Summary of Available Data and Report of Expected Earthquake Risk

Oregon Critical Energy Infrastructure Hub

Portland, Oregon

Prepared for
Multnomah County

February 2, 2022
Job No. 0202424-000 (154-035-019)

SALUS RESILIENCE

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Prepared by
Salus Resilience

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Oregon Critical Energy Infrastructure Hub
Portland, Oregon

1.0 INTRODUCTION AND PROJECT UNDERSTANDING

The Cascadia Subduction Zone (CSZ) reaches from Vancouver, Canada to Cape Mendocino, California and has the capacity to produce earthquakes with a magnitude of 8.0 or higher. Geologists previously believed that these large earthquakes from the CSZ have a recurrence interval of 400 to 600 years; however, research done by a team of scientists at Oregon State University proved the recurrence interval is closer to 350 years. The most recent major earthquake was on January 26, 1700, a little over 300 years ago, with an estimated magnitude of 9.0 on the CSZ. Research by Oregon State University indicates that Oregon has a 37 percent chance of a large earthquake (> M8) from the CSZ within the next 50 years. Based on our understanding of these earthquakes and a recent study by the Oregon Department of Geology and Mineral Industries (DOGAMI), such an earthquake will cause significant damage to infrastructure throughout Oregon, the Portland Metro Region, and Multnomah County.

Part of Oregon's critical infrastructure includes the Oregon Critical Energy Infrastructure (CEI) Hub, which is located on a 6-mile stretch of the west shore of the lower Willamette River, as shown on Figure 1.1. The CEI Hub houses approximately 90 percent of the liquid fuel needed to support the state of Oregon and all of the jet fuel used by the Portland International Airport, as well as other hazardous materials (DOGAMI 2012). New technology, data, and mapping have greatly expanded our understanding of the effects of seismic hazards in our region, including the effects of earthquakes to soft and loose fill and alluvial soils, such as those mapped at the location of the CEI Hub site. These soils are prone to seismically induced strength loss, settlement, and slope failure or lateral spread. The 2017 DOGAMI data indicate that significant displacement will occur in this area during a 9.0 CSZ event. In addition to the hazards related to the soils at the site, a large portion of the existing infrastructure at the CEI Hub was constructed prior to our understanding of Oregon's seismic risk, including tanks constructed over 100 years ago that are still being used for hazardous material storage. The age of the tanks and infrastructure and the soil vulnerabilities result in significant risk to the CEI Hub infrastructure and the materials that are stored there.

The purpose of this study is to evaluate the geotechnical effects of an anticipated seismic event for the region on the CEI Hub and its infrastructure in order to support an evaluation of the economic ramifications for Multnomah County (County). Based on the scenarios developed by DOGAMI for emergency planning, the goals for this project, and our understanding of the geology in the area, the 9.0 CSZ earthquake scenario will be used for this evaluation. This earthquake scenario is the most likely to occur in the next 50 years and will be the most difficult for emergency response and long-term recovery because it will affect the entire Pacific Northwest.

This report summarizes the first phase in our evaluation and includes a bibliography of the data and reports used in our evaluation as well as a detailed summary of the earthquake scenario and geotechnical risk evaluation for the project. The impacts of the earthquake scenario outlined herein on the CEI Hub are not addressed in this report; however, this information will be used in the next phase of the project to evaluate the CEI Hub impacts.

The geotechnical analysis contained herein is generally based on publicly available data, though includes site-specific information where available. The collected data were used to develop generalized subsurface geologic models representative of each area evaluated, and which do not account for ground stabilization work which may have been completed by individual property owners.

1.1 Geologic Setting of the CEI Hub

The CEI Hub is within the city of Portland, Oregon and lies within the Portland Basin, one of several basins that form the Puget-Willamette forearc trough of the Cascadia subduction system (Evarts et al 2009). This trough extends from the Washington-Canada border to approximately Eugene, Oregon, includes the Puget Sound and Willamette River Valley, a distance of nearly 350 miles. Contractional tectonic stresses from the convergent CSZ also create a series of north- to northwest-trending folds that extend from the Pacific coast east to the Cascade Mountains. These folds form the valleys, hills, and mountains characteristic of northwest Oregon and the Pacific Northwest in general. The Portland Basin has also been receiving sediments from the continental-scale Columbia River system for over 20 million years (Evarts et al 2009), of which the Willamette River is a tributary and the source of the near surface sediments at the CEI Hub.

The oldest deposits in the basin form the uplands that surround the valley and are composed of 30- to 40-million-year old volcanic and marine rocks and 15- to 16-million-year old basalt flows of the Columbia River Basalt Group. These rocks were folded and uplifted along faults at the southwest and northeast margins of the Portland Basin, which include the adjacent Portland Hills. The basin itself began to form approximately 20 million years ago and is filled with a thick accumulation of river sediments, including the Troutdale Formation, a gravel to cobble conglomerate found widely throughout the Portland Basin (Evarts et al 2009).

Near the end of the last ice age, a series of cataclysmic floods flowing down the Columba River Gorge repeatedly inundated the Portland Basin up to 400 feet above sea level (Evarts et al 2009). These floods originated from the repeated failing of a glacial ice dam in northwestern Montana between 16,000 and 12,000 years ago and are collectively called the Missoula Floods. While massive gravel bars were formed in the eastern Portland Basin closest to the river, these floodwaters slowed and ponded behind the narrower Columbia River valley downstream, dropping slack water deposits of sand and silt across the entire Willamette River valley. Since the end of the last ice age 13,000 years ago, sea levels have risen over 370 feet, causing the Columbia and Willamette rivers to rapidly deposit sediments across the basin, typically through overbank deposition during yearly snowmelt floods (Evarts et al 2009). These loose sand and silt deposits have been overlain by fill in places where floodplains and wetlands were developed along the banks of the Willamette and Columbia rivers.

1.2 Seismic Setting of the CSZ

Oregon sits near the contact between two large crustal tectonic plates. The Juan de Fuca Plate forms the floor of the Pacific Ocean off the coast of the northwestern United States and moves northeastward from its spreading ridge boundary with the Pacific Plate at an average rate of approximately 1.5 inches per year. As it converges with continental North America, the Juan de Fuca Plate dips below (or "subducts") beneath the North American Plate, forming a shallow, eastward-dipping contact interface. This boundary is known as the CSZ and is responsible for the seismicity in the Pacific Northwest, producing earthquakes associated with three types of source zones: subduction interface, subduction intraslab, and shallow crustal.

Based on geologic and historical evidence, CSZ interface earthquakes occur an average of every 350 years in the form of magnitude 8 to 9.2 earthquakes. Interface earthquakes (such as the 2011 magnitude M9.0 Tohoku earthquake in northeastern Japan) are some of the largest magnitude earthquakes on record. Characteristics of this type of earthquake may include very large ground accelerations, shaking durations in excess of 3 minutes, and strong long-period ground motions that may particularly affect tall or long-period structures and deep soft soils.

Shallow crustal faults are caused by cracking of the continental crust resulting from the stress that builds as the subduction zone plates remain locked together. The Portland Hills, Oatfield, and East Bank faults run approximately in a northwest-southeast direction through downtown Portland and are generally believed to be capable of producing earthquake events in the study area. However, earthquake events on these crustal faults are less likely than the 9.0 CSZ earthquake.

Based on our discussions with the County and the project team, the scenario that will be used for this project is a M9.0 on the CSZ. This event has been widely used for evaluation and emergency planning in the Portland Metro area and Oregon because of the higher probability of its occurrence and greater area that will experience damage. Damage to the entire Pacific Northwest is expected during this scenario resulting in a much larger challenge for emergency response and recovery. DOGAMI has completed a comprehensive damage estimate based on shaking data for a 9.0 CSZ event. Based on their mapping, the CEI Hub is expected to experience very strong to severe shaking from aggregated earthquake sources, with severe shaking and moderate to heavy damage potential during a magnitude 9.0 CSZ earthquake as shown on Figure 1.2.

The anticipated ground shaking will also cause weaknesses within the subsurface soils. Liquefaction is a phenomenon where ground shaking in saturated granular (sand or silt) soils creates a rapid increase in pore water pressure that results in the sudden loss of shear strength in the soil. Sand boils and flows observed at the ground surface after an earthquake are the result of excess pore pressures dissipating upwards, carrying soil particles with the draining water. Liquefaction can result in settlement and strength loss, which can impact foundations. DOGAMI has mapped generalized liquefaction hazard at the site as moderate to high as shown on Figure 1.3. Additionally, liquefaction can cause global instability and may result in lateral spread towards water bodies and other low areas. DOGAMI has mapped the potential permanent ground deformation due to lateral spreading at the site as being between 39 and 173 inches, as shown on Figure 1.4.

1.3 History of the Oregon CEI Hub

The CEI Hub development began in the early 1900s, with the first tanks constructed in approximately 1907 at the Phillips 66 property. Since the beginning of development, the CEI Hub has expanded to five distinct areas, with 11 owners and 31 properties as indicated in Table 1.1 below. For the purposes of our evaluation, we have separated the CEI Hub into five distinct geographic areas for geotechnical evaluation. The property ownership and designated areas are shown on Figure 1.5. Closer views of each area are show in Figure 1.6 through Figure 1.10. We reviewed data collected from the State Fire Marshall, City of Portland, Portland State University (PSU), and historical aerial and satellite imagery to aid in the evaluation.

Table 1.1 - CEI Hub Areas

Area 1 - Kinder Morgan North					
Property Name	Address	City	State	Zip	Property ID
Kinder Morgan - North	11400 NW ST HELENS RD	PORTLAND	OR	97231	R323828
Area 2 - Linnton					
Property Name	Address	City	State	Zip	Property ID
BP West Coast	9930 WI/ NW ST HELENS RD	PORTLAND	OR	97231	R323779
BP West Coast	9930 NW ST HELENS RD	PORTLAND	OR	97231	R498331
BP West Coast	9900 WI/ NW ST HELENS RD	PORTLAND	OR	97231	R323771
BP West Coast	9930 WI/ NW ST HELENS RD	PORTLAND	OR	97231	R323758
Shore Terminals / Nustar	9420 WI/ NW ST HELENS RD	PORTLAND	OR	97231	R518296
Shore Terminals / Nustar	9420 WI/ NW ST HELENS RD	PORTLAND	OR	97231	R491070
Shore Terminals / Nustar	9400 S/ NW ST HELENS RD	PORTLAND	OR	97231	R324088
Shore Terminals / Nustar	9420 NW ST HELENS RD	PORTLAND	OR	97231	R518295
Shore Terminals / Nustar	9420 WI/ NW ST HELENS RD	PORTLAND	OR	97231	R518294
Area 3 - NW Natural					
Property Name	Address	City	State	Zip	Property ID
Pacific Terminal Services	7900 NW ST HELENS RD	PORTLAND	OR	97210	R324159
NW Natural	7900 WI/ NW ST HELENS RD	PORTLAND	OR	97210	R324171
NW Natural	7900 WI/ NW ST HELENS RD	PORTLAND	OR	97210	R324170
NW Natural	7598 NW ST HELENS RD	PORTLAND	OR	97210	R324113
NW Natural	7900 WI/ NW ST HELENS RD	PORTLAND	OR	97210	R324172
NW Natural	7441 SW/ NW ST HELENS RD	PORTLAND	OR	97210	R324165
NW Natural	7441 NW ST HELENS RD	PORTLAND	OR	97210	R324160
NW Natural	7540 NW ST HELENS RD	PORTLAND	OR	97210	R502592
NW Natural	7540 WI/ NW ST HELENS RD	PORTLAND	OR	97210	R324213
Area 4 - Willbridge					
Property Name	Address	City	State	Zip	Property ID
Kinder Morgan - South	5800 WI/ NW ST HELENS RD	PORTLAND	OR	97210	R324222
Kinder Morgan - South	5800 NW ST HELENS RD	PORTLAND	OR	97210	R121076
Kinder Morgan - South	6080 WI/ NW FRONT AVE	PORTLAND	OR	97210	R315782
Chevron	5533 NW DOANE AVE	PORTLAND	OR	97210	R315798
Chevron	5533 WI/ NW DOANE AVE	PORTLAND	OR	97210	R315771
Conoco Phillips	5528 WI/ NW DOANE AVE	PORTLAND	OR	97210	R315810
Conoco Phillips	5528 NW DOANE AVE	PORTLAND	OR	97210	R315769
Zenith Energy Terminals	5501 NW FRONT AVE	PORTLAND	OR	97210	R315845
Zenith Energy Terminals	5501 NW FRONT AVE	PORTLAND	OR	97201	R315777
McCall Oil	5700 NW FRONT AVE	PORTLAND	OR	97210	R315872
McCall Oil	5480 WI/ NW FRONT AVE	PORTLAND	OR	97210	R315786
Area 5 - Equilon					
Property Name	Address	City	State	Zip	Property ID
Equilon	3610-3640 NW ST HELENS RD	PORTLAND	OR	97210	R315819

The earliest available aerial photographs of the study area were taken by the U.S. Army Corp of Engineers (USACOE) in 1923 with coverage limited to Area 4 and Area 5. Tanks associated with Kinder Morgan and Chevron are visible on the 1923 aerial photograph, which displays approximately 30 percent of the tanks present today.

1.3.1 Area 1 - Kinder Morgan North

Area 1 includes one property owned by Kinder Morgan and is located at 11400 NW St. Helens Road on the north end of the Linnton neighborhood and includes riverfront as shown on Figure 1.5. The earliest available photograph of Area 1 is from 1936. At that time, 12 tanks are visible on the southwest portion of the property, and the northeast portion of the property is a combination of industrial land and the Willamette River. Extensive in-river filling of the northeast portion of the property occurred through 1941 when five additional tanks were constructed on the new land. Between 1954 and 1955, three additional tanks were added to the northeast portion of the property. Additional land was added along the shoreline of the property between 1956 and 1961. Based on available data, the oldest tank remaining at this property was constructed in 1914 and is currently out of service. Of the original tanks present in 1936, three were replaced in 1944, 1958, and 2011. Two of the original tanks have been removed permanently. Based on data provided by the City of Portland (City), PSU, and satellite imagery, there are currently 33 tanks present (Cone 2020 and Dusicka 2019). Additional details are provided in *Section 4.0 Geologic Risk of the CEI Hub in a CSZ Earthquake*.

1.3.2 Area 2 - Linnton

Area 2 includes nine properties owned by BP West Coast at 9900 and 9930 NW St Helens Road and Shore Terminals/Nustar at 9400 and 9420 NW St Helens Road. All nine properties are located north of the St. Johns Bridge and include riverfront.

1.3.2.1 BP West Coast

BP West Coast includes four properties. Three located on the west side of NW St Helens Road with no tank infrastructure and one property with tanks located on the east side of NW St Helens Road along the Willamette River. The earliest available photograph of the BP West Coast property is a 1940 aerial photograph that shows eight tanks present on the southern portion of the property, and two on the northern portion of the property. Between 1948 and 1957, the shoreline of BP West Coast was filled to add approximately 30 feet of land between the existing tanks and the Willamette River. By 1962, the additional tanks present today were constructed on the northern portion of the property. Based on data provided by the City, PSU, and satellite imagery, there are currently 30 tanks present (Cone 2020 and Dusicka 2019).

1.3.2.2 Shore Terminals/Nustar

Shore Terminals/Nustar includes five properties. Two properties on the west side of NW St. Helens Road include vacant land, small office buildings, and four small tanks that appear to have been installed between 1968 and 1977. Two properties located on the east side of NW St Helens Road include extensive tank infrastructure along the Willamette River. The earliest available photograph of the Shore Terminals/Nustar property is a 1939 aerial photograph that shows that the majority of the tank infrastructure is located on the northern portion of the northern property. That photograph also shows the southern portion of the property as well as the adjoining southern property are partially vegetated with filling activity visible. Additional filling continued on both properties through 1962, and the number of tanks approximately doubled. A large expansion of tanks on the southern property occurred between 1977 and 1984 and included additional shoreline filling. Two additional tanks were constructed on the southern portion of the southern property in 2007. The third property located on the east side of NW St Helens Road is a small, vacant piece of land on the northwest corner of the main Shore Terminals/Nustar property. Based on data provided by the City, PSU, and satellite imagery, there are currently 39 tanks present (Cone 2020 and Dusicka 2019).

1.3.3 Area 3 - NW Natural

Area 3 includes nine properties owned by Pacific Terminal Services and NW Natural at 7900, 7598, 7441, and 7540 NW St Helens Road. All nine properties are located between the St. Johns Bridge and the Burlington Northern Santa Fe railroad bridge, and include riverfront. The earliest available aerial photograph of this property is from 1936, and much of the southern portion of the property is wetland and an inlet of the Willamette River. Over 30 tanks are present on the northern portion and western property. Two large tanks are present on what appears to be a filled area of land adjacent to the Willamette River forming a partial island for the tanks. Additional filling occurred through 1944 on the southern portion of the property, and additional infrastructure was constructed, including tanks. By the late 1990s and into the 2000s, significant infrastructure was removed from the property. Based on data provided by the City, PSU, and satellite imagery, there are currently eight tanks present (Cone 2020 and Dusicka 2019).

1.3.4 Area 4 - Willbridge

Area 4 includes 11 properties owned by Kinder Morgan (5800 and 6080 NW St Helens Road), Chevron (5533 NW Doane Avenue), Conoco Phillips (5528 Doane Avenue), Zenith Energy Terminals (5501 NW Front Avenue), and McCall Oil (5700 and 5480 NW Front Avenue). All 11 properties are located south of the Burlington Northern Santa Fe railroad bridge and includes some riverfront properties.

1.3.4.1 Kinder Morgan South

Kinder Morgan South includes three properties. One property is located on the east side of NW St Helens Road, along the Willamette River with no tank infrastructure. The other two properties with tanks are located on the west side of NW St Helens Road and do not include riverfront. The earliest aerial photograph from 1923 depicts limited tank infrastructure constructed on the southern property. By 1936 the northern property remained vacant, undeveloped land and the southern property has been developed with approximately 15 tanks. Additional tanks were added to the southern property by 1944, and additional roads were constructed around the northern and southern properties. By 1956, approximately 20 tanks had been constructed on the northern property. Infrastructure continued to be added or removed over the next 50 years. Based on data provided by the City, PSU, and satellite imagery, there are currently 134 tanks present (Cone 2020 and Dusicka 2019).

1.3.4.2 Chevron

Chevron includes two properties. One property is located on the east side of NW St Helens Road along the Willamette River and appears to have one tank which was installed between 1944 and 1956. The larger property with the majority of the tank infrastructure is located on the west side of NW St Helens Road and does not include riverfront. Minor development of the property was visible in the earliest available aerial photograph from 1923. Major development of this property continued through 1936, when 12 tanks were visible on the property. Significant development of the property continued through the early 1960s, with larger tanks constructed on the eastern portion of the property and smaller volume tanks constructed on the west portion of the property. Based on data provided by the City, PSU, and satellite imagery, there are currently 146 tanks present (Cone 2020 and Dusicka 2019).

1.3.4.3 Conoco Phillips

Conoco Phillips includes two properties. One property is located on the east side of NW St Helens Road along the Willamette River and does not have any tank infrastructure based on satellite imagery. The larger property located on the west side of NW St. Helens Road was first developed prior to 1936. Approximately 20 tanks are visible on the westernmost portion of the property in 1936. The remaining property appears undeveloped, with a small water body noted east of the existing tanks. By 1944, the water body and been filled, and new tank infrastructure was installed to the east and south. By 1970, the majority of the tank infrastructure had been constructed on the site. Based on available records, the tanks all appear to be the original structures. Based on data provided by the City, PSU, and satellite imagery, there are currently 93 tanks present (Cone 2020 and Dusicka 2019). Zenith Energy Terminals.

