



# Impacts of Fuel Releases from the CEI Hub Due to a Cascadia Subduction Zone Earthquake

EXECUTIVE SUMMARY

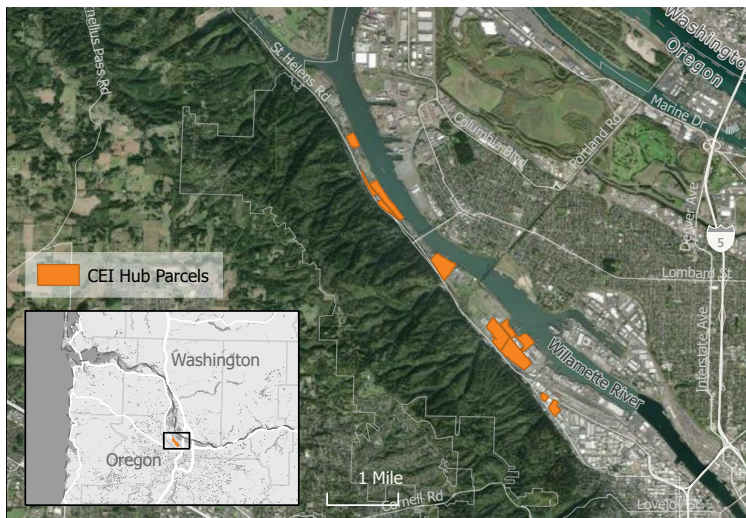
The purpose of this study is to identify the magnitude and extent of potential fossil fuel releases at the CEI Hub from a CSZ earthquake and to evaluate the resulting damages. ECONorthwest, Salus Resilience, and Enduring Econometrics prepared this report for the City of Portland and Multnomah County. For more information about this report, contact: Laura Marshall, Project Manager at marshall@econw.com.

## WHAT IS THE CEI HUB?

The Critical Energy Infrastructure Hub (CEI Hub) is a six-mile area in Northwest Portland along the Willamette River (Figure ES-1). There are 10 companies on 31 properties located at the CEI Hub that vary in size from 0.1 to 31.27 acres for a total of 219.85 acres. The CEI Hub facilities are critical to Oregon’s fossil fuel infrastructure – over 90 percent of the state’s liquid fuel supply is transported through CEI Hub facilities, including gasoline and diesel. The CEI Hub supplies all the jet fuel to Portland International Airport. There are over **150 different types of materials** stored at the CEI Hub, most of which are petroleum-based. There are **630 tanks** of varying sizes throughout the CEI Hub holding a combined active storage tank capacity of at least **350.6 million gallons**.



FIGURE ES-1. Location of CEI Hub Properties



Source: Created by ECONorthwest.

## WHAT IS THE RISK?

The CEI hub is located on unstable soils that are subject to liquefaction and lateral spreading in an earthquake, and the tanks are vulnerable to seismic activity because many were built prior to modern knowledge about earthquake risk. The proximity of the CEI hub to natural assets, like the Willamette River and Columbia River, and the dense urban core in the City of Portland, make the risk of accident, spill, or major failures due to a seismic event particularly concerning.

A magnitude 8 or 9 Cascadia Subduction Zone (CSZ) earthquake would impact the CEI Hub with ground shaking, liquefaction (soil softening and movement), lateral spread (horizontal soil movement), and landslides. The earthquake would disturb tanks and their contents and tanks that were not built to modern seismic design standards pose risk of failure. Additional fuel releases could occur due to connection failures and other incidental damages. There are containment walls in place on many CEI Hub properties,



however, in many cases, these containment structures will be insufficient to contain the potential cumulative volume of releases from multiple tank failures that would occur in a CSZ earthquake.

In total, 397 tanks could release stored materials as a result of the CSZ earthquake.<sup>1</sup> **The total potential releases from the materials stored in tanks at the CEI Hub range from 94.6 million to 193.7 million gallons** (Table ES-1). Approximately 57 percent of the total potential releases would be released onto ground and 43 percent have the potential to flow into the Willamette River. The estimates of fuel releases from the CEI Hub are the same magnitude as what was released in the Deepwater Horizon spill of 2010 — the largest oil spill in U.S. waters to date.

## WHAT WILL HAPPEN IF FUELS ARE RELEASED?

Releases of fuel from the CEI Hub into the air, ground, and water would pose threats to the resources near, downstream, and downwind of the facilities. The fuel releases are likely to cause explosions and fires which pose immediate threats to people on-site at CEI Hub facilities and on adjacent properties. A petrochemical fire poses significant risk to the surrounding areas because containment and suppression may not be possible in the aftermath of the earthquake. If the fire spreads to other properties there are very large threats to human life, safety, physical structures, and natural resources. The fumes from fires and chemical materials will also create health hazards for those who are exposed. People who are in the immediate area as well as emergency responders and clean-up personnel are most at risk from high exposure levels.

The fuel that is released into the Willamette River will behave differently depending on the type of material released. Light and medium oils, such as gasoline and diesel, float in water and will travel downstream until they are contained or evaporate. Heavier fuels will sink and travel as sediment in the river. The further the fuels travel in water, the more environmental resources they will degrade, and more properties will be impacted by oiling. The Lower Willamette River and Lower Columbia River provide habitat to an abundance of species that could be affected by fuel releases. The rivers are also transportation channels, and fuel releases would cause closures for clean-up, which would result



**“The total potential releases from the materials stored in tanks at the CEI Hub range from 94.6 million to 193.7 million gallons.”**

in economic losses for the navigation industry as well as cut off supply chains from the river when they are critically needed after the earthquake. Harms to natural resources would also result in a loss of cultural resources that are of particular importance to Tribal populations for subsistence, transportation, commerce, and ceremonial purposes.

## WHAT WILL BE THE DAMAGES AND COSTS OF FUEL RELEASES?

The minimum costs to society of potential fuel releases at the CEI Hub range from **\$359 million to \$2.6 billion** (Table ES-2). Because not all costs were monetized, this range of costs represents only a portion of the total costs likely to be imposed on society from fuel releases from the CEI Hub.

These costs do not include any costs caused by an inability to perform earthquake recovery efforts due to fuel shortages. To the extent that fuel scarcity impedes emergency response activities, there will be financial and non-financial costs, including injury

**TABLE ES-1. Summary of Total Potential Releases by Location**

| Spill Location                         | Number of Tanks with 50–100 percent failure | Number of Tanks with up to 10 percent failure | Volume Released Min (gal) | Volume Released Max (gal) |
|--|---|---|---------------------------|---------------------------|
| Ground                                 | 269   | 21  | 53,882,252                | 111,183,900               |
| Water (Including potentially in water) | 96  | 11  | 40,751,753                | 82,503,352                |
| <b>Total</b>                           | <b>365</b>                                  | <b>32</b>                                     | <b>94,634,005</b>         | <b>193,687,251</b>        |

Source: Created by Salus Resilience (see Appendix B).

<sup>1</sup> This value excludes empty tanks from the active tanks that could release materials.



| Category of Costs               | Summary of Costs   | Range of Monetized Costs for the Modeled Scenario  |
|---------------------------------|--|--|
| Direct Impacts to People        | Assuming an explosion occurs, between 0 to 7 people could be killed and 2 to 80 people could be injured. The range of costs for mortality and morbidity are between \$49,000 to \$74.1 million, with an average cost of \$37.1 million.  | \$49,000 to \$74.1 million   |
| Impacts to Property             | Assuming fuels in the water travel downstream to the Longview Bridge, the potential impact on residential property values is up to \$35.4 million. There is \$2.5 billion in total riverfront property value in the downstream area.   | \$11.8 million to \$35.4 million   |
| Impacts to Navigation           | A one-week closure of the shipping channel between the I-405 bridge and Longview Bridge would result in additional operating costs for commercial vessels of between \$11.8 million and \$17.8 million.  | \$11.8 million and \$17.8 million  |
| Impacts to Fisheries            | To the extent that fuel releases reduce reproduction or cause direct mortality to aquatic species there will be a reduction in income to the fishing industry, impacting owners, employees, and suppliers who rely on these funds. Increases in hatchery production would likely be needed, which would result in additional costs.  | Not Monetized — Potential for significant mortality to commercial fisheries species and loss to commercial fishing entities  |
| Impacts to Recreation           | Average per-trip values of recreation for participants (i.e., consumer surplus) are between \$68 to \$130 per person per day. Recreationalists contribute spending to local economies at an average value of between \$98 to \$478 per trip. Canceled recreational trips due to fuel releases would reduce both value for the participant and economic activity for the businesses that rely on the recreational spending. A one-month closure of the Lower Columbia River and Lower Willamette River for salmonid fishing would result in a loss of consumer surplus of \$3.4 million and a loss of \$3.2 million in direct trip spending.  | Not Monetized — Damage to recreational resources that cannot be easily rebuilt, such as fire damage to Forest Park, will result in long-term losses to recreation. |
| Impacts to Human Health         | The health costs of exposure to toxins for nearby people and response workers is \$121 million to \$249 million for both acute and chronic conditions. The primary health costs are increased risk of heart attack, decreases in productivity, and lost workdays. Additional costs would be borne from evacuations and strains on emergency response services.   | \$121 million to \$249 million — with potential for additional costs to mental health and non-documented physical health costs.                                    |
| Impacts to Habitats and Species | Habitats and species would be harmed from fuel releases. The costs of habitat restoration as compensation for habitat injury would require between 175 and 418 acres of wetland to be restored. An additional 39 to 1,219 acres of constructed wetland could be needed to compensate for injuries to bird populations. There is also the potential for compensation needed for aquatic and mammal species that are injured by the event. The expected total costs for habitat restoration are between \$39.7 million and \$304.3 million, depending on whether the spill occurs in the summer or in the winter. Total damages from injury to habitats and natural resources and required compensation are expected to range between \$87 million to \$669 million, depending on whether the spill occurs in the summer or in the winter. | \$87 million to \$669 million  |
| Cleanup Costs                   | Cleanup costs are projected to be between \$109 million to \$1.4 billion.  | \$109 million to \$1.4 billion   |
| Impacts to Cultural Values      | Fuel releases in the Willamette River and Columbia River would harm cultural resources that are of particular importance to Tribal populations for subsistence, transportation, commerce, and ceremonial purposes. Impacts to this area would perpetuate historical inequities to a water resource already contaminated as part of the Portland Harbor Superfund.  | Not Monetized — Impacts to waterways and aquatic species like salmon would result in large cultural losses.  |
| Impacts to Fuel Prices          | Releases of fuel from the CEI Hub would reduce the supply of fuels needed for transportation and commercial activity in Oregon. The effects of the earthquake on transportation infrastructure will alter the demand for fuels. A lack of fuel could constrain emergency response activities. The total economic cost to consumers of the higher fuel prices and reduction is between \$18.8 million and \$120.8 million. The lost value of consumption from fuel scarcity would be \$11.7 million for a three-day period.   | \$18.8 million to \$120.8 million — with additional costs from loss of consumption and delays in recovery efforts  |
| <b>Total Monetized Costs</b>    |  | <b>\$359 million to \$2.6 billion</b>  |


Source: Created by ECONorthwest.



and loss of life. The costs to society also do not include fines, penalties, lost revenue, or equipment replacement costs borne by the CEI Hub operators. Not all costs are able to be monetized due to lack of data, uncertainty, confounding variables caused by the earthquake, and/or difficulty valuing the resource. The costs are based upon a multitude of assumptions and scenarios about the type and magnitude of fuel releases, emergency response actions and timelines, and natural phenomenon like air, water, and fire dispersion — these assumptions are detailed in the full report.

## WHO WILL BE LIABLE AND HOW WILL COSTS BE PAID FOR?

The Oil Pollution Act of 1990 (OPA), passed by Congress and signed into law in the wake of the Exxon Valdez oil spill, is the established liability structure to recover damages from oil spills. Under OPA, “Responsible Parties” are liable for removal costs and damages that are attributable to their release of oil. Fuel releases from the CEI Hub could exceed the statutory liability limits established under OPA or deemed an “Act of God” (making the responsible party not liable). For these situations, OPA established the Oil Spill Liability Trust Fund to pay for any excessive or unfunded liabilities.



**“Under OPA, onshore facilities like the CEI Hub have liability limits of \$672,514,900 PER SPILL for each responsible party.”**



All damages and costs of fuel releases from the CEI Hub report are potentially recoverable under OPA, with the exception of personal injury/wrongful death, which would be potentially recoverable under separate civil action. However, what will actually be paid out to people who are harmed by fuel releases could be less than the full amount that would be required to compensate them for the damage due to transaction costs and inefficiencies. Uncompensated damages may be distributed inequitably across injured parties due to existing structural inequities in the legal system. Uncompensated damages are most likely to occur for claimants with damages that are more difficult to prove.

### Impacts of Fuel Releases from the CEI Hub

due to a Cascadia Subduction Zone Earthquake

FEBRUARY 2022

PREPARED FOR



PREPARED BY

**ECONorthwest**  
ECONOMICS • FINANCE • PLANNING

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# Chapter 1: Impacts of a Cascadia Subduction Zone Earthquake on the CEI Hub

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January 2022

Prepared for:

Multnomah County Office of Sustainability  
and City of Portland Bureau of Emergency Management

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**ECONorthwest**  
ECONOMICS • FINANCE • PLANNING

 **SALUS RESILIENCE**

Enduring Econometrics



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# 1-1 Introduction

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## 1-1.1 Background on CEI Hub

The Critical Energy Infrastructure Hub (CEI Hub) is a six-mile area in Northwest Portland along the Willamette River (Figure 1). The CEI Hub facilities are critical to Oregon’s fossil fuel infrastructure - over 90 percent of the state’s liquid fuel supply is transported through CEI Hub facilities, including gasoline and diesel. Roughly 70 percent of the fuel arrives by pipe and another 30 percent arrives by tanker barge. <sup>1</sup> The CEI Hub supplies all of the jet fuel to Portland International Airport. The natural gas stored at CEI Hub facilities is used to supplement the natural gas deliveries during peak winter demand. In addition to the fuel storage facilities, the CEI Hub also contains liquid fuel and natural gas pipelines and transfer stations, a liquefied natural gas storage tank, storage of other non-fuel materials, a high-voltage electrical substation, and transmission lines.

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<sup>1</sup> Oregon Seismic Safety Policy Advisory Committee. (2013). *The Oregon Resilience Plan: Reducing Risk and Improving Recover for the Next Cascadia Earthquake and Tsunami*, Chapter 6: Energy.



Figure 1. CEI Hub Location



Source: Created by ECONorthwest

A magnitude 8 or 9 Cascadia Subduction Zone (CSZ) earthquake would impact the CEI Hub with ground shaking, liquefaction (soil softening and movement), lateral spread (horizontal soil movement), and landslides.<sup>2</sup> The significant ground disturbance and resulting impacts to the tanks could result in releases of the materials stored at the CEI Hub into land, water, and air. A fire is also possible at the site due to the combination of flammable fuels and earthquake disturbances. Releases from fuel tanks at the CEI Hub would pose a major hazard to people, marine life, and property, as well as contaminate the environment and require significant clean-up. The purpose of this analysis is to model the likely scenarios of releases and describe the potential resulting physical impacts.

## 1-1.2 Study Purpose

On October 31st, 2019, the Multnomah County Board of Commissioners adopted resolution 2019-091 which opposes the expansion of infrastructure for transporting or storing fossil fuels in Multnomah County, and supports efforts to require fossil fuel industry to bear the full cost of damages caused by transporting, storing, or using fossil fuels. On December 18, 2019 the Portland City Council adopted ordinance 189807 that restricts large new oil train terminals and

<sup>2</sup> Yumei Wang, Steven F. Bartlett, and Scott B. Miles. (2012). *Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub: Final Report to Oregon Department of Energy and Oregon Public Utility Commission*. Oregon Department of Geology and Mineral Industries. August.

other fossil fuel projects in the City of Portland, prohibits the establishment of new major oil storage facilities in Portland, and limits expansion at existing facilities. The language in the Multnomah County Ordinance states that:

“The impacts of an earthquake or another catastrophic event involving the Critical Energy Infrastructure Hub would be significant and could include immediate threats to life and safety, longer term pollution and health effects, and economic disruption. The burden of these impacts would fall disproportionately on communities of color and low income populations, and in the absence of strong policy protections the cost of response and cleanup would be borne by taxpayers.

Multnomah County seeks to protect itself and the community from the cost of damage to fossil fuel infrastructure by exploring strategies to shift financial responsibility for costs of risks associated with fossil fuel infrastructure to the companies that own and earn revenues from the infrastructure.”

As part of the 2019 resolutions, the Board of County Commissioners approved the allocation of funds to inventory costs associated with risks to the fossil fuel infrastructure located in the CEI Hub, as well as the existence and adequacy of insurance and other financial assurance mechanisms held by the fossil fuel companies that have infrastructure in the Hub.

The purpose of this study is to identify the magnitude and extent of potential fossil fuel releases at the CEI Hub from a CSZ earthquake and to evaluate the resulting damages. Specifically, this research performs the following:

- Summarizes available information about conditions at the CEI Hub.
- Describes the likely effects of a major earthquake on CEI Hub facilities.
- Develops qualitative descriptions and quantitative estimates of the earthquake’s effects at the CEI Hub, including potential releases of fossil fuels.
- Estimates the economic impacts of fossil fuel releases and infrastructure failures.
- Identifies and describes what costs might be covered by existing insurance or federal programs and what costs are not clearly the responsibility of either owner-operators or another party.

This evaluation is limited to only the effects of a CSZ earthquake at the CEI Hub. It is beyond the scope of this analysis to consider short-term or long-term potential damages to the environment or human health caused by accidents, volatilizing toxins, and/or chemical spills not caused by a CSZ earthquake – including any potential damages not directly related to the earthquake posed by the storage tanks, railroad cars, ships, trucks, and/or pipelines carrying products to and from the CEI Hub.

A CSZ earthquake would also affect other nearby infrastructure for fuels and materials. The industrial areas of Portland, Oregon and Vancouver, Washington along the Willamette River and Columbia River store, use, and transport other fossil fuels and chemicals, including toxic



inhalation hazard materials that also have the potential to be released due to earthquake damages and would complicate response efforts and strain response resources.<sup>3</sup>

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<sup>3</sup> As defined in the Federal Register (69 FR 50987): “Toxic inhalation hazard materials (TIH materials) are gases or liquids that are known or presumed on the basis of tests to be so toxic to humans as to pose a hazard to health in the event of a release during transportation”.

## 1-2 Prior Studies Related to the CEI Hub

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Several prior studies have evaluated the impacts of a CSZ earthquake on the CEI Hub, documented hazardous materials releases, and described impacts to the surrounding environment and economy. However, these studies have not performed the analysis needed to identify the magnitude, location, and extent of releases and the specific costs on the surrounding environment. This report builds upon these prior studies to supply that needed information. As background information on the history of research of the risks at the CEI Hub, a summary of relevant prior literature is detailed below.

### 1-2.1.1 Dusicka and Norton - Liquid Storage Tanks at the Critical Energy Infrastructure (CEI) Hub Seismic Assessment of Tank Inventory (2019)

The Dusicka and Norton study from 2019 is directly related to the work being performed for this report.<sup>4</sup> In this publication, the authors evaluate the seismic integrity of the tanks at the CEI Hub and provide a conceptual estimate of \$300 million as the cost for seismic mitigation for the large capacity tanks. As part of this work the researchers also estimated the quantity and characteristics of the tanks and the supporting soil.

Through a public records request and information from the City of Portland, the authors identified nine companies with a total of total of 514 known tanks, of which 146 were identified as out of service. The majority of the tanks were built before 1960. Based on secondary information, this report concludes that there is a risk of both liquefaction and landslides at the CEI Hub from a CSZ earthquake. Structural mitigation (i.e., retrofitting the tanks so that they are more seismically resilient) could occur through tank anchoring or soil mitigation.

### 1-2.1.2 DOGAMI - Earthquake Risk Study for Oregon's CEI Hub (2012)

Prepared for the Oregon Department of Geology and Mineral Industries (DOGAMI), this 2012 study evaluated the geomorphic earthquake risks at the CEI Hub.<sup>5</sup> The seismic hazards of a CSZ earthquake on the CEI Hub include ground shaking, liquefaction, lateral spread, landslides, co-seismic settlement, and bearing capacity failures. Secondary hazards resulting from the initial seismic impacts include fire and hazardous materials releases. In addition to the tanks at the CEI Hub, this study also evaluated the pipeline that runs under the Willamette River. The pipeline was built in the 1960s and could be damaged or broken by the seismic hazards from the earthquake, particularly liquefaction and lateral spread.

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<sup>4</sup> Dusicka, P. and Norton, G. (2019). *Liquid Storage Tanks at the Critical Energy Infrastructure (CEI) Hub Seismic Assessment of Tank Inventory*. Mapleleaf LLC and Portland State University. Prepared for Portland's Bureau of Emergency Management. May.

<sup>5</sup> Wang, Y., Bartlett, S.F., Miles, S.B. (2012). *Earthquake Risk Study for Oregon's CEI Hub*. Prepared for Oregon Department of Geology and Mineral Industries (DOGAMI).



The findings from this report indicate that western Oregon will likely face an electrical blackout, extended natural gas service outages, liquid fuel shortages, and damage and losses in the tens of billions of dollars in a future major Cascadia earthquake. The report recommends immediate proactive seismic mitigation actions.

### 1-2.1.3 Other Relevant Studies

#### 1-2.1.3.1 OSSPAC - CEI Hub Mitigation Strategies: Increasing Fuel Resilience to Survive Cascadia (2019)

A study completed by the Oregon Seismic Policy Advisory Safety Commission (OSSPAC) at the request of the Oregon Governor and the State Resilience Officer focused on fuel resilience following the CSZ event.<sup>6</sup> Through meetings and testimony with experts, agencies, and interested stakeholders, OSSPAC presented findings and recommendations on the regulatory authority for: seismic upgrades, statutory authority to develop long-term mitigation efforts, public-private partnerships and incentives to harden current infrastructure, and encouraging seismic awareness in the private sector. The major finding from this work is as follows:

“The Critical Energy Infrastructure Hub is a major threat to safety, environment, and recovery after a Cascadia Subduction Zone earthquake on par with the 2011 Fukushima nuclear meltdown in Japan. Owners of privately-owned liquid fuel tanks at the Hub need to be compelled to seismically strengthen their infrastructure. No state agency is a perfect fit to be designated as the regulatory authority over these facilities.”

#### 1-2.1.3.2 Oregon Solutions - Critical Energy Infrastructure Hub Assessment Findings (2019)

A 2019 study by Oregon Solutions identified potential avenues for collaborative action that might increase resiliency of the CEI Hub.<sup>7</sup> Oregon Solutions was established at the state level through the passage of the 2001 Sustainability Act and provides collaborative governance assistance through partnerships. The report is the product of interviews conducted by Oregon Solutions with parties and stakeholders representing key interests related to the CEI Hub between July 2018 and January 2019.

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<sup>6</sup> Oregon Seismic Safety Policy Advisory Commission of the State of Oregon (OSSPAC). (2019). *CEI Hub Mitigation Strategies: Increasing Fuel Resilience to Survive Cascadia*. December 31. OSSPAC Publication 19-01.

<sup>7</sup> Oregon Solutions. (2019). *Critical Energy Infrastructure Hub Assessment Findings*. Prepared for the Portland City Club’s Earthquake Resiliency Advocacy Committee (CCERAC) and the city of Portland’s Bureau of Emergency Management (PBEM).

### 1-2.1.3.3 Other Reports

In addition to these reports that are specific to the CEI Hub, other relevant information sources include the Oregon Resilience Plan, particularly *Chapter 5: Transportation*, as well as the studies associated with the Portland Harbor Superfund site.<sup>8,9</sup>

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<sup>8</sup> More information and a copy of the Oregon Resilience Plan is available at:  
<https://www.oregon.gov/gov/policy/orr/pages/index.aspx>

<sup>9</sup> More information about the Portland Harbor Superfund is available at:  
<https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=1002155#bkground>



# 1-3 CEI Hub Fuel Releases

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## 1-3.1 Methodology

Estimating the potential failures and releases associated at the CEI Hub due to a CSZ earthquake requires combining data about the location, contents, and integrity of critical infrastructure with information about the stability and risks of the soils that they are located on. Tank data is based upon information from the Office of Oregon State Fire Marshal (OSFM) and the City of Portland (COP), the latter of which was developed from the Portland State University (2019) study of the CEI Hub.<sup>10, 11</sup> Under the Oregon Community Right to Know and Protection Act (ORS 453.307-414) that requires Oregon employers to report their hazardous substances to OSFM, including where they are stored, and the hazards associated with them.<sup>12</sup> The geological risks and susceptibility of the location to earthquake impacts is based upon a geologic analysis, detailed in Appendix A.

An onsite engineering analysis to determine tank risk and susceptibility to failure from a CSZ earthquake was not conducted for this analysis. Such a review would provide more precise estimates about the potential tank failures and releases, as well as be able to identify if individual tanks meet current seismic design standards. The estimates and characterizations of tank conditions and susceptibility to failure are based on available information from the sources identified above. It is possible that tanks are retrofitted or otherwise have lower risks of failure than identified herein. However, because that information was not publicly available or offered by the facility owners that information is not reflected in the estimates of tank contents or probability of tank failure from the CSZ earthquake.

As tanks deform and fail during an earthquake, a portion of the materials contained inside them will be released. The specific volume that is released will depend on the ground displacement, nature of the failure, capacity of the tank, and the amount of material in the tank at that time. Most tanks in the CEI Hub have floating lids, meaning that in the event of an earthquake materials could slosh outside of the tank's containment. Connection failures and other incidental damages could also result in releases even if the tank itself does not fail. Throughout the CEI Hub there is a high likelihood of liquefaction and lateral spread from a CSZ earthquake that would disturb tanks and their contents.

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<sup>10</sup> A full description of the methodologies used for the information in this section are detailed in Appendix A, which contains an evaluation of the geotechnical risks at the CEI Hub, and Appendix B, which contains an evaluation of tank contents, likelihood of failure, and location of releases.

<sup>11</sup> Dusicka, P. and Norton, G. (2019). *Liquid Storage Tanks at the Critical Energy Infrastructure (CEI) Hub Seismic Assessment of Tank Inventory*. Mapleleaf LLC and Portland State University. Prepared for Portland's Bureau of Emergency Management. May.

<sup>12</sup> More information about Oregon Community Right to Know and Protection Act (ORS 453.307-414) is available at: <https://www.oregon.gov/osp/programs/sfm/pages/community-right-to-know.aspx>

Because soils are unstable throughout the CEI Hub, the likelihood of tank failure varies based upon the age of the tank to reflect engineering design considerations for if and how much of the contents could be released. Engineering design standards have changed over time. American Society of Civil Engineers design standards and state and city building codes prior to 1993 do not meet current seismic design standards. Liquefaction of soft soils was incorporated into City of Portland requirements for seismic design after 2004. Accordingly, these dates are used as thresholds for estimating the likelihood of tank failure and percent of contents that could be released, as follows:

- **Prior to 1993:** Tanks will likely fail during the CSZ event and release 50 to 100 percent of contained materials.
- **Between 1993 and 2004:** Tanks are assumed to be designed for shaking but are susceptible to failure due to liquefaction settlement and lateral spread.<sup>13</sup> Up to 10 percent of contained materials could be released due to connection failures and other incidental damages.
- **After 2004:** Tanks have been designed to withstand appropriate shaking and deformation and thus are not likely to fail during the CSZ event. However, up to 10 percent of contained materials could be released.

Released materials will flow out onto the ground and properties of the various operators. While on-site containment structures are designed to capture a potential release, it is possible that the CSZ earthquake could damage these masonry containment walls. In many cases, these containment structures are insufficient to contain the potential cumulative volume of releases from multiple tank failures. As a result, depending on tank location, damage zone, distance from the water, and topography, substantial portions may flow into the Willamette River. Damage zones vary throughout the CEI Hub properties, with different volumes staying on land or entering the water, as described in Table 1. Appendix B provides additional information about releases by area type.

Table 1. Damage Zones by Area

| Location                 | Damage Zone (distance from water in feet) |                      |         |
|--------------------------|---|----------------------|---------|
|                          | In Water                                  | Potentially in Water | On Land |
| Area 1 - Kinder Morgan N | 0-500                                     | 500-750              | 750+    |
| Area 2 - Linnton N       | 0-500                                     | 500-750              | 750+    |
| Area 2 - Linnton S       | 0-500                                     | 500-750              | 750+    |
| Area 3 - NW Natural      | 0-250                                     | 250-500              | 500+    |
| Area 4 - Willbridge      | 0-250                                     | 250-500              | 500+    |
| Area 5 - Equilon         | N/A                                       | N/A                  | All     |

Source: Created by Salus Resilience, see Appendix B.

<sup>13</sup> Liquefaction is the phenomenon after an earthquake when soils lose holding strength, causing them to behave like a liquid rather than a solid and contents above or below the soil to be displaced. Lateral spread refers to the lateral movement of soils which can result in ground tears, open surface cracks, and fissures.

## 1-3.2 Fuel and Hazardous Material Types

There are over 150 different types of materials stored at the CEI Hub, each with a unique chemical composition. Most of the fuels stored at the CEI Hub are petroleum-based but react in the environment in different ways. The American Petroleum Institute (API) gravity is a measure of how heavy or light a petroleum liquid is compared to water. If a product has an API gravity of less than 10, it sinks in water. If the product has an API gravity greater than 10, it floats in water. Based on API ranking, the materials at CEI Hub can be assigned to the following categories.

- **Heavy Oil (API: Between 10 and 22.3):** Heavy oils are dense and have a high resistance to flow. They generally float in water and do not disperse readily.
  - **Asphalt (API: 11):** Also known as bitumen, asphalt is a highly viscous petroleum product primarily used in road construction.
  - **Bunker (API: 12 to 14):** Bunker crude oil is heavy oil typically used as a vessel fuel.
- **Medium Oil (API: Between 22.3 and 31.1):** Medium oils include motor oils, which are derived from both petroleum and non-petroleum chemicals. Most motor oils are derived from crude oil, with additives to improve certain properties. Motor oils are generally used for lubricating internal combustion engines.
- **Biodiesel (API: 25.7 to 33.0):** Biodiesel is a fuel made from natural, renewable sources, such as new and used vegetable oils and animal fats, for use in a diesel engine.
- **Light Oils (API: Greater than 31.1)**
  - **Diesel (API: 35):** Diesel oil is produced from crude oil. It is used as a fuel for diesel vehicles and burning.
  - **Jet fuel (API: 45):** Jet fuel is an aviation fuel. The most commonly used fuels for commercial aviation are Jet A and Jet A-1. Jet fuel is a mixture of a large number of different hydrocarbons.
  - **Ethanol (API: 48):** Ethanol is an alcohol product produced from corn, wheat, sugar cane, and biomass and is primarily used as an additive in gasoline to increase its octane level or as a stand-alone fuel.
  - **Gasoline (API: 60):** Gasoline or petrol is a petroleum-derived liquid flammable mixture consisting mostly of hydrocarbons and enhanced with isooctane or aromatics hydrocarbons toluene and benzene to increase octane ratings.<sup>14</sup> It is used as fuel for gasoline vehicles and burning.
- **Liquified Natural Gas (API: N/A):** Natural gas is lighter than air and will dissipate into the air if released.
- **Additives (API: N/A):** Nearly all commercial motor oils contain additives. Additives are used for viscosity and lubricity, contaminant control, for the control of chemical breakdown, and for seal conditioning of oil.

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<sup>14</sup> ALS Life Sciences. (No Date). *Library of Petroleum Products and Other Organic Compounds*. Retrieved from <https://www.alsglobal.es/media-general/pdf/library-of-petroleum-products-and-other-organic-compounds.pdf>

- **Slop Oil (API: Varies):** Slop Oil is defined as oil that is emulsified with water and solids. It is not usable as a fuel and contains similar contamination properties as the original oil source it contains.
- **Other:** Other products that do not fall into one of the prior categories includes unknown/unavailable contents, cutter, hydraulic fluids, storm water, and water.
- **Empty:** Tanks without any materials are categorized as “Empty”.
- **Out of Service:** Tanks listed as out of service, rather than empty or with materials.
- **Extra Heavy Oil (API: Less than 10):** There is no evidence of extra heavy oils at the CEI Hub.

#### 1-3.2.1.1 Flammability

Different fuel types have different risks of ignition. Whether materials burn following a release determines the range of air-quality and in-water environmental impacts. The assigned flammability of the materials is based upon Occupational Safety and Health Administration (OSHA) categories, as follows:<sup>15</sup>

- **Category 1:** Liquids with flashpoints below 73.4°F (23°C) and boiling point at or below 95°F (35°C). Examples: gasoline, some medium oils, and natural gas.
- **Category 2:** Liquids with flashpoints below 73.4°F (23°C) and boiling points at or above 95°F (35°C). Examples: Unleaded gasoline, ethanol, and bunker.
- **Category 3:** Liquids with flashpoints at or above 73.4°F (23°C) and at or below 140°F (60°C). Examples: Diesel, biodiesel, and jet fuel.
- **Category 4:** Includes liquids having flashpoints above 140°F (60°C) and at or below 199.4°F (93°C). When a Category 4 flammable liquid is heated for use to within 30°F (16.7°C) of its flashpoint, it must be handled as a Category 3 liquid with a flashpoint at or above 100°F (37.8°C). Examples: Marine diesel.

#### 1-3.2.1.2 Hazardous Materials

Materials are deemed hazardous based on a combination of flammability, environmental harm, and risk from direct exposure to humans. Materials have their own Material Safety Data Sheets (MSDSs) that define the risk of harm. The categories used for this analysis are based on the MSDSs, as follows:

- **Category H – Hazardous**
  - All flammable materials are considered hazardous except for biodiesel.
  - Examples include gasoline, diesel, ethanol, jet fuel, and others.
- **Category NH – Non-Hazardous**
  - Examples include contact water and stormwater.
- **Not Available**

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<sup>15</sup> OSHA’s Directorate of Training and Education. (No Date). *Flammable Liquids: 29 CFR 1910.106*. Retrieved from [https://www.osha.gov/sites/default/files/training-library\\_TrngandMatlsLib\\_FlammableLiquids.pdf](https://www.osha.gov/sites/default/files/training-library_TrngandMatlsLib_FlammableLiquids.pdf)



- Information was not available for these materials.
- Examples include motor oil, transmission fluid, additives, and others.

### 1-3.3 Quantities of Materials at CEI Hub

There are **630 tanks** of varying sizes throughout the CEI Hub holding a combined active storage tank capacity of at least **350.6 million gallons**.<sup>16, 17</sup> There is varying information available about the 630 tanks, as follows:

- **558 tanks** have available location data from either OSFM data, COP data, or City of Portland permitting information.<sup>18</sup> Of these tanks:
  - 143 are listed as “Out of Service” and thus not evaluated in the analysis.
  - 18 are listed as “Empty”.
  - 4 tanks have unknown contents. These tanks are located at Chevron (1 tank), and Shore Terminals (3 tanks). These tanks are evaluated in the analysis as “Unknown” material types.
  - 393 tanks are in service and have known contents information. Of these tanks:
    - 365 tanks have tank capacity information, measured in gallons.
    - 28 tanks are missing capacity information. These tanks are located at BP (2 tanks), Shore Terminals (1 tank) and Zenith Energy (25 tanks).
- **72 tanks** were identified via aerial photographs but are not identified in the OSFM or COP datasets; these tanks are all in Area 4 (Zenith Energy) and are all relatively small tanks. These tanks are missing specific location details, tank age, tank contents, and tank capacity information. Because of the missing information these tanks were excluded from the analysis. Due to the location of the property, it is likely that any releases from these tanks would be onto the ground.

There are 415 active tanks, defined as tanks that are not out of service and excluding the 72 tanks in Area 4 of unknown status that were identified in aerial photos alone. Empty tanks are included in the active tank definition, as they could be filled. The majority of the active tank total capacity at the CEI Hub, approximately 65 percent or 215 million gallons, are light oils (e.g., gasoline and diesel) (Table 2).

Table 2. Total Maximum Capacity of Materials at CEI Hub in Active Tanks

| Material Type | Maximum Tank Capacity (gallons) | Percent of Total Maximum Capacity | Number of Tanks | Percent of Tanks |
|---------------|---------------------------------|-----------------------------------|-----------------|------------------|
| Light Oil     | 215,337,397                     | 65%                               | 130             | 31%              |
| Medium Oil    | 43,829,634                      | 13%                               | 144             | 35%              |

<sup>16</sup> For comparison to prior research estimates, Dusicka and Norton (2019) estimated that there are at least 362 tanks with a total capacity of 362.9 million gallons (8.64 million barrels) across all tanks (including out of service tanks).

<sup>17</sup> The 350.6 million gallons value does not account for out of service tanks or the 102 tanks that have unknown capacity. Accordingly, the true value of total capacity is likely higher than this value. However, tanks are rarely filled to full capacity, so this total capacity value does not reflect the amount of total materials on site.

<sup>18</sup> City of Portland, *Portland Maps*, available at: portlandmaps.com

|              |                    |             |            |             |
|--------------|--------------------|-------------|------------|-------------|
| Heavy Oil    | 34,928,796         | 10%         | 29         | 7%          |
| Other        | 24,587,064         | 7%          | 50         | 12%         |
| Natural Gas  | 7,100,000          | 2%          | 1          | 0%          |
| Biodiesel    | 4,082,877          | 1%          | 10         | 2%          |
| Slop Oil     | 1,826,017          | 1%          | 16         | 4%          |
| Additive     | 702,924            | 0%          | 13         | 3%          |
| Empty        | 344,469            | 0%          | 18         | 4%          |
| Unknown      | 0                  | 0%          | 4          | 1%          |
| <b>Total</b> | <b>332,739,178</b> | <b>100%</b> | <b>415</b> | <b>100%</b> |

Source: Salus Resilience, Appendix B

Note: Out of service tanks and the tanks of unknown status in Area 4 are not included in the total.

Although total maximum tank capacity represents the maximum amount of materials that could be located at the CEI Hub, tanks are not usually filled to full capacity. Average fill levels are available for 314 tanks from the COP data. On average for the tanks with information, tanks are filled to 67 percent capacity. Tank capacity is variable, since active tanks have their contents filled and distributed regularly. The utilization of the tanks varies by day, tank, owner, material, shipments, and other factors. An assumption in this analysis is that all active tanks are filled to 67 percent capacity. Using the 67 percent fill assumption, the total contents in active tanks at is 233.5 million gallons, on average (Table 3).

Table 3. Estimated Filled Capacity of Materials at CEI Hub in Active Tanks

| Material Type | Average Expected Fill (gallons) |
|---------------|---------------------------------|
| Light Oil     | 144,738,841                     |
| Medium Oil    | 39,585,777                      |
| Heavy Oil     | 23,402,293                      |
| Other         | 16,473,333                      |
| Natural Gas   | 4,757,000                       |
| Biodiesel     | 2,808,788                       |
| Slop Oil      | 1,223,431                       |
| Additive      | 470,959                         |
| Empty         | 0                               |
| Unknown       | 0                               |
| <b>Total</b>  | <b>233,460,422</b>              |

Source: Salus Resilience, Appendix B

Note: Out of service tanks and the tanks of unknown status in Area 4 are not included in the total.

## 1-3.4 Tank Age

Of the 415 active tanks, 91 percent were built prior to 1993 or are missing information on year built, in which case they are assumed to have been built prior to 1993 (Table 4).<sup>19</sup> Tank age drives the assumptions for which tanks will fail, as described in Section 3.1.

<sup>19</sup> There were 72 tanks without a known year built and assumed to have been built prior to 1993.

Table 4. Number of Active Tanks and Year Built by Material Type

| Material Type or Status | Built before 1993 or Unknown | Built between 1993-2004 | Built after 2004 | Total      |
|-------------------------|------------------------------|-------------------------|------------------|------------|
| Medium Oil              | 142                          | 2                       |                  | 144        |
| Light Oil               | 110                          | 14                      | 6                | 130        |
| Other                   | 47                           |                         | 3                | 50         |
| Heavy Oil               | 25                           | 4                       |                  | 29         |
| Empty                   | 16                           | 2                       |                  | 18         |
| Slop Oil                | 15                           | 1                       |                  | 16         |
| Additive                | 11                           |                         | 2                | 13         |
| Biodiesel               | 10                           |                         |                  | 10         |
| Unknown                 | 4                            |                         |                  | 4          |
| Natural Gas             |                              |                         | 1                | 1          |
| <b>Total</b>            | <b>380</b>                   | <b>23</b>               | <b>12</b>        | <b>415</b> |

Source: Salus Resilience, Appendix B

### 1-3.5 Pipelines and Rail Tankers

The CEI Hub is supplied by the Olympic Pipeline which connects as far north as Bellingham, Washington and transports gasoline, diesel, and jet fuel in pipes between 12 to 20 inches in diameter (Figure 2).<sup>20</sup> There are also other pipelines connecting to the CEI Hub for fuels, including the Kinder Morgan pipeline that links petroleum terminals in the Portland region, including to the Portland International Airport. Like tanks, pipelines are also subject to potential failure due to seismic risks. For the Olympic Pipeline, breaks could occur north of the CEI Hub. Pipeline contents and the resulting risk of release vary by day. Since the material is ultimately stored in tanks at the CEI Hub, the effect of pipeline releases is partially accounted for in the tank capacity. Given these uncertainties, this analysis does consider the effects of a pipeline rupture at the CEI Hub, but focuses solely on tank capacity.

<sup>20</sup> For more information see BP Olympia Pipeline website: [https://www.bp.com/en\\_us/united-states/home/products-and-services/pipelines/our-pipelines.html#accordion\\_olympic](https://www.bp.com/en_us/united-states/home/products-and-services/pipelines/our-pipelines.html#accordion_olympic)

Figure 2. Olympic Pipeline Map



Source: BP, Olympic Overview website, available at: [https://www.bp.com/content/dam/bp/country-sites/en\\_us/united-states/home/documents/products-and-services/pipelines/olympic-overview.pdf](https://www.bp.com/content/dam/bp/country-sites/en_us/united-states/home/documents/products-and-services/pipelines/olympic-overview.pdf)

There are also railroad tankers that travel to CEI Hub properties for storage and shipment. For example, rail cars filled with Canadian tar sands crude oil are transported through the Columbia River Gorge to the CEI Hub. The crude oil is then stored in tanks before being transported to other locations, such as China, South Korea, and West Coast refineries.<sup>21</sup> Like the pipelines, the stored material from railroad tankers is accounted for in the tanks. It is beyond the scope of this analysis to also consider potential risks and economic damages associated with railroad tanker derailment due to a CSZ earthquake outside of the CEI Hub. However, the 2016 oil tanker derailment in Moiser, Oregon discussed in Section 5.1.1 provides a case study of the effects of releases of Bakken crude oil along the Columbia River.

### 1-3.6 Ground Releases

Of the 415 total active tanks, 308 are in active use and have the potential to release contents onto to the ground.<sup>22</sup> Based on location and tank age, 285 tanks have the potential to release 50 to 100 percent of their tank contents onto the ground and 23 tanks have the potential to release up to

<sup>21</sup> Friedman, G.R. (2019). Crude oil trains increasingly travel through Portland, alarming regulators. *The Oregonian*. August 29. Available at: <https://www.oregonlive.com/news/g66l-2019/04/877e9ecf591571/crude-oil-trains-increasingly-travel-through-portland-alarming-regulators.html>

<sup>22</sup> A detailed table is provided in Appendix B.



10 percent of their contents onto the ground. In total, a range of 53.9 million gallons to 111.2 million gallons would be released to ground surfaces (Table 5).

Table 5. Materials with Potential to Release to the Ground Surface

| Substance Type | Number of Tanks | Volume Released Min (gal) | Volume Released Max (gal) |
|----------------|-----------------|---------------------------|---------------------------|
| Medium Oil     | 144             | 19,506,218                | 39,069,770                |
| Light Oil      | 73              | 30,811,094                | 63,657,094                |
| Other          | 36              | 2,195,027                 | 5,241,511                 |
| Empty          | 18              | 0                         | 0                         |
| Heavy Oil      | 17              | 323,948                   | 647,895                   |
| Slop Oil       | 8               | 462,794                   | 925,588                   |
| Additive       | 7               | 146,803                   | 293,605                   |
| Biodiesel      | 3               | 436,369                   | 872,738                   |
| Natural Gas    | 1               | 0                         | 475,700                   |
| Unknown        | 1               | 0                         | 0                         |
| <b>Total</b>   | <b>308</b>      | <b>53,882,252</b>         | <b>111,183,900</b>        |

Source: Created by Salus Resilience, Appendix B

### 1-3.7 Water Releases

Based on location and tank age, 107 active tanks have the potential to release materials that could flow into the Willamette River.<sup>23</sup> Of those, 96 of these tanks have the potential to release between 50 to 100 percent of their contents to the Willamette River and 11 tanks have the potential to release up to 10 percent of their contents into the water. In total, a range of 40.8 million to 82.5 million gallons could potentially reach the water (Table 6).

Table 6. Materials with Potential to Release to the Water Surface

| Substance Type | Number of Tanks | Volume Released Min (gal) | Volume Released Max (gal) |
|----------------|-----------------|---------------------------|---------------------------|
| Light Oil      | 57              | 26,474,505                | 53,930,869                |
| Other          | 14              | 1,782,545                 | 3,565,452                 |
| Heavy Oil      | 12              | 11,290,612                | 22,598,542                |
| Slop Oil       | 8               | 148,763                   | 297,557                   |
| Biodiesel      | 7               | 968,025                   | 1,936,050                 |
| Additive       | 6               | 87,303                    | 174,881                   |
| Unknown        | 3               | 0                         | 0                         |
| <b>Total</b>   | <b>107</b>      | <b>40,751,753</b>         | <b>82,503,352</b>         |

Source: Created by Salus Resilience, Appendix B

### 1-3.8 Total Potential Releases

In total, 397 tanks could release stored materials as a result of the CSZ earthquake.<sup>24</sup> Based on tank age and location, approximately 365 tanks could release 50 to 100 percent of their materials and 32 tanks could release up to 10 percent of stored materials. Together, the total potential

<sup>23</sup> A detailed table is provided in Appendix B.

<sup>24</sup> This value excludes empty tanks from the active tanks that could release materials.

releases from the materials stored in tanks at the CEI Hub range from 94.6 million to 193.7 million gallons (Table 7). Approximately 57 percent of the total potential releases would be released onto ground and 43 percent have the potential to flow into the Willamette River.

Table 7. Summary of Total Potential Releases by Location

| Spill Location                         | Number of Tanks with 50–100 percent failure | Number of Tanks with up to 10 percent failure | Volume Released Min (gal) | Volume Released Max (gal) |
|--|---|---|---------------------------|---------------------------|
| Ground                                 | 269   | 21  | 53,882,252                | 111,183,900               |
| Water (Including potentially in water) | 96  | 11  | 40,751,753                | 82,503,352                |
| <b>Total</b>                           | <b>365</b>                                  | <b>32</b>                                     | <b>94,634,005</b>         | <b>193,687,251</b>        |

Source: Created by Salus Resilience, Appendix B

### 1-3.9 Burning Materials and Fire Potential

A fire at the CEI Hub involving the fuels stored on-site is a likely scenario following a CSZ earthquake. Many fuel storage tanks have a metal floating lid which in an earthquake could scrape against the metal perimeter, creating a spark and potentially a fire. Fires within tanks could result in large explosions, further threatening people, property, and environmental resources. There are also power lines throughout the CEI Hub which could fall due to the earthquake and serve as a potential ignition source.

Of the 393 active tanks that are not empty and have known contents at the CEI Hub, 200 tanks (approximately 51 percent), have materials that are known to be flammable (Table 8). Based on the total estimate of releases, approximately 93 percent of releases will be of flammable materials (i.e., in Category 1 through 4). The total capacity of tanks with flammable materials is 298.7 million gallons. Therefore, the contents of these tanks all have the potential to burn, either on land or in the water. Because burning requires both a fuel and an ignition source, the specific amount of materials that would burn are a function of location and event-specific factors.

Table 8. Tanks and Capacity by Flammability Category

| Flammability Category       | Number of Tanks | Volume Released Min (gal) | Volume Released Max (gal) |
|-----------------------------|-----------------|---------------------------|---------------------------|
| Category 1 (Most Flammable) | 106             | 37,987,895                | 78,549,612                |
| Category 2                  | 28              | 22,455,581                | 45,248,842                |
| Category 3                  | 66              | 27,474,245                | 55,541,111                |
| Category 4                  | 0               | 0                         | 0                         |
| Not Flammable               | 14              | 864,764                   | 1,729,889                 |
| Unknown                     | 183             | 5,851,521                 | 12,617,797                |
| Empty                       | 18              | 0                         | 0                         |
| <b>Total</b>                | <b>415</b>      | <b>94,634,005</b>         | <b>193,687,251</b>        |

Source: Created by Salus Resilience, Appendix B

# 1-4 Substance Information

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## 1-4.1 Substance Toxicities

The fuels stored at the CEI Hub are toxic, meaning that they can harm living things. Accordingly, release of these materials will be harmful to organisms that they come in to contact with through the ground, water, and/or air. The level of harm depends on the substance, the level of exposure, and the pathway of exposure. Harm to living organisms can be caused by direct physical contact – such as oil smothering plant and animals – or biochemical, which refers to the poisonous nature of the chemicals.<sup>25</sup> The chemical characteristics of petroleum substances also interact with the physical and biochemical features of the habitat where a spill occurs – meaning that the total effect is a combination of both the substance that is released as well as the environment that it is released into.

The biochemical response varies based on the specific chemical composition of the compound. Because fuels, additives, oils, and the other substances stored at the CEI Hub have different chemical compositions depending on the specific blend, they can vary in toxicity even within certain categories of substances.<sup>26</sup>

Two of the primary toxic biochemical substances associated with petroleum products are **volatile organic compounds (VOCs)** and **polycyclic aromatic hydrocarbons (PAHs)**. VOCs disperse into the air and can be toxic when inhaled. Because VOCs evaporate into the air, they are generally a concern only right after oil is spilled – oil floating on water surfaces quickly volatize and lose their VOCs. At the site of a fresh oil spill, these VOCs can threaten nearby residents, responders working on the spill, and air-breathing marine mammals.<sup>27</sup> In contrast, PAHs can persist in the environment for many years, in some cases continuing to harm organisms long after the oil first spills. Studies in Alaska and Washington suggest that PAHs are particularly harmful to fish eggs and embryos.<sup>28</sup>

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<sup>25</sup> NOAA, Office of Response and Restoration, *The Toxicity of Oil: What's the Big Deal?*. Available at: <https://response.restoration.noaa.gov/about/media/toxicity-oil-whats-big-deal.html>

<sup>26</sup> NOAA, Office of Response and Restoration, *How Toxic is Oil?*. Available at: <https://response.restoration.noaa.gov/oil-and-chemical-spills/significant-incidents/exxon-valdez-oil-spill/how-toxic-oil.html>

<sup>27</sup> NOAA, Office of Response and Restoration, *The Toxicity of Oil: What's the Big Deal?*. Available at: <https://response.restoration.noaa.gov/about/media/toxicity-oil-whats-big-deal.html>

<sup>28</sup> NOAA, Office of Response and Restoration, *How Toxic is Oil?*. Available at: <https://response.restoration.noaa.gov/oil-and-chemical-spills/significant-incidents/exxon-valdez-oil-spill/how-toxic-oil.html>

### 1-4.1.1 Toxicity by Substance

Oil is grouped into five basic groups in the Code of Federal Regulations (Table 9).<sup>29</sup> The two most common substances at the CEI Hub, gasoline and diesel, are in Group 1 and Group 2, respectively. Diesel is one of the most acutely toxic oil types and can cause high mortality rates in fish and invertebrates when released into water resources.<sup>30</sup>

Table 9. Five Basic Groups of Oil

|  |  |
|--|--|
| <b>Group 1: Non-Persistent Light Oils (Gasoline, Condensate)</b>             | Highly volatile (should evaporate within 1-2 days).<br>Do not leave a residue behind after evaporation.<br>High concentrations of toxic (soluble) compounds.<br>Localized, severe impacts to water column and intertidal resources.<br>Cleanup can be dangerous due to high flammability and toxic air hazard.   |
| <b>Group 2: Persistent Light Oils (Diesel, No. 2 Fuel Oil, Light Crudes)</b> | Moderately volatile; will leave residue (up to one-third of spill amount) after a few days.<br>Moderate concentrations of toxic (soluble) compounds.<br>Will "oil" intertidal resources with long-term contamination potential.<br>Cleanup can be very effective.  |
| <b>Group 3: Medium Oils (Most Crude Oils, IFO 180)</b>                       | About one-third will evaporate within 24 hours.<br>Oil contamination of intertidal areas can be severe and long-term.<br>Oil impacts to waterfowl and fur-bearing mammals can be severe.<br>Cleanup most effective if conducted quickly.   |
| <b>Group 4: Heavy Oils (Heavy Crude Oils, No. 6 Fuel Oil, Bunker C)</b>      | Little or no evaporation or dissolution.<br>Heavy contamination of intertidal areas likely.<br>Severe impacts to waterfowl and fur-bearing mammals (coating and ingestion).<br>Long-term contamination of sediments possible.<br>Weathers very slowly.<br>Shoreline cleanup difficult under all conditions.  |
| <b>Group 5: Sinking Oils (Slurry Oils, Residual Oils)</b>                    | Will sink in water.<br>If spilled on shoreline, oil will behave similarly to a Group 4 oil.<br>If spilled on water, oil usually sinks quickly enough that no shoreline contamination occurs.<br>No evaporation or dissolution when submerged.<br>Severe impacts to animals living in bottom sediments, such as mussels.<br>Long-term contamination of sediments possible.<br>Can be removed from the bottom of a water body by dredging. |

Source: NOAA, Office of Response and Restoration, *Oil Types*, Available at: <https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/oil-types.html>

Jet fuel is not included in the five basic groupings, but is also stored at the CEI Hub. Jet fuel is composed of light hydrocarbons with low viscosities. When spilled on open water, most of the

<sup>29</sup> Title 33, Chapter I, Subchapter O, Part 155, Subpart D. §155.1020.

<sup>30</sup> NOAA, Office of Response and Restoration, *Small Diesel Spills*. Available at: <https://response.restoration.noaa.gov/sites/default/files/Small-Diesel-Spills.pdf>



jet fuel will evaporate or naturally disperse within a day or less, leading predominantly to air quality impacts rather than aquatic impacts.<sup>31</sup> However, jet fuel can attach to fine-grained suspended sediments in the water, which then settle out and get deposited on the bottom of a waterbody. Although jet fuels are relatively less acutely toxic than diesel, high levels of mortality in animals and plants are expected where larger amounts of this type of petrochemical soak into wetland soils.

Biodiesel and non-petroleum oils, which are also stored at the CEI Hub in lower quantities, generally have low fire risk and a lower risk of biochemical toxicity, but pose a high risk of smothering to wildlife. The physical effects of coating animals and plants with oil include hypothermia, dehydration, diarrhea, starvation, or suffocation from the clogging of nostrils, throat, or gills, as well as from the reduction in water oxygen content.<sup>32</sup>

Ethanol, another substance present at the CEI Hub, is also toxic to animals through primarily physical effects. However, instead of smothering, the main risk from ethanol is lower dissolved oxygen levels which can kill fish and other aquatic species.<sup>33</sup>

## 1-4.2 Fate and Transport of Contaminants

Fate and transport refer to the outcomes of released materials – how far they go and where they end up. Because of their different chemical compositions, oils vary in terms of how they react with the environment. Depending on their density, oils that are heavier than water will sink while oils that are lighter than water will float on the surface (absent heavy disturbances). Light oils like gasoline have a density of 0.85 gram per cubic centimeter (g/cc) – most types of oils have densities between about 0.90 and 0.98 g/cc.<sup>34</sup> The density of river water is usually about 1.0 g/cc.

Heavy oils can have a density as high as 1.01 g/cc, meaning they would sink in a river. Clean up can be very difficult and disruptive to the environment for this type of spill. Methods for cleaning up heavy oil spills can include vacuuming, dredging, scraping, and other invasive methods. Because these methods directly affect the environment, they can result in relatively greater injury to habitats, species, and other natural resources.

Medium and light oils are lighter than water and, due to their volatility, will disperse into the air through evaporation. Within a few days following a spill, light crude oils can lose up to 75 percent of their initial volume and medium crudes up to 40 percent through evaporation, but

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<sup>31</sup> NOAA, Office of Response and Restoration, *Kerosene and Jet Fuel Spills*. Available at: <https://response.restoration.noaa.gov/sites/default/files/Kerosene-Jet-Fuel.pdf>

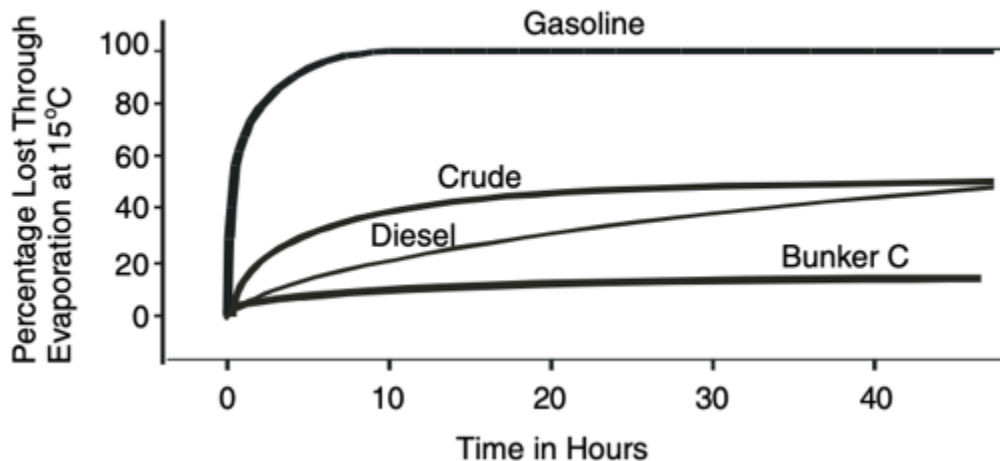
<sup>32</sup> NOAA, Office of Response and Restoration, *Non-Petroleum Oil Spills*. Available at: <https://response.restoration.noaa.gov/sites/default/files/Non-Petroleum-Oil.pdf>

<sup>33</sup> NOAA, Office of Response and Restoration, *Denatured Ethanol Spills*. Available at: <https://response.restoration.noaa.gov/sites/default/files/Denatured-Ethanol.pdf>

<sup>34</sup> NOAA, Office of Response and Restoration, *Oil Spills in Rivers*. Available at: <https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/oil-spills-rivers.html>

heavy oils will lose only 10 percent of their volume in the first few days following a spill (Figure 3).<sup>35</sup>

Figure 3. Evaporation Rates of Different Types of Oils



Source: National Research Council. (2003). *Oil in the Sea III: Inputs, Fates, and Effects*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/10388>.

