Mitigation Measures

Tank are inspected and tested in accordance with industry standards, such as API 653 and STI SP001. In addition, the terminal provides secondary containment for all oil stored on site.

The truck loading rack is equipped with remotely activated ESD valves that can be used to isolate transfers. Similarly, all tanks have block valves that can be 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 following an earthquake from shaking or differential displacements. Similarly, piping is susceptible to damage from differential displacements of supports and anchor points.

If tanks or piping are damaged in an earthquake, the concrete containment walls that form part of the secondary containment are critical in controlling the spill and its associated environmental and safety hazards. These walls are also susceptible to damage during an earthquake. 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.

5.2 Fire Control and Suppression Systems

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

Inside the Main Tank Farm area, tanks 45, 61, 163 and 164 are protected by a foam system which is charged by municipal water. Tanker Truck Loading Racks (TTLR) 1 through 4, the Butane Storage Vessel, Pump Station and the terminal warehouse have a deluge fire protection system. Finally, the Chevron dock is protected by a series of hydrants and fire monitors, all served by a municipal water connection.

All fire and foam suppression system rely on municipal water to function.

In the event of a fire, terminal personnel are trained to fight incipient state fires only, and to initiate fire suppression systems while first responders arrive. Specific steps to take outlined in the Facility Response Plan include:

- Evaluate the Situation
- Approach from upwind.
- Notify local police and fire departments.

- Appropriately trained personnel may attempt to extinguish incipient stage fires if it can be done safely.
- If fire / explosion is a result of a pipe rupture, isolate product release by closing valves.
- Undertake basic site control:
    - Make assessment of hazards
    - Isolate the area
    - Keep people away from the scene and outside the safety perimeter.
    - Establish safety zones and escape routes.
- Respond to the fire:
    - Establish a Command Post and lines of communication.
    - Maintain site control.
    - Establish Incident Command / Unified Command as necessary.'
- Call in additional resources if on scene personnel and equipment are inadequate to handle the emergency.

Terminal containment walls can function as firewalls to limit spread of fire from one area to another and into surrounding areas.

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 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).

Automated Sprinkler Systems

The Butane storage area, Bulk Oil Truck Loading Rack and Office area are protected by an automatic fire sprinkler system. In addition, Tank Farms and Pump Row systems are protected by a manual foam system.

The dock area is protected by manually operated fire monitors.

Firefighting Foam

The foam system type and quantity was reviewed and approved by the Authority Having Jurisdiction as part of a recent project.

Spill Response Kits

The terminal is equipped with spill response kits strategically located throughout the terminal including at the Warehouse, Maintenance Building, Truck Loading Rack, Main Yard, Boat House, the landside of the Dock, and the end of the Dock. The Spill Response Kit includes boom, absorbent pads, granular absorbents, skimmers, pumps, hoses, tools, and personal protective equipment.

Power and Communications

The terminal is equipped with six diesel emergency generators, including two portable generators and two portable compressors. The emergency generators can power critical functions, to manage water and flooding even during a total loss of municipal power.

The generators provide emergency backup power for radios and lighting, as well as for the compressor that powers critical functions at the terminal, including systems that manage water and flooding.

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.

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.

Transfer pumps can be remotely shut down from the control room. Isolating damaged sections of piping or tanks requires shutting manual valves, with the exception of the truck loading rack, which can be isolated remotely by way of motorized ESD valves.

Spills will be 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 are susceptible to damage during an earthquake and might not provide adequate protection following an earthquake and subsequent spill from a tank.

5.5 Terminal Staffing, Monitoring, and Response

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

The terminal is staffed by at least two personnel at all times. The personnel are trained to initiate spill control measures if a leak is detected.

5.5.1 Seismic Vulnerabilities

None identified.

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.

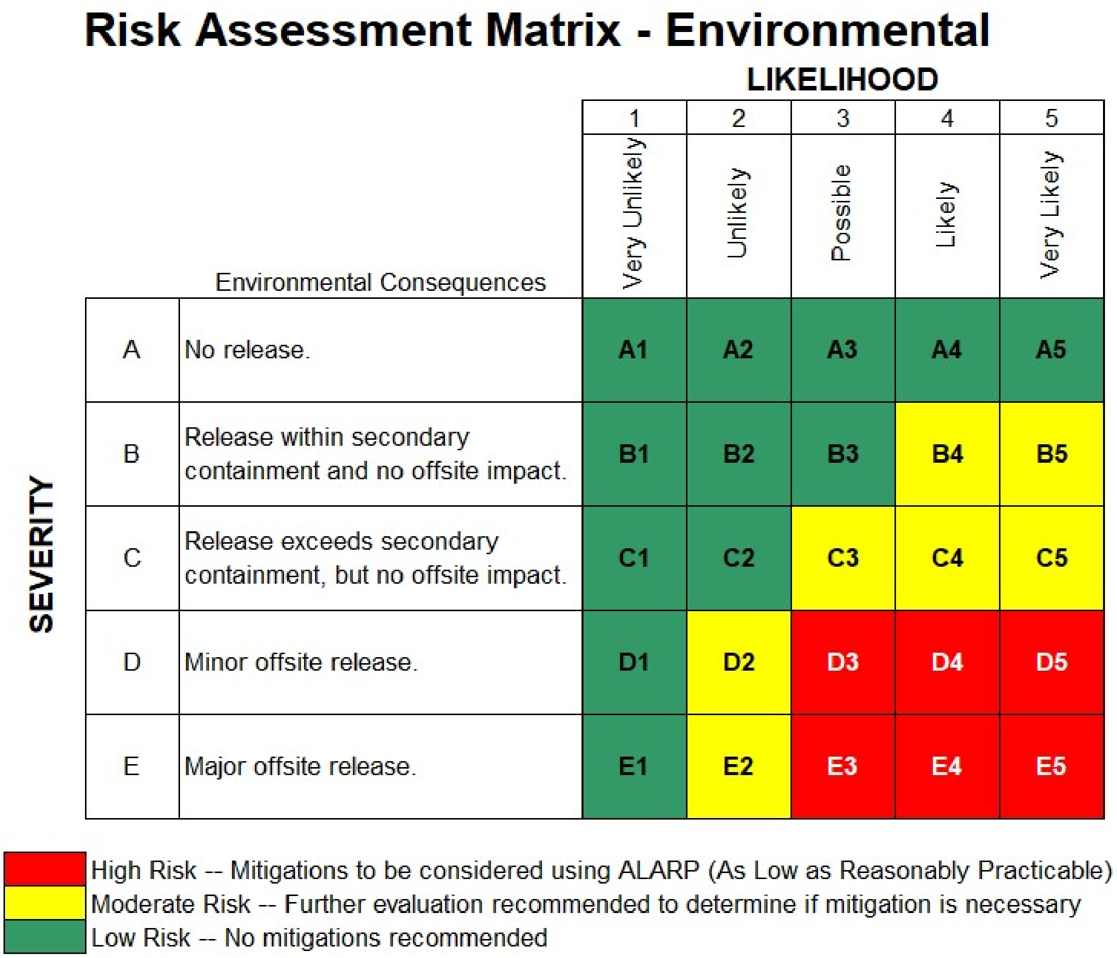
The Severity rating considered potential spill volumes, secondary containment mechanisms, operational or other safeguards that are in place, type of contents (i.e. flammability or combustibility of contents), and criticality of the component in emergency response. The potential impact on public health and safety are also considered within the Life Safety severity, by considering whether the consequences would extend beyond property lines and into publicly accessible areas. 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 also assigned two sets of scores, representing vulnerability with and without the considerations of geotechnical soil displacements. This is to inform the terminal of relative risks associated with the global liquefaction and lateral spreading hazard versus those associated with ground shaking.

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

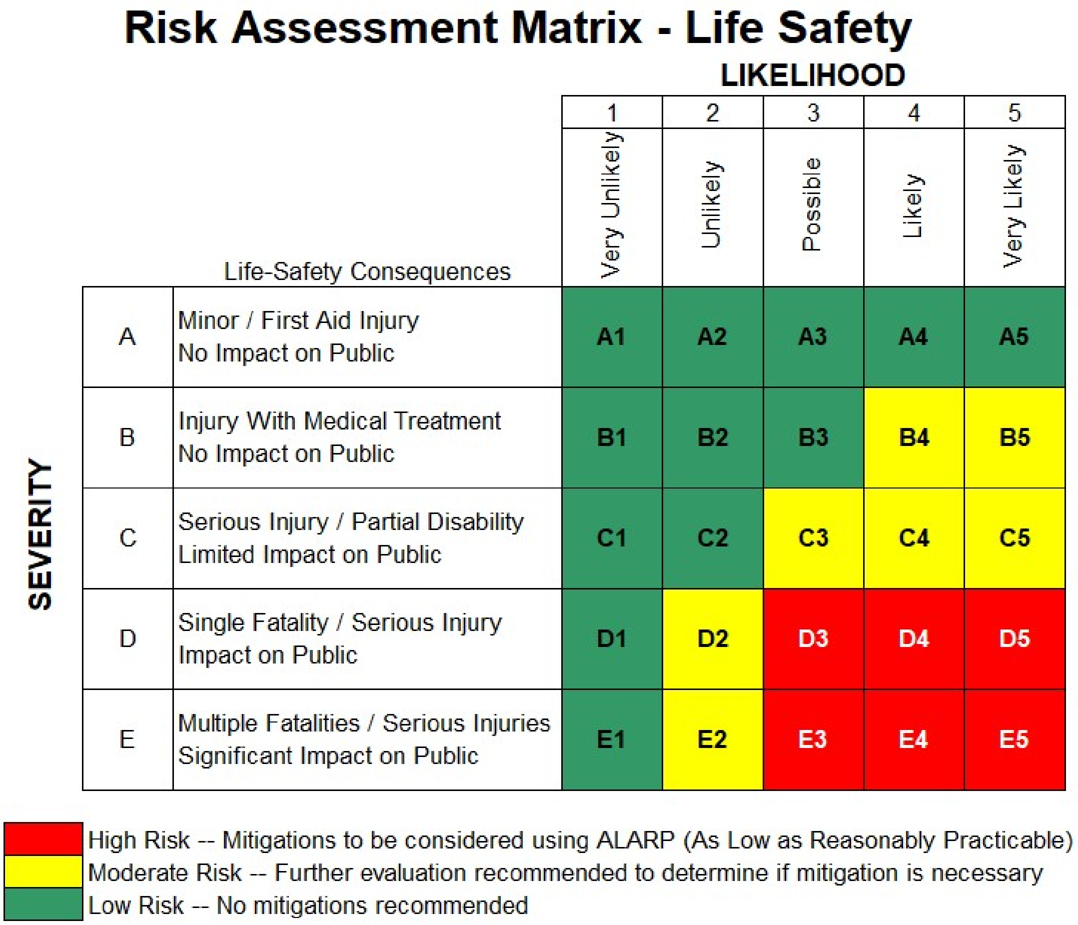


Risk Assessment Matrix - Environmental

			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. Although the Likelihood of a spill may increase as a result of ground deformations, severity of consequences are typically the same. Thus, the risk categorization (or color) does not necessarily change due to the addition of ground deformations. Where the with- and without- ground deformation score results in a difference in categorization, the without ground deformation categorization is also indicated.

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

Main Yard Tank Farm	Small (Lube) Tank Farm	MM1 & MM2 Yards	Blending & Slurry Areas	Butane Storage, Offloading, & Dock	Safety Systems & Buildings
Containment Walls	Containment Walls	Containment Walls	(none)	Containment Walls (T-108 Yard)	Water Main
				Piping in Trench under Roadway	Foam System
				Chevron Dock	Fire Pump
				Dock Piping	Deluge System

Table 7-2 - Summary of Moderate Risk Items

Main Yard Tank Farm	Small (Lube) Tank Farm	MM1 & MM2 Yards	Blending & Slurry Areas	Butane Storage, Offloading, & Dock	Safety Systems & Buildings
Piping[1]	Piping[1]	Piping[1]	Secondary Containment	Piping[1]	(none)
Oil Water Separator[2]	Tank 29	Tank 33		Trench under Roadway[2]	
Tank 1	Tank 30	Tank 34		Tank 108[2]	
Tank 3	Tank 37	Tank 35		Green plastic tanks[2]	
Tank 45	Tank 38	Tank 36		Additive Totes[2]	
Tank 48	Tank 39	Tank 79		Butane Tank[2]	
Tank 51	Tank 40	Tank 91		Truck Offloading Structure[2]	
Tank 60	Tank 41	Tank 113		Fire Control Room[2]	
Tank 62	Tank 46	Tank 131		Dock Office[2]	
Tank 100	Tank 56	Tank 132		Floating Dock/Boom	
Tank 101	Tank 65				
Tank 109	Tank 72				
Tank 128	Tank 80				
Tank 144	Tank 81				
Tank 145	Tank 83				
Tank 150	Tank 84				
Tank 163	Tank 85				
Tank 164	Tank 87				
	Tank 89				

Main Yard Tank Farm	Small (Lube) Tank Farm	MM1 & MM2 Yards	Blending & Slurry Areas	Butane Storage, Offloading, & Dock	Safety Systems & Buildings
	Tank 92				
	Tank 104				
	Tank 105				
	Tank 106				
	Tank 110				
	Tank 112				
	Tank 114				
	Tank 116				
	Tank 117				
	Tank 118				
	Tank 138				
	Tank 139				
	Tank 147				
	Tank 148				
	Tank 149				
	Tank 151				
	Tank 152				
	Tank 160				

1. All piping (except at the dock) is Moderate with ground deformations due to Likelihood. Non-flammable product piping is Low Risk without ground displacements. Piping for flammable fuels are Moderate Risk with- or without- ground deformation due to Life Safety Severity.

2. These items are Low Risk without consideration of ground deformation and elevated to Moderate with ground deformation due to increased Likelihood of damage.

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 lateral ground deformations varies from about 1 ft near the warehouse and lube yard, to over 5 ft at the waterfront. Corresponding vertical displacements vary from 6 in. to over 30 in. at the site, with the potential for higher localized settlements.

Our structural and safety assessments considered these potential displacements.

7.2 Structural

Many of the tanks in the Main Yard have a Moderate Risk due to their flammable contents and a higher Life Safety severity. Other tanks in the Main Yard are Moderate Risk due to a higher Likelihood of damage driven by an over-constrained condition with stairs or piping, as shown in the example photos of Figure 7-1.

Moderate Risk tanks in the MM1 Yard, MM2 Yard, and Lube Yard are generally unanchored and have a high aspect ratio. Some tanks in the Lube Yard also have over-constrained piping.

Pipelines are rated Moderate throughout the Terminal due to differential displacements from ground deformation and the anticipated pipe stresses. At the dock, pipelines are rated High due to a higher consequence of damage and spill directly into the river. Additionally, the dock piping is likely to experience high stresses due to its supported condition on the wharf and the higher soil displacements estimated at the river front. Similarly piping in the trench under the roadway is rated High due to likelihood for high stresses due to differential soil displacements.

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

Figure 7-1: Example Over-Constrained Conditions

Left: Short pipe run to anchored pump at Tank 117

Right: Anchored stair handrail at Tank 100

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 for foam distribution. It is highly unlikely municipal water will be available following the DLE considered by the Rules.

Since the foam system, fire pump, and deluge systems are dependent on municipal water, which is unlikely to be available following the DLE, and the consequence of these systems being unavailable, these items are deemed a High 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. Chevron Willbridge SPCC, “Willbridge Spill Prevention, Control, and Countermeasure Plan,” Jensen Hughes, December 12, 2020.

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10. "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.

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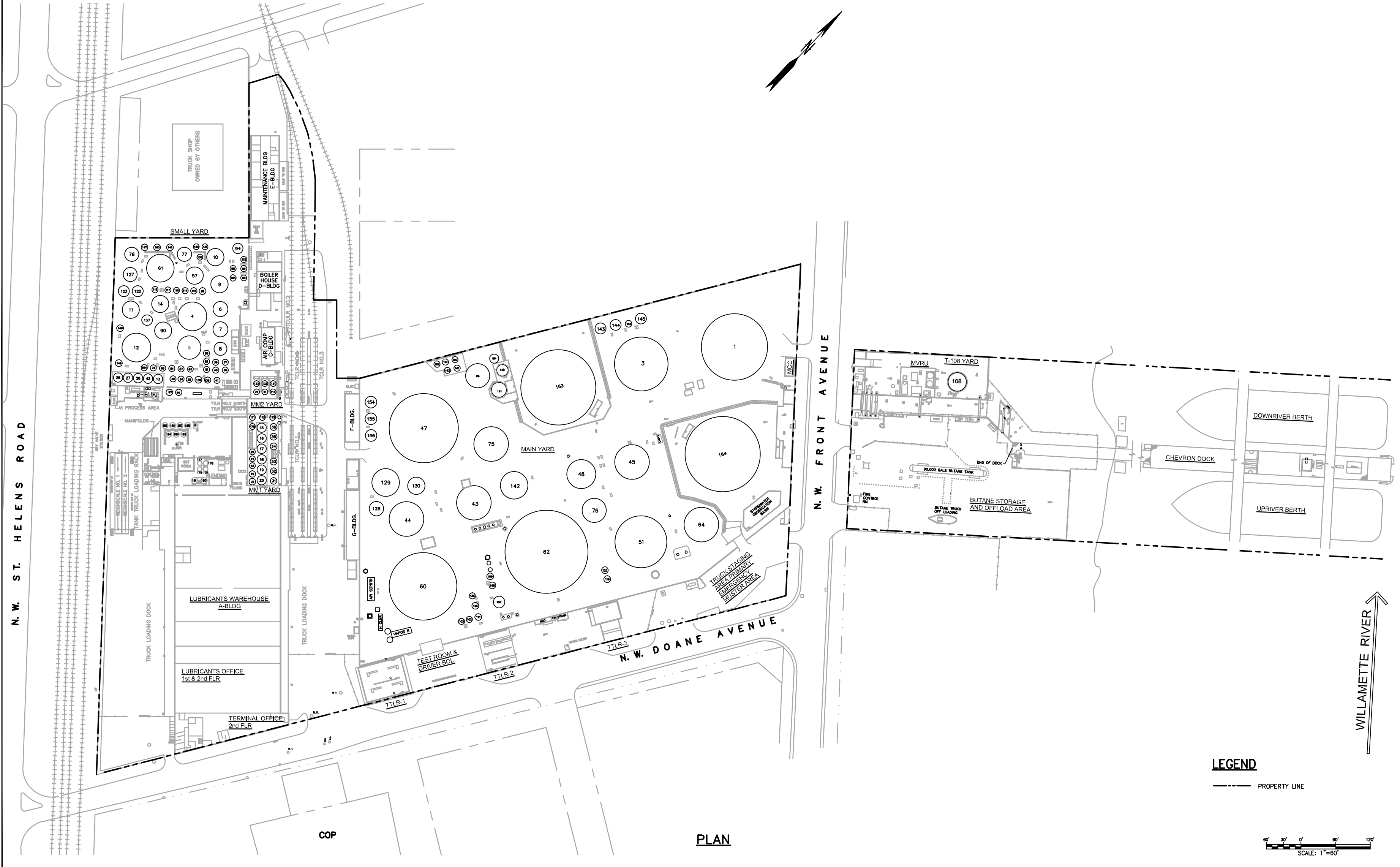
12. STI Standard SP001 “Standard for the Inspection of Aboveground Storage Tanks, Steel Tank Institute (STI),” 6th Edition, 2018.

13. 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, 200

Appendix A

Site Plan & Inventory



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ATGI PROJECT NUMBER 42-123

REFERENCE DRAWINGS

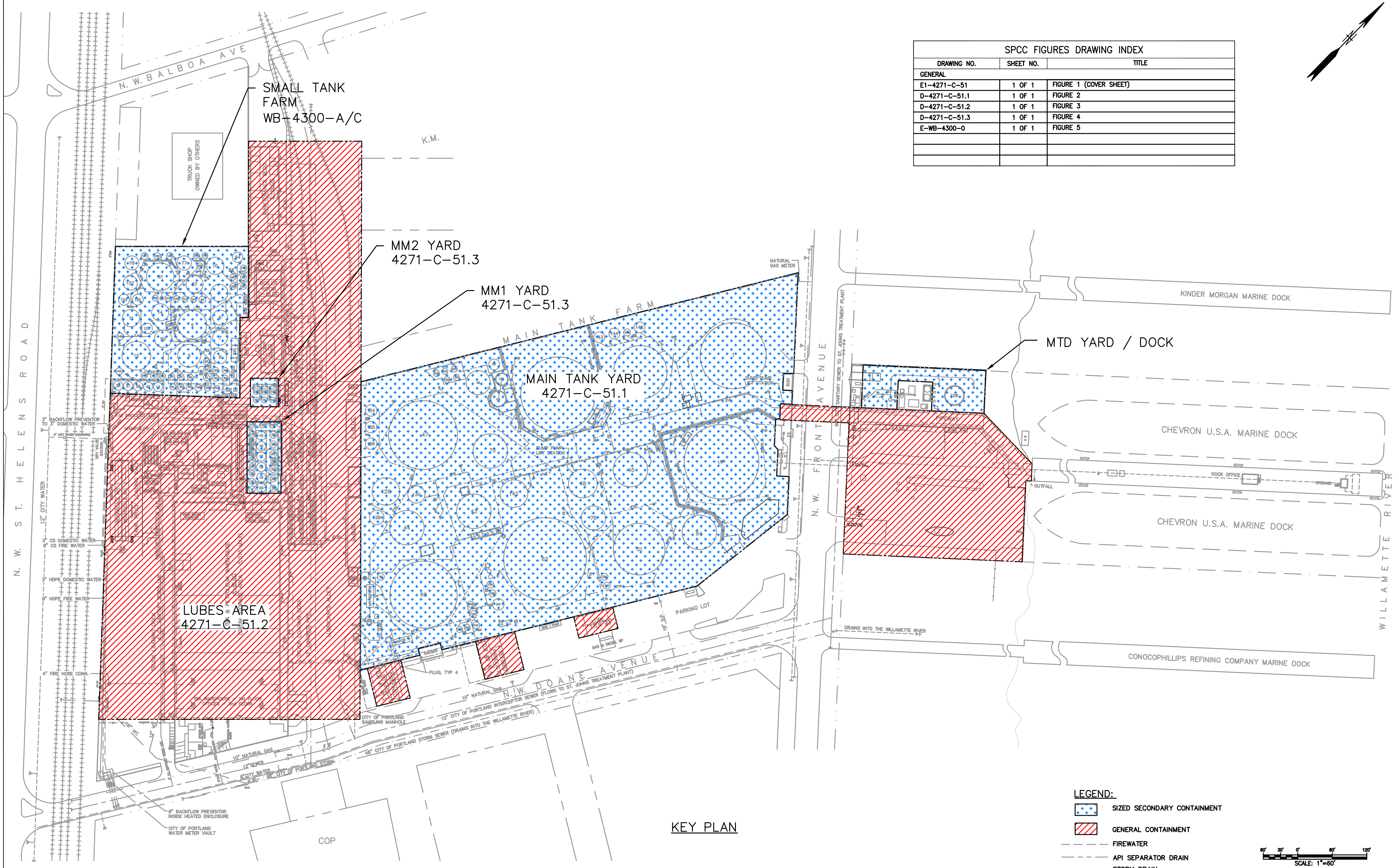
REVISIONS

			GENERAL REVISION	7	11/19/12	UPDATED SITE PLAN	3	01/03/10
			REVISED MTD TANK FARM	6	06/22/12	UPDATED SITE PLAN	2	03/02/02
GENERAL REVISION	9	02/28/19	UPDATED LOGO	5	03/17/11	REVISED TRUCK LOADING OFFICE DRAIN	1	04/26/00
FOR RECORD	8	11/20/12	UPDATED BORDER	4	12/07/10	FOR REFERENCE ONLY	0	12/16/99

Chevron U.S.A. Products Company
Willbridge Lubricants Plant

SCALE 1"=60'-0" DATE 10/04/99 APPROVED
DR. DABYNUM CH. DLB DR. APP. ENGR.
OPR'G. DEPT. ENG. DEPT.

WILLBRIDGE LUBRICANTS PLANT
TITLE PLOT PLAN
W.O.
S.O.
DWG NO. E1-WB-4300-0
REV. 9



KEY PLAN

SPCC FIGURES DRAWING INDEX		
DRAWING NO.	SHEET NO.	TITLE
GENERAL		
E1-4271-C-51	1 OF 1	FIGURE 1 (COVER SHEET)
D-4271-C-51.1	1 OF 1	FIGURE 2
D-4271-C-51.2	1 OF 1	FIGURE 3
D-4271-C-51.3	1 OF 1	FIGURE 4
E-WB-4300-0	1 OF 1	FIGURE 5

LEGEND:

▦	SIZED SECONDARY CONTAINMENT
▨	GENERAL CONTAINMENT
— — — —	FIREWATER
—— - - - ——	API SEPARATOR DRAIN
—— · —— · ——	STORM DRAIN
—— - ——	SANITARY SEWER
— — — —	POTABLE WATER
—— · · ——	NATURAL GAS

60' 30' 0' 60' 120'
SCALE: 1"=60'

ALPHA TECHNICAL GROUP INC.
2929 NW 29th AVE, PORTLAND, OR. 97210
Tel:(503)227-3317/Fax:(503)227-3244

ATGI PROJECT NUMBER: 42-82

REFERENCE DRAWINGS

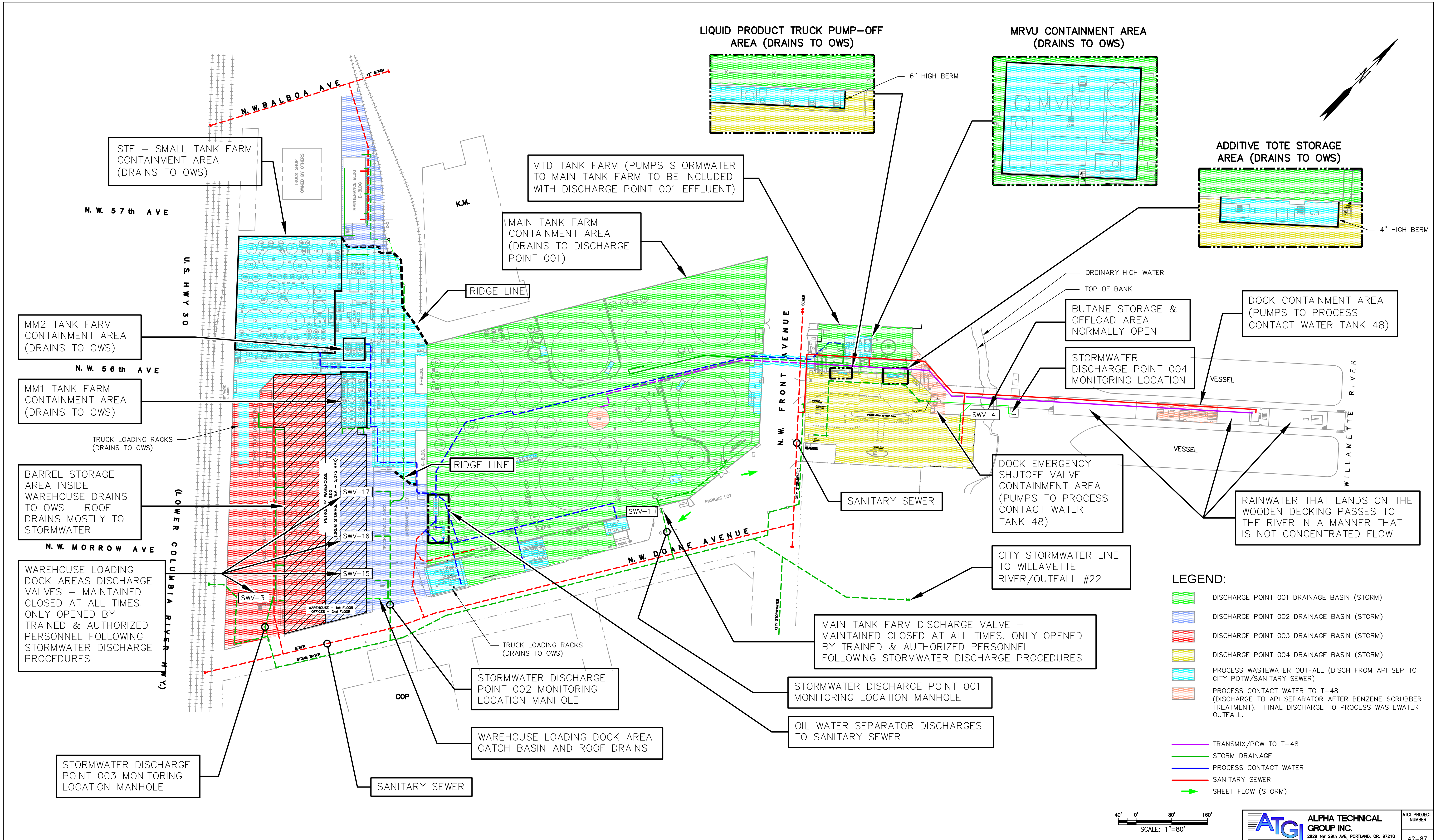
REVISIONS

FOR REVIEW & COMMENT	A	03/02/14	
GENERAL REVISIONS	B	11/08/19	

Chevron U.S.A. Products Company
Willbridge Lubricants Plant

WILLBRIDGE LUBRICANTS PLANT
TITLE SPCC PLAN – PLOT PLAN
FIGURE 1 (COVER SHEET)

SCALE 1"=60'-0" DATE 10/04/99 APPROVED
DR. DABYNUM CH. DLB DR. APP. ENGR.
OPR'G. DEPT. ENG. DEPT.
W.O.
S.O.
DWG NO. E1-4271-C-51
REV. B



ALPHA TECHNICAL GROUP INC.
2929 NW 29th AVE, PORTLAND, OR. 97210
Tel:(503)227–3317/Fax:(503)227–3244

ATGI PROJECT NUMBER 42–87

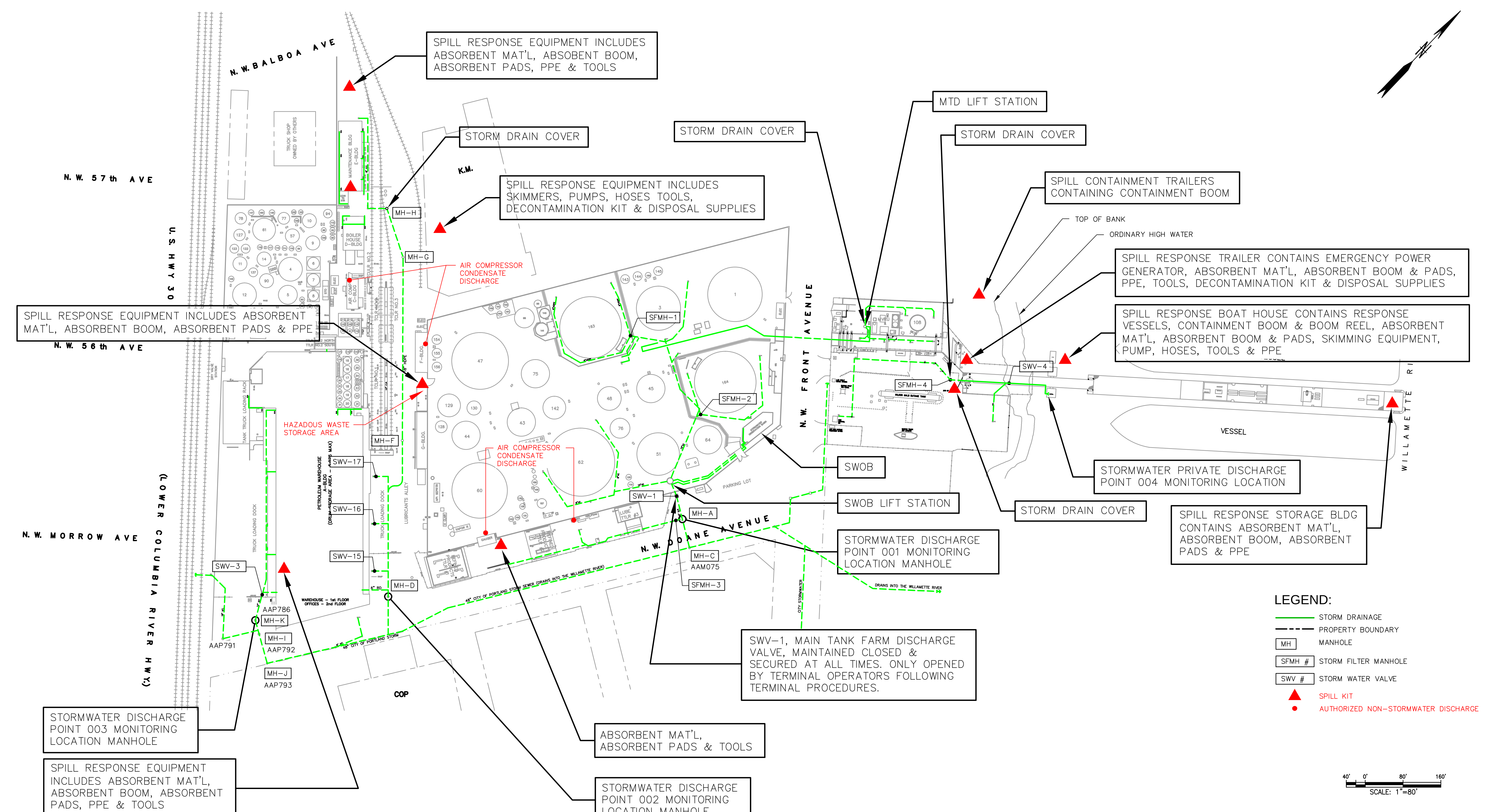
REFERENCE DRAWINGS

REVISIONS													
0	03/30/16	INITIAL ISSUE FOR PLAN UPDATE	HVT	JPD	JPD	4	10/03/18	GENERAL REVISION	HVT	JPD	JPD
1	04/22/16	GENERAL REVISION	HVT	JPD	JPD	5	02/20/19	GENERAL REVISION	HVT	JPD	JPD
2	07/10/17	GENERAL REVISION	HVT	JPD	JPD	6	05/08/20	GENERAL REVISION	HVT	JPD	JPD
3	12/27/17	GENERAL REVISION	HVT	JPD	JPD						