Zenith Energy Terminals (formerly Arc Logistics) includes two properties. Both properties are located on the west side of NW Front Avenue and share a property line with Conoco Phillips. The smaller of the two properties, which is approximately 3 acres, was undeveloped until at least 1944 when buildings were constructed on the property. By 1964, one tank was constructed on the western portion of the property. A second tank was constructed by 1980, and all preexisting buildings had been removed. The larger property was first developed as housing in the early 1940s. Limited tank infrastructure development was present by 1948, on the northwest corner of the property, adjacent to the housing. By 1959, the housing had been removed, and additional tanks were constructed. Between 1964 and 1968, the former housing area had been filled and graded for additional tank infrastructure, which continued to expand through the mid-1980s. Based on data provided by the City, PSU, and satellite imagery, there are currently 97 tanks present (Cone 2020 and Dusicka 2019).

1.3.4.4 McCall Oil

McCall Oil includes two properties, both located on the east side of NW St. Helens Road, along the shore of the Willamette River. Both properties were part of the Willamette River prior to 1968. Significant filling of the site and surrounding properties continued through the 1980s. The earliest available aerial photograph of the area shows the present-day tank infrastructure had been constructed by 1986. Based on data provided by the City, PSU, and satellite imagery, there are currently 26 tanks present (Cone 2020 and Dusicka 2019).

1.3.4.5 Zenith Energy

Zenith Energy includes two properties, both located on the west side of NW St Helens Road and are not located on the riverfront. Development of the larger property to the south was noted in the 1956 aerial photograph, and one of the two tanks on the smaller property to the north was noted in the 1964 aerial photograph. By 1990, all tanks currently present were visible on the aerial photographs. Tank decommissioning's appeared as early as the 1998 aerial photograph. Based on data provided by satellite imagery and Portland Fire & Rescue (PF&R 2021), there are currently 86 tanks present.

1.3.5 Area 5 - Equilon

Area 5 includes one property owned by Equilon. The property is located on the west side of NW St Helens Road. The earliest available aerial photograph indicates that tank infrastructure was present prior to 1936 on the southeast portion of the property. Three additional tanks were constructed on the northwest portion of the property between 1944 and 1956, and a fourth tank was added in the 1990s. Based on data provided by satellite imagery, there are currently 14 tanks present.

2.0 DATA REVIEW

As part of this evaluation, we reviewed multiple technical documents, including construction reports, geotechnical reports, previous studies of the CEI Hub, and previous studies of the CSZ expected earthquake. Our document review included both publicly available data and confidential data necessary for the completion of this evaluation. Publicly available data included updated data from DOGAMI, the City, Oregon Solutions, PSU, and private contractors who have completed work at the CEI Hub. Confidential data were provided by the Oregon Office of State Fire Marshal (OSFM) in the form of a data table (Appendix A). Confidential data will be removed from the report prior to publishing. Detailed review included review of boring logs, permit applications, aerial photographs, and detailed infrastructure data provided by both OSFM and the City.

A detailed bibliography of the resource documents reviewed is provided in Table 2.1 (attached). Specific properties for which documents were reviewed as part of the geologic risk evaluation in *Section 4.0 Geologic Risk of the CEI Hub in a CSZ Earthquake* are highlighted on Figure 1.5 through Figure 1.9.

Using the technical documents provided by the City and other sources, a detailed analysis of the geologic risk to the CEI Hub in a CSZ earthquake was conducted. This included the use of local boring logs as well as the updated DOGAMI data to evaluate the ground shaking, liquefaction, and lateral displacement expected at the CEI Hub during a CSZ earthquake. Details of this evaluation are provided in Section 4.0 Geologic Risk of the CEI Hub in a CSZ Earthquake.

No site visits, subsurface explorations, or individual tank evaluations were included in the scope of work for the project.

2.1 Tank Data Collection and Review

During the initial data gathering process, it became clear that the data available from the OSFM would likely not include all data necessary to construct a complete inventory of tanks and supporting infrastructure at the CEI Hub. A critical part of this evaluation was to include an inventory of the tanks and supporting infrastructure at the CEI Hub, which would later be used to evaluate the impacts of a CSZ earthquake on the CEI Hub. Data necessary to do this would include exact location of tanks and supporting infrastructure and the age of the tanks and supporting infrastructure. During a phone call with Mark Johnston, Assistant Chief Deputy at OSFM, (Johnston 2020), Mr. Johnston indicated that tank owners are not required to report the exact location of the tanks, rather, only the quadrant of the property in which the stored material is located is required. Additionally, OSFM does not keep records of supporting infrastructure, and tank owners are not required to report the age of the tanks. Mr. Johnston indicated that the information on tank age would likely need to be requested directly from the property owners; however, he expects doing so would involve a lengthy legal process. Publicly available data collected regarding the infrastructure at the CEI Hub are provided in *Section 3.0 Tanks and Infrastructure of the CEI Hub*.

Another key aspect of the data collection was to include the contents of each tank at the CEI. As discussed with Mr. Johnston, property owners are only required to report the amount of hazardous substances on their property once a year, and that report only needs to include the maximum daily amount at any given point during the year. Therefore, the OSFM data were supplemented with data compiled by the City and PSU (see discussion below). Data collected regarding the contents of the tanks at CEI hub are provided in *Section 3.0 Tanks and Infrastructure of the CEI Hub*.

3.0 TANKS AND INFRASTRUCTURE OF THE CEI HUB

Salus received two main datasets regarding the tanks present at the CEI Hub, both of which were incomplete. The first dataset was provided by the City in the form of a web map (Cone 2020) and feature layer (Appendix A). The web map and feature layer were created from data collected during the PSU study of the CEI Hub (Dusicka 2019). This feature layer was compared to available satellite photographs of the CEI Hub to obtain an inventory of the number of tanks present in each area and each property. Approximately 122 tanks observed during a review of satellite imagery were not included in the web map; therefore, we had no information on tanks or their contents. The majority of these 122 tanks observed in satellite imagery coincide to tanks located at Zenith Energy and Equilon, which are not listed in the COP dataset feature layer. Table 3.1 (attached) provides an abridged summary of the data provided in the feature layer and the additional tanks at Zenith Energy (107 tanks),Equilon (14 tanks), and NW Natural (1 tank)identified from satellite photographs.

The second dataset was a confidential data table provided from the OSFM's office (Appendix A). This dataset was obtained through a Freedom of Information Act (FOIA) request submitted by John Wasiutynski from the City on behalf of Salus. The data received from the OSFM are data collected by the OSFM as part of the Community Right to Know (CR2K) program. The OSFM maintains the records associated with the Oregon Community Right to Know and Protection Act of 1985 (ORS 453.307-414), which requires Oregon employers to report their hazardous substances to OSFM, including where they are stored and the hazards associated with them (OSP 2021). Employers reporting hazardous substances are required to follow specific survey instructions but are only required to report substances once per calendar year, or if a substantive change occurs (OSFM 2020).

Following receipt of the OSFM data, Salus compared the dataset to that previously received from the City. Limited redundancies were noted that allowed for merging of the data. In a follow-up conversation with OSFM, it was noted that employers are only required to report the maximum daily amount of any substance present at their entire property and the general quadrant of their property it is stored at (Johnston 2020). For example, a property may have four above ground storage tanks (ASTs) that each hold 25 gallons of gasoline, four ASTs that each hold 20 gallons of diesel, and four ASTs that each hold 10 gallons of oil. This property will report 100 gallons of gasoline, 80 gallons of diesel, and 40 gallons of oil during their yearly submittal to OSFM. Due to the amalgamation of substances in the OSFM records, this dataset is not useful for identification of contents of individual tanks. The confidential dataset is provided in Appendix A.

Additional information was collected from City (Portland Fire & Rescue) resources and permit applications to cover the Zenith, Equilon, and NW Natural properties. This information was compared with the above data sets and incorporated into our tank database.

In addition to the inventory of tanks present at the CEI Hub, Salus made efforts to create an inventory of supporting infrastructure present at the CEI Hub. No existing datasets were found inventorying supporting infrastructure; therefore, Salus relied on satellite imagery, the City web map, and Portland Maps to identify buildings present at the CEI Hub (Portland Maps 2020). A summary of this inventory is provided in Table 3.2 (attached).

4.0 GEOLOGIC RISK OF THE CEI HUB IN A CSZ EARTHQUAKE

This section presents estimates of site and soil behavior of the CEI Hub areas during a magnitude 9.0 CSZ earthquake. Estimates for the level of ground motion shaking were evaluated, the soil at each of the areas was characterized based on the existing data provided by the City, and estimates of liquefaction settlement and lateral spread were developed for each location.

4.1 CSZ Earthquake Ground Motion Shaking Intensity

Since the publication of the 2017 DOGAMI report, several additional resources have been published that can estimate the intensity of the ground motion shaking in the project areas. The resources are in the form of ground motion models published as a part of the Next Generation Attenuation-Subduction (NGA-Subduction) (Bozorgnia and Stewart 2020) research effort and simulations published in Frankel et al. (2018). The ground motion models are developed from recordings and simulations of subduction zone events around the world and developed for compatibility with probabilistic assessments of ground motion shaking, such as those used in building design and, as such, include model features to address uncertainty. The simulations represent the synthetic modeled ground surface response of 30 magnitude 9.0 events occurring in the CSZ using a large-scale numerical model of the Pacific Northwest.

The shaking of a site at the ground surface is influenced by the stiffness of the surface soil. Softer soil will typically amplify ground motion shaking more than stiff soils. While the DOGAMI report includes these soil effects and the NGA-Subduction ground motion models (GMMs) can account for these effects, the Frankel et al. (2018) simulation dataset does not. For a more direct comparison, the two new data sources (the NGA-Subduction and Frankel et al. 2018 simulations) are evaluated in the following sections for a hard soil or rock-like site condition so a consistent basis of comparison between the models can be used. Where ground motion intensity values in this study are evaluated at the ground surface, the site classes and factors commonly used in the National Earthquake Hazards Reduction Program (NEHRP) are used to adjust the earthquake intensity hard-soil and rock condition to a surface condition in order to reflect the soft site soils. The NEHRP site factors are a simplified intensity-dependent ratio of ground motion intensity between stiff and soft sites, and they are widely adopted in design standards, such as the Oregon Structural Specialty Code, International Building Code, and American Association of State and Highway and Transportation Officials seismic design standards.

4.1.1 NGA-Subduction Ground Motion Models

The NGA-Subduction project is one of a series of research projects created to facilitate the development of ground motion models for use in seismic hazard assessments. Previous NGA projects were done for shallow crustal earthquakes (NGA-West1 and NGA-West2) and for stable continental regions (NGA-East) and the resulting models are widely used in the International Building Code (IBC) and in other design and research applications. The NGA-Subduction project is focused on the development of ground motion models for subduction zones and results from this project are in the process of being published.

Two ground motion models have been produced from the NGA-Subduction project, the Kuehn et al. (2020) model (KBCG20), and the Parker et al. (2020) model (PSHAB20). These models use information about a specified earthquake scenario to estimate the intensity of ground shaking at a site. Typical inputs for these models include the earthquake magnitude, rupture distance from the site to the epicenter, site soil stiffness, and depth to the rupture. Because of the variability and uncertainty of the ground motion shaking for a specified earthquake scenario, the models are used to develop percentiles of the ground motion intensity response. For example, for a given earthquake scenario, the ground motion models are commonly used to estimate a median, 50th percentile ground motion intensity response, in which half of the modeled ground motions values are greater than and half less than the median response. Instead of only evaluating the median (50th percentile) ground motion, it is standard practice to also consider the 84th percentile intensity response, which represents the median response plus a standard deviation (or “sigma”) of the response values.

Ground motion models, such as the KBCG20 and PSHAB20, which consider the effects of uncertainty on the level of ground motion shaking are commonly adapted for use in seismic hazard assessments that depend on the likelihood of a certain level of ground motion shaking occurring, such as in the seismic design of new buildings.

4.1.2 Frankel et al. (2019) Simulations

A series of simulations of ruptures of the CSZ interface were conducted and published in Frankel et al. (2019). Thirty ruptures of magnitude 9.0 and greater of the CSZ were modeled for a variety of rupture parameters and locations along the CSZ interface zone. One of the products of these simulations are synthetic ground motion recordings at locations throughout the Pacific Northwest. The synthetic seismograms are representative of individual earthquake events and are not comprehensive or representative of the full range of uncertainty of ground motions due to a CSZ interface event.

For this study, the ground motions were selected for the model grid point nearest 45.57 degrees N, -122.76 degrees E, the closest model grid point to the project study area. The synthetic ground motions are two-component (north-south and east-west) synthetic acceleration time histories for a stiff soil condition. The soil condition used at the ground surface in the Frankel et al. (2019) model is a site with time averaged shear wave velocity in the top 100 feet (30 meters) of approximately 2,000 feet per second (600 meters per second). Figure 4.1 below shows the response spectrum for the 60 acceleration time series selected from the Frankel et al. (2019) model in blue with the median in red.

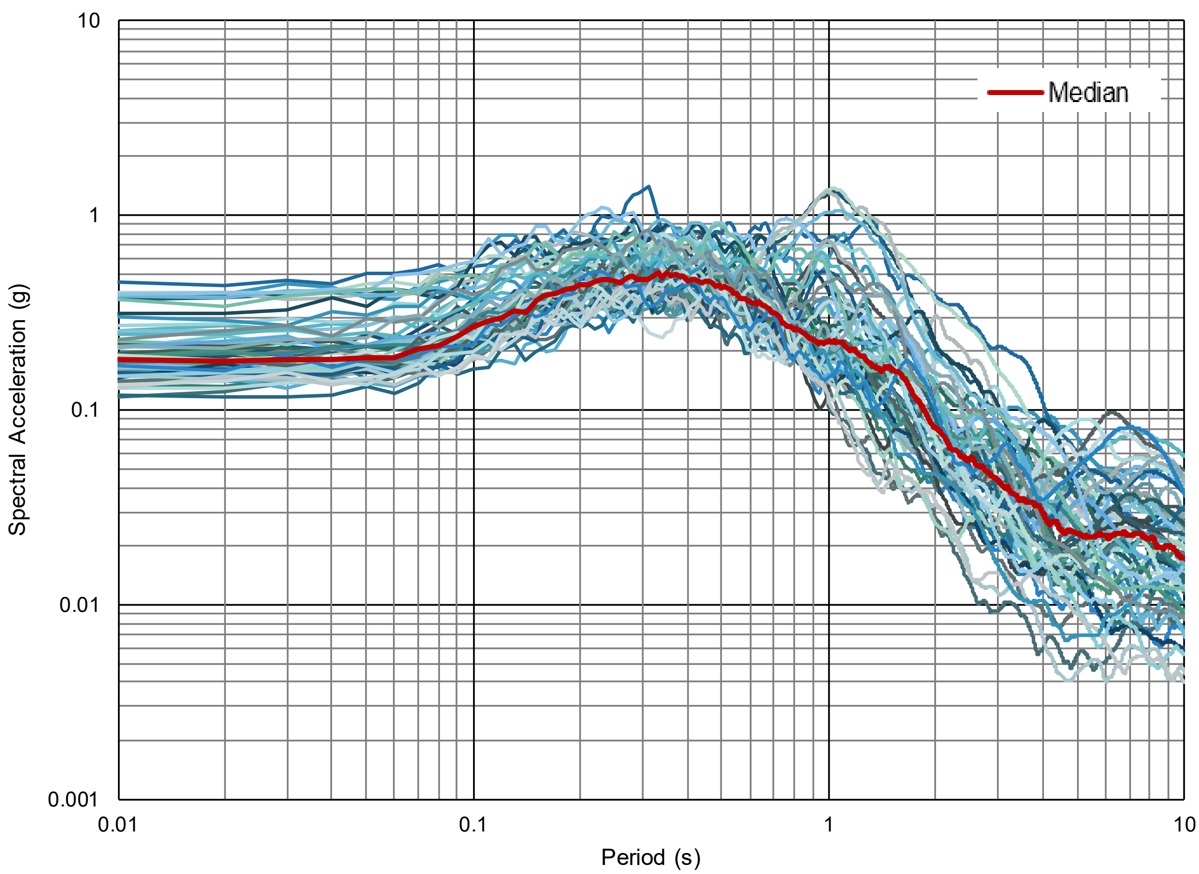


Figure 4.1 CSZ Ground Motion Components (Frankel et al. 2019)

4.1.3 Ground Motion Intensity Comparison

This study evaluates the level of shaking at the project sites of interest for a magnitude 9.0 rupture of the CSZ. This is commonly referred to as a "deterministic" event; the computed level of ground motion shaking is computed for a specific event and the likelihood of that event occurring is not considered. In analyses where the likelihood of a seismic event occurring is considered, the seismic assessment is referred to as "probabilistic." Structures designed using the IBC are typically designed considering the lesser of an 84th percentile deterministic event and a probabilistic hazard assessment for a probability of exceedance of 2 percent in 50 years.

In engineering design, the ground motions due to seismic shaking are commonly transformed to a spectral acceleration response spectrum that can be used to model how an earthquake is experienced by a building/structure, Spectral acceleration values for the available calculation methods are shown on Figure 4.2 below for a stiff soil or rock-like Site Class B/C condition. The black line represents a probabilistic geometric mean spectrum from the 2014 USGS hazard maps commonly used in IBC design for new construction. This probabilistic curve includes the effects of both subduction events and shallow crustal events, represents the hazard of a 2 percent probability of exceedance in 50 years (equivalent to a 2,475-year return period), and is shown for comparison only. The red and blue lines are computed from the PSHAB20 and KBCG20 GMMs, respectively, with the solid lines representing the median and dashed lines representing the 84th-percentile ground motion (median plus one standard deviation, sigma). The PSHAB20 and KBCG20 GMMs were computed using the earthquake characteristics shown in Table 4.1 below. The green line is the median of the Frankel et al. (2019) simulations. The gray points are the surface intensity values from the DOGAMI (2018) report decreased by a factor of 1.2 to remove the effects of soft soil amplification and approximate a stiff soil or rock-like condition similar to the condition used for the other lines plotted on the figure. The 1.2 factor is consistent with the NEHRP amplification ratio between the site class used in the DOGAMI (2018) map near the project site (Class D, representative of the surface soil condition) and the site class used in this study for the Frankel et al. (2018) simulations and NGA-Sub GMMs (Class C, representative of a stiff soil or soft rock condition).