After a spill occurs, how the physical and chemical characteristics of oil interact with the physical and biochemical features of the habitat is known as “weathering”. Weathering is influenced by the characteristics of the substance, including:

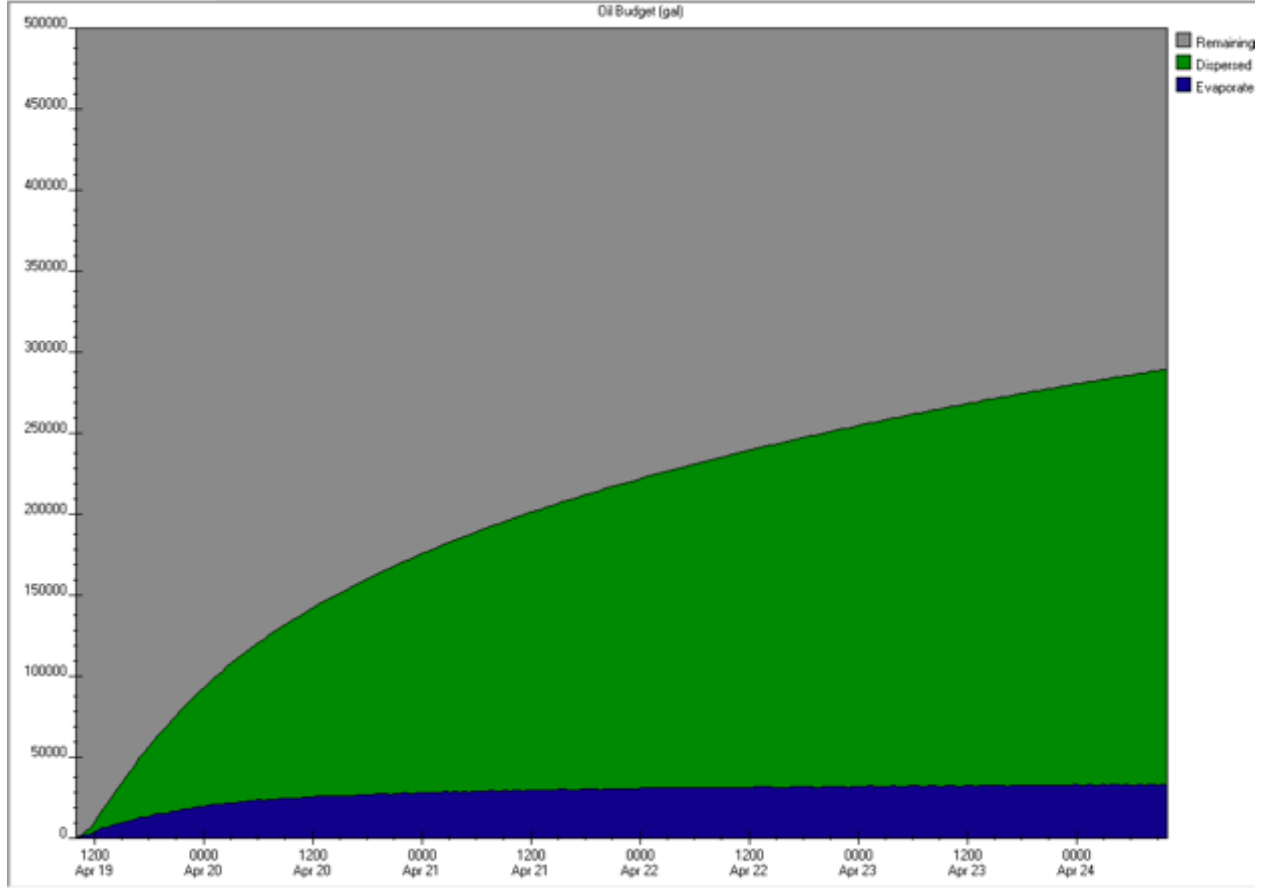
- How rapidly the substance evaporates;
- How easily the substance is broken down by microbes in the environment; and
- How rapidly sunlight degrades the substance.

Weathering can be modeled using NOAA’s Automated Data Inquiry for Oil Spills (ADIOS) that uses location- and material-specific parameters to model the results of oil releases into water environments.<sup>36</sup> For a heavy oil, like bunker, a large percentage of the oil will remain even weeks later (Figure 4). In contrast, a light oil, like gasoline, will fully disperse or evaporate within 1 or 2 days (Figure 5).

<sup>35</sup> National Research Council. (2003). *Oil in the Sea III: Inputs, Fates, and Effects*. Washington, DC: The National Academies Press.

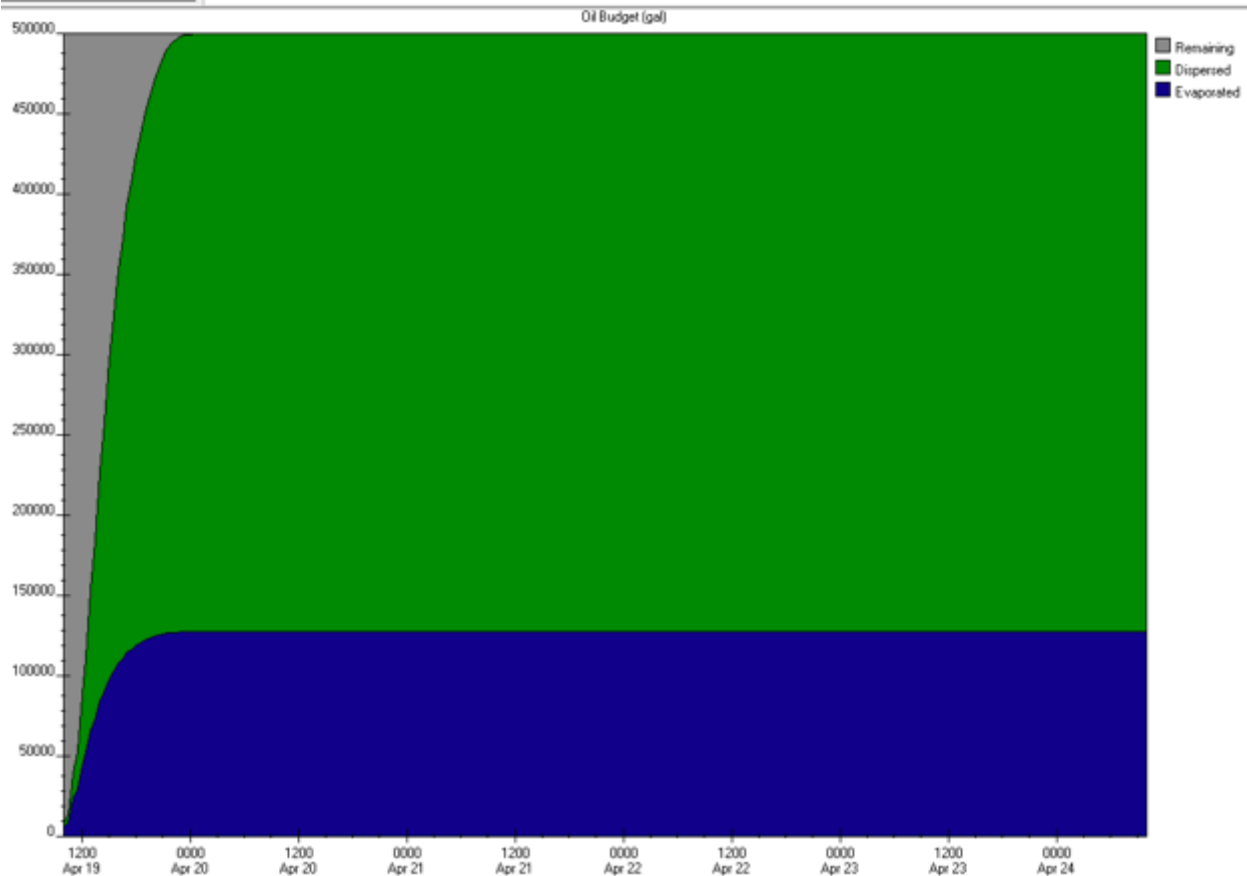
<sup>36</sup> More information about the ADIOS model can be found at: <https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/adios.html>

Figure 4. Weathering of Heavy Oil (Bunker), NOAA ADIOS Model Results



Source: NOAA ADIOS® (Automated Data Inquiry for Oil Spills) Model

Figure 5. Weathering of Light Oil (Diesel), NOAA ADIOS Model Results



Source: NOAA ADIOS® (Automated Data Inquiry for Oil Spills) Model

Materials that are dispersed through the water column are not easily recoverable via clean-up. Dispersed and remaining materials will continue to interact with the environment in which they reside through oxidation, biodegradation, and emulsification, defined as follows:<sup>37</sup>

- **Oxidation** is when water and oxygen combine with oil to produce water-soluble compounds. This process affects oil slicks mostly around their edges. Thick slicks may only partially oxidize, forming *tar balls*. These dense, sticky, black spheres may linger in the environment, and can collect in the sediments of slow-moving streams or lakes or wash up on shorelines long after a spill.
- **Biodegradation** occurs when micro-organisms such as bacteria feed on oil. A wide range of micro-organisms is required for a significant reduction of the oil. As a clean-up method to support biodegradation, nutrients such as nitrogen and phosphorus are

<sup>37</sup> Environmental Protection Agency. (No Date). *The Fate of Spilled Oil*. Retrieved from <https://archive.epa.gov/emergencies/content/learning/web/html/oilfate.html#:~:text=Evaporation%20occurs%20when%20the%20lighter,sink%20to%20the%20ocean%20floor.>



sometimes added to the water to encourage the micro-organisms to grow and reproduce. Biodegradation tends to work best in warm water environments.

- **Emulsification** is a process that forms *emulsions*, a mixture of small droplets of oil and water. Emulsions are formed by wave action, and greatly hamper weathering and cleanup processes. Two types of emulsions exist: water-in-oil and oil-in-water. Water-in-oil emulsions formed when strong currents or wave action causes water to become trapped inside viscous oil. These emulsions may linger in the environment for months or even years. Emulsions cause oil to sink and disappear from the surface, which give the false impression that it is gone and the threat to the environment has ended.

### 1-4.3 Oil Spill Clean-Up

Clean-up actions following oil spills in water resources fall generally into three categories depending on the weathering characteristics of the released substance(s):

- **Containment without removal:** Generally performed for volatile substances like light fuels that will naturally quickly evaporate or disperse and often is done using booms. Because the oil remains on the surface, this is an effective method.
- **Containment with removal:** Generally used with heavier fuels, such as through accelerated biodegradation, use of skimmers, use of sorbents (materials to soak up liquids), use of dispersants, and in situ burning.<sup>38</sup>
- **Intensive removal:** Intensive removal includes dredging and scraping vegetation and soils, as well as direct removal of oil residues from animals.

Clean-up on shorelines or other land depends on the habitat characteristics. Clean-up responses are time-sensitive to prevent the runoff of substance into water resources. Containment methods can be used to minimize this risk. Natural processes of evaporation, oxidation, and biodegradation also occur for spills on land. Physical clean-up methods can include wiping with sorbent materials, pressure washing, raking, and bulldozing, as well as burning – with proper disposal after materials have been removed from the site.<sup>39</sup>

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<sup>38</sup> EPA Office of Emergency and Remedial Response. (1999). *Understanding Oil Spills and Oil Spill Responses*.

<sup>39</sup> EPA Office of Emergency and Remedial Response. (1999). *Understanding Oil Spills and Oil Spill Responses*.

# 1-5 Case Studies of Other Fossil Fuel Infrastructure Failures

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Other fossil fuel releases provide examples of the effects of releases in different environments and for different substances. This section describes other fossil fuel infrastructure failures, their effects, and their associated damages. These case studies are not meant to be comprehensive of all instances of fossil fuel failures and oil spills. Rather, it provides examples that can be used to understand the potential effects of fuel releases at the CEI Hub. Failures at the CEI Hub due to a CSZ earthquake have the potential to result in the largest oil spill in U.S. history. Estimates of releases are the same magnitude as what was released in the Deepwater Horizon spill – the largest oil spill in U.S. waters to date.

## 1-5.1 Case Study Details

The case studies are organized into four categories:

- Case studies of fuel releases in Oregon;
- Case studies of fuel releases in river shipping channels and water resources;
- Case studies of other fuel releases at tank farms, near sensitive habitat, or due to earthquakes.

### 1-5.1.1 Fuel Releases in Oregon

There have been spills of other fossil fuels in Oregon, particularly related to road and rail incidences. A failure at the CEI Hub would be more than ten times larger than the previous largest oil spill that occurred in 1984. An oil spill on the scale of the potential releases at the CEI Hub is unprecedented. In terms of the environmental effects of the spill, the guidance from the Clean Water Act and the Oregon Department of Environmental Quality highlights how even minimal oil releases require a response to minimize damages. Any amount of oil spilled into water and spills over 42 gallons on land must be reported to emergency services in Oregon.<sup>40</sup>

#### 1-5.1.1.1 Lindsey Lake Tanker Spill near Hood River, OR (2019)

On February 11, 2019, a tanker truck carrying winter-grade diesel fuel overturned on Interstate 84 near Hood River, Oregon. An estimated 4,400 gallons of winter blend diesel were spilled onto the roadway, approximately half of which flowed into the partially frozen Lindsey Lake

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<sup>40</sup> Oregon Department of Environmental Quality, *How To Report A Spill*. Available at: <https://www.oregon.gov/deq/Hazards-and-Cleanup/env-cleanup/Pages/How-To-Report-A-Spill.aspx#:~:text=The%20National%20Response%20Center%3A%201%2D800%2D424%2D8802&text=Where%20is%20the%20spill%3F,What%20spilled%3F>

nearby.<sup>41</sup> Lindsey Lake is hydraulically connected to the Columbia River as well as a known salmon spawning lake habitat, making the spill a threat to the greater regional ecosystem. As part of containment, responders placed a boom on the lake to protect spawning locations and sensitive vegetation.<sup>42</sup> In addition, impacted snow was collected and monitoring wells were installed to further determine environmental damage. Oregon Department of Environmental Quality (DEQ) issued the operating party Space Age Fuel a civil penalty of \$66,000 for environmental damages.<sup>43</sup> As of October 22, 2019, the cleanup cost to date was \$3.4 million.<sup>44</sup>

#### 1-5.1.1.2 Columbia River Oil Train Derailment near Mosier, OR (2016)

On June 3, 2016 an oil train derailed near Mosier, Oregon, resulting in the discharge of 47,000 gallons of Bakken crude oil approximately 600 feet from the Columbia River.<sup>45</sup> Four train cars caught fire and the fire was extinguished the next day. The incident resulted in the closure of I-84 (10 hours) and the rail line, as well as a nearby park. People were evacuated from their homes, and damage to the city's wastewater system prevented residents from using water for three days.

The day after the incident, an oil sheen on the Columbia River prompted the use of booms for containment. Within a few days, the sheen dissipated with no further cleanup beyond the containment booms. There were no observed effects on wildlife from the incident.<sup>46</sup> Air quality monitoring began the day of the incident. In the immediate area of the derailment, there were detected levels of Benzene, Hexane, O<sub>2</sub>, PM<sub>2.5</sub>, and VOC.<sup>47</sup> More broadly, PM<sub>10</sub>, O<sub>2</sub>, PM<sub>2.5</sub>, and VOCs were detected as far as 3 miles away.<sup>48</sup>

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<sup>41</sup> U.S. Environmental Protection Agency. (No Date). *Lindsey Lake Tanker Truck Spill*. Available at: [https://response.epa.gov/site/site\\_profile.aspx?site\\_id=14106](https://response.epa.gov/site/site_profile.aspx?site_id=14106)

<sup>42</sup> Oregon Department of Environmental Quality. (2019). *Presentation to the Environmental Quality Commission*. November 15. Available at: [https://www.oregon.gov/deq/EQCdocs/11152019\\_EmergencyResponse\\_Slides.pdf](https://www.oregon.gov/deq/EQCdocs/11152019_EmergencyResponse_Slides.pdf)

<sup>43</sup> Oregon Department of Environmental Quality. (2020). *Notice of Civil Penalty Assessment and Order Case No. LQ/SP-ER-2019-296*. April 24. Available at: <https://www.oregon.gov/deq/nr/0420SpaceAgeFuel.pdf>

<sup>44</sup> Oregon Department of Environmental Quality. (2019). *Presentation to the Environmental Quality Commission*. November 15. Available at: [https://www.oregon.gov/deq/EQCdocs/11152019\\_EmergencyResponse\\_Slides.pdf](https://www.oregon.gov/deq/EQCdocs/11152019_EmergencyResponse_Slides.pdf)

<sup>45</sup> U.S. Environmental Protection Agency, Region 10. (2016). *Mosier Oil Train Derailment*. Available at: [https://response.epa.gov/site/site\\_profile.aspx?site\\_id=11637](https://response.epa.gov/site/site_profile.aspx?site_id=11637)

<sup>46</sup> U.S. National Response Team. (2016). *Mosier Oil Train Derailment*. Available at: <https://nrt.org/site/download.ashx?counter=4472>

<sup>47</sup> Center for Toxicology and Environmental Health. (2016). *Mosier Unit Train Derailment Mosier, OR Preliminary Summary of Air Monitoring Results June 5, 2016*. Available at: <https://www.deq.state.or.us/Webdocs/Forms/Output/FPController.ashx?SourceIdType=11&SourceId=6115&Screen=Load>

<sup>48</sup> Center for Toxicology and Environmental Health. (2016). *Mosier Unit Train Derailment Mosier, OR Preliminary Summary of Air Monitoring Results June 5, 2016*.

### 1-5.1.1.3 Tanker SS MobilOil, Columbia River, OR (1984)

On March 19, 1984, the oil tanker SS MobilOil grounded on the Columbia River near St. Helens. The National Transportation Safety Board determined the cause to be a steering gear failure which forced the ship to run aground on a rocky reef.<sup>49</sup> The reef ripped open four holding tanks and released an estimated 170,000 gallons of heavy residual oil, number six fuel oil, and industrial fuel oil into the river.<sup>50</sup> Oil was spread along the Washington and Oregon coastal shoreline as far south as Cannon Beach and as far north as the entrance to the Strait of Juan de Fuca.

The containment and cleanup effort involved 60 people who used booms to block moorings and marinas. The total cleanup cost was estimated at \$3 million, and the cost to repair the tanker was estimated at \$5 million.<sup>51</sup> After the spill, there were many dead waterbirds in the area.

### 1-5.1.2 Fuel Releases into Shipping Channels and Water Resources

The CEI Hub is along the Willamette River, a shipping channel for accessing the Port of Portland and other port facilities. Previous incidents of oil spills in river shipping channels demonstrate not only the environmental effects of discharge into water and riparian habitats but also the economic impact that results from the closure of shipping lanes.

#### 1-5.1.2.1 Refugio Incident near Gaviota, CA (2015)

The Refugio Incident near Gaviota, California was a pipeline oil spill located north of Refugio State Beach in Santa Barbara County, California. On May 19, 2015, Line 901, a 10.6-mile pipeline owned by Plains All American Pipeline, ruptured and spilled over 123,000 gallons of crude oil.<sup>52</sup> Over 53,000 gallons of the spilled oil ended up in the Pacific Ocean, where it caused death and disruption to wildlife and vegetation, as well as other environmental damages.<sup>53</sup> The oil reached

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<sup>49</sup> Speich, S.M., and Thompson, S.P. (1987). *Impacts on Waterbirds from the 1984 Columbia River and Whidbey Island, Washington, Oil Spills*. Available at: <https://sora.unm.edu/sites/default/files/journals/wb/v18n02/p0109-p0116.pdf>

<sup>50</sup> U.S. Department of Energy Office of Scientific and Technical Information (1984). *Marine accident report - grounding of United States Tankship SS MOBIL OIL, in the Columbia River near Saint Helens, Oregon, March 19, 1984*. Available at: <https://www.osti.gov/biblio/5742109-marine-accident-report-grounding-united-states-tankship-ss-mobiloil-columbia-river-near-saint-helens-oregon-march>

<sup>51</sup> U.S. Department of Energy Office of Scientific and Technical Information. (1984). *Marine accident report - grounding of United States Tankship SS MOBIL OIL, in the Columbia River near Saint Helens, Oregon, March 19, 1984*.

<sup>52</sup> Anderson, M. (2020). *Refugio Beach Oil Spill Draft Damage Assessment and Restoration Plan/ Environmental Assessment Presentation*. May 13. Available at [https://pub-data.diver.orr.noaa.gov/admin-record/6104/DARPPublicMeetingMAndersonIntroOverviewSlides\\_5-13-20\\_forwebposting.pdf](https://pub-data.diver.orr.noaa.gov/admin-record/6104/DARPPublicMeetingMAndersonIntroOverviewSlides_5-13-20_forwebposting.pdf)

<sup>53</sup> NOAA. (2015). *Refugio Beach Oil Spill*. Available at <https://darrp.noaa.gov/oil-spills/refugio-beach-oil-spill>; National Oceanic and Atmospheric Administration (NOAA). (2020). *Draft Restoration Plan to Support Recovery of Natural Resources Following Refugio Beach Oil Spill*. April 22. Available at: [https://pub-data.diver.orr.noaa.gov/admin-record/6104/20200422\\_FINAL%20DARP%20Press%20Release.mediaready.pdf](https://pub-data.diver.orr.noaa.gov/admin-record/6104/20200422_FINAL%20DARP%20Press%20Release.mediaready.pdf)

other beaches as far south as Los Angeles County.<sup>54</sup> In March of 2020, nearly five years after the incident, a \$22.3 million settlement was authorized through the Damage Assessment and Restoration Plan and Environmental Assessment.

The spill impacted recreation, commercial fisheries, and closed beaches. Recreation closures occurred at Refugio State Beach (1 month)<sup>55</sup> and El Capitán State Beach (2 months).<sup>56</sup> The Draft Restoration Plan estimates over 140,000 lost recreational user-days valued at \$3.9 million.

Air quality monitoring began the day after the spill for approximately one month for VOCs, benzene, hexane, toluene, atmospheric flammability as a percent of the lower explosive limit, and hydrogen sulfide (H<sub>2</sub>S).<sup>57</sup> The air monitoring did not detect crude oil-associated compounds that exceeded U.S. Environmental Protection Agency standards for VOCs. As such, the assessment determined no human health risks from these airborne compounds. Of note is that there was no fire or ignition of VOCs from the event.

#### 1-5.1.2.2 TX City Y Spill in Houston Channel, TX (2014)

On March 22, 2014, the bulk carrier M/V Summer Wind collided with the oil tank-barge Kirby 27706 in Galveston Bay near Texas City, Texas. As a result, the barge spilled approximately 168,000 gallons of intermediate fuel oil into lower Galveston Bay, the majority of which then flowed into the Gulf of Mexico.<sup>58</sup> Most of the discharged oil was on shorelines between Galveston and Matagorda Islands.<sup>59</sup> Damages and impacts for this incident are still being evaluated, but the release caused the closure of the heavily trafficked Port of Houston for 3 days.<sup>60</sup> As of 2015, PAHs from the oil spill continue to pose environmental risks in the marine environment.<sup>61</sup> In 2016, Kirby Island Marine L.P. agreed to pay \$4.9 million in Clean Water Act civil penalties due to the incident.<sup>62</sup>

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<sup>54</sup> NOAA. (2020). *Draft Restoration Plan to Support Recovery of Natural Resources Following Refugio Beach Oil Spill*. April 22.

<sup>55</sup> Rocha, Veronica (2015). "El Capitan beach to reopen a month after Santa Barbara County oil spill". *Los Angeles Times*. June 19.

<sup>56</sup> Moore, J.C. (2015). "Refugio State Beach to reopen today after oil-spill closure". *Ventura County Star*. July 17.

<sup>57</sup> Center for Toxicology and Environmental Health, LLC. (2015). *Community Air Monitoring and Sampling Summary: Refugio Incident*. June 15.

<sup>58</sup> NOAA, Office of Response and Restoration. (2014). *Texas City Y Oil Spill*. Available at: <https://darrp.noaa.gov/oil-spills/texas-city-y>

<sup>59</sup> Yin, F., Hayworth, J. S., & Clement, T. P. (2015). A tale of two recent spills—comparison of 2014 Galveston Bay and 2010 Deepwater Horizon oil spill residues. *PLoS one*, 10(2), e0118098.

<sup>60</sup> NOAA, Office of Response and Restoration. (2014). *Update on the Texas City "Y" Response in Galveston Bay*. Available at: <https://response.restoration.noaa.gov/about/media/update-texas-city-y-response-galveston-bay.html>

<sup>61</sup> Yin, F., Hayworth, J. S., & Clement, T. P. (2015). A tale of two recent spills—comparison of 2014 Galveston Bay and 2010 Deepwater Horizon oil spill residues. *PLoS one*, 10(2), e0118098.

<sup>62</sup> U.S. Department of Justice. (2016). *Kirby Inland Marine to Pay \$4.9 Million in Civil Penalties and Provide Fleet-Wide Improvements to Resolve U.S. Claims for Houston Ship Channel Oil Spill*. September 27. Available at:



### 1-5.1.2.3 Deepwater Horizon in the Gulf of Mexico (2010)

The Deepwater Horizon oil spill is the largest spill in the history of the United States. On April 20, 2010, an explosion occurred on the Deepwater Horizon drilling platform in the Gulf of Mexico, leading to the largest offshore oil spill in U.S. history. The explosion caused the rig to sink and leaked 134 million to 206 million gallons of oil into the Gulf over three months.<sup>63</sup> The initial explosion killed eleven men. The Deepwater Horizon oil spill killed thousands of marine mammals and sea turtles, and also contaminated their habitats.<sup>64</sup> Containment measures included floating booms, skimmer boats, and sorbents. Chemical dispersants were also used to facilitate oil degradation. During the spill response there was a temporary flight restriction over the area as well as on-the-ground access restrictions.

A major public health impact was air pollution. A study following the incident found four primary sources of pollutants: (a) Hydrocarbons (HCs) evaporating from the oil; (b) smoke from deliberate burning of the oil slick; (c) combustion products from the flaring of recovered natural gas; and (d) ship emissions from the recovery and cleanup operations.<sup>65</sup> Studies have noted that the air pollution impacts could have been much worse for a spill of similar size closer to populated areas, closer to the surface, or in a region with larger NO<sub>x</sub> sources.

The financial claims were largely settled when a Federal District judge approved the largest environmental damage settlement in United States history – \$20.8 billion – on April 4, 2016.<sup>66</sup> In 2016, BP calculated their total cost for the oil spill, including both damages, fines, and economic loss, as \$61.6 billion.<sup>67</sup>

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<https://www.justice.gov/opa/pr/kirby-inland-marine-pay-49-million-civil-penalties-and-provide-fleet-wide-improvements>

<sup>63</sup> United States of America v. BP Exploration & Production, Inc., et al. (2015). *Findings of fact and conclusions of law: Phase Two trial. In re: Oil spill by the oil rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010, No. MDL 2179, 2015 WL 225421.* (Doc. 14021). U.S. District Court for the Eastern District of Louisiana. Retrieved from [https://www.gpo.gov/fdsys/pkg/USCOURTS-laed-2\\_10-md-02179/pdf/USCOURTS-laed-2\\_10-md-02179-63.pdf](https://www.gpo.gov/fdsys/pkg/USCOURTS-laed-2_10-md-02179/pdf/USCOURTS-laed-2_10-md-02179-63.pdf)

<sup>64</sup> NOAA. (2017). *Deepwater Horizon Oil Spill Longterm Effects on Marine Mammals, Sea Turtles.* Available at: <https://oceanservice.noaa.gov/news/apr17/dwh-protected-species.html#:~:text=The%20scientists%20concluded%20that%20the,turtles%2C%20and%20contaminated%20their%20habitats>.

<sup>65</sup> Middlebrook, A. M., Murphy, D. M., Ahmadov, R., Atlas, E. L., Bahreini, R., Blake, D. R., & Ravishankara, A. R. (2012). Air quality implications of the Deepwater Horizon oil spill. *Proceedings of the National Academy of Sciences, 109*(50), 20280-20285.

<sup>66</sup> NOAA. (2017). *Explosion triggered economic, environmental devastation, and a legal battle.* April 20. Available at <https://www.noaa.gov/explainers/deepwater-horizon-oil-spill-settlements-where-money-went>

<sup>67</sup> BP. (2016). *2Q 2016 Results: Conference Call on July 24, 2016.* Available at: <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-second-quarter-2016-results-presentation-slides-and-script.pdf>

#### 1-5.1.2.4 Eagle Otome in Port Arthur, TX (2010)

On January 23, 2010, a barge and its towing vessel collided with the tanker Eagle Otome on the Sabine Neches Canal in Port Arthur, Texas. The Eagle Otome was punctured and an estimated 462,000 gallons of Olmeca crude sour oil was spilled into the canal.<sup>68</sup> The spill caused a shipping lane closure of 16 miles and impacted local residents, 136 of whom were temporarily evacuated from the site. Clean up responses at the crash site were delayed for approximately 12 hours due to high levels of hydrogen sulfide. Air monitoring beyond the immediate area did not indicate the presence of hydrogen sulfide, but there was a strong petroleum odor. The spill resulted in \$1.5 million in damages to the Eagle Otome, \$35,000 to the towing vessel, and \$381,000 to the barge vessel.

#### 1-5.1.2.5 Enbridge Line 6B in the Kalamazoo River, MI (2010)

On July 25, 2010, a rupture in the Enbridge line 6B pipeline caused oil to leak into the wetlands adjacent to the Kalamazoo River in Michigan. The leak consisted of two batches of heavy bituminous crude oil diluted with lighter petroleum products.<sup>69</sup> It was several hours before the leak was discovered in which time several residents had called the local health department complaining from a heavy oil smell in the air. The spill flowed downstream 38 miles.

Containment and recovery were ongoing for the next four years. Responders installed oil absorbent and a boom at two parks near battle Creek and used vacuum trucks to recover oil from the source area. The Kalamazoo River was closed to the public for 1.5 years, then periodically opened and closed for dredging of submerged oil for the next three years. The presence of benzene and other constituents in the oil posed a respiratory threat to public health and safety. The Michigan Department of Community Health issued a Fish Consumption Advisory and a Swimming Advisory, both of which were in place until June 28, 2012.

#### 1-5.1.2.6 DM932 Tanker and Barge Collision near New Orleans, LA (2008)

On July 23, 2008, tanker Tintomara collided with fuel barge DM932 on the Mississippi River near downtown New Orleans. The Tintomara suffered minor damage, but the DM932 barge split into two sections, releasing 270,000 gallons of spilled #6 fuel oil into the Mississippi River.<sup>70</sup> Response to the spill required 2,300 personnel, 130,000 feet of containment boom, 200 boats, and 35 skimmers.<sup>71</sup>

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<sup>68</sup> National Transportation Safety Board. (2010). *Collision of Tankship Eagle Otome with Cargo Vessel Gull Arrow and Subsequent Collision with the Dixie Vengeance Tow Sabine-Neches Canal, Port Arthur, Texas*. January 23. Available at: <https://maritimesafetyinnovationlab.org/wp-content/uploads/2015/02/ntsb-eagle-otome-collision-2010.pdf>

<sup>69</sup> [https://www.fws.gov/midwest/es/ec/nrda/MichiganEnbridge/pdf/FinalDARP\\_EA\\_EnbridgeOct2015.pdf](https://www.fws.gov/midwest/es/ec/nrda/MichiganEnbridge/pdf/FinalDARP_EA_EnbridgeOct2015.pdf)

<sup>70</sup> NOAA, Damage Assessment, Remediation, and Restoration Program. (2008). *Fuel Barge DM 932*. Available at: <https://darrp.noaa.gov/oil-spills/fuel-barge-dm932>

<sup>71</sup> Simmons, R. (2009). *Tank Barge DM 932 Spill: Response from the Perspective of the "Environmental Unit"*. Available at: <https://archive.epa.gov/emergencies/content/fss/web/pdf/simmons.pdf>

Oil from the barge spread over 100 miles of the lower Mississippi River. More than 130,000 gallons of an oil and water mix were recovered.<sup>72</sup> The river was temporarily closed to vessel traffic for 8 hours to lift the barge out of the water. The incident impacted terrestrial and riparian habitats in the over 100-mile span. In addition, the sediments at the bottom of the river were contaminated.

#### 1-5.1.2.7 M/V Westchester in Plaquemines Parish, Louisiana (2000)

On November 28, 2000, the M/V Westchester tanker lost steerage and grounded in Plaquemines Parish, Louisiana. The initial loss of steerage was due to a crankcase explosion onboard.<sup>73</sup> The grounding punched a hole in the cargo tank and an estimated 550,000 gallons of crude oil spilled into the Mississippi River.

Containment measures included placing booms at key bayous and cuts and deploying skimmers to collect oil from the water surface. The case is notable for its efficient recovery of lost oil which was aided by the riprap on the west bank which trapped the oil. Vessel traffic on the Mississippi River was halted the next day for 21 river miles. The river was reopened to inbound traffic one day later on November 30, 2000 and was opened to both up-river and down-river traffic on December 1, 2000.<sup>74</sup> Several thousand acres of terrestrial, riparian, and oceanic habitat were impacted by the spill. The spill exposed flora and fauna in these areas to black oil, emulsified oil, and sheen. Approximately 19,000 kilograms of finfish and shellfish biomass were lost through direct kill and lost production. In addition, recreation fishing and waterfowl hunting were affected by closures and limited access to boat launch points.

#### 1-5.1.3 Other Fuel Releases

Failure and fuel releases at the CEI Hub would not only flow into the Willamette River, but also affect the ground resources. The case studies in this section include others at fuel tank farms as well as fuel releases caused by earthquakes. In addition to the effect on terrestrial resources, these incidents also demonstrate the potential for fire and air quality hazards that could result from fossil fuel tank failures.

##### 1-5.1.3.1 Savoonga AVEC Tank Farm in Savoonga, AK (2021)

On February 27, 2021, a bulk oil storage tank located at Savoonga Power Plant, operated by Alaska Village Electric Coop, spilled while fuel was being transported between tanks. The power plant is located on St. Lawrence Island, 450 feet from the Bering Sea. The tank leaked an

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<sup>72</sup> NOAA. (2000). *Tanker and Barge Collision in New Orleans, LA Update August 4, 1000 EDT*. Available at: <https://incidentnews.noaa.gov/incident/7861/521838/8929>

<sup>73</sup> Michel, J., Henry Jr, C. B., & Thumm, S. (2002). Shoreline assessment and environmental impacts from the M/T Westchester oil spill in the Mississippi River. *Spill Science & Technology Bulletin*, 7(3-4), 155-161.

<sup>74</sup> NOAA. (2001). *Final Damage Assessment/Restoration Plan and Environmental Assessment: M/V Westchester Crude Oil Discharge*. Available at: <https://www.gc.noaa.gov/gc-rp/west-fnl.pdf>

estimated 20,000 gallons of #2 Diesel into secondary containment.<sup>75</sup> A valve left open on a bulk fuel tank caused the leak. The valve was closed and investigators determined there was no environmental impact – oil did not flow into the Bearing Sea or into the nearby wetland tundra.<sup>76</sup> Containment of the spill involved excavating contaminated snow and pumping diesel fuel pooled under the snow. In addition, nine cubic feet of impacted frozen soil was chipped out with a jackhammer. There were no public closures associated with the spill due to its remote location.

#### 1-5.1.3.2 Contra Costa NuStar in Crockett, CA (2019)

On October 15, 2019, an explosion occurred at the NuStar energy fuel storage facility in Crockett, California. The facility stored ethanol, gasoline, diesel, and aviation fuels. The fire damaged two tanks containing 250,000 gallons of ethanol.<sup>77</sup> The explosion started a seven-hour-long fire which had serious health and safety effects on the region. All personnel were evacuated from the site and emergency response services were onsite within minutes. The fire consumed thousands of gallons of fuel and investigators found high levels of smoke particulates, but not unusually high amounts of toxic substances.<sup>78</sup> A small grass area also caught on fire. The fires were put out later that same day.

There was a shelter in place ordered approximately one hour after the explosion for nearby residents of Crockett and Rodeo for approximately 7 hours. Contra Costa County also issued a public health order for people in the neighboring communities of Crockett, Rodeo, and Hercules to stay indoors due to poor air quality.<sup>79</sup> Residents were advised to leave air conditioning and fans off and place damp towels in door and window openings. In addition, the twelve-home community of Tormey (located near the NuStar facility entrance) was evacuated and four schools in the area were closed for two days. Both directions of Interstate 80 near the facility were shut down for six hours to help manage the fire. The fire was eventually contained with foam.

#### 1-5.1.3.3 Great East Japan (Tohoku) Earthquake and Tsunami (2011)

The devastating Great East Japan Earthquake and Tsunami, also known as the Tohoku Event, occurred on March 11, 2011 when a magnitude 9.0 earthquake occurred about 80 miles off the

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<sup>75</sup> Alaska Department of Environmental Conservation. (2021). *Savoonga AVEC Tank Farm Diesel Oil Release*.

<sup>76</sup> McChesney, R. (2018). *No environmental impact from 22,000-gallon heating oil spill in Savoonga*. Alaska Public Media. March 18. Available at: <https://www.alaskapublic.org/2018/03/15/no-environmental-impact-from-22000-gallon-heating-oil-spill-in-savoonga/>

<sup>77</sup> Associated Press. (2019). *Earthquake probed as possible cause of California fuel fire*. October 16. Available at: <https://apnews.com/article/4b2b77c5ecec4b01b8ef6c70beeb7ca6>

<sup>78</sup> Sciacca, A. (2019). "Supes consider tightening rules over fuel storage facilities in wake of NuStar explosion". *East Bay Times*. Available at: <https://www.eastbaytimes.com/2019/10/22/concerns-about-nustar-explosion-in-crockett-prompt-contra-costa-officials-to-review-safety-ordinance/>

<sup>79</sup> Contra Costa Health. (2019). *Data Incident Report: October 15, 2019*. Available at: <https://cchealth.org/hazmat/data-incident-report/60548099.pdf>

northeast coast of Japan. Over 20,000 people died and over 500,000 were forced to evacuate. The Fukushima nuclear plant disaster is the most well-known hazardous materials release resulting from the event. However, there were also many instances of toxic substance releases, explosions, and fires resulting from failures at other industrial facilities. At some facilities, the cause of the damage was the earthquake, while at others it was the tsunami.<sup>80</sup> Excluding the costs of the Fukushima nuclear power plant failures, the total economic damages of the event exceed \$210 billion.

The Great East Japan earthquake also demonstrates the complexities of responding to oil spill events during an environmental disaster. In Ichihara City, liquefied petroleum gas tanks exploded due to ground motion and resulted in fires that spread to asphalt tanks and buildings throughout the facility that took ten days to extinguish.<sup>81</sup> In the Sendai area, a fire at a petrochemical complex, ignited by a spark caused by tank friction, burned a gasoline tank, asphalt tanks, molten sulfur tanks, and oil handling facilities. Many other oil tanks and petrochemical facilities were damaged by the tsunami and often were washed out to sea.

## 1-5.2 Case Studies Summary

The case studies in this section vary in terms of the amount of the spill, the contents spilled, and where it was spilled at. Accordingly, the extent and costs of damages and secondary effects like fires also vary as well. Of the case studies discussed in this section, the potential releases at the CEI Hub following a CSZ event will be similar to the large events, Deepwater Horizon and the Great East Japan earthquake, in terms of level of releases and resulting damages to the environment, health, and safety. Table 10 summarizes common elements for each case study.

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<sup>80</sup> Krausmann, E., & Cruz, A. M. (2013). Impact of the 11 March 2011, Great East Japan earthquake and tsunami on the chemical industry. *Natural hazards*, 67(2), 811-828.

<sup>81</sup> Zama, S., Nishi, H., Hatayama, K., Yamada, M., Yoshihara, H., & Ogawa, Y. (2012). On damage of oil storage tanks due to the 2011 off the Pacific Coast of Tohoku Earthquake (Mw9. 0), Japan. In *Proceedings of the 15th world conference on earthquake engineering (WCEE)* (Vol. 2428, pp. 1-10).



Table 10. Case Study Summary

| Case Study  | Year | Spill Amount                 | Type of Oil  | Spill Location                    | Fire Status   |
|---|------|------------------------------|--|-----------------------------------|---|
| <b>Fuel Releases in Oregon</b>                                  |      |                              |  |                                   |   |
| Oregon Lindsey Lake Tanker Spill                                | 2019 | 4,400 gallons                | Diesel fuel (Light Oil)  | Ground and freshwater             | None  |
| Columbia River Oil Train Derailment                             | 2016 | 47,000 gallons               | Bakken crude oil (Light Oil)   | Ground and freshwater             | Fire on ground  |
| Tanker SS MobilOil Spill  | 1984 | 170,000 gallons              | Number 6 Crude Oil and Industrial Fuel Oil (Light and Medium Oils)                 | Freshwater and saltwater          | None  |
| <b>Fuel Releases into Shipping Channels and Water Resources</b> |      |                              |  |                                   |   |
| Refugio Incident  | 2015 | 123,000 gallons              | Crude oil  | Freshwater and saltwater          | None  |
| TX City Y Spill   | 2014 | 168,000 gallons              | Intermediate fuel oil (Medium Oil)   | Ground, freshwater, and saltwater | None  |
| Deepwater Horizon   | 2010 | 134-206 million gallons      | Macondo crude oil (Light Oil)  | Saltwater                         | Fire on the drilling platform                               |
| Eagle Otome   | 2010 | 462,000 gallons              | Olmecca crude oil (Light Oil)  | Freshwater and saltwater          | None  |
| Enbridge Line 6B  | 2010 | Over 1 million gallons       | Diluted bitumen (Heavy Oil)  | Freshwater                        | None  |
| DM 932 Tanker   | 2008 | 270,000 gallons              | Number 6 fuel oil (Heavy Oil)  | Freshwater                        | None  |
| M/V Westchester   | 2000 | 550,000                      | Sweet Nigerian crude oil (Light Oil)   | Freshwater                        | None  |
| <b>Other Fuel Releases</b>                                      |      |                              |  |                                   |   |
| Savoonga AVEC Tank Farm   | 2021 | 20,000 gallons               | #2 Diesel (Light Oil)  | Ground                            | None  |
| Contra Costa NuStar   | 2019 | 250,000 gallons              | Ethanol (Light Oil)  | Ground                            | Fire on the ground  |
| Great East Japan (Tohoku) Earthquake and Tsunami                | 2011 | Large (exact amount unknown) | Multiple fuel types (e.g., diesel, asphalt, crude) (Light, Medium, and Heavy Oils) | Ground, freshwater, and saltwater | Multiple fires at petrochemical and fuel storage facilities |

Source: Created by ECONorthwest

## 1-5.3 Other Evaluations of Fossil Fuel Impacts Near CEI Hub

### 1-5.3.1 Tesoro Savage Petroleum Terminal at the Port of Vancouver

The Vancouver Energy Distribution Terminal Facility was proposed to be located on the Columbia River, approximately 10 miles north of the CEI Hub and would be owned and operated by the Tesoro Savage Petroleum Terminal LLC. The proposed crude oil terminal facility would have a capacity of 360,000 barrels of crude oil per day that it would receive by train, store onsite, and then load onto marine vessels to be transported to west coast refineries.

Given the proximity and the similar resources that would be transported at the Tesoro Savage Petroleum Terminal compared to what is stored at the CEI Hub, the research conducted as part of this proposal is also relevant to the potential impacts of releases at the CEI Hub due to a CSZ earthquake.

A 2016 report<sup>82</sup> evaluated impacts to fishing and natural resources from the “worst-case scenarios” from the Draft Environment Impact Statement for the proposed Vancouver Energy Distribution Terminal Facility.<sup>83</sup> The two scenarios are a tanker grounding near Vancouver that would spill over 189,845 barrels (bbls) (about 8 million gallons), and for a train derailment near the Bonneville Dam that would spill 20,000 bbls.

The authors assumed that the spill occurred during spring (between mid-April and mid-May), corresponding with peak salmon populations in the Lower Columbia River. Based on the timing assumptions as well as estimates detailed in the report about fate and transport modelling, the estimated damages to Columbia River habitats from the vessel grounding in Vancouver is \$171.3 million, including \$114.4 million for injured habitats in the river channel and \$56.9 million for injuries to floodplain wetlands adjacent to the river. The estimated damages to Columbia River habitats from the upriver train derailment scenario is \$84.9 million, including \$54.5 million for injured habitats in the river channel and \$30.4 million for injuries to floodplain wetlands adjacent to the river.<sup>84</sup>

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<sup>82</sup> Abt Associates Inc. and Bear Peak Economics. (2016). Potential Fishing Impacts and Natural Resource Damages from Worst-Case Discharges of Oil on the Columbia River. Submitted to: Matthew Kernutt, Assistant Attorney General Washington Attorney General’s Office. May 12.

<sup>83</sup> The Draft Environment Impact Statement is available at: <https://www.efsec.wa.gov/efsec-document/Tesoro%20Savage/SEPA/docGroup/Draft%20Environmental%20Impact%20Statement>

<sup>84</sup> All dollar values from Abt Associates Inc. and Bear Peak Economics are 2016 values.

# 1-6 Direct Impacts of a CSZ Earthquake on the CEI Hub

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The direct impacts of a CSZ earthquake on the CEI Hub and the resulting effects on the surrounding people, property, and environment will likely be exacerbated by the surrounding destruction of the event. Roads, bridges, and many other infrastructure types will be damaged in the earthquake, which will likely impair access to the site to take actions like fire suppression, rescues, containment, monitoring, and other immediately needed steps to minimize the damage from releases. Absent any failures of the CEI Hub and associated fuel releases, there would still be threats to people, property, and the environments from the earthquake. For example, commercial and recreational river activity would likely be impacted from an earthquake due to accessibility and hazards for a period of time, even without any releases from the CEI Hub. The intent of this analysis is to include only effects that are attributable to containment failures at the CEI Hub, and not impacts from the earthquake in general.

The impacts that could be attributable to releases at the CEI Hub that are evaluated in this analysis include:

- Loss of life and injuries directly related to releases at the CEI Hub site or adjacent parcels;
- Effects on navigation and river-related commercial activity;
- Short-term and long-term effects on the environment;
- Short-term and long-term effects from air quality impacts;
- Impacts to cultural resources.

## 1-6.1 Earthquake Considerations

Impacts from CEI Hub releases will vary both on the magnitude of the earthquake, the extent of releases, if a fire occurs, and the ability to respond quickly to contain releases. Spill response will be a primary determining factor in how quickly the releases are contained and how far they spread, particularly for releases into the water. Spill responses usually occur as soon as a spill is reported to the spill response team.<sup>85</sup> However, response actions to fuel releases resulting from the CSZ earthquake will likely be substantially delayed due to damaged infrastructure and resource shortages.

The Cascadia Playbook from Oregon Office of Emergency Management suggests that Regional Hazardous Materials Emergency Response Teams (RHMERT) will be contacted within 6 hours

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<sup>85</sup> The Lower Columbia Spill Response Plan, as well as all the response plans associated with Region 10 Regional Response Team (RRT) and the Northwest Area Committee (NWAC) is available at: <https://www.rrt10nwac.com/GRP/>

after an event where oil and hazardous materials need to be controlled and contained.<sup>86</sup> Initiating containment of oil and hazardous materials spills or releases in impacted areas is estimated to begin 24 hours after the event. While these timelines represent best practices, there are potential impediments to a rapid response particularly around access, personnel and resource availability, and other hazards present at the site, each of which are discussed below.

**Prior Characterizations of Responding to CEI Hub Failures After a CSZ Event from OSSPAC (2019)<sup>87</sup>**  
“Other large-scale catastrophes would be unfolding throughout the City and region. Emergency response personnel would struggle to address the disaster occurring at the CEI Hub because roads, bridges, utilities, and communication systems would be damaged or destroyed. And recovery vehicles would be unable to access and use the very fuel that spills from the CEI Hub’s tanks.”

### 1-6.1.1 Access Considerations

Access to the CEI Hub via road or river may be difficult or dangerous due to damage to roads and infrastructure. Following the CSZ earthquake, reopening Tier 1 and Tier 2 state highways in the Willamette Valley will take approximately 1 to 3 days.<sup>88</sup> Access via waterway will also be complicated due to the CSZ earthquake. Structures such as bridges and piers may collapse into the waterway, posing hazards for both access and containment. Access to boat launches may similarly be restricted, causing delays.

### 1-6.1.2 Personnel and Resource Availability

The CEI Hub will not be the only area with hazardous releases due to a CSZ earthquake. Release of hazardous materials could also occur from train derailments or damage to vessels. Within the Lower Columbia River, there are additional fuel storage facilities at the NuStar and Tesoro terminals in the Port of Vancouver. There are also other fuel storage facilities in surrounding areas which could have spills due to the CSZ earthquake. Accordingly, resources may be thinly spread throughout these response sites and spills either at the CEI Hub or other locations may extend further than they would have if resources were not constrained by the coinciding incidents.

### 1-6.1.3 Release of Toxic Inhalation Hazard Materials

As defined by the Hazardous Materials Regulations, toxic inhalation hazard materials (TIH materials) are gases or liquids that are known or presumed on the basis of tests to be so toxic to humans as to pose a hazard to health in the event of a release.<sup>89</sup> Chlorine gas and anhydrous ammonia are the most common TIH chemicals. Other TIH chemicals include sulfur dioxide,

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<sup>86</sup> Oregon Office of Emergency Management. (2018). *Cascadia Playbook Version 3.0*. Retrieved from [https://www.oregon.gov/oem/emresources/Plans\\_Assessments/Pages/Other-Plans.aspx](https://www.oregon.gov/oem/emresources/Plans_Assessments/Pages/Other-Plans.aspx)

<sup>87</sup> Oregon Seismic Safety Policy Advisory Commission of the State of Oregon (OSSPAC). (2019). *CEI Hub Mitigation Strategies: Increasing Fuel Resilience to Survive Cascadia*. December 31. OSSPAC Publication 19-01.

<sup>88</sup> Oregon Seismic Safety Policy Advisory Commission (OSSPAC). (2013). *The Oregon Resilience Plan: Chapter 5. Transportation*. February.

<sup>89</sup> 49 CFR parts 171-180.

ethylene oxide, hydrogen fluoride, and others. Although not stored at the CEI Hub itself, TIH materials are present within the area near the CEI Hub. Evaluating the effect of these chemical releases is beyond the scope of this study, however, the release of those materials due to a CSZ earthquake could complicate spill response efforts at the CEI Hub. In particular, release of TIH materials could limit access to respond to the spill if the presence of TIH substances renders the area too dangerous for emergency personnel.

## 1-6.2 Direct Impacts to People and Property

### 1-6.2.1 Risk of Harm to People Near the CEI Hub

There are 10 companies on 31 properties located at the CEI Hub that vary in size from 0.1 to 31.27 acres for a total of 219.85 acres.<sup>90</sup> On average there, are 0.8 full-year equivalent workers per acre,<sup>91</sup> for a total of approximately 200 people on-site throughout the CEI Hub properties. Including the adjacent properties to CEI Hub parcels there are 1,400 acres of land, suggesting approximately 1,100 workers. More generally, the zip codes where the CEI Hub is located (97231 and 97210) have a total combined population of 16,508 and total employment of 31,517.<sup>92</sup> In addition to the physical presence of these people, there are also people driving through for personal or business reasons and river-related transport that could put people at risk from CEI Hub failures from a CSZ earthquake.

The potential for CEI Hub failures to impact people and cause injury or loss of life will depend in part on when the event happens – if it happens on a weekday or weekend, during the day or at night, and what season – since that will influence how many people are working in and around the site. During weekends and at night, there will be fewer people in the area based on use patterns. Similarly, during the winter there may be fewer people on the water compared to a sunny day at the height of the fishing season.

Industrial fuel fires from other locations provide a sense of the potential scale and damage that could occur from CEI Hub failures due to a CSZ earthquake. One of the largest onshore industrial disasters was the BP America Refinery Explosion in Texas City, Texas in 2005. The series of large explosions and fire was caused by buildup of flammable liquid gas. A total of 18 people were killed and 180 were injured. A shelter-in-place order was issued that required 43,000 people to remain indoors. Houses were damaged as far away as three-quarters of a mile from the refinery.<sup>93</sup> There were 2,600 employees located on the 1,200 acre site at the time of the

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<sup>90</sup> See Appendix B for a full list of properties and their characteristics.

<sup>91</sup> Oregon Quarterly Census of Economics and Wages (QCEW). QCEW contains confidential information and was available for this study through a data use agreement with the Oregon Employment Department. All results are aggregated and reported in a way that maintains confidentiality standards.

<sup>92</sup> IMPLAN 2019 Study Area Data for Combined Zip Codes 97231 and 97210.

<sup>93</sup> U.S. Chemical Safety and Hazard Investigation Board. (2007). *Investigation Report Refinery Explosion and Fire: BP, Texas City, Texas*. March 23. Report No. 2005-04-I-TX. Available at: <https://www.csb.gov/bp-america-refinery-explosion/>



explosion – meaning that 0.6 percent of people were killed and 6.9 percent of people were injured from the event.

Another oil refinery explosion occurred in 2016 at the ExxonMobil Refinery in Baton Rouge, Louisiana. This incident was caused by the release of isobutane vapors that were ignited by a nearby welding machine. Six workers were injured and/or burned from the explosion. There were 3,000 maximum people on site when the event occurred, suggesting a 0.2 percent injury rate for the 2,100-acre facility.

The CEI Hub and adjacent properties represents an area of approximately 1,500 acres with an estimated 1,200 workers (based on the 0.8 workers per acre estimate).<sup>94</sup> This area is 25 percent lower than the BP site and 40 percent higher than the Exxon Mobile site. Applying the injury and mortality rate from the two incidents to the CEI Hub and adjacent properties suggests that between 0 to 7 people could be killed and 2 to 80 people could be injured.

Table 11. Injury and Morality Rates and Estimates for Number of People Affected in the CEI Hub Area

|                                    |      | <b>Estimate of People Affected in the CEI Hub Area (1,200 people on 1,500 acres)</b> |
|------------------------------------|------|--|
| <b>BP Mortality Rate (Low)</b>     | 0%   | 0  |
| <b>Exxon Mortality Rate (High)</b> | 0.6% | 7  |
| <b>BP Injury Rate (Low)</b>        | 0.2% | 2  |
| <b>Exxon Injury Rate (High)</b>    | 6.9% | 80   |

Source: Created by ECONorthwest

These two incidents inform potential low and high estimate of injury and mortality that could occur from explosions or fires at CEI Hub due to a CSZ event. However, estimates of injury and mortality are highly uncertain since any explosions or fires are difficult to predict if and when they will occur and be contained. The two example incidents are at oil refineries and are therefore processing facilities, rather than storage facilities like the CEI Hub. Despite these uncertainties, applying the injury and mortality rates provides an order of magnitude estimate of the potential harm to people. A fire that spreads throughout the CEI Hub and any adjoining areas could pose a higher threat of mortality and morbidity. A fire without an explosion that is quickly contained would post a lower threat.

In the event that there are also fires at the CEI Hub or at nearby industrial sites, which are likely to occur, people and property will be further threatened by direct fire risk as well as air quality health impacts. Evacuations will be extremely challenging during this time due to ground damage, potential impacts to the telecommunication network, and strained emergency response resources. Fire response resources may not be able to immediately address the blazes at these locations, which could result in the fire spreading throughout the area. Of note, burning is sometimes a clean-up mechanism used for oil spills, so fuel ignition could decrease the amount of oil that contaminates the environment via land or water. Air quality impacts are discussed further in Section 6.5 of this report.

<sup>94</sup> Oregon Quarterly Census of Economics and Wages, by permission.

A March 12, 2019 fire at NW Metals Inc. in Portland demonstrates the emergency response and potential health effects from fires at industrial sites. During this event the City of Portland and Multnomah County issued an evacuation order for residents between Northeast 60th and 76th avenues and Northeast Columbia Boulevard and Alberta Street, using buses to evacuate residents without personal transportation. Particulate matter was the primary concern from this event, which poses a health risk, particularly to young children, seniors, and people with compromised respiratory systems.<sup>95</sup> Toxic chemicals in the air were also a concern, including asbestos, aldehydes, acid gases, sulfur dioxide, nitrogen oxides, polycyclic aromatic hydrocarbons, benzene, toluene, styrene, metals, and dioxins.

### 1-6.2.2 Impacts to Properties

CEI Hub property owners will experience the largest property damage resulting from tank failures. Some of the tank failures and lateral spread ground movement has the potential to impact adjacent property owners as private property is displaced throughout the area. Fires can also spread across properties – the extent of the damage will vary by the spread of the fire. For example, if the fire spreads to forest park during drought conditions it could spread through the forest canopy, posing increased challenges for containment.<sup>96</sup>

Fuel releases in the Willamette River from the CEI Hub have the potential to oil shorelines and impact waterfront properties CEI Hub fuel releases that reach the Willamette River or flow downstream will primarily impact the state-owned waterways, since the State of Oregon owns the bed and the banks of navigable rivers up to the high-water mark.<sup>97</sup> This analysis assumes that a spill could impact properties from the I-405 bridge to the Lewis and Clark Bridge between Longview, Washington and Rainier, Oregon. In this section of the Willamette River, Multnomah Channel, and Columbia River there are approximately 1,011 properties spanning four counties in both Oregon and Washington (Table 12).