Chevron Products Company
Marketing Operations, San Ramon

DRAINAGE & CONTAINMENT PLANS
SITE PLAN
DRAINAGE BASIN AREAS
WILLBRIDGE OREGON

SCALE 1"=50'–0" DATE 10/04/99
DR. DAB CH. DLB DR. APP. JPD ENGR.
OPR'G DEPT. – ENG. DEPT. –
APPROVED – – –
Q
W.O. –
S.O. –
FIG 1–3 (WIL–C–007)
REV 6



ALPHA TECHNICAL GROUP INC.
2929 NW 29th AVE, PORTLAND, OR. 97210
Tel:(503)227-3317/Fax:(503)227-3244

ATGI PROJECT NUMBER 42-87

REFERENCE DRAWINGS

REVISIONS

0	03/30/16	INITIAL ISSUE FOR PLAN UPDATE	HVT	JPD	JPD	4	10/02/18	GENERAL REVISION	HVT	JPD	JPD
1	04/22/16	GENERAL REVISION	HVT	JPD	JPD	5	05/18/20	GENERAL REVISION	HVT	JPD	JPD
2	07/10/17	GENERAL REVISION	HVT	JPD	JPD						
3	12/19/17	GENERAL REVISION	HVT	JPD	JPD						

Chevron Products Company
Marketing Operations, San Ramon

SCALE 1"=50'-0" DATE 10/04/99
DR. DAB CH. DLB DR. APP. JPD ENGR.
OPR'G DEPT. – ENG. DEPT. –
APPROVED – – –

DRAINAGE & CONTAINMENT PLANS
SITE PLAN
STORMWATER DRAINAGE
WILLBRIDGE OREGON

Q
W.O. –
S.O. –

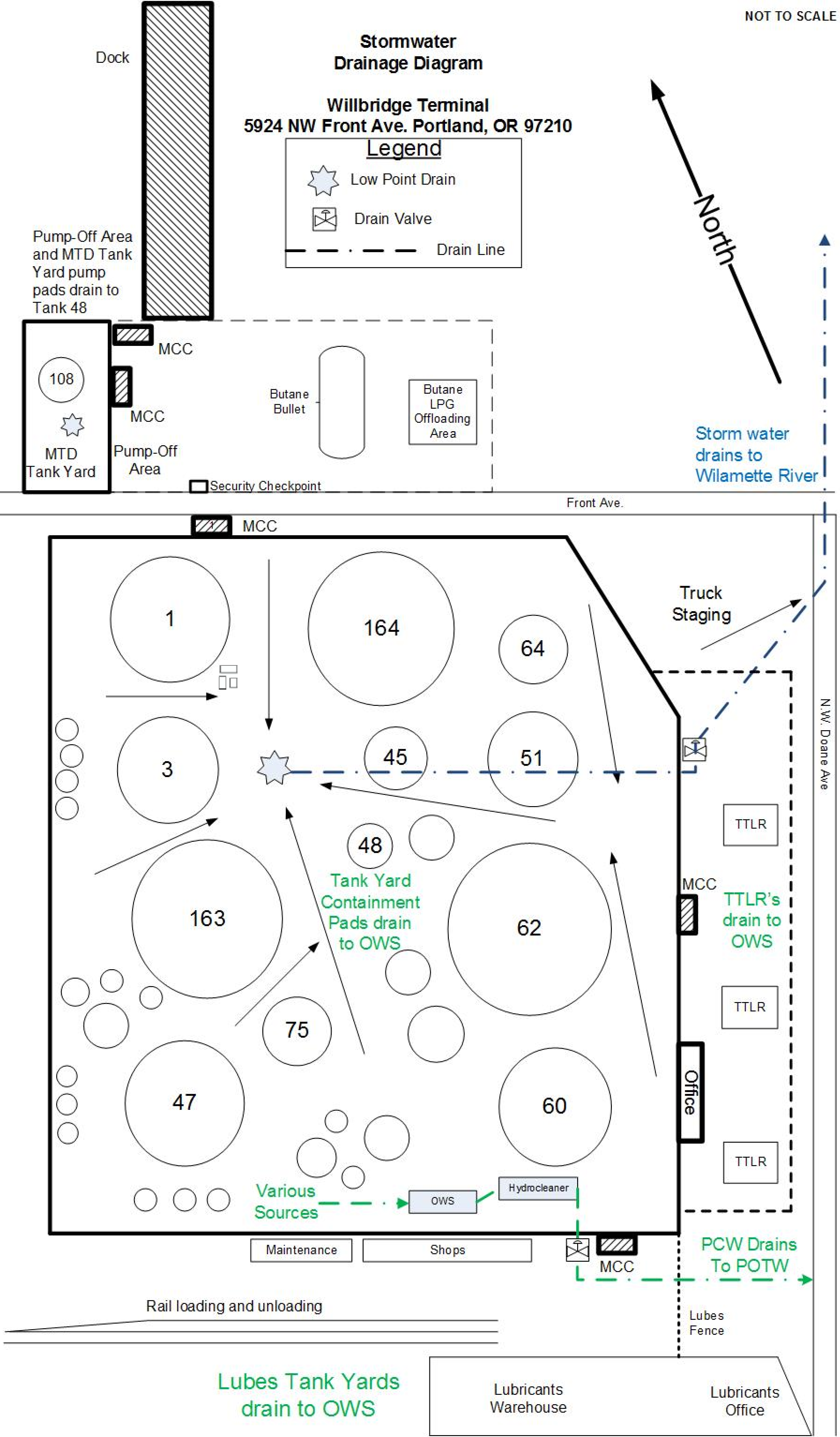
FIG 1-4 (WIL-C-008)

REV 5

NOT TO SCALE

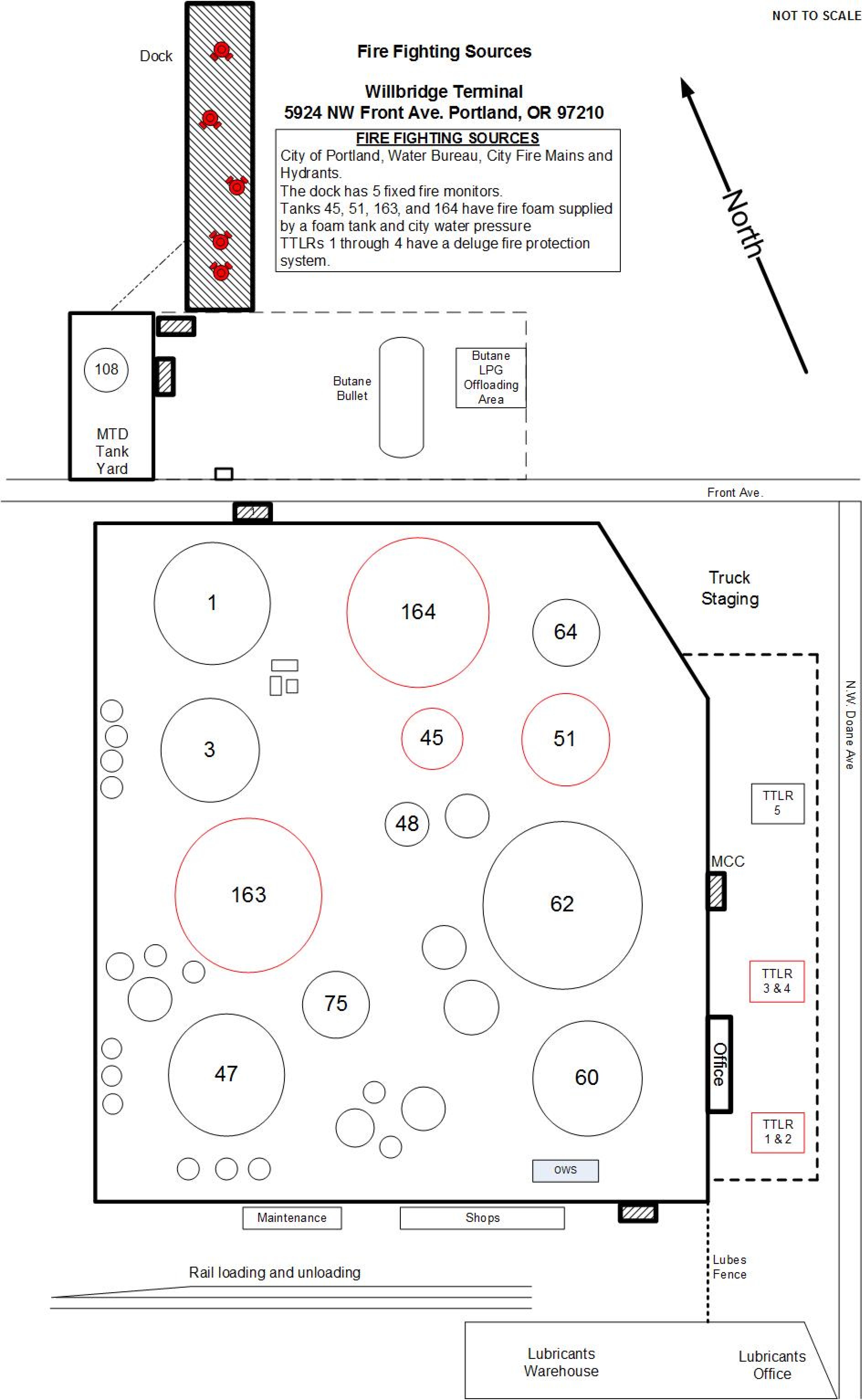
Stormwater Drainage Diagram

Willbridge Terminal
5924 NW Front Ave. Portland, OR 97210



Fire Fighting Sources

Willbridge Terminal
5924 NW Front Ave. Portland, OR 97210



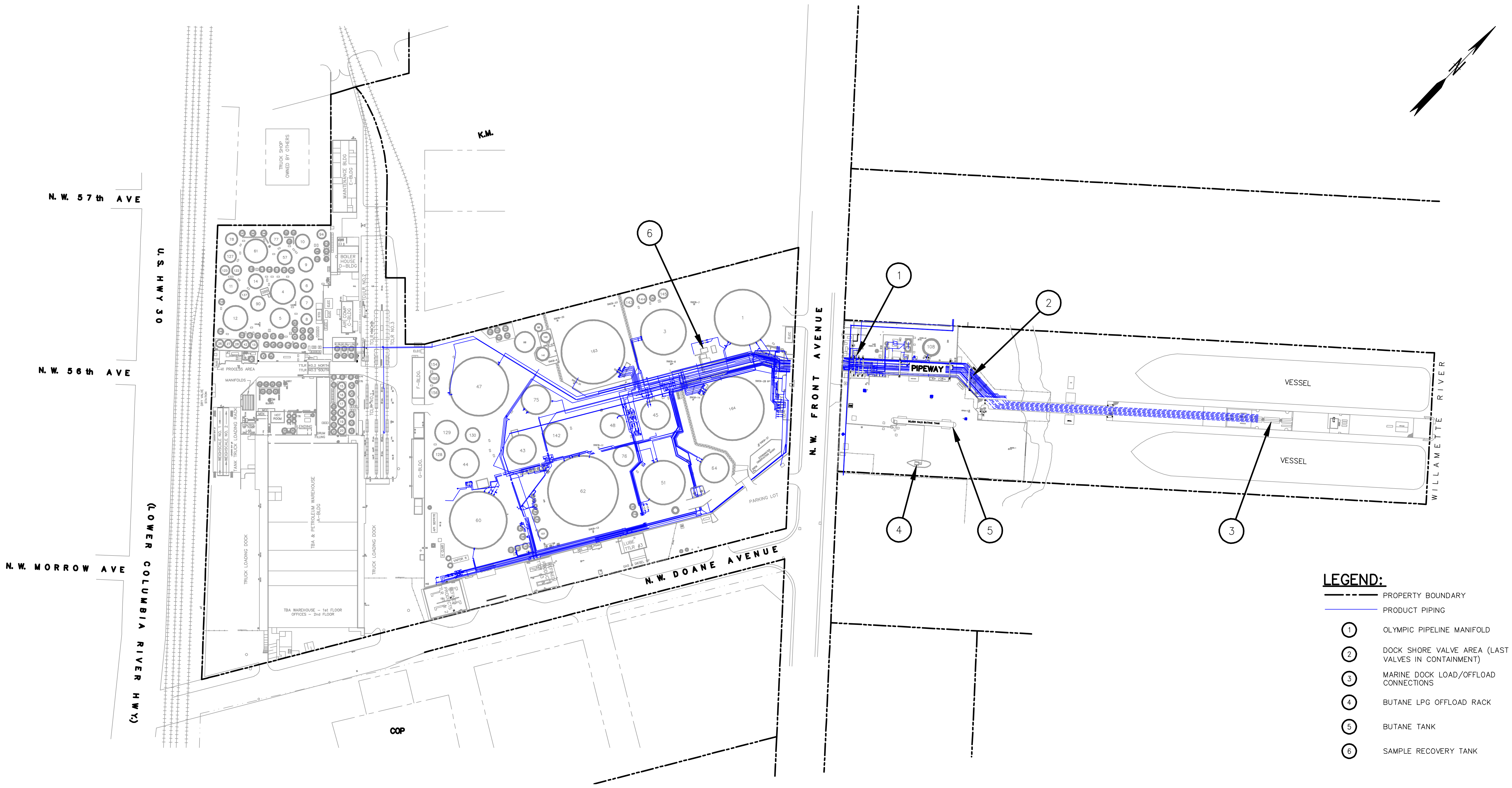
FIRE FIGHTING SOURCES

City of Portland, Water Bureau, City Fire Mains and Hydrants.

The dock has 5 fixed fire monitors.

Tanks 45, 51, 163, and 164 have fire foam supplied by a foam tank and city water pressure

TTLRs 1 through 4 have a deluge fire protection system.



LEGEND:

— - —	PROPERTY BOUNDARY
——	PRODUCT PIPING
①	OLYMPIC PIPELINE MANIFOLD
②	DOCK SHORE VALVE AREA (LAST VALVES IN CONTAINMENT)
③	MARINE DOCK LOAD/OFFLOAD CONNECTIONS
④	BUTANE LPG OFFLOAD RACK
⑤	BUTANE TANK
⑥	SAMPLE RECOVERY TANK

40' 0' 80' 160'
SCALE: 1"=80'

FOR REVIEW & COMMENT
05/17/17

ALPHA TECHNICAL GROUP INC.
2929 NW 29th AVE, PORTLAND, OR. 97210
Tel:(503)227-3317/Fax:(503)227-3244

ATGI PROJECT NUMBER 42-87

REFERENCE DRAWINGS

REVISIONS

A	05/17/17	FOR REVIEW & COMMENT	HVT	JPD	JPD

Chevron Products Company
Marketing Operations, San Ramon

SCALE 1"=50'-0"
DATE 10/04/99
DR. DAB
CH. DLB
DR. APP. JPD
ENGR.
OPR'G DEPT. –
ENG. DEPT. –
APPROVED
–
–
–

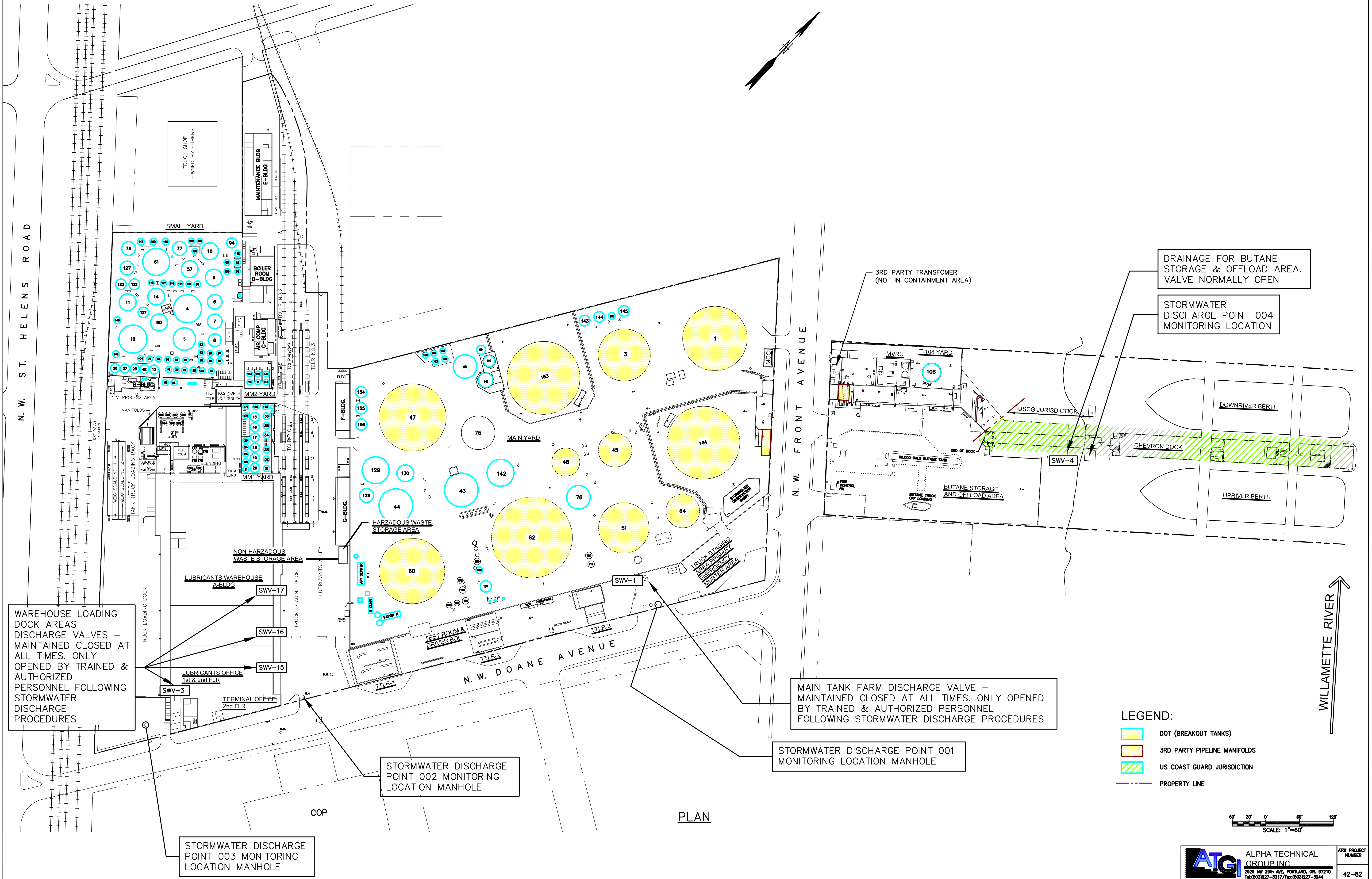
FRP/SPCC
WIL PIPING DIAGRAM

WILLBRIDGE OREGON

Q
W.O. –
S.O. –

WIL-PIPING DIAGRAM

REV A



WAREHOUSE LOADING DOCK AREAS DISCHARGE VALVES – MAINTAINED CLOSED AT ALL TIMES. ONLY OPENED BY TRAINED & AUTHORIZED PERSONNEL FOLLOWING STORMWATER DISCHARGE PROCEDURES

MAIN TANK FARM DISCHARGE VALVE – MAINTAINED CLOSED AT ALL TIMES. ONLY OPENED BY TRAINED & AUTHORIZED PERSONNEL FOLLOWING STORMWATER DISCHARGE PROCEDURES

3RD PARTY TRANSFOMER
(NOT IN CONTAINMENT AREA)

DRAINAGE FOR BUTANE STORAGE & OFFLOAD AREA. VALVE NORMALLY OPEN

STORMWATER DISCHARGE POINT 004 MONITORING LOCATION

STORMWATER DISCHARGE POINT 001 MONITORING LOCATION MANHOLE

STORMWATER DISCHARGE POINT 002 MONITORING LOCATION MANHOLE

STORMWATER DISCHARGE POINT 003 MONITORING LOCATION MANHOLE

LEGEND:

🟨	DOT (BREAKOUT TANKS)
🟨	3RD PARTY PIPELINE MANIFOLDS
▨	US COAST GUARD JURISDICTION
—·—	PROPERTY LINE

ALPHA TECHNICAL GROUP INC.
2929 NW 29th AVE, PORTLAND, OR. 97210
Tel:(503)227-3317/Fax:(503)227-3244

ATGI PROJECT NUMBER 42-82

REFERENCE DRAWINGS

REVISIONS

			GENERAL REVISION	7	11/19/12	UPDATED SITE PLAN	3	01/03/10
GENERAL REVISION	10	11/11/19	REVISED MTD TANK FARM	6	06/22/12	UPDATED SITE PLAN	2	03/02/02
GENERAL REVISION	9	02/28/19	UPDATED LOGO	5	03/17/11	REVISED TRUCK LOADING OFFICE DRAIN	1	04/26/00
FOR RECORD	8	11/20/12	UPDATED BORDER	4	12/07/10	FOR REFERENCE ONLY	0	12/16/99

Chevron
Chevron U.S.A. Products Company
Willbridge Lubricants Plant

SCALE 1"=60'-0" DATE 10/04/99 APPROVED
DR. DABYNUM CH. DLB DR. APP. ENGR.
OPR'G. DEPT. ENG. DEPT.

WILLBRIDGE LUBRICANTS PLANT
TITLE PLOT PLAN
FIGURE 5

W.O.
S.O.
DWG NO. E1-WB-4300-0
REV. 10

Tank Number	Year Built	Service	In Service?	Capacity in Gallons	Dimensions (Dia x Ht)	Welded or Riveted	Roof Type	Roof Shape	Foundation Type	Bottom Type	Bottom Replacement	Seismic Upgrade	Inspection Program	Last Internal inspection date	Last External Inspection date
1	1998	Flammable Fuel	Yes	3,017,322	115 x 48	Welded	Internal Fl Roof	Geo Dome	Concrete	Single w/ HDPE Liner			API-653	2018	2023
3	1999	Flammable Fuel	Yes	2,033,850	93 x 48	Welded	Internal Fl Roof	Geo Dome	Concrete Ringwall	Single w/ HDPE Liner			API-653	2019	2023
4	1913	Non-Combustible Petroleum	Yes	434,632	50 x 30	welded rivets	Fixed Roof	Cone	Concrete	Single Bottom	1994		API-653	2015	2020
5	1913	Non-Combustible Petroleum	Yes	351,744	40 x 40	welded rivets	Fixed Roof	Cone	Concrete	Single Bottom	1995		API-653	2016	2021
6	2019	Non-Combustible Petroleum	Yes	92,500	26 x 25	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2019	2019	STI-SP001	2019	2022
7	2018	Non-Combustible Petroleum	Yes		26 x 33	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2018	2018	STI-SP001	2018	2023
8	2017	Non-Combustible Petroleum	Yes		22 x 42	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2017	2017	STI-SP001	2017	2022
9	1949	Non-Combustible Petroleum	Yes	162,200	30 x 32	welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2003	2022
10	1949	Non-Combustible Petroleum	Yes	158,500	30 x 32	welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2021	2021
11	1949	Non-Combustible Petroleum	Yes	202,500	30 x 40	welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2006	2022
12	1949	Non-Combustible Petroleum	Yes	556,195	50 x 40	welded	Fixed Roof	Cone	Gravel	Single Bottom			API-653	2005	2022
13	1913	Non-Combustible Petroleum	Yes	43,800	18 x 24	welded	Fixed Roof	Cone	Concrete	Single Bottom	1994		API-653	2005	2022
14	1949	Non-Combustible Petroleum	Yes	179,000	30 x 36	welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2005	2020
15	1993	Non-Combustible Petroleum	Yes	26,900	16 x 20	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2013	2023
16	1993	Non-Combustible Petroleum	Yes	26,900	16 x 20	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2013	2023
17	1994	Non-Combustible Petroleum	Yes	26,900	16 x 20	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1994		STI-SP001	2011	2022
18	1913	Non-Combustible Petroleum	Yes	27,342	16 x 20	welded rivets	Fixed Roof	Cone	Concrete	Single Bottom	1992		STI-SP001	2006	2023
19	1993	Non-Combustible Petroleum	Yes	28,392	16 x 20	welded rivets	Fixed Roof	Cone	Concrete	Single Bottom	1992		STI-SP001	2012	2022
20	1914	Non-Combustible Petroleum	Yes	26,900	16 x 20	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2013	2023
21	1954	Non-Combustible Petroleum	Yes	13,500	11 x 20	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1992		STI-SP001	2004	2023
22	1954	Non-Combustible Petroleum	Yes	12,700	11 x 20	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1997		STI-SP001	2017	2022
23	1997	Non-Combustible Petroleum	Yes	7,700	10 x 15	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1997		STI-SP001	2004	2023
24	1993	Non-Combustible Petroleum	Yes	7,700	10 x 15	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2006	2023
25	1913	Non-Combustible Petroleum	Yes	8,143	10 x 15	welded rivets	Fixed Roof	Cone	Concrete	Single Bottom	1991		STI-SP001	2011	2022
26	1913	Non-Combustible Petroleum	Yes	27,000	16 x 20	welded rivets	Fixed Roof	Cone	Concrete	Single Bottom	1994		STI-SP001	2011	2022
27	1913	Non-Combustible Petroleum	Yes	27,000	16 x 20	welded	Fixed Roof	Cone	Concrete	Single Bottom	1987		STI-SP001	2011	2022
28	1913	Non-Combustible Petroleum	Yes	27,000	16 x 20	welded rivets	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2004	2022
29	1949	Non-Combustible Petroleum	Yes	11,600	10 x 20	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2004	2023
30	1949	Non-Combustible Petroleum	Yes	11,600	10 x 20	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2004	2023
31	1950	Non-Combustible Petroleum	Yes	11,100	11 x 17	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2014	2019
32	1950	Non-Combustible Petroleum	Yes	19,900	11 x 17	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2017	2022
33	?	Non-Combustible Petroleum	Yes	23,900	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2014	2019
34	?	Non-Combustible Petroleum	Yes	23,400	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2004	2023
35	?	Non-Combustible Petroleum	Yes	23,400	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2013	2023
36	?	Non-Combustible Petroleum	Yes	23,400	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2013	2023
37	1949	Non-Combustible Petroleum	Yes	18,100	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2014	2019
38	1949	Non-Combustible Petroleum	Yes	18,400	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2006		STI-SP001	2006	2019
39	1949	Non-Combustible Petroleum	Yes	18,300	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2014	2019
40	1949	Non-Combustible Petroleum	Yes	18,500	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2004	2019
41	1949	Non-Combustible Petroleum	Yes	18,300	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2014	2019
42	1913	Non-Combustible Petroleum	Yes	26,600	16 x 20	welded rivets	Fixed Roof	Cone	Concrete	Single Bottom	1994		STI-SP001	2004	2022
43	1993	Non-Combustible Petroleum	Yes	800,255	60 x 40	Welded	Fixed Roof	Cone	Asphalt	Single Bottom	1993		API-653	2008	2022
44	2015	Non-Combustible Petroleum	Yes	802,998	60 x 40	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2015		API-653	2015	2020
45	1999	Flammable Fuel	Yes	803,502	60 x 47	Welded	Internal Fl Roof	Geo Dome	Concrete Ringwall	Single w/ HDPE Liner			API-653	2011	2023
46	1924	Non-Combustible Petroleum	Yes	10,600	10 x 20	Welded	Fixed Roof	Cone	Asphalt	Single Bottom	2014		STI-SP001	2014	2023

47	1920	Combustible Fuel	Yes	3,472,938	120 x 40	Welded Rivet	Fixed Roof	Cone	Concrete	Double Bottom	1996		API-653	2009	2023
48	1929	Flammable Fuel	Yes	300,888	50 x 30	Rivet	Internal Fl Roof	Cone	Concrete	Double Bottom	2009		API-653	2021	2023
51	2000	Flammable Fuel	Yes	2,352,462	90 x 56	Welded	Internal Fl Roof	Geo Dome	Concrete Ringwall	Single w/ HDPE Liner			API-653	2019	2023
56	?	Non-Combustible Petroleum	Yes	23,700	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2005		STI-SP001	2004	2019
57	1921	Non-Combustible Petroleum	Yes	142,000	30 x 30	Rivet	Fixed Roof	Cone	Gravel	Single Bottom	2006		STI-SP001	2005	2019
60	2001	Flammable Fuel	Yes	4,625,754	117 x 64	Welded	Internal Fl Roof	Geo Dome	Concrete Ringwall	Single w/ HDPE Liner			API-653	2021	2023
61	1941	Non-Combustible Petroleum	Yes	377,163	48 x 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom	2014		API-653	2013	2023
62	1999	Flammable Fuel	Yes	6,058,752	144 x 56	Welded	Internal Fl Roof	Geo Dome	Concrete Ringwall	Single w/ HDPE Liner			API-653	2020	2023
64	1947	Combustible Fuel	Yes	751,590	60 x 40	Welded	Fixed Roof	Cone	Concrete	Double Bottom	2005		API-653	2005	2023
65	1998	Non-Combustible Petroleum	Yes	16,600	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1998		STI-SP001	2013	2023
72	1959	Non-Combustible Petroleum	Yes	18,100	10 x 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom	1997		STI-SP001	2017	2022
75	1952	Combustible Fuel	Yes	811,944	60 x 48	Welded	Fixed Roof	Cone	Concrete	Double Bottom	2012		API-653	2012	2023
76	1960	Non-Combustible Petroleum	Yes	466,969	42 x 48	Welded	Fixed Roof	Cone	Asphalt	Single Bottom			API-653	2004	2020
77	1960	Non-Combustible Petroleum	Yes	121,000	25 x 36	Welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2004	2019
78	1960	Non-Combustible Petroleum	Yes	98,600	24 X 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom	2003		STI-SP001	2022	2022
79	1960	Non-Combustible Petroleum	Yes	14,800	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1992		STI-SP001	2005	2019
80	?	Non-Combustible Petroleum	Yes	16,400	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2005		STI-SP001	2005	2019
81	1951	Non-Combustible Petroleum	Yes	18,312	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2009		STI-SP001	2016	2021
82	1951	Non-Combustible Petroleum	Yes	18,000	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2014	2019
83	1951	Non-Combustible Petroleum	Yes	18,100	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2014	2019
84	1952	Non-Combustible Petroleum	Yes	17,500	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2014	2019
85	1952	Non-Combustible Petroleum	Yes	18,000	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2013	2022
87	1998	Non-Combustible Petroleum	Yes	18,100	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1998		STI-SP001	2013	2023
88	1950	Non-Combustible Petroleum	No	19,392	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2006	2006
89	1952	Non-Combustible Petroleum	Yes	19,397	10 x 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2006	2020
90	1954	Non-Combustible Petroleum	Yes	190,000	30 x 40	Welded	Fixed Roof	Cone	Asphalt	Single Bottom			STI-SP001	2016	2021
91	1961	Non-Combustible Petroleum	Yes	16,758	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1991		STI-SP001	2011	2022
92	1961	Non-Combustible Petroleum	Yes	18,312	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2006	2021
94	?	Non-Combustible Petroleum	Yes	63,000	18 x 35	Welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2015	2020
96	1966	Non-Combustible Petroleum	Yes	17,800	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2004	2023
97	1966	Non-Combustible Petroleum	Yes	19,100	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993	1993	STI-SP001	2019	2019
98	1968	Non-Combustible Petroleum	Yes	470,000	42 x 48	Welded	Fixed Roof	Cone	Asphalt	Single Bottom			API-653	2020	2020
99	?	Non-Combustible Petroleum	No	57,500	19 x 30	Rivet	Fixed Roof	Cone	Asphalt	Single Bottom			STI-SP001	2014	2014
100	1946	Non-Combustible Petroleum	Yes	18,000	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2005	2020
101	1958	Non-Combustible Petroleum	Yes	18,100	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2015	2020
102	1978	Combustible Fuel	Yes	8,610	10.5 x 20	Welded	Fixed Roof	Cone	Anchored	Double Bottom	2022	2022	STI-SP001	2022	2022
103	1978	Combustible Fuel	No	8,610	10.5 x 20	Welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2003	2023
104	1937	Non-Combustible Petroleum	Yes	18,000	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2015	2020
105	1969	Non-Combustible Petroleum	Yes	18,100	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2013		STI-SP001	2006	2021
106	1969	Non-Combustible Petroleum	Yes	23,700	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2015		STI-SP001	2015	2020
108	1970	Combustible Fuel	Yes	198,912	30 x 40	Welded	Fixed Roof	Cone	Concrete	Double Bottom	2006		STI-SP001	2005	2023
109	?	Non-Combustible Petroleum	Yes	18,100	10 x 30	Rivet	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2005	2020
110	?	Non-Combustible Petroleum	Yes	18,500	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2005	2020
112	?	Non-Combustible Petroleum	Yes	18,400	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2007		STI-SP001	2006	2021
113	1973	Non-Combustible Petroleum	Yes	16,632	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1992		STI-SP001	2013	2023
114	?	Non-Combustible Petroleum	Yes	18,100	10 x 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2006	2021
116	1976	Non-Combustible Petroleum	Yes	18,300	10 x 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom	2019		STI-SP001	2019	2019
117	?	Non-Combustible Petroleum	Yes	18,000	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2005	2020