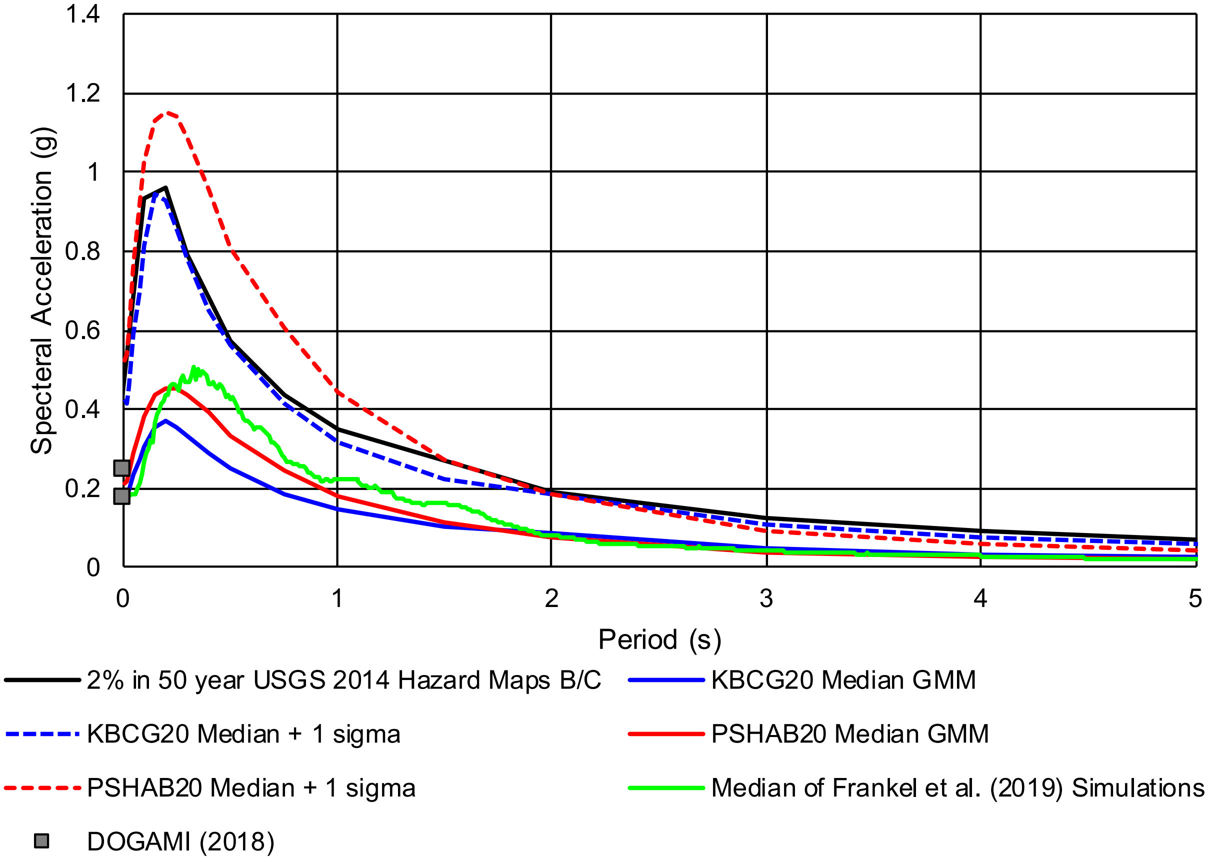


Figure 4.2 CSZ Spectral Response

Table 4.1 - KBCG20 and PSHAB20 Earthquake Parameters

Parameter	Value
Region and Type	Cascadia Interface
Moment Magnitude	9.0
V_{S30}	760 meters per second
Rupture Distance	72 kilometers
Rupture Depth	10 kilometers

Figure 4.2 indicates that the level of ground motion shaking shown in the DOGAMI hazard maps is similar to the intensity estimated from the most recent ground motion models for a CSZ rupture. However, the uncertainty range of the GMMs indicates that an 84th percentile event represents a significantly higher level of ground motion shaking than the median earthquake event; specifically, the peak ground acceleration (equivalent to the spectral response at a period of zero seconds) is approximately 100 percent higher for the 84th percentile event than the median event.

The median of the Frankel et al. (2019) simulations have a similar PGA as both the DOGAMI hazard maps and the KBCG20 and PSHAB20 ground motion models. The PGA values of the simulated ground motions range from 0.12 to 0.45. The simulations represent a range of rupture scenarios for the CSZ, not just a worst-case scenario. The similarity of the simulations to the other estimates of ground motion shaking indicate that the site is susceptible to strong shaking from interface CSZ events anywhere along the fault.

The scope of the liquefaction and lateral spread analyses presented later in this section only considered the median event at the ground surface and not also the 84th percentile event (sigma event).

4.2 Representative Soil Information and Liquefaction Analysis

Available geotechnical subsurface soil information was collected for the areas of interest of this study. This section presents the generalized subsurface conditions of the soil at each of the locations. The characterization of the soil at these sites is representative only and not intended to replace a more detailed geotechnical design study at each location, and the values provided in this report are not intended for use in geotechnical design. The references for the geotechnical reports and other subsurface information cited in this section can be found in the attached Table 2.1.

Key information from the geotechnical reports used to characterize subsurface conditions at the sites primarily included logs of mechanically drilled borings and cone penetration test (CPT) soundings. From the borings, we evaluated standard penetration test (SPT) blow count (N_{SPT}) data, which is a standardized soil sampling method used throughout the geotechnical industry. The CPT soundings include advancing a steel probe equipped with electronic instrumentation to measure resistance, friction, and other soil parameters. Equivalent N_{SPT} values can be obtained from CPT soundings to help compare data to the drilled borings.

The soil at each area was generalized into stratigraphic units that were evaluated for their potential for immediate liquefaction settlement, an approximate upper and lower bound of N_{SPT} values and a representative fines content in the soil layer. The upper and lower bound N_{SPT} values are used to provide a range of anticipated liquefaction settlement at each site, lower N_{SPT} values indicate larger amounts of potential surface settlement during an earthquake. For the lateral spread analyses, only the lower-bound N_{SPT} profile was used.

The subsurface soil information in this section considers fine-grained soils as generally “non-liquefiable” as the focus of this study is on immediate ground surface settlements that will occur following an earthquake event. While fine-grained soils, such as silt and clay, may experience strength loss during an earthquake that results in failure of foundations and structures at the ground surface, these soils generally contribute less to ground surface settlement than coarse-grained sand and gravel. A detailed design study for each of the project areas, including further review of soil laboratory testing data may be required to characterize the likelihood of strength loss in the fine-grained soil deposits.

4.2.1 Area 1 - Kinder Morgan North

Geotechnical soil information for Area 1 is documented in a report by GeoEngineers (2011). The soil at the site generally consists of a dense layer of gravel and coarse-grained fill over layers of layers of silt and clay that appear to be generally non-liquefiable. Approximately 38 to 40 feet below the ground surface (bgs) is a unit of potentially liquefiable coarse-grained sandy silt and silt with sand that may have beds of fine-grained clayey silt and silty clay. The groundwater table appears to be approximately 4 feet bgs. The representative stratigraphy of the area is shown in Table 4.2 (below).

The range of N_{SPT} values for the stratigraphic units are equivalent corrected blow counts from CPT soundings in the area as provided in the GeoEngineers (2011) report.

Table 4.2 - Kinder Morgan North Area Soil Stratigraphy

Stratigraphic Unit	Potentially Liquefiable	Upper Bound N_{SPT} (blows/foot)	Lower Bound N_{SPT} (blows/foot)	Fines Content (percent)	Thickness (feet)
Gravel and Silty Sand Fill	Yes	50	50	10	4
Clayey Silt to Silty Clay	No	11-22	5	60	34
Silty Sand	Yes	27	16	50	6
Clayey Silt to Silty Clay	No	50	13	60	2
Sand with Silt	Yes	35	21	40	4
Basalt	Top of bedrock encountered at approximately 50 feet below ground surface				

4.2.2 Area 2 - Linnton

The Linnton Area has the most available subsurface information of the areas reviewed in this study. Therefore, there was enough information for Area 2 information to characterize the northern and southern parcels separately.

4.2.2.1 North Area 2 - Linnton

Geotechnical soil information for the north region of Area 2 is documented in a series of reports from URS Corporation (2006, 2007a, 2007b), Professional Service Industries, Inc. (PSI) (2015) and Hart Crowser (1992). The stratigraphy generally consists of liquefiable coarse-grained fill and stream deposits overlying a layer of non-liquefiable fine-grained deposits, which overlies a deeper layer of liquefiable coarse-grained alluvial deposits. The ordinary high-water elevation was considered the top of the groundwater table at this site and is approximately 14 feet bgs. The representative stratigraphy of the area is shown in Table 4.3.

Table 4.3 - Linnton Northern Area Soil Stratigraphy

Stratigraphic Unit	Potentially Liquefiable	Upper Bound N_{SPT}	Lower Bound N_{SPT}	Fines Content (percent)	Thickness (feet)
Sandy Fill with Silt	Yes	22	8	10	20
Coarse-Grained Stream Deposits	Yes	N/A	10	10	0-10
Fine-Grained Alluvial Deposits	No	20	12	70	10-20
Sandy Alluvial Deposits	Yes	22	14	10	30
Basalt	Top of bedrock encountered at approximately 70 feet below ground surface				

In the series of URS reports the average N_{SPT} values for each of the stratigraphic units is reported and plotted with all available N_{SPT} measurements. The upper- and lower-bound N_{SPT} values were selected to represent reasonable upper and lower bounds of the available N_{SPT} data. These values are generally consistent with the noted subsurface information in the PSI and Hart Crowser reports.

The liquefiable coarse-grained stream deposits do not appear to be present throughout the site. However, because these soils represent a significant contribution to the potential for liquefaction settlement and lateral spread in the area of the site, they were considered to be 10 feet thick in the analysis of the lower-bound N_{SPT} values only and not in the upper-bound N_{SPT} value analysis.

4.2.2.2 South Area 2 - Linnton

Geotechnical soil information for the southern region of Area 2 is documented in a series of reports and technical memoranda by CH2MHILL (2006a, b, c, and d) and a report by Dames and Moore (1981). The soil generally consists of coarse-grained liquefiable gravel fill and silty sand overlying non-liquefiable fine-grained silt and clay. The groundwater table is indicated to be at approximately 18 feet bgs.

In the CH2MHILL reports, N_{SPT} values of the stratigraphic units are reported as a range. The upper and lower N_{SPT} values are taken as the middle of the range plus and minus 25 percent of the range.

Table 4.4 - Linnton Southern Area Soil Stratigraphy

Stratigraphic Unit	Potentially Liquefiable	Upper Bound N_{SPT}	Lower Bound N_{SPT}	Fines Content (percent)	Thickness (feet)
Gravel Fill	Yes	17	7	5	10
Silty Sand	Yes	9	5	45	20
Silt and Clay	No	20	9	75	35
Basalt	Top of bedrock encountered at approximately 65 feet below ground surface				

4.2.3 Area 3 - NW Natural

The subsurface soil information of Area 3 is characterized in a series of geotechnical reports by GeoEngineers (2005, 2012, 2015, 2016. 2018). Soil in this area generally consists of a unit of liquefiable coarse-grained sandy silt and fill over a thicker layer of non-liquefiable fine-grained alluvial silt. The groundwater table appears to be approximately 10 feet bgs from soil borings at the site. Soil stratigraphy information is provided in Table 4.5.

The N_{SPT} values for each of the stratigraphic units were approximated as the average of N_{SPT} values from the stratigraphic units as measured in four soil borings at the site plus and minus one half of the standard deviation.

Table 4.5 - NW Natural Northern Area Soil Stratigraphy

Stratigraphic Unit	Potentially Liquefiable	Upper Bound N_{SPT}	Lower Bound N_{SPT}	Fines Content (percent)	Thickness (feet)
Sandy Silt and Poorly Graded Sand Fill	Yes	17	7	10	20
Fine-Grained Alluvial Silt	No	8	5	80	55
Basalt	Top of bedrock encountered at approximately 80 feet below ground surface				

4.2.4 Area 4 - Willbridge

The subsurface soil information of Area 4 is characterized in reports by GeoEngineers (1998, 2000a, 2000b), PSI (2015), AMEC Earth and Environmental (2004), URS Corporation (2001) and the City of Portland (1968). However, much of the soil information in these reports only extends to depths of 20 to 40 feet bgs and does not extend to the top of the basalt bedrock. The GeoEngineers (1998) and PSI (2015) reports were the reports most significantly used to develop the generalized stratigraphy profile in Table 4.6 for Area 4.

The stratigraphy in Area 4 generally consists of liquefiable sandy fill and loose sand overlying a layer of fine-grained non-liquefiable stiff silt. Below the silt is a layer of liquefiable loose sand deposits. The groundwater table appears to be approximately 10 feet bgs.

Upper and lower bounds for the N_{SPT} values were computed from soil borings in the GeoEngineers (1998) and PSI (2015) reports that extended to the basalt. The N_{SPT} values were approximated as the average of N_{SPT} values from the stratigraphic units as measured in three soil borings at the site plus and minus one half of the standard deviation. The N_{SPT} values from this subset of the soil information available for the site are generally representative of the soil conditions documented in the other subsurface information reports.

Table 4.6 - Willbridge Area Soil Stratigraphy

Stratigraphic Unit	Potentially Liquefiable	Upper Bound N_{SPT}	Lower Bound N_{SPT}	Fines Content (percent)	Thickness (feet)
Sandy Fill and Loose Sand	Yes	19	9	5	25
Stiff Silt	No	9	9	75	15
Loose Sand	Yes	8	8	5	10
Basalt	Top of bedrock encountered at approximately 50 feet below ground surface				

4.2.5 Area 5 - Equilon

The subsurface soil information of Area 5 is characterized in reports by GeoDesign Inc. (2006), Rittenhouse-Zeman and Associates, Inc. (1990) and Shannon and Wilson, Inc. (1965). The soil at the site generally consists of a layer of liquefiable loose sand and sandy fill over a layer of stiff silt overlying a layer of liquefiable loose sand. The groundwater table appears to be at a depth of approximately 10 feet bgs. The stratigraphy information for Area 5 is shown in Table 4.7 (below).

Area 5 has generally lower N_{SPT} values for similar stratigraphic units than the other areas. The deep layer of loose sand did not have any N_{SPT} values at this location and so the N_{SPT} values of Area 4 were assumed. The Upper and Lower bound N_{SPT} Values in table 4.7 represent the range of N_{SPT} values measured in each stratigraphic layer. However, because there is so little variability in these values relative to the mean, the standard deviation of N_{SPT} was not considered for this site as it was for Areas 3 and 4.

Table 4.7 - Equilon Area Soil Stratigraphy

Stratigraphic Unit	Potentially Liquefiable	Upper Bound N_{SPT}	Lower Bound N_{SPT}	Fines Content (percent)	Thickness (feet)
Sandy Fill and Loose Sand	Yes	7	4	5	25
Stiff Silt	No	6	4	75	20
Loose Sand	Yes	8	8	10	10
Basalt	Top of bedrock encountered at approximately 50 feet below ground surface				

4.3 Surface Settlement Due to Liquefaction of Coarse-Grained Soil

Each of the characteristic soil profiles in the five areas were evaluated for estimated surface settlement due to liquefaction. The simplified Idriss and Boulanger (2008) procedure for estimating liquefaction effects during an earthquake was used. This calculation method uses the soil information provided in Tables 4.2 through 4.7 above and parameters for a characteristic earthquake. The earthquake used in this analysis was a magnitude 9.0 earthquake with a ground surface PGA of 0.3 g, which is approximately equal to the median surface response of a deterministic event as discussed in *Section 4.1 CSZ Earthquake Ground Motion Shaking Intensity*. The estimated surface settlement at each area is shown in Table 4.8.

Table 4.8 - Estimated Surface Settlement due to Liquefaction

Area	Estimated Settlement (inches)	
	Upper Bound N_{SPT} Profile	Lower Bound N_{SPT} Profile
Area 1 - Kinder Morgan North	0	2
Area 2 - Linnton North	8	19
Area 2 - Linnton South	7	8
Area 3 - NW Natural	3	9
Area 4 - Willbridge	9	14
Area 5 - Equilon	15	17

Additional estimates of surface settlement are included for some of the areas in the geotechnical reports reviewed in this study. These surface estimates are generally not evaluated for a deterministic CSZ event and use a probabilistic earthquake hazard level. A summary of the available estimates of surface settlement from these reports is in Table 4.9 below. The estimates in Area 2 North and Area 4 are based on shallow exploration data and do not consider settlement of the soil from the ground surface to the bedrock, including the deep liquefiable sand layer observed in some of the areas. The more detailed estimate of surface settlement for Area 2 South in the CH2MHILL (2006) report computed with the Ishihara and Yoshimine (1992) simplified method generally agrees with the estimate from this study in Table 4.8.

Table 4.9 - Reported Surface Settlement in Reviewed Historical Reports

Area	Reported Surface Settlement	Report	Method
Area 2 - Linnton North	1.5 to 1.75 inches	PSI (2015)	CPT
Area 2 - Linnton South	6 to 9 inches	CH2MHILL (2006)	Ishihara and Yoshimine (1992)
Area 4 - Willbridge	3 to 4.25 inches	GeoEngineers (1998)	CPT

4.4 Lateral Spread Potential

The estimated lateral spread at each site was evaluated for the five areas using the Youd, Hansen, and Bartlett (2002) simplified procedure. The Youd, Hansen, and Bartlett (2002) procedure estimates the amount of horizontal movement at a location on a slope or some distance away from a free-standing soil face due to earthquake-induced liquefaction of coarse-grained soil.

The inputs to the Youd, Hansen, and Bartlett (2002) simplified procedure include earthquake magnitude and distance, the cumulative thickness of liquefiable soil units at the site, the average mean grain size of the granular layers (D_{50}), the average fines content of the granular layers, and information about the geometry of the slope. The Youd, Hansen, and Bartlett (2002) procedure is limited to earthquake magnitudes 6 to 8, and a magnitude 8 earthquake was considered for this study. If the procedure is extrapolated to a magnitude 9 earthquake, the estimated lateral spread increases by a factor of 7. The earthquake distance used was 70 kilometers and is consistent with the deterministic seismic hazard analyses discussed in *Section 4.1 CSZ Earthquake Ground Motion Shaking Intensity*. The thickness of the liquefiable soil layers and fines content of the soil layers used in this analysis is consistent with the stratigraphy profiles given in *Section 4.2 Representative Soil*

Information. A single representative D_{50} of 0.25 millimeters for all granular soil was estimated from the laboratory testing results provided in the historical subsurface information documents discussed in *Section 4.2 Representative Soil Information*. The range of the D_{50} for both the shallow and deep granular materials was fairly consistent and ranged from 0.1 to 0.7 millimeters.

The Youd, Hansen, and Bartlett (2002) correlations depend on the geometry of the site investigated and consider either a sloping ground condition or a free-face condition. For this study, we evaluated the surface profile at each area on the cross-section lines shown on Figures 1.5 to 1.9 using LiDAR data (DOGAMI 2014) for upland topography and bathymetry data (2005) for offshore slopes. Generally, the areas at each of the sites where tanks are located are flat and has little to no slope. However, along the Willamette River, there is a consistent elevation change from the ground surface down to the edge of the river. Under the surface of the river, the slope of this elevation change generally becomes more gradual and the submerged slope ends at approximately the same elevation as the basalt encountered in the reviewed borings. In this preliminary study, we considered the elevation change from the upland ground surface to the approximate bottom of the submerged slope as a free-face soil condition that ranged from 50 to 70 feet tall for most locations. For Area 3, we considered the height of the free face only to include the surficial liquefiable sand as the free face condition that has a height of 20 feet. Horizontal lateral spread displacement estimates are provided in Table 4.10 below as a function of distance from the soil free-face.