Table 12. Waterfront Properties between I-405 and Lewis and Clark Bridge, by County

| County                | Number of Waterfront Properties |
|-----------------------|---------------------------------|
| Multnomah County (OR) | 312                             |
| Columbia County (OR)  | 497                             |
| Clark County (WA)     | 34                              |
| Cowlitz County (WA)   | 168                             |
| <b>Total</b>          | <b>1,011</b>                    |

Source: Calculated by ECONorthwest using geospatial parcel data for each county

Note: Property counts include waterfront properties in the Multnomah Channel

<sup>95</sup> Multnomah County. (2018). *Evacuations expand Monday night in Northeast Portland due to unhealthy smoke from fire*. March 12. Available at: <https://multco.us/multnomah-county/news/evacuations-expand-monday-night-northeast-portland-due-unhealthy-smoke-fire>

<sup>96</sup> Trout Mountain Forestry and Moore Iacofano Goltsman, Inc. (2009). *City of Portland Wildfire Readiness Assessment: Gap Analysis Report*. Available at: <https://www.portlandoregon.gov/parks/article/238523>

<sup>97</sup> Oregon Department of State Lands. (No Date). *Public Use of Oregon’s Rivers and Lakes*. Available at: [https://www.oregon.gov/dsl/ww/documents/nav\\_brochure.pdf](https://www.oregon.gov/dsl/ww/documents/nav_brochure.pdf)

### 1-6.3 Navigation and Commercial Activity Impacts

The navigation channel of the Willamette River is a critical shipping area for marine vessels that provides access to the CEI Hub as well as other nearby facilities, including Terminal 2, Terminal 4, the Swan Island Industrial Park, and other private businesses. To understand the extent of navigation and commercial activity, vessel counts were derived from vessel Automatic Identification System (AIS) data provided by the Bureau of Ocean Energy Management (BOEM) and NOAA as of 2017.<sup>98</sup> This data source contains total counts for large vessels, but excludes small vessels not required to have automatic identification systems. Daily counts were calculated for the entire year for the Willamette from the 405 bridge to the Lewis and Clark Bridge (Highway 433) between Longview, Washington and Rainier, Oregon. Each vessel was counted once per day for each day of the year using a unique identifier. Vessel types in the AIS data are standard categories used by the U.S. Coast Guard, NOAA, and the BOEM.<sup>99</sup>

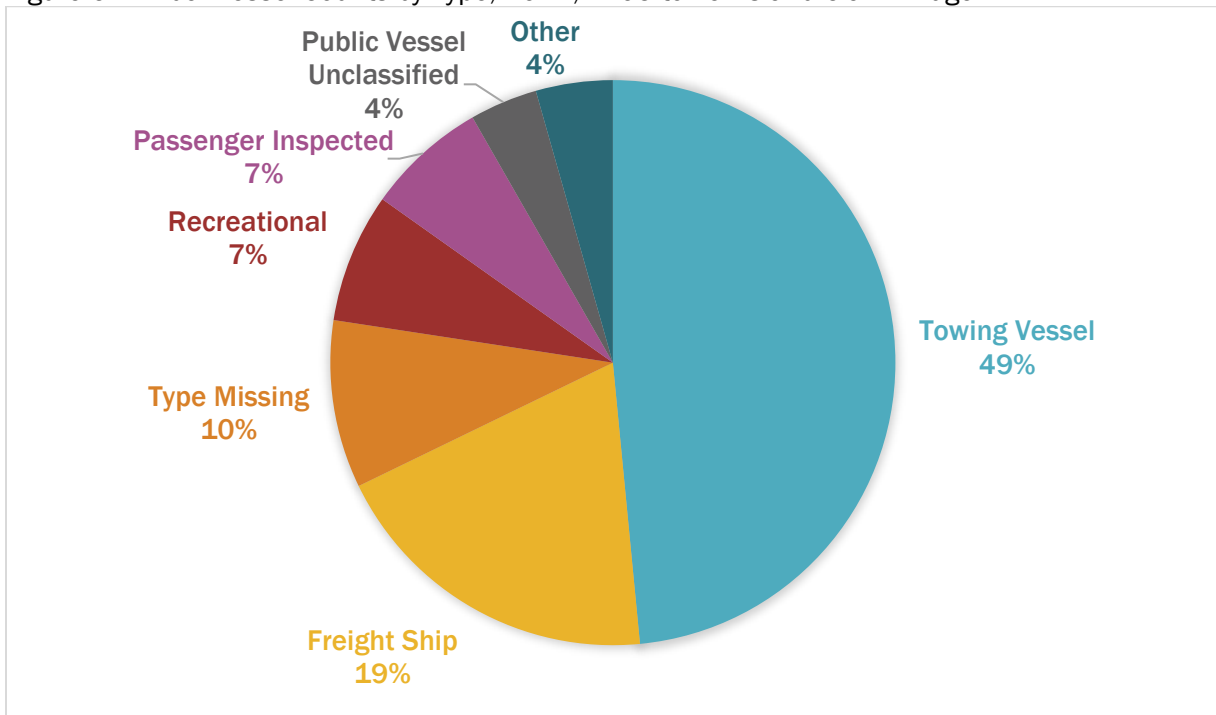
Based on the AIS data, there were 16,065 total vessels that passed by the CEI Hub on the Willamette River and the portion of the Columbia River in 2017 (annual total). Of the total vessels, approximately 49 percent were towing vessels and the remainder were other vessel types including public, commercial, and recreational vessels (Figure 6). Vessel counts vary slightly by day of week, ranging from a low of 42 average vessels per day on Sundays to a high of 45 vessels per day on Mondays. There is some variation by month, with a low of 1,000 vessels in January and a high of 1,476 vessels in July – for an average of 1,339 vessels per month (Figure 7).

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<sup>98</sup> Automatic Identification System (AIS) data obtained from: <https://marinecadastre.gov/data/>

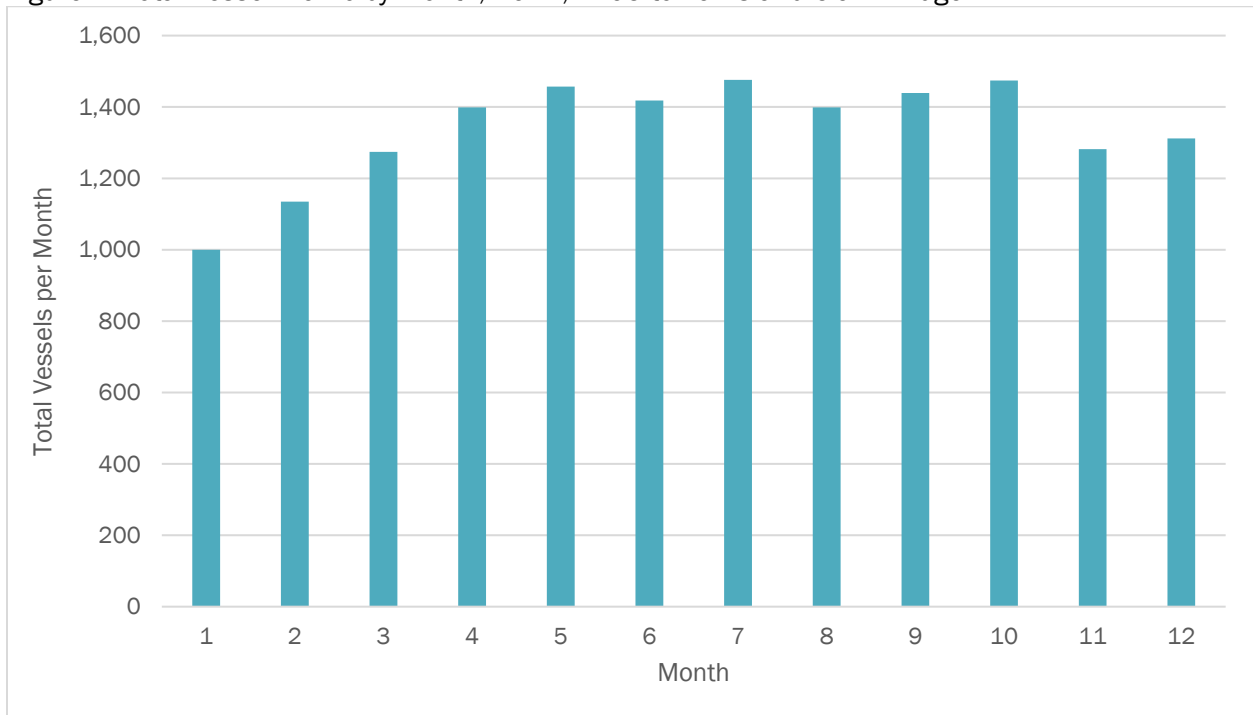
<sup>99</sup> More information on the classification of vessel types is available at: <https://coast.noaa.gov/data/marinecadastre/ais/VesselTypeCodes2018.pdf>

Figure 6. Annual Vessel Counts by Type, 2017, I-405 to Lewis and Clark Bridge



Source: Automatic Identification System (AIS) data provided by the Bureau of Ocean Energy Management (BOEM). (2017). Retrieved from <https://marinecadastre.gov/data/>

Figure 7. Total Vessel Traffic by Month, 2017, I-405 to Lewis and Clark Bridge

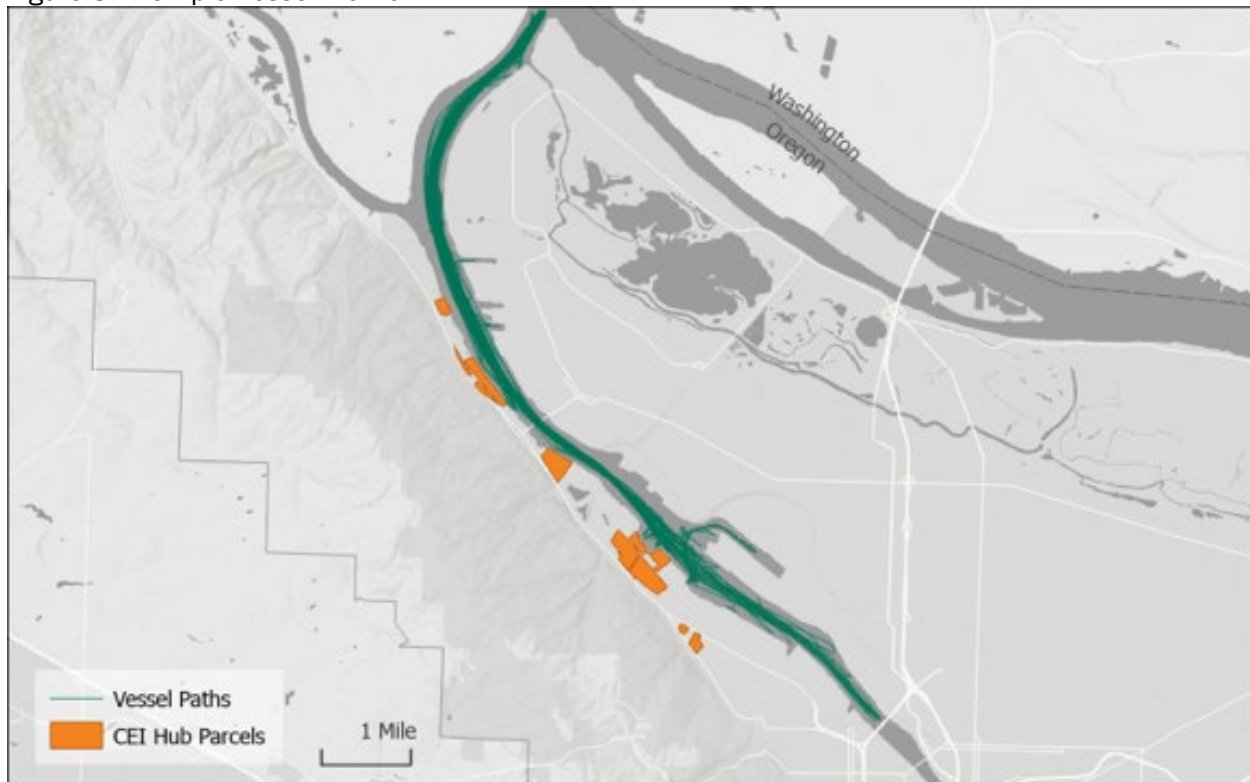


Source: Source: Automatic Identification System (AIS) data provided by the Bureau of Ocean Energy Management (BOEM). (2017). Retrieved from <https://marinecadastre.gov/data/>

Figure 8 depicts towing vessel traffic paths (in green) for a combination of high volume, average volume, and low volume sample days from 2017 for the Willamette River near the CEI Hub. As demonstrated in the map, the river area immediately adjacent to the CEI Hub and downstream between the CEI Hub and the confluence with the Columbia River are the most heavily used vessel traffic areas of the Willamette River.



Figure 8. Example Vessel Traffic



Source: Created by ECONorthwest using vessel path data from Automatic Identification System (AIS) data provided by the Bureau of Ocean Energy Management (BOEM). (2017). Retrieved from <https://marinecadastre.gov/data/>

### 1-6.3.1 Impact of Navigation Closures

To the extent that navigation impedes commercial activity, it will be impacted by the closure of the shipping channel resulting from failure to contain the materials located at the CEI Hub. The length of time for closures of this shipping channel due to CEI Hub failure will likely extend for days, but debris from earthquake including potential bridge delays could lead to extended closures. Historically, shipping channel closures only last for several days to minimize the impact of closures on transportation and because clean-up actions occur as soon as possible.<sup>100</sup> Following a CSZ earthquake, there may be added delays due to access. For every day of closure there would be on average 42 vessels impacted.

### 1-6.4 Recreation Impacts

There are multiple recreation resources that could be impacted by releases at the CEI Hub. Water-based recreation would be impacted by discharges, likely resulting in closures to the area for multiple months. Terrestrial recreation would be impacted by air quality impacts as well as any fire that occurs at the site. Figure 9 is a map of recreation resources either on or within immediate proximity to the Willamette River from the City of Portland.

<sup>100</sup> For example, in the Texas City Y spill the shipping channel was open after 3 days.

Figure 9. Recreation Resources in Proximity to the CEI Hub



Source: City of Portland, Bureau of Planning and Sustainability. (2020). *Willamette River Greenway Inventory*. December 16.

In addition to the recreation resources in the immediate vicinity of the CEI Hub there are also popular recreation sites that could be impacted by released materials at the CEI Hub. Forest Park, a 5,200 urban forest owned by the Portland Parks and Recreation, is located Northwest of the CEI Hub in the upland area on the opposite side of Highway 30/NW Saint Helen’s Road. Visitation at Forest Park is most likely to be impacted by air quality hazards, particularly during any fire that occurs. The Cascadia earthquake will also likely affect visitation at Forest Park due to the damage to roads and other infrastructure, as well as downed trees and other hazards within the park itself.

Downstream of the CEI Hub is Sauvie Island, an island located between the Willamette River and Columbia River that hosts a large wildlife refuge, agricultural farms, and private residences. During the summer, boat access and beaches are popular recreation sites. During the fall and early winter, Sauvie Island Wildlife Refuge is used for waterfowl hunting. Impacts from CEI Hub failure and releases would temporarily impact Sauvie Island recreation sites and activities from airborne releases caused by burning in the event of a fire. Water contamination could also impact Sauvie Island boating and swimming. The extent of water contamination would vary depending on containment actions in the spill response. Fishing and waterfowl hunting at Sauvie Island are likely to be impaired immediately and in the years following the spill due to lingering environmental toxins. The Cascadia earthquake will also likely affect visitation at Sauvie Island due to the damage to roads and other infrastructure, as well as downed trees and other hazards within the park itself.

### 1-6.4.1 Water-Based Recreation

The water-based recreation resources in and around the CEI Hub are primarily boat ramps with access to the Willamette River. Within the anticipated closure area from the confluence with the Columbia River and the I-405 bridge, there are two boat ramps that provide both motorized and non-motorized boat access, Swan Island boat ramp and Cathedral Park boat ramp, and two boat ramps that only allow non-motorized access, at McCarthy Park and Kelley Point Park. There is also the fishing dock at Cathedral Park, which is a short-term tie-up dock. Visitation counts are not maintained at any of these sites. However, estimates from Portland Parks and Recreation for Swan Island boat ramp suggest that there are 2,500 launches and retrievals each year from this site alone.<sup>101</sup>

River recreation in the Willamette River is primarily for motorized fishing vessels (Table 13). For this reason, use is especially pronounced in the fishing season for salmon and steelhead, beginning in May and extending through the summer months. Motorized personal watercraft also uses this stretch for boat tours along the Willamette River near the City Center. People also launch kayaks, paddleboards, sailboats, and other dingies from these locations.

Table 13. Activity Days by Waterbody and Activity Type (2008)

| Activity Type       | Columbia River          |                  | Willamette River        |                  |
|---------------------|-------------------------|------------------|-------------------------|------------------|
|                     | Number of Activity Days | Percent of Total | Number of Activity Days | Percent of Total |
| Fishing             | 231,955                 | 61%              | 210,020                 | 55%              |
| Sailing             | 30,131                  | 8%               | 5,007                   | 1%               |
| Personal Watercraft | 9,239                   | 2%               | 11,730                  | 3%               |
| Waterskiing         | 12,482                  | 3%               | 48,425                  | 13%              |
| Cruising            | 91,071                  | 24%              | 104,829                 | 27%              |
| Hunting             | 8,071                   | 2%               | 3,965                   | 1%               |
| <b>Total</b>        | <b>382,949</b>          | <b>100%</b>      | <b>383,976</b>          | <b>100%</b>      |

Source: Created by ECONorthwest with data from Oregon State Marine Board. (2011). Waterbodies in Rank Order. Available at: <https://data.oregon.gov/Recreation/Waterbodies-In-Rank-Order/rqyv-cfng>

More specific fishing use data is available for the Lower Columbia River (from the mouth to Bonneville dam) and the Lower Willamette River (Willamette Falls to the confluence with the Columbia River, including the Multnomah Channel). In total for both rivers there were 322,717 salmonid anglers, which averages approximately 40,923 per month throughout the season. There is variation in number of anglers year over year and it correlates to the size of the fishing run, which has been declining in recent years compared to the high in 2010 (Table 14).

<sup>101</sup> Email communication from Maya Agarwal, Portland Parks & Recreation, on March 16, 2021.

Table 14. Recreational Salmonid Anglers on the Lower Columbia River and Lower Willamette River

| Year | Lower Columbia River    |                   | Lower Willamette River  |                   | Total                   |                   |
|------|-------------------------|-------------------|-------------------------|-------------------|-------------------------|-------------------|
|      | Annual Salmonid Anglers | Average per Month | Annual Salmonid Anglers | Average per Month | Annual Salmonid Anglers | Average per Month |
| 2020 | 236,205                 | 23,621            | 86,512                  | 17,302            | 322,717                 | 40,923            |
| 2019 | 194,797                 | 19,480            | 73,267                  | 14,653            | 268,064                 | 34,133            |
| 2018 | 254,304                 | 25,430            | 68,910                  | 13,782            | 323,214                 | 39,212            |
| 2017 | 313,166                 | 31,317            | 57,836                  | 11,567            | 371,002                 | 42,884            |
| 2016 | 413,143                 | 41,314            | 71,528                  | 14,306            | 484,671                 | 55,620            |
| 2015 | 441,421                 | 44,142            | 99,352                  | 19,870            | 540,773                 | 64,013            |
| 2014 | 450,771                 | 45,077            | 80,286                  | 16,057            | 531,057                 | 61,134            |
| 2013 | 368,940                 | 36,894            | 111,393                 | 22,279            | 480,333                 | 59,173            |
| 2012 | 402,553                 | 40,255            | 115,456                 | 23,091            | 518,009                 | 63,347            |
| 2011 | 427,465                 | 42,747            | 136,186                 | 27,237            | 563,651                 | 69,984            |
| 2010 | 423,378                 | 42,338            | 135,802                 | 27,160            | 559,180                 | 69,498            |

Source: Oregon Department of Fish and Wildlife, *Columbia River Fisheries, Recreation data*, available at: <https://www.dfw.state.or.us/fish/OSCRP/CRM/index.asp>

Note: Data is collected for the Lower Columbia River for the months of February to October. Data is collected for the Willamette River is for the months of March to July. Species with data collected are Shad, spring chinook, steelhead, sturgeon. Due to annual changes in fisheries management (e.g., closures, bag limits), there are not necessarily the same opportunities for fishing year over year. This data does not include tributaries of the rivers.

Immediate impacts to river recreation from failure of the CEI Hub would be the closure of these access points while clean-up occurs. Based on the timeline for the Refugio Incident in California (which was smaller than what would likely occur at the CEI Hub), clean-up will likely last multiple months. Some of these closures as well as voluntary ends to use may occur regardless of the CEI Hub spill due to the damage from the CSZ earthquake. Depending on liquefaction at other sites, roads and access points likely would not be usable anyways for an extended period of time. Water quality of the Willamette River will likely also be impacted due to the sediment loading resulting from the earthquake, which would impact fishing conditions in particular.

#### 1-6.4.2 Fish Consumption

Longer term, the residual contaminants from the CEI Hub failures could result in fishing advisories to limit consumption of aquatic species in this area. However, there are currently fishing advisories in place for resident fish in this stretch of the Lower Willamette.<sup>102</sup> Resident fish should not be eaten at all due to their high concentrations of polychlorinated biphenyls (PCBs) that pose a risk to human health. Resident fish include carp, brown bullhead, bass, walleye, and other fish that live their whole lives in the Lower Willamette. The advisory does not apply to migratory fish like salmon, steelhead, and shad.

<sup>102</sup> The April 11, 2018 Lower Willamette fish advisory is available from the Oregon Health Authority at: <https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/RECREATION/FISHCONSUMPTION/Pages/Lower-Willamette-Fish-Advisory.aspx>

### 1-6.4.3 Terrestrial Recreation

The terrestrial recreation sites located near the CEI Hub, between the confluence with the Willamette River and I-405 and with views of the river, include the following sites, as well as informal use along the banks of the river, particularly on the Northern side:

- Cathedral Park
- Forest Park
- Kelley Point Park
- Greenway Trail
- Willamette Cove Natural Area
- Harbor View Property
- McCarthy Park
- Swan Island Park
- St. Johns Bridge Viewpoint
- Railroad Bridge Viewpoint

Many of these are popular sites for people throughout the Portland metro area and beyond. Like water-based recreation, terrestrial recreation will be impacted by the earthquake due to access and potential hazards. There will likely be temporary air-quality impacts to these sites resulting from the smoke from the fire and hazardous aerosol chemical releases that—in absence of CSZ earthquake closures—could affect recreation at these sites, but there will likely already be recreation closures at these sites due to other CSZ earthquake impacts.

## 1-6.5 Air Quality Impacts

With tank failure, the fuels, additives, gasses, and other materials stored at the CEI Hub could ignite, releasing a toxic plume into the air. Even if it did not ignite, volatilization of harmful components of the materials would also travel beyond the site. This air would spread throughout the area, posing health risks to people, pets, livestock, and wildlife. The health impacts of these releases would be most immediate and severe for the people working in and around the CEI Hub. There are populated areas located primarily north, south, and east of the CEI Hub, and depending on wind conditions there could be extreme risks to human health from this harmful plume. This section focuses on the physical changes in air quality – health effects and costs are discussed in detail in the next chapter.

### 1-6.5.1 Types of Chemicals and Particulates Released

Air quality in the Portland metro region is, at times, already hazardous, primarily the result of wildfire and wood burning stove smoke with stagnate air (ozone and particulate matter),<sup>103</sup> as

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<sup>103</sup> More information about smoke related DEQ air quality advisories is available at: <https://www.oregon.gov/deq/aq/Pages/Air-Pollution-Advisories.aspx>



well as releases from manufacturing facilities.<sup>104</sup> Any air quality impacts from a release at the CEI Hub would only compound any existing concerns. Petrochemicals that are not burned are toxic and contain chemicals such as benzene, toluene, xylene, ethylbenzene, and others. Burning petrochemicals produce several types of air pollutants including VOCs, NO<sub>x</sub>, sulfur dioxide (SO<sub>2</sub>), and particulate matter (PM<sub>2.5</sub>). All of these pollutants can have negative effects on human health and quality of life, from shortness of breath to respiratory infections, blood diseases, and cancer.<sup>105</sup> Local populations will be vulnerable to the adverse health effects of these pollutants, which may lead to increases in illnesses, reduced quality of life, and increased costs of treatment. These types of air quality impacts have been observed in other major oil spills.<sup>106</sup>

### 1-6.5.2 Dispersion of Releases

The areas immediately surrounding the spill site may be subject to acute hazardous levels of airborne chemicals. As gasoline quickly evaporates from the fuel spill site, the surrounding air becomes highly concentrated with chemical compounds found in gasoline, often including butane, pentane, benzene and toluene.<sup>107</sup> At high concentrations, the particulates in these gasoline vapor clouds may lead to a variety of acute adverse health effects for exposed individuals (see Section 6.5.2 for specific acute health risks). The Department of Labor's Occupational Safety and Health Administration (OSHA) has set the maximum allowable air pollution standards for gasoline at 300ppm over an 8-hour time-weighted average concentration and 550 ppm for a 15-minute exposure<sup>108</sup>.

Figures 11 and 12 show a map of the projected area of toxic vapor risk under two prevailing wind conditions for the area surrounding the CEI Hub<sup>109</sup>. Dark shaded areas are likely to exceed or greatly exceed the OSHA 8-hour time-weighted average limits for gasoline particulate exposure. The yellow zones immediately surrounding each tank area represent the zones at risk of a fire ignition. Depending on the severity, location

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<sup>104</sup> More information about industrial air quality concerns is available from Oregon Department of Environmental Quality at: <https://www.oregon.gov/deq/aq/Pages/Air-Quality-Map.aspx>

<sup>105</sup> National Institute of Health. (2019). "Chemicals and Contaminants". *Tox Town: U.S National Library of Medicine*. Retrieved from: <https://toxtown.nlm.nih.gov/chemicals-and-contaminants>.

<sup>106</sup> Middlebrook, A. M., Murphy, D. M., Ahmadov, R., Atlas, E. L., Bahreini, R., Blake, D. R., & Ravishankara, A. R. (2012). Air quality implications of the Deepwater Horizon oil spill. *Proceedings of the National Academy of Sciences*, 109(50), 20280-20285.

<sup>107</sup> U.S. Department of Health and Human Services. (1995). *Toxicological Profile for Gasoline*. Atlanta, GA: Agency for Toxic Substances and Disease Registry. <https://www.atsdr.cdc.gov/toxprofiles/tp72.pdf>.

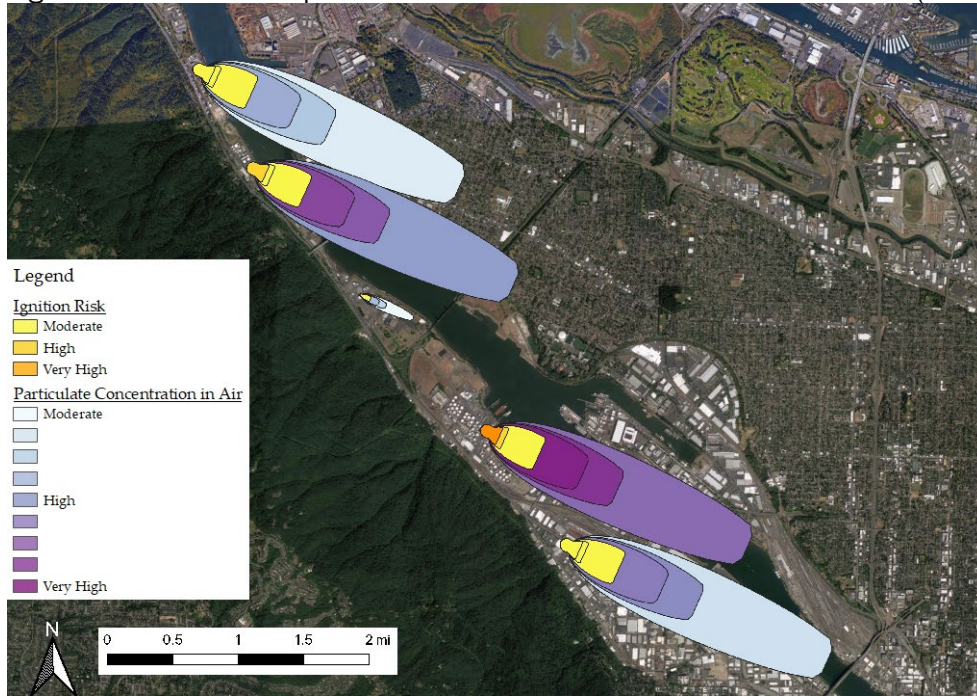
<sup>108</sup> CFR 1910.1000: <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1000>

<sup>109</sup> The area of hazardous air quality was modeled using software developed by the NOAA Emergency Response Division and the EPA Office of Emergency Management that evaluates the short-term air dispersion of chemicals from a spill site. The software, called ALOHA (Areal Locations of Hazardous Atmospheres), was used to generate a map of the one-hour dispersion of particulates from the gasoline release site using climate characteristics for Portland, OR and information regarding the chemical composition of a generic gasoline mixture from HHS (1995).



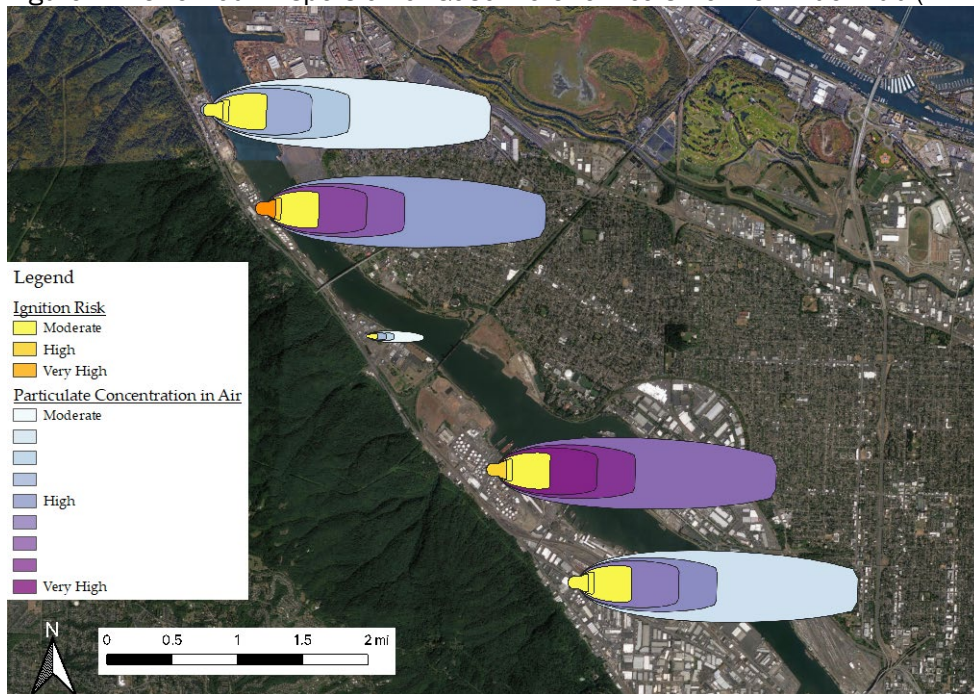
and spread of the spill, the concentration of hazardous gasoline vapor may extend beyond these regions. Figure 13 shows the levels of risk of mild to severe burns. The highest zone of risk from a burning gas fire represents a high probability of death within 60 seconds of exposure.

Figure 10: One-Hour Dispersion of Gasoline Chemicals from CEI Fuel Hub (NNW Wind Direction)



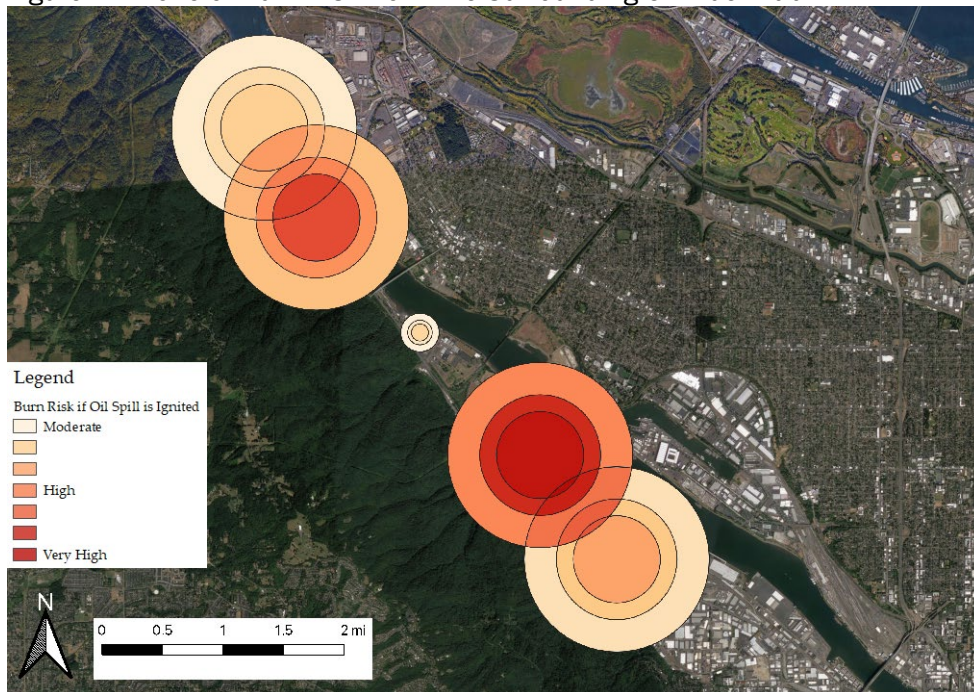
Source: NOAA and EPA ALOHA software, output created by ECONorthwest

Figure 11: One-Hour Dispersion of Gasoline Chemicals from CEI Fuel Hub (W Wind Direction)



Source: NOAA and EPA ALOHA software, output created by ECONorthwest

Figure 12: Zone of Burn Risk from Fire Surrounding CEI Fuel Hub



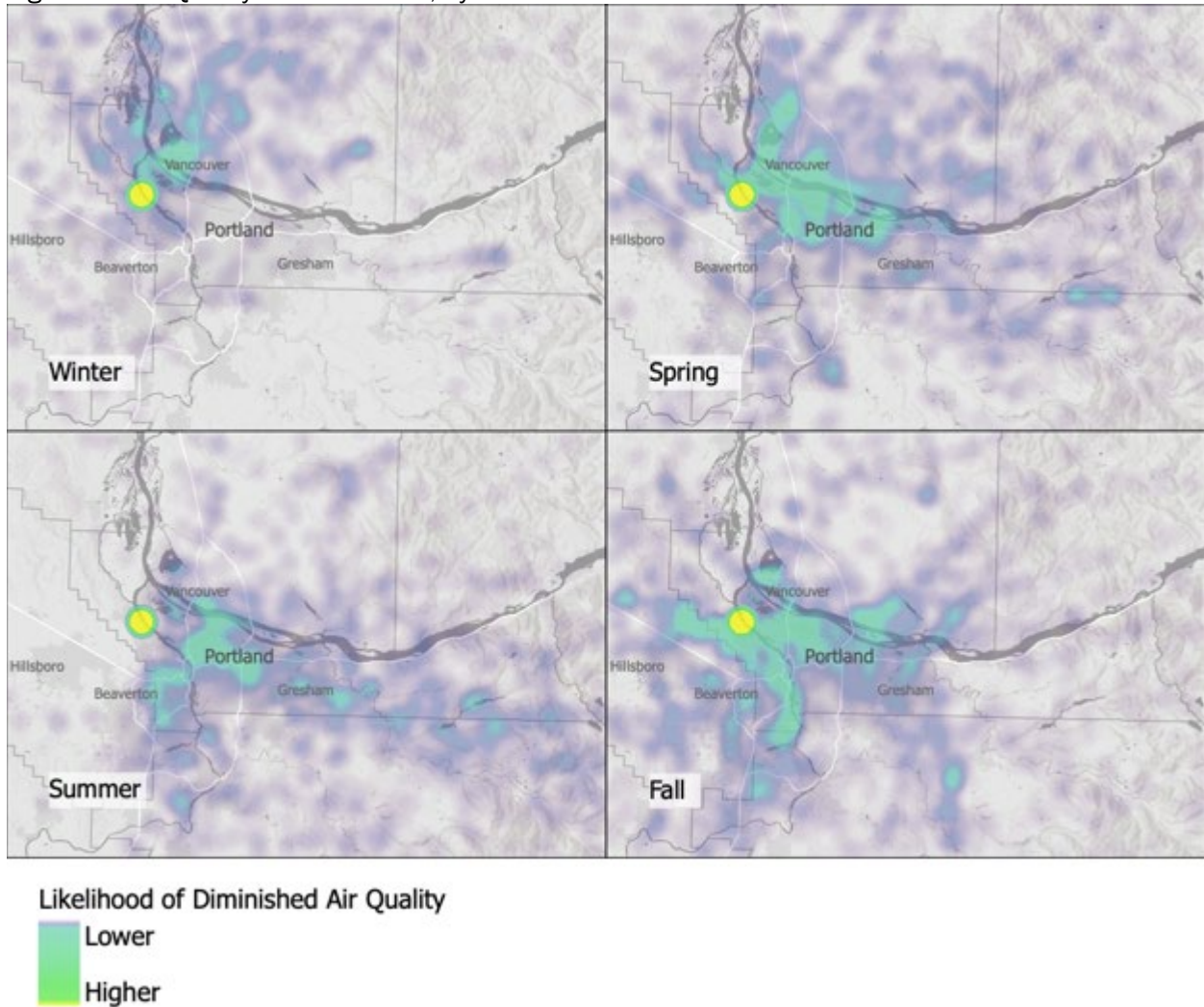
Source: NOAA and EPA ALOHA software, output created by ECONorthwest

The ultimate direction of any air plume from releases at the CEI Hub are very weather specific and can vary from day to day. Nevertheless, there are seasonal trends that put certain portions of the Portland Metro region's population at higher risk. NOAA's Air Resources Laboratory's Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) is one of the most



widely used models for atmospheric trajectory and dispersion calculations.<sup>110</sup> A series of scenarios modeling 24 hour releases during a systematic sample of 12 days per season in 2020 show that the Portland area experiences high weather variability in fall and spring, but more consistent trends in the winter and summer. Should the CSZ event occur in the summer, residents to the south and east of the CEI Hub are likely to experience the greatest air-quality decreases, while residents in the north are likely to experience greater harms in the winter (Figure 10).

Figure 13: Air Quality Plume Models, by Season.



Source: NOAA HYSPLIT analysis performed by ECONorthwest

<sup>110</sup> Stein, A. F., Draxler, R. R., Rolph, G. D., Stunder, B. J., Cohen, M. D., & Ngan, F. (2015). NOAA's HYSPLIT atmospheric transport and dispersion modeling system. *Bulletin of the American Meteorological Society*, 96(12), 2059-2077.

The length of time when there is hazardous air quality will depend on containment and response options. Burning petrochemicals will persist for as long as materials are burning – which is also a function of the extent of any fire spread. If the fire spreads to other industrial, residential, or forested areas then there will be additional chemicals released into the smoke plume and the fire will likely last longer and be more difficult to contain. Materials that are not burned will only be hazardous in the immediate release area and will dissipate after they breakdown naturally.

### 1-6.5.3 Evacuations

These results show the locations of populations likely to be at the greatest risk of danger from chemical exposure or burns. Evacuation would likely be recommended (though not necessarily feasible) for parts or all of the communities of Linnton and Cathedral Park, as well as the adjacent industrial zones, particularly in any areas approaching the lower explosive limit for gasoline (14,000 ppm).

### 1-6.5.4 Impacts on Other Emergency Response Efforts

Fuel releases from the CEI Hub and any associated fires, needed evacuations, and spill response activities will strain emergency service resources in the aftermath of the earthquake. The additional risks to human health caused by infrastructure failures at the CEI Hub will take away from emergency response resources that are needed for other earthquake impacts. This increase in demand for emergency services will increase the costs of providing those services. In the worst-case scenario, there may not be enough resources to meet all of the needs for emergency response. Fire response, evacuation, hospital, emergency transportation, law enforcement, and environmental response capacity will all be required to respond to fuel releases from the CEI Hub. These resources may not be available for the CEI Hub, causing the effects to spread without containment. Any resources dedicated to the CEI Hub are taking away from emergencies elsewhere and this scarcity will likely cause added injury and mortality.

## 1-6.6 Habitat Impacts

### 1-6.6.1 Effect of Substance Releases on Fish and Wildlife

Oil spills from CEI Hub failures have the potential to cause direct mortality and long-term harm to fish and wildlife in both the immediate area of the spill as well as in water resources as materials are transported downstream. Oil releases can affect wildlife not only through the initial direct exposure, but also through impacts to habitats and clean-up activities. Oil contamination can also degrade habitats and limit food supplies, which could cause secondary

mortality or other harm to species and indirect mortality.<sup>111</sup> These factors of toxicity and habitat impairment, as well as the physiological stress from oil spills, can also affect the reproductive success of species.<sup>112</sup> Lastly, clean-up actions can also be disruptive, particularly more invasive actions like suctioning, dredging, and burning contaminated vegetation. Specific concerns from oil spills for different types of species include:<sup>113</sup>

- **Birds:** Birds are likely to be exposed to oil as they float on the water's surface. Oiled birds can lose the ability to fly, dive for food, or float on the water which could lead to drowning. Oil interferes with the water repellency of feathers and can cause hypothermia. Oil ingestion has been shown to cause suppression to the immune system, organ damage, skin irritation and ulceration, and behavioral changes. Damage to the immune system can lead to secondary infections that cause death, while behavioral changes may affect an animal's ability to find food or avoid predators.
- **Shellfish:** Oil can be toxic to shellfish including bottom dwelling (lobsters, crabs, etc.) and intertidal (clams, oysters, etc.) species. The bottom dwelling species may be particularly vulnerable when oil becomes highly concentrated along the shoreline.
- **Fish:** Fish can be impacted directly through uptake by the gills, ingestion of oil or oiled prey, effects on eggs and larval survival, or changes in the ecosystem that support the fish. Adult fish may experience reduced growth, enlarged livers, changes in heart and respiration rates, fin erosion, and reproductive impairment when exposed to oil. Oil has the potential to impact spawning success as eggs and larvae of many fish species are highly sensitive to oil toxins.

Because oil has the potential to persist in the environment long after a spill event, it can have long-term impacts on fish and wildlife populations. Accordingly, injuries can persist well beyond the direct clean-up from an incident.

Anadromous fish species in the Columbia River and Willamette River are species of particular concern for impacts from fuel releases at the CEI Hub because they are listed as threatened or endangered under state and federal law. An oil spill in these river systems would present an additional stressor on salmon and steelhead, in addition to the other stressors the populations face from habitat degraded by dams and reservoirs, as well as climate change and the resulting high water temperature conditions.<sup>114</sup> An oil spill could also interfere with the anadromous fish species' ability to find their way back to their spawning grounds due to significant changes in the environmental conditions of the rivers.

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<sup>111</sup> National Research Council. (2003). *Oil in the Sea III: Inputs, Fates, and Effects*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/10388>.

<sup>112</sup> NOAA, Office of Response and Restoration, *How Toxic is Oil?*. Available at: <https://response.restoration.noaa.gov/oil-and-chemical-spills/significant-incidents/exxon-valdez-oil-spill/how-toxic-oil.html>

<sup>113</sup> U.S. Fish and Wildlife Department. (2010). *Effects of Oil on Wildlife and Habitat*.

<sup>114</sup> Testimony of Dr. Zachary Penney in Columbia Riverkeeper, et al. Final Adjudication Brief: Tesoro Savage, LLC. Vancouver Energy Distribution Terminal. Case Number 15-001.

## 1-6.6.2 Habitat Types in and Around CEI Hub

NOAA maintains environmental sensitivity maps that identify natural resources that are potentially at-risk if an oil spill occurs nearby. The NOAA environmental sensitivity maps for the Columbia River include mapping of the CEI Hub.<sup>115</sup> Resources immediately near the CEI Hub include birds, fish, and reptiles, such as:

- **Birds:** Bald eagle, osprey, and other waterfowl.
- **Fish:** Chinook salmon, coho salmon, sockeye salmon, steelhead, white sturgeon, eulachon, and others.
- **Reptiles:** Western pond turtle and western painted turtle.

The lower Columbia River supports 74 populations of salmon, steelhead, and bull trout.<sup>116</sup> Many of these species are listed as threatened or endangered under state and federal law. In 2020 there were 7.0 million adult and jack species counted at Bonneville dam and 70,000 counted at Willamette Falls.<sup>117, 118</sup>

The largest Caspian Tern and Double-crested Cormorant colonies in the Western United States nest in the Columbia River Estuary. An oil spill during nesting season could wipe out a significant portion their population.

Downstream of the CEI Hub, there are additional environmentally sensitive resources. The downstream area of the Willamette River, Columbia River, and their tributaries includes the Sauvie Island Wildlife Area, Ridgefield National Wildlife Refuge, Julia Butler Hansen Refuge for The Columbian White-Tailed Deer, and the Lewis and Clark National Wildlife Refuge.<sup>119, 120</sup> These refuge areas support wintering and migrating concentrations of waterfowl and shorebirds, provide juvenile salmonid rearing habitat, and contribute to the food supply for a wide swath of environmental resources. There are also multiple areas of Freshwater Forested/Shrub Wetland habitat located downstream of the CEI Hub that are hydrologically connected to the Willamette or Columbia Rivers.<sup>121</sup> Because they are downstream of the CEI

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<sup>115</sup> The CEI Hub is mapped as “ESI20” for the Columbia River, available at: [https://response.restoration.noaa.gov/esi\\_download#Oregon](https://response.restoration.noaa.gov/esi_download#Oregon)

<sup>116</sup> State of Salmon in Watersheds. (2020). *Lower Columbia River*. Available at: <http://teststateofsalmon.wa.gov/regions/lower-columbia-river/salmon/>

<sup>117</sup> Columbia Basin Fisheries Agencies and Tribes, *Fish Passage Center Website*. Available at: <https://www.fpc.org/>

<sup>118</sup> Counts include Chinook salmon (Adult and Jack), Coho salmon (Adult and Jack), Steelhead, Sockeye salmon, Pink salmon, Chum salmon, Lamprey, and Shad.

<sup>119</sup> Abt Associates Inc. and Bear Peak Economics. (2016). *Potential Fishing Impacts and Natural Resource Damages from Worst-Case Discharges of Oil on the Columbia River*. Submitted to: Matthew Kernutt, Assistant Attorney General Washington Attorney General’s Office. May 12.

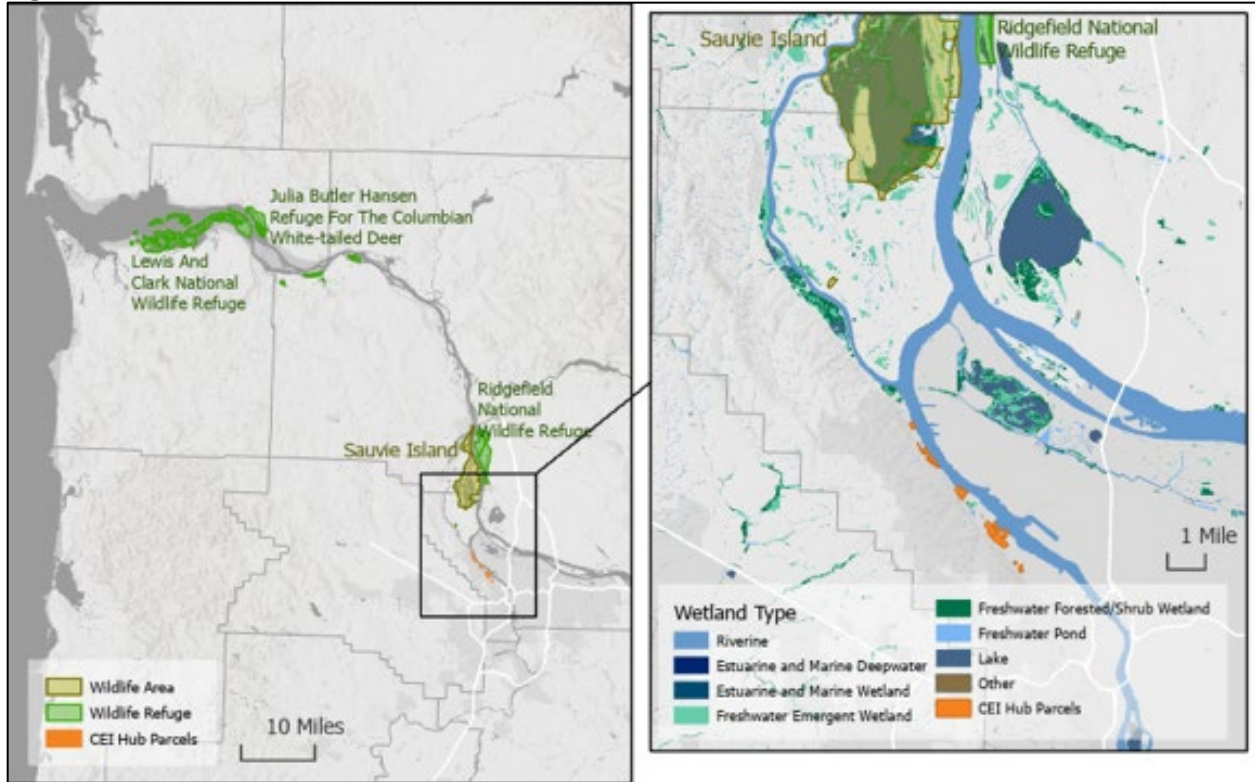
<sup>120</sup> Region 10 Regional Response Team (RRT) and the Northwest Area Committee (NWAC). (2015). *Lower Columbia Spill Response Plan*. October. Available at: <https://www.rrt10nwac.com/GRP/>

<sup>121</sup> U.S. Fish and Wildlife Service, *National Wetland Inventory Mapper*. Available at: <https://www.fws.gov/wetlands/data/mapper.html>



Hub, all of these resources have the potential to be impacted depending on river conditions and spill response activities. Figure 11 displays the location of these sensitive habitat and wildlife areas.

Figure 14. Location of Sensitive Wildlife and Habitat Areas



Source: Created by ECONorthwest using information from U.S. Fish and Wildlife Service, National Wetland Inventory mapper

### 1-6.6.3 Extent of Releases from CEI Hub

The impact on habitats and species from tank failures at the CEI Hub is based primarily on the amount of material that flows into the water. Because the CEI Hub is an industrial area, releases only onto the ground are not likely to cause extensive habitat impacts. Fires and the chemical vapors that they produce could impact wildlife in the same way that they can impact humans.

As discussed in Section 3, between 40.8 million to 82.5 million gallons of oil and hazardous materials could potentially flow into the Willamette River due to a CSZ earthquake and subsequent tank failures. This level of spill would be between one-quarter to one-half of what was released over three months in the Deepwater Horizon oil spill. When the oil is released into the Willamette River, it will flow with the river current until it is contained or until it reaches the Pacific Ocean. Table 11 details the seasonal average river currents for the Willamette and Columbia Rivers at the closest upstream gages to the CEI Hub. As demonstrated in these values, the river current (i.e., velocity) can be more than to six times faster in the winter compared to the summer and is faster in the Columbia River than the Willamette River.

Table 15. Seasonal Average Water Velocity (feet per second)

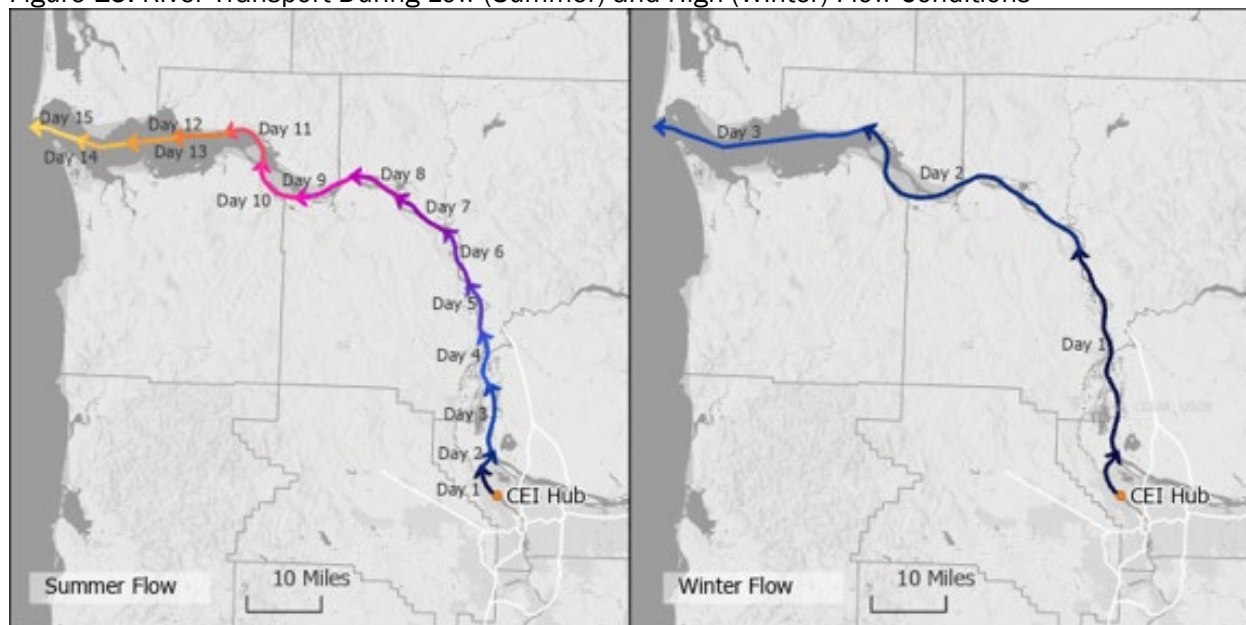
|               | <b>Willamette River at Broadway Bridge,<br/>Portland, OR</b> | <b>Columbia River at Vancouver,<br/>Washington</b> |
|---------------|--|--|
| <b>Winter</b> | 1.58   | 2.45   |
| <b>Spring</b> | 0.48   | 1.20   |
| <b>Summer</b> | 0.24   | 0.47   |
| <b>Fall</b>   | 0.56   | 1.09   |

Source: Calculated by ECONorthwest based on information from USGS, *National Water Information System: Web Interface*, available at: <https://nwis.waterdata.usgs.gov/nwis>

The river currents describe how fast remaining materials will flow downstream. As discussed in Section 4.2, because materials evaporate and disperse over time, there are fewer remaining materials each day. Heavier fuels will remain longer in the water without dispersing or evaporating. Modelling current and weathering information also informs the extent of contamination based on when containment and clean-up activities commence.

Based on the current in the summer it will take approximately 15.5 days for materials released from the CEI Hub into the Willamette River to reach the Pacific Ocean (Figure 12). In contrast, during the winter when currents are faster, it will take approximately 3 days for remaining materials released from the CEI Hub into the Willamette River to reach the Pacific Ocean. These timelines are without containment actions. With containment actions the flow of released materials would be stopped where the containment occurs. Of note, fuels and industrial containments are likely to also enter the Willamette River and Columbia River from other sites due to the CSZ earthquake, so containment actions will be needed at other locations as well. Containment before releases reach the ocean may not be possible due to the damages to infrastructure following the earthquake and other complications.

Figure 15. River Transport During Low (Summer) and High (Winter) Flow Conditions



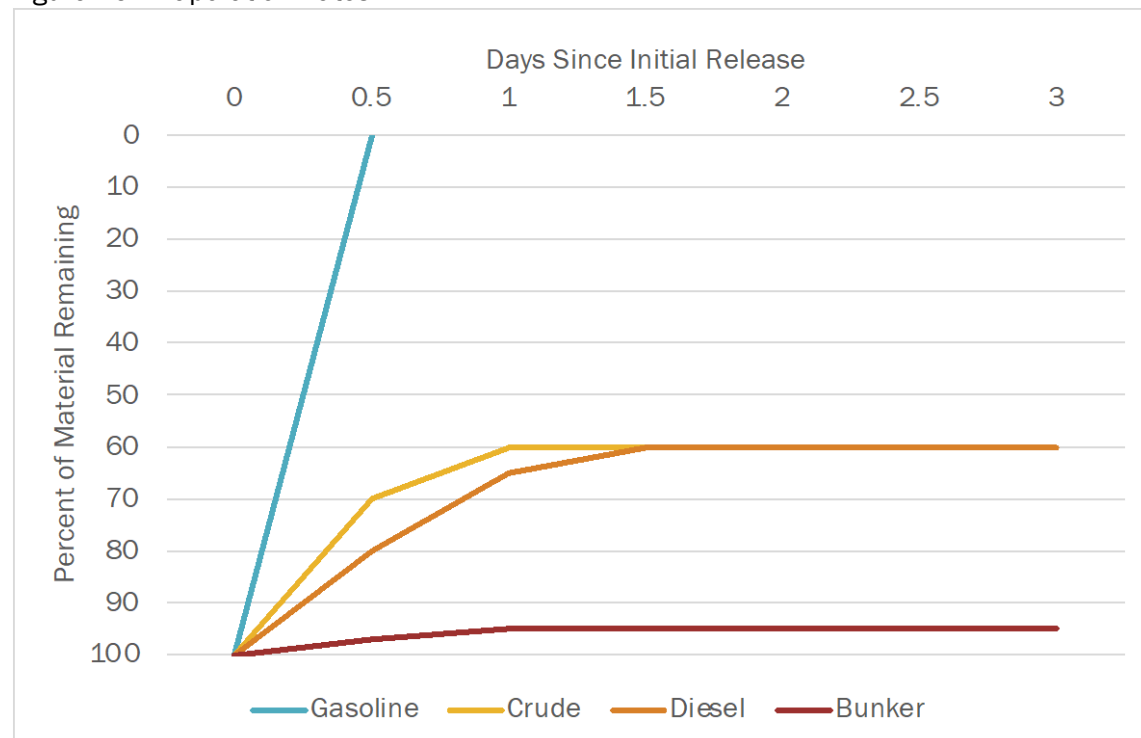
Source: Created by ECONorthwest using data from USGS

As discussed in section 4.2, not all the materials released from the CEI Hub will remain in the water for the length of time it would take to reach the Pacific Ocean. After 10 hours, almost of all the gasoline, ethanol, and aviation fuel will have evaporated into the air, particularly during hotter days when evaporation rates are higher and more sunlight and microbes can break down the chemicals.<sup>122</sup> Diesel and crude oil will evaporate in part, but up to 60 percent could be remaining when the materials reach the Pacific Ocean.<sup>123</sup> Because these light fuels float on top of the water they will largely flow with the river. Heavier oils like asphalt and bunker crude oil will sink in the water and largely remain in any environment that they come in contact with on riverbeds and shorelines. Despite sinking, heavier oils will continue to be transported by the water velocity, although at a slower rate than non-sinking lighter oils that remain on the water surface. Figure 13 models sample evaporation rates for gasoline, crude, diesel, and bunker fuels over time for the first three days.

<sup>122</sup> National Research Council. (2003). *Oil in the Sea III: Inputs, Fates, and Effects*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/10388>.

<sup>123</sup> National Research Council. (2003). *Oil in the Sea III: Inputs, Fates, and Effects*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/10388>.

Figure 16. Evaporation Rates



Source: Created by ECONorthwest using information from National Research Council (2003) and NOAA ADIOS model results.

Applying the evaporation rates described previously to the materials that could be potentially released at the CEI Hub results in the finding that after three days between 20.9 million and 42.3 million gallons of diesel, medium, and heavy oils could be remain in the water (excluding additives and unknown materials). Because most evaporation occurs early, in the low flow scenario in the summer these levels of materials are likely to remain about as high for the remaining days and be transported to the Pacific Ocean. This level of contamination is likely to result in significant mortality among aquatic species throughout the lower Willamette and Columbia Rivers. Mortality and impacts to sensitive species will be particularly pronounced if the spill occurs during the salmon spawning seasons in the late spring to early fall.

#### 1-6.6.4 Effect of Ground Spills on Properties

The habitat impacts of spills onto the ground at the CEI Hub will not be as severe as the water resources because materials will not be transported on the ground and there are not sensitive habitats in the terrestrial area of the CEI Hub. However, releases on to the ground will contaminate the soil and require clean-up efforts and site remediation, such as soil removal. Oil sheens on the ground are possible for years afterwards even with remediation actions.

### 1-6.7 Impacts to Cultural Resources

The CEI Hub is located on the native lands of the member tribes of the Confederated Tribes of the Grande Ronde and the Confederated Tribes of the Siletz. Historically, the Willamette River

has been used by local tribes for subsistence, transportation, commerce, and ceremonial purposes. Impacts to aquatic species from fuel releases at the CEI Hub would result in a reduction of these values for local tribes.

The Cultural Resources Analysis Report for the Portland Harbor Superfund Site (2005) details some of the specific cultural resources near the CEI Hub:<sup>124</sup>

“Some Tribes retain treaty rights to salmon and other fish including lamprey, not only as a source of food but also as part of their culture and spirituality. Wetlands in this region are also culturally important because wetlands support wapato, a harvested item that was traded between Chinookans in the Portland Basin and other Native peoples at the coast. The only known location that currently supports wapato is a small riverine wetland located in the Swan Island Lagoon. Native vegetation was also gathered for food and tools.”