118	1976	Non-Combustible Petroleum	Yes	17,800	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2014	2019
119	1977	Combustible Fuel	No	19,613	10.5 x 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2006	2023
120	1977	Flammable Fuel	No	19,612	10.5 x 30	Welded	Internal Fl Roof	Cone	Gravel	Single Bottom			STI-SP001	2003	2023
121	1978	Flammable Fuel	Yes	9,660	12 x 29.5	Welded	Internal Fl Roof	Cone	Concrete	Double Bottom	2007		STI-SP001	2006	2023
122	?	Non-Combustible Petroleum	Yes	57,600	19 x 29	Welded	Fixed Roof	Cone	Gravel	Single Bottom	2006		STI-SP001	2005	2020
123	?	Non-Combustible Petroleum	Yes	57,600	19 x 29	Welded	Fixed Roof	Cone	Gravel	Single Bottom	2015		STI-SP001	2014	2019
127	?	Non-Combustible Petroleum	Yes	96,500	24 x 30	Welded/Rivets	Fixed Roof	Cone	Gravel	Single Bottom	1995		STI-SP001	2014	2019
128	?	Non-Combustible Petroleum	Yes	96,000	23 x 32	Welded/Rivets	Fixed Roof	Cone	Asphalt	Single Bottom	1993		STI-SP001	2018	2023
129	?	Non-Combustible Petroleum	Yes	621,371	48 x 49	Welded	Fixed Roof	Cone	Asphalt	Single Bottom	1993		API-653	2016	2021
130	?	Non-Combustible Petroleum	Yes	248,657	30 x 48	Welded	Fixed Roof	Cone	Asphalt	Single Bottom	1993		STI-SP001	2015	2020
131	?	Non-Combustible Petroleum	Yes	18,400	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2007		STI-SP001	2012	2022
132	?	Non-Combustible Petroleum	Yes	17,976	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2005	2020
133	?	Non-Combustible Petroleum	Yes	19,300	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2020	2020
135	1982	Combustible Fuel	No	19,352	10 x 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2006	2023
136	1982	Flammable Fuel	No	24,537	12 x 30	Welded	Internal Fl Roof	Cone	Gravel	Single Bottom			STI-SP001	1988	2023
137	?	Non-Combustible Petroleum	Yes	62,000	18 x 32	Welded	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2017	2022
138	1948	Non-Combustible Petroleum	Yes	18,000	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2014	2019
139	1983	Non-Combustible Petroleum	Yes	23,500	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2009		STI-SP001	2009	2022
140	?	Non-Combustible Petroleum	Yes	78,000	20 x 35	Welded	Fixed Roof	Cone	Ring Wall Concrete	Single Bottom	2009	2009	STI-SP001	2009	2022
141	?	Non-Combustible Petroleum	Yes	143,800	26 x 36	Welded	Fixed Roof	Cone	Ring Wall Concrete	Single Bottom	2009	2009	STI-SP001	2009	2022
142	1984	Non-Combustible Petroleum	Yes	628,548	48 x 48	Welded	Fixed Roof	Cone	Concrete	Single Bottom			API-653	2007	2022
143	1993	Non-Combustible Petroleum	Yes	58,000	19 x 30	Welded	Fixed Roof	Cone	Gravel	Single Bottom	1993		STI-SP001	2015	2020
144	?	Non-Combustible Petroleum	Yes	57,500	19 x 30	Rivets	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2006	2021
145	?	Non-Combustible Petroleum	Yes	57,500	19 x 30	Welded/Rivets	Fixed Roof	Cone	Gravel	Single Bottom			STI-SP001	2006	2021
146	?	Combustible Fuel	Yes	22,715	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2007		STI-SP001	2007	2020
147	?	Non-Combustible Petroleum	Yes	23,700	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2004	2020
148	?	Non-Combustible Petroleum	Yes	32,100	12 x 40	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2013	2023
149	1984	Non-Combustible Petroleum	Yes	23,700	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2014		STI-SP001	2014	2019
150	?	Non-Combustible Petroleum	Yes	23,700	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2015	2020
151	1984	Non-Combustible Petroleum	Yes	18,200	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	2014		STI-SP001	2014	2019
152	?	Non-Combustible Petroleum	Yes	18,200	10 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2004	2020
154	?	Non-Combustible Petroleum	Yes	76,547	20 x 35	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2020	2020
155	?	Non-Combustible Petroleum	Yes	78,000	20 x 35	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2015	2020
156	?	Non-Combustible Petroleum	Yes	77,000	20 x 35	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2005	2021
157	?	Non-Combustible Petroleum	Yes	65,500	20 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1993		STI-SP001	2019	2019
158	?	Non-Combustible Petroleum	No	23,700	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	1987	1992
159	1987	Flammable Fuel	No	25,071	12 x 30	Welded	Internal Fl Roof	Cone	Gravel	Single Bottom			STI-SP001	2006	2023
159	?	Non-Combustible Petroleum	No	23,700	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom	1992		STI-SP001	1992	1997
160	?	Non-Combustible Petroleum	Yes	23,700	12 x 30	Welded	Fixed Roof	Cone	Concrete	Single Bottom			STI-SP001	2004	2020
163	2009	Flammable Fuel	Yes	5,490,492	130 x 64	Welded	Internal Fl Roof	Geo Dome	Concrete Ringwall	Single w/ HDPE Liner			API-653	2014	2023
164	2009	Flammable Fuel	Yes	5,639,718	130 x 64	Welded	Internal Fl Roof	Geo Dome	Concrete Ringwall	Single w/ HDPE Liner			API-653	2009	2023
165	1985	Flammable Fuel	No	3,595	6 x 17	Welded	N/A - Horizontal	N/A - Horizontal	Gravel	N/A - Horizontal			STI-SP001		2013
166	1991	Flammable Fuel	Yes	1,468	5 x 10	Welded	N/A - Horizontal	N/A - Horizontal	Anchored	N/A - Horizontal			STI-SP001	not required	2018
170	1946	Non-Combustible Petroleum	No	10,000	10 x 16	Rivets	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2016
171	?	Non-Combustible Petroleum	Yes	10,000	10 x 16	Rivets	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
172	?	Non-Combustible Petroleum	Yes	10,000	10 x 16	Rivets	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
173	?	Non-Combustible Petroleum	Yes	10,000	10 x 16	Rivets	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
174	?	Non-Combustible Petroleum	Yes	3,500	6 x 17	Rivets	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021

175	?	Non-Combustible Petroleum	Yes	3,500	6 x 17	Rivets	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
176	1974	Non-Combustible Petroleum	Yes	2,250	8 x 8	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2023
177	1974	Non-Combustible Petroleum	Yes	2,250	8 x 8	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2023
178	1974	Non-Combustible Petroleum	Yes	2,250	8 x 7	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2023
179	1974	Non-Combustible Petroleum	Yes	2,250	8 x 7	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2023
180	1993	Non-Combustible Petroleum	Yes	5,000	10 x 8	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
181	1993	Non-Combustible Petroleum	Yes	5,000	10 x 8	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
182	1994	Non-Combustible Petroleum	Yes	10,000	11 x 16	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
183	1994	Non-Combustible Petroleum	Yes	10,000	11 x 16	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
184	1994	Non-Combustible Petroleum	Yes	10,000	11 x 16	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
185	1994	Non-Combustible Petroleum	Yes	10,000	11 x 16	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
186	1994	Non-Combustible Petroleum	Yes	10,000	11 x 16	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
187	1994	Non-Combustible Petroleum	Yes	10,000	11 x 16	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021
188	1994	Non-Combustible Petroleum	Yes	10,000	11 x 16	Welded	Fixed Roof	Cone	Concrete	Elevated Cone Bottom			STI-SP001	not required	2021

Appendix B

Geotechnical Assessment

155 Grand Avenue
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May 30, 2024

SGH Project No. 237372.00-CHPO / Gannett Fleming Project No. 078229

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

Re: Technical Memorandum
Preliminary Geotechnical Assessment
Chevron Willbridge 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 Chevron Products Company (Chevron) Willbridge Terminal located at 5533 NW Doane Avenue 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 February 29, 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 are comprised of over 150 liquid product storage tanks, dock, product transfer pipelines, and associated facilities. Several geotechnical investigations and assessments have been completed for the site. 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 February 29, 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 evaluation of seismic hazards 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 tanks, the dock, and associated facilities.
- Preparation of this memorandum.

SITE CONDITIONS

The terminal is located on the east side of NW St. Helens Road east of the foothills of the Tualatin Mountains along the shoreline of the Willamette River as shown in Figure 1. The site is relatively flat at roughly elevation 40 feet (NAVD88). Terminal improvements include steel liquid products storage tanks about 5 to 145 feet in diameter within various tank yards (Main Yard, Small Yard, MM1 Yard, MM2 Yard, and T-108 Yard), tank truck loading rack, dock, butane storage and offload area, pipelines, secondary containment walls, and associated facilities. We understand the tanks are supported on shallow foundations. In addition, the timber dock is primarily supported on timber piles, with portions of the dock approach trestle supported on relatively shallow concrete footings. An aerial image of the terminal is presented in Figure 2. Bathymetric survey data collected by the United States Army Corps of Engineers indicate the waterfront slope is roughly 70 feet high.

EXISTING DATA

Several previous geotechnical investigations were performed at the site. These are summarized in the following reports. The boring and CPT logs from these studies are included in Appendix A.

- Geotechnical Engineering Report, Proposed 90,000-gallon Butane Tank, Chevron USA, Willbridge Terminal, Portland, Oregon, prepared by Professional Service Industries, Inc. (PSI) dated September 11, 2015 (PSI 2015). The report summarizes a geotechnical investigation including two Cone Penetration Tests completed at the site in April 2015.

- Report of Geotechnical Engineering Services, Chevron Willbridge Terminal Expansion, NW Front Avenue, Portland, Oregon, prepared by GeoDesign, Inc. (GeoDesign) dated June 4, 2008 (GeoDesign 2008). The report summarizes a geotechnical investigation including seven borings completed at the site in February and March 2008.

- Geotechnical Engineering Report, Willbridge Intercompany Pipeline, Portland, Oregon, prepared by GeoEngineers dated June 8, 2000 (GeoEngineers 2000). The report summarizes a geotechnical investigation including ten borings completed at the site in May 2000.

- Report of Geotechnical Engineering Services, Tank No. 62 Replacement Project, Chevron Willbridge Terminal, Portland, Oregon, prepared by Pacific Environmental Group, Inc. (PEG) dated October 15, 1998 (PEG 1998). The report summarizes a geotechnical investigation including six borings completed at the site in September 1998.

- Log of Boring, Wharf Improvements, Chevron USA Products Company, Willbridge Terminal, Portland, Oregon, Drawing Sheet 6 prepared by Winzler & Kelly dated October 19, 1995 (Winzler & Kelly 1995). The drawing includes stick logs of four borings performed at the Dock by Dames & Moore in 1973.

SUBSURFACE CONDITIONS

The site is underlain by various amounts of fill materials placed during site development. Regional geologic mapping indicates the fill 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 Grande Ronde Basalt of the Columbia River Basalt Group at depth.

The previous borings by others indicate subsurface conditions encountered that are generally consistent with site development and regional geology. The borings indicate subsurface soils are generally comprised of fill, alluvial deposits, and bedrock. The fill primarily consists of very loose to medium dense sands with varying amounts of silt and gravel. Alluvial deposits underlying the fill are comprised of fine-grained and sandy soils. The fine-grained alluvium encountered generally consist of very soft to very stiff silts interlayered with clays and sands deposited by successive historic flood events. Sandy alluvium generally underlying the fine-grained alluvial primarily consist of loose to medium dense sands. The alluvial deposits are underlain by basalt bedrock encountered at depths ranging from about 40 feet to 45 feet below the ground surface.

Data from the overwater boring logs indicate conditions that are generally consistent with geologic mapping. The logs indicate subsurface soils in the area of the dock are comprised of fine-grained and sandy alluvial deposits (very soft to stiff silts and loose to medium dense sands) underlain by bedrock. The depth to bedrock encountered in these borings was relatively thin offshore (as little as about 10 feet thick) and increased with distance from the shoreline, with top of rock elevations ranging from about Elevation -48 to -74 feet (NAVD88).

Groundwater

Shallow groundwater was generally encountered in the onshore borings at depths ranging from about 2 to 17 feet. 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 the dominant M_w of 9.3 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 liquefy. The range of field (uncorrected) Standard Penetration Test (SPT) sampler blow count values (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 Fill	2 - 24
Fine-Grained Alluvium	1 - 23
Sandy Alluvium	6 - 28

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 (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 liquefaction-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 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 in response to the design earthquake 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, 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 acting on soils within and above the liquefied layer (seismic inertial loading). 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 lateral displacements associated with lateral spreading (seismically-induced ground deformation), 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.

Lateral spreading will also impose kinematic lateral loads on pile foundations where the soil movements occur relative to the piles. This will primarily impact the dock, with the impacts being greatest near the shoreline where the liquefiable soils are the thickest and potential deformations are the greatest. Kinematic loads will also affect any onshore pile-supported structures.

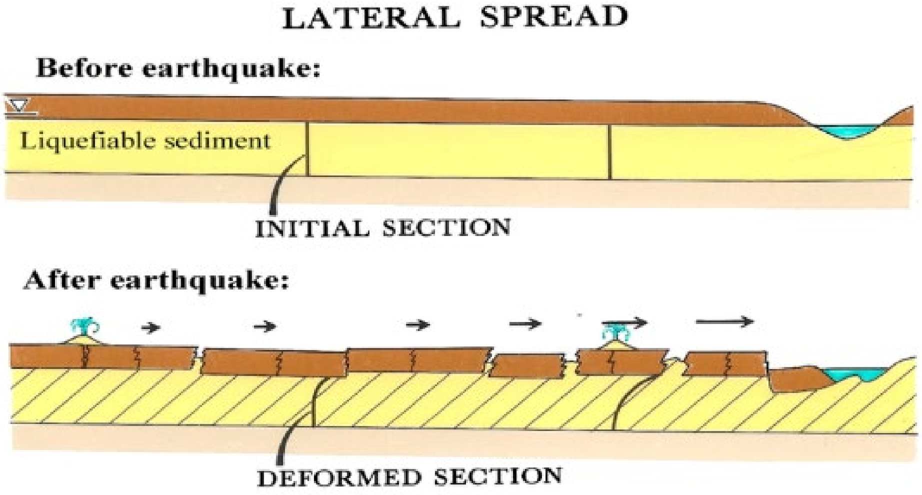

Exhibit 1: Schematic of Lateral Spread Characteristics (Youd 2018)

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. Our estimates of seismically-induced lateral ground deformations based on the approach developed by Zhang, et al. (2004) are depicted in Exhibit 2 below. These estimates consider the proximity of the site to the free face slope of the waterfront along the Willamette River and a slope height of 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. As shown in Exhibit 2, there is a reduction in estimated deformations with greater distances from the shoreline, with the risk of lateral spreading greatest within a distance of about three times the waterfront slope height (flow slide zone). In the flow slide zone, unlimited shear strains may develop leading to a flow-type failure. In this case, large masses of ground may travel long distances (likely more than 5 feet) in the form of liquefied flows or blocks of ground riding on liquefied flows. The estimates of lateral spread deformation presented in Exhibit 2 are also shown on an aerial image of the terminal shown in the attached Figure 3. As shown in Figure 3, estimated lateral spread deformations range from about 3 feet on the east side of NW Front Avenue (in the area of the dock, T-108 yard, and butane storage and offload area) to about 1 to 2 ½ feet on the west side of NW Front Avenue (in the area of the Main Yard, MM1 Yard, MM2 Yard, and Small Yard).

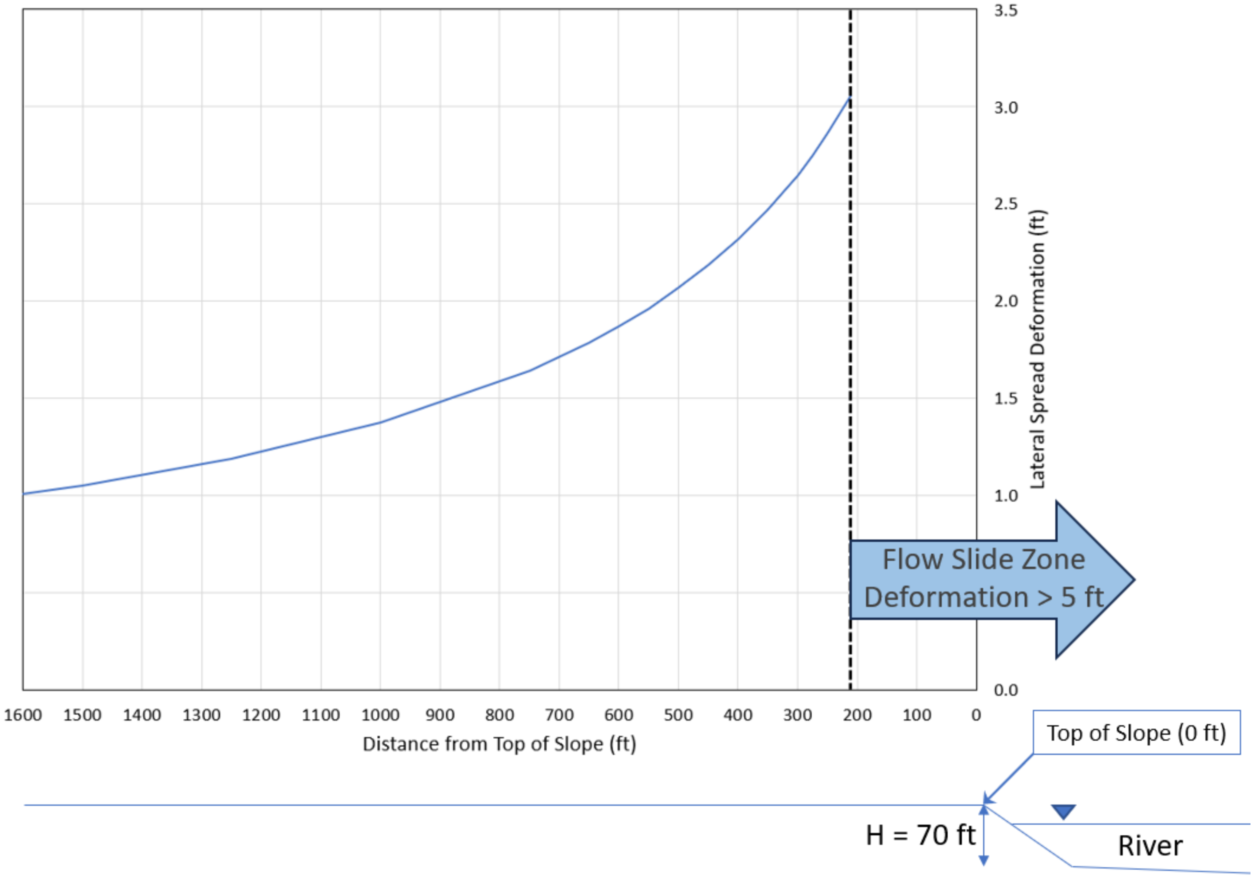

Exhibit 2: Seismically-Induced Lateral Ground Deformation

As indicated previously, the primary mechanisms of liquefaction-induced settlement are reconsolidation, ejecta-induced, and shear-induced deformation. It should be noted that 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 2 below. These estimates do not consider shear-induced foundation settlements discussed previously.

Table 2: 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	4 to > 30
All the Above	6 to > 30

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 lateral spreading near the shoreline, where the potential for flow slide failure exists, which can result in impacts on the facilities in this area including kinematic loading on piles supporting the dock. The risk of lateral spreading at the site is significantly reduced at greater distances from the shoreline. Where seismically-induced vertical and lateral ground deformations are not acceptable, mitigation measures could be considered. Mitigation of shoreline deformation could consist of a subsurface buttress and/or bulkhead structure depending on waterfront configuration. The installation of a waterfront/shoreline buttress would not only mitigate the deformations near the shoreline, but also at greater distances from the shoreline. In addition, the potential for lateral spreading on the waterside of a shoreline buttress and potential kinematic load impacts on the existing dock would need to be assessed. Assuming lateral deformations are acceptable or have been mitigated, 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 conclusions regarding the overall seismic risk.

LIMITATIONS

This report has been prepared for the sole use of SGH and Chevron, 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

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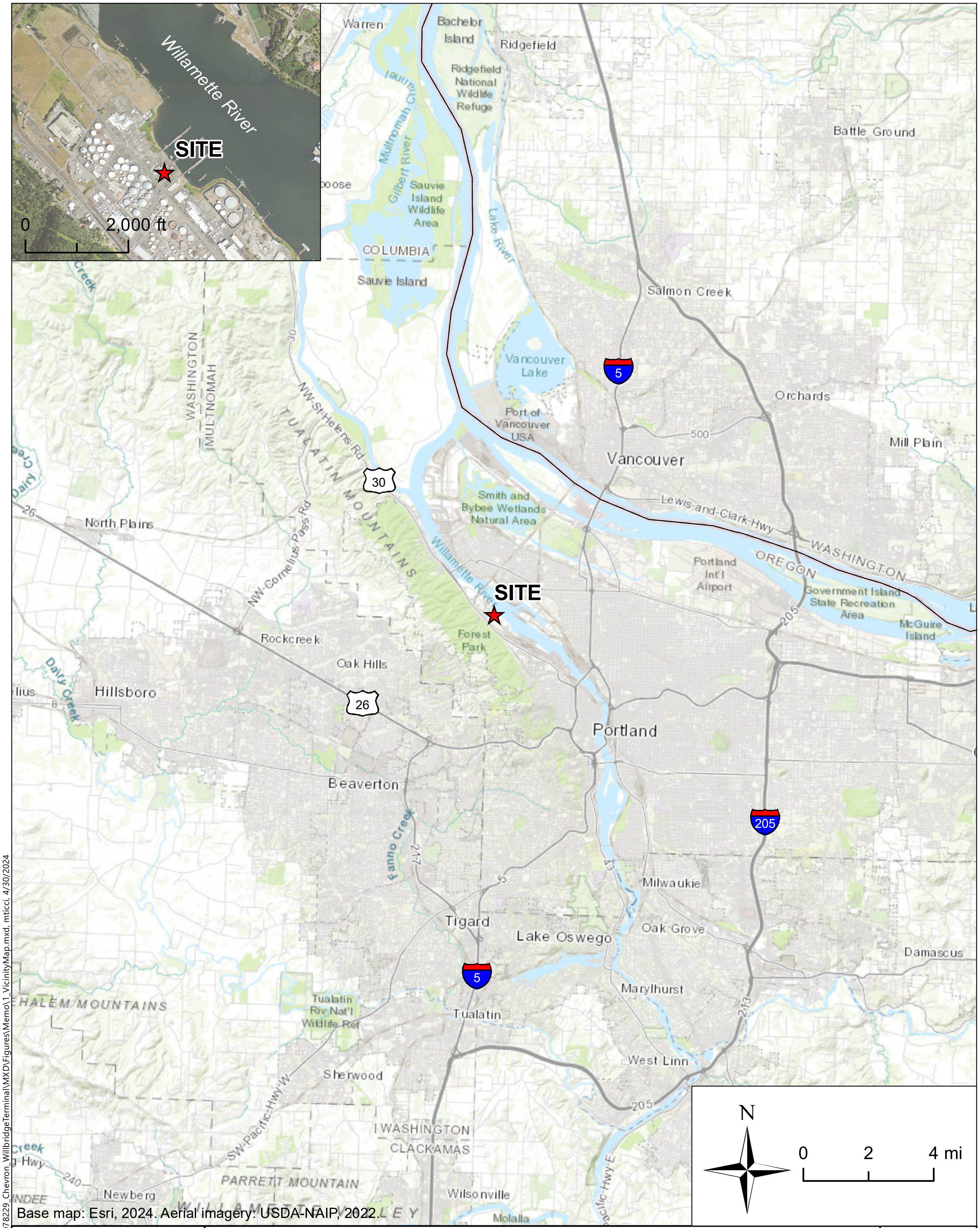
FIGURES



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

\\cphfs23\EnvSci\Projects\07\078229_Chevron_WillbridgeTerminal\MXD\Figures\Memo1_VicinityMap.mxd, mticci, 4/30/2024

GANNETT FLEMING

SITE VICINITY PLAN

Chevron Willbridge Terminal
Preliminary Geotechnical Assessment
Portland, Oregon

FIGURE

1

Date: 4/30/2024
By: M. Ticci
Scale: 1:250,000
Project No: 078229

N

0 100 200 ft

0 50 100 m

Legend

-·-·-· Site Boundary (approximate)

Imagery: USDA-NAIP, 2022.

GANNETT FLEMING

SITE PLAN

Chevron Willbridge Terminal
Preliminary Geotechnical Assessment
Portland, Oregon

FIGURE

2

Date: 5/2/2024	By: M. Ticci	Scale: 1:2,400	Project No: 078229

\\cphfs23\EnvSciLI\Projects\07\078229_Chevron_WillbridgeTerminal\MXD\Figures\Memo\2_SitePlan.mxd, 5/2/2024, mticci

Legend

- - - Site Boundary (approximate)

— Lateral Spread Deformation Contours (ft)

🟥 Flow Slide Zone (Deformation > 5 ft) See Report

Imagery: USDA-NAIP, 2022.

GANNETT FLEMING

PRELIMINARY LATERAL SPREAD DEFORMATIONS

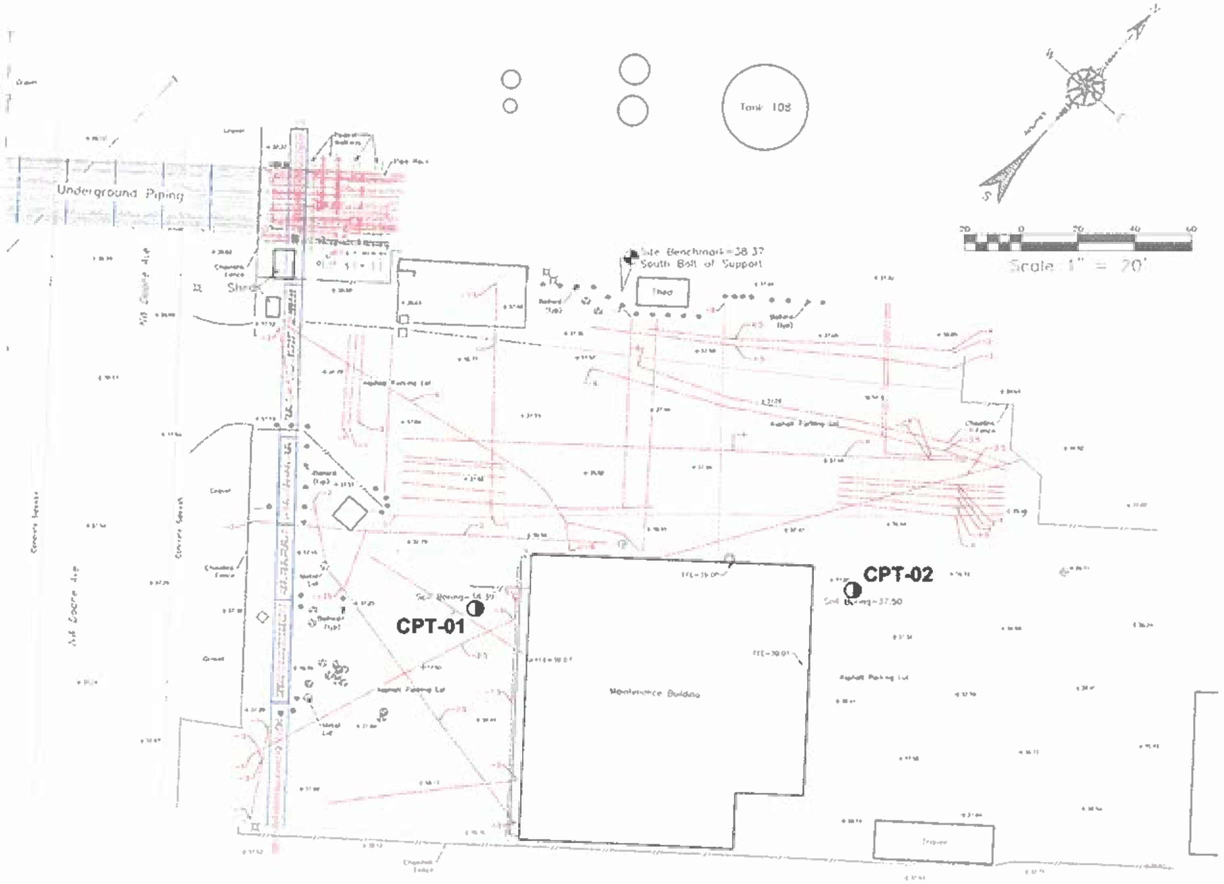
Chevron Willbridge Terminal
Preliminary Geotechnical Assessment
Portland, Oregon

FIGURE 3

Date: 5/22/2024	By: M. Ticci	Scale: 1:2,400	Project No: 078229

\\cphfs23\EnvSciLI\Projects\07\078229_Chevron_WillbridgeTerminal\MXD\Figures\Memo\3_LatSpread_Deformation.mxd, 5/22/2024, mticci

APPENDIX A – EXISTING DATA



LEGEND

◑ APPROXIMATE CPT PROBE LOCATION
CPT-01

BASE DRAWING PROVIDED TO PSI BY SUNOCO LOGISTICS PARTNERS, LP ON MAY 26, 2015

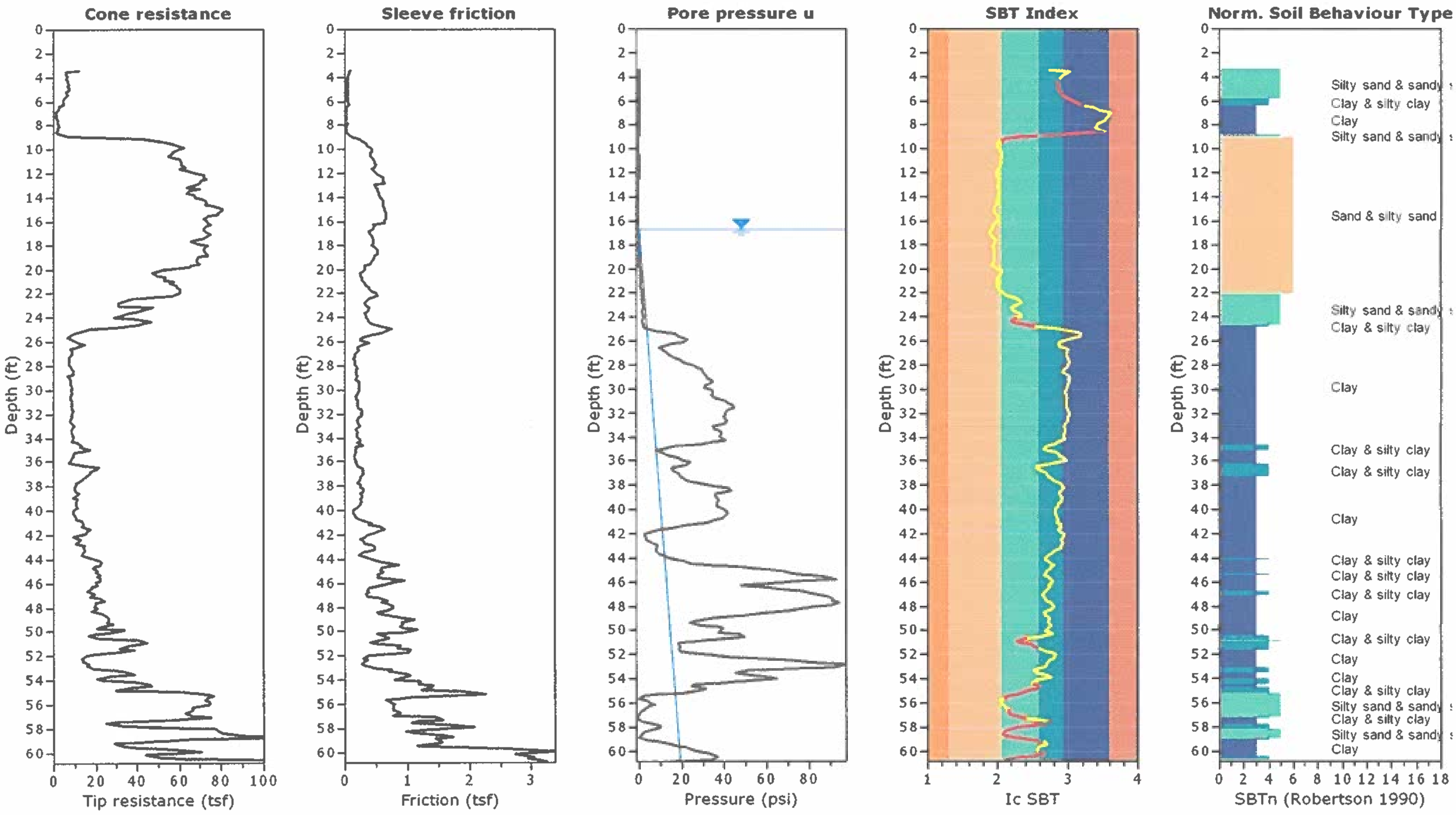
psi Information To Build On Engineering • Consulting • Testing	DATE: JUNE 2015	PROPOSED BUTANE STORAGE TANK CHEVRON USA 5924 NW FRONT AVENUE PORTLAND, OREGON	PSI PROJECT NUMBER 0704805
PSI, INC. 6032 N. CUTTER CIRCLE, SUITE 480 PORTLAND, OREGON 97217 (503) 289-4778	DRAWN BY: ESR	**SITE EXPLORATION PLAN**	**FIGURE 2**

APPENDIX A – CPT LOGS

Professional Service Industries, Inc. (PSI)
6032 North Cutter Circle, Suite 480
Portland, Oregon 97217
(503) 289-1778

Project: **0704805 - Chevron Butane Tank**
Location: **Wilbridge Terminal, Portland, Oregon**