Table 4.10 - Estimated Lateral Spread at Each Area Varied by Distance to Free Face

Area	Estimated Lateral Spread (feet) Distance to Free Face of Soil				
	50 Feet	100 Feet	250 Feet	500 Feet	1000 Feet
Area 1 - Kinder Morgan North	8	5	3	2	1
Area 2 - Linnton North	20	13	8	5	3
Area 2 - Linnton South	13	9	5	3	2
Area 3 - NW Natural	6	4	2	2	1
Area 4 - Willbridge	14	9	5	4	2
Area 5 - Equilon	15	10	6	4	2

Geotechnical reports for locations in some of the areas reviewed for this study included estimates of lateral spread as shown in Table 4.11. As with the liquefaction settlement analyses discussed in Section 4.3, these reports evaluate the lateral spread potential for a probabilistic design condition and not a deterministic condition representative of a magnitude 9 subduction event. The CPT analyses in PSI (2015) and Geoengineers (1998) do not consider surface geometry, are of limited depth, and are simplified procedures similar to the Youd, Hansen, and Bartlett (2002) analysis conducted for this study.

The CH2MHILL (2006) analysis was a 2-dimensional finite difference model run with the software FLAC for the edge slope of the soil along the Willamette River, the same slope considered a free-face in this study. The FLAC analyses were conducted with detailed soil models for a series of earthquake time histories to model the behavior of the slope during an earthquake. While there have been several advancements in numerical modeling and understanding subduction zone earthquake hazards in the

Portland area, the analyses conducted in the CH2MHILL report are generally representative of detailed, high-quality analyses and result in a similar maximum displacement as estimated with the Youd, Hansen, and Bartlett (2002) analysis above.

Table 4.11 - Reported Surface Settlement in Reviewed Historical Reports

Area	Reported Lateral Spread	Report	Method
Area 2 - Linnton North	1.3 to 1.8 feet	PSI (2015)	CPT
Area 2 - Linnton South	1.2 to 12.7 feet	CH2MHILL (2006)	2D FLAC Nonlinear Analysis
Area 4 - Willbridge	4.6 to 6.7 feet	GeoEngineers (1998)	CPT

5.0 TECHNICAL REFERENCES

References for project-specific documents reviewed are included in Table 2.1.

Bozorgnia, Yousef, and Jonathan Stewart. "Data Resources for NGA-Subduction Project." PEER Report 02/2020, Pacific Earthquake Engineering Research Center, UC Berkeley.

DOGAMI 2012. DOGAMI Lidar Data 7.5' Quadrangle (LDQ) Series Publications, www.OregonGeology.org.

Evarts, R.C., J.E. O'Connor, R.E. Wells, and I.P. Madin 2009. The Portland Basin: A (big) river runs through it. GSA Today, 19(9), pp.4-10.

Frankel, A., Wirth, E., Marafi, N., Vidale, J., and Stephenson, W. (2018), Broadband Synthetic Seismograms for Magnitude 9 Earthquakes on the Cascadia Megathrust Based on 3D Simulations and Stochastic Synthetics, Part 1: Methodology and Overall Results. Bulletin of the Seismological Society of America, 108 (5A), 2347-2369. doi: https://doi.org/10.1785/0120180034.

Idriss, I.M. and R.W. Boulanger 2008. Soil Liquefaction during Earthquakes by Earthquake Engineering Research Institute MNO-12.

Kenji Ishihara, Mitsutoshi Yoshimine. "Evaluation of Settlements in Sand Deposits Following Liquefaction During Earthquakes" *Soils and Foundations.* Volume 32, Issue 1. 1992, Pages 173-188, ISSN 0038-0806, https://doi.org/10.3208/sandf1972.32.173.

Kuehn, Bozorgnia, Campbell, and Gregor, "Partially Nonergodic Ground-Motion Model for Subduction Regions using NGA-Subduction Database," PEER Report 2020/04, Pacific Earthquake Engineering Research Center, UC Berkeley.

Parker, G.A., Stewart, J.P., Hassani, B., Atkinson, G.M., and Boore, D.M. (2020). "NGA-Subduction Global Ground Motion Models with Regional Adjustment Factors". PEER Report xx/2020, Pacific Earthquake Engineering Research Center, UC Berkeley.

Portland Fire & Rescue (PF&R), 2021. E-mail from Jerome Perryman, Hazardous Materials Inspector, PF&R to Michael Silva, City of Portland. May 5.

PortlandMaps 2020. Metadata, 2005 Willamette River Bathymetry, https://www.portlandmaps.com/metadata/index.cfm?&action=DisplayLayer&LayerID=53730, accessed December 23, 2020.

Youd T.L., C.M. Hansen, and S.F. Bartlett 2002. Revised Multilinear Regression Equations for Prediction of Lateral Spread Displacement. Journal of Geotechnical and Geoenvironmental Engineering, Vol. 128, No. 12.

\\haleyaldrich.com\share\pdx_data\Notebooks\154035019_Critical_Energy_Infrastructure_Hub_Seismic_Risk_Analysis\Deliverables\Report-Deliverable-1\Report-ExpectedEarthquakeRisk_FINAL\2022_0202_HCHA_Expected Earthquake Risk Report_F.docx

Table 2.1: Documents Reviewed
Portland, Oregon

	Author	Document	Date	Format	Summary
1	AMEC Earth & Environmental	Geotechnical Engineering Report, Chevron Asphalt Facility, Portland, Oregon	December 2004	Report	Subsurface information related to the design and construction of a new rail spur track and driveway for truck shipments.
2	AMEC Earth & Environmental	Locations of Deep Gravel, Hydrogeologic Zone Pumping Test Wells, Constructed on City of Portland Property in 2008	January 2009	Report Excerpt	Only Figure 1 and Borings EX-S-03-123, EX-S-04-125, EX-S-05-125, PM-01-018, PM-01-085, PM-01-120, PM-01-147, and PM-05-024.
3	CH2MHILL (2006a)	Geotechnical Data Report, Valero LP Portland Terminal, Tank Farm Expansion Project	June 2006	Report	Subsurface information related to the design and construction of two new 100,000-barrel gasoline/diesel storage tanks.
4	CH2MHILL (2006b)	Geotechnical Recommendations Report, Valero LP Portland Terminal, Tank Yard 5 Expansion Project	June 2006	Report	Subsurface information and interpreted soil parameters related to the design and construction of two new 100,000-barrel gasoline/diesel storage tanks.
5	CH2MHILL (2006c)	Seismic Site Hazard Report, Valero LP Portland Terminal, Tank Yard 5 Expansion Project	August 2006	Report	Subsurface information and interpreted soil parameters for a seismic hazard analysis related to the design and construction of two new 100,000-barrel gasoline/diesel storage tanks.
6	CH2MHILL (2006d)	Valero LP Portland Terminal Tank Yard 5 Expansion Project	October 6, 2006	Technical Memorandum	Interpreted soil properties for proposed jet grout ground improvements related to the design and construction of two new 100,000-barrel gasoline/diesel storage tanks.
7	City Club of Portland	Big Steps Before the Big One: How the Portland area can bounce back after a major earthquake	February 14, 2017	Report	Research report on the resiliency of the City of Portland area.
8	City of Portland, Oregon	Portland Maps	December 24, 2020	Website	Online mapping service
9	City of Portland, Oregon	CoP Application for Permit #2018-181859-000-00-CO	August 21, 2018	Permit Application	Accessed via Portland Maps website on May 7, 2021
10	City of Portland, Oregon	Geotechnical Investigation, Ramsey Lake Trunk Sewer, CSO Combination, BES Project Number 5273	December 20, 1994	Report	NOT IN PROJECT AREA
11	City of Portland, Oregon	Site plans of Equilon and Zenith Properties with tank content information.	No dates	Site plans	Mark ups provide fill and content info for some tanks on Equilon and Zenith properties. Plans were provided by CoP Bureau of Emergency Management and the Portland Fire & Resuce on May 7, 2021 via email.
12	City of Portland, Oregon	Portland Bureau of Planning and Sustainability's Fossil Fuel Terminal Zoning Amendments website	2020	Website	Provides overview of the Fossil Fuel Terminal Zoning Amendments that restrict the development of new and expansion of storage tank capacity at existing terminals.
13	City of Portland, Oregon	NW Saltzman Road, Culvert Replacement City Map	April 2002	Report Excerpt	Only Plates 1-11, Borings 1-9
14	City of Portland, Oregon	NW St. Helens Rd. NW 35th Ave. Sanitary Sewer System	June 1968	Report Excerpt	Boring Logs and Maps only
15	City of Portland, Oregon	SLRT Monitoring Demolition and Installation Project E10516	November 24, 2014	Report Excerpt	Only Logs HA-1a, HA-1b, HA-2 and HA-3.
16	Cone, Paul City of Portland	CEI Hub analysis	Updated December 4, 2020	Web Map	Web map of the CEI Hub based of data gathered during the 2019 PSU study.
17	Dames & Moore	Final Report, Extended Soils Investigation and Oil Seepage Control Scheme, Portland Terminal, Portland, Oregon	January 13, 1981	Report	Subsurface information related to the design and construction of a cement-bentonite cutoff wall.
18	Dames & Moore	Foundation Investigation, Proposed Whirly Crane, 3450 N.W. Front Street, Portland, Oregon	August 1972	Report Excerpt	Only Plate 1 and Boring 2

	Author	Document	Date	Format	Summary
19	DOGAMI	DOGAMI Open-File Report O-18-02 Earthquake Regional Impact Analysis For Clackamas, Multnomah, and Washington Counties, Oregon	2018	Website	Provides information about potential impacts to Multnomah county from a magnitude 9 Cascadia Subduction Zone earthquake.
20	Dusicka, P. and Norton, G. Portland State University	Liquid Storage Tanks at the Critical Energy Infrastructure (CEI) Hub; Seismic Assessment of Tank Inventory	No Date	Presentation	Summary of the Seismic Assessment of Tank Inventory report completed in 2019.
21	Dusicka, P. and Norton, G. Portland State University	Liquid Storage Tanks at the Critical Energy Infrastructure (CEI) Hub; Seismic Assessment of Tank Inventory	May 2019	Report	Summary of tank failures in past earthquakes, data on CEI Hub tanks, CEI Hub tank inventory, and potentially mitigation options.
22	Fore K. and Mills, M. Oregon Solutions	Critical Energy Infrastructure Hub	March 2019	Report	Assessment to determine potential avenues for collaborative action that could increase resiliency of the CEI Hub.
23	GeoDesign Inc	Report Of Geotechnical Engineering Services, Penske Property, 4285 NW Yeon Avenue, Portland, Oregon	July 25, 2006	Report	Subsurface information related to the design and construction of a new 5,000 square foot single story building.
24	GeoEngineers	Site Specific Seismic Hazard Report, Proposed New Pre-fabricated Metal Building, Northwest Natural Gasco Facility, 7900 NW Street Helens Road, Portland, Oregon, File No. 6024-002-06	November 7, 2012	Letter Report	Subsurface information and interpreted soil parameters for a site specific seismic hazard analysis related to the design and construction of a new fabricated metal building.
25	GeoEngineers	Geotechnical Engineering Report, Gasco LNG Tank Containment Retrofit, Portland LNG Plant, Portland, Oregon	June 1, 2018	Report	Subsurface information related to the retrofit of an existing containment basin.
26	GeoEngineers	Geotechnical Engineering Report, Gasco Water Tank and Ancillary Building, Portland, Oregon	November 3, 2005	Report	Subsurface information related to the design and construction of a new water storage tank and an associated building.
27	GeoEngineers	Geotechnical Engineering Report, Proposed Communication Tower, Portland LNG Plant, Portland, Oregon	July 22, 2015	Report	Subsurface information related to the design and construction of a new 80-foot-tall steel lattice communication tower.
28	GeoEngineers	Geotechnical Engineering Report, Tank No. 51 Replacement Project, Chevron Willbridge Terminal, Portland, Oregon	November 18, 1999	Report	Subsurface information related to the design and construction of a new storage tank.
29	GeoEngineers	Geotechnical Engineering Services, Soil Liquefaction and Lateral Spreading Mitigation, Linnton Terminal Tank Replacement, Portland, Oregon	January 7, 2011	Report	Subsurface information and interpreted soil parameters for liquefaction-induced settlement and lateral spreading mitigation related to the design and construction of a new storage tank, including compaction grouting ground improvement.
30	GeoEngineers	Geotechnical Engineering Services, Willbridge Terminal Tank Replacement, Portland, Oregon	July 25, 2011	Report	Subsurface information and soil parameters related to the design and construction of three (3) new 120,000 bbl storage tanks, including liquefaction and slope stability analyses.
31	GeoEngineers	Report of Geotechnical Engineering Services, Tank No. 62 Replacement Project, Chevron Willbridge Terminal, Portland, Oregon	October 15, 1998	Report	Subsurface information related to the design and construction of a new storage tank.

	Author	Document	Date	Format	Summary
32	GeoEngineers	Geotechnical Engineering Report, Portland LNG Plant - New Heater System, Portland, Oregon, File No. 6024-172-01	January 22, 2016	Report & Addendum Letter	Subsurface information and interpreted soil parameters related to the design and construction of a new oil heater, heat exchanger, and associated piping, including liquefaction and lateral spread analyses.
33	GeoEngineers (2000a)	Geotechnical Engineering Report, Tank No. 60 Replacement Project, Chevron Willbridge Terminal, Portland, Oregon	August 7, 2000	Report	Subsurface information related to the design and construction of a new storage tank.
34	GeoEngineers (2000b)	Geotechnical Engineering Report, Willbridge Intercompany Pipeline, Portland, Oregon	June 8, 2000	Report	Subsurface information related to the design and construction of a new pipeline and vapor recovery unit.
35	Goldfinger, Chris	Turbidite Event History - Methods and Implications for Holocene Paleoseismicit of the Cascadia Subduction Zone	2012	Professional Paper	Study of turbidites to develop of record of paleoearthquakes in the Cascadia Subduction Zone.
36	Hart Crowser	Geotechnical Engineering Design Study, Proposed Fender Pile Replacement, ARCO Products Company Bulk Terminal, Portland, Oregon	November 30, 1992	Report	Subsurface information related to new breasting and mooring dolphins.
37	Johnston, Mark, OSFM	Interview with Della Graham, Hart Crowser	December 4, 2020	Interview	Phone call with Mark Johnston, Regulatory Services Division, Oregon Office of State Fire Marshal
38	Johnston, Mark, OSFM	Interview with Della Graham, Hart Crowser	January 6, 2021	Interview	Phone call with Mark Johnston, Regulatory Services Division, Oregon Office of State Fire Marshal
39	Multnomah County	Multnomah County Services Contract Number: DCA-SVCSGEN-12459-2021	April 13, 2020	Contract	Services Contract
40	Oregon Department of Energy	2020 Biennial Energy Report	November 2020	Report	A comprehensive review of energy resources, policies, trends, and forecasts for the State of Oregon.
41	Oregon Seismic Safety Policy Advisory Commission	CEI Hub Mitigation Strategies	December 31, 2019	Report	Mitigation strategies for the CEI Hub including increasing fuel resilience to survive Cascadia.
42	Oregon State Police	Oregon State Fire Marshal Survey Information Instructions	No Date	Document	Instructions for yearly reporting of hazardous substance storage in the State of Oregon.
43	Oregon State Police	Oregon State Fire Marshal Hazardous Materials Database	Accessed December 4, 2020	Web Portal	Hazardous substance storage information and incident reports from emergency responders.
44	PacRim Geotechnical Inc.	Geotechnical Report, Proposed Replacement Of Asphalt Tanks, 5480 Front Avenue, Portland, Oregon	December 10, 1999	Report	Subsurface information related to the design and construction of four (4) new storage tanks.
45	Papaefthimiou, J. and Fore, K. Portland Bureau of Emergency Management	City of Portland & Critical Energy Infrastructure Hub	January 2019	Presentation	Summary of the Linnton community risks associated with the CEI Hub
46	Professional Service Industries, Inc.	Geotechnical Engineering Report, Proposed 90,000 Gallon Butane Tank, BP West Coast Products Company, Portland Terminal, 9930 NW St. Helens Road, Portland, Oregon	June 26, 2014 (Revised: February 13, 2015)	Report	Subsurface information and interpreted soil parameters for a site-specific hazard analysis related to the design and construction of a new 90,000-gallon butane storage tank, including drilled pier foundations.
47	Professional Service Industries, Inc.	Geotechnical Engineering Report, Proposed 90,000-Gallon Butane Tank, Chevron USA, Willbridge Terminal, 5924 NW Front Avenue, Portland, Oregon	June 5, 2015 (Revised: September 11, 2015)	Report	Subsurface information related to the design and construction of a new 90,000-gallon butane storage tank and blending facility, including drilled pier foundations.

	Author	Document	Date	Format	Summary
48	Rittenhouse-Zeman & Associates, Inc.	Subsurface Exploration And Geotechnical Engineering Report, Texaco TRMI Distribution Center, Portland, Oregon	June 1990	Report	Subsurface information related to the design and construction of a new 113,500 bbl gasoline storage tank.
49	Shannon and Wilson, Inc.	Subsurface Investigation, Guilds Lake Interceptor Sewer & Portsmouth Tunnel, Portland, Oregon	October 20, 1965	Report	Boring Logs and Maps only
50	Steven, Thompson & Runyan, Inc.	Unit 2 Phase II Linnton Interceptor Boring Logs	November 30, 1973	Report Excerpt	Boring Logs and Maps only
51	Tetra Tech	Mitigation Action Plan	September 2016	Report	Summary of how natural hazards will affect the City of Portland and the ways the impacts can be reduced.
52	Tony Schick Oregon Public Broadcasting	How We Mapped NW Portland's 'Tank Farms'	September 29, 2015	Article	Detailed discussion of data gathering process to map the CEI Hub.
53	URS Corporation	Final Geotechnical Analyses Report, Proposed Seawall Replacement, BP Terminal 22, Linnton, Oregon	April 2007	Report	Subsurface information related to the design and construction of a new sheet pile wall (supersedes April 2006 report).
54	URS Corporation	Final Geotechnical Report, Proposed Seawall Replacement, BP Terminal 22, Linnton, Oregon	April 2006	Report	Subsurface information related to the design and construction of a new sheet pile wall (superseded by April 2007 report).
55	URS Corporation	Geotechnical Data Report, 48" Force Main, Portland NW CSO Force Main System, Portland, Oregon	April 2001	Report	Figure 1 (site plan), Borings FM48-20 through FM48-24 with associated lab test data (particle size distribution and plasticity charts)
56	URS Corporation	Geotechnical Report, Proposed Oil-Water Separator, BP - Terminal 22, Linnton, Oregon	February 2007	Report	Subsurface information related to the design and construction of a new oil-water separator.
57	Wang, Y., Bartlett, S. F., and Miles, S. DOGAMI	Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub	August 2012	Report	Earthquake risk study of the CEI Hub as part of the Oregon Energy Assurance Project with the Oregon Department of Energy.