Water provides important cultural value by sustaining fish and ecosystems that tribal and non-tribal members depend on; riparian vegetation used as food, medicine, and fiber for clothing, baskets, and tools; and other organic and non-organic materials used for subsistence and cultural purposes.

The impacts from releases at the CEI Hub on migratory species, in particular salmon and steelhead, would also impact tribal nations that rely on Columbia Basin salmon throughout Oregon and Washington, both upstream and downstream of the CEI Hub site on the Willamette River and Columbia River. Reductions in salmon populations due to CEI Hub fuel releases could threaten tribal treaty rights to continue to take fish both on their reservations and at all usual and accustomed fishing places. The Columbia River tribes' treaty fishing rights are property rights and require compensation under the Fifth Amendment of the United States Constitution if their rights are infringed upon.<sup>125</sup>

Some non-tribal members would also experience cultural loss from harm to the environment caused by fuel releases at the CEI Hub. Pioneering research on *solastalgia*, the grief that people feel when a landscape that they are connected to is dramatically altered, suggests that loss of the functions of a natural resource can cause feelings of isolation from others, less community participation, perceptions of loss of nature, and worsened mental health.<sup>126</sup>

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<sup>124</sup> Ellis, D.V., Allen, J.M., and Hajda, Y. (2005). *Cultural Resource Analysis Report for the Portland Harbor Superfund Site, Portland, Oregon*.

<sup>125</sup> The legal precedent for compensation was established in “Confederated Tribes of the Umatilla Reservation v. Alexander” in 1977.

<sup>126</sup> Eisenman, D P., Kyaw, M.T., Eclarino, K. (2021). *Review of the Mental Health Effects of Wildfire Smoke, Solastalgia, and Non-Traditional Firefighters*. UCLA Center for Healthy Climate Solutions, David Geffen School of Medicine at UCLA, & Climate Resolve.

The Willamette River has been the site of tremendous investment through the Portland Harbor Superfund Clean Up,<sup>127</sup> and those efforts have been working to improve the environmental conditions to support cultural values related to habitats and the species they support. Particularly for tribes, restoring this ecosystem is of particular importance to correct historic loss of cultural value.

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<sup>127</sup> More information about the Portland Harbor Superfund Site is available at:  
<https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=1002155#bkground>



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# Chapter 2: Costs of Impacts from Cascadia Subduction Zone Earthquake at CEI Hub

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# 2-1 Introduction

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## 2-1.1 Chapter Overview

Fuel releases from the CEI Hub because of a Cascadia Subduction Zone (CSZ) earthquake will impose substantial economic costs on the region. These costs accrue both as financial costs of responding to the spill, cleaning it up, and restoring the environment, as well as non-market economic losses to individual welfare. This chapter builds upon the physical description of direct impacts from the CEI Hub discussed in the previous chapter by calculating the costs of both the immediate and downstream effects of the fuel releases. In addition to the costs of the direct physical effects of the releases, this chapter also describes the costs to the fuel market as well as the costs of cleanup and restoration activities.

## 2-1.2 Scenario Modeling and Uncertainty

There is inherent uncertainty associated with estimating the economic costs of CEI Hub fuel releases due to a CSZ earthquake. A key factor is the quantity of fuel released, which, as discussed in the prior chapter, is predicated by assumptions about the integrity of the tanks and underlying soils, as well as the magnitude of the earthquake. While the Columbia River Area Contingency Plan lays out a framework for a quick response to an oil spill, the CSZ's impacts to roads, bridges, and other infrastructure will impair response times and further affect how far the fuels will spread, particularly in the river.<sup>1</sup> Economic costs are also dependent on the ultimate fate of the fuels. If fuel releases catch fire, there will be additional impacts to property and air quality. However, burning could minimize the amount of fuel that is released into the ground and water and limiting habitat impacts. Additional uncertainty is inherent in the analysis due to the variation based on the environmental conditions of when the spill occurs (e.g., what time of year, the temperature, wind patterns, etc.).

Uncertainty also accrues from the fact that the CEI spill would co-occur with a major earthquake. The interaction of these incidents includes many physical unknowns. What is certain is that the earthquake will increase the difficulty of responding to the spill of materials from CEI Hub. An earthquake is more likely to compound harms by delaying clean-up efforts, delaying efforts to re-open shipping, and reducing access to fuels exactly when they are needed for emergency generators and clean-up equipment.

For these reasons, this analysis does not present a single estimate of the costs of fuel releases. Instead, each section describes the specific assumptions and methodologies used to obtain any monetary cost estimates. The assumptions are based upon the best available information to

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<sup>1</sup> USCG Sector Columbia River. (2020). *Columbia River Area Contingency Plan*. Available at: <https://homeport.uscg.mil/Lists/Content/Attachments/60907/SCR%20ACP%202020-Signed%20LOP%20USCG.pdf>. Accessed November 30, 2021.

model the most likely scenario of the magnitude and extent of the impact and corresponding costs. Not all impacts have monetary cost estimates. When possible, costs are described in per unit estimates to provide the information needed to scale the costs based on the magnitude of impacts to demonstrate how costs could change if impacts are more or less severe than modelled. Some impacts, such as impacts to cultural resources, are intentionally not monetized because monetization implies that such values are fungible – but because they are specific to place and history these values are generally not interchangeable with any other good or service.

The costs and damages calculated and described in this chapter are those that are attributable to the release of fuels from the CEI Hub. This distinction between what is attributable to the fuel releases and what is not is determined by establishing the baseline scenario and calculating damages that are in addition to that baseline. The baseline scenario is what would have occurred but for the CEI Hub fuel releases. In the case of CEI Hub fuel releases due to a CSZ earthquake, all damages caused by the earthquake are included in the baseline scenario, and therefore not included as costs and damages attributable to fuel releases from the CEI Hub.

## 2-2 Cost of Direct Impacts to People

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The spill and any resulting fires have the potential to cause direct physical impacts to people working at or near the CEI Hub when the earthquake occurs.<sup>2</sup> This analysis estimates the costs of direct impacts to people by estimating mortality and morbidity rates from explosions and fires at other fuel storage locations. Section 1-6.2.1 of Chapter 1 details the specific scenarios that could result in between 0 to 7 people killed, and 2 to 80 people injured. These mortality and morbidity rates do not consider any delays in emergency response or earthquake-related confounding factors that could result in higher rates of death and injury. These values do not include any mortality and morbidity caused by fires or people other than on-site workers being harmed by the event.<sup>3</sup> The values also do not include instances of suicide or mental health, which have been seen after other oil spills.<sup>4,5</sup> For this reason these values should be considered minimum estimates of total direct costs to people.

The standard approach for valuing changes in risk of mortality is the value of a statistical life (VSL). This approach relies on labor market data to decouple the marginal change in pay for working in a profession with a higher risk of mortality. Extrapolating these marginal changes into the value of a whole life produces a single dollar value that is regularly used in economic analysis. The current VSL used by the Federal Government in benefit-cost analysis is \$10.3 million.<sup>6,7</sup>

Estimates of injury (i.e., morbidity) are more difficult to discern than mortality because impacts can vary significantly by the type of harm incurred. The most appropriate equivalence to the injuries expected at the CEI Hub are workers compensation claims that include lost wages, medical expenses, and damages from pain and suffering. In 2016, the average worker's compensation payment was \$24,900.<sup>8</sup>

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<sup>2</sup> Other potential harms to people from impacts to air quality and water quality are discussed in later sections.

<sup>3</sup> Health effects from air quality are discussed in Section 2-7 of this Chapter.

<sup>4</sup> Hennessy-Fiske, M. (2010). "Suicide is called another casualty of BP oil spill". *The Los Angeles Times*. June 24. Available at: <https://www.latimes.com/archives/la-xpm-2010-jun-24-la-na-oil-spill-grief-20100625-story.html>

<sup>5</sup> Rung, A. L., Oral, E., Fonham, E., Harrington, D. J., Trapido, E. J., & Peters, E. S. (2019). The long-term effects of the Deepwater Horizon oil spill on women's depression and mental distress. *Disaster medicine and public health preparedness*, 13(2), 183-190.

<sup>6</sup> U.S. Environmental Protection Agency. (2016). *Guidelines for Preparing Economic Analyses*.

<sup>7</sup> All dollar values are reported in October 2021 terms using the Bureau of Labor Statistics' Consumer Price Index for all Urban Consumers (CPI-U). <https://www.bls.gov/cpi/>. Accessed November 30, 2021.

<sup>8</sup> Martindale-Nolo Research. (2016). *2016 Worker's Compensation Trends*. Available at: <https://www.lawyers.com/legal-info/workers-compensation/workers-compensation-settlements-awards/workers-compensation-settlements-and-awards-how-much-will-i-get-for-my-injury-or-illness.html>

Applying these values to the estimates of mortality and morbidity due to fuel releases from the CEI Hub that cause explosions and fire produces estimates that range from \$49,800 to \$74.1 million, summarized in Table 1 below.

Table 1. Costs to People due to an Explosion from CEI Hub Fuel Releases

|              | Low Rates of Mortality and Morbidity | High Rates of Mortality and Morbidity |
|--------------|--------------------------------------|---------------------------------------|
| Injury       | \$49,800                             | \$1,992,000                           |
| Mortality    | \$0                                  | \$72,100,000                          |
| <b>Total</b> | <b>\$49,800</b>                      | <b>\$74,092,000</b>                   |

Source: Calculated by ECONorthwest

## 2-3 Cost of Impacts to Property

### 2-3.1 Impacts to Waterfront Properties

Environmental quality is a key component of the price of residential real estate. Impairments to environmental quality can lead to reductions in property values, however, the transient nature of oil spills means that price changes are normally more pronounced during the period of maximum uncertainty that occurs immediately following an incident.<sup>9</sup> The measured drops in price for river- or ocean-front properties from oil spills range between 0 and 16 percent reductions in property value, with the effects typically disappearing after cleanup.<sup>10,11,12</sup> Persistent drops in home values after a spill cleanup may be attributable to changes in perceived risk of future spills.<sup>13,14</sup> This implies that for any risks of a spill about which homebuyers are already aware, the risk of a spill may be factored into property values. Changes in perceived risk that occur after a prominent spill may then result in more persistent declines in property values.

<sup>9</sup> Winkler, D. T., & Gordon, B. L. (2013). The effect of the BP Oil spill on volume and selling prices of oceanfront condominiums. *Land Economics*, 89(4), 614-631.

<sup>10</sup> Cano-Urbina, J., Clapp, C. M., & Willardsen, K. (2019). The effects of the BP Deepwater Horizon oil spill on housing markets. *Journal of Housing Economics*, 43, 131-156.

<sup>11</sup> Simons, R. A. (1999). The effect of pipeline ruptures on noncontaminated residential easement-holding property in Fairfax County. *Appraisal Journal*, 67, 255-263.

<sup>12</sup> Simons, R. A., Winson-Ceideman, K., & Brian, A. (2001). The Effects of an Oil Pipeline Rupture on Single-Family House Prices. *Appraisal Journal*, 410-418.

<sup>13</sup> Hansen, J. L., Benson, E. D., & Hagen, D. A. (2006). Environmental hazards and residential property values: Evidence from a major pipeline event. *Land Economics*, 82(4), 529-541.

<sup>14</sup> Roddewig, R. J., Brigden, C. T., & Baxendale, A. S. (2018). A pipeline spill revisited: how long do impacts on home prices last?. *The Appraisal Journal*, 86(1), 23-47.



Home values along the southern gulf coast dropped between 4 and 8 percent following the Deepwater Horizon oil spill in 2010, with effects lasting until 2015.<sup>15</sup> Earlier peer-reviewed work found a reduction in home values between \$21-\$28 per square foot, or 10.1 to 13.5 percent of sale prices, in gulf coast condominiums in Alabama in the 100 days following the same spill, while another study found only an 8.8 percent drop in prices during the summer months prior to the capping of the spill and no net price change following the capping.<sup>16</sup>

Other studies have examined the effect of spills on non-coastal properties. A 2001 study found a 10 percent drop in value of homes with property rights adjacent to the Patuxent River in Maryland following a major spill in April 2000.<sup>17</sup> This work was later expanded in 2018 to show that the negative effects on property values were not persistent, and no price difference was found for affected properties after 18 months following the incident.<sup>18</sup> Following a 1993 rupture of the Colonial Pipeline in Fairfax County, Virginia, homes within 2 miles of the pipeline decreased in value by up to 5.5 percent.<sup>19</sup> There was also a strong negative relationship found between home prices and proximity to the Olympic Pipeline in northwest Washington in the five years following a major rupture in 1999.<sup>20</sup>

### 2-3.1.1 Potential Property Value Impacts

Downstream riverfront properties between the I-405 and Longview bridges on the Columbia River, as well as properties on the Willamette River, Multnomah Channel, and Scappoose Bay could experience declines in real property value due to CEI Hub fuel releases. Applying a range of estimates from the empirical literature produces impacts that range from \$11.7 to \$35.4 million, summarized in Table 2.

Table 2. Estimated Residential Property Value Losses for Columbia Riverfront Properties

| Loss Scenario | Clark       | Multnomah    | Cowlitz     | Columbia    | Total               |
|---------------|-------------|--------------|-------------|-------------|---------------------|
| 4%            | \$1,489,000 | \$7,644,000  | \$1,253,000 | \$1,408,000 | <b>\$11,793,000</b> |
| 6%            | \$2,047,000 | \$10,511,000 | \$1,722,000 | \$1,936,000 | <b>\$16,216,000</b> |
| 8%            | \$2,977,000 | \$15,288,000 | \$2,505,000 | \$2,816,000 | <b>\$23,587,000</b> |
| 10%           | \$3,722,000 | \$19,110,000 | \$3,132,000 | \$3,520,000 | <b>\$29,483,000</b> |
| 12%           | \$4,466,000 | \$22,932,000 | \$3,758,000 | \$4,224,000 | <b>\$35,380,000</b> |

<sup>15</sup> Cano-Urbina, J., Clapp, C. M., & Willardsen, K. (2019). The effects of the BP Deepwater Horizon oil spill on housing markets. *Journal of Housing Economics*, 43, 131-156.

<sup>16</sup> Winkler, D. T., & Gordon, B. L. (2013). The effect of the BP Oil spill on volume and selling prices of oceanfront condominiums. *Land Economics*, 89(4), 614-631.

<sup>17</sup> Simons, R. A., Winson-Ceideman, K., & Brian, A. (2001). The Effects of an Oil Pipeline Rupture on Single-Family House Prices. *Appraisal Journal*, 410-418.

<sup>18</sup> Roddewig, R. J., Brigden, C. T., & Baxendale, A. S. (2018). A pipeline spill revisited: how long do impacts on home prices last?. *The Appraisal Journal*, 86(1), 23-47.

<sup>19</sup> Simons, R. A. (1999). The effect of pipeline ruptures on noncontaminated residential easement-holding property in Fairfax County. *Appraisal Journal*, 67, 255-263.

<sup>20</sup> Hansen, J. L., Benson, E. D., & Hagen, D. A. (2006). Environmental hazards and residential property values: Evidence from a major pipeline event. *Land Economics*, 82(4), 529-541.

Source: ECONorthwest analysis of assessor data from Clark, Multnomah, Cowlitz, and Columbia counties.

These values exclude commercial, industrial, and agricultural properties. Given that negative price effects have also been seen in properties near, but not adjacent to, rivers, it is possible that additional properties could experience temporary property value declines. In addition, due to the complexity of clean-up following a CSZ earthquake it is possible that the effects will persist longer than the two years of expected effects. Impacts of oiling would also occur to houseboats in the Multnomah Channel. Property value impacts to these in-water homes would likely be larger than the literature values used to calculate the losses. Given these considerations, the property value impact values in Table 2 should be considered minimum values of property value impacts.

These effects are likely to persist for approximately two years following the spill event, and do not include any other property value declines as a result of the CSZ earthquake. Most of the impacts to property values (65 percent) are in Multnomah County while the remaining 35 percent is split relatively evenly across Clark, Cowlitz, and Columbia counties. Realized market losses would be experienced by property owners who choose to sell during the period of depressed values. Even if a homeowner chooses not to sell and their property values eventually rebound, they will experience a loss of ability to enjoy the riverfront amenity of their property or may feel their enjoyment of living there will diminish due to the fear of future spills.

Most of the riverfront properties in the area are commercial, industrial, and other non-residential properties (about \$2.5 billion in total riverfront property value). Although these markets operate differently than residential markets, these properties could be subject to additional reductions in property value.

There are over 30 marinas or ports downstream of the CEI Hub but upstream of the Longview Bridge that would likely be oiled based on river transport from the spill site, particularly during higher winter river flow periods. There are over 4,000 boat slips on these properties and hundreds of floating houses. These in-river properties would experience direct oiling of their built property, in addition to oiling of the shoreline. We do not explicitly value the additional property damages from oiling, but acknowledge that it is a likely additional cost.

## 2-3.2 Impacts to Water Users

Downstream of the CEI Hub, the Columbia River is not a direct primary municipal water source. As such, there are not expected to be direct effects to water users from CEI Hub fuel releases. There are groundwater sources downstream of the CEI Hub that could have a hydrological connection with contaminated surface water. Because of these groundwater-surface water interactions, the groundwater supply may be contaminated in sites downstream from the spill. Heavy oils would pose particular risks to groundwater resources as they are more likely to sink, infiltrate, and remain in the environment over time.

Due to the risk of contamination, it is likely that downstream groundwater sources would need to be tested for volatile organic compounds and other hazardous materials. For example, the Ranney collector wells that supply water to the City of St. Helens are adjacent to the Columbia River and would likely require testing to ensure the water is not contaminated with residual fuels. Groundwater testing costs approximately \$380 per test.<sup>21</sup> Modern filtration systems should be able to remove any residual fuel materials. If water treatment systems fail to remove the fuel materials, then the costs of additional treatment methods would be in the millions of dollars.

Other permit holders for wastewater discharge and water intake could be affected, particularly those downstream of the spill. There are 153 permits for wastewater release into the Lower Columbia River for Oregon and 41 for Washington. For the duration of the cleanup period, these permit holders may be affected by not being allowed to discharge over this period.

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<sup>21</sup> Melstrom, R. T., Reeling, C., Gupta, L., Miller, S. R., Zhang, Y., & Lupi, F. (2019). Economic damages from a worst-case oil spill in the Straits of Mackinac. *Journal of Great Lakes Research*, 45(6), 1130-1141.

## 2-4 Cost of Impacts to Navigation

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Major oil spills often lead to closures of navigational shipping channels. The 2014 Texas City Y oil spill led to a five-day closure of the Houston Ship Channel, stranding nearly 100 vessels at the ports of Houston and Texas City.<sup>22</sup> Similarly, releases of fuel into the Willamette River, Multnomah Channel, or Columbia River would impact vessels that rely on these shipping channels for navigation when the channels are closed during the cleanup period. These vessels will incur costs due to increased expenses during the time of the delay. Additional operating expenses from delays include the costs of crew, maintenance and repair, and fuel costs.

The length of delays due to closure of the navigation channels depends on the length of cleanup. The most likely closure period is between three to seven days – but harm from the earthquake will complicate cleanup activities and could extend this timeframe further. This analysis provides estimates for one day and one week. The analysis uses the number of vessels that use navigation channels between the I-405 bridge on the Willamette River to the Longview Bridge located downstream on the Columbia River, as described in Section 1-6.3 in Chapter 1.

Vessel operating costs are based on hourly estimates from Nathan Associates (2012)<sup>23</sup> that are multiplied by 24 and inflated to 2021 dollars to obtain a daily closure cost on low, average, and high traffic days. Table 3 summarizes the average daily and weekly costs for the three types of volume days. A one-week closure of the navigation channel would result in operating costs of approximately \$16.2 million during a period of average vessel traffic.

Table 3. Average Daily Vessel Operating Costs in Area of Analysis (2021 Dollars)

| Vessel Traffic | Count of Vessels | Average Daily Operating Cost | Average Weekly Operating Cost |
|----------------|------------------|------------------------------|-------------------------------|
| Low            | 33               | \$1,690,000                  | \$11,830,000                  |
| Average        | 42               | \$2,315,000                  | \$16,205,000                  |
| High           | 47               | \$2,552,000                  | \$17,864,000                  |

Source: Calculated by ECONorthwest

Note: Values have been rounded to the thousands.

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<sup>22</sup> ESI Inc. (2014). Case Study – Houston Ship Channel Oil Spill. Available at: <http://www.green-marine.org/wp-content/uploads/2014/06/ESI-Case-Study-Houston-Shipping-Channel-Oil-Spill-V-1.01.pdf>. Accessed November 30, 2021.

<sup>23</sup> Nathan Associates Inc. (2012). *Economic Analysis of North Atlantic Right Whale Ship Strike Reduction Rule*. Prepared for the National Oceanic & Atmospheric Administration. December.

## 2-5 Costs of Impacts to Commercial Fisheries

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Fuel releases into the Willamette River from the CEI Hub have the potential to cause harm to aquatic species (see Section 1-6.6.1 in Chapter 1 for information about how species can be harmed by fuel releases). Many aquatic species in Oregon are sources of economic value because they contribute to commercial enterprises or contribute value to tribal and subsistence fisheries.<sup>24</sup>

Coastal commercial fisheries in Oregon have an annual harvest value of \$153.8 million (2017 dollars, excluding distant water fisheries).<sup>25</sup> Washington commercial fisheries generate approximately \$65.1 million in sales (2006 dollars).<sup>26</sup> This economic activity supports personal income for employees and owners who participate in harvest, as well as wholesalers, processors, and the many other supply chain operations that rely on catch from coastal waters. The Port of Astoria at the mouth of the Columbia River alone supports \$209 million in annual economic activity (i.e., output) from the direct and secondary effects of the commercial fishing industry.<sup>27</sup> Cowlitz County, which includes the Port of Longview on the Columbia River, had a commercial fishing value of \$380,000 in 2006.<sup>28</sup> Commercial fishing in the Lower Columbia River is dominated by salmon fishing. The Lower Columbia River accounts for 1.8 percent of the commercial fisheries sales in Washington and had a value of \$1.2 million in 2006.<sup>29</sup> There is limited commercial fishing in the Upper Columbia River, but the area does support recreational and tribal fishing. There is limited commercial fishing on the Willamette River. In addition to commercial harvest, fisheries in Oregon and Washington also support commercial charter fishing enterprises.

Tribal fisheries will be impacted in the same way as commercial fisheries. However, tribal fisheries could experience disproportionate adverse impacts because tribal fishing occurs in-river and is reliant on fish populations that are more likely to travel through the Lower Columbia River and be exposed to CEI Hub fuel releases. The residual contaminants from the CEI Hub failures could result in fishing advisories to limit consumption of aquatic species in

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<sup>24</sup> Impacts of fuel releases to recreational fishing is discussed in Section 2-6, impacts to tribal fisheries are discussed in Section 2-10.

<sup>25</sup> ECONorthwest. (2019). *Economic Contributions of Oregon's Commercial Marine Fisheries*. Prepared for Oregon Department of Fish and Wildlife. October.

<sup>26</sup> TCW Economics. (2008). *Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State*. Prepared for Washington Department of Fish and Wildlife. December.

<sup>27</sup> ECONorthwest. (2019). *Economic Contributions of Oregon's Commercial Marine Fisheries*. Prepared for Oregon Department of Fish and Wildlife. October.

<sup>28</sup> TCW Economics. (2008). *Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State*. Prepared for Washington Department of Fish and Wildlife. December.

<sup>29</sup> TCW Economics. (2008). *Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State*. Prepared for Washington Department of Fish and Wildlife. December.

this area.<sup>30</sup> These advisories are more likely to apply to resident, non-anadromous fish species such as trout, carp, brown bullhead, bass, and walleye. These species are also sources of food for people who participate in subsistence fishing – including both tribal and non-tribal populations.

To the extent that fuel releases impact harvestable catch there will be declines in economic activity (e.g., the income for operators and employees, number of jobs supported through direct and secondary effects, and contribution to economic value added in Oregon) and value for tribal and subsistence fisheries. The impact on commercial fisheries and charter operations will be proportional to any increases in the difficulty of catch. The Lower Columbia River commercial fisheries are the most likely to experience loss of revenue caused by declines in salmon populations because they are reliant on Columbia River Basin species. At-sea and coastal off-shore commercial fisheries have access to a range of species from other river basins.

If releases of fuel from the CEI Hub cause less reproduction of certain anadromous fish species during the spawning season that could reduce the population of the species in later years when they would have otherwise been available to be commercially harvested. Fish populations are also likely to be impacted by sedimentation from the earthquake and experience additional stresses that could harm survival and reproduction in the aftermath of the event.

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<sup>30</sup> There are currently fishing advisories for resident fish populations in the Lower Willamette River due to high concentrations of PCBs.



## 2-6 Cost of Impacts to Recreation

Recreation could be impacted by fuel releases from the CEI Hub due to contamination of water resources as well as any harm caused by fires ignited by the fuel releases. As discussed in Section 1-6.4 of Chapter 1, fishing, hunting, swimming, and boating are the most likely to be affected due to fuel releases. The impact to recreation will be closures initially until cleanup is complete, followed by water quality advisories and fish consumption advisories.

The cost to recreation is the value of the cancelled trips that cannot occur because of the fuel releases. The effects of the earthquake will also impact recreation because of harm to infrastructure like roads, docks, boat ramps, parking lots, as well as hazard trees. The lingering effects of fuel releases could lead to additional fish consumption and swimming advisories due to residual toxins in the water. Long-term impacts to recreation due to CEI Hub fuel releases would also occur if a fire damages recreational sites – particularly Forest Park because burned trees would take decades to replace with regrowth.

Recreational use associated with public goods is a source of two distinct types of economic value. The first, known as ‘consumer surplus’ accrues to recreators and is a measure of the difference between an individual’s willingness to pay to engage in outdoor recreation, and the amount they actually have to pay. Because many types of outdoor recreation do not have access fees that are competitively priced, these consumer surplus values can be substantial. Past empirical research has estimated an average consumer surplus value for motorized boating of \$68.14 per person per day. If the river is closed or contaminated as a result of releases from the CEI Hub, recreational boaters would do something else, and this value represents the loss to the participant that would be incurred from being unable to engage in their preferred activity.

Table 4. Per Person per Day Consumer Surplus Values by Activity Type (2021 Dollars)

| Activity             | Consumer Surplus Value |
|----------------------|------------------------|
| Fishing              | \$83.50                |
| Hiking               | \$98.60                |
| Hunting              | \$90.37                |
| Motorized boating    | \$68.14                |
| Nature related       | \$70.20                |
| Nonmotorized boating | \$127.17               |
| <b>Average</b>       | <b>\$80.13</b>         |

Source: Rosenberger, R. S., White, E. M., Kline, J. D., & Cvitanovich, C. (2017). Recreation economic values for estimating outdoor recreation economic benefits from the National Forest System. Gen. Tech. Rep. PNW-GTR-957. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Table 3.

Note: Inflated to 2021 dollars using the CPI Inflation Calculator. Values are for Forest Service Region 6: Pacific Northwest.

The second type of economic value that accrues from recreation is the economic activity that occurs. Recreators spend money on food, gasoline, lodging (if overnight), equipment purchases, and entry fees. During a spill, this economic activity would not accrue to these businesses. Average per trip expenditures are summarized in Table 5. These values represent the per trip spending that could be lost if trips do not occur due to fuel releases from the CEI Hub. This spending supports economic activity by supporting owners and workers where the spending

occurs and through supply chain effects. As an example of the magnitude of the importance of recreational spending, in 2019 the recreational fishing industry for the Lower Columbia River supported a total of \$7.29 million in economic contributions to Oregon.<sup>31,32</sup>

Table 5. Per Trip Expenditures by Activity Type (2021 Dollars)

| Activity         | Per Trip Expenditures |
|------------------|-----------------------|
| Fishing          | \$195.74              |
| Hunting          | \$386.95              |
| Shellfishing     | \$478.49              |
| Wildlife Viewing | \$97.89               |

Source: Dean Runyan. (2009). *Fishing, Hunting, Wildlife Viewing, and Shellfishing in Oregon, 2008*. Prepared for Oregon Department of Fish and Wildlife and Travel Oregon.

Note: Inflated to 2021 dollars using the CPI Inflation Calculator.

The impacts on fuel releases from the CEI Hub will be impacted by the damage caused by the earthquake to other infrastructure. In the short-term (days to weeks after the event) recreation will be limited due to access and potential contaminants from other sources. Fishing advisories after the event are most likely to cause long term impacts that are specific to CEI Hub fuel releases. A one-month closure of the Lower Columbia River and Lower Willamette River for salmonid fishing would result in a loss of consumer surplus of \$3.4 million and a loss of \$3.2 million in direct trip spending (2021 dollars), based on the number of anglers for 2020. These values do not account for any substitute trips to other sites or any additional fishery closures beyond the salmonid values provided in the recreational data (see Table 14 in Section 1-6.4.1 of Chapter 1). These values also do not account for non-fishing boating trips that could also be lost due to recreational access closures, or any other type of impacted recreation, such as closures due to fire damage.

<sup>31</sup> The Research Group, LLC. (2021). *Oregon Commercial and Recreational Fishing Industry Economic Activity Coastwide and in Proximity to Marine Reserve Sites for Years 2018 and 2019*. Prepared for Oregon Department of Fish and Wildlife, Marine Reserve Program and Marine Resource Program. June.

<sup>32</sup> The Lower Columbia River is defined as downstream of Bonneville Dam to the mouth of the Columbia River.

## 2-7 Cost of Impacts to Human Health

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Regardless of whether the fuel released from the CEI Hub would volatilize or burn, there are potential substantial acute air quality impacts to nearby residents, workers, and first responders. These air quality impacts present themselves as health effects, and due to the substantial volume of fuel spill, may be unavoidable.

### 2-7.1 Deepwater Horizon Health Costs

For people in the immediate area of fuel releases the primary risk is death or injury from explosions and fires. These potential harms are discussed in Section 2-2. Health impacts to people in the immediate area can also accrue from exposure to petrochemical fumes, both from vapor as well as fire plumes. The immediate area is the area where the fumes are located with the highest density during and immediately after the fuel releases. Workers and first responders are most at-risk to health effects from exposure in this area.

The Deepwater Horizon Oil Spill incident provides an example of health costs that can arise from large fuel spills. The Deepwater Horizon incident exposed response workers, volunteers, and residents to hazardous chemicals in the form of burning crude oil and from the clean-up chemicals, including Corexit oil dispersant. Many of the response workers were people who lived and work in the area, including fishermen who were valuable to use for their boats and labor.

The Gulf Long-term Follow-up Study (GuLFSTUDY) is a study overseen by the National Institute of Environmental Health Sciences to study the health of individuals who helped with the oil spill response and clean-up, took training, signed up to work, or were sent to the Gulf to help in some way after the Deepwater Horizon disaster.<sup>33</sup> A study of medical records for responses workers seven years after the event found that people involved in the oil spill cleanup operations still experience persistent alterations or worsening of their hematological, hepatic, pulmonary, and cardiac functions.<sup>34</sup>

In January 2013, a settlement was approved to compensate workers and residents for health effects from the oil spill. The medical settlement was included in the \$7.8 billion settlement for all private claims.<sup>35</sup> Not all people are allowed to file medical claims under this settlement agreement – people must have been either a “clean-up worker” or “resident” for at least 60 days during the timeframe of the spill and response. People who experienced acute conditions were eligible for a lump-sum payment amount of \$1,300 for response workers and \$900 for residents.

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<sup>33</sup> More information about the GuLFSTUDY is available at: <https://gulfstudy.nih.gov/en/index.html>

<sup>34</sup> D’Andrea, M. A., & Reddy, G. K. (2018). The development of long-term adverse health effects in oil spill cleanup workers of the Deepwater Horizon offshore drilling rig disaster. *Frontiers in Public Health*, 6, 117.

<sup>35</sup> NOAA, *Deepwater Horizon oil spill settlements: Where the money went*, Available at: <https://www.noaa.gov/explainers/deepwater-horizon-oil-spill-settlements-where-money-went>

As of 2019, BP has paid \$67 million toward medical claims and has funded an additional \$105 million effort to operate community-based health programs along the Gulf Coast.<sup>36</sup> There are reports of lump-sum values not being sufficient, difficulty navigating the process to submit medical claims, long timeframes to receive compensation, and difficulty obtaining compensation for chronic injuries among claimants. For these reasons, the \$172 million is not the full health costs of the Deepwater Horizon Oil Spill incident, but rather only the amount that was compensated out of much larger costs to human health. Despite the many, ongoing efforts to study health effects, there is no estimate of the total costs to human health from Deepwater Horizon.

## 2-7.2 Health Risks from Exposure to Toxins

Acute exposure to high levels of airborne gasoline chemicals has been shown to cause adverse respiratory, cardiovascular, and hematological outcomes. Respiratory illnesses have been observed in animals subject to prolonged exposure to concentrations of only 100 ppm over twelve weeks.<sup>37</sup> Cardiovascular and neurological issues have also been observed after prolonged exposure in animals and humans. Symptoms such as headaches, dizziness, eye irritation, breathing difficulties, and nausea can occur from acute gasoline exposure. Chemical pneumonia also is one of the primary risks of exposure to very high concentrations. A 2019 review of 26 studies on the effect of gasoline exposure on pulmonary function found a significant negative relationship between lung function and length of chemical exposure.<sup>38</sup> As demonstrated in the follow-up studies from the Deepwater Horizon incident, long-term health effects for clean-up workers and nearby residents include disorders and diseases of the blood, liver, and heart.<sup>39</sup>

In addition to physical health effects there are also mental health costs of oil spills. The most common mental health symptoms of large oil spill events are depression, anxiety, and post-traumatic stress disorder (PTSD).<sup>40</sup> Other mental health effects can include stress, suicide, domestic violence, and substance abuse.<sup>41</sup> There is also evidence of inequities in how mental

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<sup>36</sup> Sneath, S. (2019). "8 years after BP oil spill, thousands of medical claims still not paid". *NOLA*. Available at: [https://www.nola.com/news/environment/article\\_50997394-26d7-50c2-9a64-1a7d1eec1d45.html](https://www.nola.com/news/environment/article_50997394-26d7-50c2-9a64-1a7d1eec1d45.html)

<sup>37</sup> U.S. Department of Health and Human Services. (1995). *Toxicological Profile for Gasoline*. Atlanta, GA: Agency for Toxic Substances and Disease Registry. <https://www.atsdr.cdc.gov/toxprofiles/tp72.pdf>.

<sup>38</sup> Moghadam, S. R., Afshari, M., Moosazadeh, M., Khanjani, N., & Ganjali, A. (2019). *The effect of occupational exposure to petrol on pulmonary function parameters: a review and meta-analysis*. *Reviews on environmental health*, 34(4), 377-390.

<sup>39</sup> D'Andrea, M. A., & Reddy, G. K. (2018). The development of long-term adverse health effects in oil spill cleanup workers of the Deepwater Horizon offshore drilling rig disaster. *Frontiers in Public Health*, 6, 117.

<sup>40</sup> Weir, K. (2012). "Class Act: The Oil Spill's Reverberations". *American Psychological Association*. Available at: <https://www.apa.org/gradpsych/2012/03/oil-spill>

<sup>41</sup> MDB Inc. (2013). *Mental Health Following the Deepwater Horizon Oil Spill*. Prepared for the National Institute of Environmental Health Sciences. December.

health is experienced - lower income individuals are more likely to report a higher level of overall distress.<sup>42</sup>

In addition to acute health risks from exposure, there is also a risk of fatality in the immediate zones surrounding the potential fire location. Fatalities have occurred from inhalation of gasoline vapor at very high concentrations, above 5,000 ppm.<sup>43</sup>

### 2-7.3 Health Costs from Hazardous Air Quality

Airborne pollutants from CEI Hub fuel releases and fuel ignition are likely to lead to adverse health outcomes for the areas with high levels of immediate acute exposure to gasoline chemicals and the broader area of lower levels of particulate matter exposure. Exposure to particulate matter can cause a range of acute health impacts, which include non-fatal heart attacks, hospital admissions, emergency department visits, bronchitis, respiratory symptoms, asthma exacerbation, lost workdays, and minor restricted activity days.<sup>44</sup>

Each of these health impacts cause increases in health care costs, as well as decreases in welfare for the individuals affected. The EPA uses both components when evaluating the economic benefits and costs of air quality regulations. The economic cost per case for each ailment is summarized in Table 6. Column two of the table shows the derived rates of incidence of exposure to PM<sub>2.5</sub> levels for 4,000 tons of airborne gasoline chemicals based on scenario modelling for a fuel spill incident in California. Assuming a similar release of particulate matter from the CEI Hub spill (likely a conservative assumption, given that the magnitude of oil spilled would likely exceed 4,000 tons of airborne gasoline chemicals), the health costs to the population affected by exposure to the airborne gasoline would be approximately \$8.9 million based on exposure to all populations in Multnomah and Clark Counties. Additional long-term outcomes that could lead to more severe chronic health outcomes or mortality are possible but not quantified. As such, this estimated health cost should be taken as a lower bound estimate.

Table 6. Costs from Acute Exposure to Air Pollution from Oil Spill

| Health Effect                                     | Cost per Case | Cases per 1,000 Exposures | Cost of Exposure in Multnomah and Clark Counties |
|---|---------------|---------------------------|--|
| Non-Fatal Heart Attacks                           | \$157,540     | 0.02                      | \$4,969,000                                      |
| Hospital Admissions-Respiratory (all ages)        | \$37,366      | 0.01                      | \$165,000  |
| Hospital Admissions-Cardiovascular (over age 18)  | \$51,868      | 0.01                      | \$578,000  |
| Emergency department visits for asthma (all ages) | \$596         | 0.01                      | \$9,000  |

<sup>42</sup> Drescher, C. F., Schulenberg, S. E., & Smith, C. V. (2014). The Deepwater Horizon Oil Spill and the Mississippi Gulf Coast: Mental health in the context of a technological disaster. *American Journal of Orthopsychiatry*, 84(2), 142.

<sup>43</sup> U.S. Department of Health and Human Services. (1995). *Toxicological Profile for Gasoline*. Atlanta, GA: Agency for Toxic Substances and Disease Registry. <https://www.atsdr.cdc.gov/toxprofiles/tp72.pdf>.

<sup>44</sup> U.S. Environmental Protection Agency [U.S. EPA]. (2012). *Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter*. EPA-452/R-12-005.

| Health Effect                                    | Cost per Case | Cases per 1,000 Exposures | Cost of Exposure in Multnomah and Clark Counties |
|--|---------------|---------------------------|--|
| Acute bronchitis (age 8-12)                      | \$661         | 0.05                      | \$38,000   |
| Lower respiratory symptoms (age 7-14)            | \$30          | 0.67                      | \$23,000   |
| Upper respiratory symptoms (asthmatics age 9-11) | \$46          | 0.97                      | \$53,000   |
| Asthma exacerbation (asthmatics ages 6-18)       | \$79          | 2.42                      | \$210,000  |
| Lost workdays (ages 18-65)                       | \$212         | 4.30                      | \$333,000  |
| Minor restricted-activity days (ages 18-65)      | \$95          | 25.43                     | \$2,520,000                                      |
| <b>Total Avoided Morbidity Benefit</b>           |               |                           | <b>\$8,898,000</b>                               |

Source: Created by ECONorthwest using data from U.S. Environmental Protection Agency. (2012). *Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter*. Available at: <https://www3.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf>. Tables 5-18, 5-19 and 5-20.

Note: Values have been inflated to 2021 dollars using the BLS CPI-U. Level of exposure relates to a reduction of 4,000 tons of PM<sub>2.5</sub> in a seven-county area of California.

Estimating both acute and chronic medical costs can be done by taking a proportional value based on the Deepwater Horizon settlement claims. This is an imperfect and likely lower bound estimate because it is based on the environmental conditions and clean up that occurred in Deepwater Horizon, which was an event at-sea, rather than in a large urban metropolitan area. As discussed above, the values are for medical claims, rather than medical costs. For these reasons the estimates are likely a lower-bound value and actual health costs would be higher. Based on a value of \$1.28 per gallon from Deepwater Horizon (including \$105 million for community-based health programs) the total compensated costs for acute and chronic conditions would be between \$121 million to \$248 million, depending on the extent of fuel releases.

Table 7. Compensated Health Costs of CEI Hub Fuel Releases, Deepwater Horizon Transfer Method

|      | Gallons Released | Cost          |
|------|------------------|---------------|
| Low  | 94,634,005       | \$121,470,514 |
| High | 193,687,251      | \$248,613,486 |

Source: Created by ECONorthwest

## 2-7.4 Evacuation Costs

The air and water pollutant hazards and fire risk or possibility of active fires would trigger emergency evacuations in affected areas surrounding the CEI Hub. Based on the modeling of air pollutant dispersal (and depending on the weather and wind conditions during the spill), the areas likely facing toxic levels of pollutants would be immediately surrounding the tanks in the Linnton neighborhood, as well as the neighborhoods west and east of the St. John's Bridge (portions of the St. Johns, University Park, Cathedral Park and Portsmouth neighborhoods). If all census tracts areas within the outer extent of the air plume shown in the map are evacuated, this means a population of about 89,500 people will need to evacuate either to emergency shelter, friends and family, outside lodging, or other locations. Additional evacuations could occur as a precautionary measure. The harm to transportation infrastructure could increase the costs of evocations or make evacuations infeasible, which would increase health costs.



Costs accrue through a combination of providing emergency services, temporary lodging, gas, food, and other essentials. Other costs include those associated with missed work or additional physical or emotional health consequences. A 2003 study on the costs of a 1998 hurricane in North Carolina found that the direct costs to evacuees ranged from \$81 for households who moved to shelters and \$418 for residents who stayed in a hotel.<sup>45</sup> Although the length of stays away from home varied across survey respondents, the average length of time was 5 days.

Table 8: Evacuation Costs Per Household from Hurricane Bonnie

| Expenditure        | Hotel | Friends/Family | Shelter | Other |
|--------------------|-------|----------------|---------|-------|
| Lodging            | \$247 | \$0            | \$0     | \$0   |
| Food               | \$143 | \$95           | \$70    | \$26  |
| Entertainment      | \$19  | \$1            | \$4     | \$0   |
| Other              | \$8   | \$35           | \$7     | \$3   |
| Total Direct Costs | \$418 | \$131          | \$81    | \$30  |
| Percent of Cases   | 16%   | 6%             | 70%     | 9%    |

Source: Whitehead, J. C. (2003). One million dollars per mile? The opportunity costs of hurricane evacuation. *Ocean & coastal management*, 46(11-12), 1069-1083. Inflated to 2021 dollars using consumer price index data from the US Bureau of Labor Statistics.

Applying the costs breakdown from Table 6 to the 89,500 number of potentially evacuated residents (35,800 households) results in an estimated total cost of \$4.7 million in private costs borne by evacuees. This excludes the cost of providing shelter and emergency services during the evacuation, in addition to time and travel costs to residents and the costs of missed work.

## 2-8 Cost of Impacts to Habitats and Species

When hazardous chemicals and oil spill into the environment, natural resource Trustees are authorized by several federal and state laws to assess and recover damages for injury to natural resources and their supporting habitats.<sup>46</sup> These laws have outlined a Natural Resource Damage Assessment (NRDA) process that identifies the extent of harm as well as the amount of compensation necessary to make the public whole. The NRDA process relies on well-established environmental and economic measurement techniques under a strict legal and regulatory framework to ultimately determine the monetary damages as a result of environmental harm. This section of this report describes the potential magnitude, extent, and

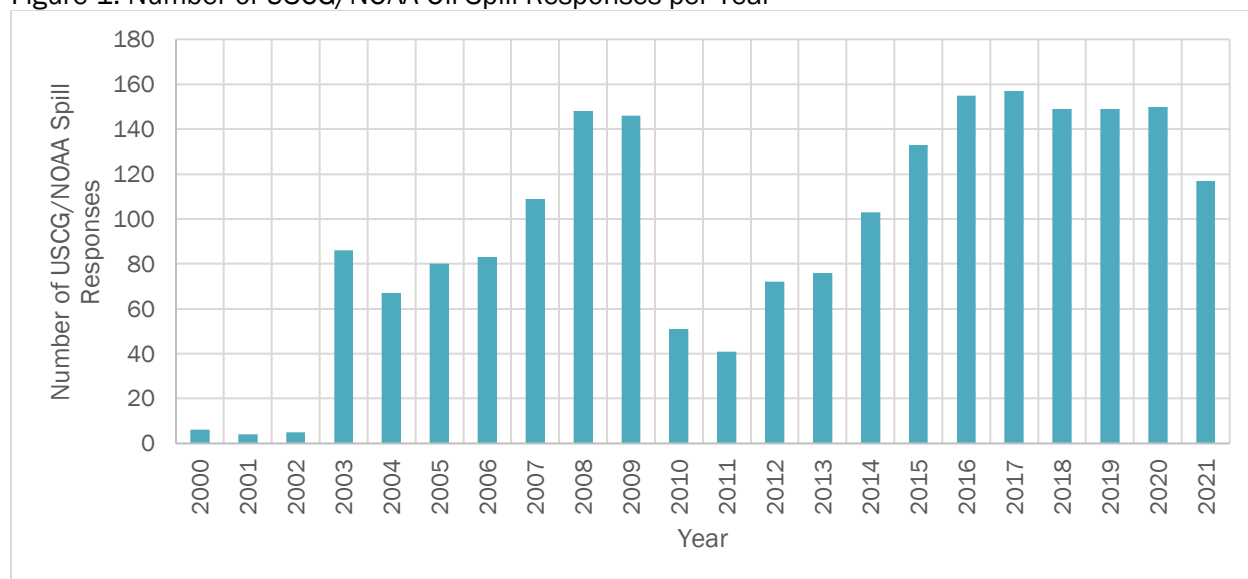
<sup>45</sup> Whitehead, J. C. (2003). One million dollars per mile? The opportunity costs of hurricane evacuation. *Ocean & coastal management*, 46(11-12), 1069-1083.

<sup>46</sup> Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 USC §9601, et seq. (CERCLA) and the Oil Pollution Act of 1990, 33 USC. §2701, et seq. (OPA).

duration of the environmental injury caused by a potential spill at the CEI Hub and the expected damages as determined by the NRDA process.

Unfortunately, oil spills in marine waters are not a particularly uncommon occurrence. Anytime there is a spill or potential spill in U.S. waters, the U.S. Coast Guard is notified and depending on the size of the spill, will engage NOAA's Emergency Response Division to provide emergency scientific support to aid in projecting the trajectory of the oil and identify potential resources at risk. From 2000 through 2021, NOAA's Emergency Response Division provided support for over 2,000 potential spills, with the last five years averaging approximately 150 incidents per year (Figure 1).<sup>47</sup>

Figure 1. Number of USCG/NOAA Oil Spill Responses per Year



Source: NOAA Office of Response and Restoration, Raw Incident Data. <https://incidentnews.noaa.gov/raw/index>. Accessed 11/17/21.

While this frequency of spills may seem discouraging from an environmental-quality perspective, it has resulted in a well-developed system for responding to and assessing oil spills in U.S. waters. Due to a combination of State and Federal statutes (including ORS 468 and the Oil Pollution Act of 1990), this same mechanism would be enacted following a spill at the CEI Hub. Following the release of oil into the environment, all NRDA's are structured to:

1. Evaluate the pathway by which the oil interacts with natural resources;
2. Measure the degree to which those resources are exposed to the oil;
3. Quantify the degree to which those resources are injured by the oil;
4. Identify a set of restoration projects that will adequately compensate the public; and

<sup>47</sup> NOAA Office of Response and Restoration, *Raw Incident Data*, available at: <https://incidentnews.noaa.gov/raw/index>.

5. Determine the damages as either the loss of value or the cost of restoration.

Most natural resources and ecosystems recover to their baseline state following an oil spill. This can be aided by cleaning up the contamination or implementing other techniques (i.e., primary restoration) to accelerate this recovery. However, even if an ecosystem fully recovers from a spill several years into the future, there is still a period of interim loss, during which the ecosystem was impaired because of the spill, and as a result, the public lost value. This interim loss can be addressed through compensatory restoration actions that "provide services of the same type and quality, and of comparable value as those injured."<sup>48</sup> For example, constructed or enhanced wetlands can serve as compensatory restoration for oiled wetlands. They can also serve as compensation for oiled birds by supplementing necessary habitats that may otherwise be regionally limited.

Determining the sufficient quantity of restoration is performed through one of several scaling techniques. When damages are determined via the cost of restoration that provides equivalent ecological services or resources, the appropriate amount of restoration is calculated using service-to-service or resource-to-resource methods.

When applied to habitats, techniques such as Habitat Equivalency Analysis (HEA) or the Habitat-Based Resource Equivalency Method (HaBREM) use metrics representing the set of ecological services or biological productivity flowing from a habitat (and their relative change as a percentage of total services provided) over time as inputs.<sup>49</sup> Using a fixed discount rate  $r$ , the present value stock of services,  $S$ , from a given habitat,  $h$ , is calculated as the integral of discounted service flows over time,  $t$ , multiplied by the spatial area,  $A_h$ , from which those services are generated.<sup>50</sup> This value, for a given habitat, is referred to as discounted service acre years ( $DSAYS_h$ ) and is calculated as:

$$DSAYS_h = A_h \cdot \int_t^T e^{-rt} \cdot (S_{h,0}(t) - S_{h,1}(t)) dt$$

The HEA/HaBREM approach measures both the loss of ecological services caused by an injury as well as the gain in services from a given restoration project.

When applied to resources (e.g., fauna), the Resource Equivalency Analysis (REA) method functions in a similar framework to HEA/HaBREM; however, it now captures the flow of ecological services provided by an animal over its lifetime. For instance, the general set of ecological services provided by an animal for any year related in present value terms is a discounted-species-year, or  $DSY$ . These services are provided in a binary condition by the

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<sup>48</sup> 15 CFR Part 990.53(c)(2)

<sup>49</sup> The HaBREM approach is a similar habitat-based assessment technique that can be applied to the measurement of ecological injury; however, the scaling metric applied is some objective measure of habitat productivity rather than the degree of ecological services provided. Additional discussion can be found in Baker et al. (2020).

<sup>50</sup> A description of the choice of the discount rate in HEA and REA can be found in Julius (1999).

existence of the animal, so marginal declines in services are not applied in a REA. *DSYs* for a given species are calculated:

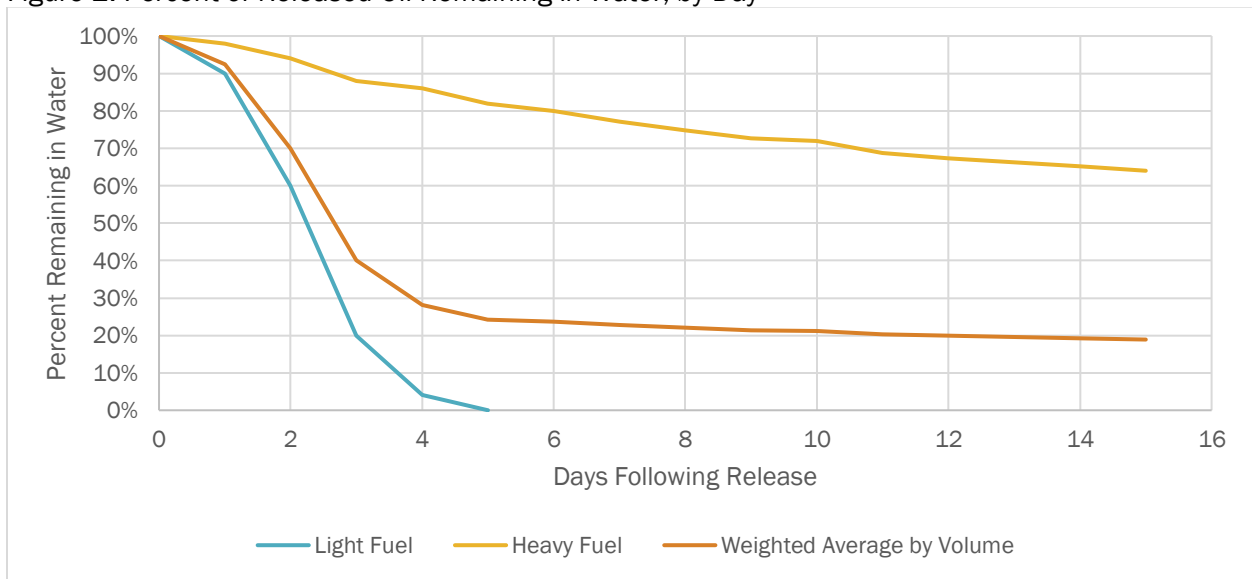
$$DSY_{s_a} = \int_t^T e^{-rt} \cdot (Q_{a,0}(t) - Q_{a,1}(t)) dt$$

where  $Q_a(t)$  is the quantity of animal-years in a given state. This approach can also incorporate information on the life history (e.g., survival and fecundity) of the species and incorporate population-level indirect measures of injury.

## 2-8.1 Release, Pathway, Exposure

As described in Section 1-4.2 of Chapter 1 of this report, oil released as a result of a failure at the CEI Hub will undergo both weathering and transport in the days following the spill. The degree of weathering – through dispersion or evaporation – is dependent on the type of oil, with lighter, more volatile fuels disappearing from the Willamette and Columbia Rivers more quickly than heavier fuels. While lighter fuels are more detrimental to air quality impacts, they are relatively less harmful in an aquatic environment. Figure 2 shows the percent of the oil that is expected to remain in the waters of the Willamette and Columbia Rivers, by day, following the release.

Figure 2. Percent of Released Oil Remaining in Water, by Day



Source: Enduring Econometrics

In a marine environment, oil spills tend to disperse across the surface of the water, with physical processes determining the ultimate thickness of the surface sheen and potential for accumulation on shorelines. In marine spills, oil sheens are generally categorized by thickness and visual characteristics, with “rainbow sheens” approximately less than 0.005 millimeters thick, “thin metallic-appearance films” between 0.005 and 0.08 millimeters thick, “emulsified

oil” between 0.08 and 1 millimeters thick, and strands of “thick, emulsified oil” that are generally greater than 1 mm in thickness.<sup>51</sup>

A riverine environment is fundamentally different, particularly when a sufficient volume of oil is released into a constrained area, leading to an increased thickness of the surface sheen and greater shoreline oiling. Current estimates of the quantity of oil expected to reach the Willamette and Columbia rivers (between 40.7 and 82.5 million gallons) divided by the total surface area where the oil is expected to travel (~89,405 acres) indicates that the release from the CEI Hub is large enough to generate sheens of nearly continuous emulsified oil through the rivers, even when accounting for the seasonal effects of river flow and weathering (Table 9).

Table 9. Expected Thickness of Oil Sheen on the Willamette and Columbia Rivers

| Season | Low-Release Estimate  | High-Release Estimate |
|--------|-----------------------|-----------------------|
| Winter | 0.30 (emulsified oil) | 0.60 (emulsified oil) |
| Summer | 0.08 (emulsified oil) | 0.16 (emulsified oil) |

Source: Enduring Econometrics

## 2-8.2 Injury to Habitats

This comparatively thick oil sheen will travel down the Columbia and Willamette rivers and accumulate along shorelines and in the river (Table 10). These habitats are essential in the life history of many animals, with wetlands and benthic environments providing particularly productive ecological services.

Table 10. Acres, by Habitat Type, Potentially Affected by CEI-Hub Release

| Habitat Type                   | Acres  |
|--------------------------------|--------|
| Wetlands                       |        |
| Freshwater Emergent            | 19,948 |
| Freshwater Forested/Shrub      | 19,475 |
| Estuarine and Marine           | 22,140 |
| In-Stream (Benthos)            |        |
| Freshwater Pond                | 1,485  |
| Lake                           | 7,123  |
| Riverine                       | 26,099 |
| Estuarine and Marine Deepwater | 54,698 |

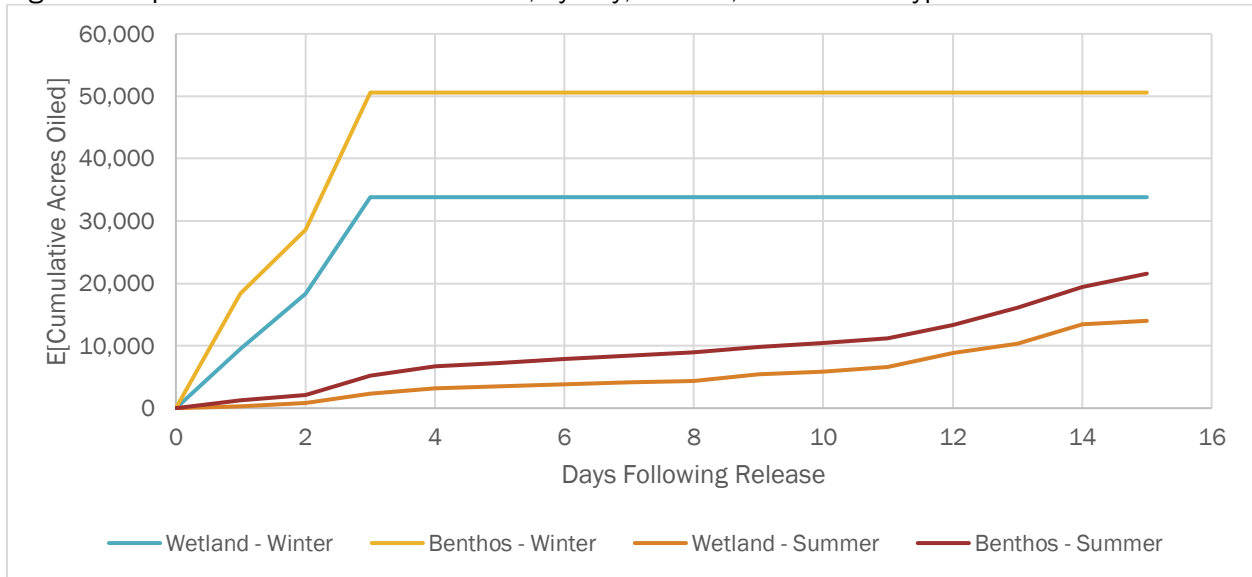
Source: Created by ECONorthwest using information from U.S. Fish and Wildlife Service, National Wetland Inventory mapper

The degree of oiling of these habitats is dependent on the fate and transport of the oil on the rivers, which, as described earlier, is dependent on the mix of oil released and the seasonal velocity of the rivers. In winter, higher river velocity will cause a larger density of oil to reach

<sup>51</sup> Svejkovsky, J., Hess, M., Muskat, J., Nedwed, T. J., McCall, J., & Garcia, O. (2016). Characterization of surface oil thickness distribution patterns observed during the Deepwater Horizon (MC-252) oil spill with aerial and satellite remote sensing. *Marine Pollution Bulletin*, 110(1), 162-176.

habitats further downstream before natural weathering of the released oil can occur. The comparative acres oiled by day following the release by habitat type are displayed in Figure 3. Due to the higher river flows, a release from the CEI Hub in winter will lead to a larger expected number of acres of habitat oiled compared to a release in summer.