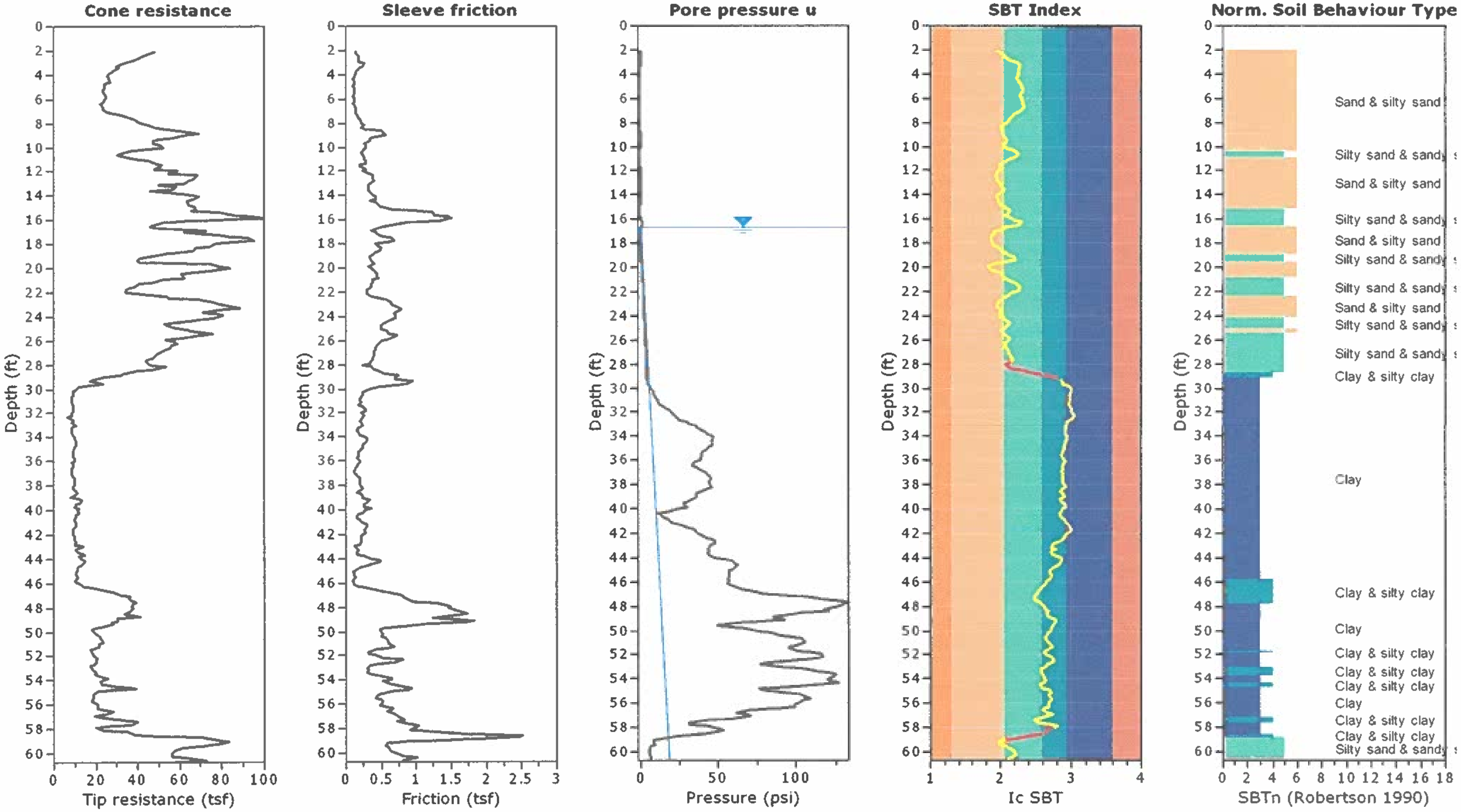
CPT: CPT-01
Total depth: 60.86 ft, Date: 4/29/2015
Surface Elevation: 38.39 ft
Coords: X:0.00, Y:0.00
Cone Type: Hogentogler
Cone Operator: Oregon Geotechnical Explorations



Professional Service Industries, Inc. (PSI)
6032 North Cutter Circle, Suite 480
Portland, Oregon 97217
(503) 289-1778

Project: **0704805 - Chevron Butane Tank**
Location: **Wilbridge Terminal, Portland, Oregon**

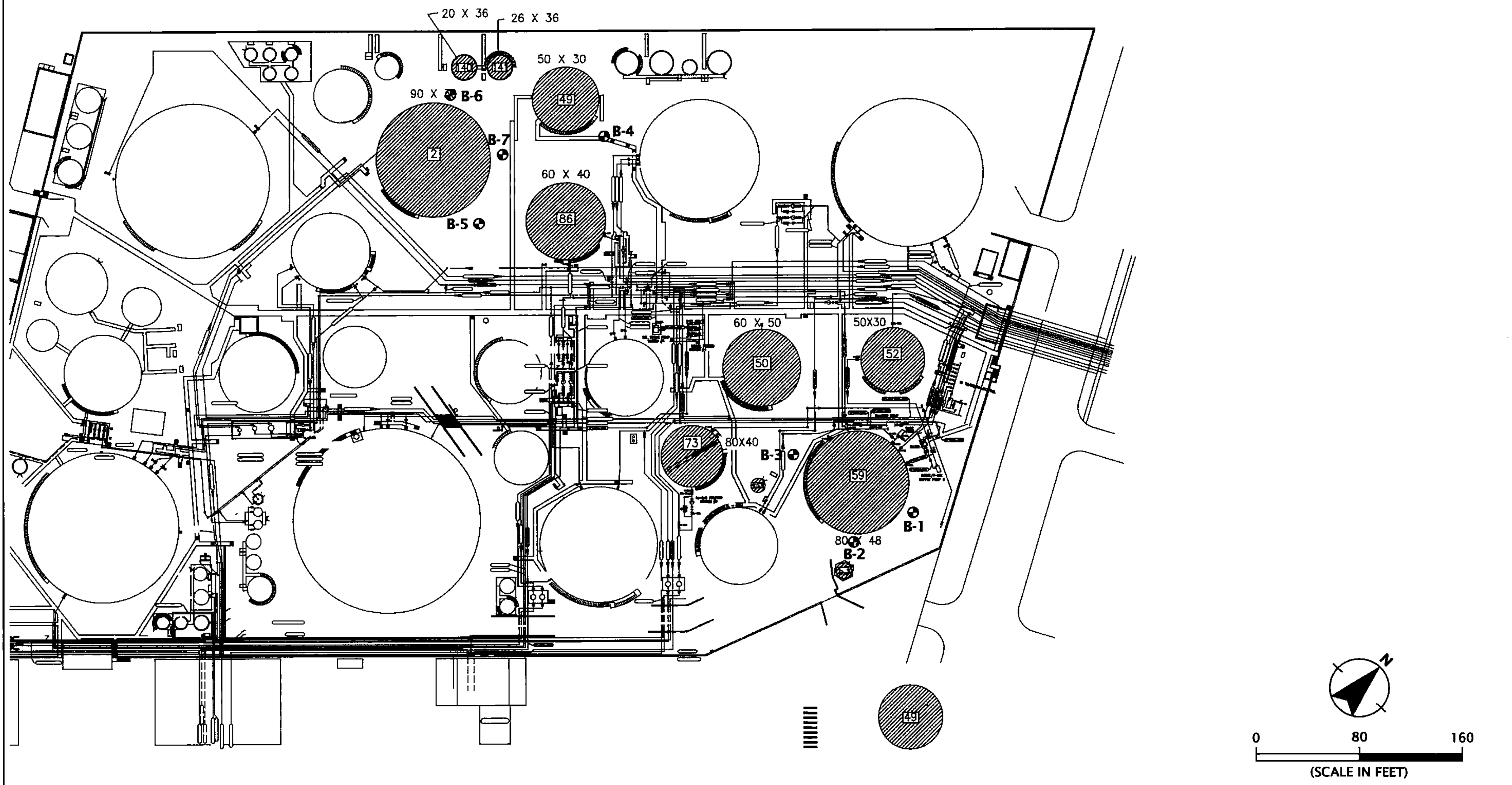
CPT: CPT-02
Total depth: 60.70 ft, Date: 4/28/2015
Surface Elevation: 37.50 ft
Coords: X:0.00, Y:0.00
Cone Type: Hogentogler
Cone Operator: Oregon Geotechnical Explorations



CPeT-IT v.1.7.6.42 - CPTU data presentation & interpretation software - Report created on: 6/1/2015, 8:47:14 AM
Project file: P:\704 Geotech & Environmental\0704800 - 0704899\0704805 - GEO Chevron Butane Tank (Sunoco Logistics Willbridge Termina, Portland, OR)\Analysis\CPT Analysis\0704805-Chevron Butane Tank.cp

LEGEND:

B-1 ● BORING



SITE PLAN BASED ON DRAWING PROVIDED BY
KURT LIEBE, MARCH 4, 2008

SITE PLAN

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE 2

CHEVRON-1-01

JUNE 2008

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Portland OR 97224
Off 503.968.8787 Fax 503.968.3068

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Printed By: aday | Print Date: 6/3/2008 8:21:02 AM
File Name: \\chromite\Files\Jobs\A-D\Chevron\Chevron-1\Chevron-1-01\Figures\CAD\Chevron-1-01-F2-SP.dwg | Layout: FIGURE 2

APPENDIX A

FIELD EXPLORATIONS

GENERAL

We explored subsurface conditions by drilling seven borings (B-1 through B-7) to a maximum depth of approximately 50 feet BGS. Figure 2 shows the approximate boring locations. The borings were drilled between February 25 and March 3, 2008 by Cascade Drilling, Inc. of Clackamas, Oregon.

A member of our geotechnical staff observed the explorations. We obtained representative samples of the various soils encountered in the explorations for geotechnical laboratory testing. Classifications and sampling intervals are presented on the exploration logs included in this appendix.

SAMPLING METHODS

Soil samples were obtained from the borings using the following methods:

- SPTs were performed in general conformance with ASTM D 1586. The sampler was driven with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler 1 foot, or as otherwise indicated, into the soils is shown adjacent to the sample symbols on the exploration logs. Disturbed samples were obtained from the split barrel for subsequent classification and index testing.
- Higher-quality, relatively undisturbed samples were obtained at selected intervals by pushing a shelby tube sampler 24 inches ahead of the boring front. Shelby tube samples are preferred for consolidation and strength testing due to the lower level of disturbance.

SOIL AND ROCK CLASSIFICATION

The soil samples were classified in accordance with the "Exploration Key" (Table A-1) and "Soil Classification System" (Table A-2), which are included in this appendix. The exploration logs indicate the depths at which the soil or rock or their characteristics change, although the change actually could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications and sampling intervals are shown on the exploration logs included in this appendix.

LABORATORY TESTING

CLASSIFICATION

The soil samples were classified in the laboratory to confirm field classifications. The laboratory classifications are included on the exploration logs if those classifications differed from the field classifications.

MOISTURE CONTENT

We tested the natural moisture content of selected soil samples obtained from the explorations in general accordance with ASTM D 2216. The natural moisture content is a ratio of the weight of the water to dry soil in a test sample and is expressed as a percentage. The moisture contents are included in the exploration logs presented in this appendix.

ATTERBERG LIMITS

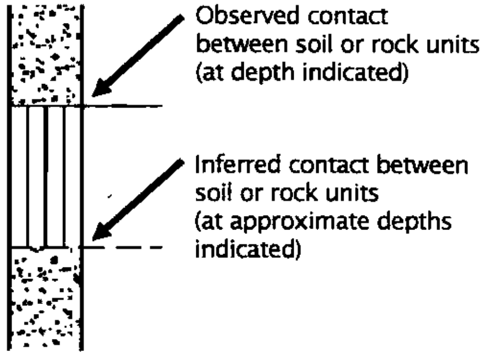
Atterberg limits tests were performed on two samples obtained from the borings in general accordance with ASTM D 4318. Atterberg limits include the liquid limit, plastic limit, and the plasticity index of soils. These index properties are used to classify soils and for correlation with other engineering properties of soils. Figure A-8 presents the test results.

CONSOLIDATION TESTS

Consolidation tests were performed on selected samples of the silty soils in general conformance with ASTM D 2435. This test determines the magnitude and rate of consolidation of soil when it is restrained laterally and drained axially while subjected to incrementally applied controlled-stress loading. The test results are used to estimate the magnitude and rate of settlement of the site soils under a specific increase in effective stress. The test results are presented on Figure A-9.

SYMBOL	SAMPLING DESCRIPTION
	Location of sample obtained in general accordance with ASTM D 1586 Standard Penetration Test with recovery
	Location of sample obtained using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D 1587 with recovery
	Location of sample obtained using Dames & Moore sampler and 300-pound hammer or pushed with recovery
	Location of sample obtained using Dames & Moore or 3-inch-O.D. split-spoon sampler and 140-pound hammer or pushed with recovery
⊠	Location of grab sample
▮	Rock coring interval
∇	Water level during drilling
▼	Water level taken on date shown

Graphic Log of Soil and Rock Types



GEOTECHNICAL TESTING EXPLANATIONS

ATT	Atterberg Limits	P	Pushed Sample
CBR	California Bearing Ratio	PP	Pocket Penetrometer
CON	Consolidation	P200	Percent Passing U.S. Standard No. 200 Sieve
DD	Dry Density	RES	Resilient Modulus
DS	Direct Shear	SIEV	Sieve Gradation
HYD	Hydrometer Gradation	TOR	Torvane
MC	Moisture Content	UC	Unconfined Compressive Strength
MD	Moisture-Density Relationship	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal

ENVIRONMENTAL TESTING EXPLANATIONS

CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
ppm	Parts per Million	MS	Moderate Sheen
		HS	Heavy Sheen

EXPLORATION KEY

TABLE A-1

RELATIVE DENSITY - COARSE-GRAINED SOILS

Relative Density	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)
Very Loose	0 - 4	0 - 11	0 - 4
Loose	4 - 10	11 - 26	4 - 10
Medium Dense	10 - 30	26 - 74	10 - 30
Dense	30 - 50	74 - 120	30 - 47
Very Dense	More than 50	More than 120	More than 47

CONSISTENCY - FINE-GRAINED SOILS

Consistency	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)	Unconfined Compressive Strength (tsf)
Very Soft	Less than 2	Less than 3	Less than 2	Less than 0.25
Soft	2 - 4	3 - 6	2 - 5	0.25 - 0.50
Medium Stiff	4 - 8	6 - 12	5 - 9	0.50 - 1.0
Stiff	8 - 15	12 - 25	9 - 19	1.0 - 2.0
Very Stiff	15 - 30	25 - 65	19 - 31	2.0 - 4.0
Hard	More than 30	More than 65	More than 31	More than 4.0

PRIMARY SOIL DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS (more than 50% retained on No. 200 sieve)	GRAVEL (more than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVELS (< 5% fines)	GW or GP	GRAVEL
		GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)	GW-GM or GP-GM	GRAVEL with silt
			GW-GC or GP-GC	GRAVEL with clay
		GRAVELS WITH FINES (> 12% fines)	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND (50% or more of coarse fraction passing No. 4 sieve)	CLEAN SANDS (<5% fines)	SW or SP	SAND
		SANDS WITH FINES (≥ 5% and ≤ 12% fines)	SW-SM or SP-SM	SAND with silt
			SW-SC or SP-SC	SAND with clay
		SANDS WITH FINES (> 12% fines)	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS (50% or more passing No. 200 sieve)	SILT AND CLAY	Liquid limit less than 50	ML	SILT
			CL	CLAY
			CL-ML	silty CLAY
			OL	ORGANIC SILT or ORGANIC CLAY
		Liquid limit 50 or greater	MH	SILT
			CH	CLAY
			OH	ORGANIC SILT or ORGANIC CLAY
HIGHLY ORGANIC SOILS			PT	PEAT

MOISTURE CLASSIFICATION

Term	Field Test
dry	very low moisture, dry to touch
moist	damp, without visible moisture
wet	visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Secondary granular components or other materials such as organics, man-made debris, etc.

Percent	Silt and Clay In:		Percent	Sand and Gravel In:	
	Fine-Grained Soils	Coarse-Grained Soils		Fine-Grained Soils	Coarse-Grained Soils
< 5	trace	trace	< 5	trace	trace
5 - 12	minor	with	5 - 15	minor	minor
> 12	some	silty/clayey	15 - 30	with	with
			> 30	sandy/gravelly	sandy/gravelly

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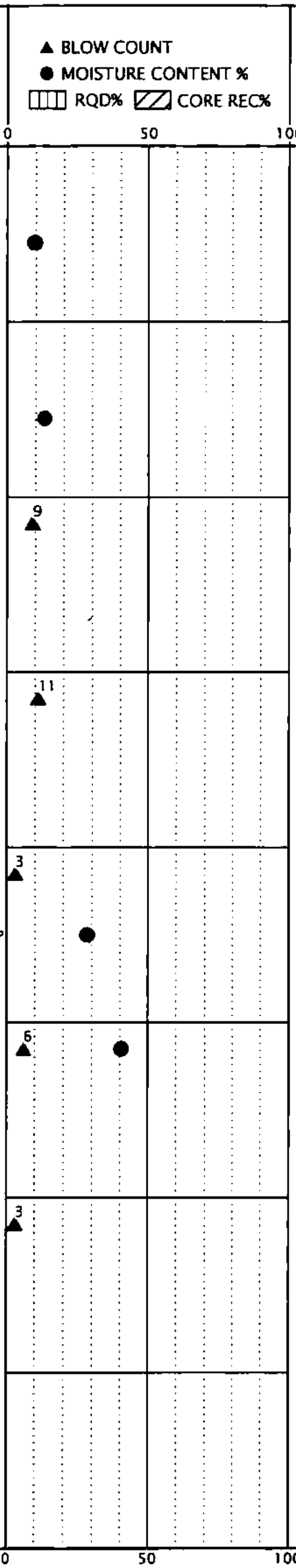
SOIL CLASSIFICATION SYSTEM

TABLE A-2

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0	CRUSHED ROCK.	0.2		
	Loose to medium dense, gray, medium SAND (SP), trace gravel and silt; moist, angular - **FILL**.			
5	becomes brown at 5.0 feet			
	Loose to medium dense, gray SAND (SP), trace silt; moist.	9.0		Hand auger to 8.0 feet to clear for utilities.
10				⊻ 13.0 feet, during exploration
15	becomes dark gray and wet at 15.0 feet			
	Soft, dark brown SILT (ML); wet.	17.0		
20				
	grades to medium stiff at 23.0 feet		DD CON PP	DD = 94 pcf PP = 3.75 tsf
25			ATT	LL = 48% PL = 28%
30	grades to soft at 30.0 feet			
	Exploration completed at a depth of 31.5 feet.	31.5		Surface elevation was not measured at the time of exploration.
35				
40				



DRILLED BY: Cascade Drilling, Inc.
LOGGED BY: BBP
COMPLETED: 02/25/08

BORING METHOD: hollow-stem auger (see report text)
BORING BIT DIAMETER: 8-inch

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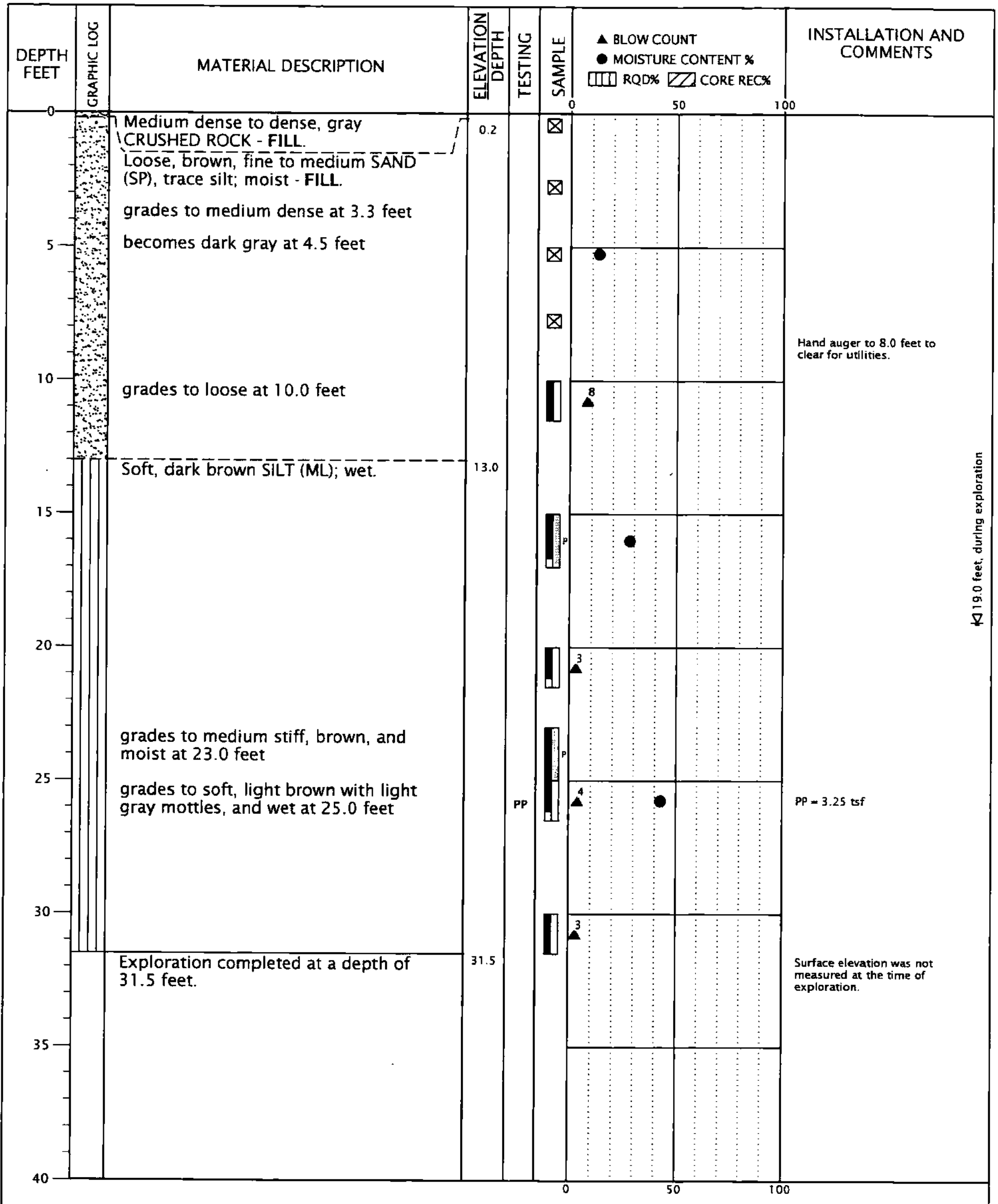
BORING B-1

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-1



Medium dense to dense, gray CRUSHED ROCK - **FILL**.

Loose, brown, fine to medium SAND (SP), trace silt; moist - **FILL**.

grades to medium dense at 3.3 feet

becomes dark gray at 4.5 feet

grades to loose at 10.0 feet

Soft, dark brown SILT (ML); wet.

grades to medium stiff, brown, and moist at 23.0 feet

grades to soft, light brown with light gray mottles, and wet at 25.0 feet

Exploration completed at a depth of 31.5 feet.

Hand auger to 8.0 feet to clear for utilities.

∇ 19.0 feet, during exploration

PP = 3.25 tsf

Surface elevation was not measured at the time of exploration.

DRILLED BY: Cascade Drilling, Inc.

LOGGED BY: BBP

COMPLETED: 02/25/08

BORING METHOD: hollow-stem auger (see report text)

BORING BIT DIAMETER: 8-inch

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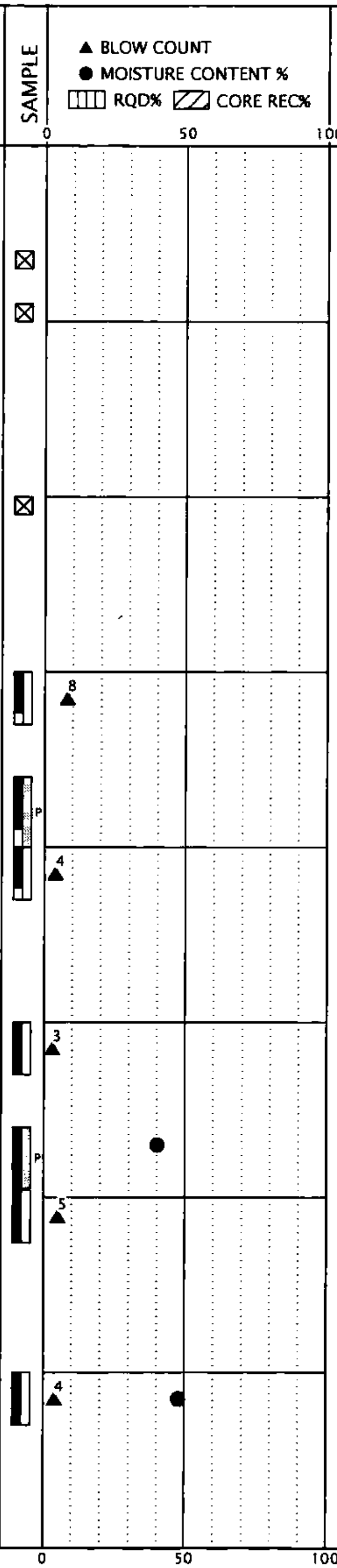
BORING B-2

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-2

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	INSTALLATION AND COMMENTS
0	Medium dense, gray CRUSHED ROCK; dry.	0.3			⊲ 3.0 feet during exploration
	Loose to medium dense, brown, fine to medium SAND (SP), trace silt; dry to moist - **FILL**.	3.0		☒	
	Loose to medium dense, gray, fine to coarse SAND (SP), trace clay and organics; wet.	4.5		☒	
5	Medium stiff, gray, sandy SILT (ML); wet.				Hand auger to 8.0 feet to clear for utilities.
10	Loose, dark gray, fine to medium SAND (SP), trace silt; wet, rapid dilatancy.	9.5		☒	
	Medium stiff to stiff, gray SILT (ML), trace clay; moist.	13.0			
15					
20	Very loose to loose, brown, fine SAND (SP), trace to minor silt; wet, rapid dilatancy.	19.5	PP		PP = 2.5 tsf
25	Very soft to soft, brown SILT (ML), trace to minor sand; wet, interbedded with fine, silty sand.	25.0			
			DD CON		DD = 81 pcf
30			PP		PP = 2.5 tsf
35	grade to soft to medium stiff at 35.0 feet				
40					



DRILLED BY: Cascade Drilling, Inc.

LOGGED BY: BBP

COMPLETED: 03/03/08

BORING METHOD: hollow-stem auger (see report text)

BORING BIT DIAMETER: 8-inch

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CHEVRON-1-01

JUNE 2008

BORING B-3

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-3

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % ▥ RQD% ▨ CORE REC% 0 50 100	INSTALLATION AND COMMENTS
40		Medium dense, gray-brown, fine SAND (SP), trace silt; wet, interbedded with silt to sandy silt.	40.0			22	
45		Dense, dark gray to black, fine SAND (SP), trace silt to fine SAND with silt (SP-SM); moist to wet, slow dilatancy.	45.0			34	
50		Exploration terminated due to refusal on bedrock at a depth of 49.6 feet.	49.6			0-50/1"	Note: chatter, wood fiber in cuttings at 49.0 feet. Surface elevation was not measured at the time of exploration.
55							
60							
65							
70							
75							
80						0 50 100	

DRILLED BY: Cascade Drilling, Inc.
LOGGED BY: BBP
COMPLETED: 03/03/08

BORING METHOD: hollow-stem auger (see report text)
BORING BIT DIAMETER: 8-inch

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CHEVRON-1-01

JUNE 2008

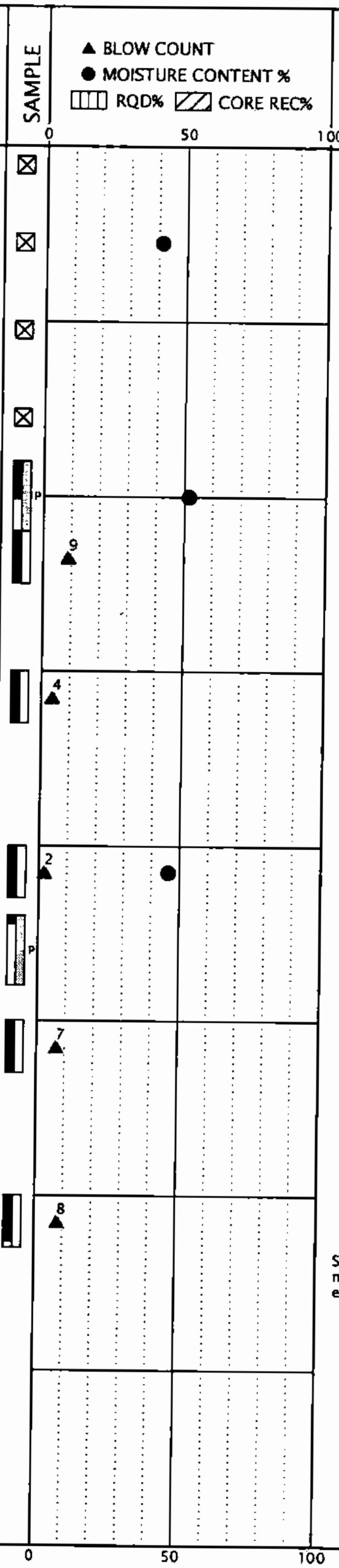
BORING B-3
(continued)

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-3

BORING LOG CHEVRON-1-01-B1-7.GPJ GEODESIGN.GDT PRINT DATE: 6/3/08:08

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0	Medium dense to dense, gray CRUSHED ROCK; dry.	0.3		▽2.0 fee during exploratio
	Loose to medium dense, brown, fine to medium SAND (SP), trace silt; dry to moist - **FILL**.			
	grades to medium dense to dense, fine to coarse with minor gravel, and wet at 2.5 feet			
5	Soft, gray SILT (ML), trace sand and clay; wet, slow dilatancy, petroleum-like odor.	4.5		
	grades to very soft at 9.0 feet			Hand auger to 8.0 feet to clear for utilities.
10			PP	PP = 0.0 tsf
	Stiff, gray SILT (ML), minor clay; moist.	11.0		
15	grades to medium stiff with trace sand and wet at 15.0 feet			
20	grades to very soft to soft with trace clay at 20.0 feet			
25	grades to medium stiff to stiff with some clay at 25.0 feet			
30	becomes light brown with minor clay and moist to wet at 30.0 feet			
	Exploration completed at a depth of 31.5 feet.	31.5		Surface elevation was not measured at the time of exploration.
35				
40				



DRILLED BY: Cascade Drilling, Inc.

LOGGED BY: BBP

COMPLETED: 02/26/08

BORING METHOD: hollow-stem auger (see report text)

BORING BIT DIAMETER: 8-inch

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CHEVRON-1-01

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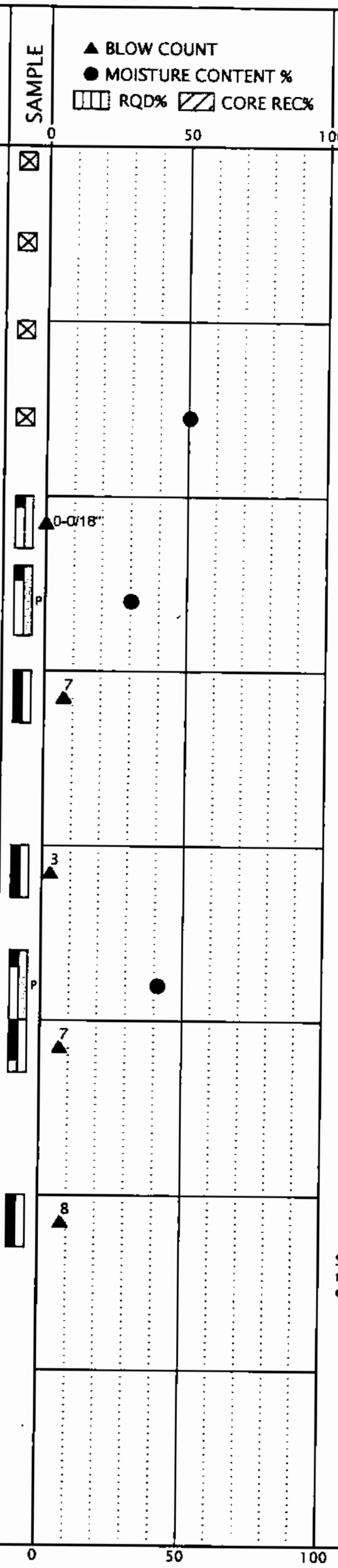
BORING B-4

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-4

BORING LOG CHEVRON-1-01-B1-7.GPJ GEODESIGN.GDT PRINT DATE: 6/3/08:OB

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0	Medium dense to dense, gray CRUSHED ROCK; dry.	0.2		▽2.0 fee during exploratio
	Loose to medium dense, brown, fine to medium SAND (SP), trace silt; dry to moist - **FILL.** becomes brown-gray and wet at 3.0 feet			
5	Soft, dark gray, sandy SILT (ML) to fine SAND with silt (SP-SM); wet.	4.5		
	Loose, dark gray, fine, silty SAND (SM); wet.	6.5		Hand auger to 8.0 feet to clear for utilities.
10	Very soft, dark gray SILT (ML), minor sand; wet.	10.0		
15	grades to medium stiff, gray with trace to minor sand at 15.0 feet			
20	grades to soft and interbedded with sandy silt at 20.0 feet			
25	grades to medium stiff with some clay at 23.0 feet		PP DD CON	DD = 77 pcf PP = 1.0 tsf
30	Exploration completed at a depth of 31.5 feet.	31.5		Surface elevation was not measured at the time of exploration.
35				
40				



DRILLED BY: Cascade Drilling, Inc.