Table 3.1 - CEI Hub Tank Inventory
Portland, Oregon

Area 1 - Kinder Morgan North				
Kinder Morgan - North - 11400 NW St Helens Road, Portland, OR 97231 - Property ID R232828				
Tank ID[1]	Contents	Capacity (Gal)	Year	Type
KML10007	Out of Service	418,278	1922	Vertical Fixed Roof
KML11017	Out of Service	469,938	1941	Internal Floating Roof
KML11019	Out of Service	469,896	1941	Internal Floating Roof
KML17018	Gasoline	735,714	1941	Internal Floating Roof
KML17020	Gasoline	742,896	1941	Internal Floating Roof
KML17027	Gasoline	739,074	1954	Internal Floating Roof
KML20011	Diesel	856,506	1932	Vertical Fixed Roof
KML2024	Out of Service	92,896	1937	Vertical Fixed Roof
KML30016	Diesel	1,253,784	1941	Vertical Fixed Roof
KML3034	Storm Water	137,046	1925	Vertical Fixed Roof
KML305	Out of Service	12,936	1926	Vertical Fixed Roof
KML306	Out of Service	12,936	1926	Vertical Fixed Roof
KML309	Out of Service	12,936	1926	Vertical Fixed Roof
KML310	Out of Service	12,936	1926	Vertical Fixed Roof
KML312	Out of Service	12,936	1926	Vertical Fixed Roof
KML313	Out of Service	12,936	1926	Vertical Fixed Roof
KML314	Out of Service	12,936	1926	Vertical Fixed Roof
KML315	Out of Service	12,936	1926	Vertical Fixed Roof
KML326	Out of Service	12,600	NA	Vertical Fixed Roof
KML330	Out of Service	12,012	1926	Vertical Fixed Roof
KML331	Out of Service	12,936	1926	Vertical Fixed Roof
KML45028	Gasoline	1,889,538	1955	Internal Floating Roof
KML532	Out of Service	29,908	1965	Vertical Fixed Roof
KML55008	Out of Service	2,288,832	1933	Vertical Fixed Roof
KML55022	Gasoline	2,309,286	1928	Vertical Fixed Roof
KML55023	Out of Service	2,312,016	1944	Internal Floating Roof
KML59029	Gasoline	2,454,060	1955	Vertical Fixed Roof
KML72021	Diesel	2,842,297	2011	Vertical Fixed Roof
KMLSalt tower	Contact Water	22,890	NA	Vertical Fixed Roof
Area 2 - Linnton				
BP West Coast - 9930 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323779				
Tank ID	Contents	Capacity (Gal)	Year	Type
No known tanks present				
BP West Coast - 9930 NW St Helens Road, Portland, OR 97231 - Property ID R498331				
Tank ID	Contents	Capacity (Gal)	Year	Type
BP1	Gasoline	3,808,434	1940	Internal Floating Roof
BP10	Diesel	1,008,840	1941	Fixed Roof
BP11	Gasoline	1,354,122	1940	Internal Floating Roof
BP12	Ethanol	605,346	1961	Internal Floating Roof
BP13	Ethanol	602,994	1961	Internal Floating Roof
BP14	Diesel	1,121,736	1942	Fixed Roof
BP15	Biodiesel	804,972	1943	Fixed Roof
BP17	Diesel	3,329,340	1940	Fixed Roof
BP18	Diesel	1,104,726	1945	Fixed Roof
BP19	Oily Wastewater	198,828	1961	Internal Floating Roof
BP2	Groundwater Remediation	1,231,000	1957	Internal Floating Roof
BP21	Gasoline additive	220,080	1961	Fixed Roof
BP24	Gasoline Additive	20,286	1970	Fixed Roof
BP25	Gasoline Additive	20,241	1966	Fixed Roof
BP23b	Diesel Lubricity Additive	2,100	2005	Horizontal Tank
BP23a	Diesel additive	2,000	2005	Fixed Roof
BP3	Gasoline	1,584,366	1957	Internal Floating Roof
BP4	Gasoline	1,105,860	1957	Internal Floating Roof

BP40	Unavailable	0	1954	Fixed Roof
BP41	Out of Service	0	1954	Fixed Roof
BP42	Out of Service	0	1954	Fixed Roof
BP43	Out of Service	0	1954	Fixed Roof
BP44	Out of Service	0	1954	Fixed Roof
BP45	Unavailable	0	1954	Fixed Roof
BP46	Biodiesel	221,970	1954	Fixed Roof
BP5	Gasoline	895,314	1957	Internal Floating Roof
BP6	Gasoline	1,014,384	1957	Internal Floating Roof
BP7	Gasoline	648,018	1957	Internal Floating Roof
BP8	Gasoline	790,272	1957	Internal Floating Roof
BP9	Diesel	2,295,636	1940	Fixed Roof
BP West Coast - 9900 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323771				
Tank ID	Contents	Capacity (Gal)	Year	Type
No known tanks present				
BP West Coast - 9930 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323758				
Tank ID	Contents	Capacity (Gal)	Year	Type
No known tanks present				
Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R518296				
Tank ID[1]	Contents	Capacity (Gal)	Year	Type
NU23	Gasoline/Diesel additive	10,048	NA	Cone
NU24	Biodiesel additive	NA	NA	Horizontal Tank
NU30	NA	NA	NA	NA
Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R491070				
Tank ID[1]	Contents	Capacity (Gal)	Year	Type
NU10026	Gasoline/diesel	4,200,000	2007	Internal Floating Roof
NU10027	Gasoline/diesel	4,200,000	2007	Internal Floating Roof
NU1009	Gasoline/Diesel	392,887	1981	Internal Floating Roof
NU1010	Gasoline/Diesel	393,264	1980	Internal Floating Roof
NU1011	Ethanol/Gasoline	393,149	1980	Internal Floating Roof
NU2705	Diesel	1,158,532	1980	Internal Floating Roof
NU2706	Gasoline/Diesel	1,085,895	1980	Internal Floating Roof
NU3201	Ethanol	1,264,793	1979	Internal Floating Roof
NU3203	Gasoline/Diesel	1,265,942	1979	Internal Floating Roof
NU3204	Gasoline/Diesel	1,267,302	1979	Internal Floating Roof
NU4402	Gasoline/Diesel	1,761,801	1979	Internal Floating Roof
NU4507	Out of Service	1,849,692	1980	Internal Floating Roof
NU6408	Gasoline/Diesel	2,649,782	1981	Internal Floating Roof
NU1315	Out of service	56,124	1938	Cone
NU1316	Out of service	56,112	1938	Cone
Shore Terminals - 9400 WI/NW St Helens Road, Portland, OR 97231 - Property ID R324088				
Tank ID	Contents	Capacity (Gal)	Year	Type
No known tanks present				
Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R518295				
Tank ID[1]	Contents	Capacity (Gal)	Year	Type
NU2020	Gasoline	821,940	1935	Internal Floating Roof
NU2021	Gasoline	832,032	1935	Internal Floating Roof
NU2022	Gasoline	832,032	1935	Internal Floating Roof
NU2113	Biodiesel	865,857	1938	Internal Floating Roof
NU2511	MFO	1,060,587	1925	Cone
NU2512	MFO	1,049,587	1925	Cone
NU3510	Ethanol	1,456,019	1937	Internal Floating Roof
NU3605	MFO	1,442,470	1938	Cone
NU3614	Gasoline/Diesel	1,398,810	1958	Internal Floating Roof
NU5618	Gasoline	2,220,204	1958	Internal Floating Roof
NU5901	Gasoline	2,414,958	1929	Internal Floating Roof
NU5902	Diesel	2,386,734	1929	Internal Floating Roof
NU5919	Diesel	2,147,688	1935	Cone
NU703	Cutter	309,498	1938	Internal Floating Roof

NU8006	Gasoline/Diesel	3,379,698	1953	Internal Floating Roof
NU8007	Gasoline	3,338,748	1953	Internal Floating Roof
NU8308	Gasoline/Diesel	3,352,746	1969	Internal Floating Roof
NU181	Gasoline/Diesel additive	7,685	NA	Cone
NU195	NA	NA	NA	NA
NU212	NA	NA	NA	NA
NU5209	Gasoline/Diesel	2,190,678	1971	Internal Floating Roof
Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R512294				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
Area 3 - NW Natural				
Pacific Terminal Services - 7900 NW St. Helens Road, Portland, OR 97210 - Property ID R324159				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
PA1	Residual oil	60,000	1980	NA
PA2	Diesel oil	60,000	1980	NA
PA3	Residual oil	20,000	1980	NA
NW Natrual - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324171				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
NW Natrual - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324170				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
PA4	Residual oil	80,000	1940	NA
PA5	Residual oil	55,000	1940	NA
NW Natrual - 7598 NW St. Helens Road, Portland, OR 97210 - Property ID R324113				
Tank ID[1]	**Contents**	**Capacity (Gal)**	**Year**	**Type**
PA6	Diesel oil	12	1988	NA
PA7	Residual oil	475	1993	NA
NWN-Tank 001	Liquefied Natural Gas	7,100,000	NA	NA
NW Natrual - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324172				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
NW Natrual - 7441 SW/NW St. Helens Road, Portland, OR 97210 - Property ID R324165				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
NW Natrual - 7441 NW St. Helens Road, Portland, OR 97210 - Property ID R324160				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
NW Natrual - 7540 NW St. Helens Road, Portland, OR 97210 - Property ID R3502592				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
NW Natrual - 7540 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324213				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
Area 4 - Willbridge				
Kinder Morgan - 5800 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324222				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
KMW100	Diesel	3,381,000	1949	Vertical Fixed Roof
KMW101	Gasoline	3,381,000	1949	Internal Floating Roof
KMW102	Out of Service	306,600	1951	Vertical Fixed Roof
KMW103	Out of Service	168,000	1950	Vertical Fixed Roof
KMW104	Lubricity additive	168,000	1950	Vertical Fixed Roof
KMW105	Ethanol	168,000	1951	Internal Floating Roof
KMW106	Out of Service	302,546	1951	Vertical Fixed Roof
KMW116	Gasoline	3,385,200	1961	Internal Floating Roof
KMW117	Biodiesel	567,000	1951	Internal Floating Roof
KMW118	Gasoline	2,360,400	1951	Internal Floating Roof
KMW123	Gasoline	3,322,200	1952	Internal Floating Roof
KMW124	Gasoline	3,393,600	1952	Internal Floating Roof
KMW128	Gasoline	2,347,800	1953	Internal Floating Roof

KMW134	Gasoline	2,364,600	1955	Internal Floating Roof
KMW137	Out of Service	222,936	1956	Vertical Fixed Roof
KMW138	Avgas	571,830	1956	Internal Floating Roof
KMW139	Out of Service	572,628	1956	Vertical Fixed Roof
KMW140	Storm water	630,000	1956	Vertical Fixed Roof
KMW141	Out of Service	730,800	1956	Vertical Fixed Roof
KMW143	Out of Service	252,927	1959	Vertical Fixed Roof
KMW152	Ethanol	47,800	1964	Internal Floating Roof
KMW84	Gasoline	2,356,200	1948	Internal Floating Roof
KMW86	Out of Service	222,805	1948	Vertical Fixed Roof
KMW87	Out of Service	222,469	1948	Vertical Fixed Roof
KMW88	Out of Service	222,574	1948	Vertical Fixed Roof
KMW89	Out of Service	222,919	1948	Vertical Fixed Roof
KMW12003	Gasoline	5,040,000	2012	Internal Floating Roof
KMW85	Diesel	2,347,800	1948	Vertical Fixed Roof
Kinder Morgan - 5800 NW St. Helens Road, Portland, OR 97210 - Property ID R121076				
Tank ID[1]	Contents	Capacity (Gal)	Year	Type
KMW12001	Jet A	5,040,000	2012	Internal Floating Roof
KMW12002	Diesel	5,040,000	2012	Internal Floating Roof
KMW155	Out of Service	4,200	1965	Vertical Fixed Roof
KMW156	Out of Service	7,667	1965	Vertical Fixed Roof
KMW157	Out of Service	24,868	1969	Vertical Fixed Roof
KMW158	Out of Service	24,851	1969	Vertical Fixed Roof
KMW159	Out of Service	21,000	1969	Vertical Fixed Roof
KMW160	Out of Service	24,860	1969	Vertical Fixed Roof
KMW161	Out of Service	24,863	1969	Vertical Fixed Roof
KMW162	Out of Service	24,850	1969	Vertical Fixed Roof
KMW163	Out of Service	24,856	1969	Vertical Fixed Roof
KMW169	Out of Service	24,990	1928	Vertical Fixed Roof
KMW170	Out of Service	24,990	1928	Vertical Fixed Roof
KMW171	Out of Service	24,990	NA	Vertical Fixed Roof
KMW172	Out of Service	24,990	NA	Vertical Fixed Roof
KMW176	Out of Service	25,353	NA	Vertical Fixed Roof
KMW177	Out of Service	24,457	NA	Vertical Fixed Roof
KMW186	Out of Service	25,604	NA	Vertical Fixed Roof
KMW187	Out of Service	24,000	NA	Vertical Fixed Roof
KMW188	Out of Service	24,600	NA	Vertical Fixed Roof
KMW189	Out of Service	24,035	NA	Vertical Fixed Roof
KMW2	Jet A	3,175,200	1915	Vertical Fixed Roof
KMW3	Out of Service	553,350	1915	Vertical Fixed Roof
KMW5	Out of Service	439,605	1915	Vertical Fixed Roof
KMW52	Jet A	3,229,800	1923	Vertical Fixed Roof
KMW54	Diesel	3,435,600	1929	Vertical Fixed Roof
KMW6	Out of Service	215,166	1915	Vertical Fixed Roof
KMW61	Out of Service	25,200	1929	Vertical Fixed Roof
KMW62	Out of Service	11,676	1929	Vertical Fixed Roof
KMW63	Out of Service	24,766	1929	Vertical Fixed Roof
KMW69	Jet A	3,431,400	1937	Vertical Fixed Roof
KMW7	Out of Service	440,538	1915	Vertical Fixed Roof
KMW70	Jet A	1,461,600	1938	Vertical Fixed Roof
KMW71	Transmix	862,260	1937	Vertical Fixed Roof
KMW73	Transmix	546,714	1937	Vertical Fixed Roof
KMW74	Out of Service	305,712	1937	Vertical Fixed Roof
KMW75	Out of Service	25,000	1938	Vertical Fixed Roof
KMW76	Out of Service	25,000	1938	Vertical Fixed Roof
KMW8	Out of Service	216,804	1915	Vertical Fixed Roof
KMW10	Out of Service	22,722	1915	Vertical Fixed Roof
KMW11	Out of service	22,722	1915	Vertical Fixed Roof

KMW12	Out of service	22,722	1915	Vertical Fixed Roof
KMW125	Out of service	12,525	1946	Vertical Fixed Roof
KMW126	Out of service	24,703	1923	Vertical Fixed Roof
KMW127	Out of service	24,703	1923	Vertical Fixed Roof
KMW129	Out of service	7,728	1927	Vertical Fixed Roof
KMW13	Out of service	2,856	1915	Vertical Fixed Roof
KMW131	Out of service	4,737	1954	Vertical Fixed Roof
KMW14	Out of service	2,856	1915	Vertical Fixed Roof
KMW145	Out of service	7,980	1960	Vertical Fixed Roof
KMW146	Out of service	7,980	1960	Vertical Fixed Roof
KMW147	Out of service	7,980	1961	Vertical Fixed Roof
KMW148	Out of service	7,980	1961	Vertical Fixed Roof
KMW15	Out of service	2,856	1915	Vertical Fixed Roof
KMW153	Out of service	7,637	1965	Vertical Fixed Roof
KMW154	Out of service	7,637	1965	Vertical Fixed Roof
KMW16	Out of service	2,814	1915	Vertical Fixed Roof
KMW166	Contact Water	33,600	1970	Vertical Fixed Roof
KMW167	Contact Water	24,024	1928	Vertical Fixed Roof
KMW17	Out of service	2,814	1915	Vertical Fixed Roof
KMW173	Jet A	49,980	1972	Vertical Fixed Roof
KMW18	Out of Service	2,814	1915	Vertical Fixed Roof
KMW190	Additive	8,400	Unknown	Horizontal Tank
KMW192	Additive	8,064	Unknown	Horizontal Tank
KMW193	Additive	10,080	Unknown	Horizontal Tank
KMW194	Slop water	6,300	Unknown	Horizontal Tank
KMW22	Out of service	11,760	1915	Vertical Fixed Roof
KMW23	Out of service	11,718	1915	Vertical Fixed Roof
KMW25	Out of service	11,760	1915	Vertical Fixed Roof
KMW26	Out of service	22,806	1916	Vertical Fixed Roof
KMW30	Out of service	11,718	1915	Vertical Fixed Roof
KMW31	Out of service	11,760	1915	Vertical Fixed Roof
KMW32	Out of service	11,472	1915	Vertical Fixed Roof
KMW33	Out of service	17,472	1915	Vertical Fixed Roof
KMW34	Out of service	17,481	1915	Vertical Fixed Roof
KMW35	Out of service	4,397	1924	Vertical Fixed Roof
KMW36	Out of service	4,368	1924	Vertical Fixed Roof
KMW37	Out of service	4,368	1924	Vertical Fixed Roof
KMW38	Out of service	4,368	1924	Vertical Fixed Roof
KMW39	Out of service	4,397	1924	Vertical Fixed Roof
KMW4	Out of service	215,754	1915	Vertical Fixed Roof
KMW40	Out of service	5,544	1923	Vertical Fixed Roof
KMW41	Out of service	5,502	1923	Vertical Fixed Roof
KMW42	Out of service	5,502	1923	Vertical Fixed Roof
KMW43	Out of service	5,502	1923	Vertical Fixed Roof
KMW44	Out of service	5,515	1923	Vertical Fixed Roof
KMW45	Out of service	5,540	1923	Vertical Fixed Roof
KMW46	Out of service	11,642	1923	Vertical Fixed Roof
KMW47	Out of service	11,600	1923	Vertical Fixed Roof
KMW48	Out of service	11,642	1923	Vertical Fixed Roof
KMW49	Out of service	11,677	1923	Vertical Fixed Roof
KMW50	Out of service	11,507	1923	Vertical Fixed Roof
KMW51	Out of service	11,634	1923	Vertical Fixed Roof
KMW56	Out of service	19,867	1929	Vertical Fixed Roof
KMW57	Out of service	19,800	1929	Vertical Fixed Roof
KMW58	Out of service	19,800	1929	Vertical Fixed Roof
KMW59	Out of service	19,855	1929	Vertical Fixed Roof
KMW60	Out of service	19,824	1929	Vertical Fixed Roof
KMW65	Jet A	861,336	1930	Vertical Fixed Roof