Figure 3. Expected Cumulative Acres Oiled, by Day, Season, and Habitat Type



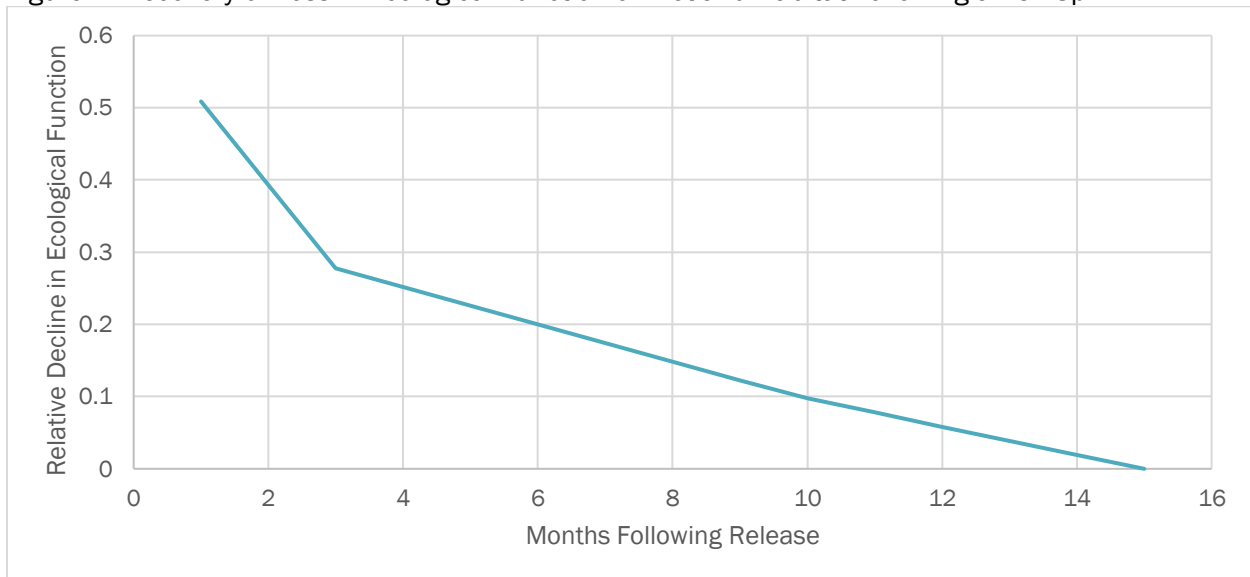
Source: Enduring Econometrics

After the oil accumulates in wetlands and along the river bottom, it causes both a physical injury and chemical injury to the ecological function of those habitats. Fortunately, these impairments are not permanent, and evaluations following other oil spills in estuarine environments found that the decline in function following an oil spill tends to resolve approximately 15 months following the release. While the initial injury can be profound (exceeding a 50 percent decline in ecological function) in the first months after a spill, as the oil weathers and moves around in a dynamic riverine environment, the initial injury slowly dissipates, and the habitats recover to a point where they eventually reach baseline conditions, as shown in Figure 4.<sup>52</sup> These effects can be exacerbated or mitigated by the initial baseline function of the habitat and other co-occurring anthropogenic stressors or cleanup activity.

<sup>52</sup> NOAA, et al. (2009). *Final Restoration Plan and Environmental Assessment for the November 26, 2004, M/T Athos I Oil Spill on the Delaware River near the Citgo Refinery in Paulsboro, New Jersey.*



Figure 4. Recovery of Loss in Ecological Function of Wetland Habitat Following an Oil Spill



Source: NOAA, et al. (2009). *Final Restoration Plan and Environmental Assessment for the November 26, 2004, M/T Athos I Oil Spill on the Delaware River near the Citgo Refinery in Paulsboro, New Jersey.*

### 2-8.2.1 Habitat Restoration as Compensation for Habitat Injury

The combination of the magnitude, extent, and duration of the injury to wetland and benthic habitats, applied to a HEA or HaBREM framework, provides a calculated value of either DSAYs or some other present value measure of lost ecological productivity. This value is then compared to the gains from potential restoration projects, measured using an equivalent or comparable metric. While wetlands and benthic habitats provide different types of ecological services, their relative productivity can be scaled to a single type of wetland restoration project. Specifically, an acre of wetland generally contributes 2.5 times as much productivity to ecological function as an acre of riverine benthic habitat.<sup>53</sup> Applying this scaling factor allows a single restoration type (constructed wetland) to compensate for both types of injured habitat.

Constructed wetland restoration generally takes areas that (prior to human involvement) were historically naturally occurring wetlands and reverts them to wetlands by improving the underlying hydrology and introducing native plant species. This can occur either through filling dredged river areas, removing levees or berms, or removing fill that had been used to elevate former wetlands. Following the construction of a wetland, it still takes several seasons (and up to 18 years) for the habitat to become fully colonized and begin producing ecological services of the same type and function as the habitat it was designed to replace.<sup>54</sup> These

<sup>53</sup> NOAA, et al. (2009). *Final Restoration Plan and Environmental Assessment for the November 26, 2004, M/T Athos I Oil Spill on the Delaware River near the Citgo Refinery in Paulsboro, New Jersey.*

<sup>54</sup> Baker, M., Domanski, A., Hollweg, T., Murray, J., Lane, D., Skrabis, K., ... & DiPinto, L. (2020). Restoration scaling approaches to addressing ecological injury: the habitat-based resource equivalency method. *Environmental management*, 65(2), 161-177.

constructed habitats require extensive monitoring and adaptive management to ensure they become fully established.

These constructed habitats themselves, however, are not immune to the effects of climate change and sea-level rise and are generally expected to cease producing ecological benefits at some point in the future. The ecological service flows produced by the habitat from its construction to its eventual cessation of services can be similarly calculated in present value as a number of DSAYs or some other measure of productivity gained over time. Dividing the present value of ecological services or productivity lost as a result of the spill by the services or productivity gained from an acre of restoration determines the number of acres of restoration needed to fully compensate the public for the spill. Using a common set of injury and restoration metrics, a restoration project that is anticipated to be constructed five years following the spill, take 18 years to reach full function (per Baker et al., 2020) and produce compensatory ecological services for a total of thirty years, results in between 175 - 418 acres of constructed wetland necessary to compensate for the injury from the spill at the CEI Hub.

Table 11. Summary of Habitat Injury and Restoration Requirements from CEI Hub Spill

|        | Wetland-Equivalent DSAYs Lost due to Injury | Wetland DSAYs Gained from an Acre of Restoration | Acres Wetland Needed |
|--------|---|--|----------------------|
| Winter | 4,505                                       | 10.8   | 418                  |
| Summer | 1,885                                       | 10.8   | 175                  |

Source: Enduring Econometrics

## 2-8.3 Injury to Resources

The oil released into the environment causes additional direct and indirect mortality to birds, fish, and mammals that utilize and rely on the Willamette and Columbia Rivers. While the habitat is necessary for their vitality, the direct injury to animals as a result of oiling is an additive component of an NRDA injury assessment. There are many species of birds, fish, and marine mammals that are particularly susceptible to injury from a spill at the CEI Hub. NOAA Environmental Sensitivity Index (ESI) data identify the species and numbers of animals that utilize the Willamette and Columbia Rivers by river mile and time of year.<sup>55</sup> Cleanup costs for rescue and rehabilitation of species are included in “Response and Cleanup Costs” in Section 2-9 of this Chapter.

### 2-8.3.1 Avian Injury

Many birds use the rivers downstream of the CEI Hub for foraging, nesting, and as a stopover during seasonal migration. Birds are generally cannot discern oil from water and often become coated in oil if it is in waterways. This oil causes both a physical and chemical injury to the birds, with some dying soon after exposure to oil. For other birds, the oil disrupts their ability to shed water from their plumage, impairing foraging behavior and leading to starvation and

<sup>55</sup> NOAA Office of Response and Restoration, *Environmental Sensitivity Index Maps and Data*, available at: <https://response.restoration.noaa.gov/resources/environmental-sensitivity-index-esi-maps>.

eventual death.<sup>56</sup> A common visual following oil spills is the extensive cleanup and rehabilitation of oiled birds; however, following their release, these birds still exhibit high rates of mortality and generally do not re-enter the breeding population.<sup>57, 58, 59</sup>

The expected avian injury from a spill at the CEI Hub is a function of both the degree of oiling, by river mile, and the seasonal population of birds. Table 12 below lists the potential population of birds exposed to oil by guild and river mile in summer, while Table 13 lists potential populations exposed in winter. The source of this data is the Environmental Sensitivity Index (ESI) classification system, which is environmental data designed and collected specifically to inform oil spill planning and response. ESI data characterize the marine and coastal environments and wildlife by their sensitivity to spilled oil.

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<sup>56</sup> Burger, A. E. (1993). Estimating the mortality of seabirds following oil spills: effects of spill volume. *Marine pollution bulletin*, 26(3), 140-143.

<sup>57</sup> De La Cruz, S. E., Takekawa, J. Y., Spragens, K. A., Yee, J., Golightly, R. T., Massey, G., ... & Ziccardi, M. (2013). Post-release survival of surf scoters following an oil spill: an experimental approach to evaluating rehabilitation success. *Marine Pollution Bulletin*, 67(1-2), 100-106

<sup>58</sup> Anderson, D.W., F. Gress, and D.M. Fry. 1996. Survival and dispersal of oiled brown pelicans after rehabilitation and release. *Marine Pollution Bulletin*. 32(10): 711-718;

<sup>59</sup> Anderson, D.W., S.H. Newman, P.R. Kelly, S.K. Herzog, and K.P. Lewis. 2000. An experimental soft-release of oil-spill rehabilitated American coots (*Fulica americana*): I. Lingering effects on survival, condition and behavior. *Environmental Pollution*. 107: 285- 294.

Table 12. Potential Bird Populations Exposed to Oil by River Mile (Day), Summer

| Day                                   | 1   | 2    | 3     | 4     | 5     | 6    | 7    | 8    | 9    | 10     | 11     | 12    | 13    | 14     | 15  |
|---------------------------------------|-----|------|-------|-------|-------|------|------|------|------|--------|--------|-------|-------|--------|-----|
| River Mile                            | 7.2 | 14.4 | 21.6  | 28.8  | 36    | 43.2 | 50.4 | 57.6 | 64.8 | 72     | 79.2   | 86.4  | 93.6  | 100    | 108 |
| Degree Oiling                         | 92% | 70%  | 40%   | 28%   | 24%   | 24%  | 23%  | 22%  | 21%  | 21%    | 20%    | 20%   | 20%   | 19%    | 19% |
| <b>Population Potentially Exposed</b> |     |      |       |       |       |      |      |      |      |        |        |       |       |        |     |
| Ducks                                 | -   | -    | 1,000 | 1,300 | 1,000 | -    | -    | -    | 300  | 20,250 | 40,000 | 6,000 | 1,000 | 1,000  | -   |
| Gulls                                 | -   | -    | -     | -     | -     | -    | -    | -    | -    | -      | 450    | 900   | -     | 41,300 | -   |
| Cormorants                            | -   | -    | -     | -     | -     | -    | -    | -    | -    | -      | -      | -     | 220   | 17,920 | 200 |
| Hérons                                | -   | -    | -     | 1,007 | -     | -    | -    | 100  | 100  | 120    | 700    | -     | -     | -      | -   |
| Bald Eagle                            | 2   | 2    | 8     | 22    | -     | 2    | 8    | 12   | -    | 44     | 16     | 62    | 44    | 38     | 16  |

Source: NOAA ESI Maps and Data, Available at: <https://www.fisheries.noaa.gov/inport/item/40258>.

Table 13. Potential Bird Populations Exposed to Oil by River Mile (Day), Winter

| Day                                   | 1       | 2      | 3       |
|---------------------------------------|---------|--------|---------|
| River Mile                            | 36.0    | 72.0   | 108.0   |
| Degree Oiling                         | 92%     | 70%    | 40%     |
| <b>Population Potentially Exposed</b> |         |        |         |
| Ducks                                 | 595,700 | 42,550 | 155,100 |
| Gulls                                 | -       | -      | 22,850  |
| Cormorants                            | -       | -      | 18,340  |
| Hérons                                | 1,007   | 320    | 700     |
| Shorebirds                            | 31,000  | -      | 2,000   |
| Bald Eagle                            | 32      | 66     | 176     |
| Brown Pelican                         | -       | -      | 20,000  |
| Sandhill Crane                        | 4,575   | -      | -       |

Source: Enduring Econometrics

Applying measures of the percent mortality of birds, by oiling category, from past spills to expected oiled populations by season in the Willamette and Columbia Rivers produces estimates of the direct injury from a spill at the CEI Hub. A REA evaluation of the life-histories of these species produces a discounted present value indirect injury of both future fledgling mortality and decreased reproductive success.<sup>60</sup> The resulting direct and indirect injury to birds as a result of a spill at the CEI Hub is presented in Table 14 and Table 15 below. The greater extent of oiling and increased presence of birds in winter results in a greater injury.

Table 14. Expected Bird Injury, Summer

|  | Ducks | Gulls | Cormorants | Hérons | Bald Eagle |
|--|-------|-------|------------|--------|------------|
| <b>Direct Injury</b>                                       | 826   | 645   | 261        | 17     | 2          |
| <b>Discounted Lost Productivity - Mortality</b>            | 1,621 | 929   | 519        | 24     | 3          |
| <b>Discounted Lost Productivity - Reproductive Failure</b> | 788   | 199   | 76         | 5      | -          |

Source: Enduring Econometrics

Table 15. Expected Bird Injury, Winter

|  | Ducks  | Gulls | Cormorants | Hérons | Shorebirds | Bald Eagle | Brown Pelican | Sandhill Crane |
|--|--------|-------|------------|--------|------------|------------|---------------|----------------|
| <b>Direct Injury</b>                                       | 35,159 | 719   | 544        | 50     | 5,386      | 5          | 281           | 148            |
| <b>Discounted Lost Productivity - Mortality</b>            | 68,981 | 1,035 | 1,081      | 70     | 7,737      | 7          | 393           | 207            |
| <b>Discounted Lost Productivity - Reproductive Failure</b> | 33,532 | 222   | 159        | 15     | -          | -          | -             | -              |

Source: Enduring Econometrics

<sup>60</sup> NOAA, et al. (2009). *Final Restoration Plan and Environmental Assessment for the November 26, 2004, M/T Athos I Oil Spill on the Delaware River near the Citgo Refinery in Paulsboro, New Jersey.*

### 2-8.3.2 Habitat Restoration as Compensation for Avian Injury

Bird populations are often habitat or food limited, and appropriate habitat restoration can serve as direct compensation for an injury to bird populations. This approach relies on directly relating the biological productivity of habitats to specific bird species and making adjustments based on their ecological efficiency (ability to convert wetland biomass into bird biomass).<sup>61</sup> Values vary by bird guild based on their average weight, the type of food they eat (vegetation, insects, or fish), and the ability of an acre of wetland habitat to provide sufficient additional food to support additional birds. This approach is regularly used to calculate the additional acres of wetland needed to compensate for a bird injury and utilizes a standard set of REA criteria in measuring benefits across time as the injury.<sup>62</sup> The full set of inputs necessary are listed in Table 16 below and result in an additional restoration requirement of between 39 – 1,219 acres of constructed wetland, depending on the season of the spill.

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<sup>61</sup> French McCay, D.P and Rowe, J.J. (2003). Habitat Restoration as Mitigation for Lost Production at Multiple Trophic Levels. *Marine Ecology Progress Series*. 264:233- 247.

<sup>62</sup> NOAA, et al. (2009). *Final Restoration Plan and Environmental Assessment for the November 26, 2004, M/T Athos I Oil Spill on the Delaware River near the Citgo Refinery in Paulsboro, New Jersey*.



Table 16. Habitat Restoration Scaling for Bird Injury, by Guild

|                                       | Ducks     | Gulls | Cormorants | Herons | Shorebirds | Bald Eagle | Brown Pelican | Sandhill Crane |
|---------------------------------------|-----------|-------|------------|--------|------------|------------|---------------|----------------|
| Average Wet Weight (kg)               |           |       |            |        |            |            |               |                |
| Adult                                 | 1.21      | 0.53  | 2.3        | 2.3    | 0.06       | 4.79       | 3.5           | 4.295          |
| Juvenile                              | 1.09      | 0.36  | 2.3        | 2.3    | 0.06       | 4.79       | 3.5           | 4.295          |
| Ecological Efficiency                 | 0.02      | 0.04  | 0.04       | 0.04   | 0.02       | 0.04       | 0.04          | 0.04           |
| Dry Weight to Wet Weight              | 0.22      | 0.22  | 0.22       | 0.22   | 0.22       | 0.22       | 0.22          | 0.22           |
| Dry Weight to AFDW                    | 0.8       | 0.8   | 0.8        | 0.8    | 0.8        | 0.8        | 0.8           | 0.8            |
| Compensatory Production Required      |           |       |            |        |            |            |               |                |
| Summer                                | 31,899    | 3,292 | 8,674      | 474    | -          | 109        | -             | -              |
| Winter                                | 1,357,669 | 3,667 | 18,058     | 1,372  | 6,929      | 259        | 10,369        | 6,708          |
| Spartina Marsh Secondary Productivity | 1,153     | 1,153 | 1,153      | 1,153  | 1,153      | 1,153      | 1,153         | 1,153          |
| Compensatory Acres Marsh Required     |           |       |            |        |            |            |               |                |
| Summer                                | 28        | 3     | 8          | 0      | -          | 0          | -             | -              |
| Winter                                | 1,178     | 3     | 16         | 1      | 6          | 0          | 9             | 6              |

Source: NOAA, et al. (2009). *Final Restoration Plan and Environmental Assessment for the November 26, 2004, M/T Athos I Oil Spill on the Delaware River near the Citgo Refinery in Paulsboro, New Jersey.*; French McCay, D.P and J.J. Rowe. 2003. Habitat Restoration as Mitigation for Lost Production at Multiple Trophic Levels. *Marine Ecology Progress Series*. 264:233- 247.

## 2-8.4 Aquatic Injury and Restoration

The lower Columbia River is an important habitat for a number of fish, including several species whose populations are threatened or endangered. Anadromous fish types expected to be harmed by the spill include both juvenile and adult sockeye, fall and spring chinook, Coho, chum, and summer and winter steelhead. Other species with high utilization of the spill area include starry flounder and white sturgeon. Due to the life histories of many of these species, direct mortality from an oil spill can result in substantial population impacts for many subsequent generations. Particularly at risk are juvenile migrating fry and embryos, with studies following the Exxon Valdez spill finding that elevated egg mortality continued for at least four years after the spill.<sup>63</sup>

Existing anthropogenic stressors on wild populations of fish make quantifying a potential aquatic injury particularly complex. Existing habitat degradation, impairment due to hydropower dams, competition with hatchery fish, and ongoing harvest are known as the “four Hs” impeding the recovery of these threatened and endangered species.<sup>64</sup> A spill from the CEI Hub will exacerbate these dynamics and potentially lead to a greater injury than would otherwise be observed in a non-threatened population.

Table 17 summarizes the threatened and endangered species that are present in the Lower Columbia River. The summer months have the highest returning populations, but species return throughout the year – meaning fuel releases from the CEI Hub could impact reproduction for these species no matter when the event occurs.

Table 17. Threatened and Endangered Species Present in the Lower Columbia River

| Species                          | Federal Status | Freshwater Entry Period |
|----------------------------------|----------------|-------------------------|
| Snake River Sockeye              | Endangered     | April to October        |
| Snake River Chinook              | Threatened     | February to October     |
| Lower Columbia River Chinook     | Threatened     | February to October     |
| Upper Willamette River Chinook   | Threatened     | February to October     |
| Upper Columbia River Chinook     | Endangered     | February to October     |
| Columbia River chum salmon       | Threatened     | October to December     |
| Upper Columbia River steelhead   | Threatened     | Year-round              |
| Snake River Basin steelhead      | Threatened     | Year-round              |
| Lower Columbia River steelhead   | Threatened     | Year-round              |
| Upper Willamette River steelhead | Threatened     | Year-round              |

<sup>63</sup> Rice, S. D., Thomas, R. E., Carls, M. G., Heintz, R. A., Wertheimer, A. C., Murphy, M. L., ... & Moles, A. (2001). Impacts to pink salmon following the Exxon Valdez oil spill: persistence, toxicity, sensitivity, and controversy. *Reviews in Fisheries Science*, 9(3), 165-211.

<sup>64</sup> Hoekstra, J. M., Bartz, K. K., Ruckelshaus, M. H., Moslemi, J. M., & Harms, T. K. (2007). Quantitative threat analysis for management of an imperiled species: Chinook salmon (*Oncorhynchus tshawytscha*). *Ecological Applications*, 17(7), 2061-2073.

| Species                         | Federal Status                  | Freshwater Entry Period    |
|---------------------------------|---------------------------------|----------------------------|
| Middle Columbia River steelhead | Threatened                      | Year-round                 |
| Pacific Eulachon/Smelt          | Threatened                      | December to May            |
| Bull Trout                      | Threatened                      | Not Anadromous             |
| Pacific Lamprey                 | None (State Species of Concern) | Parasitic (varies by host) |

Source: Oregon Department of Fish and Wildlife, Threatened, Endangered, and Candidate Fish and Wildlife Species, available at: [https://www.dfw.state.or.us/wildlife/diversity/species/threatened\\_endangered\\_candidate\\_list.asp](https://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp)

Early studies have estimated that the total cost of salmon recovery in the lower Columbia River is \$1.6 billion (in 2021 dollars), yet only approximately 22 percent of these costs have been fully funded.<sup>65,66</sup> While an estimate of the restoration costs of an aquatic injury are complex and very scenario-dependent, they may require sufficient funding of upwards of \$1.2 billion to minimally place fish in the lower Columbia River on a recovery trajectory, with a likelihood that the assessed restoration costs for just the impacts from the spill would be much lower. Surveys in Oregon and beyond suggest that households are willing to pay up to \$179 per year for recovery of salmon populations (2019 dollars).<sup>67</sup>

In past spills in riverine environments, aquatic restoration amounted to 3 percent of the cost of habitat and bird restoration. These estimated based on prior spills suggests a habitat injury restoration cost of \$580,000 to \$4.5 million, with a median value of \$2.5 million (Table 18). Fuel releases are less common in the Pacific Northwest, meaning that there are fewer empirical examples of the effect of large-scale fuel releases on native fish populations in this location. The actual costs are likely to be closer to the higher end of the range of the restoration costs due to the importance of aquatic species to the riverine ecosystems of the Columbia River and Willamette River.

Table 18. Estimated Aquatic Injury Habitat Restoration Costs

| Restoration                                | Total Cost |             | Median Cost |
|--|------------|-------------|-------------|
|  | Summer     | Winter      |             |
| Aquatic Injury (3% of habitat restoration) | \$587,912  | \$4,497,248 | \$2,542,580 |

Source: Enduring Econometrics

<sup>65</sup> Dennis Canty, Funding for Salmon Recovery in Washington State, Evergreen Funding Consultants, Olympia WA, March 2011, p. 6, <https://rco.wa.gov/wp-content/uploads/2019/07/GSRO-SalmonRecoveryFundingEvergreen-2011.pdf>. Accessed on 11/29/21.

<sup>66</sup> Washington State RCO (2020). State of Salmon in Watersheds in 2020. <https://stateofsalmon.wa.gov/statewide-data/funding/>. Accessed on 11/29/21.

<sup>67</sup> Lewis, D.J., Dundas, S.J., Kling, D.M., Lew, D.K., and Hacker, S.D. 2019. The non-market benefits of early and partial gains in managing threatened salmon. *PLoS ONE* 14(8): e0220260. <https://doi.org/10.1371/journal.pone.0220260>

## 2-8.5 Marine Mammal Injury and Restoration

Many marine mammals spend time in the lower Columbia River, including summer populations of approximately 1,100 California sea lions and 90 Stellar sea lions; and a year-round population of harbor seals that exceeds 1,800 animals.<sup>68</sup> While adult marine mammals rarely exhibit direct mortality from oil spills, they do exhibit serious health effects that cause an increased risk of death from disease, as well as loss of reproductive success following exposure to oil. Following the Deepwater Horizon Oil Spill, dolphins living in areas with higher concentrations of oil were more likely to exhibit hypoadrenocorticism, moderate to severe lung disease, and higher rates of early fetal loss and late-term abortions.<sup>69</sup>

Conversely, however, many marine mammals in the lower Columbia River are considered a nuisance species due to their predation of threatened and endangered salmonids. The Endangered Salmon Prevention and Predation Act of 2018 amended the Marine Mammal Protection Act (MMPA) to allow the removal of up to 540 California sea lion and 176 Steller sea lions between 2020 and 2025.<sup>70</sup> This population control measure is a direct response to the already depleted salmon populations. Thus, following an oil spill, it is unlikely that restoration will be conducted to enhance marine mammal populations that are already considered to be at nuisance levels. However, the amendments to the MMPA do not authorize other types of mortality to sea lions in the Lower Columbia, and any mortality due to an oil spill would still be a compensable injury. One possibility for compensating for the unpermitted take of marine mammals could be supplemental funding for salmonid restoration.

## 2-8.6 Restoration Costs

Scaling approaches used allow all habitat and resource injuries to be compensated through additional wetland restoration. These restoration costs can vary wildly by the type of restoration action, the availability of suitable acreage, and regional cost differences. Recent projects in the lower Columbia River range from \$31,500 to \$151,600 per acre.<sup>71,72</sup> Large restoration projects performed as compensation for an oil spill would likely land at the upper end of this range due to the scarcity of available restoration sites and expansive monitoring and

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<sup>68</sup> NOAA ESI Maps and Data. <https://www.fisheries.noaa.gov/inport/item/40258>. Accessed 11/19/21.

<sup>69</sup> Lane, S. M., Smith, C. R., Mitchell, J., Balmer, B. C., Barry, K. P., McDonald, T., ... & Schwacke, L. H. (2015). Reproductive outcome and survival of common bottlenose dolphins sampled in Barataria Bay, Louisiana, USA, following the Deepwater Horizon oil spill. *Proceedings of the Royal Society B: Biological Sciences*, 282(1818), 20151944.; Schwacke, L. H., Smith, C. R., Townsend, F. I., Wells, R. S., Hart, L. B., Balmer, B. C., ... & Rowles, T. K. (2014). Health of common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana, following the Deepwater Horizon oil spill. *Environmental science & technology*, 48(1), 93-103.

<sup>70</sup> National Marine Fisheries Service (2020). <https://www.fisheries.noaa.gov/feature-story/noaa-fisheries-authorizes-states-and-tribes-remove-sea-lions-preying-protected-fish>. Accessed 11/19/21.

<sup>71</sup> NOAA Restoration Center Community-based Restoration Program (2006). "Ramsey Wetland Complex Off-channel Habitat Design and Restoration."

<sup>72</sup> Crest (2020). Otter Point Restoration and Enhancement Project. LCREP Grant #03-2011.

adaptive management requirements. The expected total costs for habitat restoration are \$39.7 million should the spill occur in the summer, and \$304.3 million if it occurs in the winter.

Table 19. Estimated Habitat Restoration Costs

| Restoration                                | Acres Required |        | Average Cost per Acre | Total Cost                      |                      |
|--|----------------|--------|-----------------------|---------------------------------|----------------------|
|  | Summer         | Winter |                       | Summer                          | Winter               |
| Habitat Injury                             | 175            | 418    | \$91,575              | \$16,025,625                    | \$38,278,350         |
| Avian Injury                               | 39             | 1,219  | \$91,575              | \$3,571,425                     | \$111,629,925        |
| Total Habitat Restoration                  |                |        |                       | \$19,597,050                    | \$149,908,275        |
| Aquatic Injury (3% of habitat restoration) |                |        |                       | \$587,912                       | \$4,497,248          |
| Marine Mammal Injury                       |                |        |                       | Included in Aquatic Restoration |                      |
| <b>Total Restoration Costs</b>             |                |        |                       | <b>\$39,782,012</b>             | <b>\$304,313,798</b> |

Source: Enduring Econometrics

## 2-8.7 NRDA Assessment Costs

In addition to the restoration required as compensation, the Oil Pollution Act of 1990 requires responsible parties to pay Trustee assessment costs while also paying for their own consultants, attorneys, and contractors to navigate the NRDA process and implement restoration. As a share of total expenditure by PRPs, these assessment costs can be substantial. Following 1996 T/V Julie N oil spill in Portland, Maine, total costs of designing, implementing, and managing restoration amounted to \$1.8 million, while assessment costs totaled \$2.4 million (a multiplier of 1.2).<sup>73</sup> Including assessment costs and restoration costs, total damages from injury to habitats and natural resources are expected to range between \$87 million in the summer to \$669 million in the winter.

Table 20. Total Habitat and Resource Restoration and Assessment Costs

| Category                                  | Total Cost          |                      |
|---|---------------------|----------------------|
|   | Summer              | Winter               |
| Total Restoration Costs                   | \$39,782,012        | \$304,313,798        |
| Expected Assessment Costs                 | \$47,738,413        | \$365,176,557        |
| <b>Total Habitat and Resource Damages</b> | <b>\$87,520,425</b> | <b>\$669,490,356</b> |

Source: Enduring Econometrics

## 2-9 Response and Cleanup Costs

While the total NRDA costs are substantial, they only play a minor burden in the ultimate expenditure by responsible parties following an oil spill. Although sizable, past evaluations of

<sup>73</sup> Mauseth, G. S., & Csulak, F. G. (2003). Damage Assessment and Restoration Following the JULIE N Oil Spill: A Case Study. In *International Oil Spill conference* (Vol. 2003, No. 1, pp. 409-412). American Petroleum Institute.

oil spill response and NRDAs have estimated these total costs to amount to only 26 percent of the total known costs of an oil spill.<sup>74</sup> Other costs include penalties, third-party damages, and response and cleanup costs. This section focuses on the expected costs of responding to the spill, including the costs of cleaning up the oil using best practices to minimize harm to the environment.

There are many factors that affect the cost of responding to an oil spill. Magnitude of the spill, geography, type of oil, and the time of year all affect costs.<sup>75</sup> The concurrent effects of a CSZ event and the oil spill will severely limit agencies and companies from responding to an oil spill in a way they might in any other state of the world. Thus, these costs should be inferred as a substantial lower bound that do not take into account the broader response efforts expected in the days and weeks following the earthquake.

The amount of fuel spilled has a non-linear effect on cleanup costs. Larger spills are more logistically complex and may require additional technologies and resources that are not regionally available.<sup>76</sup> In addition to volume, the length of the shoreline oiled also has a dramatic, non-linear effect on cleanup costs for the same reasons.<sup>77</sup>

Aside from volume and linear shoreline, the type of oil spilled is a substantial determinant of cleanup costs. Lighter oils are easier to remove from the water; however, they produce significant health and safety hazards for response workers. On the other hand, heavier oils, while less volatile, are more persistent and produce a greater physical challenge for cleanup efforts. Combined, however, cleanup costs for lighter oils tend to be lower.<sup>78</sup>

Empirically analyses have evaluated past spills by volume and shoreline extent of oiling to determine a per-gallon cost of fuel spilled.<sup>79</sup> Applying those estimates to the projected oil-in-water estimate from the CEI Hub results in a range of costs that vary between \$109 million to \$1.4 billion, depending on the methodology applied (Table 21). The value of costs for fuel releases at the CEI Hub will likely be between these values because less booming/staging would be needed than for an open-water spill, but extensive shoreline treatment will still be required. The higher proportion of light fuels – compared to the heavier fuels that cause more oiling of shorelines – could result in lower levels of clean-up costs compared to the \$16.60 per gallon.

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<sup>74</sup> Helton, D., & Penn, T. (1999). Putting response and natural resource damage costs in perspective. In *International Oil Spill Conference* (Vol. 1999, No. 1, pp. 577-583). American Petroleum Institute.

<sup>75</sup> Etkin, D. S. (1999). Estimating cleanup costs for oil spills. In *International oil spill conference* (Vol. 1999, No. 1, pp. 35-39). American Petroleum Institute.

<sup>76</sup> Montewka, J., Weckström, M., & Kujala, P. (2013). A probabilistic model estimating oil spill cleanup costs—a case study for the Gulf of Finland. *Marine pollution bulletin*, 76(1-2), 61-71.

<sup>77</sup> Etkin, D. S. (2000). Worldwide analysis of marine oil spill cleanup cost factors. In *Arctic and marine oilspill program technical seminar* (Vol. 1, pp. 161-174). Environment Canada; 1999.

<sup>78</sup> Moller, T. H., Parker, H. D., & Nichols, J. A. (1987). Comparative costs of oil spill cleanup techniques. In *International Oil Spill Conference* (Vol. 1987, No. 1, pp. 123-127). American Petroleum Institute.

<sup>79</sup> Moller, T. H., Parker, H. D., & Nichols, J. A. (1987). Comparative costs of oil spill cleanup techniques. In *International Oil Spill Conference* (Vol. 1987, No. 1, pp. 123-127). American Petroleum Institute.



These cleanup costs are in addition to all aforementioned costs in the prior sections for impacts to habitats.

Table 21. Expected Range of Response and Cleanup Costs

| Source of Cost Estimate                            | Cost per Gallon | Volume Estimate |            | Total Response Cost |                 |
|--|-----------------|-----------------|------------|---------------------|-----------------|
|  |                 | Low             | High       | Low                 | High            |
| All Large Marine Spills                            | \$2.67          | 40,751,753      | 82,503,352 | \$108,807,181       | \$ 220,283,950  |
| Marine Spills with Similar Shoreline Oiling Extent | \$16.60         | 40,751,753      | 82,503,352 | \$676,479,100       | \$1,369,555,643 |

Source: Enduring Econometrics

## 2-10 Impacts to Cultural Values

Traditional monetary measures of economic importance are inappropriate to describe the value of cultural and tribal use of natural resources that could be impacted by fuel releases from the CEI Hub. Monetization implies substitutability (i.e., that monetary compensation at some level can make whole the loss of the service, because equivalent services may be purchased). Given that many, if not all, cultural services are defined by place, tradition, and continuity of use and practice, no alternative resource could provide a sufficient substitute for the resources in question. Because of the uncertainty, complexity, and inadequacy involved with identifying a monetary measure for cultural values, they are not monetized or quantified – but should be considered to have significant economic value and importance.

Federally recognized tribes do have Trustee authority to claim losses to cultural values, and several NRDA settlements include restoration projects to specifically address these injuries, separate from those designed to compensate for losses to habitats and resources. The federally recognized tribes that rely on the resources of the Willamette River and Columbia River include the:

- Confederated Tribes of the Warm Springs Reservation of Oregon,
- Confederated Tribes and Bands of the Yakama Nation,
- Nez Perce Tribe,
- Confederated Tribes of the Umatilla Indian Reservation,
- Confederated Tribes of Grand Ronde, and
- Confederated Tribes of Siletz.

## 2-11 Cost of Impacts to Fuel Prices

An indirect effect of fuel releases at the CEI Hub is a loss of the primary liquid fuel supply source for Oregon. The CEI Hub stores approximately 90 percent of Oregon’s liquid fuel

supply, including all of the jet fuel for the Portland International Airport and the gasoline and diesel for the Portland metropolitan region. The loss of the fuel supply would occur at the same time as other impacts from the Cascadia earthquake. As a result, pipelines, roads, tankers, barges, and other infrastructure would be impeded from delivering more fuel to the region. Because of the impacts to roads and transportation infrastructure, there will be less transportation, suggesting less demand for fuel. Fuel shortages caused by CEI Hub fuel releases will also result in delays and shortages for earthquake recovery efforts.

There will be fuel shortages after the fuel supply at the airport and commercial fueling stations is depleted. Much of Oregon will likely run out of gasoline and diesel within 1 week (based on the average six-day delivery cycle for pipeline transfers to the CEI Hub).<sup>80</sup> The Portland International Airport requires approximately 500,000 gallons of jet fuel per day and has limited storage on site.<sup>81</sup> The airport will likely run out of jet fuel in 1 to 2 days if pipeline deliveries stop due to damage or fuel releases. Truck capacities for jet fuel are only 10,000 gallons maximum, which would not be sufficient to replace the pipeline supply. Natural gas stored at the CEI Hub is used to address peak winter fuel demand – so there will potentially be higher natural gas costs if the CSZ earthquake occurs when demand for natural gas is high.<sup>82</sup>

The resulting shortage of fuel supply will likely result in price increases. While these price increases will be a response to increased scarcity, these changes tend to be “sticky” and relatively slow to respond, thus leading to shortages of fuel. Additional fuel will likely need to arrive by road or barge. Due to earthquake damage to transportation infrastructure, it will likely not be possible in the short-term to deliver fuel supplies to the Portland area or the Oregon coast. Areas of Oregon that are able to access alternative fuel supplies will experience higher fuel costs due to the costs of transportation and reduction in supply.

The disruption of the fuel supply will impose direct costs on all businesses that are reliant on commercial transportation. Some of these businesses will already be harmed by the effects of the earthquake because the roads are inaccessible for transportation. Other businesses will incur costs if their goods are not able to be delivered to them or if their products are not able to be distributed to their customers. Other business activities that are reliant on liquid fuel, such as manufacturing machines, may not be able to operate while the fuel shortage occurs.

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<sup>80</sup> Wang, Y., Bartlett, S.F., Miles, S.B. (2012). *Earthquake Risk Study for Oregon’s CEI Hub*. Prepared for Oregon Department of Geology and Mineral Industries (DOGAMI).

<sup>81</sup> Port of Portland. (2014). *Regular Commission Meeting Agenda*. January 8. Available at: [http://cdn.portofportland.com/pdfs/Jan14\\_AG\\_Fin.pdf](http://cdn.portofportland.com/pdfs/Jan14_AG_Fin.pdf)

<sup>82</sup> Only a maximum 10 percent of the supply from the natural gas tank at NW Natural is expected to be released. However, connection failures and other impacts from the earthquake could impede natural gas delivery to customers.

## 2-11.1 Price Effects

Although no perfect comparisons exist for the specific case of the Cascadia Subduction Zone Earthquake oil spills from the CEI Hub, several similar large-scale protracted supply shocks offer a good comparison for understanding the potential impact on fuel prices and fuel-dependent business activity.

The 2011 Great East Japan Earthquake caused fuel supply to be shut off to 1.66 million households in three prefectures of the Tohoku region in northern Japan for nearly six weeks.<sup>83</sup> After early periods of fuel buying following the earthquake, demand dropped by 30 percent after the earthquake. However, supply shutdowns due to earthquake damage in the Tohoku region (accounting for about a 30 percent drop in crude oil processed in the month after the earthquake) led to an overall jump in prices following the earthquake of about 1.1 to 3 yen per liter (about 4 to 12 cents per gallon in USD). The impacts of fuel shortages were alleviated by importing oil tank trucks from other regions to aid with long-distance oil transportation. This, coupled with the easing of regulatory restrictions by the government (such as lowering stockpiling requirements and promoting sharing of resources) allowed the supply and prices to rebound to pre-earthquake levels within about 3 months after the disaster.

### 2-11.1.1 Retail Gasoline Price Effects of Shutoff

The Colonial Pipeline, which provides refined petroleum products for nearly half of the eastern U.S., was forced to shut off service between May 7 and May 12, 2021, due to security and privacy concerns from a ransomware attack.<sup>84</sup> A gasoline shortage ensued across the mid- and lower-Atlantic, with rising prices seen throughout the pipeline's service area between New Jersey and Houston. Because the shortage was uncorrelated to other economic indicators, it provides a useful case study in the price and consumer effects of a pipeline failure. The analysis that follows uses the Colonial Pipeline shortage as a case study on the effects of a pipeline failure on fuel prices and consumer demand for gasoline.

Many East Coast states experienced acute price jumps in gasoline in the week or and week following the Colonial Pipeline service outage. Figure 5 shows data from Gas Buddy, a fuel price tracking app that publishes daily price data at the state- and metro-level for retail gasoline. Prices in Virginia and North Carolina jumped by about 7.5 percent, or 20 cents per gallon, between May 7, when the shutoff began, and May 16, when prices peaked following the shortage.<sup>85</sup> Oregon prices, which were unaffected by the shortage, are shown for reference.

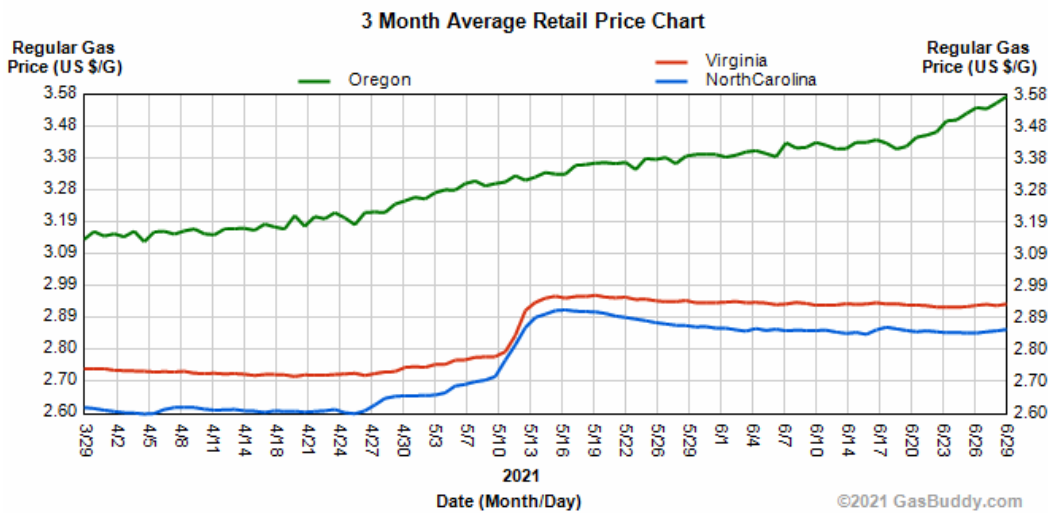
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<sup>83</sup> Asia-Pacific Energy Research Center. (2015). *The Impact on Oil Distribution by the Great East Japan Earthquake, and future issues and countermeasures*.

<sup>84</sup> Hall, M. (2021). "The Colonial Pipeline is back up, but gas shortages have gotten worse and it'll take time to make up the shortfall". *Business Insider*. Available at: <https://www.businessinsider.com/when-will-colonial-pipeline-gas-shortages-end-2021-5>

<sup>85</sup> GasBuddy, *18 Month Average Retail Price Chart*, available at: <https://www.gasbuddy.com/charts>

Figure 5: Retail Gasoline Prices in VA, NC, and OR: April to June 2021



Source: GasBuddy, 18 Month Average Retail Price Chart, available at: <https://www.gasbuddy.com/charts>

Data from the Energy Information Administration (EIA), which is reported weekly at the regional level, shows a similar trend across the Atlantic Region (which includes all East Coast states between Maine and Florida). Gas prices rose 8.6 and 16.1 cents per gallon in the region during the week of and week following the service shutoff, or a 5.6 percent net jump in prices<sup>86</sup> (Figure 5). During the last 10 years in this period, the average price change in the same period of May has been -0.2 percent, suggesting that all of this price increase is likely attributable to the service shortage.

The Colonial Pipeline shutoff had a differential effect on gas prices in states based on their reliance on the pipeline for their total fuel supply. The pipeline provides refined petroleum products to 45 percent of the East Coast US, but across states there is a large variation in the overall dependence on the pipeline for gasoline supply. Across much of the lower Atlantic, for example, over 70 percent of the supply of liquid fuel comes from the pipeline, while in Mississippi and the North Atlantic, less than 30 percent of gasoline is supplied by the pipeline Table 22. Factors such as the presence of port cities to receive fuel shipments and abundance of refineries in each state affects their overall dependence on the Colonial Pipeline for supply. The Plantation Pipeline, which runs parallel with much of the Colonial Pipeline, supports a smaller portion of the petroleum supply in each state.

The gulf coast states of Mississippi, Alabama and Georgia have a low, medium, and high level of reliance on the pipeline, respectively, and each experienced different gas price effects (Table 22). As shown in Figure 5, the higher reliance on the pipeline for gasoline supply was associated with a greater rise in gas prices. Although other factors may have contributed to this relationship, it suggests that states with a greater diversification of fuel supply sources may

<sup>86</sup> U.S. Energy Information Administration, *Gasoline and Diesel Fuel Update*, available at: <https://www.eia.gov/petroleum/gasdiesel/>

have been better able to maintain supply and avoid greater price surges during the pipeline shutoff.

Table 22: Gasoline Prices in Gulf Coast States During Colonial Pipeline Shutoff

| State       | Proportion of Liquid Fuel Provided by Colonial Pipeline | May 5 (\$/gal) | May 8 (\$/gal) | May 11 (\$/gal) | May 14 (\$/gal) | Total 11-day Price Increase (\$) |
|-------------|---|----------------|----------------|-----------------|-----------------|----------------------------------|
| Mississippi | Less than 30%   | \$2.57         | \$2.59         | \$2.64          | \$2.71          | \$0.14                           |
| Alabama     | Between 30% and 70%                                     | \$2.65         | \$2.68         | \$2.73          | \$2.84          | \$0.19                           |
| Georgia     | Over 70%  | \$2.69         | \$2.72         | \$2.85          | \$2.92          | \$0.23                           |

Source: GasBuddy and Colonial Pipeline

### 2-11.1.2 Market Implications of Pipeline Shutoff

Although primarily a supply-side phenomenon, the price effects were driven both by the reduced supply and increased demand for gasoline over concerns of a long-term shortage. According to data from GasBuddy, demand rose by 1.5 percent on the East Coast after the shutoff<sup>87</sup>.

The shutoff likely had other implications. The shutoff led to gas station outages in fifteen states and the District of Columbia during the weeks following the shutoff. Up to 88 percent of gas stations in DC had fuel outages at the height of the shortage, according to tracking by GasBuddy<sup>88</sup>. These outages, as well as long lines waiting for gasoline driven by jumps in demand, led to lost wages and productivity for those waiting to buy gas or those unable to fuel commuter vehicles. Additionally, some airlines altered their flight paths and were forced to find alternative sources of fuel<sup>89</sup>. The temporary high costs of fuel, gas outages, and effects on fuel-dependent sectors of the economy also likely had ripple effects on supporting industries.

### 2-11.1.3 Summary of Economic Effects of Colonial Pipeline Service Outage

In summary, a brief pipeline outage led to a prolonged two-week shortage of retail gasoline in the East Coast US, due to a supply crunch and the resultant panic-buying. This outage drove a roughly 16 cent increase in East Coast gasoline prices, with price jumps increases exceeding 20 cents per gallon in some states. This led to an estimated \$35 million in surplus prices paid by retail gasoline consumers on the East Coast over two weeks and may have imposed additional economic losses on workers, transportation industries and other fuel-dependent sectors. States

<sup>87</sup> GasBuddy. (2021). *National Average Sees Big Jump Thanks to Colonial Outage*. Available at: <https://www.gasbuddy.com/go/national-average-sees-big-jump-thanks-to-colonial-outage>

<sup>88</sup> GasBuddy. (2021). *Colonial Pipeline Shutdown: Fuel Outages by State*. Available at: <https://www.gasbuddy.com/go/colonial-pipeline-shutdown-fuel-outages-by-state>

<sup>89</sup> Krauss, C., Chokshi, N., and Sanger, D.E. (2021). "Gas Pipeline Hack Leads to Panic Buying in the Southeast". *The New York Times*. May 12. Available at: <https://www.nytimes.com/2021/05/11/business/colonial-pipeline-shutdown-latest-news.html>

that were less reliant on the pipeline for their fuel supply may have experienced less of a price drop in response to the shutoff.

#### 2-11.1.4 Estimating the Fuel Price and Consumption Effects in CEI Hub

The Oregon Department of Environmental Quality reported that about 1.738 million gallons of gasoline and 789.1 million gallons of diesel were consumed in Oregon in 2019. Given the nature of the projected fuel shutoff from a CEI Hub disaster, it is estimated that two primary forces will impose a cost for gasoline users. First, the loss of fuel will result in a temporary loss in ability to consume gasoline, particularly in any portions facing severe infrastructure damage. These losses will primarily be faced by residents in the Portland metro area. Second, the loss of fuel supply for the rest of the state will force other cities to meet fuel demand through importing from more costly sources. This means the rest of the state is likely to face higher prices of gasoline during the period of supply adjustment or potentially the entire duration that the CEI Hub is offline. These two portions of the total economic cost are quantified here.

First, the period of near total shutdown of fuel supply in the hardest-hit areas of Portland is expected to last anywhere from several days to weeks or even months. Conservatively assuming a loss of three days' worth of fuel supply to Portland, this translates to about 2.2 million gallons of lost gasoline consumption and 895,000 gallons of diesel consumption. Since the price of gasoline reflects the level of benefits people receive from its use, the value of the lost gasoline consumption reflects a lower boundary on the direct economic costs of the shutoff. At average current fuel prices in Oregon, this cost would be about \$11.7 million (Table 23).

Table 23: Value of Lost Fuel Consumption in Portland Following Spill

| Fuel Type | Price per Gal | Lost Consumption in Portland Over 3 Days (gal) | Value of Lost Consumption |
|-----------|---------------|--|---------------------------|
| Gasoline  | \$3.80        | 2,183,000                                      | \$8,297,000               |
| Diesel    | \$3.80        | 895,000  | \$3,400,000               |
| Total     | \$3.80        | 3,078,000                                      | \$11,697,000              |

Source: Created by ECONorthwest using gas price data from American Automobile Association, available at <https://gasprices.aaa.com/?state=OR>, and 2021 Clean Fuels Forecast by the Oregon Office of Economic Analysis and Oregon Department of Environmental Quality, available at: <https://www.oregon.gov/deq/ghgp/Documents/cfp-Forecast2021.pdf>.

Second, the fuel price effects are likely to be seen statewide as demand is met from more costly sources. Given the length of time for prices to adjust after the Japan earthquake and the Colonial Pipeline shutoff, it is likely that consumers across the state would face higher prices for the duration of time the CEI Hub is offline. The price increases seen in Georgia, which was over 70 percent dependent on the Colonial Pipeline for fuel supply, during the May 2021 shutoff were about \$0.23 per gallon, with prices remaining high even after the pipeline returned back to service. With average daily statewide gasoline consumption of 4.8 million gallons of gasoline and 1.95 million gallons of diesel, assuming only a temporary drop in demand, this means the total economic cost to consumers of the higher fuel prices may be between \$18.8 million (for a



two-week duration as during the Colonial Pipeline shutoff) and \$120.8 million (for a three-week duration as during the Great Japan Earthquake) (Table 24).

Table 24: Fuel Price Effects of CEI Hub Supply Interruption

| Fuel Type    | Assumed Increase in Fuel Price | <i>Two-Week Interruption</i> |  | <i>Three Month Interruption</i> |  |
|--------------|--------------------------------|------------------------------|--|---------------------------------|--|
|              |                                | Statewide Fuel Consumption   | Cost of increased prices to consumers (assuming highly inelastic demand) | Statewide Fuel Consumption      | Cost of increased prices to consumers (assuming highly inelastic demand) |
| Gasoline     | \$0.20                         | 66,663,000                   | \$13,333,000   | 428,548,000                     | \$85,710,000   |
| Diesel       | \$0.20                         | 27,317,000                   | \$5,463,000  | 175,611,000                     | \$35,122,000   |
| <b>Total</b> | <b>\$0.20</b>                  | <b>93,980,000</b>            | <b>\$18,796,000</b>  | <b>604,159,000</b>              | <b>\$120,832,000</b>   |

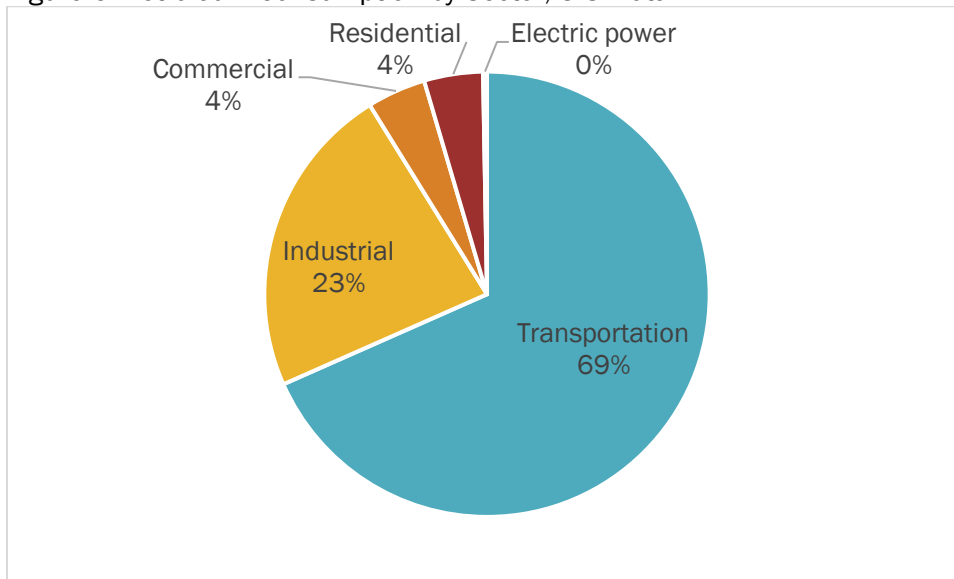
Source: ECONorthwest analysis of data from GasBuddy for states impacted by the Colonial Pipeline Shutoff and the 2021 Clean Fuels Forecast by the Oregon Office of Economic Analysis and Oregon Department of Environmental Quality, available at: <https://www.oregon.gov/deq/ghgp/Documents/cfp-Forecast2021.pdf>.

These costs do not include any costs caused by an inability to perform earthquake recovery efforts due to fuel shortages. To the extent that fuel scarcity impedes emergency response activities, there will be financial and non-financial costs, including injury and loss of life.

## 2-11.2 Business Responses

The direct effect of lost fuel supply would mean fuel-dependent businesses would likely face a temporary halt in operations until a replacement fuel source became widely available. Based on data collected by the Energy Information Administration, the transportation sector is the largest consumer of petroleum fuel (24 quadrillion btu annually in the U.S.), compared to about 8 quadrillion btu by the industrial sector and less than 2 btu for the commercial and residential sectors (Figure 6).

Figure 6. Petroleum Consumption by Sector, U.S. Total



Source: Created by ECONorthwest using data from the U.S. Energy Information Administration, *Gasoline and Diesel Fuel Update*, available at: <https://www.eia.gov/petroleum/gasdiesel/>

Although the transportation sector is most directly reliant on petroleum fuel, the commercial, retail and manufacturing sectors all rely on the transportation sector, in addition to many of the crucial emergency response activities. Because it is difficult to project infrastructure damage, it is uncertain how much the transportation sector and businesses that depend on transportation infrastructure to operate will be impacted. However, the Oregon Resilience Plan identifies transportation as a key sector to ensure an efficient and effective response to a Cascadia earthquake<sup>90</sup>. Fuel may be prioritized through directing initial resources to fuel depots for emergency and critical transportation use.

Fuel shortages, or higher-priced fuel, are both likely to compound the structural damages caused by the earthquake. About 80 percent of buildings in the Portland metro area are projected to suffer damage from the earthquake according to FEMA<sup>91</sup>. Since many retail and commercial businesses rely on electricity from non-petroleum fuel sources, these sectors would likely suffer more indirectly from supply chain disruptions or added costs from shipping and moving of intermediate and final goods.

<sup>90</sup> Oregon Seismic Safety Policy Advisory Commission (OSSPAC). (2013). *The Oregon Resilience Plan*. February. Available at: [https://www.oregon.gov/oem/documents/oregon\\_resilience\\_plan\\_final.pdf](https://www.oregon.gov/oem/documents/oregon_resilience_plan_final.pdf)

<sup>91</sup> U.S. Department of Homeland Security. (2011). *National Infrastructure Simulation and Analysis Center Homeland Infrastructure Threat and Risk Analysis Center Office of Infrastructure Protection National Protection and Programs Directorate*. November 18. Available at: <https://www.bluestonehockley.com/wp-content/uploads/2016/01/FEMA-earthquake-study.pdf>

## 2-11.3 Non-Commercial Costs

The fuel shortage will also impact households through disrupting the ability to commute to work, access childcare, or necessary services. Such costs may exacerbate existing inequities in access to work and essential goods and services. For example, a 2008 report found that working poor individuals spend a substantially higher portion of income on commuting—8.4 percent of total income for the working poor who drive to work compared to only 3.8 percent for other workers.<sup>92</sup> This means that added fuel costs are likely to hit low-income workers particularly hard. These fuel shortages will also complicate the ability for individuals to evacuate, add to prices at grocery stores, and constrain leisure travel.

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<sup>92</sup> Puentes, R., and Roberto, E. (2008). *Commuting to Opportunity: The Working Poor and Commuting in the United States*. Available at: <https://www.brookings.edu/research/commuting-to-opportunity-the-working-poor-and-commuting-in-the-united-states/>

## 2-12 Summary of Costs

The costs of fuel releases from the CEI Hub are from a variety of sources including both direct physical impacts, fuel market impacts, cleanup, and losses in economic value. Not all costs are able to be monetized due to lack of data, uncertainty, confounding variables caused by the earthquake, and/or difficulty valuing the resource. The costs are based upon a multitude of assumptions and scenarios about the type and magnitude of fuel releases, emergency response actions and timelines, and natural phenomenon like air, water, and fire dispersion. Table 25 summarizes the range of values for each category of costs. In addition to these values there could be other costs associated with rebuilding and repairing of fossil fuel infrastructure at the CEI Hub, if that occurs, such as environmental impact studies, infrastructure recertification, infrastructure abandonment, and other operational costs.

The minimum costs to society of potential fuel releases at the CEI Hub range from **\$359 million to \$2.6 billion**. Because not all costs were monetized, this range of costs represents only a portion of the total costs likely to be imposed on society from fuel releases from the CEI Hub. The social costs do not include fines, penalties, lost revenue, or equipment replacement costs borne by the CEI Hub operators. Prior large oil spills demonstrate the large costs to both society as well as the operating companies imposed by oil spill events. For example, Deepwater Horizon resulted in a total cost to BP of \$61.6 billion for all penalties, claims, and liabilities.<sup>93</sup> Although the fuel releases at CEI Hub would be occurring under very different circumstances than Deepwater Horizon, the similar volume of releases suggests that there could be similar large costs to CEI Hub operators. The subsequent chapter discusses if and how costs to society would be reimbursed through the existing claims processes.