LOGGED BY: BBP

COMPLETED: 02/26/08

BORING METHOD: hollow-stem auger (see report text)

BORING BIT DIAMETER: 8-inch

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CHEVRON-1-01

JUNE 2008

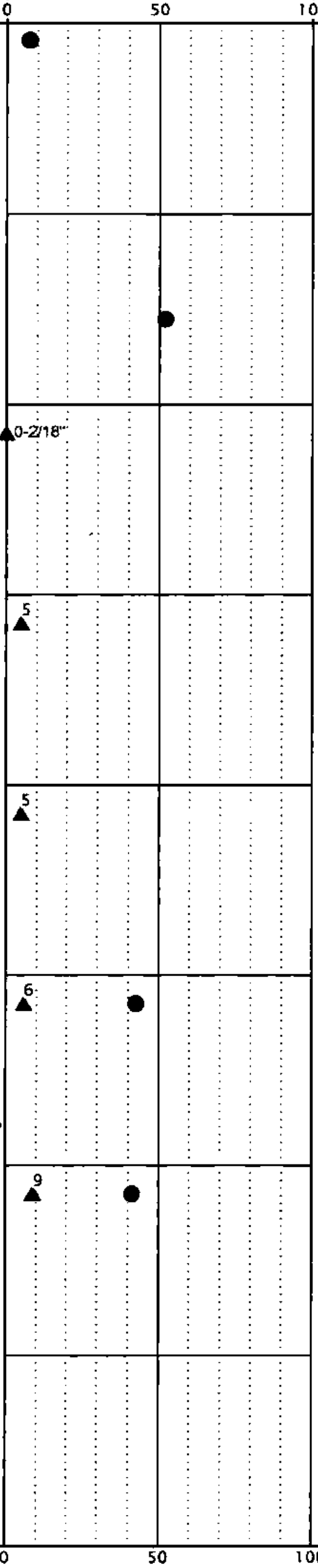
BORING B-5

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-5

BORING LOG CHEVRON-1-01-B1-7.GPJ GEODESIGN.GDT PRINT DATE: 6/3/08:08

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION / DEPTH	TESTING	SAMPLE	INSTALLATION AND COMMENTS
0	Medium dense to dense, gray CRUSHED ROCK; dry.	0.3		☒	⊻ 4.0 feet during exploration
	Loose, brown, fine SAND (SP), trace silt; dry to moist - **FILL**.	2.5		☒	
	Loose, brown, fine to medium SAND (SP), trace silt; dry to moist.	3.8			
5	Soft, brown SILT (ML), trace clay; wet.	4.1		☒	
	Very loose to loose, dark brown, fine to medium SAND (SP), trace silt; wet.	7.0			
	Soft to medium stiff, dark gray, sandy SILT (ML); wet.			☒	Hand auger to 8.0 feet to clear for utilities.
10	grades to soft and brown-gray at 10.0 feet				
15	grades to medium stiff and light brown with some clay at 15.0 feet				
20					
	with trace sand, and few iron oxide nodules at 23.0 feet				
25					
	grades to stiff at 28.0 feet			P	
30			ATT PP		PP = 2.0 tsf LL = 39% PL = 30% Surface elevation was not measured at the time of exploration.
	Exploration completed at a depth of 31.5 feet.	31.5			
35					
40					



DRILLED BY: Cascade Drilling, Inc.

LOGGED BY: BBP

COMPLETED: 02/26/08

BORING METHOD: hollow-stem auger (see report text)

BORING BIT DIAMETER: 8-inch

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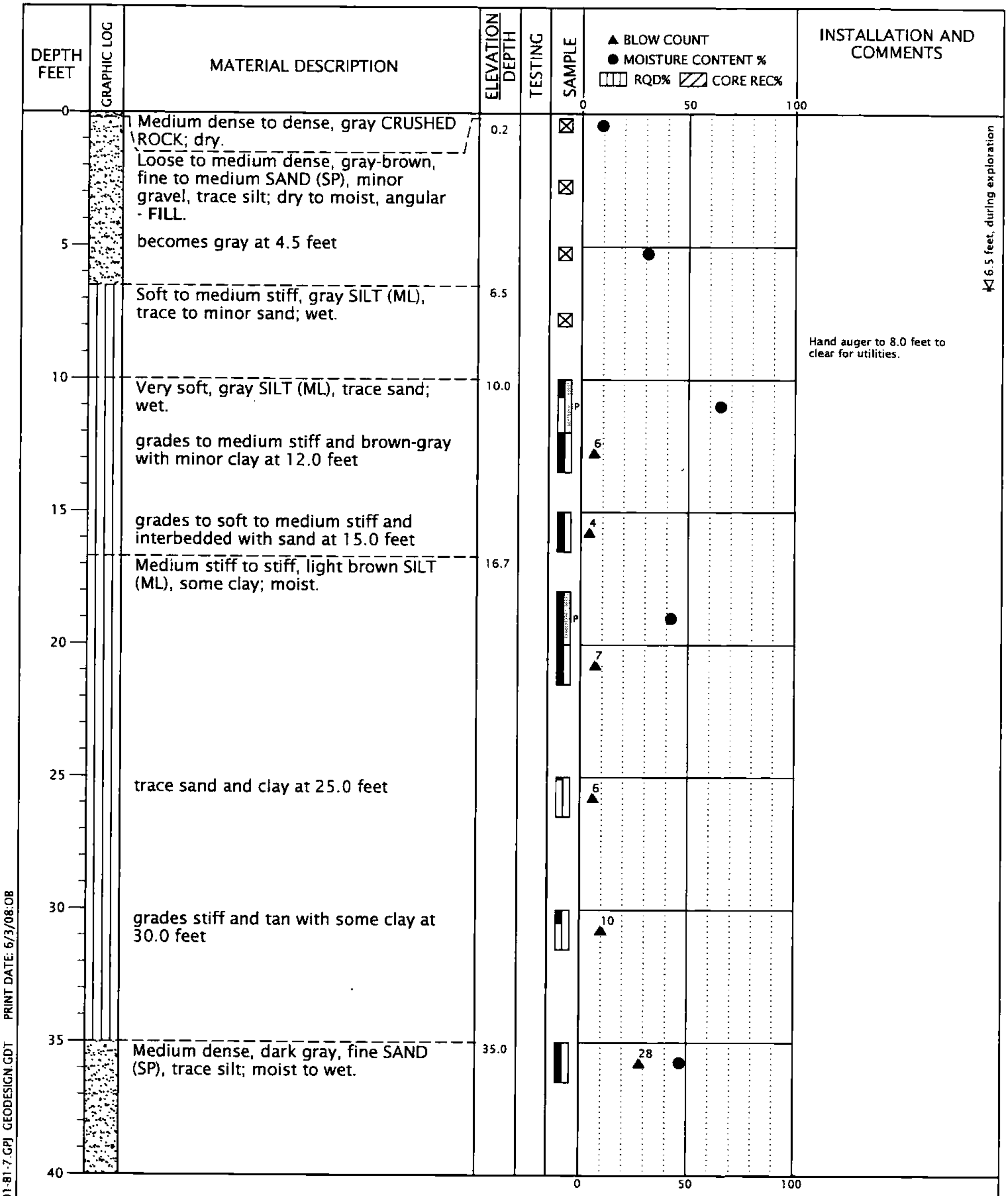
CHEVRON-1-01

BORING B-6

JUNE 2008

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-6



MATERIAL DESCRIPTION	ELEVATION DEPTH	▲ BLOW COUNT	INSTALLATION AND COMMENTS
Medium dense to dense, gray CRUSHED ROCK; dry.	0.2		
Loose to medium dense, gray-brown, fine to medium SAND (SP), minor gravel, trace silt; dry to moist, angular - **FILL**.			
becomes gray at 4.5 feet			▽6.5 feet, during exploration
Soft to medium stiff, gray SILT (ML), trace to minor sand; wet.	6.5		Hand auger to 8.0 feet to clear for utilities.
Very soft, gray SILT (ML), trace sand; wet.	10.0		
grades to medium stiff and brown-gray with minor clay at 12.0 feet		6	
grades to soft to medium stiff and interbedded with sand at 15.0 feet		4	
Medium stiff to stiff, light brown SILT (ML), some clay; moist.	16.7	7	
trace sand and clay at 25.0 feet		6	
grades stiff and tan with some clay at 30.0 feet		10	
Medium dense, dark gray, fine SAND (SP), trace silt; moist to wet.	35.0	28	

DRILLED BY: Cascade Drilling, Inc.

LOGGED BY: BBP

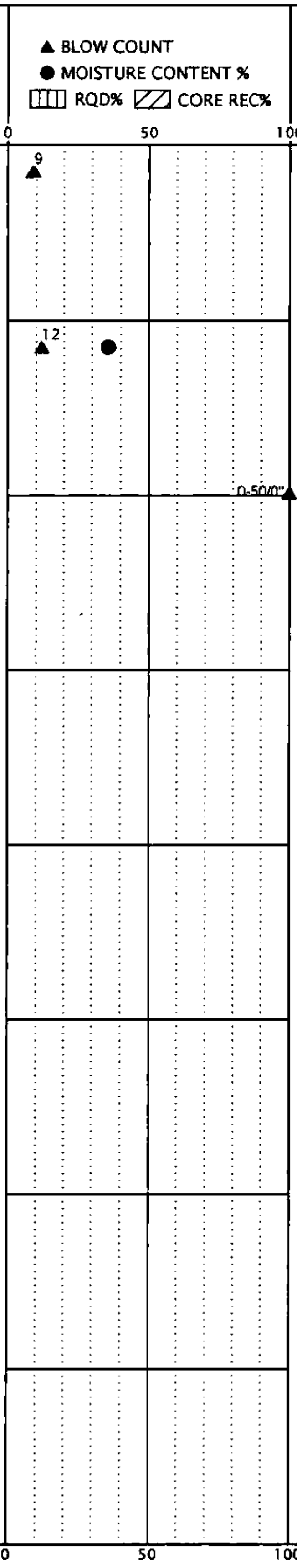
COMPLETED: 02/29/08

BORING METHOD: hollow-stem auger (see report text)

BORING BIT DIAMETER: 8-inch

GEODESIGN INC 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068	CHEVRON-1-01	**BORING B-7**	
	JUNE 2008	CHEVRON WILLBRIDGE TERMINAL EXPANSION PORTLAND, OR	**FIGURE A-7**

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	INSTALLATION AND COMMENTS
40		grades to loose and wet at 40.0 feet				
45		grades to medium dense and gray at 45.0 feet				
50		Exploration completed at a depth of 50.0 feet.	50.0			Surface elevation was not measured at the time of exploration.
55						
60						
65						
70						
75						
80						



DRILLED BY: Cascade Drilling, Inc.
LOGGED BY: BBP
COMPLETED: 02/29/08

BORING METHOD: hollow-stem auger (see report text)
BORING BIT DIAMETER: 8-inch

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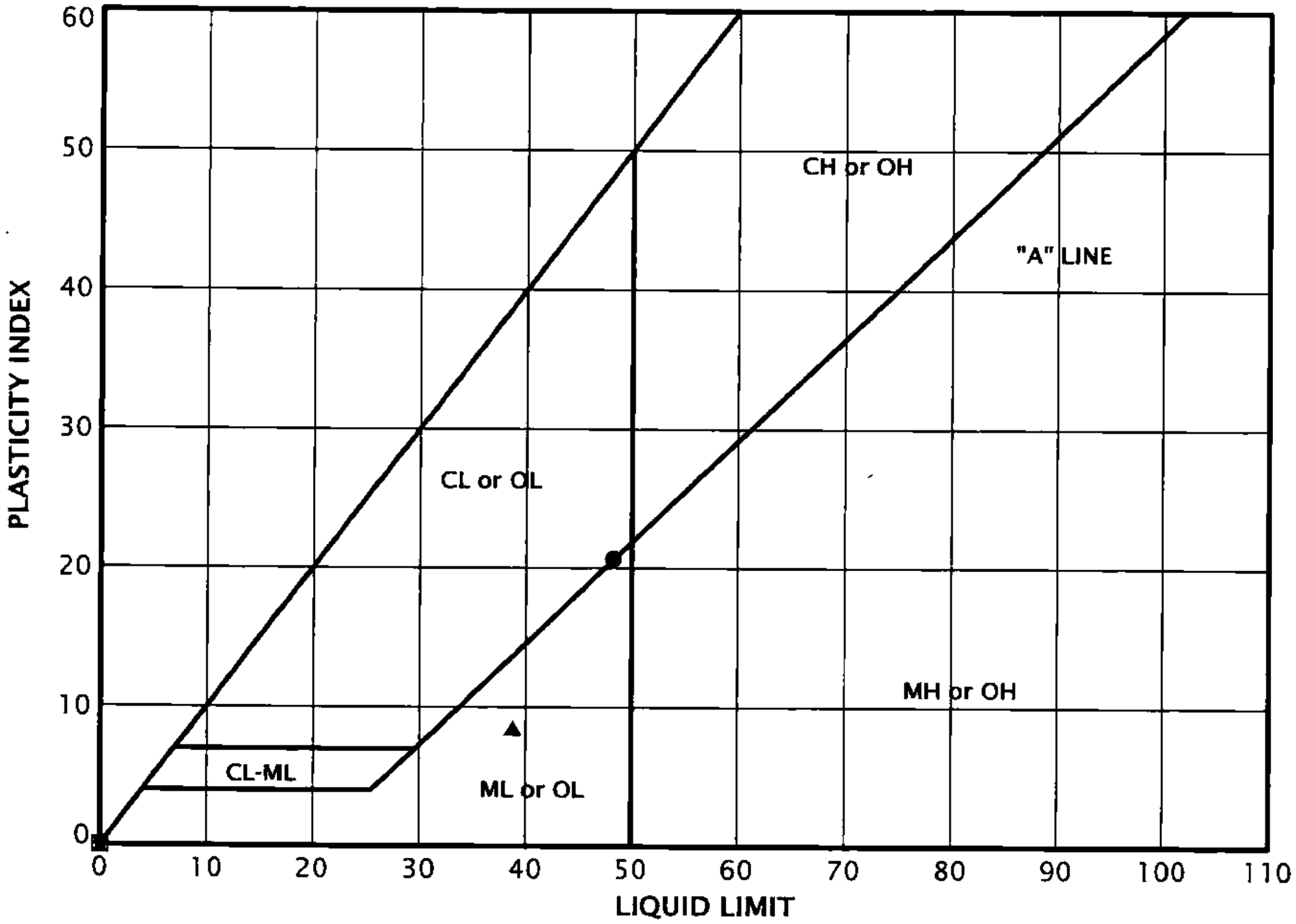
CHEVRON-1-01

JUNE 2008

BORING B-7
(continued)

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-7



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
●	B-1	25.0	40	48	28	20
☒	B-3	35.0	48	NP	NP	NP
▲	B-6	30.0	41	39	30	9
★	B-7	18.0	42	NP	NP	NP

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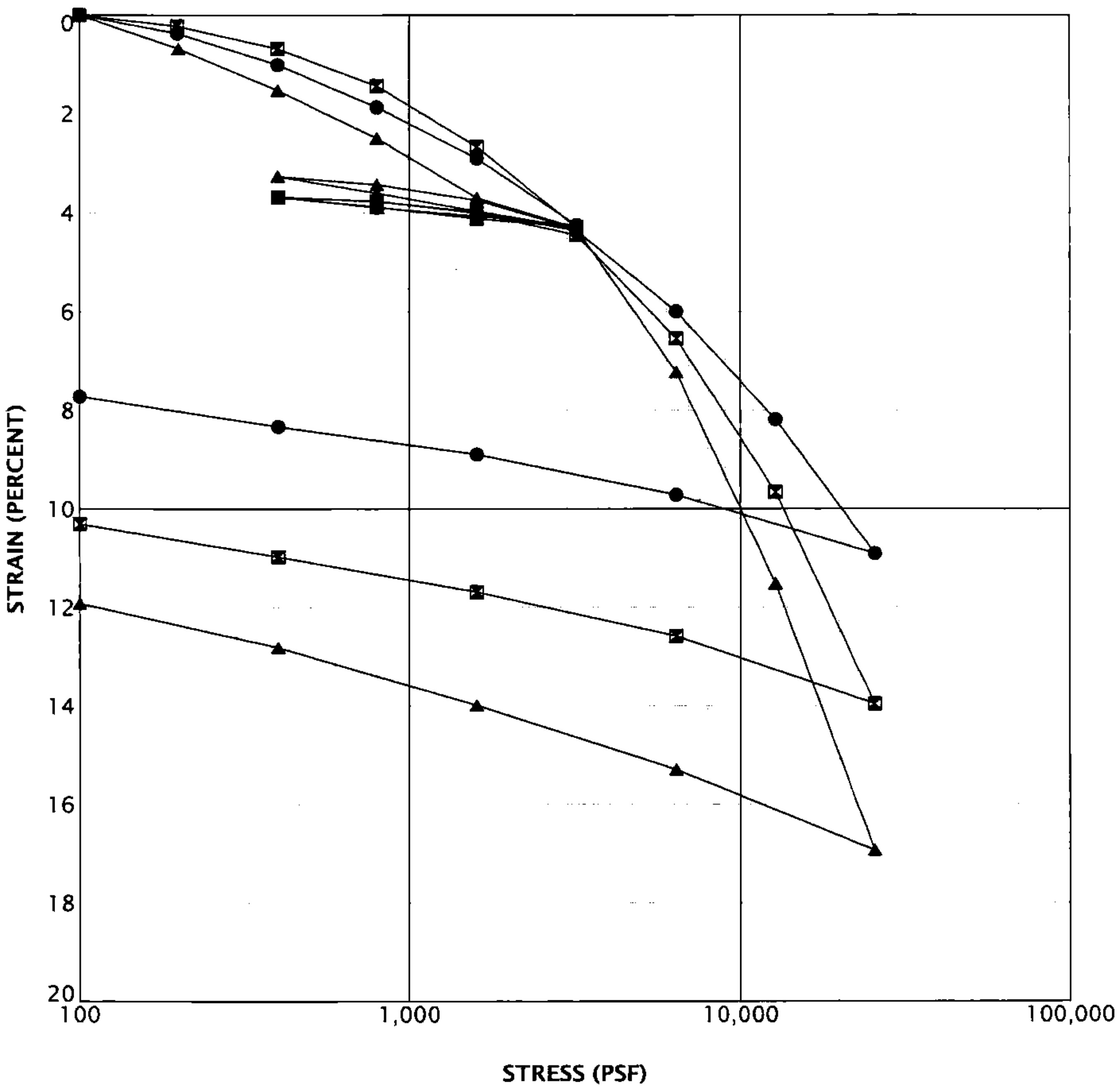
CHEVRON-1-01

JUNE 2008

ATTERBERG LIMITS TEST RESULTS

CHEVRON WILLBRIDGE TERMINAL EXPANSION
PORTLAND, OR

FIGURE A-8



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)
●	B-1	22.5	28	94
☒	B-3	28.5	40	81
▲	B-5	23.0	41	77

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CHEVRON-1-01	**CONSOLIDATION TEST RESULTS**		
JUNE 2008	CHEVRON WILLBRIDGE TERMINAL EXPANSION PORTLAND, OR	**FIGURE A-9**	

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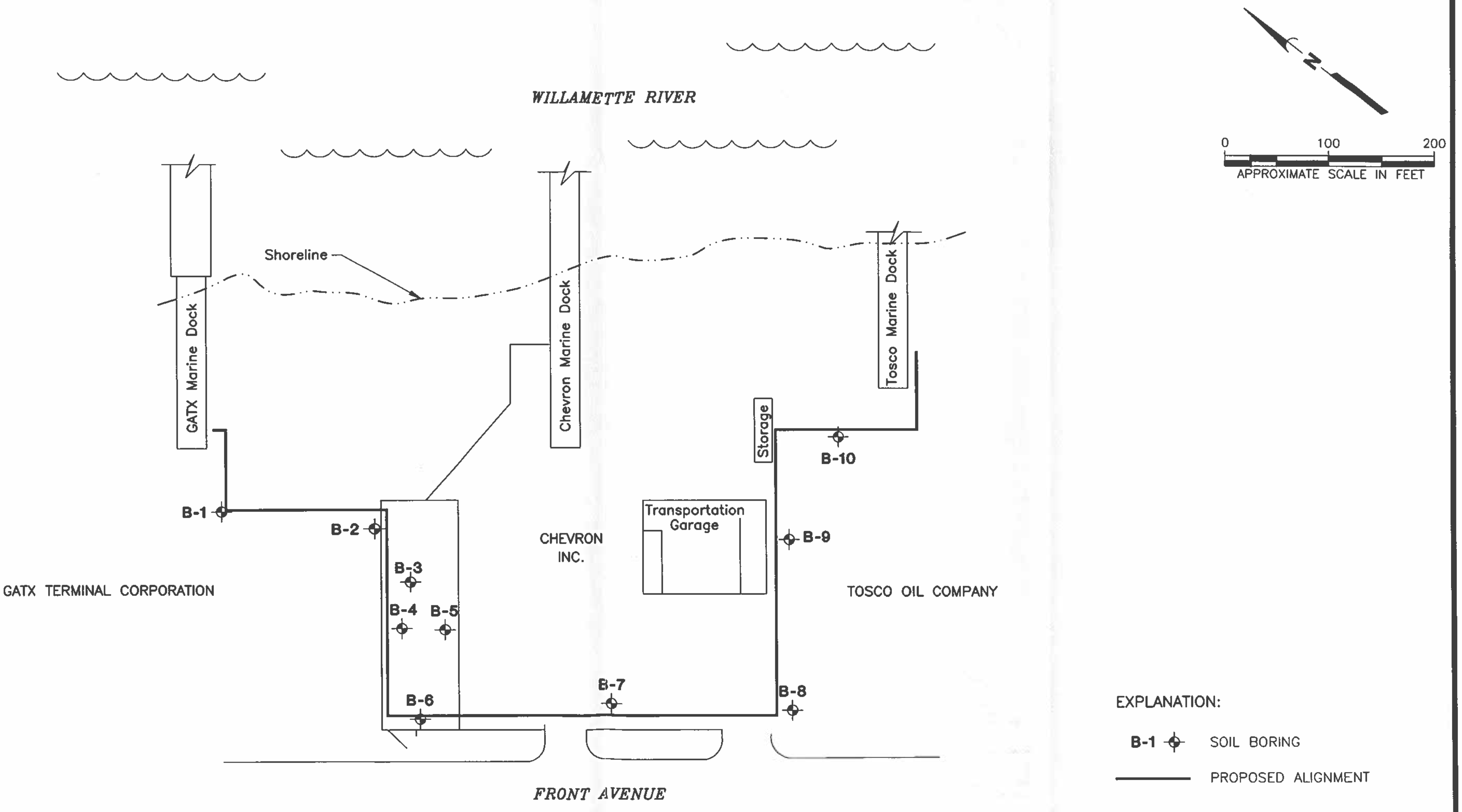

Note: The locations of all features shown are approximate.

Reference: Drawing provided by McDowell Welding and Pipefitting, dated 05/10/00.

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SITE PLAN

FIGURE 2

0372-134-00 BAS:RJW 05/30/00

APPENDIX A

FIELD EXPLORATIONS

Subsurface conditions at the site were explored by 10 borings drilled with truck-mounted hollow-stem auger and mud-rotary equipment. The borings were drilled to depths varying from 11.5 and 41.5 feet. Figure 2 shows the approximate boring locations.

Drilling services were provided by Geo-Tech Explorations, Inc. of Tualatin, Oregon. Field activities were observed by a member of GeoEngineers' staff.

Soil samples were obtained from the borings using one of the following methods:

1. Standard penetration tests were performed in some of the borings in general conformance with ASTM Test Method D 1586. The sampler was driven with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler 1 foot, or as otherwise indicated, into the soils is shown adjacent to the sample symbols on the boring logs. Disturbed samples were obtained from the split barrel for subsequent classification and index testing.
2. Relatively undisturbed samples were obtained using a Dames & Moore Type-U sampler. The sampler was driven using a 300-pound hammer falling 30 inches, similar to the standard penetration test samples, and the penetration resistance was recorded for general correlation. Samples retained from the split barrel consist of up to six, 1-inch-high by 2.48-inch-diameter brass rings. Disturbed rings were generally not retained.

Materials encountered in the borings were classified in the field in general accordance with ASTM Standard Practice D 2488, the Standard Practice for the Classification of Soils (Visual-Manual Procedure), which is described in Figure A-1. Figure A-2 provides a description of the boring log forms. Soil classifications and sampling intervals are shown in the boring logs in this appendix. Inclined lines at the material contacts shown on the logs indicate uncertainty as to the exact contact elevation, rather than the inclination of the contact itself.

Cuttings were placed in containers and left at the site for disposal by others. The borings were backfilled with bentonite chips or with weak cement/bentonite grout.

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SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More Than 50% Retained on No. 200 Sieve	GRAVEL More Than 50% of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More Than 50% of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More Than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less Than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or More	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Descriptions of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry—Absence of moisture, dusty, dry to the touch

Moist—Damp, but no visible water

Wet—Visible free water or saturated, usually soil is obtained from below water table

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SOIL CLASSIFICATION SYSTEM

FIGURE A-1

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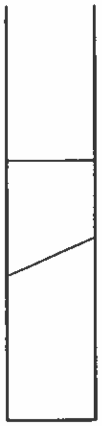
LABORATORY TESTS:

AL	Atterberg limits
CP	Compaction
CS	Consolidation
DS	Direct Sheer
GS	Grain – size
%F	Percent fines
HA	Hydrometer analysis
SK	Permeability
SM	Moisture content
MD	Moisture and density
SP	Swelling pressure
TX	Triaxial compression
UC	Unconfined compression
CA	Chemical analysis

SOIL GRAPH:



SM Soil Group Symbol (See Note 2)

Distinct Contact Between Soil Strata

Gradual or Approximate Location of Change Between Soil Strata

⊻ Water Level

Bottom of Exploration

BLOW-COUNT/SAMPLE DATA:

Blows required to drive a 2.4–inch I.D. split–barrel sampler 12 inches or other indicated distances using a 140–pound hammer falling 30 inches.

22 ■ Location of relatively undisturbed sample

12 ☒ Location of disturbed sample

17 ☐ Location of sampling attempt with no recovery

Blows required to drive a 1.5–inch I.D. (SPT) split–barrel sampler 12 inches or other indicated distances using a 140–pound hammer falling 30 inches.

10 ◨ Location of sample obtained in general accordance with Standard Penetration Test (ASTM D 1586) procedures

26 ◫ Location of SPT sampling attempt with no recovery

P I Location of relatively undisturbed sample obtained using a 2.4–inch–diameter thin–wall sample tube. Sample obtained in general accordance with ASTM D 1587.

"P" indicates sampler pushed with weight of hammer or against weight of drill rig.

▤ Location of grab sample

NOTES:

1. The reader must refer to the discussion in the report text, the Key to Boring Log Symbols and the exploration logs for a proper understanding of subsurface conditions.
2. Soil classification system is summarized in Figure A–1.

GEI 121-90

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KEY TO EXPLORATION LOG SYMBOLS

FIGURE A-2

Project McDowell Welding & Pipe Fitting, Inc.	Job Number 0372-134-00	Location Portland, Oregon

Date Drilled	05/25/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	Dames & Moore	Hammer Data	300 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes
0				GW	3/4-inch-minus crushed rock (medium dense, moist) (fill)			
				SP	Brown poorly graded fine sand, trace silt (loose, moist)			
	100	1	5			5.6	87	MD
5	100	2	4					
10	100	3	6					
					Boring completed at 11.5 feet on 05/25/00 No ground water encountered during drilling			
15								
20								

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-1

FIGURE A-3

Project	Job Number	Location
McDowell Welding & Pipe Fitting, Inc.	0372-134-00	Portland, Oregon

Date Drilled	05/25/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	SPT	Hammer Data	140 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	Sample	Graphic Log	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
0						GW	3/4-inch-minus crushed rock (medium dense, moist) (fill)				0
						SP	Brown poorly graded fine sand, trace silt (loose, moist)				
	67	1	6								
5	100	2	5								5
10	67	3	2				Consistency decreases to very loose				10
							Boring completed at 11.5 feet on 05/25/00 No ground water encountered during drilling				
15											15
20											20

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-2

FIGURE A-4

Project McDowell Welding & Pipe Fitting, Inc.	Job Number 0372-134-00	Location Portland, Oregon

Date Drilled	05/25/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Mud-rotary	Equipment	Truck-mounted Mud-rotary	Drill Bit	Tri-Cone
Sample Method	Dames & Moore and SPT	Hammer Data	300 lbs. and 140 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	41.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	Sample	Graphic Log	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
0						SP	Brown poorly graded fine sand, trace silt (loose, moist)				0
	57	1	6	■				10.4	91	MD	
5	100	2	10	■				14.7	91	MD, DS	5
10	100	3	13	■							10
							Consistency increases to medium dense				
							Moisture content increases to wet ▼				
15	100	4	10	■			Color grades to gray Petroleum odor	21.4		SM, GS	15
20											20

Note: See Figure A-2 for explanation of symbols

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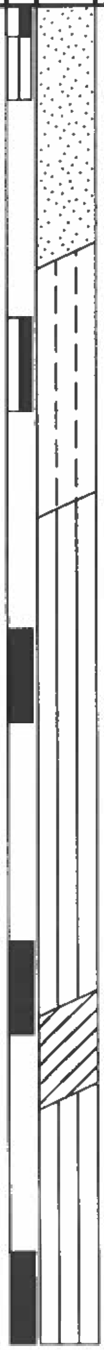
LOG OF BORING B-3

FIGURE A-5

Project	Job Number	Location
McDowell Welding & Pipe Fitting, Inc.	0372-134-00	Portland, Oregon



DEPTH IN FEET	% Recovery	Sample No.	Blow Count	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
20	33	5	8		Consistency decreases to loose Petroleum odor				20
				MH	Gray clayey silt (soft, wet)				
25	100	6	3						25
				ML	Gray silt, trace fine sand, occasional small wood fragments (soft, wet)				
30	100	7	3			44.3	75	MD, CS	30
35	100	8	2						35
				CL	Greenish gray silty clay with fine organic material (very soft, wet)				
				ML	Mottled gray and brown silt, trace fine sand (soft, wet)				
40	100	9	4						40
					Boring completed at 41.5 feet on 05/25/00 Ground water observed at a depth of 12.0 feet on 05/26/00				

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-3
(Continued)

FIGURE A-5

Project McDowell Welding & Pipe Fitting, Inc.	Job Number 0372-134-00	Location Portland, Oregon

Date Drilled	05/25/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	SPT	Hammer Data	140 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	Sample	Graphic Log	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
0						SP	Brown poorly graded fine sand, trace silt (loose, moist)				0
	67	1	9								
5	100	2	10								5
10	100	3	11				Consistency increases to medium dense				10
							Boring completed at 11.5 feet on 05/25/00 No ground water encountered during drilling				
15											15
20											20

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-4

FIGURE A-6

Project	Job Number	Location
McDowell Welding & Pipe Fitting, Inc.	0372-134-00	Portland, Oregon

Date Drilled	05/25/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	Dames & Moore	Hammer Data	300 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	Sample	Graphic Log	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
0						SP	Brown poorly graded fine sand, trace silt (loose, moist)				0
	67	1	6								
5	100	2	7					12.0	87	MD	5
10	100	3	9								10
							Boring completed at 11.5 feet on 05/25/00 No ground water encountered during drilling				
15											15
20											20

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-5

FIGURE A-7

Project McDowell Welding & Pipe Fitting, Inc.	Job Number 0372-134-00	Location Portland, Oregon

Date Drilled	05/25/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	SPT	Hammer Data	140 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes
0				GW	3/4-inch-minus crushed rock (medium dense, moist) (fill)			
				SP	Brown poorly graded fine sand, trace silt (loose, moist)			
				SM	Brown silty fine sand (very loose, moist)			
	33	1	3					
5	67	2	6	SP	Gray poorly graded fine sand, trace silt (loose, moist) Petroleum odor			
10	100	3	8		Petroleum odor			
					Boring completed at 11.5 feet on 05/25/00 No ground water encountered during drilling			
15								
20								

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-6

FIGURE A-8

Project	McDowell Welding & Pipe Fitting, Inc.	Job Number	0372-134-00	Location	Portland, Oregon
Date Drilled	05/25/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	SPT	Hammer Data	140 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	Sample	Graphic Log	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
0						TOPSOIL SP	3 inches topsoil Brown poorly graded fine sand, trace silt (loose, moist)				0
	67	1	6								
5	100	2	6					12.3		SM	5
							Color grades to gray Petroleum odor				
10	100	3	6								10
							Boring completed at 11.5 feet on 05/25/00 No ground water encountered during drilling				
15											15
20											20

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-7

FIGURE A-9

Project	Job Number	Location
McDowell Welding & Pipe Fitting, Inc.	0372-134-00	Portland, Oregon

Date Drilled	05/26/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	Dames & Moore	Hammer Data	300 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	Sample	Graphic Log	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
0						GW	3/4-inch-minus crushed rock (medium dense, moist) (fill)				0
						SP	Brown poorly graded fine sand, trace silt (loose, moist)				
	100	1	5	■							
5	100	2	4	■				9.6	93	MD	5
10	100	3	7	■							10
							Boring completed at 11.5 feet on 05/26/00 No ground water encountered during drilling				
15											15
20											20

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-8

FIGURE A-10

GEI GENERAL BO LOG 0372134.GPJ GEI_CORP.GDT 6/7/00 0372-134-00

Project	McDowell Welding & Pipe Fitting, Inc.	Job Number	0372-134-00	Location	Portland, Oregon
Date Drilled	05/26/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	SPT	Hammer Data	140 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	Sample	Graphic Log	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
0						GW	3/4-inch-minus crushed rock (medium dense, moist) (fill)				0
						SP	Brown poorly graded fine sand, trace silt (medium dense, moist)				
	67	1	11					9.2		SM	
5	100	2	7								5
							Consistency decreases to loose				
10	100	3	8								10
							Color grades to gray				
							Petroleum odor				
							Boring completed at 11.5 feet on 05/26/00 No ground water encountered during drilling				
15											15
20											20

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-9

FIGURE A-11

Project	McDowell Welding & Pipe Fitting, Inc.	Job Number	0372-134-00	Location	Portland, Oregon
Date Drilled	05/26/00	Logged By	Trevor N. Hoyles (TNH)	Contractor	Geotech Explorations, Inc.
Drill Method	Hollow-stem Auger	Equipment	Truck-mounted Hollow-stem Auger	Drill Bit	Auger
Sample Method	SPT	Hammer Data	140 lbs./30"	X-coordinate: Y-coordinate:	Not Determined Not Determined
Total Depth (ft)	11.5	Elevation (ft)	Not Measured	Datum: System:	Not Determined Not Determined

DEPTH IN FEET	% Recovery	Sample No.	Blow Count	Sample	Graphic Log	USCS Group Symbol	Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Other Tests And Notes	DEPTH IN FEET
0						GW	3/4-inch-minus crushed rock (medium dense, moist) (fill)				0
						SP	Brown poorly graded fine sand, trace silt (loose, moist)				
	100	1	9								
5	100	2	10					12.8		SM	5
10	100	3	5								10
							Boring completed at 11.5 feet on 05/26/00 No ground water encountered during drilling				
15											15
20											20

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING B-10

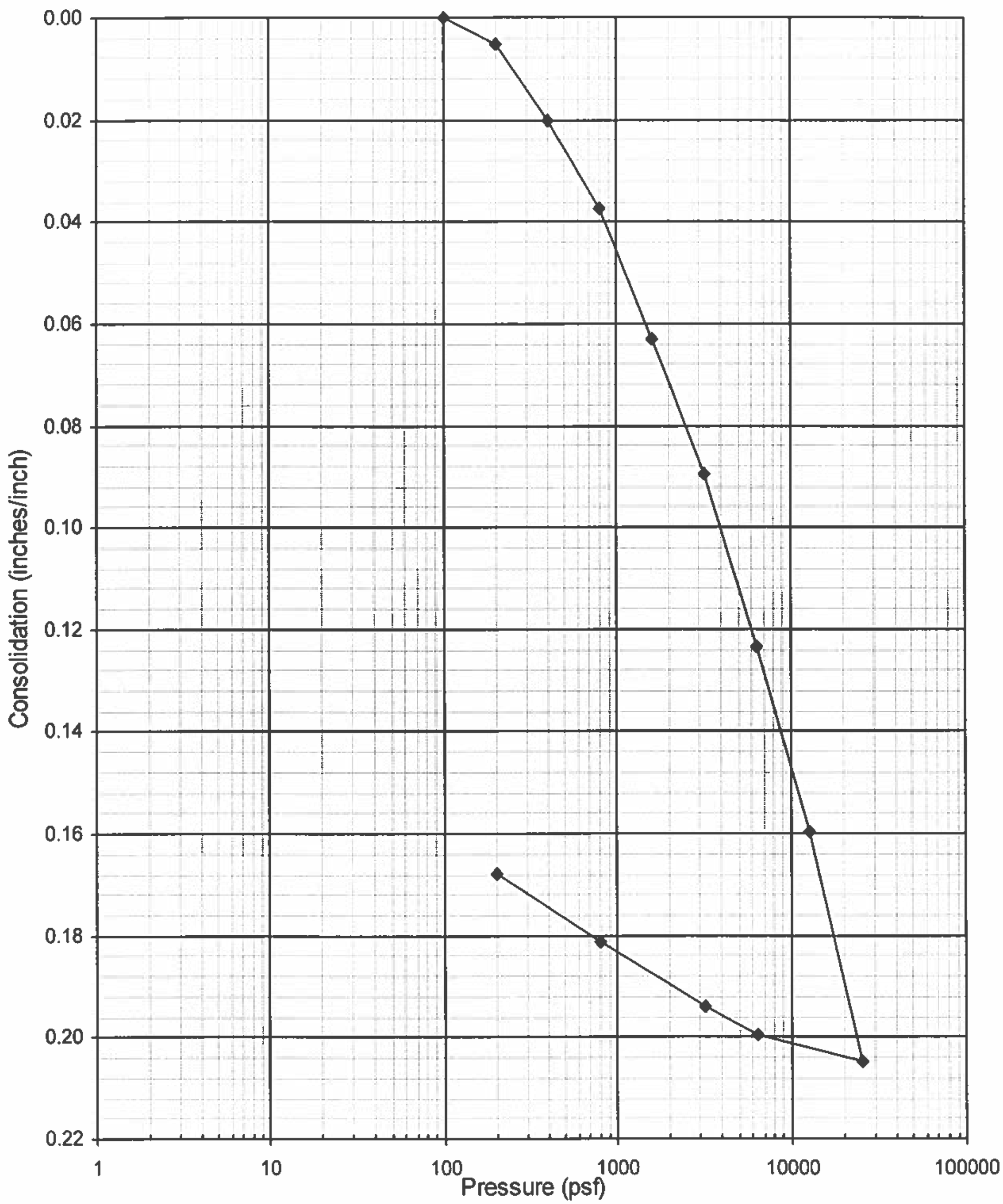
FIGURE A-12

APPENDIX B

LABORATORY TEST RESULTS

The following laboratory tests were performed:

1. Ten moisture content and/or density determinations in general accordance with ASTM Test Methods D 2216 and D 2937, respectively, to evaluate the fill suitability of the native soils. The test results are presented on the boring logs in Appendix A.
2. One consolidation test in general accordance with ASTM Test Method D 2435 to evaluate the compressibility of the site soils. Figure B-1 shows the test results.
3. One direct shear test in general accordance with ASTM Test Method D 3080 to evaluate the bearing capacity of the foundation soils. Figure B-2 shows the test results.
4. One particle size analyses in general accordance with ASTM Test Method D 4318 to confirm field classifications and evaluate the liquefaction potential of the site soils. Figure B-3 shows the test results.