KMW66	Out of service	856,800	1930	Vertical Fixed Roof
KMW72	Out of service	549,024	1937	Vertical Fixed Roof
KMW77	Out of service	25,741	1938	Vertical Fixed Roof
KMW82	Out of service	11,642	1923	Vertical Fixed Roof
KMW83	Out of service	19,867	1923	Vertical Fixed Roof
KMW9	Out of service	22,722	1915	Vertical Fixed Roof
KMW90	Out of service	2,982	1946	Vertical Fixed Roof
Kinder Morgan - 6080 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R315782				
Tank ID	Contents	Capacity (Gal)	Year	Type
No known tanks present				
Chevron - 5533 NW Doane Avenue, Portland, OR 97210 - Property ID R315798				
Tank ID[1]	Contents	Capacity (Gal)	Year	Type
CH1	Unleaded Gasoline	3,412,315	1997	Internal Floating Roof
CH100	Gear Lube	17,624	1946	Fixed Roof
CH101	Compressor Oil	17,284	1958	Fixed Roof
CH109	Delo GL 80/90	17,624	NA	Fixed Roof
CH128	Rykon Prem 32	74,586	NA	AST
CH129	Base Oil	642,935	NA	Fixed Roof
CH130	Base Oil	255,112	NA	Fixed Roof
CH142	Base Oil	648,620	1984	Fixed Roof
CH143	Supreme 5W30	62,033	NA	Fixed Roof
CH144	Havoline 10W30	61,864	NA	Fixed Roof
CH145	Out of Service	61,864	NA	Fixed Roof
CH150	Delo 400-10	25,311	NA	Fixed Roof
CH154	Map 100	83,422	NA	Fixed Roof
CH155	Delo 400-15W40	83,422	NA	Fixed Roof
CH156	Delo 400-30	83,022	NA	Fixed Roof
CH164	Swing Tank	6,354,155	2009	AST
CH3	Unleaded Gasoline	2,392,178	1999	Fixed Roof
CH43	Base Oil	837,085	1993	Fixed Roof
CH44	Base Oil	835,393	1920	Fixed Roof
CH45	Ethanol	958,693	1999	Fixed Roof
CH47	Unleaded Gasoline	3,609,743	1929	Fixed Roof
CH48	Water/Oil Slop	396,547	1979	Fixed Roof
CH60	Unleaded Gasoline	4,999,697	2001	Fixed Roof
CH62	Unleaded Gasoline	6,812,135	2000	Fixed Roof
CH64	Diesel	844,275	1947	Fixed Roof
CH75	Jet Fuel	1,004,586	1952	Fixed Roof
CH76	Base Oil	498,258	1960	Fixed Roof
CH96	Additive	17,624	1966	Fixed Roof
CH163	Swing Tank	6,354,155	2009	AST
CH122	1000 THF	61,864	NA	Fixed Roof
CH97	Additive	17,624	1966	Fixed Roof
CH127	ATF dex 111	109,976	NA	Fixed Roof
CH118	Blend Mix/ Line Wash	17,577	1976	Fixed Roof
CH139	Blend Mix/ Line Wash	25,591	NA	Fixed Roof
CH28	Blend Mix/ Line Wash	29,071	1913	Fixed Roof
CH176	Blended Oil	2,632	NA	Fixed Roof
CH177	Blended Oil	2,632	NA	Fixed Roof
CH178	Blended Oil	2,632	NA	Fixed Roof
CH179	Blended Oil	2,632	NA	Fixed Roof
CH180	Blended Oil	4,700	1993	Fixed Roof
CH181	Blended Oil	4,700	1993	Fixed Roof
CH182	Blended Oil	11,374	1994	Fixed Roof
CH183	Blended Oil	11,374	1994	Fixed Roof
CH184	Blended Oil	11,374	1994	Fixed Roof
CH185	Blended Oil	11,374	1994	Fixed Roof
CH186	Blended Oil	11,374	1994	Fixed Roof

CH187	Blended Oil	11,374	1994	Fixed Roof
CH188	Blended Oil	11,374	1994	Fixed Roof
CH27	Chevron 7075F	29,613	1913	Fixed Roof
CH9	Chevron 7075F	169,193	1949	Fixed Roof
CH57	Citgo Brt Stock 150	152,433	1921	Fixed Roof
CH25	Clarity PM 150	8,665	1913	Fixed Roof
CH16	Clarity PM 220	29,447	1913	Fixed Roof
CH22	Clarity PM 220	13,982	1954	Fixed Roof
CH41	Clarity Saw Guide 46	17,331	1949	Fixed Roof
CH133	CVX 3105	17,577	NA	Fixed Roof
CH147	Delo 100-40	25,523	NA	Fixed Roof
CH90	Delo 400-15W40	208,848	1954	Fixed Roof
CH123	Delo 400-40	61,864	NA	Fixed Roof
CH14	Delo 6170 CFO 20W40	190,343	1950	Fixed Roof
CH106	Delo G/L 80/90	17,818	1969	Fixed Roof
CH138	Drive Train Fluid HD 10	17,378	NA	Fixed Roof
CH37	Drive Train Fluid HD 10	17,378	1949	Fixed Roof
CH105	Empty	17,624	1969	Fixed Roof
CH116	Empty	17,724	1976	Fixed Roof
CH132	Empty	18,165	NA	Fixed Roof
CH152	Empty	17,624	NA	Fixed Roof
CH160	Empty	25,447	NA	Fixed Roof
CH19	Empty	29,071	NA	Fixed Roof
CH21	Empty	29,583	1992	Fixed Roof
CH23	Empty	13,982	1997	Fixed Roof
CH24	Empty	8,859	1993	Fixed Roof
CH29	Empty	11,750	1949	Fixed Roof
CH30	Empty	11,750	1949	Fixed Roof
CH34	Empty	25,379	NA	Fixed Roof
CH40	Empty	18,018	NA	Fixed Roof
CH42	Empty	29,583	1913	Fixed Roof
CH79	Empty	17,378	1960	Fixed Roof
CH81	Empty	17,724	1951	Fixed Roof
CH84	Empty	17,184	1952	Fixed Roof
CH88	Empty	17,624	1850	Fixed Roof
CH12	ExxonMobil EM-100	586,302	1950	Fixed Roof
CH17	ExxonMobile EHC45	29,327	1913	Fixed Roof
CH35	FAMM Tara 30 DP 30	25,379	NA	Fixed Roof
CH7	Famm Taro Sepcial 70	100,594	1913	Fixed Roof
CH6	GEO HDAX L ASH 40	100,277	1913	Fixed Roof
CH56	GST ISO 100	25,379	NA	Fixed Roof
CH110	GST ISO 32	17,624	NA	Fixed Roof
CH113	Hybase C414	17,378	NA	Fixed Roof
CH131	Hybase C414	17,577	NA	Fixed Roof
CH28	Industrial EP 150	17,771	1949	Fixed Roof
CH114	Industrial EP 220	17,624	NA	Fixed Roof
CH82	Infineum M7038	17,624	1951	Fixed Roof
CH65	Lubrizol 4991	17,524	1938	Fixed Roof
CH87	Lubrizol 4991	17,430	1913	Fixed Roof
CH11	Lubrizol 4991D	211,915	1950	Fixed Roof
CH151	MAR EO 9250-40	17,724	NA	Fixed Roof
CH4	Neutral 220R	435,761	1913	Fixed Roof
CH61	Neutral 600R	400,379	1941	Fixed Roof
CH5	Neutral Oil	365,834	1913	Fixed Roof
CH89	Oil Stop	19,431	1952	Fixed Roof
CH137	Oloa 2000	60,757	NA	Fixed Roof
CH85	Oloa 44200	17,671	1952	Fixed Roof
CH18	Oloa 550006L	29,583	1913	Fixed Roof

CH112	Oloa 6073EV	17,818	NA	Fixed Roof
CH91	Oloa 9740C	17,671	1961	Fixed Roof
CH102	Out of Service	12,954	1978	Fixed Roof
CH103	Out of Service	13,006	1978	Fixed Roof
CH119	Out of Service	19,593	1977	Fixed Roof
CH120	Out of Service	19,593	1977	Fixed Roof
CH121	Out of Service		1978	Fixed Roof
CH135	Out of Service	19,379	1982	Fixed Roof
CH136	Out of Service	20,303	1982	Fixed Roof
CH140	Out of Service	83,234	NA	Fixed Roof
CH141	Out of Service	140,308	NA	Fixed Roof
CH158	Out of Service	NA	NA	Fixed Roof
CH159	Out of Service	25,379	1987	Fixed Roof
CH80	Out of Service	17,378	NA	Fixed Roof
CH92	Out of Service	17,577	1961	Fixed Roof
CH10	Paratone 8451	169,616	1950	Fixed Roof
CH78	Paratone 8451	311,722	1960	Fixed Roof
CH20	Pennzoil 75HC	29,071	1914	Fixed Roof
CH117	Raffene 2000L	17,624	1976	Fixed Roof
CH13	Raffene 750L	45,682	NA	Fixed Roof
CH46	Red Chain Bar 150	11,750	1924	Fixed Roof
CH77	RPM HDMO 15W40	128,511	1960	Fixed Roof
CH83	RPM HDMO 15W40	17,331	1951	Fixed Roof
CH149	RPM HDMO 30	26,311	NA	Fixed Roof
CH99	RPM UGL 80W90	62,033	NA	Fixed Roof
CH98	Rykon Oil 46	91,364	1968	Fixed Roof
CH94	Rykon Oil 68	67,419	NA	Fixed Roof
CH15	Rykon Prem 32	28,951	1913	Fixed Roof
CH26	Rykon Prem 32	29,447	1913	Fixed Roof
CH8	Rykon Prem MV	104,897	1913	Fixed Roof
CH72	Saw Guide 150	17,284	1959	Fixed Roof
CH36	Shell MV1 100	25,379	NA	Fixed Roof
CH31	SynFluid $, 4CST	8,712	1953	Fixed Roof
CH108	Techron Additive	208,425	1970	Fixed Roof
CH104	Texaco Havoline 5S30	17,331	NA	Fixed Roof
CH146	Transmix	25,447	NA	Fixed Roof
CH157	Turbine Oil	52,872	NA	AST
CH148	VER 800 Mar 30	33,839	NA	Fixed Roof
CH33	Viscoplex 1-604	13,997	NA	Fixed Roof
CH32	Viscoplex 7-305	13,918	1950	Fixed Roof
CH29	NA	17,724	1949	Fixed Roof
CH51	NA	NA	NA	NA
Chevron - 5533 WI/NW Doane Avenue, Portland, OR 97210 - Property ID R315771				
Tank ID[1]	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
Conoco Phillips - 5528 WI/NW Doane Avenue, Portland, OR 97210 - Property ID R315810				
Tank ID[1]	**Contents**	**Capacity (Gal)**	**Year**	**Type**
PH2561	Marine Fuel Oil	1,569,582	1929	Riveted Steel
PH2579	Hydraulic Tractor Oil	1,800	1929	Welded Steel
PH2669	Marine Diesel	449,694	1931	Riveted Steel
PH2713	Unax AW 46	109,000	1937	Welded Steel
PH2714	Guardol 15W/40	109,000	1937	Welded Steel
PH2783	Decant Oil	948,066	1937	Riveted Steel
PH2784	Diesel #2	1,439,130	1937	Riveted Steel
PH2915	Unleaded Gasoline	3,262,056	1938	Welded Steel
PH2916	Diesel #2	1,652,196	1938	Welded Steel
PH2917	RLOP 220 N	612,000	1938	Welded Steel
PH2982	Diesel #1	416,262	1941	Welded Steel

PH2983	RLOP 220 N	304,000	1941	Welded Steel
PH3407	Unleaded Gasoline	2,955,540	1949	Welded Steel
PH3408	Unleaded Gasoline	1,639,680	1949	Welded Steel
PH3409	Unleaded Gasoline	948,654	1949	Welded Steel
PH3410	Ethanol	278,964	1949	Welded Steel
PH3411	Unleaded Gasoline	259,350	1949	Welded Steel
PH3412	Diesel #1	279,426	1949	Welded Steel
PH3413	Unleaded Gasoline	259,560	1949	Welded Steel
PH3414	RLOP 220 N	200,000	1949	Welded Steel
PH3415	SUN 525	200,000	1949	Welded Steel
PH3416	RLOP 100N	200,000	1949	Welded Steel
PH3417	ULTRA S-4	200,000	1949	Welded Steel
PH3579	Industrial Fuel Oil	3,307,668	1950	Welded Steel
PH36	Stop Oil	20,496	1907	Riveted Steel
PH3623	HiTech 6576	18,228	1950	Welded Steel
PH3639	SUP SYN BL 5W/30	120,000	1951	Welded Steel
PH3739	SUN 150 B/S	200,000	1954	Welded Steel
PH3740	RLOP 600 N	277,000	1954	Welded Steel
PH3741	Ramar CLF 17E	17,500	1954	Welded Steel
PH3742	MP Gear Lube 80/90	17,500	1954	Welded Steel
PH3743	Utility	18,600	1954	Welded Steel
PH3744	HYNAP N100	17,500	1954	Welded Steel
PH3745	HITEC 5751	17,500	1954	Welded Steel
PH3746	Lubrizol 4998C	17,500	1954	Welded Steel
PH3747	Lubrizol 4990CH	17,500	1954	Welded Steel
PH3757	HITEC 1193	17,500	1954	Welded Steel
PH3760	Raffene 750L	17,500	1954	Welded Steel
PH3761	Diesel #2	3,240,342	1954	Welded Steel
PH4191	Lubrizol 48254	17,500	1964	Welded Steel
PH4192	Lubrizol 7075F	17,500	1964	Welded Steel
PH4223	Slop Oil	18,690	1968	Welded Steel
PH4241	UNAX AW 68	17,500	1968	Welded Steel
PH4242	UNAX AW 68	17,500	1968	Welded Steel
PH4243	HT4/10W	17,500	1968	Welded Steel
PH4244	Mohawk 450	17,500	1968	Welded Steel
PH4245	SUN 525	17,500	1968	Welded Steel
PH4252	Residual Fuel Oil	458,640	1968	Welded Steel
PH4253	Residual Fuel Oil	451,290	1968	Welded Steel
PH4254	PS 300	459,312	1968	Welded Steel
PH4255	Biodiesel	404,250	1968	Welded Steel
PH4256	Out of Service	195,408	1968	Welded Steel
PH4257	Out of Service	38,367	1968	Welded Steel
PH4258	Line Clippings	18,000	1968	Welded Steel
PH4259	Transmix	205,506	1968	Welded Steel
PH4266	Flush	17,500	1968	Welded Steel
PH4281	Versa Tran ATF	17,500	1969	Welded Steel
PH4300	Ramar CLF 17E	25,500	1969	Welded Steel
PH4302	RLOP 600N	17,500	1971	Welded Steel
PH4303	RLOP 100N	17,500	1971	Welded Steel
PH4305	Out of Service	8,900	1971	Welded Steel
PH4306	RLOP 100N	200,000	1971	Welded Steel
PH4318	Diesel #2	1,422,456	1973	Welded Steel
PH4320	Sup Syn BL 10W/30	35,000	1973	Welded Steel
PH4321	Uniguide II 100	35,000	1973	Welded Steel
PH4322	T5X HD 15W/40	35,000	1973	Welded Steel
PH4323	Super ATF	35,000	1973	Welded Steel
PH4331	Ethyl HITEC 6888E	25,500	1973	Welded Steel
PH4332	Super ATF	17,500	1973	Welded Steel

PH4333	Point Premier 10W/30	17,500	1973	Welded Steel
PH4334	Super 5W/20	17,500	1973	Welded Steel
PH4369	RLOP 220 N	17,500	1979	Welded Steel
PH4388	Utility	13,500	1984	Welded Steel
PH4389	Utility	13,500	1984	Welded Steel
PH4390	Bar & Chain 150	13,500	1985	Welded Steel
PH4391	Utility	13,500	1985	Welded Steel
PH4392	Utility	13,500	1985	Welded Steel
PH4393	Utility	13,500	1985	Welded Steel
PH4394	Utility	13,500	1985	Welded Steel
PH4395	Utility	13,500	1985	Welded Steel
PH4397	Lubrizol 9692A	13,500	1985	Welded Steel
PH4398	HITEC 1193A	13,500	1985	Welded Steel
PH4399	Firebird 15W/40	13,500	1985	Welded Steel
PH4400	Guardol 30	13,500	1985	Welded Steel
PH4403	HT4/30W	13,500	1985	Welded Steel
PH4404	Fleet Sup EC 15W/40	13,500	1985	Welded Steel
PH4405	HITEC 3472	13,500	1987	Welded Steel
PH4406	Lubrizol 9990A	13,500	1987	Welded Steel
PH4407	Ethyl HITEC 388	13,500	1987	Welded Steel
PH4408	Ethyl HITEC 5756	13,500	1987	Welded Steel
PH4441	Octel 9056	18,648	1993	Welded Steel
PH4327	Gasoline Slops	10,080	1974	Welded Steel
PH1471	Hydraulic Tractor Oil	17,300	1921	Riveted Steel
PH4401	Mohawk 150	13,500	1985	Welded Steel
PH4402	TSX HD10	13,500	1985	Welded Steel
PHF103	UTRA 58	25,500	1973	Welded Steel
PHF104	UTRA 59	17,500	1973	Welded Steel
Conoco Phillips - 5528 NW Doane Avenue, Portland, OR 97210 - Property ID R315769				
Tank ID	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
Zenith Energy - 5501 NW Front Avenue, Portland, OR 97210 - Property ID R315845				
Tank ID[1]	**Contents**	**Capacity (Gal)**	**Year**	**Type**
Tank 129	Asphalt	NA	NA	NA
Tank 128	Asphalt	NA	NA	NA
Tank 127	Asphalt	NA	NA	NA
Tank 70	Asphalt	NA	NA	NA
Tank 125	Asphalt	NA	NA	NA
Tank 124	Asphalt	NA	NA	NA
Tank 123	Asphalt	NA	NA	NA
Tank 122	Asphalt	NA	NA	NA
Tank 121	Asphalt	NA	NA	NA
Tank 120	Asphalt	NA	NA	NA
Tank 112	Asphalt	NA	NA	NA
Tank 110	Asphalt	NA	NA	NA
Tank 101	Asphalt	NA	NA	NA
Tank 126	Asphalt	NA	NA	NA
Tank 003	Asphalt	NA	NA	NA
Tank 71	Avgas	1,402,380	NA	Internal Floating Roof
Tank 184	Biodiesel	222,000	NA	NA
Tank 307	Caustic	NA	NA	NA
Tank 74	Charge Stock	NA	NA	NA
Tank 100	Charge Stock	NA	NA	NA
Tank 102	Charge Stock	NA	NA	NA
Tank 106	Crude Oil	5,611,788	NA	External Floating Roof
Tank 67	Crude Oil	3,234,000	NA	NA
Tank 93	Crude Oil	2,829,918	NA	NA
Tank 69	Crude Oil	NA	NA	NA

Tank 130	Crude Oil	3,200,000	NA	Internal Floating Roof
Tank 68	Crude Oil	2,900,000	NA	NA
Tank 63	Crude Oil	4,763,472	NA	Internal Floating Roof
Tank 104	Crude Oil	NA	NA	NA
Tank 105	Crude Oil	5,241,684	NA	External Floating Roof
Tank 001	Crude Oil	NA	NA	NA
Tank 308	Murol	NA	NA	NA
Tank 182	NA	NA	NA	NA
Tank 183	NA	NA	NA	NA
Tank 185	NA	NA	NA	NA
Tank 202	NA	NA	NA	NA
Tank 203	NA	NA	NA	NA
Tank 209	NA	NA	NA	NA
Tank 213	NA	NA	NA	NA
Tank 208	NA	NA	NA	NA
Tank 211	NA	NA	NA	NA
Tank 306	NA	NA	NA	NA
Tanks 95	NA	NA	NA	NA
Tank 114	NA	NA	NA	NA
Tank 302	NA	NA	NA	NA
Tank 162	NA	NA	NA	NA
Tank 166	NA	NA	NA	NA
Tank 167	NA	NA	NA	NA
Tank 168	NA	NA	NA	NA
Tank 169	NA	NA	NA	NA
Tank 170	NA	NA	NA	NA
Tank 171	NA	NA	NA	NA
Tank 172	NA	NA	NA	NA
Tank 20	NA	NA	NA	NA
Tank 173	NA	NA	NA	NA
Tank 174	NA	NA	NA	NA
Tank 180	NA	NA	NA	NA
Tank 179	NA	NA	NA	NA
Tank 206	NA	NA	NA	NA
Tank 210	NA	NA	NA	NA
Tank 177	NA	NA	NA	NA
Tank 176	NA	NA	NA	NA
Tank 178	NA	NA	NA	NA
Tank 181	NA	NA	NA	NA
Tank 200	NA	NA	NA	NA
Tank 201	NA	NA	NA	NA
N2	NA	NA	NA	NA
Tank 317	NA	NA	NA	NA
BAS #2	NA	NA	NA	NA
KO T#5	NA	NA	NA	NA
BAS #3	NA	NA	NA	NA
BAS #4	NA	NA	NA	NA
Tank 160	NA	NA	NA	NA
Tank 161	NA	NA	NA	NA
Tank 314	NA	NA	NA	NA
Tank 002	NA	NA	NA	NA
KO T#2	NA	NA	NA	NA
CAS #5	NA	NA	NA	NA
BAS #1	NA	NA	NA	NA
Tank 305	NA	NA	NA	NA
KO T#1	NA	NA	NA	NA
Tank 163	NA	NA	NA	NA
Tank 164	NA	NA	NA	NA