Table 25. Summary of Costs of Fuel Releases from the CEI Hub due to a Cascadia Earthquake

| Category of Costs        | Summary of Costs  | Range of Monetized Costs for the Modelled Scenario |
|--------------------------|---|--|
| Direct Impacts to People | Assuming an explosion occurs, between 0 to 7 people could be killed and 2 to 80 people could be injured. The range of costs for mortality and morbidity are between \$49,000 to \$74.1 million, with an average cost of \$37.1 million. | \$49,000 to \$74.1 million                         |
| Impacts to Property      | Assuming fuels in the water travel downstream to the Longview Bridge, the potential impact on residential properties values is up to \$35.4 million. There is \$2.5 billion in total riverfront property value in the downstream area.  | \$11.8 million to \$35.4 million                   |
| Impacts to Navigation    | A one-week closure of the shipping channel between the I-405 bridge and Longview Bridge would result in additional operating costs for commercial vessels of between \$11.8 million and \$17.8 million.                                 | \$11.8 million and \$17.8 million                  |

<sup>93</sup> NOAA, *Deepwater Horizon oil spill settlements: Where the money went*, Available at: <https://www.noaa.gov/explainers/deepwater-horizon-oil-spill-settlements-where-money-went>

| Category of Costs               | Summary of Costs   | Range of Monetized Costs for the Modelled Scenario   |
|---------------------------------|--|--|
| Impacts to Fisheries            | To the extent that fuel releases reduce reproduction or cause direct mortality to aquatic species there will be a reduction in income to the fishing industry, impacting owners, employees, and suppliers who rely on these funds. Increases in hatchery production would likely be needed, which would result in additional costs.  | Not Monetized – Potential for significant mortality to commercial fisheries species and loss to commercial fishing entities  |
| Impacts to Recreation           | Average per-trip values of recreation for participants (i.e., consumer surplus) are between \$68 to \$130 per person per day. Recreationalists contribute spending to local economies at an average value of between \$98 to \$478 per trip. Cancelled recreational trips due to fuel releases would reduce both value for the participant and economic activity for the businesses that rely on the recreational spending. A one-month closure of the Lower Columbia River and Lower Willamette River for salmonid fishing would result in a loss of consumer surplus of \$3.4 million and a loss of \$3.2 million in direct trip spending.   | Not Monetized – Damage to recreational resources that cannot be easily rebuilt, such as fire damage to Forest Park, will result in long-term losses to recreation. |
| Impacts to Human Health         | The health costs of exposure to toxins for nearby people and response workers is \$121 million to \$249 million for both acute and chronic conditions. The primary health costs are increased risk of heart attack, decreases in productivity, and lost workdays. Additional costs would be borne from evacuations and strains on emergency response services.   | \$121 million to \$249 million – with potential for additional costs to mental health and non-documented physical health costs.                                    |
| Impacts to Habitats and Species | Habitats and species would be harmed from fuel releases. The costs of habitat restoration as compensation for habitat injury would require between 175 and 418 acres of wetland to be restored. An additional 39 to 1,219 acres of constructed wetland could be needed to compensate for injuries to bird populations. There is also the potential for compensation needed for aquatic and mammal species that are injured by the event. The expected total costs for habitat restoration are \$39.7 million in the summer and \$304.3 million in the winter. Total damages from injury to habitats and natural resources and required compensation are expected to range between \$87 million in the summer to \$669 million in the winter. | \$87 million to \$669 million  |
| Cleanup Costs                   | Cleanup costs are projected to be between \$109 million to \$1.4 billion.  | \$109 million to \$1.4 billion   |
| Impacts to Cultural Values      | Fuel releases in the Willamette River and Columbia River would harm cultural resources that are of particular importance to Tribal populations for subsistence, transportation, commerce, and ceremonial purposes. Impacts to this area would perpetuate historical inequities to a water resource already contaminated as part of the Portland Harbor Superfund.  | Not Monetized – Impacts to waterways and aquatic species like salmon would result in large cultural losses.  |
| Impacts to Fuel Prices          | Releases of fuel from the CEI Hub would reduce the supply of fuels needed for transportation and   | \$18.8 million to \$120.8 million – with additional  |

| Category of Costs            | Summary of Costs  | Range of Monetized Costs for the Modelled Scenario            |
|------------------------------|---|---|
|                              | commercial activity in Oregon. The effects of the earthquake on transportation infrastructure will alter the demand for fuels. A lack of fuel could constrain emergency response activities. The total economic cost to consumers of the higher fuel prices and reduction is between \$18.8 million and \$120.8 million. The lost value of consumption from fuel scarcity would be \$11.7 million for a three-day period. | costs from loss of consumption and delays in recovery efforts |
| <b>Total Monetized Costs</b> |   | <b>\$359 million to \$2.6 billion</b>                         |



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# Chapter 3: Financial Responsibility for Damages Resulting from a Spill at the CEI Hub

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**ECON**orthwest  
ECONOMICS • FINANCE • PLANNING

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## 3-1 Introduction

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Each of the categories of damages that result from a spill at the CEI Hub occur directly to individuals and businesses.<sup>1</sup> The existing legal frameworks at the state and federal levels are designed to transfer the financial responsibility of those damages to liable parties. While the ultimate determination of liability and potential misconduct that will contribute to the spill at the CEI Hub during a CSZ event is a legal question, the initial incidence of economic harm is relatively unambiguous. Workers who are killed, residents who must evacuate, and citizens nationwide that value the ecological resources of the Lower Columbia River all bear the initial costs of a failure to prevent or contain a spill at the CEI Hub. The ability for those harmed to recover those damages will be laid at the hands of a legal process that will undoubtedly take many years to resolve and may compensate individuals inequitably.

This chapter of the report details the incidence for each category of economic damages, describes some of the legal mechanisms to transfer damages to liable parties, and discusses some of the potential transaction costs and sources of inefficiency that may occur as a result of the spill.

As described in Chapter 2 for calculating damages, the values of damages described herein are expected values net of the greater harms that would be caused by the CSZ earthquake. In other words, the damages and associated liabilities represent those that are attributable to the CEI Hub and could be preventable if actions are taken to reduce the risk of fuel releases.

## 3-2 Legal Mechanisms to Transfer Damages

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Response to fuel releases in navigable waters of the United States are managed by a designated Federal On-Scene Coordinator and governed by Lower Columbia River response plans developed under the Oil Pollution Act of 1990. State and local governments would also participate in the response, while residents in the area would endure economic harm from evacuation, air pollution, and reduction in property values.

### 3-2.1 Oil Pollution Act

The Oil Pollution Act of 1990 (OPA), passed by Congress and signed into law in the wake of the Exxon Valdez oil spill, sets a framework for preventing oil spills along with a liability structure to recover damages.<sup>2</sup> The law carries with itself a pre-defined nomenclature, with companies who were transporting oil that spilled called “Responsible Parties” (RPs), any oil or hazardous substance designed to be burned to produce heat or power is called “fuel,” and any discharge

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<sup>1</sup> This economic analysis is based in an anthropocentric calculation of total economic value. Accordingly, damages incurred by individuals and businesses include economic harm as a result of injury to natural and cultural resources.

<sup>2</sup> 33 CFR 138.

or substantial threat of discharge into navigable waters or adjoining shoreline is called an “incident.”<sup>3</sup>

OPA is primarily designed to prevent oil spills. Under this law, all areas of the U.S. (including the Columbia River) have oil spill contingency plans. Individual tank vessels and certain facilities (including those in the CEI Hub) have response plans that detail how to deal with a worst-case discharge or substantial threat of such a discharge. Additionally, OPA requires the staging of oil spill response and removal equipment.

Aside from aiming to prevent oil spills in the first place, OPA holds RPs liable for certain damages and clean-up costs from a spill. Specific categories of damages include:

- **Natural Resource Damages** – “injury to, destruction of, loss of, loss of use of, natural resources, including the reasonable costs of assessing the damages” is recoverable by federal, state, tribal, and foreign natural resource trustees.<sup>4</sup> Natural Resource Damage Assessment (NRDA) is the legal process that agencies use to evaluate the impacts of oil spills on public natural resources.
- **Real or Personal Property** – “injury to, or economic losses resulting from destruction of, real or personal property” is claimable by anyone who owns or leases affected property.<sup>5</sup>
- **Loss of Subsistence Use** – “loss of subsistence use of natural resources” is claimable by anyone who “uses natural resources which have been injured, destroyed, or lost.”<sup>6</sup>
- **Lost Profits and Earning Capacity** – “loss of profits or impairment of earning capacity” is claimable by anyone with loss of profits or income.<sup>7</sup>
- **Loss of Government Revenues** – “net loss of taxes, royalties, rents fees, or net profit shares” are recoverable only by the federal government, states, and local governments.<sup>8</sup>
- **Increased Public Services** – the net cost of “increased or additional public services during or after removal activities, including protection from fire, safety, or health hazards” is claimable only by states and local governments.<sup>9</sup>

RPs are liable for removal costs and damages that are attributable to their release of oil. They are not responsible for damages that would have occurred regardless of the fuel releases. This distinction between what is attributable to the fuel releases and what is not is determined by establishing the baseline scenario and calculating damages that are in addition to that baseline. The baseline scenario is what would have occurred but for the CEI Hub fuel releases. In the case

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<sup>3</sup> 33 CFR 138.20.

<sup>4</sup> 33 USC 2702(B2a).

<sup>5</sup> 33 USC 2702(B2b).

<sup>6</sup> 33 USC 2702(B2c).

<sup>7</sup> 33 USC 2702(B2e).

<sup>8</sup> 33 USC 2702(B2d).

<sup>9</sup> 33 USC 2702(B2f).

of CEI Hub fuel releases due to a CSZ earthquake, all damages caused by the earthquake are included in the baseline scenario, and therefore not the responsibility of the RPs. Establishing the specifics of the baseline scenario will be part of the legal process and likely subject to debate between injured and liable parties. The concept of baseline is critical importance in determining claims in the CSZ event and is likely to complicate the ability to determine the independent harms of the spill.

The baseline scenario will also determine what is covered by existing legal mechanisms and influence who is eligible to receive compensation. OPA is designed to cover only impacts that are net of the baseline scenario. For example, if impacts to navigation are part of the baseline scenario (i.e., they would have occurred regardless of the CEI Hub fuel releases due to other barriers in the rivers caused by the earthquakes) then the navigation operators might not be eligible to pursue claims under OPA. For these reasons the baseline scenario is critical for determining attribution of damages and what parties are eligible to use legal mechanism under OPA to recover damages.

OPA establishes liability limits for damages that vary by the type of facility. RPs at onshore facilities were originally liable for up to \$350 million per spill in 1990. Liability limits are updated annually using the CPI-U, and currently, onshore facilities have liability limits of \$672,514,900 per spill.<sup>10, 11</sup> While vessels are required to carry certificates of financial responsibility, onshore facilities are not. These liability limits can be waived if the discharge results from gross negligence or willful misconduct.<sup>12</sup>

Occasionally, oil spills cause damages that exceed the statutory liability limits established under OPA. For these situations, OPA established the Oil Spill Liability Trust Fund (OSLTF) managed by the U.S. Coast Guard's National Pollution Fund Center (NPFC). The OSLTF is primarily financed through a 9-cent per-barrel tax levied on refineries and importers/exporters of crude oil.<sup>13</sup> As of 2020, the OSLTF carries a balance of approximately \$7.3 billion.<sup>14</sup> The OSLTF makes up to \$50 million available per year to Federal On-Scene Coordinators to respond to spills and initiate NRDAs.<sup>15</sup> The remaining balance of the OSLTF is available to any person or entity that incurs removal costs or damages due to a spill.

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<sup>10</sup> 33 CFR 138.230.

<sup>11</sup> The liability limit applies to the responsible party of the onshore facility, which is defined as "any person owning or operating the facility" in 33 USC 2701 (32).

<sup>12</sup> 33 USC 2704(c).

<sup>13</sup> National Pollution Fund Center. About the OSLTF. [https://www.uscg.mil/Mariners/National-Pollution-Funds-Center/about\\_npfc/osltf/](https://www.uscg.mil/Mariners/National-Pollution-Funds-Center/about_npfc/osltf/). Accessed December 7, 2021.

<sup>14</sup> Department of Homeland Security (2020). Agency Financial Report for FY 2020. [https://www.dhs.gov/sites/default/files/publications/dhs\\_agency\\_financial\\_report\\_fy2020\\_vol2.pdf](https://www.dhs.gov/sites/default/files/publications/dhs_agency_financial_report_fy2020_vol2.pdf). Accessed December 7, 2021.

<sup>15</sup> Department of Homeland Security (2006). Oil Spill Liability Trust Fund Funding for Oil Spills. [https://www.uscg.mil/Portals/0/NPFC/docs/PDFs/OSLTF\\_Funding\\_for\\_Oil\\_Spills.pdf](https://www.uscg.mil/Portals/0/NPFC/docs/PDFs/OSLTF_Funding_for_Oil_Spills.pdf). Accessed December 7, 2021.

Any claims not paid by an RP can be submitted directly to the NPFC for payment from the OSLTF after 90 days. RPs are also able to recover certain costs incurred in their defense of claims. Specifically, this refers to costs associated with an "affirmation defense," where the RP is not the cause of the spill due to either an "act of God", "act of war", or a third party, or a "limit of liability defense," where the RP asserts that they have exceeded their liability limits and they are recoverable from the OSLTF.<sup>16</sup>

Under OPA, the term "act of God" is defined as "an unanticipated grave natural disaster or other natural phenomenon of an exceptional, inevitable, and irresistible character the effects of which could not have been prevented or avoided by the exercise of due care or foresight".<sup>17</sup> If an earthquake is determined to be an "act of God" then the RPs would not have legal liability under OPA (claims would instead be paid from the OSLTF). However, there is precedence for natural disasters not to be considered an "act of God". Hurricane Ida was not defined as an "act of God" because a hurricane of that magnitude in that area was to be expected with some regularity.<sup>18</sup> A similar argument could be made for a CSZ earthquake, but the determination would be made through the legal process.

Additional punitive measures are also included in OPA, with civil penalties totaling either \$32,500 per day or \$1,100 per barrel spilled. Incidents that are a result of gross negligence or willful misconduct incurs penalties of up to \$4,300 per barrel of oil discharged.<sup>19</sup> These penalties are generally deposited back into the OSLTF. There is no strict definition of when gross negligence occurs,<sup>20</sup> and this determination would likely be litigated to see if it applies to the RPs for fuel releases from the CEI Hub.

### 3-2.2 Oregon DEQ Oil Spill Preparedness Program

States are also permitted under OPA to establish funds to pay for costs or damages arising out of, or directly resulting from, oil pollution or the substantial threat of oil pollution.<sup>21</sup> ORS 468B.405 establishes fees on "covered vessels and offshore and onshore facilities to recover the costs of reviewing the plans and conducting the inspections, exercises, training activities" required for facility spill contingency plans. These fees total \$15,000 to \$20,000 per year for pipelines (depending on size), \$20,000 per year for onshore facilities, and other fees for vessels

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<sup>16</sup> National Pollution Fund Center. Oil Spill Claims. <https://www.uscg.mil/Mariners/National-Pollution-Funds-Center/claims/>. Accessed December 7, 2021.

<sup>17</sup> 33 USC 210(1)

<sup>18</sup> Henry, E.M., and Holden, R. (2021). Hurricane Ida and OPA's Acts of God. *The National Law Review*. September 16.

<sup>19</sup> U.S. Department of Justice, Environment and Natural Resource Division. Water. <https://www.justice.gov/enrd/water>. Accessed December 7, 2021.

<sup>20</sup> *Water Quality Insurance Syndicate v. United States of America*, Civil Action No. 15-789 (BAH), December 22, 2016.

<sup>21</sup> 33 USC 2718(b)



per trip. These fees go into the State Oil Spill Prevention Fund, which generates annual revenue of approximately \$1 million per year.<sup>22</sup>

ORS 468B.455 established an Oil Spill Control Fund, which is financed through penalties recovered for violations related to the willful or negligent discharge of oil. The Oil Spill Control Fund can be used to cover costs incurred for cleanup activities, as well as reviewing contingency plans, conducting training, and restoration activities. While an important and necessary resource that supplements the OSLTF, the Oregon Oil Spill Control Fund operates on a much smaller level, with a balance of slightly under \$30,000 at the end of 2020.<sup>23</sup>

### 3-2.3 Oregon State NRDA Statute

The State of Oregon has its own NRDA statute that gives the Oregon Department of Fish and Wildlife (ODFW) the authority to seek damages for the value of fish and wildlife injured or killed due to pollution.<sup>24</sup> This law is designed to supplement the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and provide additional State power to resolve claims. Regulations enacted pursuant to the NRDA statute provide specific detail on how ODFW will “investigate, document and assess the value of natural resource losses.”<sup>25</sup> The Oregon State NRDA statute is designed to enable the State to pursue smaller claims that might not be covered under existing federal statutes like CERCLA and OPA. Because fuel releases from the CEI Hub would be claimable under OPA, the State of Oregon would likely become a trustee and would settle through OPA – not the state NRDA process. The State of Oregon needs only to participate in one process to resolve claims.

The regulations are explicit in the methodology to calculate fish kills, fish life history, and survival rates. In addition to guidance on measuring biological harm, the regulations dictate the use of per-fish monetary values to calculate damages along with the replacement costs for fish and wildlife species.<sup>26</sup> The net economic value of lost or affected species must consider the “commercial, recreational, nonuse and other values associated with the resource.”<sup>27</sup>

### 3-2.4 Civil Claims

Many regulatory and common-law frameworks allow individuals who endure harm to pursue compensation for damages directly. Of all the categories of costs and damages resulting from a spill at the CEI Hub, personal injury claims are the only category not explicitly covered in OPA.

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<sup>22</sup> Oil Spill Contingency Planning Annual Report. (2020). Oregon Department of Environmental Quality. Available at <https://www.oregon.gov/deq/Hazards-and-Cleanup/Documents/erOilSpillPlan2020.pdf>.

<sup>23</sup> Ibid.

<sup>24</sup> ORS 468B.060.

<sup>25</sup> OAR 635-410-0000.

<sup>26</sup> Ibid.

<sup>27</sup> OAR 635-410-0030.

Any claims that directly impact people or human health would need to be brought in the local or state court system and would be subject to Oregon rules and precedent on claims for personal injury and wrongful death.

## 3-3 Transaction Costs and Inefficiencies

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Even a well-designed and efficient legal structure to transfer damages to liable parties will incur additional costs that may ultimately be borne in some manner by the liable/responsible party, the injured party, or society in general. These costs come in the form of transaction costs and the inefficiency of claims.

### 3-3.1 Claims Process

There are two types of claims that are covered under OPA – claims for removal costs and claims for damages. Removal costs are the costs that are associated with removal of the oil. Anyone may file a claim to the RPs for removal costs, including private parties, a State, and Tribal nations. Removal costs are recoverable as long as they were performed in accordance with the National Contingency Plan.<sup>28</sup> Claims are generally first presented to the RPs, then if not paid within 90 days, there is a court action or the claim is submitted directly to the OSLFT.

Claims for damages can be brought by both private and public entities, depending on the category of damages. Some damages are recoverable only by the federal government, Tribes, state governments, or other political subdivisions of states. These categories of damages include natural resource damages, loss of public revenue, and increased public services. The other categories of damages are recoverable by any person affected by the oil spill (see Section 3-2.1 for a summary of all damage types). Private claims can be combined into a class, which must be certified for members of the class to be included. Lawyers will often reach out directly to potential class members to seek their participation to enlarge the size of the class and amount of recoverable funds.

The CSZ earthquake complicates the assessment of harms attributable to fuel releases from the CEI Hub. For example, there will be fuel shortages due to both fuel releases at the CEI Hub as well as damage to transportation infrastructure that will limit the availability of replacement fuel. Similarly, costs to navigation could be incurred by vessel operators if the rivers are blocked from bridge failure(s) or debris upstream or downstream of the CEI Hub – regardless of fuel releases from the CEI Hub. If navigation is impacted from exogenous events other than CEI Hub fuel releases, then that will change the baseline scenario from which damages are calculated, affecting the value of damages attributable to the CEI Hub.

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<sup>28</sup> 33 USC 2702(b)

### 3-3.2 Transaction Costs

Transaction costs in the legal system accrue from hiring attorneys, consultants, and experts to develop claims and navigate the adjudication process. These costs can also transfer to the liable parties for many categories of damages. For instance, OPA allows natural resource trustees to recover all reasonable assessment costs, defined as "costs, legal costs, and other costs necessary to carry out this part; monitoring and oversight costs; costs associated with public participation; and indirect costs that are necessary to carry out this part."<sup>29</sup> Courts may also sometimes award attorney's fees. In both cases, the transaction costs are borne by the liable parties and are in addition to the costs the liable parties spend on their own defense. However, there may be other instances where plaintiffs hire attorneys with a contingency fee, in which they retain a share of the total damages awarded. In these cases, the plaintiffs bear the transaction costs.

### 3-3.3 Inefficiencies

Inefficiencies in the legal system primarily arise through the value of time and uncertainty. Even if damages are calculated as a sum certain value, litigation, appeals, and collection of an award can take years or decades. For instance, in 1990, the S/T American Trader oil tanker ran over its anchor off Huntington Beach, California, and spilled nearly 417,000 gallons of oil. The NRDA claims ended up going to trial, and it wasn't until 1997 that the trial was completed, and a jury awarded government agencies \$18.1 million for lost recreational use. The RP appealed, was successful in reducing the award to \$15.4 million, and ultimately settled with state and local governments for \$16 million in 1999.<sup>30</sup> This prolonged process introduces a cost and substantial risks inherent in litigation. Damages awarded by a court or jury might not fully capture the total damages claimed. Appeals of verdicts may also further reduce compensation.

### 3-3.4 Equitable Recovery

Due to transaction costs and inefficiencies, settlements of claims for civil damages – including those for natural resource damages – often are discounted. Following the Deepwater Horizon oil spill, a federal study estimated total economic value lost to natural resources to be at least \$17.2 billion.<sup>31</sup> However, in 2016 (six years after the spill), federal and state natural resource trustees settled natural resource damage claims for \$8.1 billion.<sup>32</sup> A substantial portion of that award has yet to be spent on restoration.<sup>33</sup> Despite making up only 47 percent of the estimated damages, the settlement was widely lauded and upheld by federal courts following an

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<sup>29</sup> 15 CFR 990.30.

<sup>30</sup> Chapman, D. J., & Hagemann, W. M. (2001). Environmental damages in court: the American Trader case. *The law and economics of the environment*, 319.

<sup>31</sup> Bishop, R. C., Boyle, K. J., Carson, R. T., Chapman, D., Hanemann, W. M., Kanninen, B., ... & Scherer, N. (2017). Putting a value on injuries to natural assets: The BP oil spill. *Science*, 356(6335), 253-254.

<sup>32</sup> U.S. Department of Justice. (2016). *Deepwater Horizon*. Available at: <https://www.justice.gov/enrd/deepwater-horizon>. Accessed December 7, 2021.

<sup>33</sup> NOAA, *Gulf Spill Restoration*, available at: <https://www.gulfspillrestoration.noaa.gov/>.

extensive public comment period.<sup>34</sup> This suggests that not all damages to parties will be recovered under OPA and some parties will have uncompensated costs resulting from fuel releases at the CEI Hub.

Uncompensated damages are most likely to occur for claimants with damages that are more difficult to prove. For businesses, the quality of their records will be critical to proving lost profits and/or earning capacity. For private individuals, the claims for recovery of damage to personal property and due to medical expenses could be difficult to prove that they are objectively attributable to CEI Hub fuel releases. In the Deepwater Horizon spill, health costs were claimable by coastal residents, first responders, and cleanup workers. Even if they are included in the claim, people with health symptoms are often not fully compensated for all costs they incurred. In the Deepwater Horizon spill, many claimants elected for lump sum payouts of \$900 to \$1,300 – which in some cases is less than the amount of their health care costs due to exposure to petrochemicals.<sup>35</sup>

The compensation process itself can also erode social capital in the communities that experience fuel releases. Interviews with Gulf Coast residents after Deepwater Horizon found that residents perceived “uncertainty, randomness, and unevenness in the compensation process which led to negative social comparisons and competition among community members”.<sup>36</sup> Fuel releases can also damage human capital by making a place a less attractive location to live and work, as evidenced by the impact to property values.

## 3-4 Incidence of Damages by Category

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Each of the categories of damages described in the previous sections of this report are detailed below, along with the individuals or organizations to whom they accrue. Where applicable, a potential legal framework and payment mechanism to transfer damages to liable parties is identified.

### 3-4.1 Direct Impacts to People

Assuming an explosion occurs, between 0 to 7 people could be killed and 2 to 80 people could be injured. No amount of money can restore the individual lives that would be lost if mortality occurs. The value of a statical life framework provides a potential monetary basis for the economic damages that could be recoverable under civil claims for personal injury and death.

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<sup>34</sup> NOAA, *Deepwater Horizon Settlements: Where the money went*, available at: <https://www.noaa.gov/explainers/deepwater-horizon-oil-spill-settlements-where-money-went>.

<sup>35</sup> *Plaisance, et al. v. BP Exploration & Production Inc., et al*, No. 12-968, U.S. District Court Eastern District of Louisiana Granting Final Approval of the Medical Benefits Class Action Settlement, January 11, 2013.

<sup>36</sup> Mayer, B., Running, K., & Bergstrand, K. (2015). Compensation and community corrosion: perceived inequalities, social comparisons, and competition following the Deepwater Horizon oil spill. In *Sociological Forum* (Vol. 30, No. 2, pp. 369-390). June.

The range of costs for mortality and morbidity are between \$49,000 to \$74.1 million, with an expected value of \$37.1 million. Initially, these damages accrue directly to workers injured and killed onsite or their families. Civil claims for personal injury or wrongful death can be filed through the court system, with all or a portion of damages potentially recoverable from liable parties. Compensation would occur via direct payment and may be reduced because of settlement (to account for litigation risk) and attorney's fees (if not awarded to the plaintiffs). The liable parties would incur their own litigation defense costs. Depending on the degree of injury, not all potential claimants might seek recovery of damages due to the transaction costs and risks of doing so.

### 3-4.2 Property

Assuming fuels in the water travel downstream to the Longview Bridge, the potential short-term impact on residential properties values is up to \$35.4 million. The initial damages accrue to all owners and renters of affected property. The market value reduction is an indication of the loss of economic value, so these damages accrue regardless of whether a property is sold or not. Property value claims can be filed under OPA and can be paid either by the RPs or the NPFC. Compensation would occur via direct payment and may be reduced because of settlement (to account for litigation risk) and attorney's fees. Depending on the degree of injury, not all potential claimants might seek recovery of damages due to the transaction costs. RPs would incur their own defense costs.

### 3-4.3 Navigation

A one-week closure of the shipping channel between the I-405 bridge and Longview Bridge would result in additional operating costs for commercial vessels of between \$11.8 million and \$17.8 million. The initial damages accrue to shipping companies, businesses relying on shipping, downstream consumers, and residents relying on earthquake response efforts. These losses are recoverable under OPA and can be paid either by the RPs or the NPFC. However, it may prove difficult to calculate losses for individuals or businesses not directly impacted by the navigation closure. For many consumers, these losses may be small, and transaction costs associated with filing a claim may preclude them from doing so. Any damages that are awarded may be reduced because of settlement (to account for litigation risk) and attorney's fees. RPs would incur their own defense costs.

### 3-4.4 Fisheries

To the extent that fuel releases reduce reproduction or cause direct mortality to aquatic species, there will be a reduction in income to the fishing industry, impacting owners, employees, and suppliers who rely on these funds. Initial damages accrue to the commercial fishing sector, with downstream effects impacting consumers if the losses result in price changes. Compensation would occur via direct payment, and these losses are recoverable under OPA and can be paid either by the RPs or the NPFC. Downstream consumer effects may be small (on a per-consumer

basis), and transaction costs may preclude the filing of claims. Any damages awarded may be reduced because of settlement (to account for litigation risk) and attorney's fees. RPs would incur their own defense costs.

### 3-4.5 Recreation - Consumer Surplus Values

Average per-trip values of recreation for participants (i.e., consumer surplus) are between \$68 to \$130 per person per day. These values are claimable by natural resource trustees as part of an NRDA claim under OPA. Compensation would occur via restoration projects designed to benefit recreational use in a manner that has a nexus to those activities that were affected. In this manner, lost recreational use is compensated; however, the actual individual recreators that had to change their behavior might not be. The total amount spent on restoration may be reduced because of settlement (to account for litigation risk), but all damages and reasonable assessment costs are claimable under OPA and would be paid either by the RPs or NPFC. RPs would incur their own assessment and defense costs.

### 3-4.6 Recreation - Consumer Spending

Outdoor recreation contributes spending to local economies at an average value of between \$98 to \$478 per trip. These losses initially accrue to local businesses that support recreation and are claimable under OPA. However, losses to businesses that do not exclusively serve recreators (i.e., gas stations) may be small or difficult to quantify on a per-business basis. Thus, some of these businesses may not file claims due to the associated transaction costs of doing so. Any damages awarded and paid by either the RPs or NPFC may be reduced because of settlement (to account for litigation risk) and attorney's fees. RPs would incur their own assessment and defense costs.

### 3-4.7 Human Health

The health costs to the population affected by exposure to airborne petrochemicals are approximately \$121 million to \$248 million. The primary health costs are increased risk of heart attack, decreases in productivity, and lost workdays. Initially, these costs accrue to individuals living or working near or downstream from the CEI Hub during the spill. These damages are not recoverable under OPA and would likely be pursued through civil claims for personal injury. Minor effects or those that may be confounded by time or comorbid conditions may be difficult to attribute to the spill and might not be claimed. Compensation would occur via direct payment and may be reduced because of settlement (to account for litigation risk) and attorney's fees (if not awarded to the plaintiffs). The liable parties would incur their own litigation defense costs. Depending on how potential litigation is structured, some injured parties could be left out of receiving settlement funds (see Section 3-3.4 for more information on potential inequities associated with the damage recovery process).



### 3-4.8 Habitats and Resources

Total damages from injury to habitats and natural resources and required compensation are expected to range between \$87 million in the summer to \$669 million in the winter. These values are claimable by natural resource trustees as part of an NRDA claim under OPA. Initial losses accrue to any citizens nationwide that hold value for the ecological resources and would be pursued on their behalf by natural resource trustees. Compensation would occur via restoration projects designed to replace or restore the ecological services lost because of the spill. Damages and all reasonable assessment costs would be paid for by the RPs or NPFC but may be reduced because of settlement (to account for litigation risk). RPs would incur their own assessment and defense costs.

### 3-4.9 Clean-up Costs

Total costs to clean up to oil spilled from the CEI Hub may range between \$109 million to \$1.4 billion. These costs are fully recoverable under OPA and would be paid for by the RPs. Should the RPs become financially insolvent following the spill, the remaining costs would be paid for by the NPFC.<sup>37</sup>

### 3-4.10 Cultural Values

Fuel releases in the Willamette River and Columbia River would harm cultural resources that are of particular importance to Tribal populations for subsistence, transportation, commerce, and ceremonial purposes. These losses accrue to regional Tribes and are claimable under OPA for federally recognized Tribes. Compensation would occur through restoration designed to replace or enhance these cultural services. Past NRDA settlements have included cultural exchange and apprenticeship programs. For example, the St. Lawrence NRDA settlement included over \$8.3 million in cultural restoration projects, in addition to the nearly \$7.3 million made available for ecological restoration.<sup>38</sup> Restoration costs and all reasonable assessment costs would be paid for by the RPs or NPFC but may be reduced because of settlement (to account for litigation risk). RPs would incur their own assessment and defense costs.

### 3-4.11 Fuel Prices

The total economic cost to consumers of the higher fuel prices and reduction is between \$18.8 million and \$120.8 million. The lost value of consumption from fuel scarcity would be \$11.7

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<sup>37</sup> Clean-up costs are not subject to liability limits under OPA.

<sup>38</sup> St. Lawrence River Environment Natural Resource Damage Assessment: Restoration and Compensation Determination Plan and Environmental Assessment. (2013).

[https://www.fws.gov/northeast/nyfo/ec/files/stlawrence/RCDP\\_Full\\_Final%20Revised%20May\\_2013.pdf](https://www.fws.gov/northeast/nyfo/ec/files/stlawrence/RCDP_Full_Final%20Revised%20May_2013.pdf). Accessed December 13, 2021.

million for a three-day period.<sup>39</sup> These costs would accrue to consumers throughout the state. While these costs may conceptually be pursued under OPA (as lost profits or income) or as a set of civil claims, they are unlikely to be. Price increases are an efficient response to scarcity, and the transaction costs associated with pursuing a large number of relatively small individual claims complicate the ability to quantify and recover these damages. Furthermore, past incidents that led to price shocks (e.g., the 1973 Arab oil embargo, the 1991 Persian Gulf war, and the 2020 Colonial Pipeline shutoff) have not resulted in substantial awarded damages. These economic costs are likely to be ultimately borne by consumers in the state.

## 3-5 Ultimate Financial Responsibility

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The total damages of a spill at the CEI Hub will ultimately be borne by a large swath of the Oregon economy. Legal mechanisms will place a large portion of these damages at the responsibility of the firms operating CEI Hub facilities, should they be found liable. They should expect to ultimately shoulder a large portion of the damages, assessment costs, and civil penalties in addition to funds expended in their own defense.

The expected damages from a spill at the CEI Hub covered on the OPA are \$435 million, but this value could be as high as \$803 million and does not include impacts to commercial fisheries, cultural losses, impacts to fuel prices, and RP expenditures on legal defenses.<sup>40</sup> Expected cleanup costs total \$701 million but could be as large as \$1.4 billion. Expected civil penalties under OPA total \$1.6 billion but could be as high as \$8.4 billion if it is determined that the spill is the result of gross negligence or willful misconduct. The expected value of civil claims from personal injury/wrongful death is \$46 million.<sup>41</sup>

Even though legal frameworks are designed to allow full compensation of damages, transaction costs and inefficiencies in the claims process mean that there is a likelihood that individuals, businesses, and Tribal governments may remain partially uncompensated. Uncompensated damages may be distributed inequitably across injured parties due to existing structural inequities in the legal system (see Section 3-3.4 for more information on potential inequities associated with the damage recovery process).

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<sup>39</sup> Fuel scarcity in Oregon following the CSZ earthquake would likely extend for much longer than three days – however, the three-day estimate is what is likely attributable to CEI Hub fuel releases alone and not due to other effects of damage to transportation and pipeline infrastructure due to the earthquake.

<sup>40</sup> Attorney fees of claimants can be awarded under OPA. Non-monetary transaction costs to file and monitor claims cannot be awarded.

<sup>41</sup> The \$46 million value is the sum of the expected value of direct impacts to people (\$37.1 million) and human health impacts (\$8.9 million).

## 3-6 Legal Mechanisms to Increase Financial Responsibilities

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All categories of damages outlined in this report – apart from personal injury/wrongful death – are potentially recoverable under OPA.<sup>42</sup> Any damages incurred to individuals through personal injury/wrongful death would be potentially recoverable under separate civil action. RPs could end up not paying the full amount of their damage liability under three circumstances:<sup>43</sup>

- They exceed their liability limits;
- They are not the cause of the spill; or
- They become insolvent.

Under these scenarios, damages and costs claimable under OPA may be paid by the OSLTF. The expected damages claimable under OPA do not exceed the liability limits imposed by OPA for all potential RPs at the CEI Hub. Should any of the operators at the CEI Hub become financially insolvent following the CSZ event, all OPA damages and cleanup costs can potentially be paid by the OSLTF. Ignoring transaction costs and inefficiencies, the only category of damages at risk of incomplete coverage due to financial insolvency are personal injury/wrongful death claims.

While the vast majority of damages and costs associated with a spill at the CEI Hub are recoverable through the OSLTF, the availability of external funds may still serve as an economic externality. The availability of the OSLTF, while beneficial in paying damages and costs, may be a source of unaddressed moral hazard. Moral hazard arises when parties face a lack of incentives to fully guard against risk. While common in insurance markets, moral hazard is minimized through the implementation of co-payments or deductibles that align an individual's incentives with that of the insurer. Liability limits, while beneficial in providing certainty for business operating decisions, can be a source of moral hazard.<sup>44</sup> While the CSZ event presents a relatively uncertain risk, there may be decisions that a CEI Hub facility operator can make to minimize the likelihood of catastrophic harm. Older tanks or those closer to the water can be retrofitted, reinforced, or retired.

Economic efficiency dictates that operators at the CEI Hub should fully internalize the probability of a spill and its potential costs into operations. Local policy mechanisms could be

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<sup>42</sup> Personal injury/wrongful death claims would be submitted through the civil claims process, not OPA.

<sup>43</sup> Note that damage liability is the value that is established through the claims process. Damage liability will likely be lower than total economic damages because of transaction costs, inefficiencies, and inherent inequities in the legal and claims process, as described in Section 3.

<sup>44</sup> Biais, B., Mariotti, T., Rochet, J. C., & Villeneuve, S. (2010). Large risks, limited liability, and dynamic moral hazard. *Econometrica*, 78(1), 73-118.

designed that bypass a reliance on liability limits or bankruptcy proceedings. In this manner, operators may face incentives to minimize the chance of a spill by retrofitting tanks or reinforcing spill containment structures.

Certain vessels operating in U.S. waters are required under OPA to carry certificates of financial responsibility that operate similarly to a proof of insurance.<sup>45</sup> Onshore facilities are not required to provide certificates of financial responsibility. A market-based mechanism available to encourage operators at the CEI Hub to internalize the probability of a spill and its potential costs is to require operators to provide similar certificates of financial responsibility up to the expected value of all damages, cleanup costs, and penalties, allocated to operators by volume. The total expected value of OPA damages, civil penalties under OPA, cleanup costs, and civil claims from fuel releases at the CEI Hub is \$2.8 billion. Certificates of financial responsibility would provide evidence of a firm's ability to pay their share of this value, should a spill occur. These certificates of financial responsibility can be provided through self-insurance or an insurance market, which would actuarially price the risk of a spill and potentially provide discounts for efforts to minimize its likelihood or impacts.

The State of Oregon could also increase the fee-structure for onshore facilities collected under ORS 468B.405 to cover the annualized expected value of all damages and cleanup costs of a catastrophic spill from the CEI Hub.<sup>46</sup> This pricing mechanism would increase the costs of operating facilities at the CEI Hub, while also potentially incentivizing operators to reduce the reliance on older or outdated infrastructure.

Economic tools provide incentives to optimize behavior. While regulatory inspections are a critical component of spill preparedness planning, they work best when complemented with financial structures that align both public and private incentives. These tools are ultimately not necessary for the recovery of most costs and damages (due to the liability structure provided under OPA), but they can provide mechanisms to minimize the likelihood of a spill, which would be the preferred scenario for all parties.

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<sup>45</sup> The form to apply for a certificate of financial responsibility, demonstrating the information that the certificate requires to determine financial responsibility, is available at: <https://www.uscg.mil/Mariners/National-Pollution-Funds-Center/Forms/>

<sup>46</sup> See Section 3-2.2 for more information on ORS 468B.405.

## 3-7 Opportunities for Future Research

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The purpose of this analysis is to describe the likely effects of a CSZ earthquake on the fuel stored at the CEI Hub. This research provides qualitative and quantitative descriptions of the potential amount of fuel releases, the costs that those releases could impose on society, and descriptions of if and how those costs will be reimbursed through current legal structures. This research demonstrated that there is sufficient information to determine that fuel releases are likely to occur and would impose large costs to society and the CEI Hub operators. However, there are opportunities to refine the information that was available for the analysis to provide more certainty and additional detail. The opportunities for additional research in the future fall into three categories: **refinement of the analysis, analysis of prevention actions, and expanded analysis beyond the CEI Hub facilities and CSZ earthquake scenario.**

There are numerous ways that additional research could refine the analysis in this report to provide additional information about releases and more specific damage estimates. However, all damage estimates rest on the assumptions about the amount and type of fuel that would be released. Because the likelihood of releases and materials that could be released is the basis of the research, having more accurate and complete information about the storage tanks is the first step for a more refined analysis. This research uncovered the paucity of information about the storage facilities at the CEI Hub. Some properties did not have tank storage capacity or contents information available through any government source, including the State Fire Marshal. This analysis did not conduct onsite assessments of the seismic integrity of the tanks or the soils through soil sampling or any other on the ground data collection method. Additional research working directly with the CEI Hub operators would allow for more precise information about individual tanks, their contents, and their seismic risks, all of which would lead to better estimates of what would potentially be released due to a CSZ earthquake. This information would also better prepare government agencies to respond to fuel releases or other emergency events like fires.

Once more information is available and there are more refined estimates of fuel releases from the CEI Hub, follow up studies could refine the analysis of the effects of fuel releases. These analyses could include refinement of impacts by:

- Evaluating the likelihood of fuel ignition and potential extent of fire spread under various scenarios. Having this analysis would allow for understanding of properties and public resources that are at risk of fire, such as Forest Park, businesses, and residences.
- Modeling human health impacts under ignition and non-ignition scenarios. This research would provide the information to identify the scale of needed evacuations.
- Evaluating the impacts of fuel releases on aquatic species under various response timeline and seasonality scenarios. This research would correct for the scarcity of information about impacts of fuels on aquatic species present in the Pacific Northwest, such as salmon, and could be used to model impacts to commercial and recreational fisheries.

- Studying the impact that fuel releases would have on the area’s ability to attract and retain talent and investments. In other words, evaluate if and how fuel releases would affect the brand of the Portland metro region and the area’s attractiveness as a place to live and work.
- Modeling and planning for how replacement fuel could be supplied to replace fuel released at the CEI Hub and to account for disruptions in supply chains due to earthquake damage.
- Assessing if and how fuel releases and any associated fires or other activities requiring emergency response would detract from other emergency response operations in the aftermath of the CSZ earthquake and what those costs would be.
- Conducting further legal analysis to gain clarity of CEI Hub operator responsibility under OPA, particularly with regard to the “Act of God” provision.

Many types of analyses could be conducted to inform policy responses aimed at preventing or reducing the risk of fuel releases. Studies could be conducted to better understand the costs of taking any prevention actions, such as making seismic retrofits, replacing tank infrastructure, decommissioning tanks, and other actions. A broader study could then compare the costs and benefits of taking any actions to prevent fuel releases. This type of study should also evaluate the distributions of benefits and costs to understand who would incur costs and who would experience benefits compared to current conditions. Policy responses to prevent fuel releases would likely also require additional legal analyses or planning. For example, although there is a fuel response plan for the Lower Columbia River, that plan does not include contingencies for how to perform the response after a major earthquake.

CEI Hub tanks is not the only location that is at risk during a CSZ earthquake or other event. The network of pipelines and rail infrastructure also pose risks of fuel releases. In addition, there are other fuel and hazardous material storage in Oregon and Southwest Washington that pose threats to natural resources and human health in Oregon in the event of a CSZ earthquake. Additional research could be conducted to better understand the cumulative effects from fuels and hazardous materials in the region. This analysis could be performed for a CSZ earthquake, as well as other events such as a Portland Hills earthquake or smaller spill event.



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**



Summary of Available Data and Report of Expected Earthquake Risk

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Portland, Oregon

**Prepared for**  
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**February 2, 2022**  
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**Prepared by**  
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**APPENDIX A (PROVIDED ELECTRONICALLY ONLY FOR CONFIDENTIALITY)**

**City of Portland CEI Hub Tank Infrastructure Data**  
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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 Columbia 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

## 4 | Oregon Critical Energy Infrastructure Hub

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 shown 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 had 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.

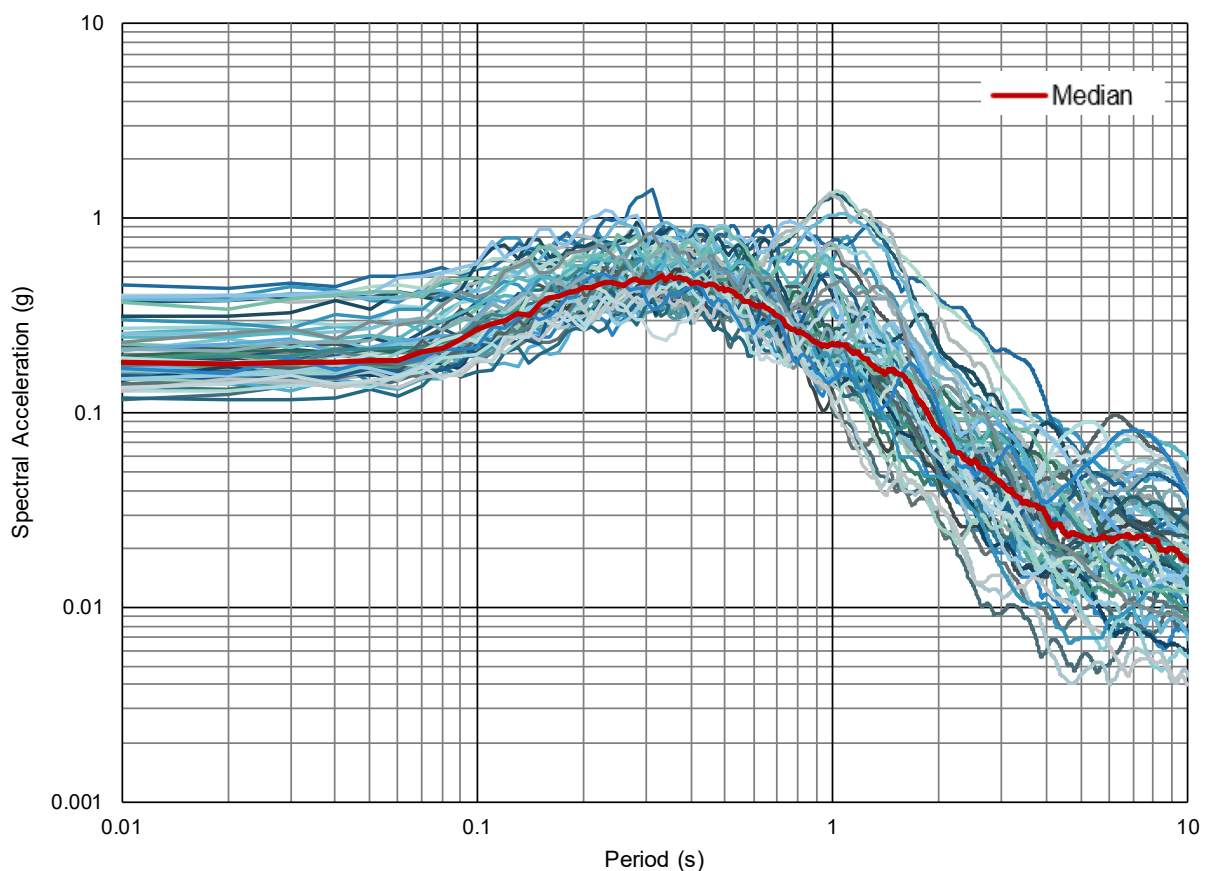


Figure 4.1 CSZ Ground Motion Components (Frankel et al. 2019)

### 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).

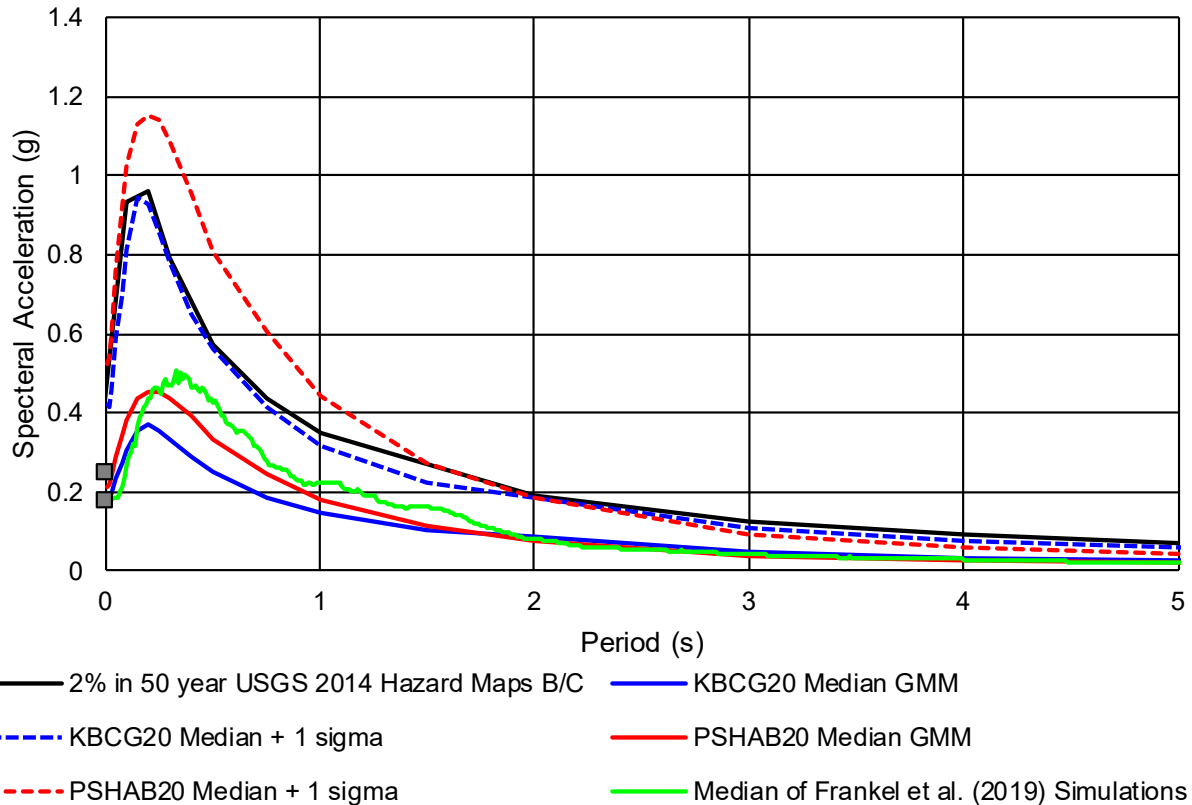


Figure 4.2 CSZ Spectral Response

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 <sub>SPT</sub> | Lower Bound N <sub>SPT</sub> | 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<sub>SPT</sub> values for each of the stratigraphic units is reported and plotted with all available N<sub>SPT</sub> measurements. The upper- and lower-bound N<sub>SPT</sub> values were selected to represent reasonable upper and lower bounds of the available N<sub>SPT</sub> 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<sub>SPT</sub> values only and not in the upper-bound N<sub>SPT</sub> 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<sub>SPT</sub> values of the stratigraphic units are reported as a range. The upper and lower N<sub>SPT</sub> 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 <sub>SPT</sub> | Lower Bound N <sub>SPT</sub> | 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 <sub>SPT</sub> | Lower Bound N <sub>SPT</sub> | 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<sub>SPT</sub> values for similar stratigraphic units than the other areas. The deep layer of loose sand did not have any N<sub>SPT</sub> values at this location and so the N<sub>SPT</sub> values of Area 4 were assumed. The Upper and Lower bound N<sub>SPT</sub> Values in table 4.7 represent the range of N<sub>SPT</sub> 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<sub>SPT</sub> 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 <sub>SPT</sub> | Lower Bound N <sub>SPT</sub> | 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 Geotechnical Engineers (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.

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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>.

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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.

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**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<br>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 Prefabricated 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 Paleoseismicity of the Cascadia Subduction Zone   | 2012                                       | Professional Paper       | Study of turbidites to develop 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<br>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.<br>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**

| <b>Area 1 - Kinder Morgan North</b>  |                           |                       |             |                        |
|--|---------------------------|-----------------------|-------------|------------------------|
| <b>Kinder Morgan - North - 11400 NW St Helens Road, Portland, OR 97231 - Property ID R232828</b> |                           |                       |             |                        |
| <b>Tank ID<sup>+</sup></b>   | <b>Contents</b>           | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| 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    |
| <b>Area 2 - Linnton</b>  |                           |                       |             |                        |
| <b>BP West Coast - 9930 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323779</b>       |                           |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>           | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                           |                       |             |                        |
| <b>BP West Coast - 9930 NW St Helens Road, Portland, OR 97231 - Property ID R498331</b>          |                           |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>           | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| 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 |

CEI Hub Risk Analysis



|  |                          |                       |             |                        |
|--|--------------------------|-----------------------|-------------|------------------------|
| 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             |
| <b>BP West Coast - 9900 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323771</b>   |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>BP West Coast - 9930 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323758</b>   |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R518296</b> |                          |                       |             |                        |
| <b>Tank ID<sup>1</sup></b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| NU23   | Gasoline/Diesel additive | 10,048                | NA          | Cone                   |
| NU24   | Biodiesel additive       | NA                    | NA          | Horizontal Tank        |
| NU30   | NA                       | NA                    | NA          | NA                     |
| <b>Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R491070</b> |                          |                       |             |                        |
| <b>Tank ID<sup>1</sup></b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| 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                   |
| <b>Shore Terminals - 9400 WI/NW St Helens Road, Portland, OR 97231 - Property ID R324088</b> |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R518295</b> |                          |                       |             |                        |
| <b>Tank ID<sup>1</sup></b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| 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 |
| <b>Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R512294</b>         |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>Area 3 - NW Natural</b>   |                          |                       |             |                        |
| <b>Pacific Terminal Services - 7900 NW St. Helens Road, Portland, OR 97210 - Property ID R324159</b> |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| PA1  | Residual oil             | 60,000                | 1980        | NA                     |
| PA2  | Diesel oil               | 60,000                | 1980        | NA                     |
| PA3  | Residual oil             | 20,000                | 1980        | NA                     |
| <b>NW Natrual - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324171</b>             |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>NW Natrual - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324170</b>             |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| PA4  | Residual oil             | 80,000                | 1940        | NA                     |
| PA5  | Residual oil             | 55,000                | 1940        | NA                     |
| <b>NW Natrual - 7598 NW St. Helens Road, Portland, OR 97210 - Property ID R324113</b>                |                          |                       |             |                        |
| <b>Tank ID<sup>1</sup></b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| PA6  | Diesel oil               | 12                    | 1988        | NA                     |
| PA7  | Residual oil             | 475                   | 1993        | NA                     |
| NWN-Tank 001   | Liquefied Natural Gas    | 7,100,000             | NA          | NA                     |
| <b>NW Natrual - 7900 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324172</b>             |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>NW Natrual - 7441 SW/NW St. Helens Road, Portland, OR 97210 - Property ID R324165</b>             |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>NW Natrual - 7441 NW St. Helens Road, Portland, OR 97210 - Property ID R324160</b>                |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>NW Natrual - 7540 NW St. Helens Road, Portland, OR 97210 - Property ID R3502592</b>               |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>NW Natrual - 7540 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324213</b>             |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| No known tanks present   |                          |                       |             |                        |
| <b>Area 4 - Willbridge</b>   |                          |                       |             |                        |
| <b>Kinder Morgan - 5800 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324222</b>          |                          |                       |             |                        |
| <b>Tank ID</b>   | <b>Contents</b>          | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>            |
| 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    |
| <b>Kinder Morgan - 5800 NW St. Helens Road, Portland, OR 97210 - Property ID R121076</b> |                |                |      |                        |
| Tank ID <sup>1</sup>   | 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    |
| <b>Kinder Morgan - 6080 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R315782</b> |                      |                |      |                        |
| Tank ID   | Contents             | Capacity (Gal) | Year | Type                   |
| No known tanks present  |                      |                |      |                        |
| <b>Chevron - 5533 NW Doane Avenue, Portland, OR 97210 - Property ID R315798</b>             |                      |                |      |                        |
| Tank ID <sup>1</sup>  | 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            |
| <b>Chevron - 5533 WI/NW Doane Avenue, Portland, OR 97210 - Property ID R315771</b>         |                       |                       |             |               |
| <b>Tank ID<sup>+</sup></b>   | <b>Contents</b>       | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>   |
| No known tanks present   |                       |                       |             |               |
| <b>Conoco Phillips - 5528 WI/NW Doane Avenue, Portland, OR 97210 - Property ID R315810</b> |                       |                       |             |               |
| <b>Tank ID<sup>+</sup></b>   | <b>Contents</b>       | <b>Capacity (Gal)</b> | <b>Year</b> | <b>Type</b>   |
| 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 <sup>1</sup> | 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 <sup>1</sup> | Contents | Capacity (Gal) | Year | Type |
|----------------------|----------|----------------|------|------|
|----------------------|----------|----------------|------|------|

No known tanks present

**McCall Oil - 5700 NW Front Avenue, Portland, OR 97210 - Property ID R315872**

| Tank ID <sup>1</sup> | 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 <sup>1</sup> | 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**

CEI Hub Risk Analysis

| Equilon - 3610-3640 St. Helens Road, Portland, OR 97210 - Property ID R315819 |                |                |      |                     |
|---|----------------|----------------|------|---------------------|
| Tank ID <sup>1</sup>  | 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:

<sup>1</sup>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**

| <b>Area 1 - Kinder Morgan North</b>  |                     |
|--|---------------------|
| <b>Kinder Morgan - North - 11400 NW St Helens Road, Portland, OR 97231 - Property ID R232828</b> |                     |
| <b>Building</b>  | <b>Area (Sq Ft)</b> |
| 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                  |
| <b>Area 2 - Linnton</b>  |                     |
| <b>BP West Coast - 9930 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323779</b>       |                     |
| <b>Building</b>  | <b>Area (Sq Ft)</b> |
| No Buildings Present   |                     |
| <b>BP West Coast - 9930 NW St Helens Road, Portland, OR 97231 - Property ID R498331</b>          |                     |
| <b>Building</b>  | <b>Area (Sq Ft)</b> |
| Bldg 1   | 27,050              |
| Bldg 2   | 8,380               |
| Bldg 3   | 2,860               |
| Bldg 4   | 2,740               |
| Bldg 5   | 930                 |
| Bldg 6   | Unknown             |
| <b>BP West Coast - 9900 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323771</b>       |                     |
| <b>Building</b>  | <b>Area (Sq Ft)</b> |
| Bldg 1   | 6,020               |
| Bldg 2   | 1,917               |
| <b>BP West Coast - 9930 WI/NW St Helens Road, Portland, OR 97231 - Property ID R323758</b>       |                     |
| <b>Building</b>  | <b>Area (Sq Ft)</b> |
| No Buildings Present   |                     |
| <b>Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R518296</b>     |                     |
| <b>Building</b>  | <b>Area (Sq Ft)</b> |
| Bldg 1   | 6,150               |
| Bldg 2   | 1,952               |
| Bldg 3   | 440                 |
| Bldg 4   | 256                 |
| Bldg 5   | 180                 |
| Bldg 6   | 96                  |
| <b>Shore Terminals - 9420 WI/NW St Helens Road, Portland, OR 97231 - Property ID R491070</b>     |                     |
| <b>Building</b>  | <b>Area (Sq Ft)</b> |
| Bldg 1   | 5,434               |
| Bldg 2   | 644                 |
| Bldg 3   | 25                  |
| <b>Shore Terminals - 9400 WI/NW St Helens Road, Portland, OR 97231 - Property ID R324088</b>     |                     |
| <b>Building</b>  | <b>Area (Sq Ft)</b> |
| 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      |

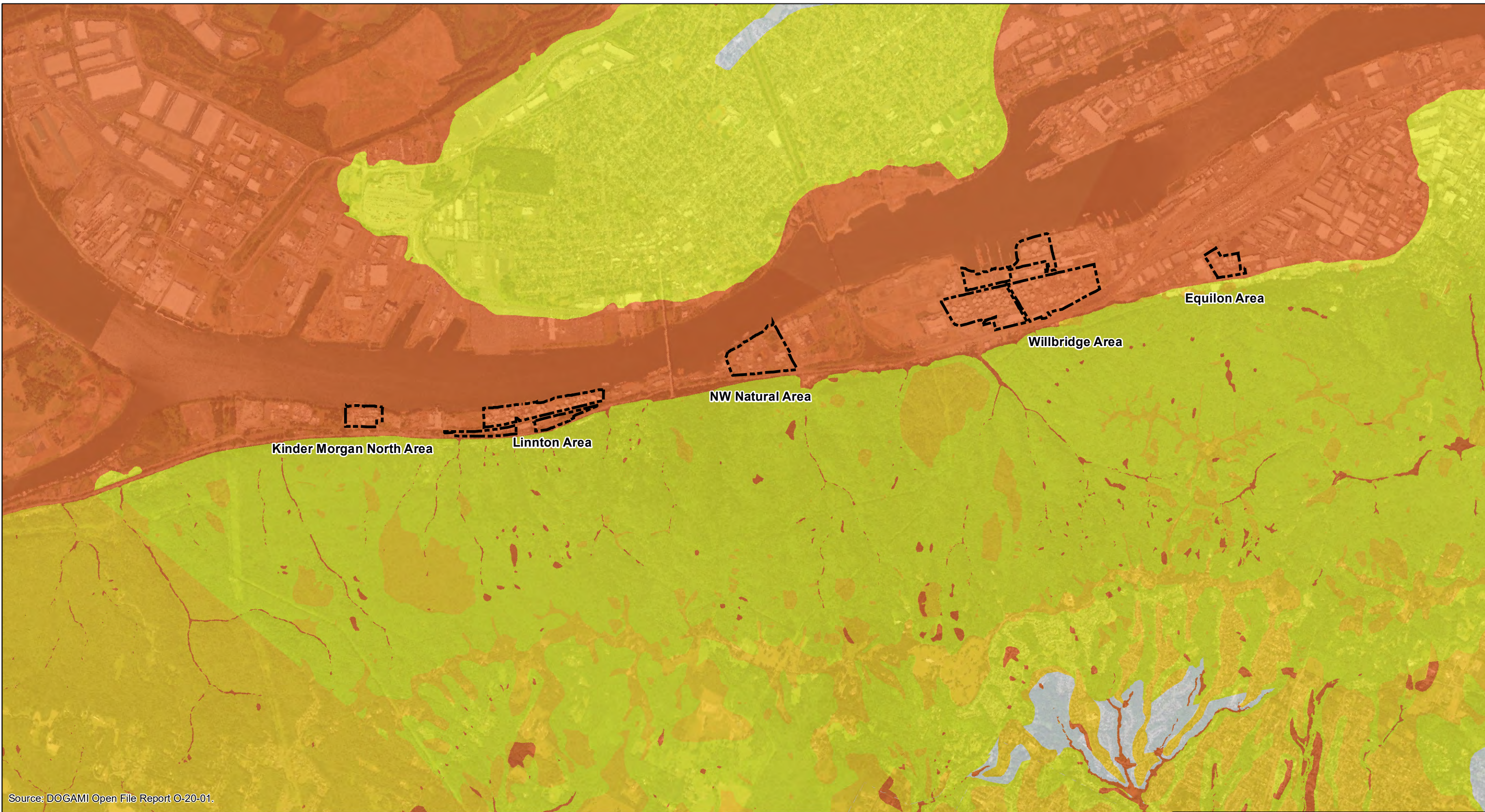


|   |                     |
|---|---------------------|
| Bldg 3  | Removed             |
| Bldg 4  | Removed             |
| <b>NW Natural - 7540 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324213</b>    |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| No Buildings Present  |                     |
| <b>Area 4 - Willbridge</b>  |                     |
| <b>Kinder Morgan - 5800 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R324222</b> |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | 55,734              |
| Bldg 2  | 1,489               |
| Bldg 3  | 1,348               |
| Bldg 4  | 848                 |
| <b>Kinder Morgan - 5800 NW St. Helens Road, Portland, OR 97210 - Property ID R121076</b>    |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | 10,061              |
| Bldg 2  | 4,792               |
| Bldg 3  | 2,500               |
| Bldg 4  | 1,456               |
| Bldg 5  | 168                 |
| Bldg 6  | 160                 |
| <b>Kinder Morgan - 6080 WI/NW St. Helens Road, Portland, OR 97210 - Property ID R315782</b> |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | NA                  |
| Bldg 2  | NA                  |
| Bldg 3  | NA                  |
| <b>Chevron - 5533 NW Doane Avenue, Portland, OR 97210 - Property ID R315798</b>             |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| 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                  |
| <b>Chevron - 5533 WI/NW Doane Avenue, Portland, OR 97210 - Property ID R315771</b>          |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | NA                  |
| <b>Conoco Phillips - 5528 WI/NW Doane Avenue, Portland, OR 97210 - Property ID R315810</b>  |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | 50,400              |
| Bldg 2  | 12,660              |
| Bldg 3  | 2,312               |
| Bldg 4  | 960                 |
| Bldg 5  | 525                 |
| Bldg 6  | 363                 |

|   |                     |
|---|---------------------|
| Bldg 7  | 264                 |
| <b>Conoco Phillips - 5528 NW Doane Avenue, Portland, OR 97210 - Property ID R315769</b> |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | 8,000               |
| <b>Zenith Energy - 5501 NW Front Avenue, Portland, OR 97210 - Property ID R315845</b>   |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| 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                 |
| <b>Zenith Energy - 5501 NW Front Avenue, Portland, OR 97210 - Property ID R315777</b>   |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| No Buildings Present  |                     |
| <b>McCall Oil - 5700 NW Front Avenue, Portland, OR 97210 - Property ID R315872</b>      |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | 980                 |
| Bldg 2  | 850                 |
| Bldg 3  | NA                  |
| Bldg 4  | NA                  |
| <b>McCall Oil - 5480 NW Front Avenue, Portland, OR 97210 - Property ID R315786</b>      |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | NA                  |
| Bldg 2  | NA                  |
| Bldg 3  | NA                  |
| Bldg 4  | NA                  |
| Bldg 5  | NA                  |
| Bldg 6  | NA                  |
| <b>Area 5 - Equilon</b>   |                     |
| <b>Equilon - 3610-3640 St. Helens Road, Portland, OR 97210 - Property ID R315819</b>    |                     |
| <b>Building</b>   | <b>Area (Sq Ft)</b> |
| Bldg 1  | 5,376               |
| Bldg 2  | 4,680               |
| Bldg 3  | 2,484               |
| Bldg 4  | 1,350               |
| Bldg 5  | 840                 |
| Bldg 6  | 180                 |







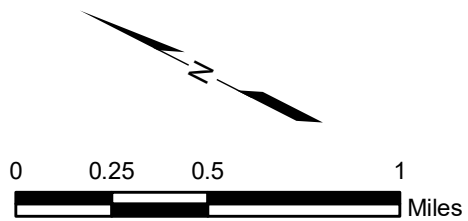
Source: DOGAMI Open File Report O-20-01.