BORING NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION	INITIAL MOISTURE CONTENT	INITIAL DRY DENSITY (LBS/FT³)
B-3	30.0	Gray silt, trace fine sand, occasional small wood fragments (ML)	44.3%	75

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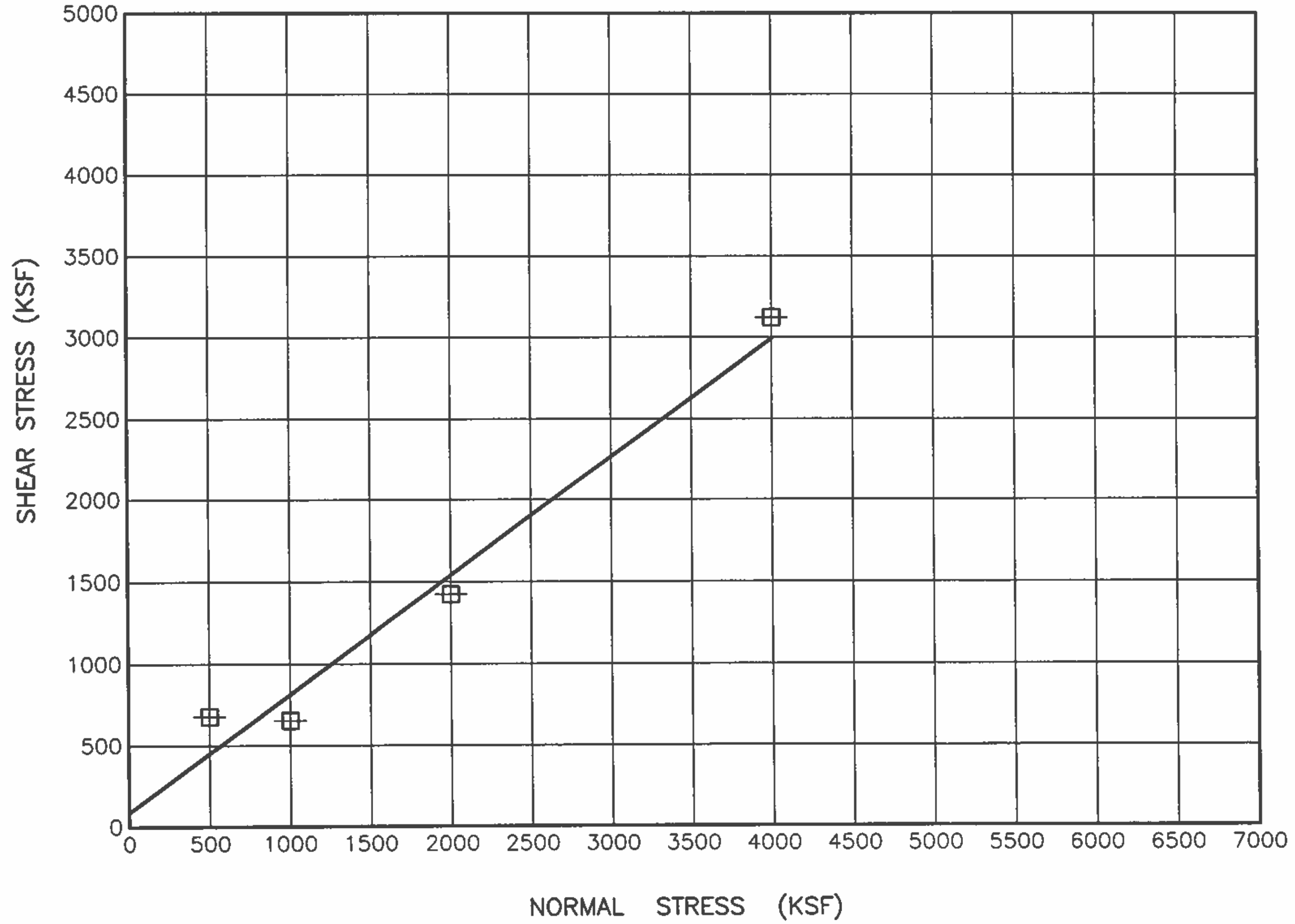
FIGURE B-1

CONSOLIDATION TEST RESULTS

0372-134-00 BAS:RJW 06/06/00

P:\0372134\00\CAD\P_SHEAR



SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	FRICTION ANGLE	COHESION (PSF)	SOIL DESCRIPTION
⊞	**B-3**	5	36°	80	Brown, poorly grade fine sand

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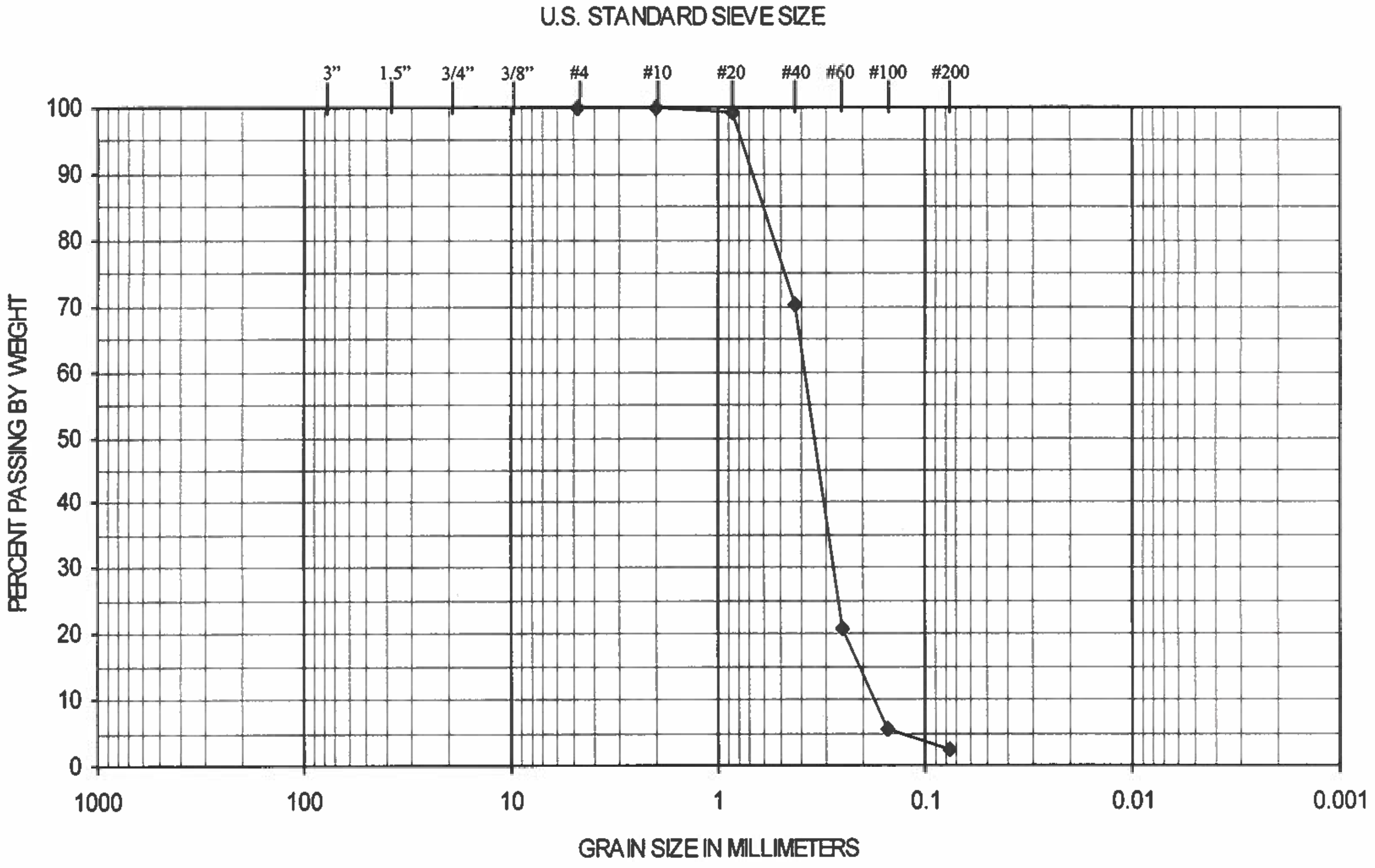
DIRECT SHEAR TEST RESULTS

FIGURE B-2

0372-134-00-2130 DRS:BAS:mln 06/06/00 (037213400A.ppt)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	BORING NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION
●	B-3	15.0	Brown poorly graded fine sand, trace silt (SP)

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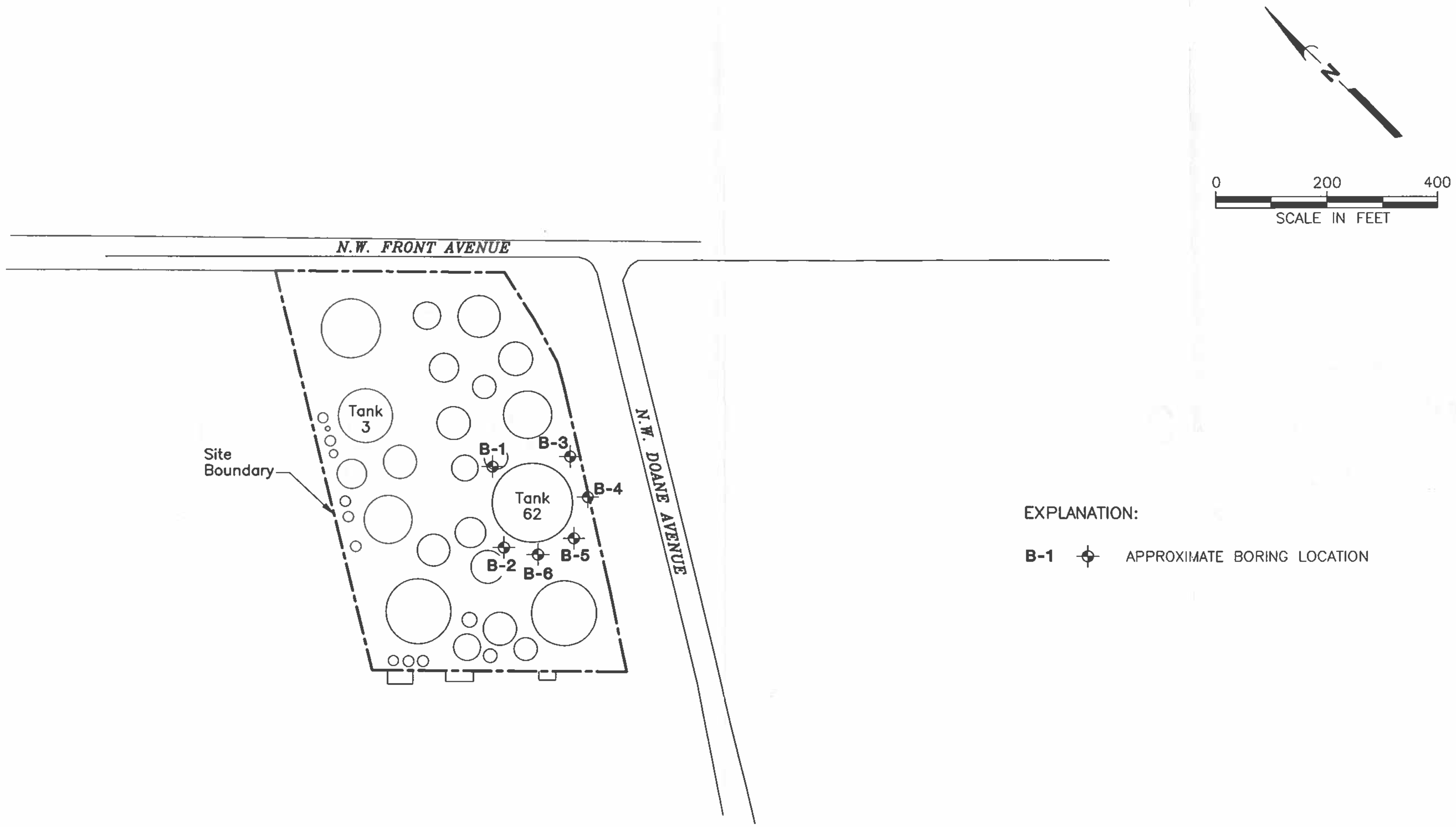
FIGURE B-3

SIEVE ANALYSIS RESULTS

P:\0372128\00\CAD\GW_SP



Note: The locations of all features shown are approximate.

Reference: Drawing entitled "General Site Plan," provided by Pacific Environmental Group, dated 10/08/98.

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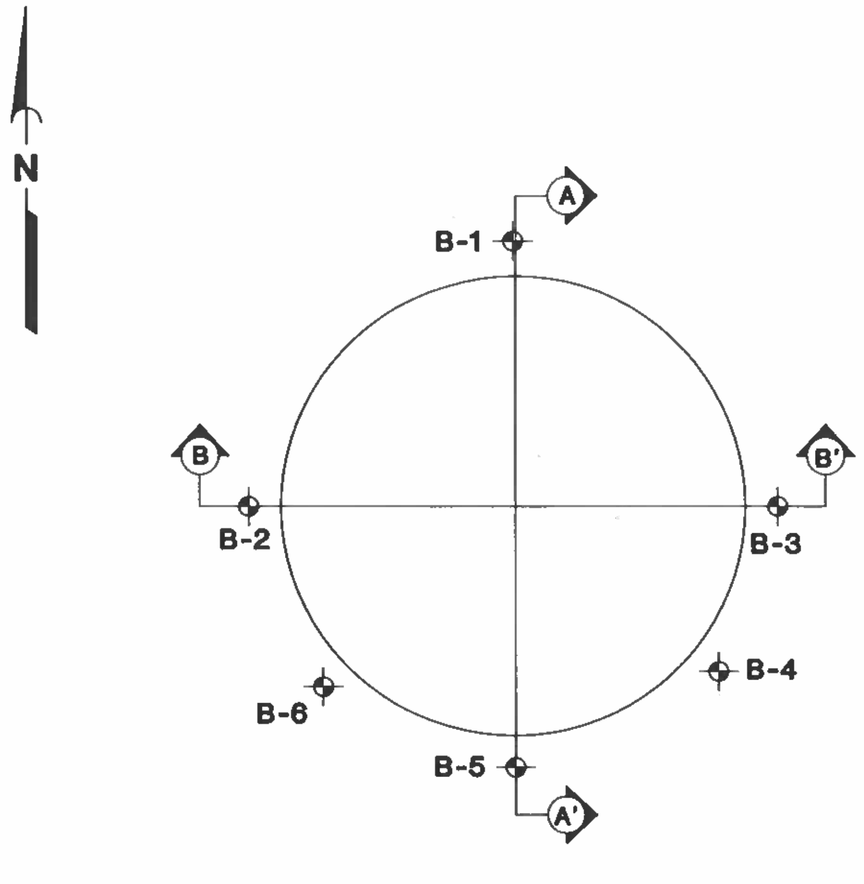
SITE PLAN

FIGURE 2

0372-128-00 BAS:RJW 10/09/98

P:\0372128\00\CA \CROSS

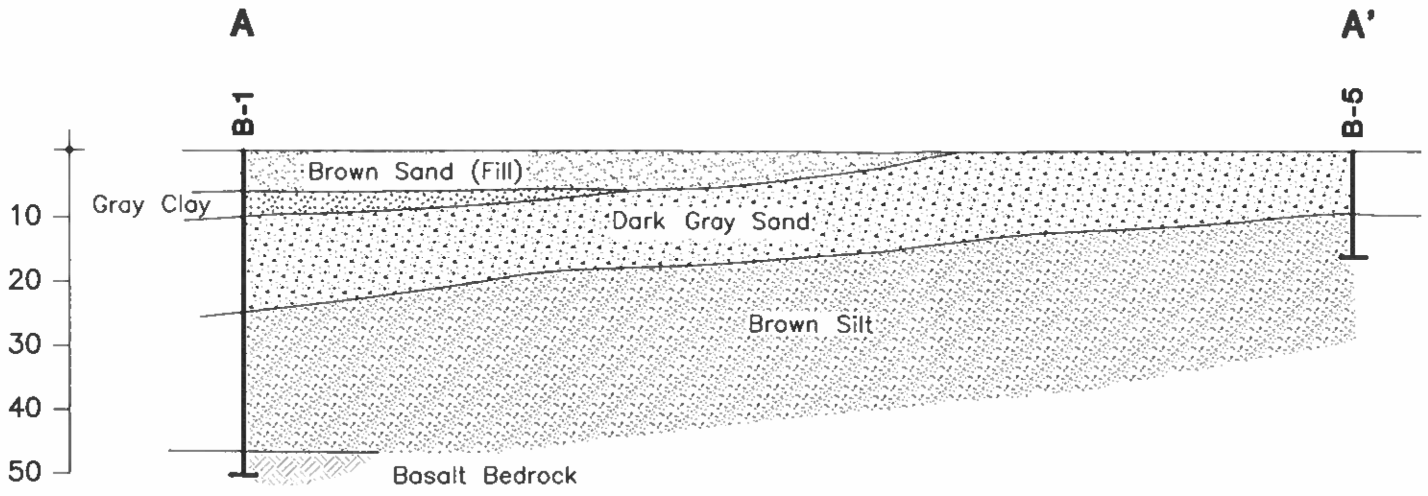


TANK 62

SCALE: 1" = 60'

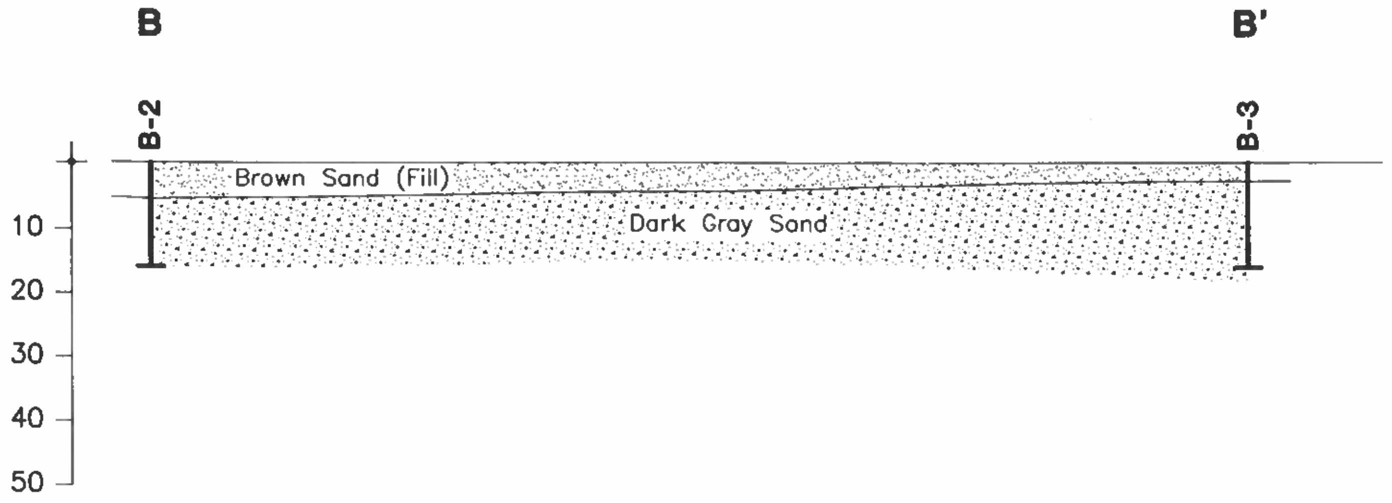
EXPLANATION:

B-1 ⌖ APPROXIMATE BORING LOCATION



CROSS SECTION A-A'

SCALE: 1" = 30'



CROSS SECTION B-B'

SCALE: 1" = 30'

Note: Subsurface conditions shown on the cross sections are interpreted based on soil conditions encountered in the borings.

Note: The locations of all features shown are approximate.

Reference: Drawing produced from sketch provided by GeoEngineers staff.

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CROSS SECTIONS

FIGURE 3

0372-128-00 BAS:RJW 10/09/98

APPENDIX A

SUBSURFACE EXPLORATION

Subsurface conditions were explored around the perimeter of the existing Tank No. 62 by drilling six borings at the approximate locations shown in Figure 2. The borings were drilled under the direction of Pacific Environmental Group on September 18, 1998. All of the borings were drilled using hollow-stem auger methods. Cascade Drilling of Clackamas, Oregon provided drilling services.

The boring locations were determined in the field by measuring from site features. Exploration locations should be considered accurate only to the degree implied by the method used.

Soil samples were obtained using one of the following methods.

1. Standard Penetration Tests were performed in the borings in general conformance with ASTM Test Method D 1586. The sampler was driven with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler 1 foot, or as otherwise indicated, into the soils is shown adjacent to the sample symbols on the boring logs. Disturbed samples were obtained from the split barrel for subsequent classification and index testing.
2. Relatively undisturbed samples were obtained using a Dames & Moore U-Type sampler in general conformance with ASTM Standard Practice D 3550. The sampler was driven using a 300-pound hammer falling 30 inches. Samples retained from the split barrel consist of up to six, 1-inch-high by 2.48-inch-diameter rings.

The boring logs indicate the depths at which the soils or their characteristics change, although the change actually may be gradual. Figure A-2 provides a description of the boring log forms. Soil classifications and sampling intervals are shown in the boring logs (Figures A-3 through A-8).

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More Than 50% Retained on No. 200 Sieve	GRAVEL More Than 50% of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More Than 50% of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More Than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less Than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or More	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Descriptions of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry -	Absence of moisture, dusty, dry to the touch
Moist -	Damp, but no visible water
Wet -	Visible free water or saturated, usually soil is obtained from below water table

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SOIL CLASSIFICATION SYSTEM

FIGURE A-1

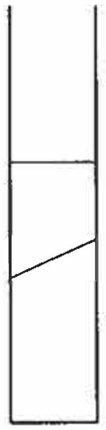
GEI85-8 5 Rev 05/93

G:\ACAD\DETAILS\GTKBR140

LABORATORY TESTS:

AL	Atterberg limits
CP	Compaction
CS	Consolidation
DS	Direct Sheer
GS	Grain – size
%F	Percent fines
HA	Hydrometer analysis
SK	Permeability
SM	Moisture content
MD	Moisture and density
SP	Swelling pressure
TX	Triaxial compression
UC	Unconfiend compression
CA	Chemical analysis
CTX	Cyclic triaxial testing

SOIL GRAPH:



SM Soil Group Symbol (See Note 2)

Distinct Contact Between Soil Strata

Gradual or Approximate Location of Change Between Soil Strata

∇ Water Level

Bottom of Boring

BLOW-COUNT/SAMPLE DATA:

Blows required to drive a 2.4–inch I.D. split–barrel sampler 12 inches or other indicated distances using a 140–pound hammer falling 30 inches.

22 ■ Location of relatively undisturbed sample

12 ☒ Location of disturbed sample

17 □ Location of sampling attempt with no recovery

Blows required to drive a 1.5–inch I.D. (SPT) split–barrel sampler 12 inches or other indicated distances using a 140–pound hammer falling 30 inches.

10 ◧ Location of sample obtained in general accordance with Standard Penetration Test (ASTM D 1586) procedures

26 ◫ Location of SPT sampling attempt with no recovery

"P" indicates sampler pushed with weight of hammer or against weight of drill rig.

P I Location of relatively undisturbed sample obtained using a 3–inch–diameter thin–wall sample tube. Sample obtained in general accordance with ASTM D 1587.

▤ Location of grab sample

NOTES:

1. The reader must refer to the discussion in the report text, the Key to Boring Log Symbols and the exploration logs for a proper understanding of subsurface conditions.
2. Soil classification system is summarized in Figure A–1.

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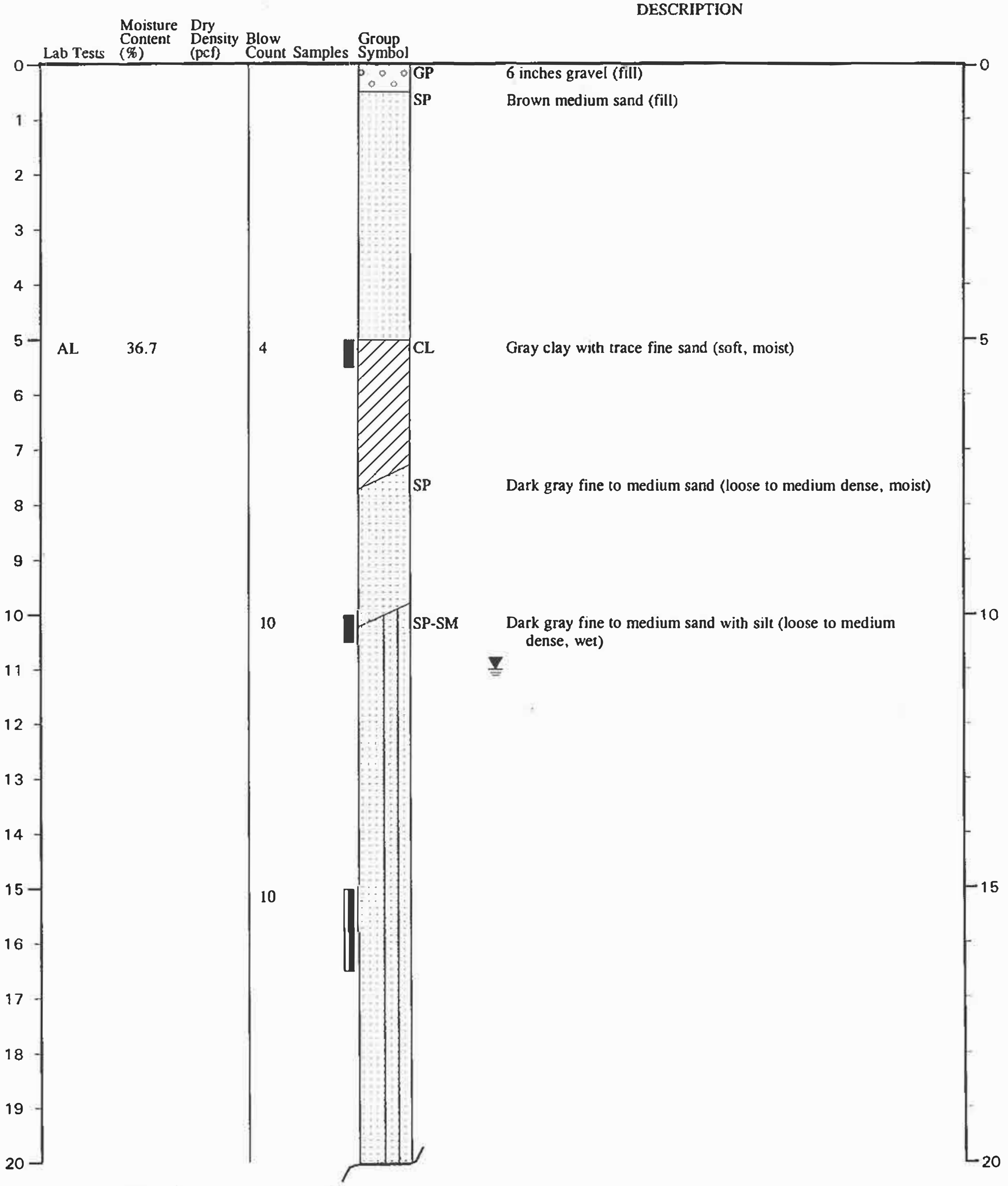
KEY TO BORING LOG SYMBOLS

FIGURE A-2

GEI 121-90

TEST DATA

BORING B-1



DEPTH IN FEET	Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
0						GP	6 inches gravel (fill)
						SP	Brown medium sand (fill)
5	AL	36.7		4	▮	CL	Gray clay with trace fine sand (soft, moist)
						SP	Dark gray fine to medium sand (loose to medium dense, moist)
10				10	▮	SP-SM	Dark gray fine to medium sand with silt (loose to medium dense, wet)
15				10	▯		

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING

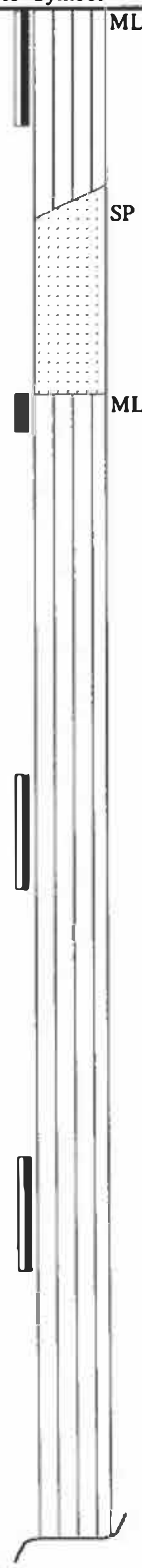
FIGURE A-3

DRS:SPM:mln 10/14/98

0372-128-00-2130

TEST DATA

BORING B-1
(Continued)



DEPTH IN FEET	Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Group Symbol	DESCRIPTION
20	SM	33.8		7	ML	Brown-gray clayey silt with trace fine sand (medium stiff, wet)
					SP	Dark gray fine to medium sand (wet)
25	CS	41.7	82	12	ML	Brown and gray clayey silt with trace fine sand (stiff, wet)
30	SM	36.9		8		Brown silt with fine sand (medium stiff to stiff, moist)
35				48		Brown silt with occasional fine sand (hard, moist)
40						

Note: See Figure A-2 for explanation of symbols

DRS:SPM:min 10/14/98

0372-128-00-2130

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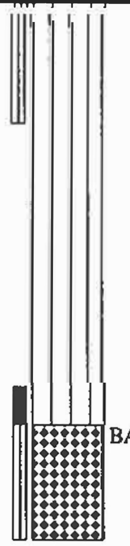
LOG OF BORING