Tank 165	NA	NA	NA	NA
Tank 152	NA	NA	NA	NA
Tank 151	NA	NA	NA	NA
Tank 158	NA	NA	NA	NA
Tank 157	NA	NA	NA	NA
Tank 156	NA	NA	NA	NA
Tank 148	NA	NA	NA	NA
Tank 149	NA	NA	NA	NA
Tank 150	NA	NA	NA	NA
Tank 142	NA	NA	NA	NA
Tank 143	NA	NA	NA	NA
Tank 144	NA	NA	NA	NA
Tank 147	NA	NA	NA	NA
Tank 146	NA	NA	NA	NA
Tank 145	NA	NA	NA	NA
Tank 140	NA	NA	NA	NA
Tank 141	NA	NA	NA	NA
Tank 300	NA	NA	NA	NA
K-23	NA	NA	NA	NA
TW-2	NA	NA	NA	NA
Tank 207	NA	NA	NA	NA
Tank 66	Universal Low-Sulfer Diesel	3,188,598	NA	NA
Tank 111	Wastewater	NA	NA	NA
Tank 113	Wastewater	NA	NA	NA
Zenith Energy - 5501 NW Front Avenue, Portland, OR 97210 - Property ID R315777				
Tank ID[1]	**Contents**	**Capacity (Gal)**	**Year**	**Type**
No known tanks present				
McCall Oil - 5700 NW Front Avenue, Portland, OR 97210 - Property ID R315872				
Tank ID[1]	**Contents**	**Capacity (Gal)**	**Year**	**Type**
MC1	Asphalt	11,247,180	1976	Cone Roof
MC19	Asphalt	427,770	1954	Cone Roof
MC2	Asphalt	11,787,300	1973	Cone Roof
MC20	Asphalt	427,770	1954	Cone Roof
MC21	Asphalt	428,064	1954	Cone Roof
MC10	Biodiesel	469,392	1974	Internal Floating Roof
MC5	Biodiesel	27,216	1974	Cone Roof
MC6	Biodiesel	27,216	1974	Cone Roof
MC9	Biodiesel	473,004	1979	Cone Roof
MC4	Bunker	9,357,936	1976	Cone Roof
MC7	Diesel	2,658,726	1978	Internal Floating Roof
MC8	Diesel	2,680,482	1977	Internal Floating Roof
MC11	Oil and water	20,160	1974	Cone Roof
MC12	Oil and water	10,080	1974	Cone Roof
McCall Oil - 5480 NW Front Avenue, Portland, OR 97210 - Property ID R315786				
Tank ID[1]	**Contents**	**Capacity (Gal)**	**Year**	**Type**
MC18	Anti-strip	4,914	1989	Cone Roof
MC22	Asphalt	18,942	1954	Cone Roof
MC23	Asphalt	18,942	1954	Cone Roof
MC24	Asphalt	19,068	2000	Cone Roof
MC25	Asphalt	79,800	2000	Cone Roof
MC26	Asphalt	79,800	2000	Cone Roof
MC27	Asphalt	79,800	2000	Cone Roof
MC28	Boiler fuel	8,358	1954	Cone Roof
MC15	Flux	21,840	1986	Cone Roof
MC16	Flux	30,198	1989	Cone Roof
MC33	Poly phosphoric acid	5,405	2005	Cone Roof
MC29	Unichem	11,000	1974	Cone Roof
Area 5 - Equilon				

Equilon - 3610-3640 St. Helens Road, Portland, OR 97210 - Property ID R315819				
Tank ID[1]	Contents	Capacity (Gal)	Year	Type
T-13519	Diesel	560,112	NA	Cone Roof
T-13520	Diesel	558,852	NA	Cone Roof
T-13521	Diesel	559,986	NA	Cone Roof
T-13522	Diesel	558,432	NA	Cone Roof
T-13523	Out of Service	565,320	NA	Cone Roof
T-13524	Diesel	559,146	NA	Cone Roof
T-36002	Diesel	1,537,704	NA	Cone Roof
T-55000	Gasoline	1,986,264	NA	Internal Fixed Roof
T-55001	Ethanol	2,331,714	NA	Internal Fixed Roof
T-80103	Diesel	3,303,636	NA	Cone Roof
T-80104	Gasoline	3,348,912	NA	Internal Fixed Roof
T-80110	Gasoline	3,317,622	NA	Internal Fixed Roof
T-84200	Gasoline	3,528,756	NA	Internal Fixed Roof
T-7017	Water	267,456	NA	External Fixed Roof

Notes:

[1]Tanks noted in satellite images, but not listed in available GIS data, are given the designation based on property ID and count, and are *italicized* . Example: Zenithh = "ZE-*Tank 1* "

NA - Data not available

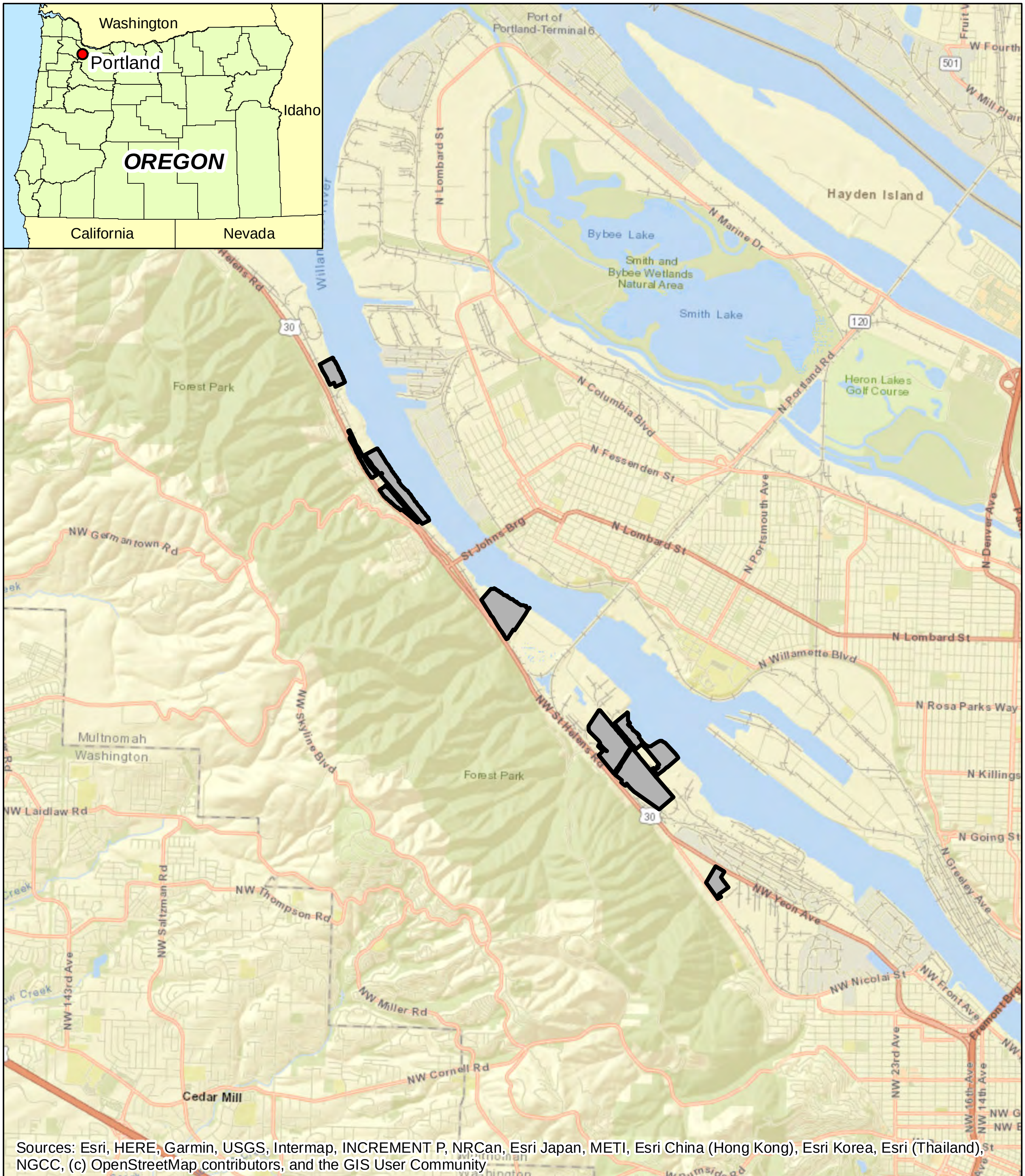
Table 3.2 - CEI Hub Supporting Infrastructure
Portland, Oregon

Area 1 - Kinder Morgan North	
Kinder Morgan - North - 11400 NW St Helens Road, Portland, OR 97231 - Property ID R232828	
Building	**Area (Sq Ft)**
Bldg 1	14,823
Bldg 2	6,800
Bldg 3	5,084
Bldg 4	4,640
Bldg 5	4,495
Bldg 6	3,472
Bldg 7	2,592
Bldg 8	2,232
Bldg 9	750
Bldg 10	527
Bldg 11	77
Area 2 - Linnton	
BP West Coast - 9930 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323779	
Building	**Area (Sq Ft)**
No Buildings Present	
BP West Coast - 9930 NW St Helens Road, Portland, OR 97231 - Property ID R498331	
Building	**Area (Sq Ft)**
Bldg 1	27,050
Bldg 2	8,380
Bldg 3	2,860
Bldg 4	2,740
Bldg 5	930
Bldg 6	Unknown
BP West Coast - 9900 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323771	
Building	**Area (Sq Ft)**
Bldg 1	6,020
Bldg 2	1,917
BP West Coast - 9930 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323758	
Building	**Area (Sq Ft)**
No Buildings Present	
Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R518296	
Building	**Area (Sq Ft)**
Bldg 1	6,150
Bldg 2	1,952
Bldg 3	440
Bldg 4	256
Bldg 5	180
Bldg 6	96
Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R491070	
Building	**Area (Sq Ft)**
Bldg 1	5,434
Bldg 2	644
Bldg 3	25
Shore Terminals - 9400 WI/NW St Helens Road, Portland, OR 97231 - Property ID R324088	
Building	**Area (Sq Ft)**
No Buildings Present	

Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R518295	
Building	**Area (Sq Ft)**
Bldg 1	6,520
Bldg 2	6,400
Bldg 3	4,840
Bldg 4	2,500
Bldg 5	460
Bldg 6	200
Bldg 7	180
Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R512294	
Building	**Area (Sq Ft)**
No Buildings Present	
Area 3 - NW Natural	
Pacific Terminal Services - 7900 NW St. Helens Road, Portland, OR 97210 - Property ID R324159	
Building	**Area (Sq Ft)**
Bldg 1	2,328
Bldg 2	1,800
NW Natural - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324171	
Building	**Area (Sq Ft)**
No Buildings Present	
NW Natural - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324170	
Building	**Area (Sq Ft)**
Bldg 1	NA
Bldg 2	NA
NW Natural - 7598 NW St. Helens Road, Portland, OR 97210 - Property ID R324113	
Building	**Area (Sq Ft)**
Bldg 1	NA
Bldg 2	Removed
Bldg 3	NA
Bldg 4	NA
Bldg 5	NA
Bldg 6	NA
Bldg 7	NA
Bldg 8	NA
Bldg 9	NA
Bldg 10	NA
Bldg 11	NA
Bldg 12	NA
NW Natural - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324172	
Building	**Area (Sq Ft)**
Bldg 1	3,000
Bldg 2	NA
Bldg 3	NA
NW Natrual - 7441 SW/NW St. Helens Road, Portland, OR 97210 - Property ID R324165	
Building	**Area (Sq Ft)**
No Buildings Present	
NW Natural - 7441 NW St. Helens Road, Portland, OR 97210 - Property ID R324160	
Building	**Area (Sq Ft)**
No Buildings Present	
NW Natural - 7540 NW St. Helens Road, Portland, OR 97210 - Property ID R3502592	
Building	**Area (Sq Ft)**
Bldg 1	Removed
Bldg 2	Removed

Bldg 3	Removed
Bldg 4	Removed
NW Natural - 7540 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324213	
Building	**Area (Sq Ft)**
No Buildings Present	
Area 4 - Willbridge	
Kinder Morgan - 5800 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324222	
Building	**Area (Sq Ft)**
Bldg 1	55,734
Bldg 2	1,489
Bldg 3	1,348
Bldg 4	848
Kinder Morgan - 5800 NW St. Helens Road, Portland, OR 97210 - Property ID R121076	
Building	**Area (Sq Ft)**
Bldg 1	10,061
Bldg 2	4,792
Bldg 3	2,500
Bldg 4	1,456
Bldg 5	168
Bldg 6	160
Kinder Morgan - 6080 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R315782	
Building	**Area (Sq Ft)**
Bldg 1	NA
Bldg 2	NA
Bldg 3	NA
Chevron - 5533 NW Doane Avenue, Portland, OR 97210 - Property ID R315798	
Building	**Area (Sq Ft)**
Bldg 1	128,836
Bldg 2	7,696
Bldg 3	3,912
Bldg 4	2,878
Bldg 5	2,004
Bldg 6	1,976
Bldg 7	1,836
Bldg 8	1,616
Bldg 9	NA
Bldg 10	NA
Bldg 11	NA
Bldg 12	NA
Bldg 13	NA
Bldg 14	NA
Chevron - 5533 WI/NW Doane Avenue, Portland, OR 97210 - Property ID R315771	
Building	**Area (Sq Ft)**
Bldg 1	NA
Conoco Phillips - 5528 WI/NW Doane Avenue, Portland, OR 97210 - Property ID R315810	
Building	**Area (Sq Ft)**
Bldg 1	50,400
Bldg 2	12,660
Bldg 3	2,312
Bldg 4	960
Bldg 5	525
Bldg 6	363

Bldg 7	264
Conoco Phillips - 5528 NW Doane Avenue, Portland, OR 97210 - Property ID R315769	
Building	**Area (Sq Ft)**
Bldg 1	8,000
Zenith Energy - 5501 NW Front Avenue, Portland, OR 97210 - Property ID R315845	
Building	**Area (Sq Ft)**
Bldg 1	22,895
Bldg 2	4,110
Bldg 3	3,930
Bldg 4	2,736
Bldg 5	2,652
Bldg 6	2,034
Bldg 7	1,716
Bldg 8	1,144
Bldg 9	864
Bldg 10	799
Bldg 11	380
Zenith Energy - 5501 NW Front Avenue, Portland, OR 97210 - Property ID R315777	
Building	**Area (Sq Ft)**
No Buildings Present	
McCall Oil - 5700 NW Front Avenue, Portland, OR 97210 - Property ID R315872	
Building	**Area (Sq Ft)**
Bldg 1	980
Bldg 2	850
Bldg 3	NA
Bldg 4	NA
McCall Oil - 5480 NW Front Avenue, Portland, OR 97210 - Property ID R315786	
Building	**Area (Sq Ft)**
Bldg 1	NA
Bldg 2	NA
Bldg 3	NA
Bldg 4	NA
Bldg 5	NA
Bldg 6	NA
Area 5 - Equilon	
Equilon - 3610-3640 St. Helens Road, Portland, OR 97210 - Property ID R315819	
Building	**Area (Sq Ft)**
Bldg 1	5,376
Bldg 2	4,680
Bldg 3	2,484
Bldg 4	1,350
Bldg 5	840
Bldg 6	180



Legend

Project Areas

0 0.5 1 2 Miles

N

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

CEI Hub Location Map

154-035-019 04/21

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Figure
1.1

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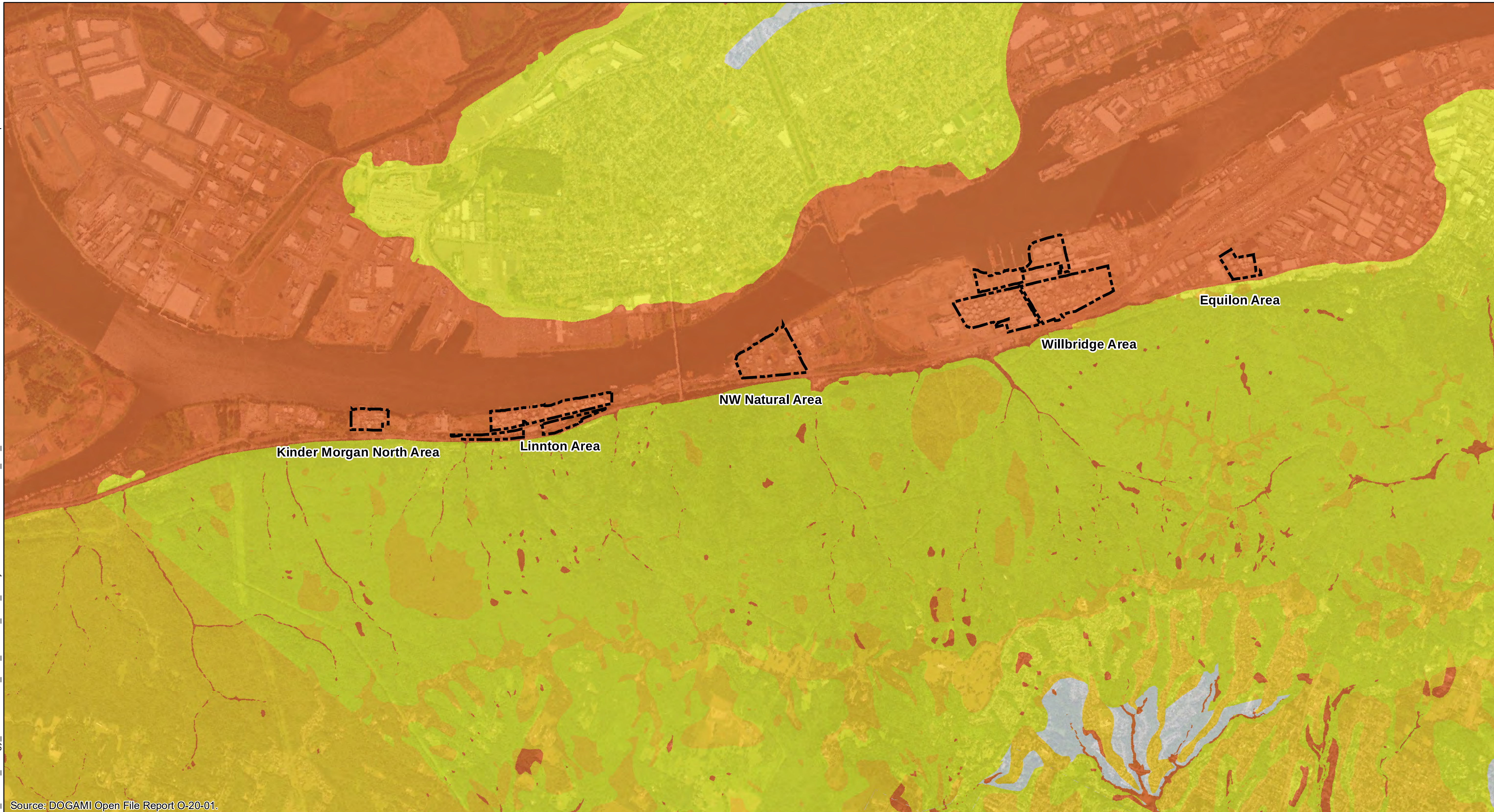