**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



Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub  
Portland, Oregon

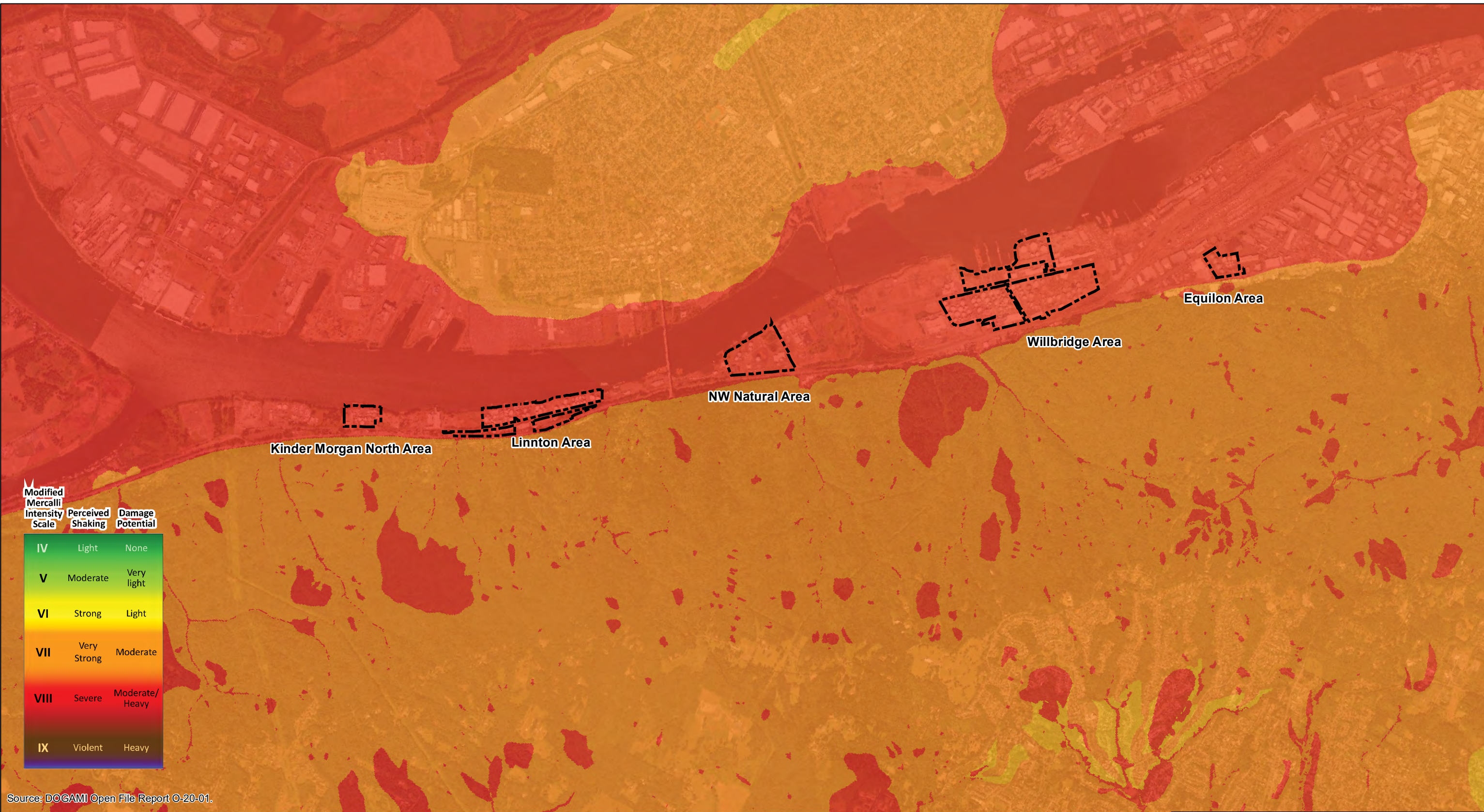
**Potential Permanent Ground Deformation  
Due to Lateral Spreading  
Cascadia Subduction Zone M9.0 Earthquake**  
154-035-019 04/21



Figure

**1.4**



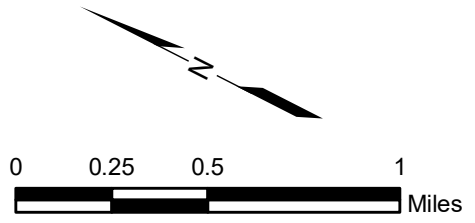


Source: DOGAMI Open File Report O-20-01.


**Legend**

 Project Areas

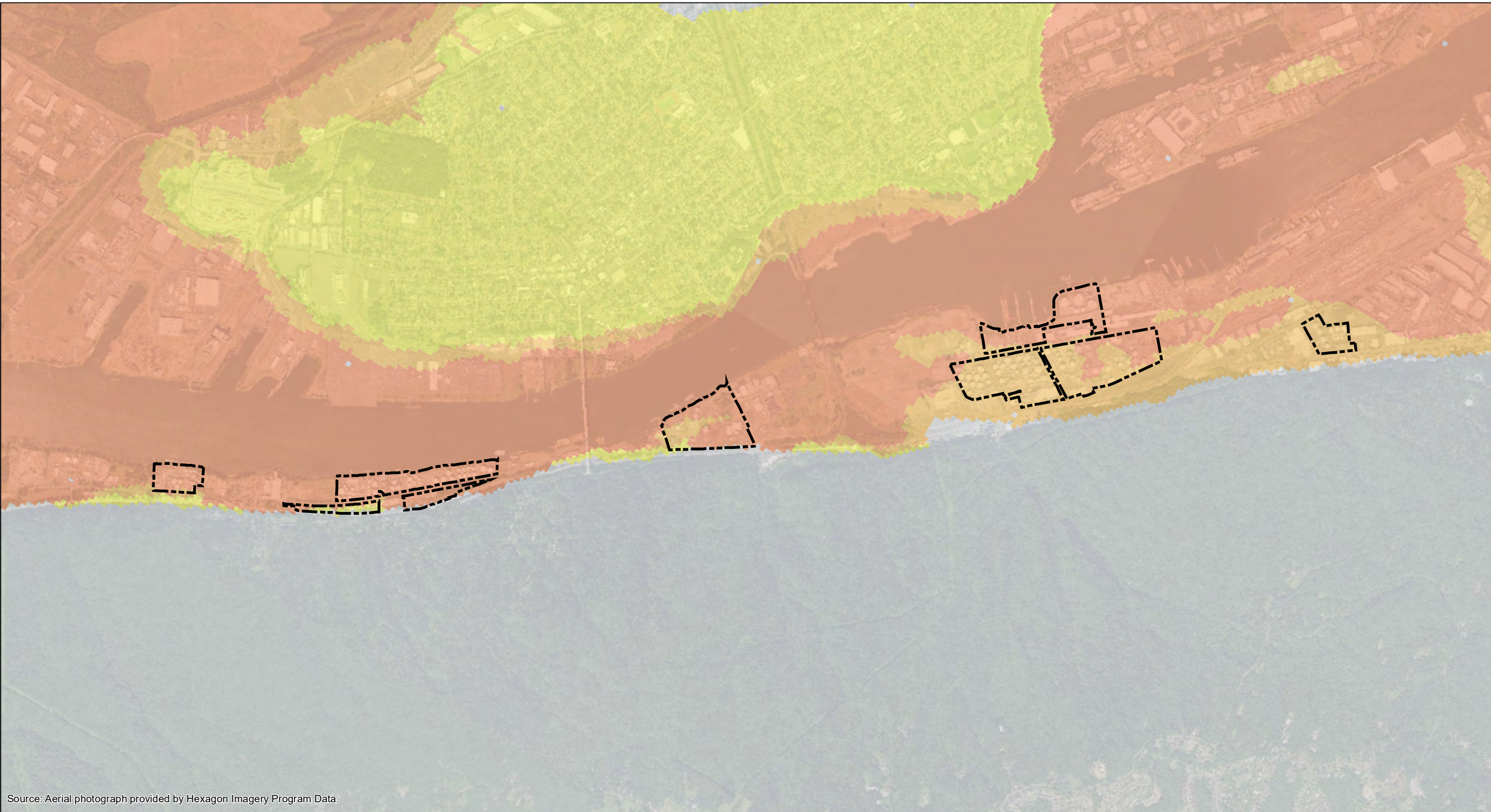
| Modified<br>Mercalli<br>Intensity<br>Scale | Perceived<br>Shaking | Damage<br>Potential |
|--|----------------------|---------------------|
| IV   | Light                | None                |
| V  | Moderate             | Very light          |
| VI   | Strong               | Light               |
| VII  | Very Strong          | Moderate            |
| VIII                                       | Severe               | Moderate/Heavy      |
| IX   | Violent              | Heavy               |



Note: Feature locations are approximate.

|   |                      |
|---|----------------------|
| Oregon Critical Energy Infrastructure Hub<br>Portland, Oregon   |                      |
| <b>Perceived Shaking and Damage Potential<br/>Simulated Cascadia Subduction Zone<br/>Magnitude 9.0 Earthquake</b>                 |                      |
| 154-035-019   | 04/21                |
| <br><i>A division of Haley &amp; Aldrich</i> | Figure<br><b>1.2</b> |





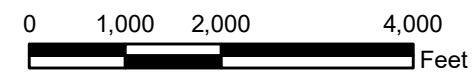
Source: Aerial photograph provided by Hexagon Imagery Program Data.

**Legend**

**DOGAMI Liquefaction Susceptibility**

- None
- Very Low
- Low
- Moderate
- High
- Very High

Project Areas



Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub  
Portland, Oregon

**Liquefaction Hazard Mapping**

154-035-019

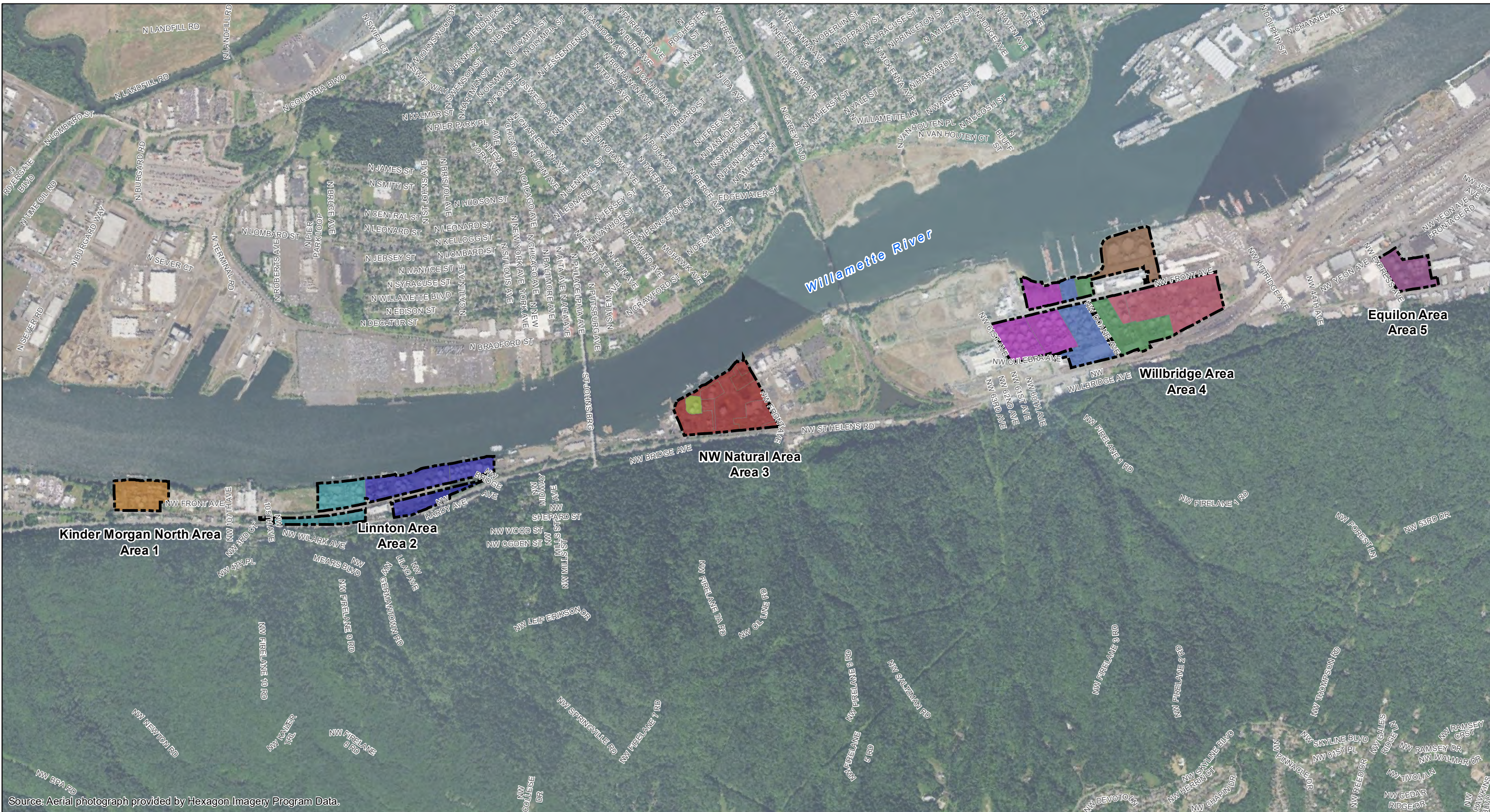
04/21



Figure

**1.3**





Source: Aerial photograph provided by Hexagon Imagery Program Data.

**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**

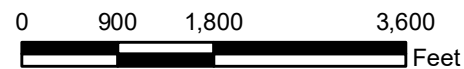
Chevron

Conoco Phillips

Kinder Morgan

McCall Oil

Zenith Energy Terminals



Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub  
Portland, Oregon

**CEI Hub Map**

154-035-019

04/21



Figure

**1.5**



Document Path: F:\Notebooks\154035019\_Critical\_Energy\_Infrastructure\_Hub\_Seismic\_Risk\_Analysis\GIS\GIS154035019\_AB\_SP.mxd Date: 3/2/2021 User Name: melissaschweitzer



Willamette River

Kinder Morgan  
Tax ID: R323828  
11400 NW ST HELENS RD

NW ST HELENS RD

NW 112TH AVE

NW 111TH AVE

NW 110TH AVE

NW 109TH AVE

NW FRONT AVE

NW 108TH AVE




NW 1ST ST

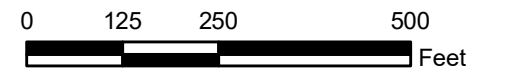
NW 2ND ST

NW 2ND CT

NW 3RD ST

**Legend**

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



Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis  
Portland, Oregon

**CEI Area 1 – Kinder Morgan North**

154-035-019

04/21

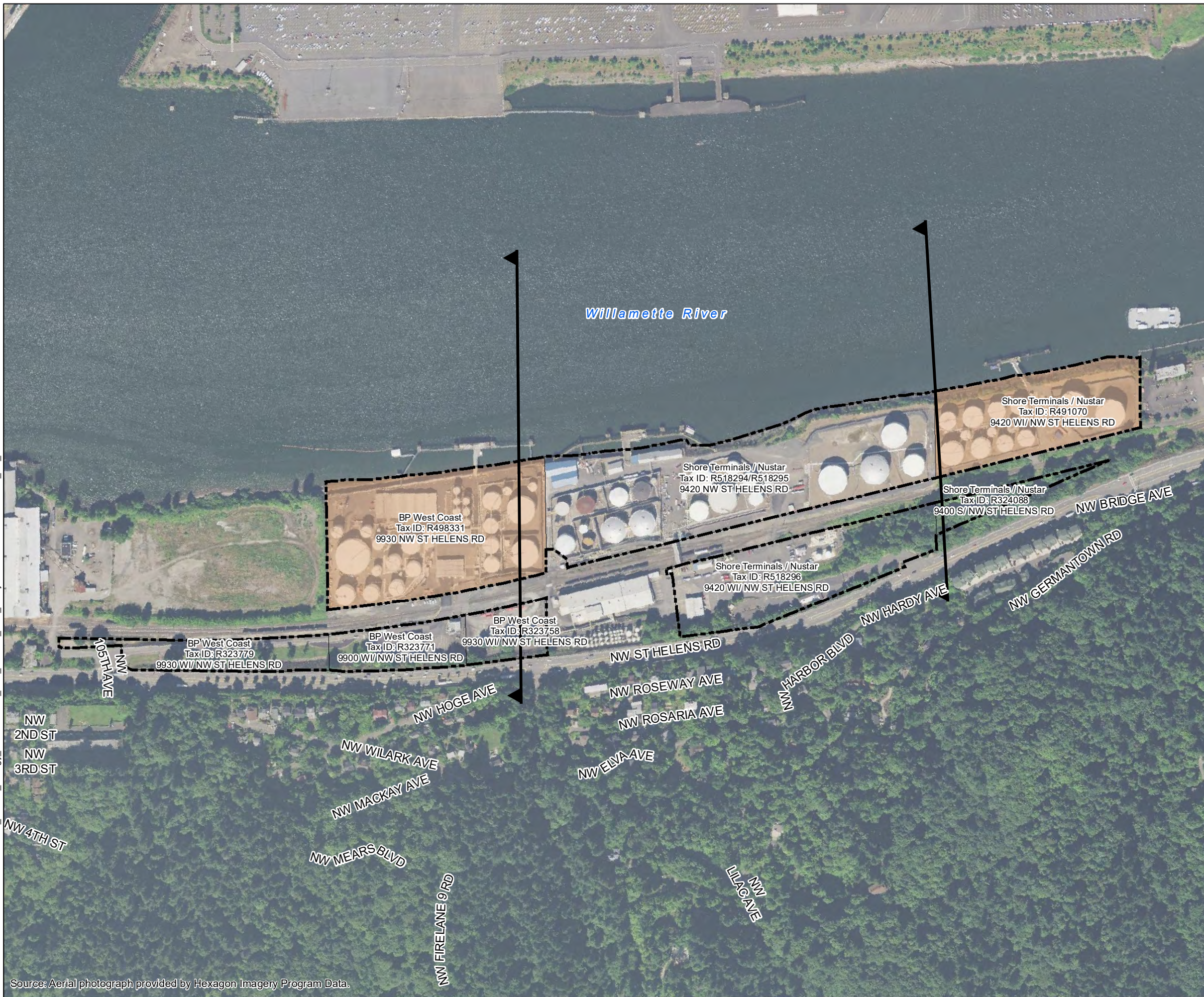


Figure  
**1.6**





Source: Aerial photograph provided by Hexagon Imagery Program Data.



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**Legend**

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

Willamette River

BP West Coast  
Tax ID: R498331  
9930 NW ST HELENS RD

Shore Terminals / Nustar  
Tax ID: R518294/R518295  
9420 NW ST HELENS RD

Shore Terminals / Nustar  
Tax ID: R491070  
9420 WI/ NW ST HELENS RD

Shore Terminals / Nustar  
Tax ID: R324088  
9400 S/ NW ST HELENS RD

BP West Coast  
Tax ID: R323779  
9930 WI/ NW ST HELENS RD

BP West Coast  
Tax ID: R323771  
9900 WI/ NW ST HELENS RD

BP West Coast  
Tax ID: R323758  
9930 WI/ NW ST HELENS RD

Shore Terminals / Nustar  
Tax ID: R518296  
9420 WI/ NW ST HELENS RD

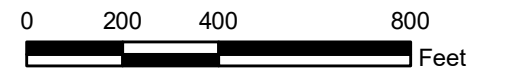
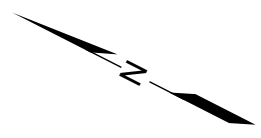
NW 2ND ST  
NW 3RD ST  
NW 4TH ST

NW WILARK AVE  
NW MACKAY AVE  
NW MEARS BLVD

NW HOGE AVE  
NW ST HELENS RD  
NW ROSEWAY AVE  
NW ROSARIA AVE  
NW ELVA AVE

NW HARBOR BLVD  
NW HARDY AVE  
NW BRIDGE AVE  
NW GERMANTOWN RD

NW LILAC AVE



Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis  
Portland, Oregon

**CEI Area 2 – Linnton**

154-035-019

04/21

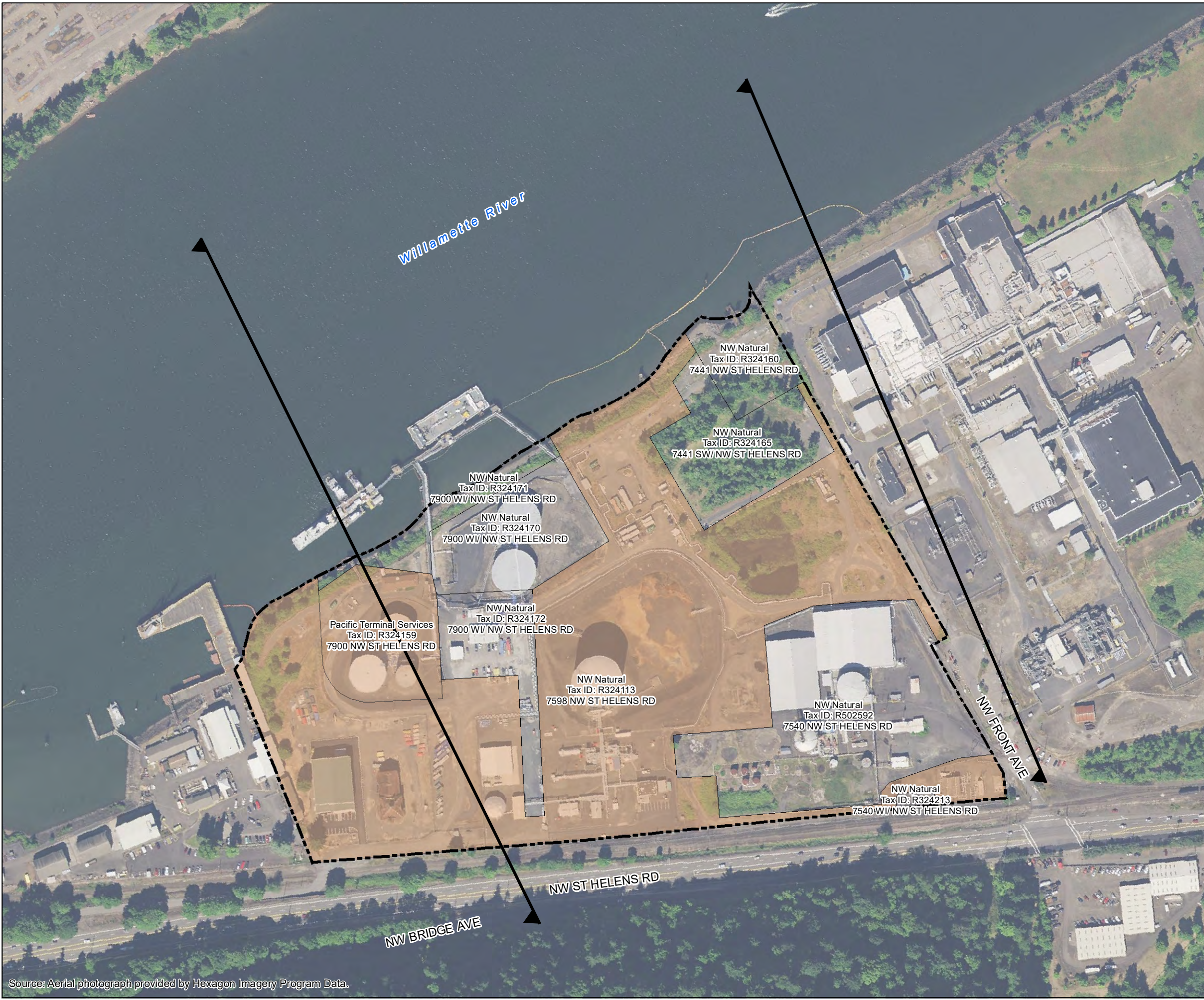


Figure  
**1.7**





Source: Aerial photograph provided by Hexagon Imagery Program Data.

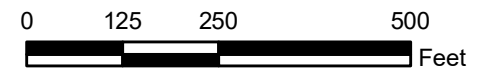


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**Legend**

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



Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis  
Portland, Oregon

**CEI Area 3 – NW Natural**

154-035-019

04/21

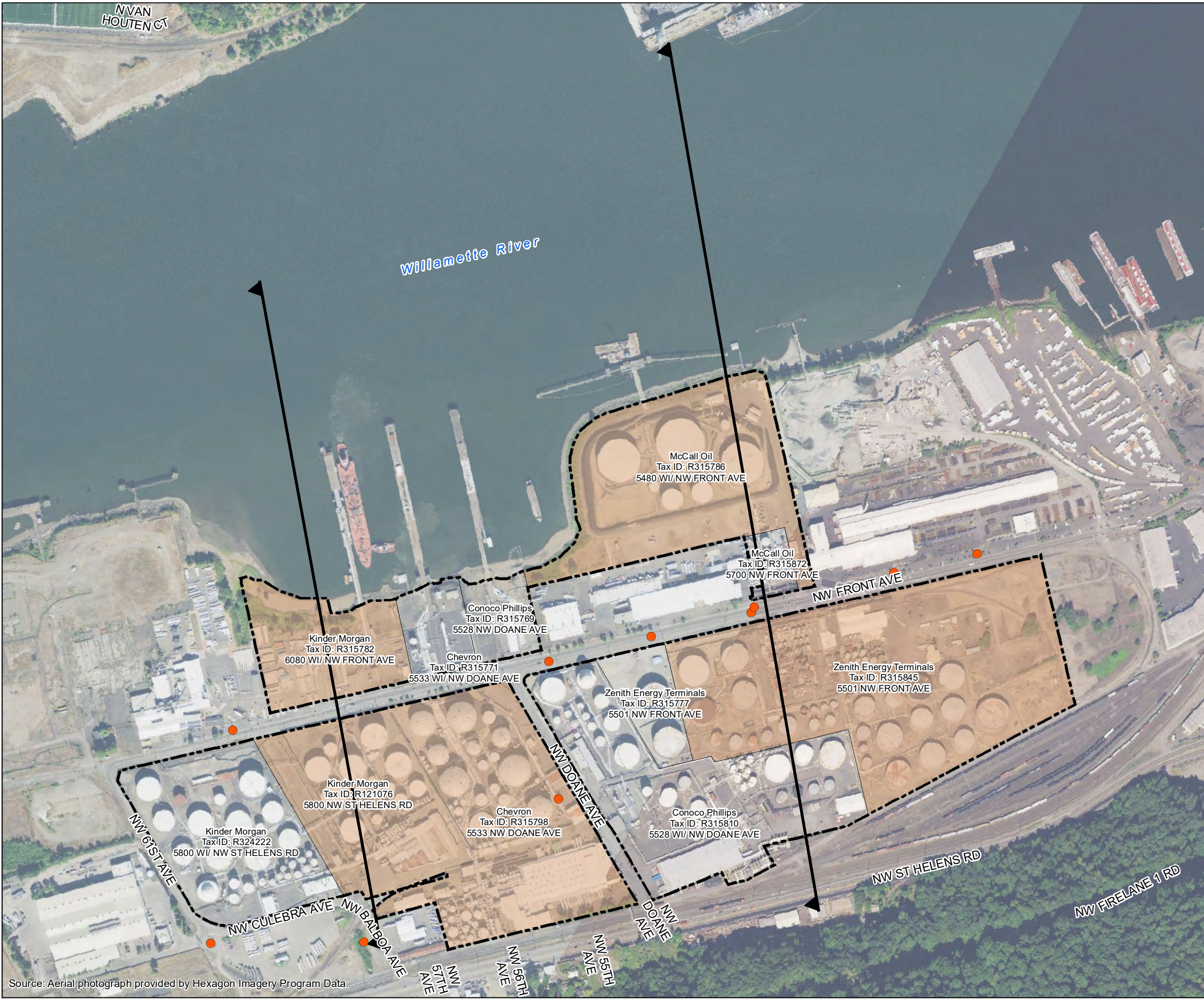


Figure  
**1.8**

Source: Aerial photograph provided by Hexagon Imagery Program Data.








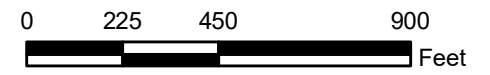
Document Path: F:\Notebooks\154035019\_Critical\_Energy\_Infrastructure\_Hub\_Seismic\_Risk\_Analysis\GIS\GIS154035019\_AB\_SP.mxd Date: 3/2/2021 User Name: melissaschweitzer



Source: Aerial photograph provided by Hexagon Imagery Program Data.

**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



Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis  
Portland, Oregon

**CEI Area 4 – Willbridge**

154-035-019

04/21






Figure  
**1.9**

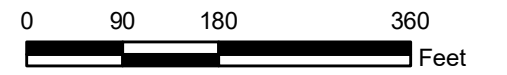




Source: Aerial photograph provided by Hexagon Imagery Program Data.

**Legend**

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



Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis  
Portland, Oregon

**CEI Area 5 – Equilon**

154-035-019

04/21



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

Report of Cascadia Subduction Zone Earthquake Impacts

**Oregon Critical Energy Infrastructure Hub**  
Portland, Oregon

**Prepared for**  
ECONorthwest and Multnomah County

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



**SALUS RESILIENCE**



Report of Cascadia Subduction Zone Earthquake Impacts

## Oregon Critical Energy Infrastructure Hub

Portland, Oregon

**Prepared for**  
ECONorthwest and Multnomah County

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

**Prepared by**  
Salus Resilience

  
**Allison Pynch, PE**  
Senior Associate

  
**Della Graham, RG**  
Senior Project, Geologist



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# Oregon Critical Energy Infrastructure Hub Portland, Oregon

## 1.0 INTRODUCTION

This report summarizes our evaluation of the infrastructure impacts of a Cascadia Subduction Zone (CSZ) Earthquake on the Critical Energy Infrastructure (CEI) Hub in Northwest Portland, Oregon. The impacts to infrastructure were developed based on the geotechnical evaluation presented in our *Summary of Available Data and Report of Expected Earthquake Risk* dated February 2, 2022, (Salus 2022), the previous work completed at the site by others as referenced in Salus (2022), and the standards and references included in this document. No on-site evaluation was completed for this scope of work.

The geotechnical evaluation summarized in Salus (2022) developed estimates of earthquake-induced ground deformation due to liquefaction settlement and lateral spreading (movement toward the river) due to a CSZ event. This report discusses the potential effects of those estimated ground movements on the seismic performance of numerous aboveground storage tanks (ASTs) at the CEI Hub. This performance evaluation is broadly based on the assumed design/construction standards for the tanks based on their age and does not account for subsequent seismic upgrades which may have been undertaken by individual property owners. Information about the tanks, such as age, capacity, and contents, is provided in Salus (2022). The data, along with the results of the tank evaluations, are also presented in Appendix A to this report.

## 2.0 TANK DAMAGE ASSESSMENT METHODOLOGY

As discussed in Salus (2022), tank data were collected from the Office of Oregon State Fire Marshal (OSFM) and the City of Portland (City), the latter of which was developed from the Portland State University (PSU) 2019 study of the CEI Hub (Dusicka and Norton 2019). After a review of the available data, it was determined that the City dataset was more complete than the OSFM dataset and would be used as the main source for the tank inventory, with additional tank counts coming from a review of aerial photographs.

The evaluation of the tank inventory indicated that 630 tanks are present at the CEI Hub:

- 512 of the 630 tanks were listed in the City database in Area 1 through Area 4. One hundred and seventeen (117) of the 630 tanks were identified through figures provided by Portland Fire and Rescue (PF&R 2021) in Area 1 through 5. One additional tank was identified through City of Portland maps (Portlandmaps.com 2021) Of these 630 tanks:
  - 390 of the 630 tanks have a material assigned to the tank.
  - 240 of the 630 tanks do not have known contents, and therefore, were not evaluated.
    - 143 are listed as Out of Service.

- 72 are listed as Unknown and do not have any information on status (in service or out of service), year built, latitude and longitude, contents, or capacity. All of these tanks are located at the Zenith property.
- 18 are listed as Empty.
- 7 are listed as Unavailable and do not have any information on status (in service or out of service), contents, or capacity.
- 193 of the 630 tanks do not have a known tank age, and therefore, were assumed to be constructed prior to 1993.

This results in 390 tanks that have enough information to be evaluated for release potential and are addressed in Sections 3.1 through 3.3. The locations of these tanks were based on either the specific location provided in the City database (latitude/longitude) or the property where it was located when a latitude/longitude was not provided. For tanks that were only located by property, the damage zones were decided based on visual inspection of the aerial photographs. Two hundred and nineteen (219) of the 390 tanks had specific locations identified. The remaining 171 of the 390 tanks had property information only. Further assumptions made for our evaluation include:

- Tank contents have not changed since the PSU study (Dusicka and Norton 2019) from which the City data are based.
- Tank capacity was provided for 516 tanks, and average fill was provided for 314 tanks from the collected data. We calculated the percent fill of the 314 tanks that had both capacity and average fill volumes by dividing the average fill volume by the tank capacity volume. The percent fill of these 314 tanks was found to be 67 percent. We then assumed that all tanks would have this same percent fill. We then applied the calculated percent fill to all tanks across the CEI Hub that had a known capacity (516 of the 630 tanks). The result was the “Expected Fill,” which is the known tank capacity multiplied by 67 percent.
- Zenith property, which has no data in the City tank data, was evaluated based on figures provided by Portland Fire & Rescue (PF&R 2021) and the volumes provided for 10 tanks on that figure are assumed to be Expected Fill. Therefore, we did not apply the average percent fill of 67 percent these 10 tanks.
- Equilon, which has no data in the City tank data or the OSFM, was evaluated based on the figure provided by Portland Fire & Rescue (PF&R 2021). Tank capacity was listed as barrels (BBLs) on the provided figure. The data was converted to gallons using the assumption that there are 42 gallons in a barrel. The average percent fill of 67 percent was then applied to the tank capacity to obtain the average expected fill.
- NW Natural has no information on materials present in the City tank data or the OSFM, however capacity for the 7.1-million-gallon Liquefied Natural Gas (LNG) tank was obtained from City of Portland permit records. We have labeled this tank *NWN-Tank 001* for evaluation purposes.



## 2.1 Tank Damage Assumptions

Tank damage assumptions were developed using information provided on building codes within the DOGAMI report (Wang 2012), specifically a memorandum by the Oregon Building Codes Division (OBCD) summarizing changing seismic design requirements in Oregon (OBCD 2012), and tank design standards provided by the American Petroleum Institute (API), American Concrete Institute (ACI), and the American Society of Civil Engineers (ASCE). These references are listed in our reference section.

No structural engineering evaluation was completed for this study. As described below, the expected performance of tanks was broadly grouped based on tank age and the building code requirements at the time of tank construction. No tank- or site-specific information regarding detailed site characterization or historical seismic upgrade work was made available to use for this study. Geotechnical assessments were based on publicly available (and limited confidential) data and information as described in Salus (2022).

Tank damage was generally based either on the tank age and/or anticipated ground deformations, as described below.

### 2.1.1 Tank Age

The age of tanks was used to determine the likely standards that were followed during the design of the tanks. For our evaluation we assumed that seismic design of the tanks at the CEI Hub location followed city/state building codes, and therefore, age-appropriate UBC-/IBC-/ASCE-based seismic requirements were used for the tanks. We have not accounted for any subsequent seismic upgrade work which may have been completed by individual property owners.

Based on our review and OBCD information (OBCD 2012) UBC/IBC/ASCE design standards, and state and city building codes were adopted in Oregon in 1974 and included seismic design parameters for a Seismic Zone of 2. It was not until 1993 that Oregon was designated a Seismic Zone 3 and the seismic design requirements were significantly increased (by 50%) to better reflect the local seismic risk. (OBCD 2012).. Further, based on information provided by the City of Portland Bureau of Development Services to DOGAMI (Wang 2012), the City of Portland first required geotechnical reports to evaluate liquefaction potential and soil strength loss in 1996. However, it was not until 2004 that silty soils such as those located at the CEI Hub were considered liquefiable. Prior to 2004 these soils were widely considered non-liquefiable.

Based on this information, we have made the following broad assumptions about tank design and performance based on the tank age.

- Tanks constructed prior to 1993 were not designed to resist levels of seismic loading required by current seismic standards and thus we have assumed that they will experience significant damage that has the potential to result in a release of materials during the CSZ event. There are 402 tanks that have been identified as being constructed prior to 1993. There are an additional 193 tanks with no tank age data that are assumed to have been constructed prior to 1993. In total, 595

tanks at the CEI Hub are assumed to be construction prior to 1993 and therefore not designed to resist current levels of seismic loading and will release material during the CSZ event.

- Tanks constructed in 1993 through 2004 are assumed to be designed for greater levels of seismic shaking than older tanks, but are assumed to be potentially susceptible to damage due to liquefaction settlement and lateral spread in sandy and silty soils. There are 23 tanks that have been identified as being constructed between 1993 and 2004.
- Tanks constructed after 2004 are assumed to have been designed to withstand earthquake shaking and associated ground deformation levels associated with current seismic design standards, and thus are unlikely to release material during the CSZ event. There are 12 tanks that have been identified as being constructed after 2004. (This does not include any older tanks which may have seismically upgraded by individual tank owners.)

Due to their age and the lack of modern-era seismic design standards, we anticipate the 402 tanks known to have been constructed before 1993 and the 193 with no age (assumed to be constructed before 1993) will likely be damaged and release material during a CSZ earthquake event.

We recognize that even tanks designed and constructed after 2004 will not necessarily have been designed to resist seismic shaking equal to the intensities that are anticipated to be associated with the CSZ. Therefore, even some of these more modern tanks are likely to experience damage; however, for purposes of this scenario evaluation that has not been quantified.

### ***2.1.2 Ground Deformation***

In Salus (2022), the potential for ground deformation due to liquefaction-induced ground settlement, lateral spreading, and slope failure was estimated. If significant enough, ground deformation can cause damage to tanks. Based on our review of tank standards and information assembled by Akhavan-Zanjani (2009), steel tanks can undergo settlement on the order of 1 to 3 feet depending on tank diameter without suffering significant distress. Allowable tilt is on the order of 0.5 to 1 foot depending on tank height. Allowable settlements are expected to be less for concrete tanks.

Tanks built during 1993 and before 2004 were evaluated based on the anticipated settlement, lateral spread, and expected slope failure due to site geometry (retaining walls, slope etc.). If settlement and lateral spread or slope failure is expected to exceed allowable amounts, the tanks were assumed to be damaged enough to release material. However, based on our evaluation, the 23 tanks built between 1993 and 2004 were not located in areas expected to exceed the allowable deformations noted above, and therefore, were not considered to release material.

### ***2.1.3 Tank Material Release***

As noted above, we anticipate the 402 tanks constructed before 1993, and the 193 assumed to be constructed before 1993, will likely be damaged during a CSZ event. The consequence of tank damage is a release of materials. We have assumed that tank damage will result in between 50 to 100 percent of the contents being released to the ground or in the water.

The 23 tanks built between 1993 and 2004 and the 12 tanks built after 2004 are expected to remain relatively intact after a CSZ event; however, we have assumed releases due to connection failures and other incidental damage may result in up to 10 percent release.

### ***2.1.4 Tank Characterization***

Tanks were grouped by content and age as outlined above. Further, we categorized the materials as flammable and hazardous based on the material identified as contents. We referenced the Safety Data Sheets (SDS) for each material to categorize the tanks as outlined below. SDS sheets were generally accessed through an online software database (CSS 2021). Tank characterizations as outlined below were incorporated into GIS and are shown on figures in Appendix C of Salus 2021.

#### ■ Tank Groups

- Group 1 - No information on contents/amount of material present (79 of 630 tanks)
- Group 2 - Out of Service/Empty (161 of 630 tanks)
- Group 3 - Content and amount of material present available
  - Group 3A - Built before 1993 (357 of 630 tanks)
  - Group 3B - Built 1993-2004 (21 of 630 tanks)
  - Group 3C - Built after 2004 (12 of 630 tanks)

#### ■ Tank Material Impact Categories

- Flammability
  - Category 1 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or below 95°F (35°C) [106 of 630 tanks]
  - Category 2 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or above 95°F (35°C) [28 of 630 tanks]
  - Category 3 - Liquids with flashpoints at or above 73.4°F (23°C) and at or below 140°F (60°C) [66 of 630 tanks]
  - Category 4 - Liquids having flashpoints above 140°F (60°C) and at or below 199.4°F (93°C) [0 tanks]
  - None (Out of Service/Empty) [161 of 630 tanks]
  - Not Flammable (14 of 630 tanks)
  - Unknown (255 of 630 tanks)

#### ■ Hazardous

- Yes - Hazardous (All flammable materials are considered hazardous) [337 of 630 tanks]
- No - Non-Hazardous (7 of 630 tanks)
- None (Out of Service/Empty) [161 of 630 tanks]
- Unknown (125 of 630 tanks)

### ***2.1.5 Damage Zone Characterization***

Damage zones were developed to indicate where materials released from failed tanks are anticipated to be located and were categorized into three categories, including released material remains on the ground, released material flows into the Willamette River, and released material has the potential to spread or be spread by water or rain to the Willamette River. These zones were estimated based on proximity to water, expected settlement and lateral spread estimates as determined in Salus (2022) our geotechnical evaluation, and topography (retaining walls and existing slopes).

We understand that containment berms, walls and other structures are present at the various CEI Hub properties. We do not have any information on these structures, no site visits were conducted, and no structural engineering evaluations were completed. However, concrete and berm structures are generally susceptible to settlement and lateral spread and have been assumed to fail, and therefore, release material where more than 1 foot of lateral movement is expected. Further, based on Environmental Protection Agency (EPA) guidance for preparation of spill prevention and control plans, these standards generally require that tank spill containment be designed to contain between 100 and 110 percent of the capacity of the largest tank within the containment area. Based on aerial photography, these containment areas generally contain several tanks that may be damaged and release their contents, therefore, the containment structures are not assumed to prevent spills during a seismic event where more than one tank is likely to be damaged and significant ground movement is anticipated.

Based on our evaluation, the damage zones were defined as shown in Table 2.1 and in Appendix C of the main report (Salus 2021).

**Table 2.1 - Damage Zone Summary**

|                          | Damage Zone (distance from slope crest/wall (feet)) |                               |                  |
|--------------------------|---|-------------------------------|------------------|
|                          | Material In Water                                   | Material Potentially in Water | Material On Land |
| Area 1 - Kinder Morgan N | 0-500   | 500-750                       | 750+             |
| Area 2 - Linnton N       | 0-500   | 500-750                       | 750+             |
| Area 2 - Linnton S       | 0-500   | 500-750                       | 750+             |
| Area 3 - NW Natural      | 0-250   | 250-500                       | 500+             |
| Area 4 - Willbridge      | 0-250   | 250-500                       | 500+             |
| Area 5 - Equilon         | n/a   | n/a                           | All              |

These damage zones were incorporated into GIS and compared to the City dataset. A discussion of the tank damage assessment results for the 630 tanks evaluated is provided in Section 3.

### 3.0 MATERIAL RELEASE ESTIMATES AT THE CEI HUB

In Section 2, we evaluated the potential for tanks to be damaged in a seismic event based on age and ground deformation. In this section, we estimate the potential volume of materials that might be released from susceptible tanks. The loss of materials is grouped in material type and proximity to the Willamette River.

#### 3.1 Estimate of Hazardous Materials Spilled to Willamette River

Of the 630 tanks present, 114 tanks were estimated to have the potential to release the contents to the Willamette River based on tank age and location. However, 30 of these tanks were categorized as Out of Service or Unavailable, and therefore not included in this summary. A detailed table of the tanks is provided in Appendix B.



### 3.1.1 Full Spill - 50 to 100 Percent of Contents

We estimate that 78 of the 84 tanks, which are all built before 1993, have the potential to release between 50 to 100 percent of their contents to the Willamette River. These tanks were sorted by content and minimum and maximum expected volume lost. A total of 20 unique substances are included in these releases as summarized below in Table 3.1.

**Table 3.1 - Materials with Potential to Release to the Willamette River by Area - Full Spill**

| Area                                  | Property                  | Contents                        | Volume Lost Minimum (gallons) | Volume Lost Maximum (gallons) |
|---------------------------------------|---------------------------|---------------------------------|-------------------------------|-------------------------------|
| 1                                     | Kinder Morgan North       | Contact Water                   | 7,668                         | 15,336                        |
|                                       |                           | Diesel                          | 509,615                       | 1,019,231                     |
|                                       |                           | Gasoline                        | 2,497,509                     | 4,995,019                     |
|                                       |                           | Storm Water                     | 45,910                        | 91,821                        |
| 2                                     | BP                        | Biodiesel                       | 344,026                       | 688,051                       |
|                                       |                           | Diesel                          | 2,968,193                     | 5,936,386                     |
|                                       |                           | Ethanol                         | 404,794                       | 809,588                       |
|                                       |                           | Gasoline                        | 3,752,258                     | 7,504,516                     |
|                                       |                           | Gasoline Additive               | 87,303                        | 174,607                       |
|                                       |                           | Groundwater Remediation         | 412,385                       | 824,770                       |
|                                       |                           | Oily Wastewater                 | 66,607                        | 133,215                       |
|                                       | Shore Terminals           | Biodiesel                       | 290,062                       | 580,124                       |
|                                       |                           | Biodiesel Additive <sup>7</sup> | NA                            | NA                            |
|                                       |                           | Cutter                          | 103,682                       | 207,364                       |
|                                       |                           | Diesel                          | 1,907,140                     | 3,814,279                     |
|                                       |                           | Ethanol                         | 911,472                       | 1,822,944                     |
|                                       |                           | Ethanol/Gasoline <sup>2</sup>   | 131,705                       | 263,410                       |
|                                       |                           | Gasoline                        | 3,504,071                     | 7,008,142                     |
| Gasoline/Diesel Additive <sup>4</sup> | 5,941                     | 11,881                          |                               |                               |
| Gasoline/Diesel <sup>3</sup>          | 6,411,500                 | 12,822,999                      |                               |                               |
| Marine Fuel Oil                       | 1,190,136                 | 2,380,271                       |                               |                               |
| 3                                     | Pacific Terminal Services | Diesel Oil                      | 20,104                        | 40,208                        |
|                                       |                           | Residual Oil <sup>6</sup>       | 65,325                        | 130,650                       |
| 4                                     | McCall Oil                | Asphalt                         | 3,767,805                     | 7,535,611                     |
|                                       |                           | Biodiesel                       | 333,937                       | 667,875                       |
|                                       |                           | Bunker                          | 3,134,909                     | 6,269,817                     |
|                                       |                           | Diesel                          | 1,788,635                     | 3,577,269                     |
|                                       |                           | Oil and water                   | 10,130                        | 20,261                        |

### 3.1.2 Minor Releases - Up to 10 Percent of Contents

We estimate that 6 of the 86 tanks (built during or after 1993) have the potential to release up to 10 percent of their contents into the Willamette River. These six tanks were sorted by content and minimum and maximum expected volume lost. A total of five unique substances are included in these releases as summarized in Table 3.2.

**Table 3.2 - Materials with Potential to Release to the Willamette River by Area - Minor Release**

| Area | Property                  | Contents                     | Volume Lost Maximum (gallons) |
|------|---------------------------|------------------------------|-------------------------------|
| 1    | Kinder Morgan North       | Diesel                       | 190,434                       |
| 2    | BP                        | Diesel Additive              | 134                           |
|      |                           | Diesel Lubricity Additive    | 141                           |
|      | Shore Terminals           | Gasoline/Diesel <sup>3</sup> | 562,800                       |
| 3    | Pacific Terminal Services | Residual Oil <sup>6</sup>    | 32                            |

### 3.2 of Hazardous Materials Potentially Spilled to Willamette River

Our evaluation indicates that 18 tanks are expected to release the following percentage of contents in areas that could potentially be released into to the Willamette River via overland flow or carried by water runoff. A detailed table of these tanks is provided in Appendix C.

#### 3.2.1 Full Spill - 50 to 100 Percent of Contents

We estimate that 12 of the 18 tanks (built prior to 1993) have the potential to release between 50 and 100 percent of their contents onto the ground surface and potentially into the Willamette River. Seven unique substances are included in these releases as summarized in Table 3.3.

**Table 3.3 - Materials with Potential to Release and Flow to the Willamette River by Area - Full Spill**

| Area | Property                  | Contents                  | Volume Lost Minimum (gallons) | Volume Lost Maximum (gallons) |
|------|---------------------------|---------------------------|-------------------------------|-------------------------------|
| 3    | Pacific Terminal Services | Residual Oil <sup>6</sup> | 6,700                         | 13,400                        |
| 4    | Conoco Phillips           | Unleaded Gasoline         | 990,106                       | 1,980,212                     |
|      | McCall Oil                | Anti-strip                | 1,646                         | 3,292                         |
|      |                           | Asphalt                   | 4,385,098                     | 8,770,197                     |
|      |                           | Boiler Fuel               | 2,800                         | 5,600                         |
|      |                           | Flux                      | 17,433                        | 34,865                        |
|      | Unichem                   | 3,685                     | 7,370                         |                               |

#### 3.2.2 Minor Releases - 10 Percent of Contents

We estimate that 6 of the 18 tanks (built after 1993) have the potential to release up to 10 percent of the tank contents in areas that could potentially reach the Willamette River due to connection failures. The tanks are located in Area 4 as summarized in Table 3.4.

**Table 3.4 - Materials with Potential to Release and Flow to the Willamette River - Minor Release**

| Area | Property   | Contents            | Volume Lost Maximum (gallons) |
|------|------------|---------------------|-------------------------------|
| 4    | Chevron    | Unleaded Gasoline   | 228,625                       |
|      | McCall Oil | Asphalt             | 17,317                        |
|      |            | Polyphosphoric Acid | 362                           |

### 3.3 Estimate of Hazardous Materials Spilled to Ground Surface

Of the tanks with known locations, 498 have the potential to release contents onto to the ground. However, 209 of these tanks are categorized as Out of Service, Empty, NA, or Unavailable. A detailed table of the remaining 289 tanks is provided in Appendix D.

#### 3.3.1 Full Spill - 50 to 100 Percent of Contents

We estimate that 268 tanks have the potential to release 50 to 100 percent of their tank contents onto the ground. These tanks were sorted by content and minimum and maximum expected volume lost. A total of 149 unique substances have the potential to be released to the ground surface as summarized in Table 3.5.