FIGURE A-3

TEST DATA

BORING B-1
(Continued)

DEPTH IN FEET	Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
40				10			Consistency decreases to stiff
45				11			Gray clayey silt with organic debris (stiff, wet)
				76		BASALT	Basalt bedrock
47							Boring completed at 47.0 feet on 09/18/98 Ground water encountered at 11.0 feet during drilling



Note: See Figure A-2 for explanation of symbols

DRS:SPM:mln 10/14/98

0372-128-00-2130

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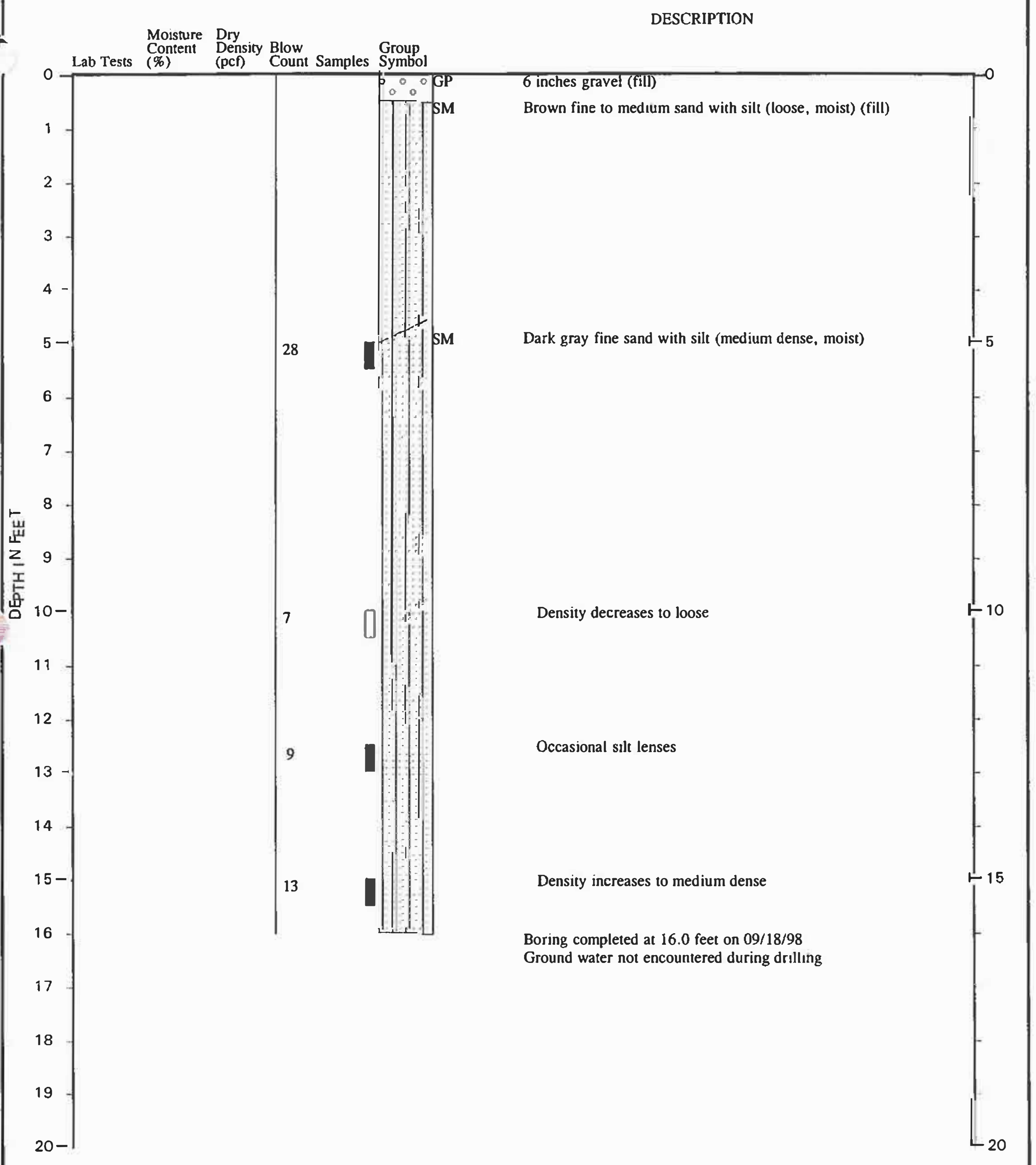
LOG OF BORING

FIGURE A-3

TEST DATA

BORING B-2



6 inches gravel (fill)

Brown fine to medium sand with silt (loose, moist) (fill)

Dark gray fine sand with silt (medium dense, moist)

Density decreases to loose

Occasional silt lenses

Density increases to medium dense

Boring completed at 16.0 feet on 09/18/98
Ground water not encountered during drilling

Note: See Figure A-2 for explanation of symbols

DRS:SPM:mln 10/14/98

0372-128-00-2130

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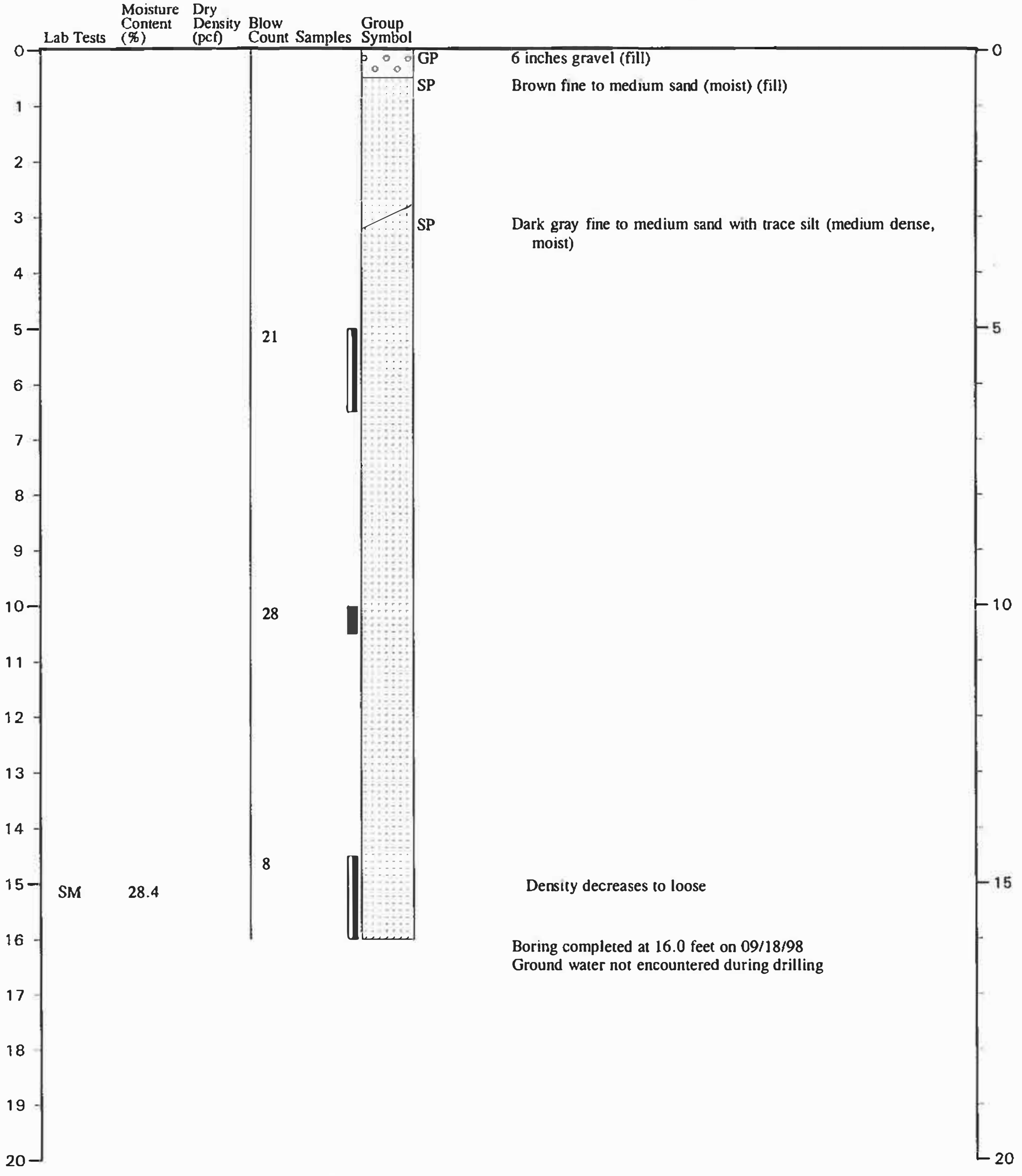
LOG OF BORING

FIGURE A-4

TEST DATA

BORING B-3



Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
					GP	6 inches gravel (fill)
					SP	Brown fine to medium sand (moist) (fill)
					SP	Dark gray fine to medium sand with trace silt (medium dense, moist)
			21			
			28			
			8			
SM	28.4					Density decreases to loose

Boring completed at 16.0 feet on 09/18/98
Ground water not encountered during drilling

Note: See Figure A-2 for explanation of symbols

DRS:SPM:min 10/14/98

0372-128-00-2130

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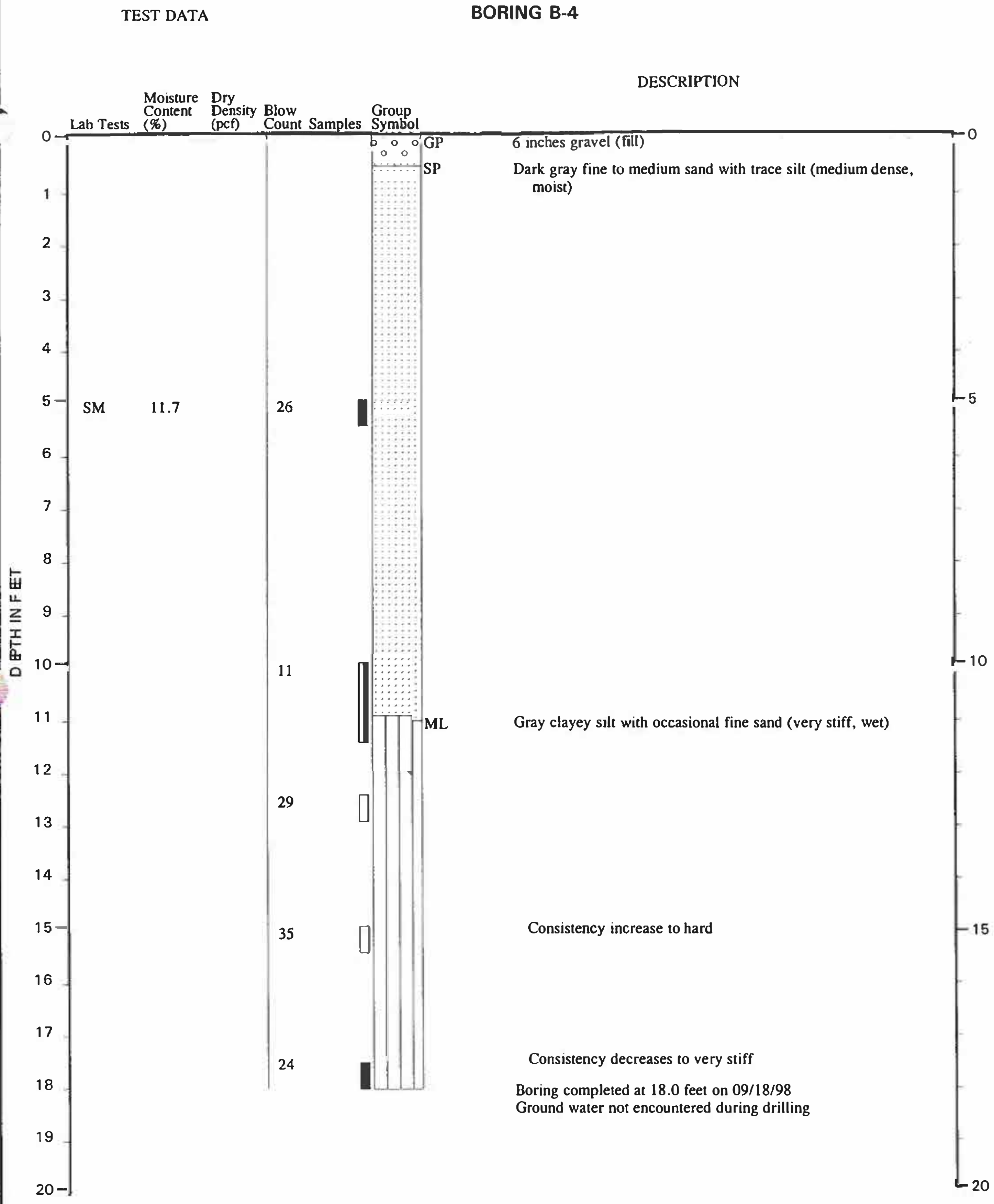
LOG OF BORING

FIGURE A-5

BORING B-4



DESCRIPTION

6 inches gravel (fill)

Dark gray fine to medium sand with trace silt (medium dense, moist)

Gray clayey silt with occasional fine sand (very stiff, wet)

Consistency increase to hard

Consistency decreases to very stiff

Boring completed at 18.0 feet on 09/18/98
Ground water not encountered during drilling

Note: See Figure A-2 for explanation of symbols

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0372128-00-213

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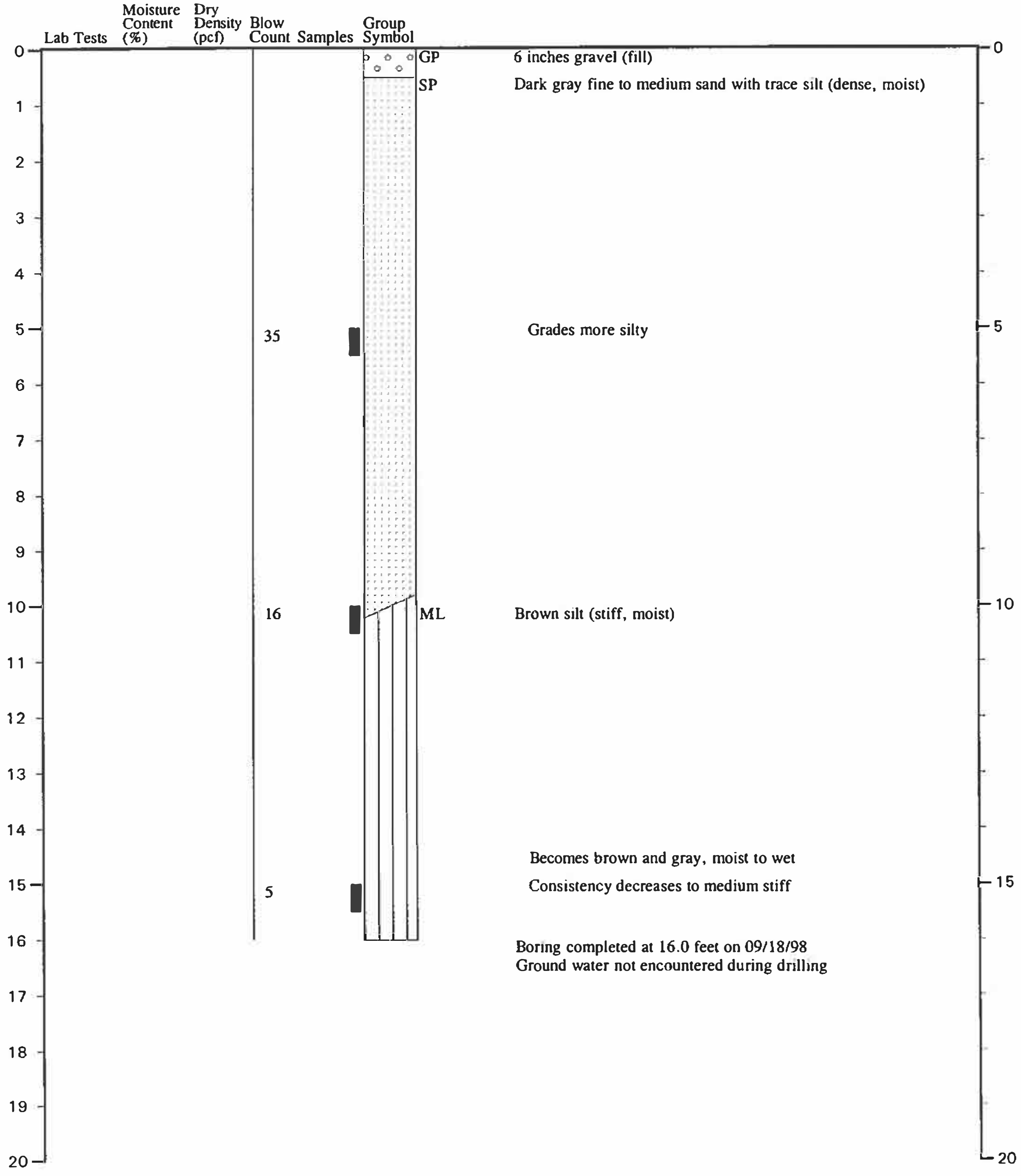
LOG OF BORING

FIGURE A-6

TEST DATA

BORING B-5



DEPTH IN FEET	Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
0						GP	6 inches gravel (fill)
0.5						SP	Dark gray fine to medium sand with trace silt (dense, moist)
5				35	■		Grades more silty
10				16	■	ML	Brown silt (stiff, moist)
14.5							Becomes brown and gray, moist to wet
15				5	■		Consistency decreases to medium stiff
16							Boring completed at 16.0 feet on 09/18/98 Ground water not encountered during drilling

Note: See Figure A-2 for explanation of symbols

DRS:SPM:mln 10/14/98

0372-128-00-2130

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LOG OF BORING

FIGURE A-7

TEST DATA

BORING B-6

DEPTH IN FEET	Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
0						GP	6 inches gravel (fill)
						SM	Brown and gray silty fine sand (medium dense, moist)
5	DS	38.9	78	13	■		
9				7	□		
10	SM	25.8				ML	Brown and gray clayey silt with trace fine sand (stiff, moist)
11	CS	32.3	87	12	■		
15				8	□		Consistency decreases to medium stiff
16							Boring completed at 16.0 feet on 09/18/98 Ground water not encountered during drilling
20							

Note: See Figure A-2 for explanation of symbols

DRS:SPM:min 10/14/98

0372-128-00-2130

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LOG OF BORING

FIGURE A-8

APPENDIX B

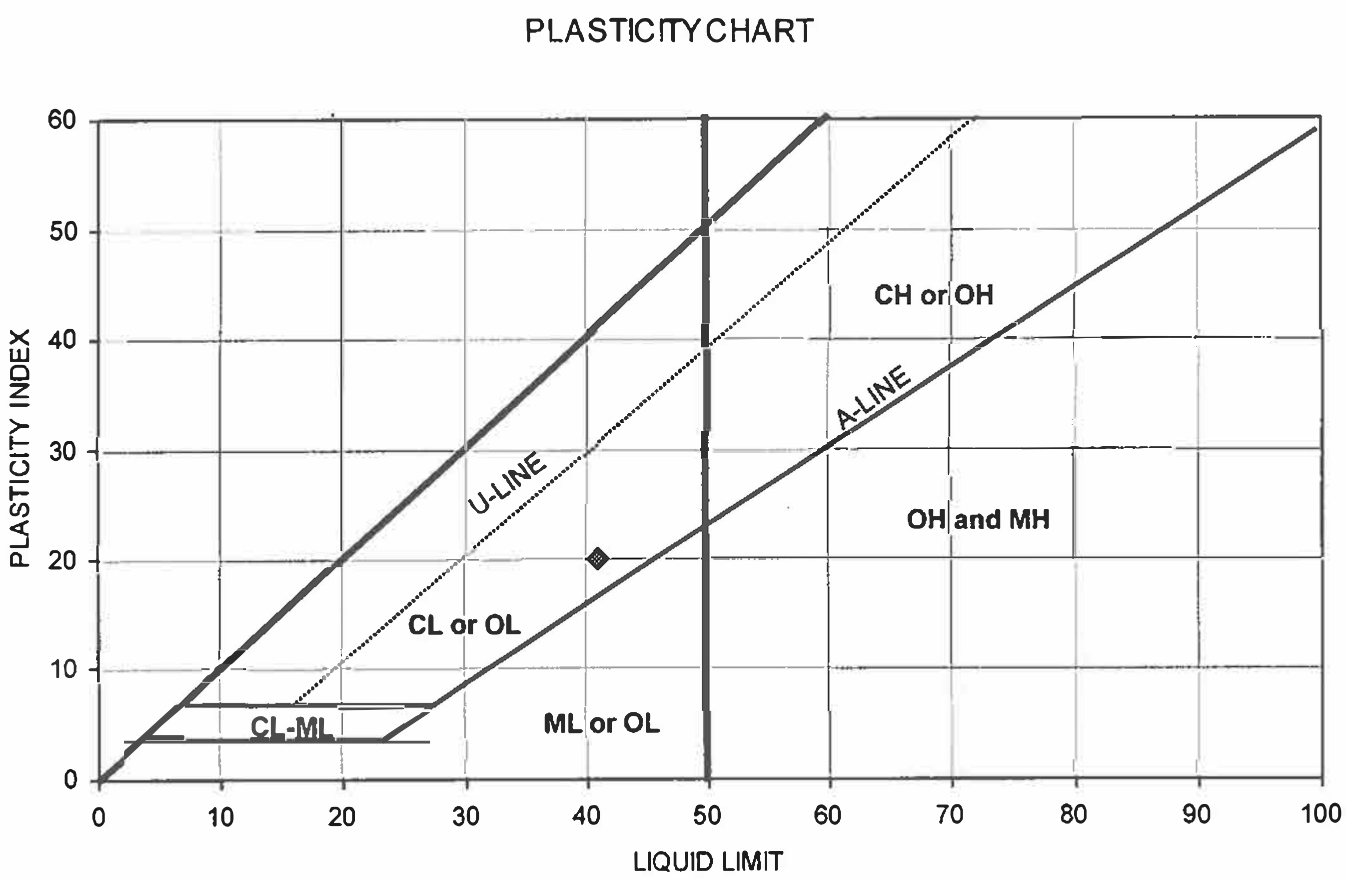
LABORATORY TEST RESULTS

Representative samples obtained from the borings were examined in the laboratory to confirm or modify field classifications. Selected soil samples were tested to determine the natural moisture content in general accordance with ASTM Test Method D 2216. The laboratory test results are summarized on the boring logs.

One Atterberg limits test was performed on a selected sample in general conformance with ASTM Test Method D 4318. The test results were used for classification purposes. Figure B-1 summarizes the test results.

One direct shear test was performed on a selected sample in general conformance with ASTM Test Method D 3080. The direct shear test results are presented on Figure B-2.

Two consolidation tests were performed on selected samples of silty soil in general conformance with ASTM Test Method D 2435. Figures B-3 and B-4 summarize the test results.



SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SOIL DESCRIPTION
◈	B-1	5.0-7.0'	36.7	41	20	Gray clay with trace fine sand (CL)

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ATTERBERG LIMITS TEST RESULTS

FIGURE B-1

0372-128-00 BAS:MAD 10/12/98

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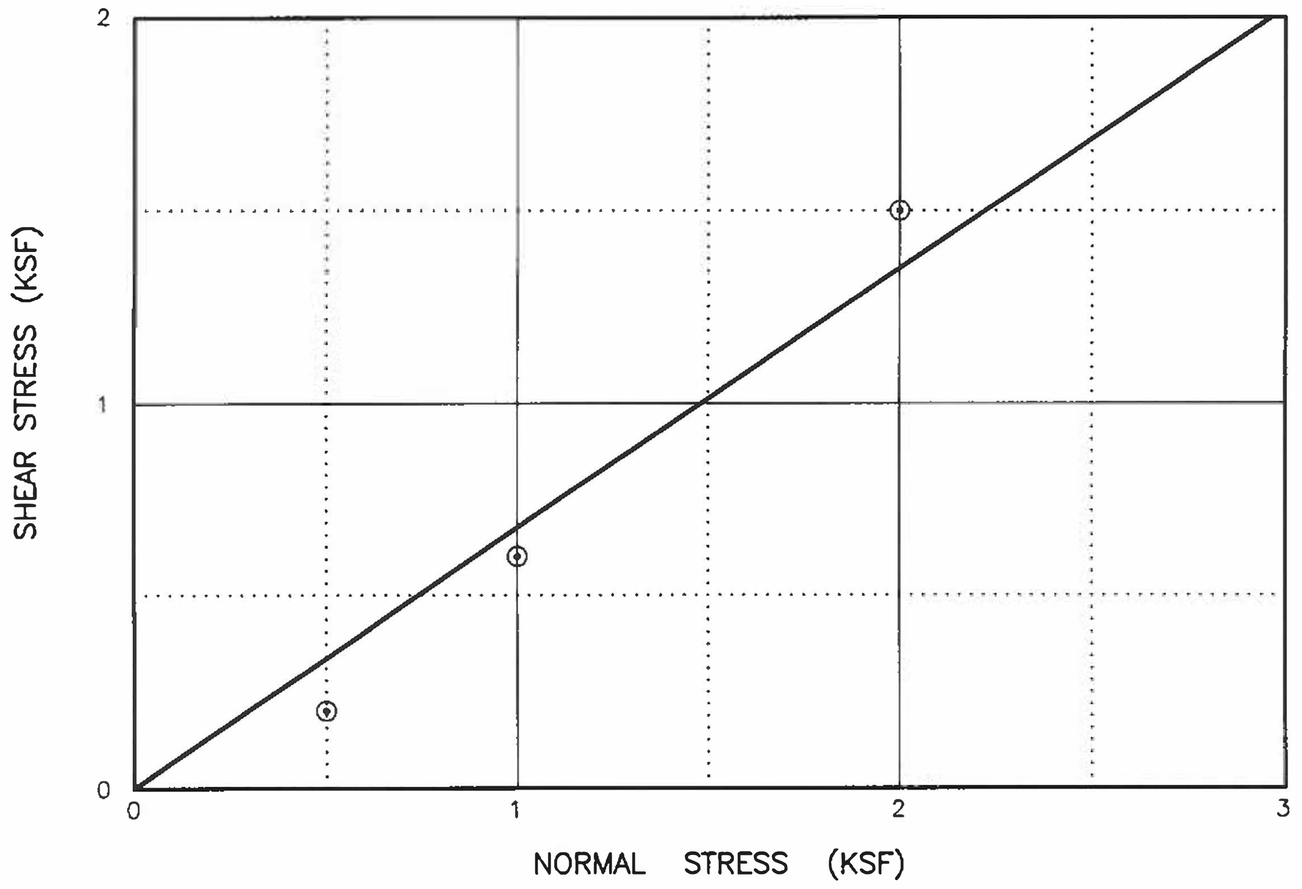

SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	FRICTION ANGLE	COHESION (PSF)	SOIL DESCRIPTION
⊙	**B-6**	5.0	34°	0	Brown silty fine to medium sand.

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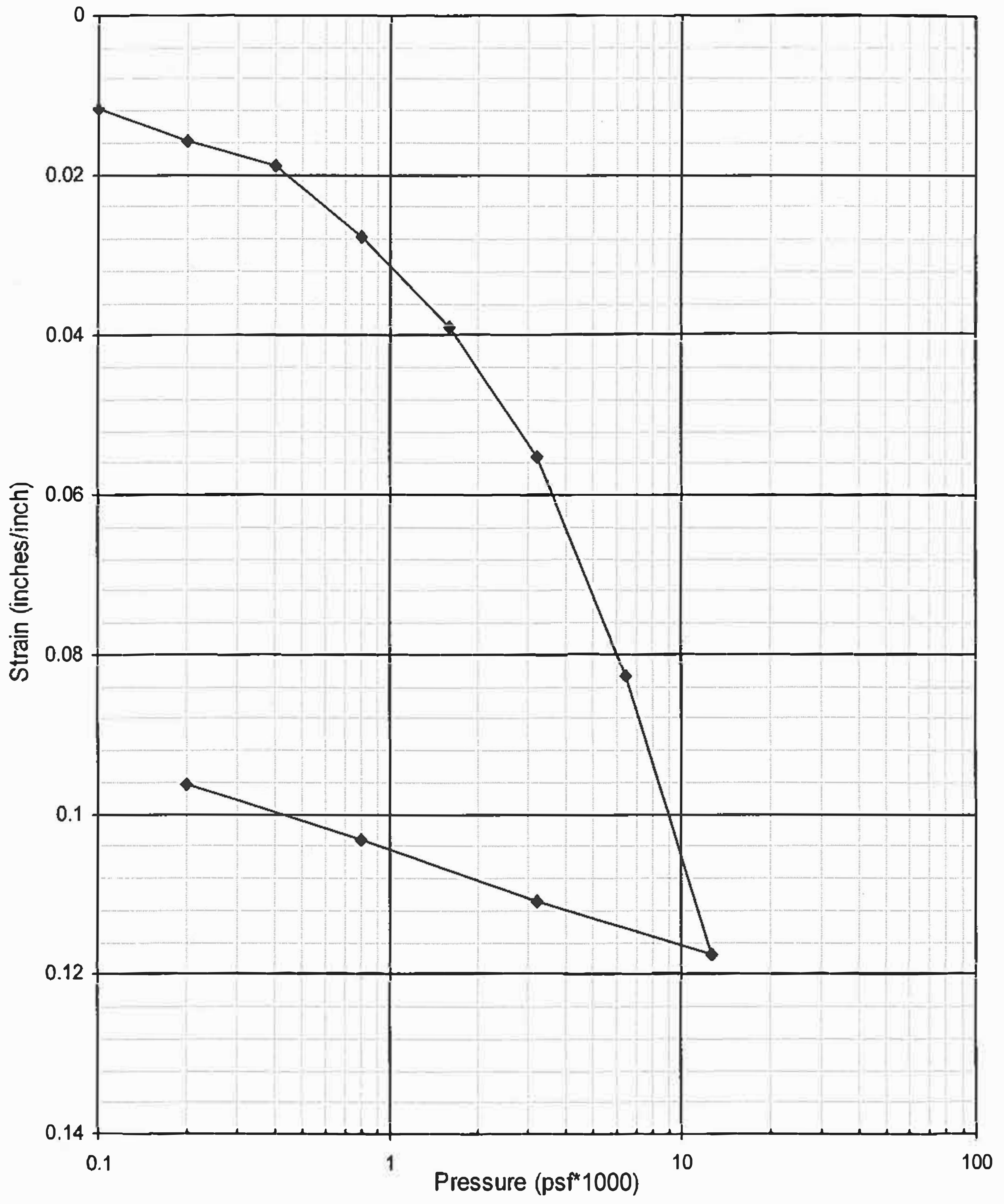
DIRECT SHEAR TEST RESULTS

FIGURE B-2



BORING NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION	INITIAL MOISTURE CONTENT	INITIAL DRY DENSITY (LBS/FT³)
B-6	11.5	Gray clayey silt with trace fine sand (ML)	32.3	87.1

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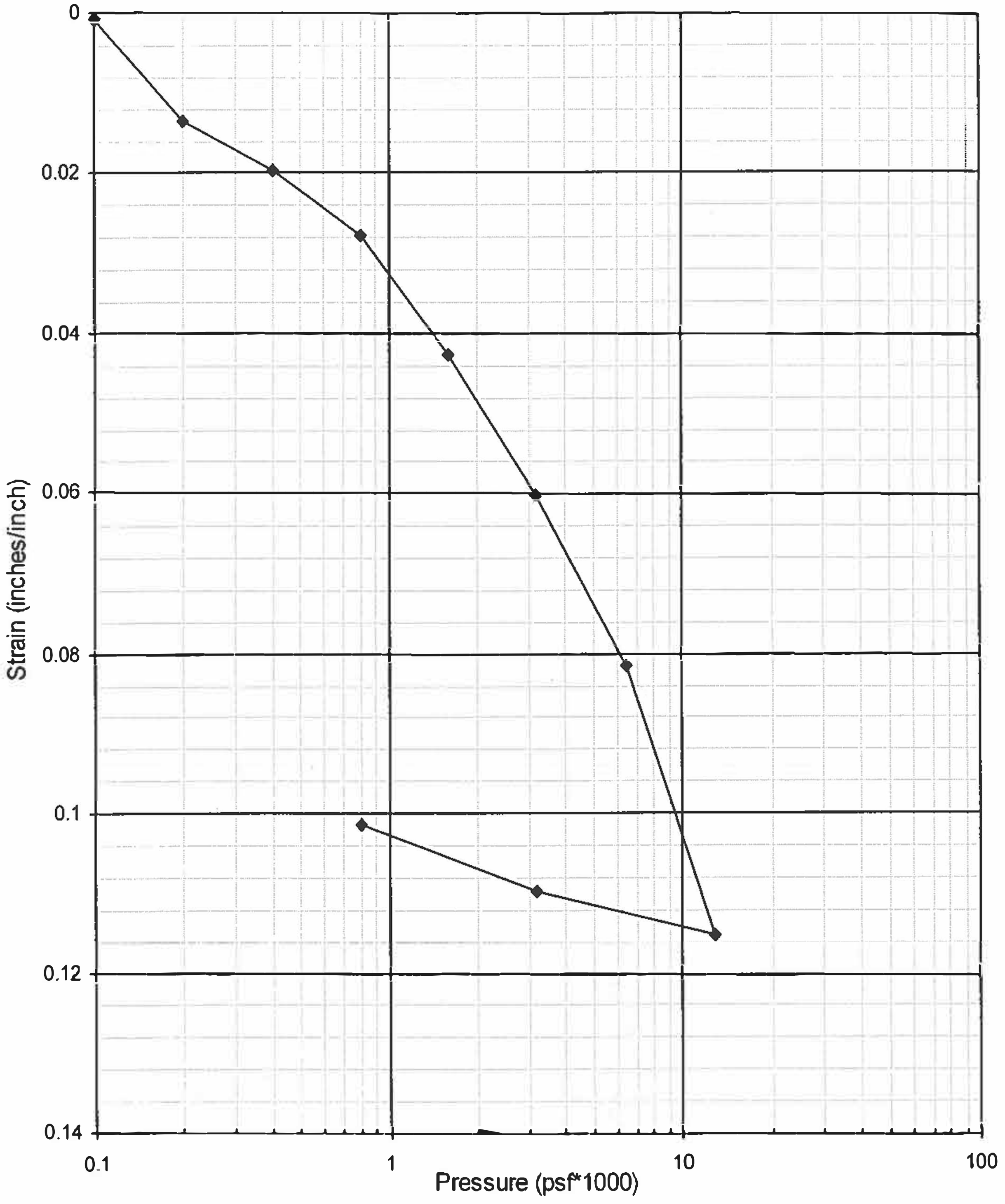
CONSOLIDATION TEST RESULTS