Legend

Potential Permanent Ground Deformation

- None
- Low (0 – 10 cm; 0 – 4 inches)
- Moderate (10 – 30 cm; 4 – 12 inches)
- High (30 – 100 cm; 12 – 39 inches)
- Very High (100 – 1180 cm; 39 – 173 inches)

Project Areas

N

0 0.25 0.5 1 Miles

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

Potential Permanent Ground Deformation Due to Lateral Spreading Cascadia Subduction Zone M9.0 Earthquake

154-035-019 04/21

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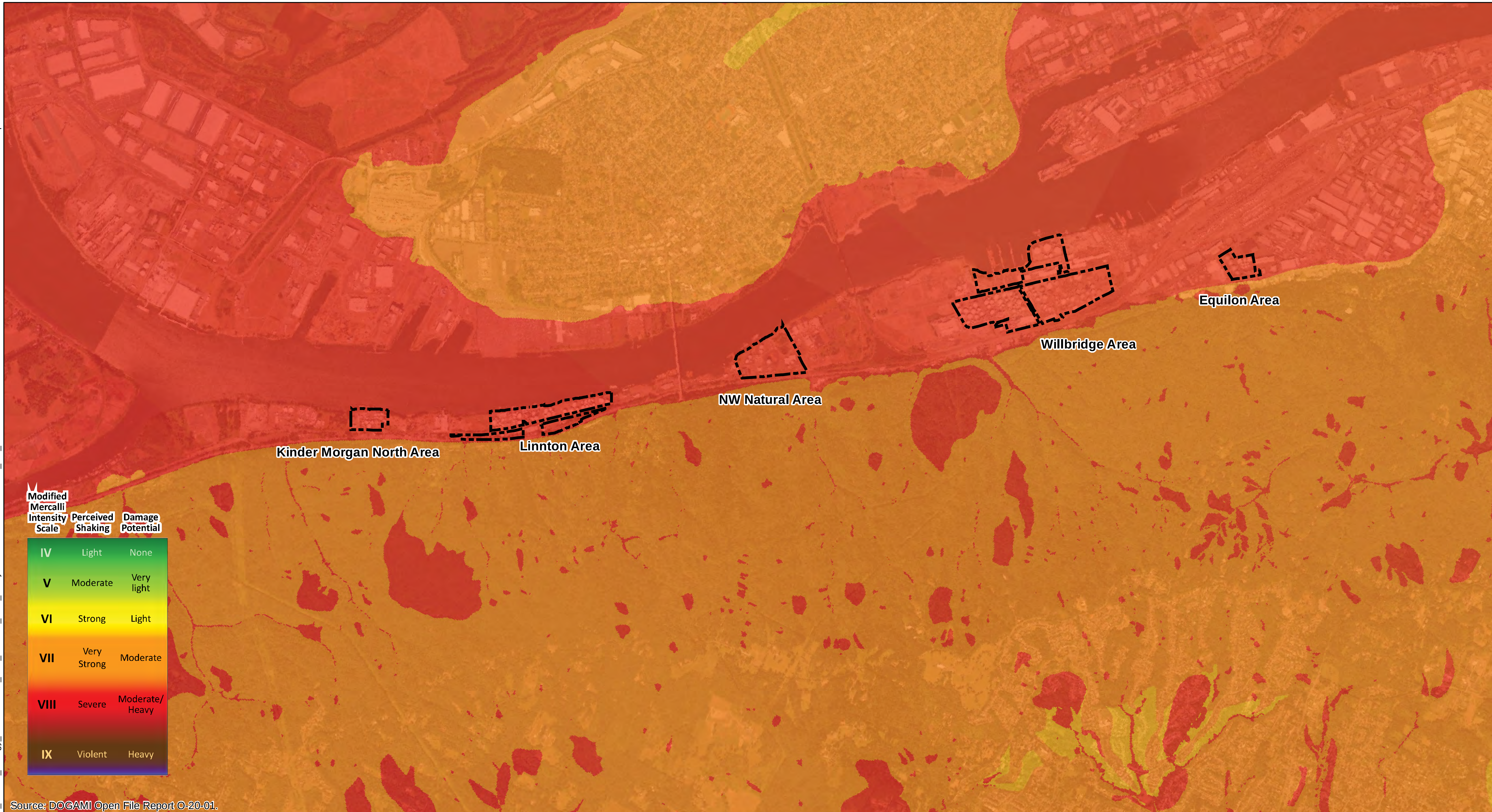
Figure **1.4**

Document Path: F:\Notebooks\154035019_Critical_Energy_Infrastructure_Hub_Seismic_Risk_Analysis\GIS\MGIS\154035019_AD_GroundMotionGroundDeformation.mxd Date: 2/22/2021 User Name: ericlindquist



Legend

Project Areas

0 0.25 0.5 1 Miles

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

Perceived Shaking and Damage Potential
Simulated Cascadia Subduction Zone
Magnitude 9.0 Earthquake

154-035-019 04/21

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Figure **1.2**

Source: Aerial photograph provided by Hexagon Imagery Program Data.

Legend

DOGAMI Liquefaction Susceptibility

- None
- Very Low
- Low
- Moderate
- High
- Very High
- Project Areas

N

0 1,000 2,000 4,000 Feet

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

Liquefaction Hazard Mapping

154-035-019 04/21

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Figure
1.3

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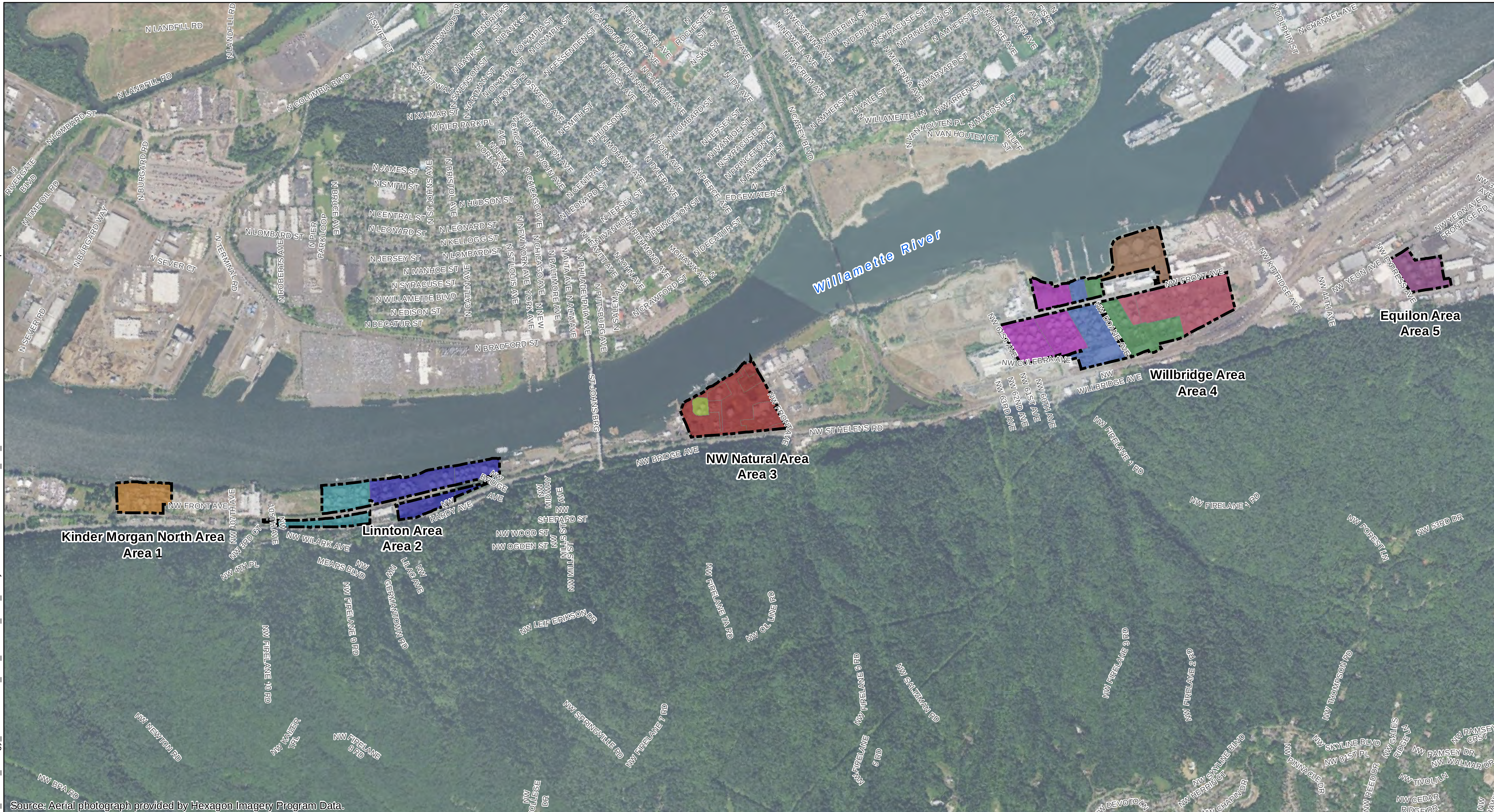

Legend

Project Areas

Kinder Morgan North Area Owners
- Kinder Morgan

Linnton Area Owners
- BP West Coast
- Shore Terminals / Nustar

NW Natural Area Owners
- NW Natural
- Pacific Terminal Services

Equilon Area Owners
- Equilon

Willbridge Area Owners
- Chevron
- Conoco Phillips
- Kinder Morgan
- McCall Oil
- Zenith Energy Terminals

N

0 900 1,800 3,600 Feet

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

CEI Hub Map

154-035-019 04/21

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Figure
1.5

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Legend

- Project Area
- Property with Geotechnical Information Used in Analysis
- Approximate Location of Geotechnical Analysis Section

N

0 125 250 500 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 1 – Kinder Morgan North

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Figure **1.6**

Legend

- Project Area
- Tax Lot Boundary
- Property with Geotechnical Information Used in Analysis
- Approximate Location of Geotechnical Analysis Section

N

0 200 400 800 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 2 – Linnton

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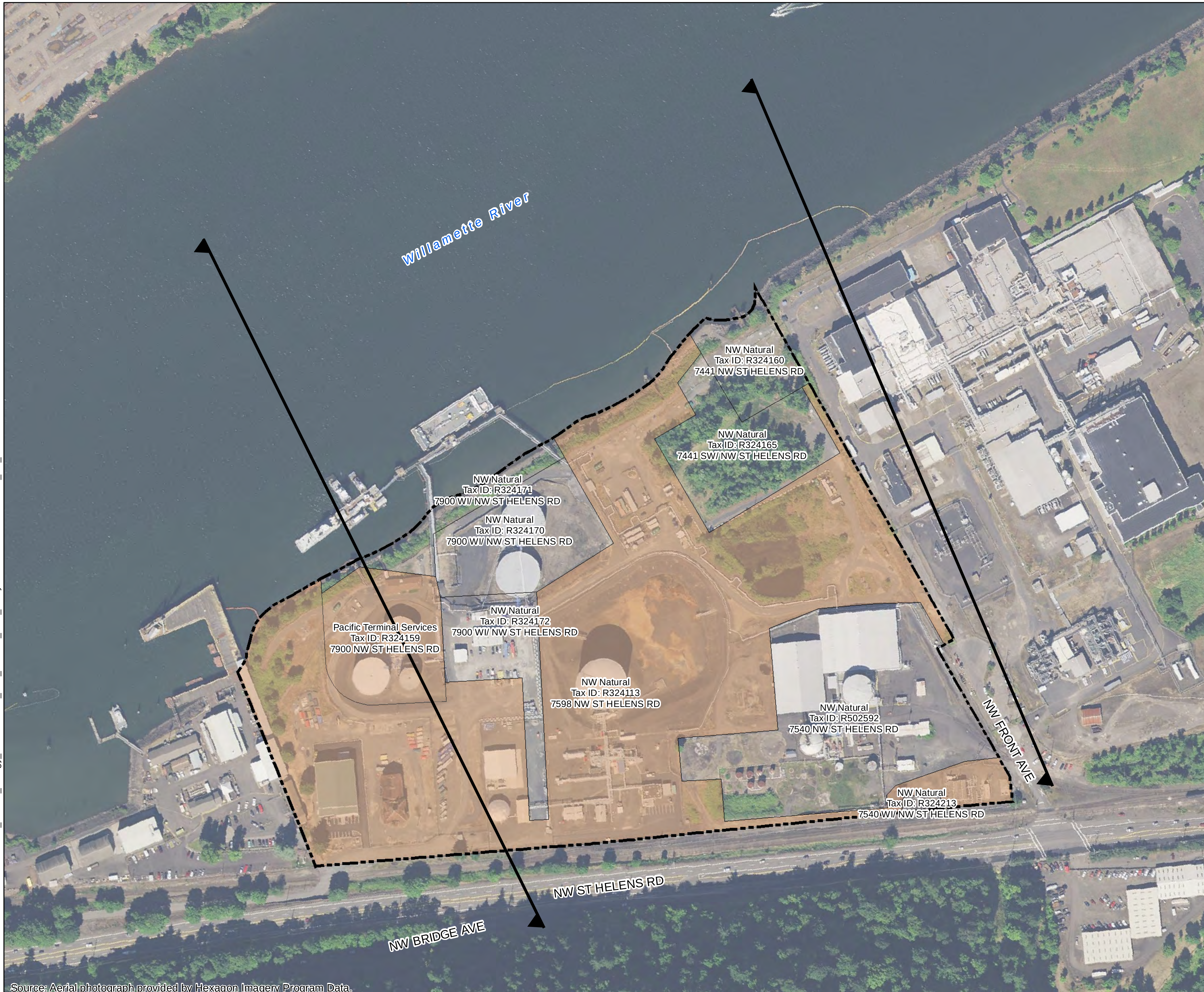
Figure **1.7**



Legend

- Project Area
- Tax Lot Boundary
- Property with Geotechnical Information Used in Analysis
- Approximate Location of Geotechnical Analysis Section

N

0 125 250 500 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 3 – NW Natural

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Figure **1.8**

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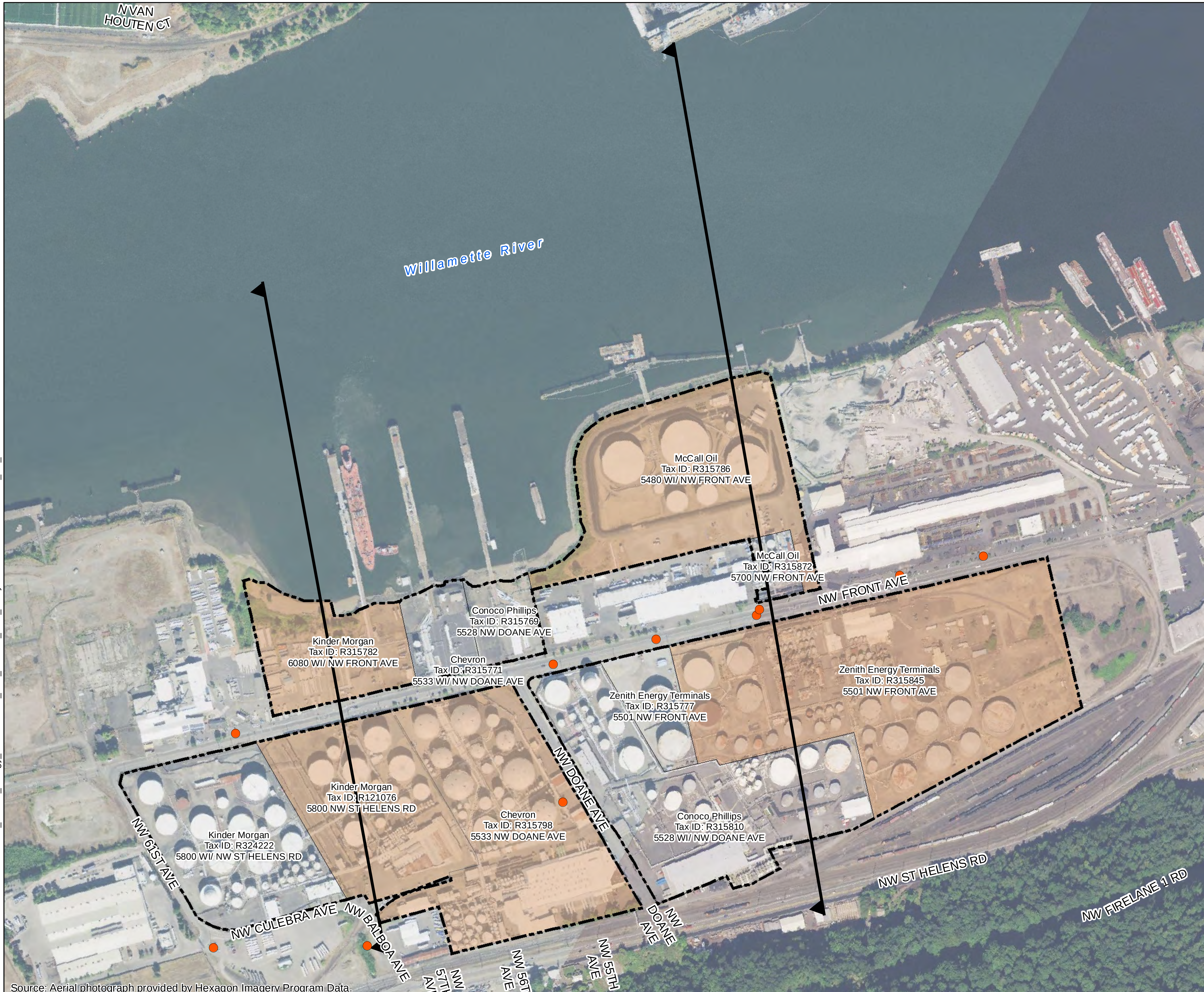

Legend

- Project Area
- Tax Lot Boundary
- Property with Geotechnical Information Used in Analysis
- BES Borings used in Geotechnical Analysis
- Approximate Location of Geotechnical Analysis Section

N

0 225 450 900 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 4 – Willbridge

154-035-019 04/21

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Figure **1.9**

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Legend

- Project Area
- Property with Geotechnical Information Used in Analysis
- BES Borings used in Geotechnical Analysis

N

0 90 180 360 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 5 – Equilon

154-035-019 04/21

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Figure
1.10

APPENDIX A
City of Portland CEI Hub Tank Infrastructure Data
Oregon State Fire Marshal CEI Hub Tank Data (Confidential)

APPENDIX A

REDACTED