FIGURE B-3



BORING NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION	INITIAL MOISTURE CONTENT	INITIAL DRY DENSITY (LBS/FT³)
B-1	25.0	Gray clayey silt with trace fine sand (ML)	41.7	82.4

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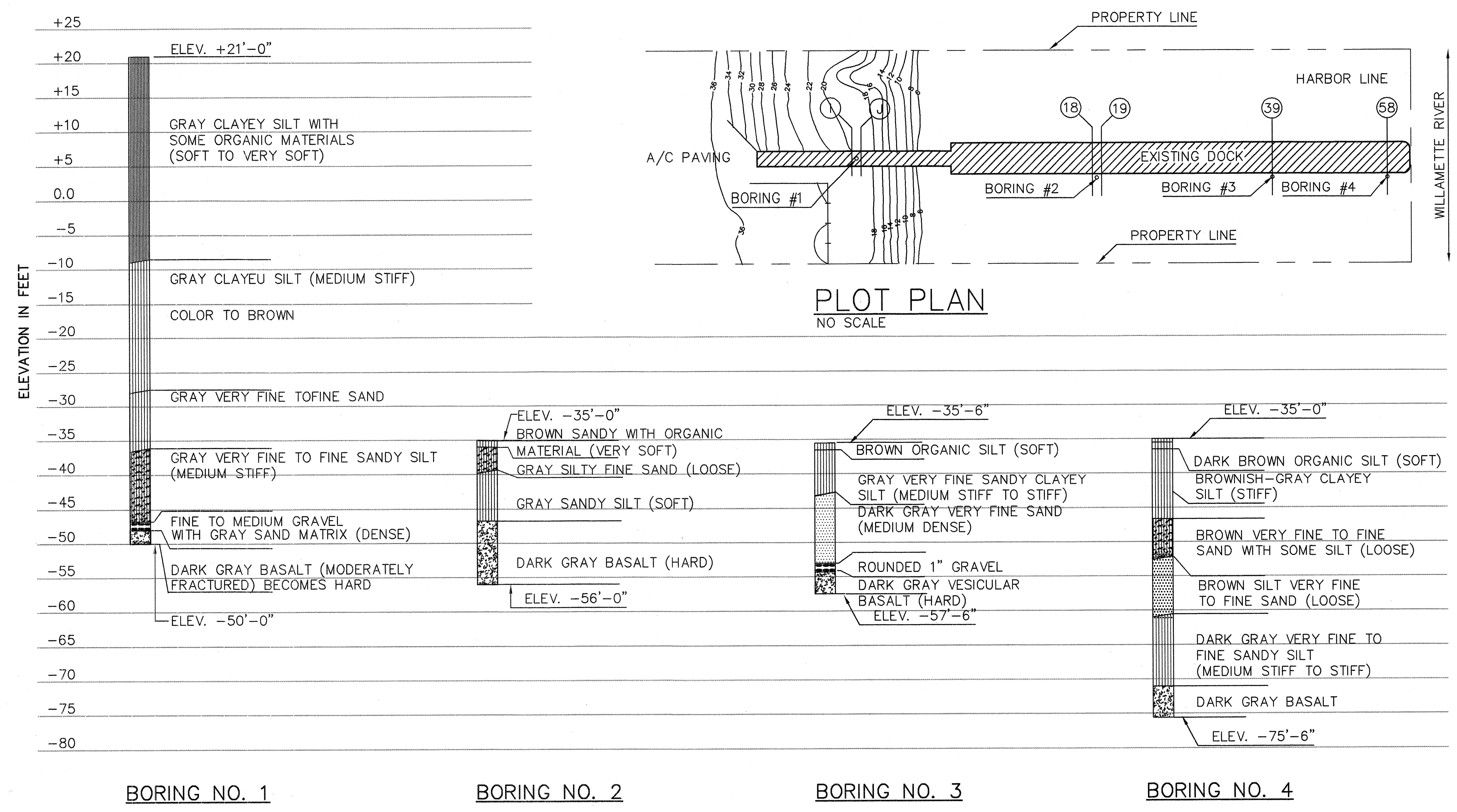
CONSOLIDATION TEST RESULTS

FIGURE B-4



LOG OF BORING

REFERENCE: "FOUNDATION INVESTIGATION" REPORT, DATED MAY 1, 1973
BY DAMES & MORE - FOUNDATION & SOILS ENGINEERS
ELEVATIONS ABOVE REFER TO CITY OF PORTLAND DATUM
REVISED FROM C. OF E. DATUM USED IN ABOVE SOILS REPORT.

file :CHEVRON\06 date 10-12-95

10/19/95

NO.	DATE	REVISIONS	BY	APPR.

DSGN	LL	CHKD	BJ
DRWN	PB	SCALE	AS SHOWN

approved date

approved date

WINZLER & KELLY
CONSULTING ENGINEERS
180 HOWARD STREET SAN FRANCISCO, CALIFORNIA (415) 546-9900

Chevron

LOG OF BORING

WHARF IMPROVEMENTS

CHEVRON U.S.A. PRODUCTS COMPANY
WILLBRIDGE TERMINAL
PORTLAND, OREGON

JOB NO.

SHEET
6

Appendix C

Risk Assessment

CRITICAL SYSTEMS RISK ASSESSMENT

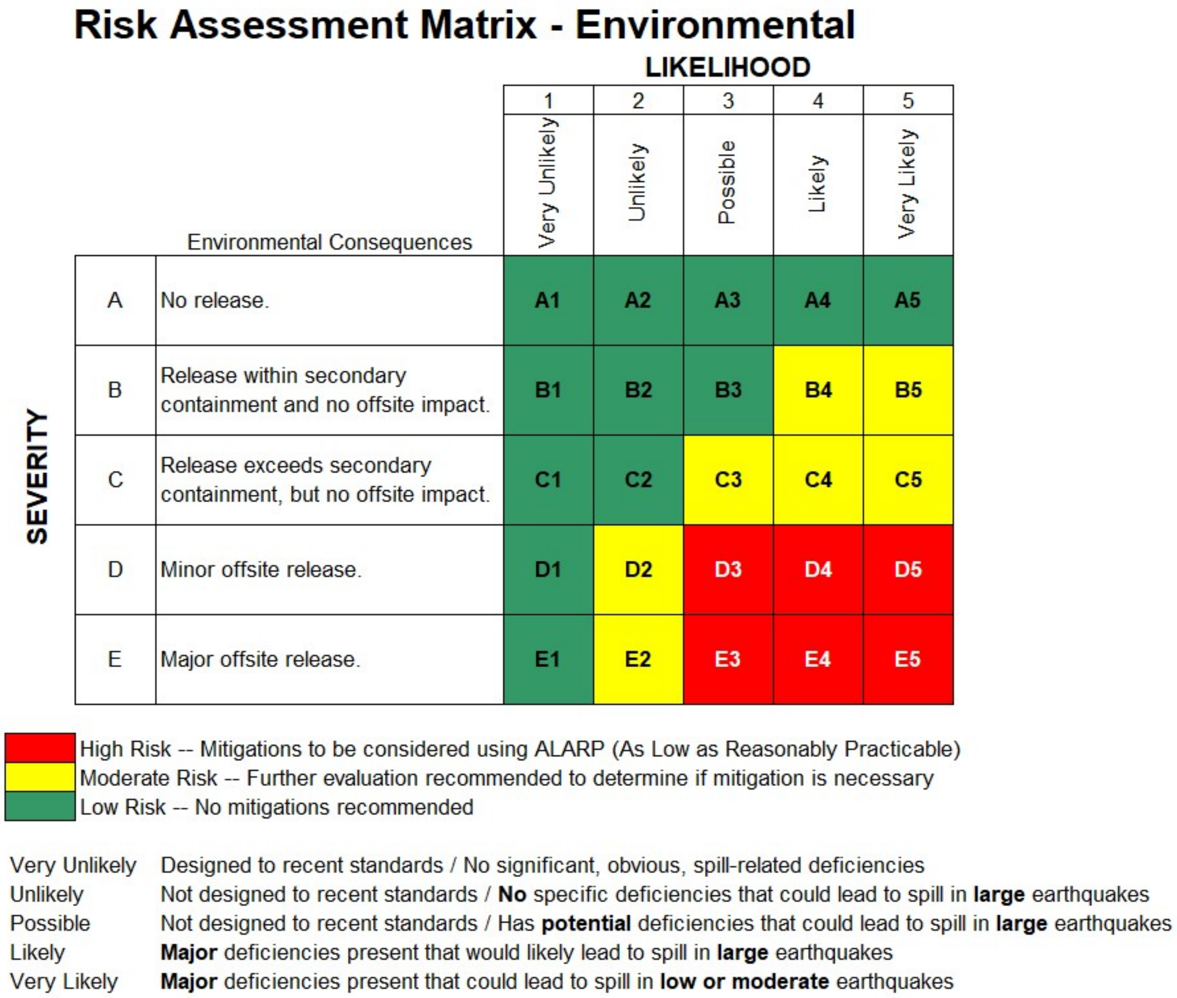
Purpose:	To identify and prioritize critical structures, equipment, tanks, and systems and the performance requirements during and following an earthquake with regards to prevention and containment of oil spills.
Scope:	This study will address all facility components covered by the Rules.
Boundaries:	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
SEVERITY	Environmental Consequences	Very Unlikely	Unlikely	Possible	Likely	Very Likely
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 8, 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
Jerry Henderson, Chevron Fuels and Lubricants, Northwest Operations Manager
Chad Brandt, Chevron Fuels and Lubricants, Maintenance & Engineering, ISC NA - West
Mike Rookstool, S.E., Chevron Technical Center, Structural Engineer

					Risk Assessment Rankings						
						Severity					
Location	Item Type	Identification	Contents	Out of Service?	Likelihood WITHOUT Soil Displacements	Environmental	Safety	Risk Score	Likelihood WITH Soil Displacements	Risk Score	Item or Score Notes
Main Yard											
Main Yard	Tank	1	Flammable Fuel		3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	3. Possible	C3	flammablility increases safety severity
	Tank	3	Flammable Fuel		3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	3. Possible	C3	flammablility increases safety severity
	Tank	43	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	44	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	45	Flammable Fuel		3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	3. Possible	C3	flammablility increases safety severity
	Tank	47	Combustible Fuel		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	48	Flammable Fuel		4. Likely	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C4	4. Likely	C4	flammablility increases safety severity
	Tank	51	Flammable Fuel		3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	3. Possible	C3	flammablility increases safety severity
	Tank	60	Flammable Fuel		3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	3. Possible	C3	flammablility increases safety severity
	Tank	62	Flammable Fuel		3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	3. Possible	C3	flammablility increases safety severity
	Tank	64	Combustible Fuel		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	75	Combustible Fuel		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	76	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	98	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	99	Non-Combustible Petroleum	Yes	3. Possible	A. No Release	A. Minor / First Aid Injury	A3	3. Possible	A3	out of service
	Tank	100	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	101	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	102	Combustible Fuel		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	103	Combustible Fuel	Yes	2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	2. Unlikely	A2	out of service
	Tank	109	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	119	Combustible Fuel	Yes	5. Very Likely	A. No Release	A. Minor / First Aid Injury	A5	5. Very Likely	A5	out of service
	Tank	120	Flammable Fuel	Yes	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	5. Very Likely	A5	out of service
	Tank	121	Flammable Fuel	Yes	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	5. Very Likely	A5	out of service
	Tank	128	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	4. Likely	B4	
	Tank	129	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	130	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
Main Yard	Tank	135	Combustible Fuel	Yes	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	5. Very Likely	A5	out of service
	Tank	136	Flammable Fuel	Yes	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	5. Very Likely	A5	out of service
	Tank	140	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	141	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	142	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	143	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	144	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	4. Likely	B4	
	Tank	145	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	150	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	

					Risk Assessment Rankings						
						Severity					
Location	**Item Type**	**Identification**	**Contents**	**Out of Service?**	**Likelihood WITHOUT Soil Displacements**	**Environmental**	**Safety**	**Risk Score**	**Likelihood WITH Soil Displacements**	**Risk Score**	**Item or Score Notes**
Main Yard											
Main Yard	Tank	154	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	155	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	156	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	157	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	158	Non-Combustible Petroleum	Yes	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	5. Very Likely	A5	out of service
	Tank	159	Flammable Fuel	Yes	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	5. Very Likely	A5	out of service
	Tank	163	Flammable Fuel		3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	3. Possible	C3	flammablility increases safety severity
	Tank	164	Flammable Fuel		3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	3. Possible	C3	flammablility increases safety severity
		Total									
	Piping	Flammable Fuels			3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	4. Likely	C4	
	Piping	Non-flammable fuels			3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	4. Likely	B4	
	Process Eqiupment	Oil Water Separator			2. Unlikely	C. Exceeds secondary containment, but no o	A. Minor / First Aid Injury	C2	3. Possible	C3	Many areas drain to OWS; possible overtopping
	Process Eqiupment	Hydrocleaner			2. Unlikely	B. Release within secondary containment	A. Minor / First Aid Injury	B2	3. Possible	B3	
	Electrical Equipment	MCC			2. Unlikely	A. No Release	B. Injury With Medical Treatment	B2	3. Possible	B3	
	Secondary Containment Walls	N/A			3. Possible	E. Major offsite release	C. Serious Injury / Limited Impact on Public	E3	4. Likely	E4	

					Risk Assessment Rankings						
						Severity					
Location	Item Type	Identification	Contents	Out of Service?	Likelihood WITHOUT Soil Displacements	Environmental	Safety	Risk Score	Likelihood WITH Soil Displacements	Risk Score	Item or Score Notes
MM1 Yard											
MM1 Yard	Tank	15	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	16	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	17	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	18	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	19	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	20	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	21	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	22	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	23	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	24	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	25	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	31	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	32	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	33	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	34	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	35	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	36	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	170	Non-Combustible Petroleum	Yes	2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	2. Unlikely	A2	out of service
	Tank	171	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	172	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	173	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	174	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	175	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
		Total									
	Piping	Non-flammable fuels			3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	4. Likely	B4	
	Secondary Containment Walls	N/A			3. Possible	D. Minor offsite release	B. Injury With Medical Treatment	D3	4. Likely	D4	

					Risk Assessment Rankings						
						Severity					
Location	Item Type	Identification	Contents	Out of Service?	Likelihood WITHOUT Soil Displacements	Environmental	Safety	Risk Score	Likelihood WITH Soil Displacements	Risk Score	Item or Score Notes
MM2 Yard											
MM2 Yard	Tank	79	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	all additive tanks
	Tank	91	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	nonflammables
	Tank	113	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	131	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	132	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	133	Non-Combustible Petroleum	Yes	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	5. Very Likely	A5	out of service
		Total									
	Piping	Non-flammable fuels			3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	4. Likely	B4	
	Secondary Containment Walls	N/A			3. Possible	D. Minor offsite release	B. Injury With Medical Treatment	D3	4. Likely	D4	drains to OWS

					Risk Assessment Rankings						
						Severity					
Location	Item Type	Identification	Contents	Out of Service?	Likelihood WITHOUT Soil Displacements	Environmental	Safety	Risk Score	Likelihood WITH Soil Displacements	Risk Score	Item or Score Notes
Small Yard (Lubes)											
Small Yard (Lubes)	Tank	4	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	5	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	6	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	7	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	8	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	9	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	10	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	11	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	12	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	13	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	14	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	26	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	27	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	28	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	29	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	30	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	37	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	38	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	39	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	40	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	41	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	42	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	46	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	56	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	57	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	61	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	65	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	72	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	77	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	78	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	80	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	81	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	82	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	83	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	84	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	85	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	

					Risk Assessment Rankings						
						Severity					
Location	Item Type	Identification	Contents	Out of Service?	Likelihood WITHOUT Soil Displacements	Environmental	Safety	Risk Score	Likelihood WITH Soil Displacements	Risk Score	Item or Score Notes
Small Yard (Lubes)											
Small Yard (Lubes)	Tank	87	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	88	Non-Combustible Petroleum	Yes	4. Likely	A. No Release	A. Minor / First Aid Injury	A4	5. Very Likely	A5	out of service
	Tank	89	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	4. Likely	B4	
	Tank	90	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	92	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	94	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	96	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	97	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	104	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	105	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	106	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	110	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	112	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	114	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	116	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	117	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	118	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	122	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	123	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
Small Yard (Lubes)	Tank	127	Non-Combustible Petroleum		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	
	Tank	137	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	138	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	139	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	146	Combustible Fuel		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	147	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
	Tank	148	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	149	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	151	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	152	Non-Combustible Petroleum		4. Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B4	5. Very Likely	B5	
	Tank	160	Non-Combustible Petroleum		5. Very Likely	B. Release within secondary containment	B. Injury With Medical Treatment	B5	5. Very Likely	B5	
		Total									
	Piping	Non-flammable fuels	Non-flammable fuels		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	4. Likely	B4	
	Secondary Containment Walls	N/A			3. Possible	D. Minor offsite release	B. Injury With Medical Treatment	D3	3. Possible	D3	

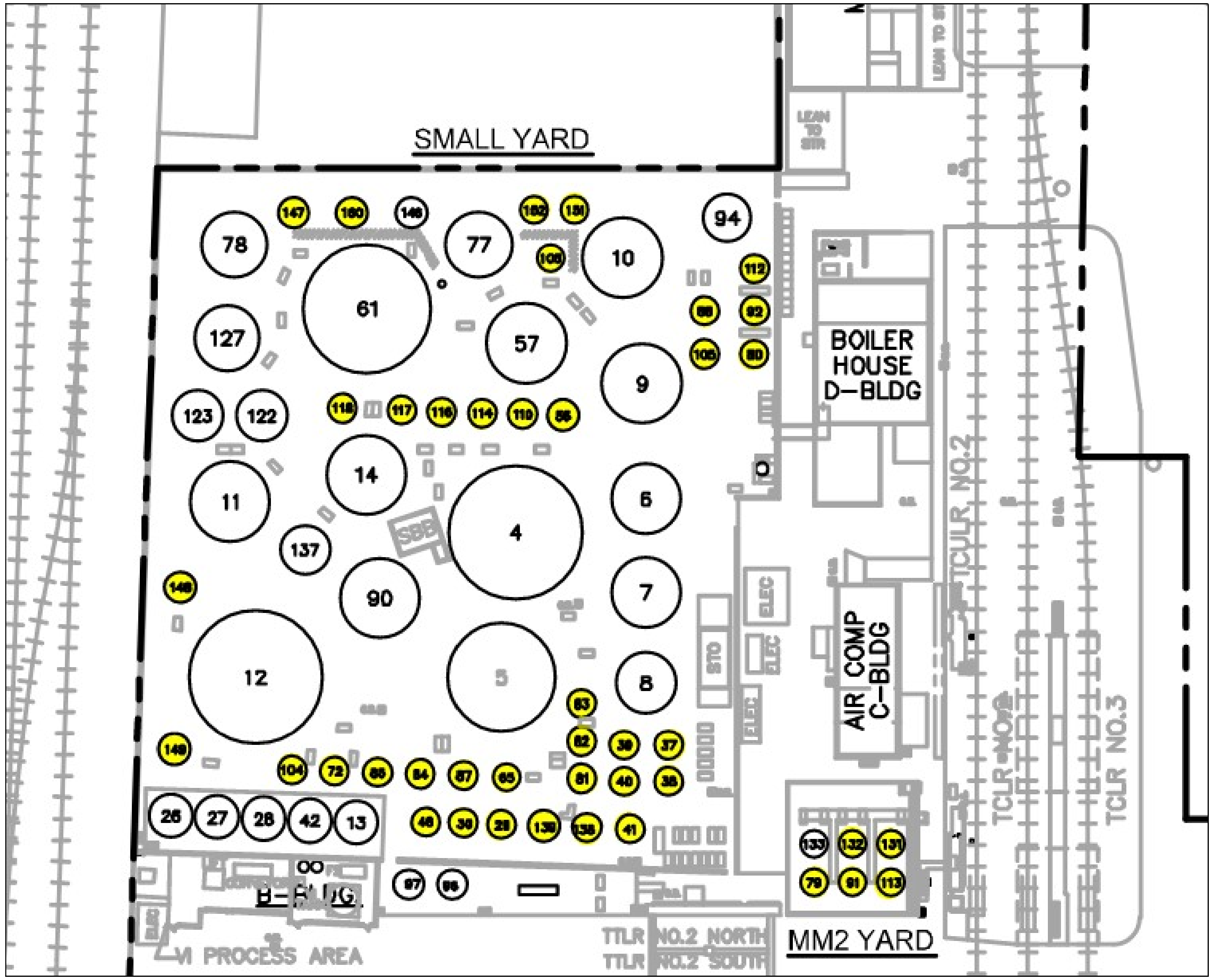
					Risk Assessment Rankings						
						Severity					
Location	Item Type	Identification	Contents	Out of Service?	Likelihood WITHOUT Soil Displacements	Environmental	Safety	Risk Score	Likelihood WITH Soil Displacements	Risk Score	Item or Score Notes
Blending											
Blending	Tank	176	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	177	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	178	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	179	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	180	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	181	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
		Total									
	Piping	Non-flammable fuels	Non-flammable fuels		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	Within building, geo does not worsen it.
	Secondary Containment	N/A			3. Possible	C. Exceeds secondary containment, but no o	B. Injury With Medical Treatment	C3	3. Possible	C3	Within building, geo does not worsen it.
	Building	Blending area			2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
Slurry											
Slurry	Tank	182	Non-Combustible Petroleum		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	
	Tank	183	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	184	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	185	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	186	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	187	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	188	Non-Combustible Petroleum		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	Slurry Tank 1	Non-flammable fuels		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	Slurry Tank 4	Non-flammable fuels		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	Slurry Tank 5	Non-flammable fuels		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
	Tank	Recovery tank ABCD	Non-flammable fuels		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	1. Very Unlikely	B1	
		Total									
	Piping	Non-flammable fuels	Non-flammable fuels		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	Within building, geo does not worsen it.
	Secondary Containment	N/A			3. Possible	C. Exceeds secondary containment, but no o	B. Injury With Medical Treatment	C3	3. Possible	C3	Within building, geo does not worsen it.
	Building	Slurry area			2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	2. Unlikely	B2	Damage to building does not worsen vulnerability of tanks

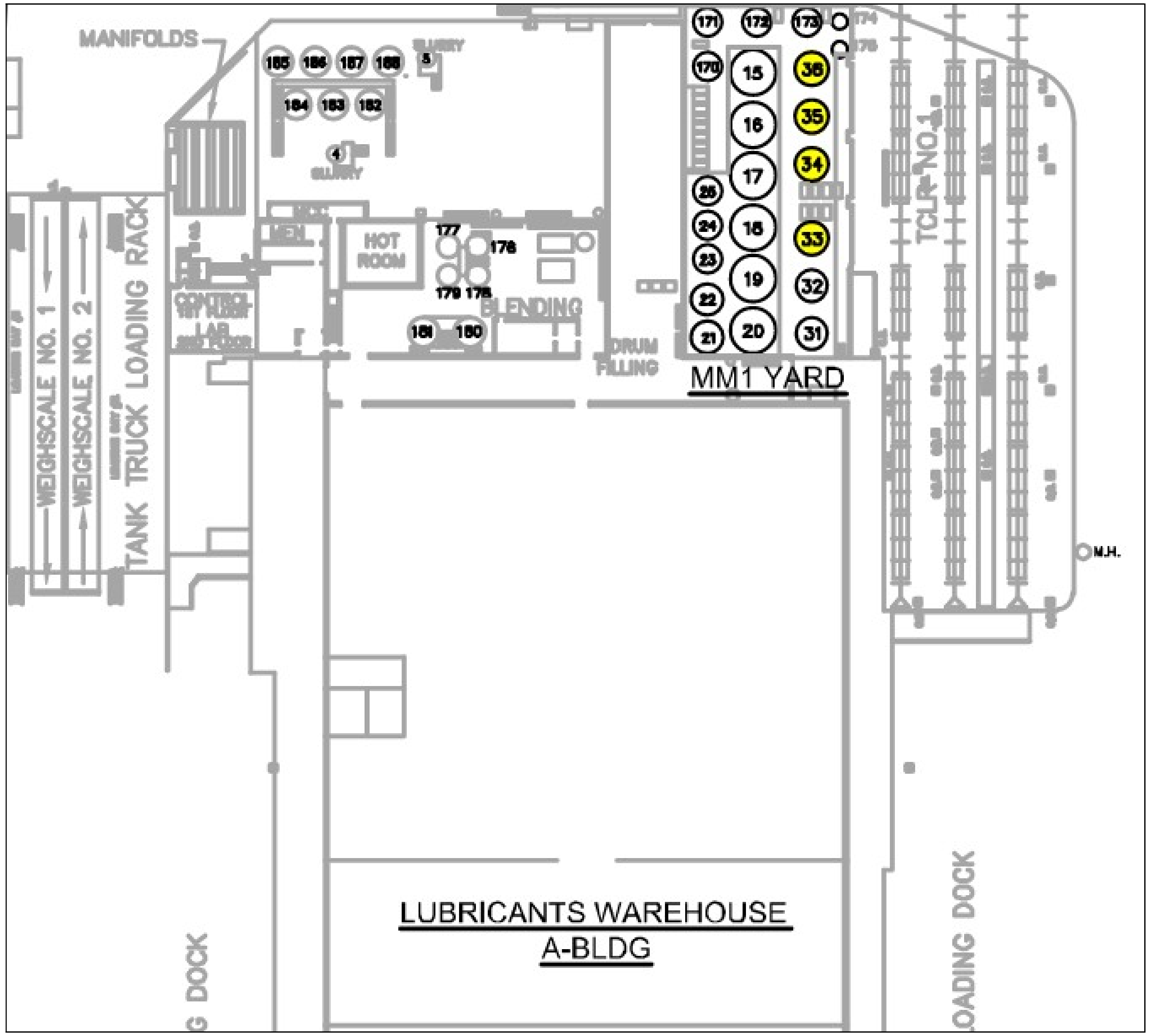
					Risk Assessment Rankings						
						Severity					
Location	Item Type	Identification	Contents	Out of Service?	Likelihood WITHOUT Soil Displacements	Environmental	Safety	Risk Score	Likelihood WITH Soil Displacements	Risk Score	Item or Score Notes
Truck Loading Racks											
	Loading Rack Structure	TTLR-1			2. Unlikely	B. Release within secondary containment	A. Minor / First Aid Injury	B2	3. Possible	B3	All truck loading racks drain to OWS
	Loading Rack Structure	TTLR-2			2. Unlikely	B. Release within secondary containment	A. Minor / First Aid Injury	B2	3. Possible	B3	
	Loading Rack Structure	TTLR-3			2. Unlikely	B. Release within secondary containment	A. Minor / First Aid Injury	B2	3. Possible	B3	
	Loading Rack Structure	TCLRs (Lube)			2. Unlikely	B. Release within secondary containment	A. Minor / First Aid Injury	B2	3. Possible	B3	
	Loading Rack Structure	Tank Truck Load Rack			2. Unlikely	B. Release within secondary containment	A. Minor / First Aid Injury	B2	3. Possible	B3	
Butane Storage and Offload Area											
	Tank	108	Combustible Fuel		3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	4. Likely	B4	
	Tank	MVRU	N/A		1. Very Unlikely	A. No Release	A. Minor / First Aid Injury	A1	4. Likely	A4	
	Tank	Vapor Control system	N/A		1. Very Unlikely	A. No Release	A. Minor / First Aid Injury	A1	4. Likely	A4	
	Tank	Green plastic tanks	Non-flammable fuels		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	4. Likely	B4	
	Tank	Salt Tank	N/A		2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	4. Likely	A4	Not in scope
		Total									
	Piping	Flammable Fuels			3. Possible	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C3	4. Likely	C4	
	Piping	Non-flammable fuels			3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	4. Likely	B4	
	Secondary Containment Walls	N/A			3. Possible	E. Major offsite release	B. Injury With Medical Treatment	E3	4. Likely	E4	
	Additive Totes	TK-138 Add	Additives		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	4. Likely	B4	
	Additive Totes	Infineon R685	Additives		1. Very Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B1	4. Likely	B4	
	Additive Totes	OLI-9103 (x2)	Additives		2. Unlikely	B. Release within secondary containment	B. Injury With Medical Treatment	B2	4. Likely	B4	
	Civil Structure	Trench under Roadway			2. Unlikely	A. No Release	B. Injury With Medical Treatment	B2	4. Likely	B4	very low likelihood of occupancy
	Piping	Piping in Trench			3. Possible	D. Minor offsite release	C. Serious Injury / Limited Impact on Public	D3	4. Likely	D4	
	Building	MCC Building			2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	4. Likely	A4	
	Tank	Butane Tank	Flammable Fuel		1. Very Unlikely	B. Release within secondary containment	C. Serious Injury / Limited Impact on Public	C1	4. Likely	C4	Operational controls (auto shutoffs) mitigate risk
	Loading Rack Structure	Truck Offloading			2. Unlikely	B. Release within secondary containment	A. Minor / First Aid Injury	B2	4. Likely	B4	
	Building	Fire Control Room			2. Unlikely	A. No Release	C. Serious Injury / Limited Impact on Public	C2	4. Likely	C4	

					Risk Assessment Rankings						
						Severity					
Location	Item Type	Identification	Contents	Out of Service?	Likelihood WITHOUT Soil Displacements	Environmental	Safety	Risk Score	Likelihood WITH Soil Displacements	Risk Score	Item or Score Notes
Chevron Dock											
	Marine Structure	Dock			3. Possible	E. Major offsite release	B. Injury With Medical Treatment	E3	4. Likely	E4	dock movement causes spill; unlikely to be occupied
	Building	Dock Office			2. Unlikely	A. No Release	B. Injury With Medical Treatment	B2	4. Likely	B4	unlikely to be occupied
	Piping	Flammable Fuels			3. Possible	E. Major offsite release	C. Serious Injury / Limited Impact on Public	E3	4. Likely	E4	spill caused by significant movement or dock collapse
	Piping	Non-flammable fuels			3. Possible	E. Major offsite release	B. Injury With Medical Treatment	E3	4. Likely	E4	spill caused by significant movement or dock collapse
	Boom Deployment / Spill Response	Boat House (Floating)			2. Unlikely	D. Minor offsite release	C. Serious Injury / Limited Impact on Public	D2	2. Unlikely	D2	EQ damage unlikely for float; boom only for minor release
Other Buildings (not in yards)											
	Building	Lubricants Office			2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	3. Possible	A3	No matl to spill within building
	Building	Lube Warehouse A-Bldg			3. Possible	A. No Release	A. Minor / First Aid Injury	A3	3. Possible	A3	Building damage unlikely to worsen behavior of racks
	Storage Racks	Racks within Warehouse			3. Possible	B. Release within secondary containment	B. Injury With Medical Treatment	B3	3. Possible	B3	Within building, geo does not worsen it.
	Building	Air Comp C-Bldg			2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	3. Possible	A3	No matl to spill within building
	Building	Boiler House D-Bldg			2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	3. Possible	A3	No matl to spill within building
	Building	Maintenance E-Bldg			2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	3. Possible	A3	No matl to spill within building
	Building	F-Bldg			2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	3. Possible	A3	No matl to spill within building
	Building	G-Bldg			2. Unlikely	A. No Release	A. Minor / First Aid Injury	A2	3. Possible	A3	No matl to spill within building
Overall Terminal											
	Emerygency Response	Operator Staffing			1. Very Unlikely	A. No Release	A. Minor / First Aid Injury	A1	1. Very Unlikely	A1	Min of 2 staff 24/7; typically 3
	Emerygency Response	Communications			1. Very Unlikely	A. No Release	A. Minor / First Aid Injury	A1	1. Very Unlikely	A1	Backup radios; backup lighting
	Power	Direct Generators			2. Unlikely	B. Release within secondary containment	A. Minor / First Aid Injury	B2	3. Possible	B3	Located in TTLR area; backup power for critical functions
	Power	Portable Generator			3. Possible	B. Release within secondary containment	A. Minor / First Aid Injury	B3	3. Possible	B3	
	Fire System	Water Main			5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	5. Very Likely	D5	no backup water sources
	Fire System	Foam System			5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	5. Very Likely	D5	depends on municipal water
	Fire System	Fire Pump			5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	5. Very Likely	D5	depends on municipal water
	Fire System	Deluge System			5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	5. Very Likely	D5	At butane tank, TTLR, lube loading rack, & warehouse
	Fire System	Dock Fire Monitors			5. Very Likely	A. No Release	D. Single Fatality / Impact on Public	D5	5. Very Likely	D5	depends on municipal water

Tanks with Moderate Risk by Location

(Moderate = Yellow Highlight ; All others are Low Risk)
(Shown with consideration of both earthquake ground shaking and soil displacements)






143
144
145
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3
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MCC
F-BLDG.
154
155
156
47
75
MAIN YARD
48
45
164
129
130
142
43
128
44
76
64
G-BLDG.
STORMWATER OBSERVATION BASIN
62
51
60
187
API SEPRTR
VAPOR R
TRUCK STAGING AREA PRIMARY EMERGENCY MUSTER AREA
TEST ROOM & DRIVER BOL
TTLR-1
TTLR-2
TTLR-3
N. W. DOANE AVENUE
N. W. FRONT AVENUE
MVRU
T-108 YARD
108
END OF DOCK
90,000 GALS BUTANE TANK
FIRE CONTROL RM
BUTANE TRUCK OFF LOADING
BUTANE STORAGE AND OFFLOAD AREA