**Table 3.5 - Materials with Potential to Release to the Ground Surface - Full Spill**

| Area              | Property | Contents                | Volume Lost Minimum (gallons) | Volume Lost Maximum (gallons) |
|-------------------|----------|-------------------------|-------------------------------|-------------------------------|
| 4                 | Chevron  | 1000 THF                | 20,724                        | 41,449                        |
|                   |          | Additive                | 11,808                        | 23,616                        |
|                   |          | ATF dex 111             | 36,842                        | 73,684                        |
|                   |          | Base Oil                | 964,907                       | 1,929,813                     |
|                   |          | Blend Mix/ Line Wash    | 24,200                        | 48,400                        |
|                   |          | Blended Oil             | 3,527                         | 7,054                         |
|                   |          | Chevron 7075F           | 66,600                        | 133,200                       |
|                   |          | Citgo Brt Stock 150     | 51,065                        | 102,130                       |
|                   |          | Clarity PM 150          | 2,903                         | 5,806                         |
|                   |          | Clarity PM 220          | 14,549                        | 29,097                        |
|                   |          | Clarity Saw Guide 46    | 5,806                         | 11,612                        |
|                   |          | Compressor Oil          | 5,790                         | 11,580                        |
|                   |          | CVX 3105                | 5,888                         | 11,777                        |
|                   |          | Delo 100-40             | 8,550                         | 17,100                        |
|                   |          | Delo 400-10             | 8,479                         | 16,958                        |
|                   |          | Delo 400-15W40          | 97,910                        | 195,821                       |
|                   |          | Delo 400-30             | 27,812                        | 55,625                        |
|                   |          | Delo 400-40             | 20,724                        | 41,449                        |
|                   |          | Delo 6170 CFO 20W40     | 63,765                        | 127,530                       |
|                   |          | Delo G/L 80/90          | 5,969                         | 11,938                        |
|                   |          | Delo GL 80/90           | 5,904                         | 11,808                        |
|                   |          | Diesel                  | 282,832                       | 565,664                       |
|                   |          | Drive Train Fluid HD 10 | 11,643                        | 23,287                        |
|                   |          | ExxonMobil EM-100       | 196,411                       | 392,822                       |
|                   |          | ExxonMobile EHC45       | 9,825                         | 19,649                        |
|                   |          | FAMM Tara 30 DP 30      | 8,502                         | 17,004                        |
|                   |          | Famm Taro Sepcial 70    | 33,699                        | 67,398                        |
| Gear Lube         | 5,904    | 11,808                  |                               |                               |
| GEO HDAX L ASH 40 | 33,593   | 67,186                  |                               |                               |
| GST ISO 100       | 8,502    | 17,004                  |                               |                               |

| Area | Property | Contents             | Volume Lost Minimum (gallons) | Volume Lost Maximum (gallons) |
|------|----------|----------------------|-------------------------------|-------------------------------|
|      |          | GST ISO 32           | 5,904                         | 11,808                        |
|      |          | Havoline 10W30       | 20,724                        | 41,449                        |
|      |          | Hybase C414          | 11,710                        | 23,420                        |
|      |          | Industrial EP 150    | 5,953                         | 11,907                        |
|      |          | Industrial EP 220    | 5,904                         | 11,808                        |
|      |          | Infineum M7038       | 5,904                         | 11,808                        |
|      |          | Jet Fuel             | 336,536                       | 673,073                       |
|      |          | Lubrizol 4991        | 11,710                        | 23,419                        |
|      |          | Lubrizol 4991D       | 70,992                        | 141,983                       |
|      |          | Map 100              | 27,946                        | 55,893                        |
|      |          | MAR EO 9250-40       | 5,938                         | 11,875                        |
|      |          | Neutral 220R         | 145,980                       | 291,960                       |
|      |          | Neutral 600R         | 134,127                       | 268,254                       |
|      |          | Neutral Oil          | 122,554                       | 245,109                       |
|      |          | Oil Stop             | 6,509                         | 13,019                        |
|      |          | Oloa 2000            | 20,354                        | 40,707                        |
|      |          | Oloa 44200           | 5,920                         | 11,840                        |
|      |          | Oloa 550006L         | 9,910                         | 19,821                        |
|      |          | Oloa 6073EV          | 5,969                         | 11,938                        |
|      |          | Oloa 9740C           | 5,920                         | 11,840                        |
|      |          | Paratone 8451        | 161,248                       | 322,496                       |
|      |          | Pennzoil 75HC        | 9,739                         | 19,478                        |
|      |          | Raffene 2000L        | 5,904                         | 11,808                        |
|      |          | Raffene 750L         | 15,303                        | 30,607                        |
|      |          | Red Chain Bar 150    | 3,936                         | 7,873                         |
|      |          | RPM HDMO 15W40       | 48,857                        | 97,714                        |
|      |          | RPM HDMO 30          | 8,814                         | 17,628                        |
|      |          | RPM UGL 80W90        | 20,781                        | 41,562                        |
|      |          | Rykon Oil 46         | 30,607                        | 61,214                        |
|      |          | Rykon Oil 68         | 22,585                        | 45,171                        |
|      |          | Rykon Prem 32        | 44,550                        | 89,099                        |
|      |          | Rykon Prem MV        | 35,140                        | 70,281                        |
|      |          | Saw Guide 150        | 5,790                         | 11,580                        |
|      |          | Shell MV1 100        | 8,502                         | 17,004                        |
|      |          | Supreme 5W30         | 20,781                        | 41,562                        |
|      |          | SynFluid \$, 4CST    | 2,919                         | 5,837                         |
|      |          | Techron Additive     | 69,822                        | 139,645                       |
|      |          | Texaco Havoline 5S30 | 5,806                         | 11,612                        |
|      |          | Transmix             | 8,525                         | 17,049                        |
|      |          | Turbine Oil          | 17,712                        | 35,424                        |
|      |          | Undefined Petroleum  | 5,938                         | 11,875                        |
|      |          | Unleaded Gasoline    | 1,209,264                     | 2,418,528                     |
|      |          | VER 800 Mar 30       | 11,336                        | 22,672                        |
|      |          | Viscoplex 1-604      | 4,689                         | 9,378                         |



| Area          | Property        | Contents                    | Volume Lost Minimum (gallons) | Volume Lost Maximum (gallons) |
|---------------|-----------------|-----------------------------|-------------------------------|-------------------------------|
|               |                 | Viscoplex 7-305             | 4,663                         | 9,325                         |
|               |                 | Water/Oil Slop              | 132,843                       | 265,686                       |
|               | Conoco Phillips | Bar & Chain 150             | 4,523                         | 9,045                         |
|               |                 | Biodiesel                   | 135,424                       | 270,848                       |
|               |                 | Decant Oil                  | 317,602                       | 635,204                       |
|               |                 | Diesel #1                   | 233,055                       | 466,111                       |
|               |                 | Diesel #2                   | 2,597,632                     | 5,195,263                     |
|               |                 | Ethanol                     | 93,453                        | 186,906                       |
|               |                 | Ethyl HITEC 388             | 4,523                         | 9,045                         |
|               |                 | Ethyl HITEC 5756            | 4,523                         | 9,045                         |
|               |                 | Ethyl HITEC 6888E           | 8,543                         | 17,085                        |
|               |                 | Firebird 15W/40             | 4,523                         | 9,045                         |
|               |                 | Fleet Sup EC 15W/40         | 4,523                         | 9,045                         |
|               |                 | Flush                       | 5,863                         | 11,725                        |
|               |                 | Gasoline Slops <sup>5</sup> | 3,377                         | 6,754                         |
|               |                 | Guardol 15W/40              | 36,515                        | 73,030                        |
|               |                 | Guardol 30                  | 4,523                         | 9,045                         |
|               |                 | HITEC 1193                  | 5,863                         | 11,725                        |
|               |                 | HITEC 1193A                 | 4,523                         | 9,045                         |
|               |                 | HITEC 3472                  | 4,523                         | 9,045                         |
|               |                 | HITEC 5751                  | 5,863                         | 11,725                        |
|               |                 | HiTech 6576                 | 6,106                         | 12,213                        |
|               |                 | HT4/10W                     | 5,863                         | 11,725                        |
|               |                 | HT4/30W                     | 4,523                         | 9,045                         |
|               |                 | Hydraulic Tractor Oil       | 6,399                         | 12,797                        |
|               |                 | HYNAP N100                  | 5,863                         | 11,725                        |
|               |                 | Industrial Fuel Oil         | 1,108,069                     | 2,216,138                     |
|               |                 | Line Clippings              | 6,030                         | 12,060                        |
|               |                 | Lubrizol 48254              | 5,863                         | 11,725                        |
|               |                 | Lubrizol 4990CH             | 5,863                         | 11,725                        |
|               |                 | Lubrizol 4998C              | 5,863                         | 11,725                        |
|               |                 | Lubrizol 7075F              | 5,863                         | 11,725                        |
|               |                 | Lubrizol 9692A              | 4,523                         | 9,045                         |
|               |                 | Lubrizol 9990A              | 4,523                         | 9,045                         |
|               |                 | Marine Diesel               | 150,647                       | 301,295                       |
|               |                 | Marine Fuel Oil             | 525,810                       | 1,051,620                     |
|               |                 | Mohawk 150                  | 4,523                         | 9,045                         |
|               |                 | Mohawk 450                  | 5,863                         | 11,725                        |
|               |                 | MP Gear Lube 80/90          | 5,863                         | 11,725                        |
|               |                 | Point Premier 10W/30        | 5,863                         | 11,725                        |
| PS 300        | 153,870         | 307,739                     |                               |                               |
| Raffene 750L  | 5,863           | 11,725                      |                               |                               |
| Ramar CLF 17E | 14,405          | 28,810                      |                               |                               |

| Area | Property            | Contents                       | Volume Lost Minimum (gallons) | Volume Lost Maximum (gallons) |
|------|---------------------|--------------------------------|-------------------------------|-------------------------------|
|      |                     | Residual Fuel Oil <sup>6</sup> | 304,827                       | 609,653                       |
|      |                     | RLOP 100N                      | 139,863                       | 279,725                       |
|      |                     | RLOP 220 N                     | 379,723                       | 759,445                       |
|      |                     | RLOP 600N                      | 98,658                        | 197,315                       |
|      |                     | Stop Oil                       | 13,127                        | 26,255                        |
|      |                     | SUN 150 B/S                    | 67,000                        | 134,000                       |
|      |                     | SUN 525                        | 72,863                        | 145,725                       |
|      |                     | Sup Syn BL 10W/30              | 11,725                        | 23,450                        |
|      |                     | SUP SYN BL 5W/30               | 40,200                        | 80,400                        |
|      |                     | Super 5W/20                    | 5,863                         | 11,725                        |
|      |                     | Super ATF                      | 17,588                        | 35,175                        |
|      |                     | T5X HD 15W/40                  | 11,725                        | 23,450                        |
|      |                     | Transmix                       | 68,845                        | 137,689                       |
|      |                     | TSX HD10                       | 4,523                         | 9,045                         |
|      |                     | ULTRA S-4                      | 67,000                        | 134,000                       |
|      |                     | Unax AW 46                     | 36,515                        | 73,030                        |
|      |                     | UNAX AW 68                     | 5,863                         | 11,725                        |
|      |                     | UNAX AW 68                     | 5,863                         | 11,725                        |
|      |                     | Uniguide II 100                | 11,725                        | 23,450                        |
|      |                     | Unleaded Gasoline              | 2,133,716                     | 4,267,431                     |
|      |                     | Utility                        | 37,889                        | 75,777                        |
|      |                     | UTRA 58                        | 8,543                         | 17,085                        |
|      |                     | UTRA 59                        | 5,863                         | 11,725                        |
|      | Versa Tran ATF      | 5,863                          | 11,725                        |                               |
|      | Kinder Morgan South | Additive                       | 8,892                         | 17,784                        |
|      |                     | Avgas                          | 191,563                       | 383,126                       |
|      |                     | Biodiesel                      | 189,945                       | 379,890                       |
|      |                     | Contact Water                  | 19,304                        | 38,608                        |
|      |                     | Diesel                         | 3,070,074                     | 6,140,148                     |
|      |                     | Ethanol                        | 72,293                        | 144,586                       |
|      |                     | Gasoline                       | 7,675,185                     | 15,350,370                    |
|      |                     | Jet A                          | 4,090,121                     | 8,180,242                     |
|      |                     | Lubricity Additive             | 56,280                        | 112,560                       |
|      |                     | Slop Water                     | 2,111                         | 4,221                         |
|      |                     | Storm Water                    | 211,050                       | 422,100                       |
|      |                     | Transmix                       | 472,006                       | 944,013                       |
|      | McCall Oil          | Asphalt                        | 6,346                         | 12,691                        |
|      | Zenith Energy       | Asphalt                        | NA                            | NA                            |
|      |                     | Avgas                          | 701,190                       | 1,402,380                     |
|      |                     | Biodiesel                      | 111,000                       | 222,000                       |
|      |                     | Caustic                        | NA                            | NA                            |
|      |                     | Charge Stock                   | NA                            | NA                            |
|      |                     | Crude Oil                      | 13,890,431                    | 27,780,862                    |
|      | Murol               | NA                             | NA                            |                               |

| Area | Property | Contents                    | Volume Lost Minimum (gallons) | Volume Lost Maximum (gallons) |
|------|----------|-----------------------------|-------------------------------|-------------------------------|
|      |          | Universal Low-Sulfur Diesel | 1,594,299                     | 3,188,598                     |
|      |          | Wastewater                  | NA                            | NA                            |
| 5    | Equilon  | Diesel                      | 2,558,686                     | 5,117,372                     |
|      |          | Ethanol                     | 781,124                       | 1,562,248                     |
|      |          | Gasoline                    | 4,080,821                     | 8,161,641                     |
|      |          | Water                       | 89,598                        | 179,196                       |

### 3.3.2 Minor Releases - 10 Percent of Contents

We estimate that 21 tanks have the potential to release up to 10 percent of their contents onto the ground. The 21 tanks were sorted by content and minimum and maximum expected volume lost. Eight unique substances have the potential to be released onto the ground surface as summarized in Table 3.6. All of these tanks are located in Area 4.

**Table 3.6 - Materials with Potential to Release to the Ground Surface - Minor Release**

| Area  | Property              | Contents              | Volume Lost Maximum (gallons) |
|-------|-----------------------|-----------------------|-------------------------------|
| 3     | Northwest Natural Gas | Liquefied Natural Gas | 475,700                       |
| 4     | Conoco Phillips       | Octel 9056            | 1,249                         |
|       | Chevron               | Base Oil              | 56,085                        |
|       |                       | Blended Oil           | 5,964                         |
|       |                       | Ethanol               | 64,232                        |
|       |                       | Swing Tank            | 851,457                       |
|       |                       | Unleaded Gasoline     | 951,669                       |
|       | Kinder Morgan South   | Diesel                | 337,680                       |
|       |                       | Gasoline              | 337,680                       |
| Jet A |                       | 337,680               |                               |

## 3.4 Estimate of Hazardous Materials Expected to Burn

During the development of the tank inventory, the materials present in the tanks were reviewed for flammability based on the flammability categories outlined on the standard MSDSs. The 390 tanks evaluated were divided based on the flammability categories defined in Section 2 (Step 2). The number of tanks in each flammability category are as follow:

- Category 1 - 106 Tanks
- Category 2 - 28 Tanks
- Category 3 - 66 Tanks
- Category 4 - 0 Tanks
- Not Flammable - 14 Tanks
- Unknown (Contents Known, Flammability Category Not Found) - 176 Tanks

Of the 390 tanks with known contents at the CEI Hub, 200 (approximately 51 percent) have materials that are known to be flammable. The estimated volume of flammable materials present at the CEI Hub

is 209,533,756 gallons. Therefore, the contents of these tanks all have the potential to burn, either on land or in the water. Because burning requires both a fuel and ignition source, it is not possible to have a specific numerical value for the estimated quantity of materials that will burn. Rather, it is only possible to estimate that 209,533,756 gallons have the *potential* to burn.

Based on the Tank Damage Assessment Methodology, we estimate that 87,246,258 to 179,996,640 gallons of flammable material will be released either to the Willamette River or on land.

### 3.5 Estimate of Hazardous Materials Present

In addition to the flammability of materials present at the CEI Hub, tank contents were also evaluated for their hazardous characteristics. The 390 tanks evaluated were divided based on hazardous or non-hazardous characteristics as defined in Section 2 (Step 2). The number of tanks in each hazard category are as follow:

- Hazardous - 337 Tanks
- Non-Hazardous - 7 Tanks
- Unknown (Contents Known, Hazard Category Not Found) - 46 Tanks

Of the 390 tanks with known contents at the CEI Hub, 337 (approximately 86 percent) have materials that have are known to be hazardous.



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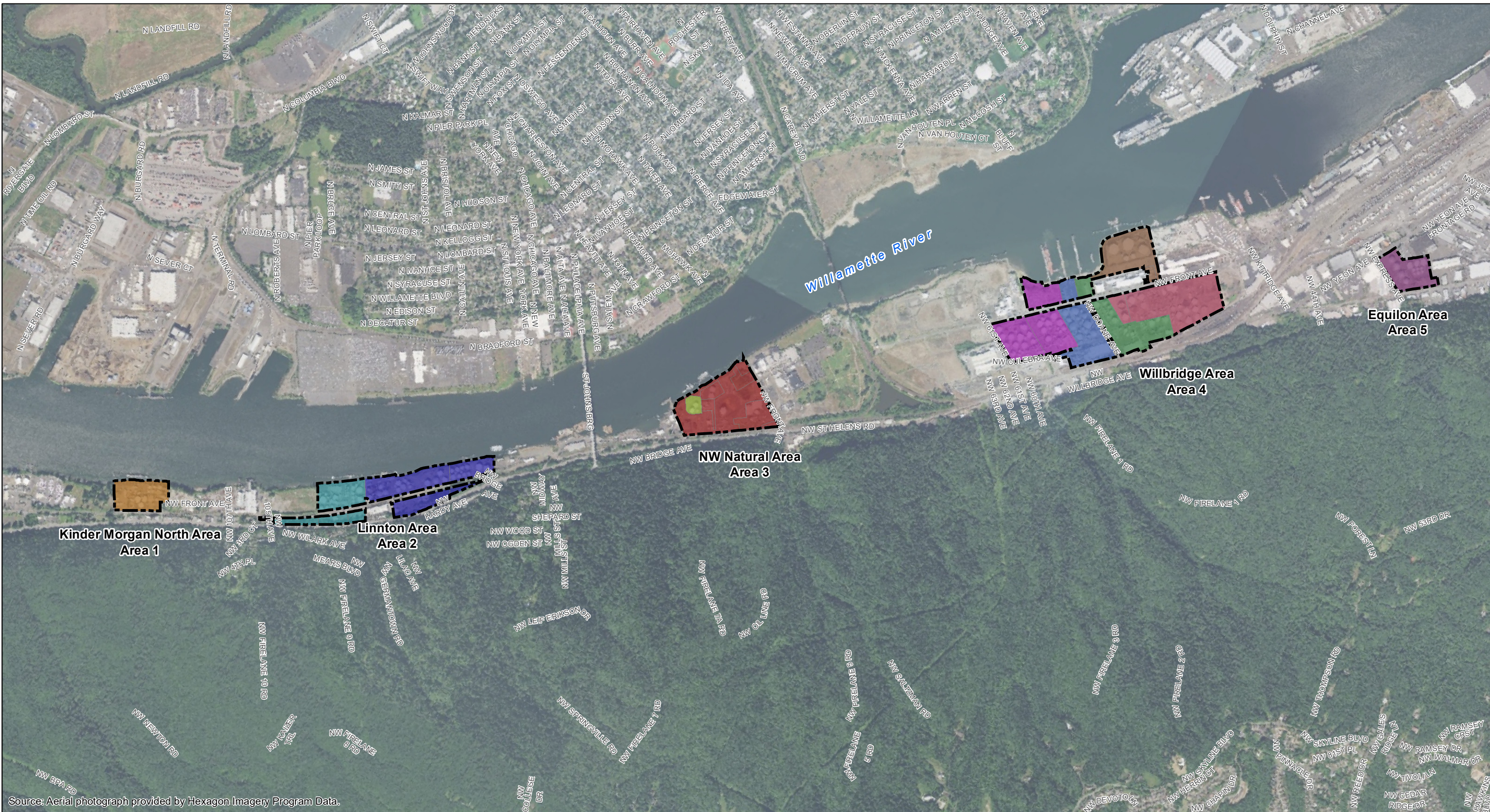
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Source: Aerial photograph provided by Hexagon Imagery Program Data.

**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**

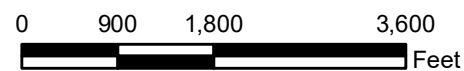
Chevron

Conoco Phillips

Kinder Morgan

McCall Oil

Zenith Energy Terminals



Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub  
Portland, Oregon

**CEI Hub Map**

154-035-019

04/21



Figure

**1**





**Tank Release**

- ▲ Flammable and Hazardous
- ▲ Empty or Out of Service

**No Tank Release**

- Flammable and Hazardous
- Taxlot Boundary

**Damage Zone**

- Material in Water
- Potentially in Water



**FIGURE 2A**  
**KINDER MORGAN NORTH**

FEBRUARY 2022  
GIS FIGURE PROVIDED BY ECONORTHWEST





### Tank Release

- ▲ Flammable and Hazardous
- ▲ No Data
- ▲ Empty or Out of Service
- ▲ Tank Failure, not Flammable and not Hazardous

### No Tank Release

- Flammable and Hazardous
- Taxlot Boundary

### Damage Zone

- Material in Water
- Potentially in Water



**FIGURE 2B  
LINNTON**

FEBRUARY 2022  
GIS FIGURE PROVIDED BY ECONORTHWEST





**Tank Release**

▲ Flammable and Hazardous

**No Tank Release**

● Flammable and Hazardous

□ Taxlot Boundary

**Damage Zone**

■ Material in Water

■ Potentially in Water



**FIGURE 2C**  
**NW NATURAL**

FEBRUARY 2022  
GIS FIGURE PROVIDED BY ECONORTHWEST





**Tank Release**

- ▲ Flammable and Hazardous
- ▲ Flammable (but not Hazardous)
- ▲ Hazardous (but not Flammable)
- ▲ No Data

- ▲ Empty or Out of Service

- ▲ Tank Failure, not Flammable and not Hazardous

**Damage Zone**

- Material in Water
- Potentially in Water

**No Tank Release**

- Flammable and Hazardous
- Hazardous (but not Flammable)
- No Data
- Taxlot Boundary



**FIGURE 2D**  
**WILLBRIDGE**

FEBRUARY 2022  
GIS FIGURE PROVIDED BY ECONORTHWEST





**Tank Release**

- ▲ Flammable and Hazardous
- ▲ Empty or Out of Service
- ▲ Tank Failure, not Flammable and not Hazardous
- Taxlot Boundary

**Damage Zone**

- Material in Water
- Potentially in Water



**FIGURE 2E  
EQUILON**

FEBRUARY 2022  
GIS FIGURE PROVIDED BY ECONORTHWEST



**APPENDIX A**  
**Full Tank Data**















| Area | Property      | Tank ID <sup>1</sup> | Latitude | Longitude | Contents                    | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>9</sup> | Year | Type | Tank Group | Flammability Category | Hazardous Category | Damage Zone | Tank Age Failures | Percent Lost Min | Percent Lost Max | Volume Lost Min | Volume Lost Max |
|------|---------------|----------------------|----------|-----------|-----------------------------|----------------|--|------|------|------------|-----------------------|--------------------|-------------|-------------------|------------------|------------------|-----------------|-----------------|
| 4    | Zenith Energy | Tank 114             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 302             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 162             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 166             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 167             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 168             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 169             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 170             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 171             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 172             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 20              | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 173             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 174             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 180             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 179             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 206             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 210             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 177             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 176             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 178             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 161             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 200             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 201             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | N2                   | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 317             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | BAS #2               | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | KO #5                | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | BAS #3               | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | BAS #4               | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 160             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 161             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 314             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 002             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | KO #2                | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | CAS #5               | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | BAS #1               | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 305             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | KO #1                | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 163             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 164             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 165             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 152             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 151             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 158             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 157             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 156             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 148             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 149             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 150             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 142             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 143             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 144             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 147             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 146             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 145             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 140             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 141             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 300             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | K-23                 | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | TW-2                 | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 207             | Unknown  | Unknown   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 66              | Unknown  | Unknown   | Universal Low-Sulfur Diesel | NA             | 3,188,598  | NA   | NA   | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,594,299       | 3,188,598       |
| 4    | Zenith Energy | Tank 111             | Unknown  | Unknown   | Wastewater                  | NA             | NA   | NA   | NA   | Group 3A   | Not Flammable         | No                 | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Zenith Energy | Tank 113             | Unknown  | Unknown   | Wastewater                  | NA             | NA   | NA   | NA   | Group 3A   | Not Flammable         | No                 | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |

Notes:

- <sup>1</sup>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: Kinder Morgan North = \*KML Tank 1 \*
- <sup>2</sup>Tank contents were listed as both gasoline and ethanol; flammability and hazard category are for gasoline.
- <sup>3</sup>Tank contents were listed as both gasoline and diesel; flammability and hazard category are for gasoline.
- <sup>4</sup>Tank contents were listed as both gasoline and diesel additives; flammability and hazard category are for gasoline.
- <sup>5</sup>Tank contents were listed as gasoline slops; flammability and hazard category are for gasoline.
- <sup>6</sup>Residual Oil and Residual Fuel Oil is a general classification for heavier oils that remain after the distillate fuel oil and lighter hydrocarbons are removed. The type of lighter hydrocarbon is unknown and therefore defaulted to the most flammable category.
- <sup>7</sup>Tank contents were listed as biodiesel additive; flammability and hazard category are for biodiesel.
- <sup>8</sup>Tank data provided by COP without geographic location; failure assumption made from satellite imagery.
- <sup>9</sup>Zenith Energy tank fill provided directly from Portland Fire and Rescue.
  - Category 1 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or below 95°F (35°C).
  - Category 2 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or above 95°F (35°C).
  - Category 3 - Liquids with flashpoints at or above 73.4°F (23°C) and at or below 140°F (60°C).
  - Category 4 - Liquids having flashpoints above 140°F (60°C) and at or below 199.4°F (93°C).
- NA - Data not available
- No - Tank substance is not hazardous.
- None - Flammability category and/or hazard category is not applicable due to tank status of Out of Service.
- Not Flammable - Tank contents are not flammable and do not fall into Category 1-4.
- Unknown - Flammability category or hazard category unknown due to unknown tank contents, or tank contents not defined in a suitable way to ascertain flammability or hazard categories.
- Yes - Tank substance is hazardous.



**APPENDIX B**  
**Tanks with Potential to Release to Willamette River**

Appendix B: Tanks with Potential to Release to Willamette River

| Area | Property            | Tank ID <sup>a</sup> | Contents                              | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>b</sup> | Year | Type                   | Tank Group | Flammability Category | Hazardous Category | Damage Zone       | Tank Age Failures | Percent Lost |      | Volume Lost |           |
|------|---------------------|----------------------|---------------------------------------|----------------|--|------|------------------------|------------|-----------------------|--------------------|-------------------|-------------------|--------------|------|-------------|-----------|
|      |                     |                      |                                       |                |  |      |                        |            |                       |                    |                   |                   | Min          | Max  | Min         | Max       |
| 2    | BP                  | BP1                  | Gasoline                              | 3,808,434      | 2,551,651  | 1940 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 1,275,825   | 2,551,651 |
| 2    | BP                  | BP10                 | Diesel                                | 1,008,840      | 675,923  | 1941 | Fixed Roof             | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 375,923     | 675,923   |
| 2    | BP                  | BP11                 | Gasoline                              | 1,354,122      | 907,262  | 1940 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 453,631     | 907,262   |
| 2    | BP                  | BP12                 | Ethanol                               | 605,346        | 405,582  | 1961 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 202,791     | 405,582   |
| 2    | BP                  | BP13                 | Ethanol                               | 602,994        | 404,006  | 1961 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 202,003     | 404,006   |
| 2    | BP                  | BP14                 | Diesel                                | 1,121,736      | 751,563  | 1942 | Fixed Roof             | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 375,782     | 751,563   |
| 2    | BP                  | BP15                 | Biodiesel                             | 804,972        | 539,331  | 1943 | Fixed Roof             | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 269,666     | 539,331   |
| 2    | BP                  | BP17                 | Diesel                                | 3,329,340      | 2,230,658  | 1940 | Fixed Roof             | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 1,115,329   | 2,230,658 |
| 2    | BP                  | BP18                 | Diesel                                | 1,104,726      | 740,166  | 1945 | Fixed Roof             | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 370,083     | 740,166   |
| 2    | BP                  | BP19                 | Only Wastewater                       | 198,828        | 133,215  | 1961 | Internal Floating Roof | Group 3A   | Not Flammable         | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | 66,607      | 133,215   |
| 2    | BP                  | BP2                  | Groundwater Remediation               | 1,231,000      | 824,770  | 1957 | Internal Floating Roof | Group 3A   | Not Flammable         | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | 412,385     | 824,770   |
| 2    | BP                  | BP21                 | Gasoline Additive                     | 220,080        | 147,454  | 1961 | Fixed Roof             | Group 3A   | Category 2            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 73,727      | 147,454   |
| 2    | BP                  | BP23a                | Diesel Additive                       | 2,000          | 1,340  | 2005 | Fixed Roof             | Group 3C   | Category 3            | Yes                | Material in Water | No Tank Failure   | 0%           | 10%  | 0           | 134       |
| 2    | BP                  | BP23b                | Diesel Lubricity Additive             | 2,100          | 1,407  | 2005 | Horizontal Tank        | Group 3C   | Category 3            | Yes                | Material in Water | No Tank Failure   | 0%           | 10%  | 0           | 141       |
| 2    | BP                  | BP24                 | Gasoline Additive                     | 20,286         | 13,592   | 1970 | Fixed Roof             | Group 3A   | Category 2            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 6,796       | 13,592    |
| 2    | BP                  | BP25                 | Gasoline Additive                     | 20,241         | 13,561   | 1966 | Fixed Roof             | Group 3A   | Category 2            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 6,781       | 13,561    |
| 2    | BP                  | BP3                  | Gasoline                              | 1,584,366      | 1,061,525  | 1957 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 530,763     | 1,061,525 |
| 2    | BP                  | BP4                  | Gasoline                              | 1,105,860      | 740,926  | 1957 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 370,463     | 740,926   |
| 2    | BP                  | BP40                 | Unavailable                           | 0              | 0  | 1954 | Fixed Roof             | Group 1    | Unknown               | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | 0           | 0         |
| 2    | BP                  | BP41                 | Out of Service                        | 0              | 0  | 1954 | Fixed Roof             | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 2    | BP                  | BP42                 | Out of Service                        | 0              | 0  | 1954 | Fixed Roof             | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 2    | BP                  | BP43                 | Out of Service                        | 0              | 0  | 1954 | Fixed Roof             | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 2    | BP                  | BP44                 | Out of Service                        | 0              | 0  | 1954 | Fixed Roof             | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 2    | BP                  | BP45                 | Unavailable                           | 0              | 0  | 1954 | Fixed Roof             | Group 1    | Unknown               | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | 0           | 0         |
| 2    | BP                  | BP46                 | Biodiesel                             | 221,970        | 148,720  | 1954 | Fixed Roof             | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 74,360      | 148,720   |
| 2    | BP                  | BP5                  | Gasoline                              | 895,314        | 599,860  | 1957 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 299,930     | 599,860   |
| 2    | BP                  | BP6                  | Gasoline                              | 1,014,384      | 679,637  | 1957 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 339,819     | 679,637   |
| 2    | BP                  | BP7                  | Gasoline                              | 648,018        | 434,172  | 1957 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 217,086     | 434,172   |
| 2    | BP                  | BP8                  | Gasoline                              | 790,272        | 529,482  | 1957 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 264,741     | 529,482   |
| 2    | BP                  | BP9                  | Diesel                                | 2,295,636      | 1,538,076  | 1940 | Fixed Roof             | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 789,038     | 1,538,076 |
| 1    | Kinder Morgan North | KML10007             | Out of Service                        | 418,278        | 179,196  | 1922 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML11017             | Out of Service                        | 469,938        | 179,196  | 1941 | Internal Floating Roof | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML11019             | Out of Service                        | 469,996        | 179,196  | 1941 | Internal Floating Roof | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML17018             | Gasoline                              | 735,714        | 179,196  | 1941 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 89,598      | 179,196   |
| 1    | Kinder Morgan North | KML17020             | Gasoline                              | 742,896        | 179,196  | 1941 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 89,598      | 179,196   |
| 1    | Kinder Morgan North | KML17027             | Gasoline                              | 739,074        | 179,196  | 1954 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 89,598      | 179,196   |
| 1    | Kinder Morgan North | KML20011             | Diesel                                | 856,506        | 179,196  | 1932 | Vertical Fixed Roof    | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 89,598      | 179,196   |
| 1    | Kinder Morgan North | KML2024              | Out of Service                        | 92,896         | 179,196  | 1937 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML30016             | Diesel                                | 1,253,784      | 840,035  | 1941 | Vertical Fixed Roof    | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 420,018     | 840,035   |
| 1    | Kinder Morgan North | KML3034              | Storm Water                           | 137,046        | 91,821   | 1925 | Vertical Fixed Roof    | Group 3A   | Not Flammable         | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | 45,910      | 91,821    |
| 1    | Kinder Morgan North | KML305               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML306               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML309               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML310               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML312               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML313               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML314               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML315               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML326               | Out of Service                        | 12,600         | 8,442  | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML330               | Out of Service                        | 12,012         | 8,048  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML331               | Out of Service                        | 12,936         | 8,667  | 1926 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML45028             | Gasoline                              | 1,889,538      | 1,265,990  | 1955 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 632,995     | 1,265,990 |
| 1    | Kinder Morgan North | KML532               | Out of Service                        | 29,908         | 20,038   | 1965 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML55008             | Out of Service                        | 2,288,832      | 1,533,517  | 1933 | Vertical Fixed Roof    | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML55022             | Gasoline                              | 2,309,286      | 1,547,222  | 1928 | Vertical Fixed Roof    | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 773,611     | 1,547,222 |
| 1    | Kinder Morgan North | KML55023             | Out of Service                        | 2,312,016      | 1,549,051  | 1944 | Internal Floating Roof | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 1    | Kinder Morgan North | KML59029             | Gasoline                              | 2,454,060      | 1,644,220  | 1955 | Vertical Fixed Roof    | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 822,110     | 1,644,220 |
| 1    | Kinder Morgan North | KML72021             | Diesel                                | 2,842,297      | 1,904,339  | 2011 | Vertical Fixed Roof    | Group 3C   | Category 3            | Yes                | Material in Water | No Tank Failure   | 0%           | 10%  | 0           | 190,434   |
| 1    | Kinder Morgan North | KMLSalt tower        | Contact Water                         | 22,890         | 15,336   | NA   | Vertical Fixed Roof    | Group 3A   | Not Flammable         | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | 7,668       | 15,336    |
| 4    | McCall Oil          | MC1                  | Asphalt                               | 11,247,180     | 7,535,611  | 1976 | Cone Roof              | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 3,765,611   | 7,535,611 |
| 4    | McCall Oil          | MC10                 | Biodiesel                             | 469,392        | 314,493  | 1974 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 157,246     | 314,493   |
| 4    | McCall Oil          | MC11                 | Oil and water                         | 20,160         | 13,507   | 1974 | Cone Roof              | Group 3A   | Not Flammable         | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | 6,754       | 13,507    |
| 4    | McCall Oil          | MC12                 | Oil and water                         | 10,080         | 6,754  | 1974 | Cone Roof              | Group 3A   | Not Flammable         | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | 3,377       | 6,754     |
| 4    | McCall Oil          | MC4                  | Bunker                                | 9,357,936      | 6,269,817  | 1976 | Cone Roof              | Group 3A   | Category 2            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 3,134,909   | 6,269,817 |
| 4    | McCall Oil          | MC5                  | Biodiesel                             | 17,216         | 18,235   | 1974 | Cone Roof              | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 9,117       | 18,235    |
| 4    | McCall Oil          | MC6                  | Biodiesel                             | 17,216         | 18,235   | 1974 | Cone Roof              | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 9,117       | 18,235    |
| 4    | McCall Oil          | MC7                  | Diesel                                | 2,658,726      | 1,781,346  | 1978 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 890,673     | 1,781,346 |
| 4    | McCall Oil          | MC8                  | Diesel                                | 2,680,482      | 1,795,923  | 1977 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 897,961     | 1,795,923 |
| 4    | McCall Oil          | MC9                  | Biodiesel                             | 473,004        | 316,913  | 1979 | Cone Roof              | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 158,456     | 316,913   |
| 2    | Shore Terminals     | NU10026              | Gasoline/Diesel <sup>a</sup>          | 4,200,000      | 2,814,000  | 2007 | Internal Floating Roof | Group 3C   | Category 1            | Yes                | Material in Water | No Tank Failure   | 0%           | 10%  | 0           | 281,400   |
| 2    | Shore Terminals     | NU10027              | Gasoline/Diesel <sup>b</sup>          | 4,200,000      | 2,814,000  | 2007 | Internal Floating Roof | Group 3C   | Category 1            | Yes                | Material in Water | No Tank Failure   | 0%           | 10%  | 0           | 281,400   |
| 2    | Shore Terminals     | NU1009               | Gasoline/Diesel <sup>c</sup>          | 392,887        | 263,234  | 1981 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 131,617     | 263,234   |
| 2    | Shore Terminals     | NU1010               | Gasoline/Diesel <sup>d</sup>          | 393,264        | 263,487  | 1980 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 131,743     | 263,487   |
| 2    | Shore Terminals     | NU1011               | Ethanol/Gasoline <sup>e</sup>         | 393,149        | 263,410  | 1980 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 131,705     | 263,410   |
| 2    | Shore Terminals     | NU1315               | Out of Service                        | 56,124         | 37,603   | 1938 | Cone                   | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 2    | Shore Terminals     | NU1316               | Out of Service                        | 56,112         | 37,595   | 1938 | Cone                   | Group 2    | None                  | None               | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 2    | Shore Terminals     | NU181                | Gasoline/Diesel Additive <sup>f</sup> | 7,685          | 5,149  | NA   | Cone                   | Group 3A   | Category 2            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 2,574       | 5,149     |
| 2    | Shore Terminals     | NU195                | Unavailable                           | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | Material in Water | Tank Failure      | 50%          | 100% | NA          | NA        |
| 2    | Shore Terminals     | NU200                | Gasoline                              | 821,940        | 550,700  | 1935 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 275,350     | 550,700   |
| 2    | Shore Terminals     | NU2021               | Gasoline                              | 832,032        | 557,461  | 1935 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 278,731     | 557,461   |
| 2    | Shore Terminals     | NU2022               | Gasoline                              | 832,032        | 557,461  | 1935 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 278,731     | 557,461   |
| 2    | Shore Terminals     | NU2113               | Biodiesel                             | 865,857        | 580,124  | 1938 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure      | 50%          | 100% | 290,062     | 580,124   |
| 2    | Shore Terminals     | NU212                | Unavailable                           | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            |                   |                   |              |      |             |           |

| Area | Property                  | Tank ID <sup>1</sup> | Contents                     | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>2</sup> | Year | Type                   | Tank Group | Flammability Category | Hazardous Category | Damage Zone       | Tank Age Failures            | Percent Lost |      | Volume Lost |           |
|------|---------------------------|----------------------|------------------------------|----------------|--|------|------------------------|------------|-----------------------|--------------------|-------------------|------------------------------|--------------|------|-------------|-----------|
|      |                           |                      |                              |                |  |      |                        |            |                       |                    |                   |                              | Min          | Max  | Min         | Max       |
| 2    | Shore Terminals           | NU2705               | Diesel                       | 1,158,532      | 776,216  | 1980 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 388,108     | 776,216   |
| 2    | Shore Terminals           | NU2706               | Gasoline/Diesel <sup>3</sup> | 1,085,895      | 727,550  | 1980 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 363,775     | 727,550   |
| 2    | Shore Terminals           | NU30                 | Unavailable                  | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | Material in Water | Tank Failure                 | 50%          | 100% | NA          | NA        |
| 2    | Shore Terminals           | NU3201               | Ethanol                      | 1,264,793      | 847,411  | 1979 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 423,706     | 847,411   |
| 2    | Shore Terminals           | NU3203               | Gasoline/Diesel <sup>3</sup> | 1,265,942      | 848,181  | 1979 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 424,091     | 848,181   |
| 2    | Shore Terminals           | NU3204               | Gasoline/Diesel <sup>3</sup> | 1,267,302      | 849,092  | 1979 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 424,546     | 849,092   |
| 2    | Shore Terminals           | NU3510               | Ethanol                      | 1,456,019      | 975,533  | 1937 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 487,766     | 975,533   |
| 2    | Shore Terminals           | NU3605               | Marine Fuel Oil              | 1,442,470      | 966,455  | 1938 | Cone                   | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 483,227     | 966,455   |
| 2    | Shore Terminals           | NU3614               | Gasoline/Diesel <sup>3</sup> | 1,398,810      | 937,203  | 1958 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 468,601     | 937,203   |
| 2    | Shore Terminals           | NU4402               | Gasoline/Diesel <sup>3</sup> | 1,761,801      | 1,180,407  | 1979 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 590,203     | 1,180,407 |
| 2    | Shore Terminals           | NU4507               | Out of Service               | 1,849,692      | 1,239,294  | 1980 | Internal Floating Roof | Group 2    | None                  | None               | Material in Water | Tank Failure                 | 50%          | 100% | NA          | NA        |
| 2    | Shore Terminals           | NU5209               | Gasoline/Diesel <sup>3</sup> | 2,190,678      | 1,467,754  | 1971 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 733,877     | 1,467,754 |
| 2    | Shore Terminals           | NU5618               | Gasoline                     | 2,220,204      | 1,487,537  | 1958 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 743,768     | 1,487,537 |
| 2    | Shore Terminals           | NU5901               | Gasoline                     | 2,414,958      | 1,618,022  | 1929 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 809,011     | 1,618,022 |
| 2    | Shore Terminals           | NU5902               | Diesel                       | 2,386,734      | 1,599,112  | 1929 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 799,556     | 1,599,112 |
| 2    | Shore Terminals           | NU5919               | Diesel                       | 2,147,688      | 1,438,951  | 1935 | Cone                   | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 719,475     | 1,438,951 |
| 2    | Shore Terminals           | NU6408               | Gasoline/Diesel <sup>3</sup> | 2,649,782      | 1,775,354  | 1981 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 887,677     | 1,775,354 |
| 2    | Shore Terminals           | NU703                | Cutter                       | 309,498        | 207,364  | 1938 | Internal Floating Roof | Group 3A   | Unknown               | Unknown            | Material in Water | Tank Failure                 | 50%          | 100% | 103,682     | 207,364   |
| 2    | Shore Terminals           | NU8006               | Gasoline/Diesel <sup>3</sup> | 3,379,698      | 2,264,398  | 1953 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 1,132,199   | 2,264,398 |
| 2    | Shore Terminals           | NU8007               | Gasoline                     | 3,338,748      | 2,236,961  | 1953 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 1,116,481   | 2,236,961 |
| 2    | Shore Terminals           | NU8308               | Gasoline/Diesel <sup>3</sup> | 3,352,746      | 2,246,340  | 1969 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 1,123,170   | 2,246,340 |
| 3    | Pacific Terminal Services | PA1                  | Residual Oil <sup>4</sup>    | 60,000         | 40,200   | 1980 | NA                     | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 20,100      | 40,200    |
| 3    | Pacific Terminal Services | PA2                  | Diesel Oil                   | 60,000         | 40,200   | 1980 | NA                     | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 20,100      | 40,200    |
| 3    | Pacific Terminal Services | PA4                  | Residual Oil <sup>4</sup>    | 80,000         | 53,600   | 1940 | NA                     | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 26,800      | 53,600    |
| 3    | Pacific Terminal Services | PA5                  | Residual Oil <sup>4</sup>    | 55,000         | 36,850   | 1940 | NA                     | Group 3A   | Category 1            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 18,425      | 36,850    |
| 3    | Pacific Terminal Services | PA6                  | Diesel Oil                   | 12             | 8  | 1988 | NA                     | Group 3A   | Category 3            | Yes                | Material in Water | Tank Failure                 | 50%          | 100% | 4           | 8         |
| 3    | Pacific Terminal Services | PA7                  | Residual Oil <sup>4</sup>    | 475            | 318  | 1993 | NA                     | Group 3B   | Category 1            | Yes                | Material in Water | No Tank Failure <sup>8</sup> | 0%           | 10%  | 0           | 32        |

Notes:

- <sup>1</sup> 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: Kinder Morgan North = \*KML-Tank 1\*
  - <sup>2</sup> Tank contents were listed as both gasoline and ethanol; flammability and hazard category are for gasoline.
  - <sup>3</sup> Tank contents were listed as both gasoline and diesel; flammability and hazard category are for gasoline.
  - <sup>4</sup> Tank contents were listed as both gasoline and diesel additives; flammability and hazard category are for gasoline.
  - <sup>5</sup> Tank contents were listed as gasoline slops; flammability and hazard category are for gasoline.
  - <sup>6</sup> Residual Oil and Residual Fuel Oil is a general classification for heavier oils that remain after the distillate fuel oil and lighter hydrocarbons are removed. The type of lighter hydrocarbon is unknown and therefore defaulted to the most flammable category.
  - <sup>7</sup> Tank contents were listed as biodiesel additive; flammability and hazard category are for biodiesel.
  - <sup>8</sup> Tank data provided by COP without geographic location; failure assumption made from satellite imagery.
  - <sup>9</sup> Zenith Energy tank fill provided directly from Portland Fire and Rescue.
- Category 1 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or below 95°F (35°C).  
Category 2 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or above 95°F (35°C).  
Category 3 - Liquids with flashpoints at or above 73.4°F (23°C) and at or below 140°F (60°C).  
Category 4 - Liquids having flashpoints above 140°F (60°C) and at or below 199.4°F (93°C).  
NA - Data not available  
No - Tank substance is not hazardous.  
None - Flammability category and/or hazard category is not applicable due to tank status of Out of Service.  
Not Flammable - Tank contents are not flammable and do not fall into Category 1-4.  
Unknown - Flammability category or hazard category unknown due to unknown tank contents, or tank contents not defined in a suitable way to ascertain flammability or hazard categories.  
Yes - Tank substance is hazardous.

**APPENDIX C**  
**Tanks with Potential to Release and Flow to Willamette River**





Appendix C: Tanks with Potential to Release and Flow to Willamette River

| Area | Property                  | Tank ID <sup>1</sup> | Contents                  | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>2</sup> | Year | Type                   | Tank Group | Flammability Category | Hazardous Category | Damage Zone          | Tank Age Failures            | Percent Lost Min | Percent Lost Max | Volume Lost Min | Volume Lost Max |
|------|---------------------------|----------------------|---------------------------|----------------|--|------|------------------------|------------|-----------------------|--------------------|----------------------|------------------------------|------------------|------------------|-----------------|-----------------|
| 4    | Chevron                   | CH1                  | Unleaded Gasoline         | 3,412,315      | 2,286,251  | 1997 | Internal Floating Roof | Group 3B   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 0%               | 10%              | 0               | 228,625         |
| 4    | McCall Oil                | MC15                 | Flux                      | 21,840         | 14,633   | 1986 | Cone Roof              | Group 3A   | Unknown               | Unknown            | Potentially in Water | Tank Failure                 | 50%              | 100%             | 7,316           | 14,633          |
| 4    | McCall Oil                | MC16                 | Flux                      | 30,198         | 20,233   | 1989 | Cone Roof              | Group 3A   | Unknown               | Unknown            | Potentially in Water | Tank Failure                 | 50%              | 100%             | 10,116          | 20,233          |
| 4    | McCall Oil                | MC18                 | Anti-strip                | 4,914          | 3,292  | 1989 | Cone Roof              | Group 3A   | Unknown               | Unknown            | Potentially in Water | Tank Failure                 | 50%              | 100%             | 1,646           | 3,292           |
| 4    | McCall Oil                | MC19                 | Asphalt                   | 427,770        | 286,606  | 1954 | Cone Roof              | Group 3A   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 50%              | 100%             | 143,303         | 286,606         |
| 4    | McCall Oil                | MC2                  | Asphalt                   | 11,787,300     | 7,897,491  | 1973 | Cone Roof              | Group 3A   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 50%              | 100%             | 3,948,746       | 7,897,491       |
| 4    | McCall Oil                | MC20                 | Asphalt                   | 427,770        | 286,606  | 1954 | Cone Roof              | Group 3A   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 50%              | 100%             | 143,303         | 286,606         |
| 4    | McCall Oil                | MC21                 | Asphalt                   | 428,064        | 286,803  | 1954 | Cone Roof              | Group 3A   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 50%              | 100%             | 143,401         | 286,803         |
| 4    | McCall Oil                | MC23                 | Asphalt                   | 18,942         | 12,691   | 1954 | Cone Roof              | Group 3A   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 50%              | 100%             | 6,346           | 12,691          |
| 4    | McCall Oil                | MC24                 | Asphalt                   | 19,068         | 12,776   | 2000 | Cone Roof              | Group 3B   | Category 1            | Yes                | Potentially in Water | No Tank Failure <sup>8</sup> | 0%               | 10%              | 0               | 1,278           |
| 4    | McCall Oil                | MC25                 | Asphalt                   | 79,800         | 53,466   | 2000 | Cone Roof              | Group 3B   | Category 1            | Yes                | Potentially in Water | No Tank Failure <sup>8</sup> | 0%               | 10%              | 0               | 5,347           |
| 4    | McCall Oil                | MC26                 | Asphalt                   | 79,800         | 53,466   | 2000 | Cone Roof              | Group 3B   | Category 1            | Yes                | Potentially in Water | No Tank Failure <sup>8</sup> | 0%               | 10%              | 0               | 5,347           |
| 4    | McCall Oil                | MC27                 | Asphalt                   | 79,800         | 53,466   | 2000 | Cone Roof              | Group 3B   | Category 1            | Yes                | Potentially in Water | No Tank Failure <sup>8</sup> | 0%               | 10%              | 0               | 5,347           |
| 4    | McCall Oil                | MC28                 | Boiler Fuel               | 8,358          | 5,600  | 1954 | Cone Roof              | Group 3A   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 50%              | 100%             | 2,800           | 5,600           |
| 4    | McCall Oil                | MC29                 | Unichem                   | 11,000         | 7,370  | 1974 | Cone Roof              | Group 3A   | Unknown               | Unknown            | Potentially in Water | Tank Failure                 | 50%              | 100%             | 3,685           | 7,370           |
| 4    | McCall Oil                | MC33                 | Polyphosphoric Acid       | 5,405          | 3,621  | 2005 | Cone Roof              | Group 3C   | Not Flammable         | Yes                | Potentially in Water | No Tank Failure              | 0%               | 10%              | 0               | 362             |
| 3    | Pacific Terminal Services | PA3                  | Residual Oil <sup>6</sup> | 20,000         | 13,400   | 1980 | NA                     | Group 3A   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 50%              | 100%             | 6,700           | 13,400          |
| 4    | Conoco Phillips           | PH3407               | Unleaded Gasoline         | 2,955,540      | 1,980,212  | 1949 | Welded Steel           | Group 3A   | Category 1            | Yes                | Potentially in Water | Tank Failure                 | 50%              | 100%             | 990,106         | 1,980,212       |

Notes:

- <sup>1</sup>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: Kinder Morgan North = "KML-Tank 1"
- <sup>2</sup>Tank contents were listed as both gasoline and ethanol; flammability and hazard category are for gasoline.
- <sup>3</sup>Tank contents were listed as both gasoline and diesel; flammability and hazard category are for gasoline.
- <sup>4</sup>Tank contents were listed as both gasoline and diesel additives; flammability and hazard category are for gasoline.
- <sup>5</sup>Tank contents were listed as gasoline slops; flammability and hazard category are for gasoline.
- <sup>6</sup>Residual Oil and Residual Fuel Oil is a general classification for heavier oils that remain after the distillate fuel oil and lighter hydrocarbons are removed. The type of lighter hydrocarbon is unknown and therefore defaulted to the most flammable category.
- <sup>7</sup>Tank contents were listed as biodiesel additive; flammability and hazard category are for biodiesel.
- <sup>8</sup>Tank data provided by COP without geographic location; failure assumption made from satellite imagery.  
 Category 1 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or below 95°F (35°C).  
 Category 2 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or above 95°F (35°C).  
 Category 3 - Liquids with flashpoints at or above 73.4°F (23°C) and at or below 140°F (60°C).  
 Category 4 - Liquids having flashpoints above 140°F (60°C) and at or below 199.4°F (93°C).  
 NA - Data not available  
 No - Tank substance is not hazardous.  
 None - Flammability category and/or hazard category is not applicable due to tank status of Out of Service.  
 Not Flammable - Tank contents are not flammable and do not fall into Category 1-4.  
 Unknown - Flammability category or hazard category unknown due to unknown tank contents, or tank contents not defined in a suitable way to ascertain flammability or hazard categories.  
 Yes - Tank substance is hazardous.

**APPENDIX D**  
**Tanks with Potential to Release to Ground Surface**

Appendix D: Tanks with Potential to Release to Ground Surface

| Area | Property | Tank ID <sup>1</sup> | Contents                | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>2</sup> | Year | Type       | Tank Group | Flammability Category | Hazardous Category | Damage Zone | Tank Age Failures            |     | Percent Lost | Percent Lost | Volume Lost | Volume Lost |
|------|----------|----------------------|-------------------------|----------------|--|------|------------|------------|-----------------------|--------------------|-------------|------------------------------|-----|--------------|--------------|-------------|-------------|
|      |          |                      |                         |                |  |      |            |            |                       |                    |             | Min                          | Max | Min          | Max          |             |             |
| 4    | Chevron  | CH10                 | Paratone 8451           | 169,616        | 113,643  | 1950 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 56,821       | 113,643     |             |
| 4    | Chevron  | CH100                | Gear Lube               | 17,624         | 11,808   | 1946 | Fixed Roof | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure                 | 50% | 100%         | 5,904        | 11,808      |             |
| 4    | Chevron  | CH101                | Compressor Oil          | 17,284         | 11,580   | 1958 | Fixed Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,790        | 11,580      |             |
| 4    | Chevron  | CH102                | Out of Service          | 12,954         | NA   | 1978 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH103                | Out of Service          | 13,006         | NA   | 1978 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH104                | Texaco Havoline 5S30    | 17,331         | 11,612   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,806        | 11,612      |             |
| 4    | Chevron  | CH105                | Empty                   | 17,624         | NA   | 1969 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH106                | Delo G/L 80/90          | 17,818         | 11,938   | 1969 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,969        | 11,938      |             |
| 4    | Chevron  | CH108                | Techron Additive        | 208,425        | 139,645  | 1970 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 69,822       | 139,645     |             |
| 4    | Chevron  | CH109                | Delo GL 80/90           | 17,624         | 11,808   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,904        | 11,808      |             |
| 4    | Chevron  | CH11                 | Lubrizol 4991D          | 211,915        | 141,983  | 1950 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 70,992       | 141,983     |             |
| 4    | Chevron  | CH110                | GST ISO 32              | 17,624         | 11,808   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,904        | 11,808      |             |
| 4    | Chevron  | CH112                | Oloa 6073EV             | 17,818         | 11,938   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,969        | 11,938      |             |
| 4    | Chevron  | CH113                | Hybase C414             | 17,378         | 11,643   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,822        | 11,643      |             |
| 4    | Chevron  | CH114                | Industrial EP 220       | 17,624         | 11,808   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,904        | 11,808      |             |
| 4    | Chevron  | CH116                | Empty                   | 17,724         | NA   | 1976 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH117                | Raffene 2000L           | 17,624         | 11,808   | 1976 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,904        | 11,808      |             |
| 4    | Chevron  | CH118                | Blend Mix/ Line Wash    | 17,577         | 11,777   | 1976 | Fixed Roof | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure                 | 50% | 100%         | 5,888        | 11,777      |             |
| 4    | Chevron  | CH119                | Out of Service          | 19,593         | NA   | 1977 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH12                 | ExxonMobil EM-100       | 586,302        | 392,822  | 1950 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 196,411      | 392,822     |             |
| 4    | Chevron  | CH120                | Out of Service          | 19,593         | NA   | 1977 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH121                | Out of Service          | NA             | NA   | 1978 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH122                | 1000 THF                | 61,864         | 41,449   | NA   | Fixed Roof | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure                 | 50% | 100%         | 20,724       | 41,449      |             |
| 4    | Chevron  | CH123                | Delo 400-40             | 61,864         | 41,449   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 20,724       | 41,449      |             |
| 4    | Chevron  | CH127                | ATF dex 111             | 109,976        | 73,684   | NA   | Fixed Roof | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure                 | 50% | 100%         | 36,842       | 73,684      |             |
| 4    | Chevron  | CH128                | Ryton Prem 32           | 74,586         | 49,973   | NA   | AST        | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 24,986       | 49,973      |             |
| 4    | Chevron  | CH129                | Base Oil                | 642,935        | 430,766  | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 215,383      | 430,766     |             |
| 4    | Chevron  | CH13                 | Raffene 750L            | 45,682         | 30,607   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 15,303       | 30,607      |             |
| 4    | Chevron  | CH130                | Base Oil                | 255,112        | 170,925  | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 85,463       | 170,925     |             |
| 4    | Chevron  | CH131                | Hybase C414             | 17,577         | 11,777   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,888        | 11,777      |             |
| 4    | Chevron  | CH132                | Empty                   | 18,165         | NA   | NA   | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH133                | CVX 3105                | 17,577         | 11,777   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,888        | 11,777      |             |
| 4    | Chevron  | CH135                | Out of Service          | 19,379         | NA   | 1982 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH136                | Out of Service          | 20,303         | NA   | 1982 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH137                | Oloa 2000               | 60,757         | 40,707   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 20,354       | 40,707      |             |
| 4    | Chevron  | CH138                | Drive Train Fluid HD 10 | 17,378         | 11,643   | NA   | Fixed Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,822        | 11,643      |             |
| 4    | Chevron  | CH139                | Blend Mix/ Line Wash    | 25,591         | 17,146   | NA   | Fixed Roof | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure                 | 50% | 100%         | 8,573        | 17,146      |             |
| 4    | Chevron  | CH14                 | Delo 6170 CFO 20W40     | 190,343        | 127,530  | 1950 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 63,765       | 127,530     |             |
| 4    | Chevron  | CH140                | Out of Service          | 83,234         | NA   | NA   | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH141                | Out of Service          | 140,308        | NA   | NA   | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH142                | Base Oil                | 648,620        | 434,575  | 1984 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 217,288      | 434,575     |             |
| 4    | Chevron  | CH143                | Supreme 5W30            | 62,033         | 41,562   | NA   | Fixed Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 20,781       | 41,562      |             |
| 4    | Chevron  | CH144                | Havoline 10W30          | 61,864         | 41,449   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 20,724       | 41,449      |             |
| 4    | Chevron  | CH145                | Out of Service          | 61,864         | NA   | NA   | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH146                | Transmix                | 25,447         | 17,049   | NA   | Fixed Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 8,525        | 17,049      |             |
| 4    | Chevron  | CH147                | Delo 100-40             | 25,523         | 17,100   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 8,550        | 17,100      |             |
| 4    | Chevron  | CH148                | VER 800 Mar 30          | 33,839         | 22,672   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 11,336       | 22,672      |             |
| 4    | Chevron  | CH149                | RPM HDMO 30             | 26,311         | 17,628   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 8,814        | 17,628      |             |
| 4    | Chevron  | CH15                 | Ryton Prem 32           | 28,951         | 19,397   | 1913 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 9,699        | 19,397      |             |
| 4    | Chevron  | CH150                | Delo 400-10             | 25,311         | 16,958   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 8,479        | 16,958      |             |
| 4    | Chevron  | CH151                | MAR EO 9250-40          | 17,724         | 11,875   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 5,938        | 11,875      |             |
| 4    | Chevron  | CH152                | Empty                   | 17,624         | NA   | NA   | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH154                | Map 100                 | 83,422         | 55,893   | NA   | Fixed Roof | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure                 | 50% | 100%         | 27,946       | 55,893      |             |
| 4    | Chevron  | CH155                | Delo 400-15W40          | 83,422         | 55,893   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 27,946       | 55,893      |             |
| 4    | Chevron  | CH156                | Delo 400-30             | 83,022         | 55,625   | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 27,812       | 55,625      |             |
| 4    | Chevron  | CH157                | Turbine Oil             | 52,872         | 35,424   | NA   | AST        | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 17,712       | 35,424      |             |
| 4    | Chevron  | CH158                | Out of Service          | NA             | NA   | NA   | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH159                | Out of Service          | 25,379         | NA   | 1987 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH16                 | Clarity PM 220          | 29,447         | 19,729   | 1913 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 9,865        | 19,729      |             |
| 4    | Chevron  | CH160                | Empty                   | 25,447         | NA   | NA   | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH163                | Swing Tank              | 6,354,155      | 4,257,284  | 2009 | AST        | Group 3C   | Unknown               | Unknown            | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 425,728     |             |
| 4    | Chevron  | CH164                | Swing Tank              | 6,354,155      | 4,257,284  | 2009 | AST        | Group 3C   | Unknown               | Unknown            | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 425,728     |             |
| 4    | Chevron  | CH17                 | ExxonMobile EHC45       | 29,327         | 19,649   | 1913 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 9,825        | 19,649      |             |
| 4    | Chevron  | CH176                | Blended Oil             | 2,632          | 1,763  | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 882          | 1,763       |             |
| 4    | Chevron  | CH177                | Blended Oil             | 2,632          | 1,763  | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 882          | 1,763       |             |
| 4    | Chevron  | CH178                | Blended Oil             | 2,632          | 1,763  | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 882          | 1,763       |             |
| 4    | Chevron  | CH179                | Blended Oil             | 2,632          | 1,763  | NA   | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 882          | 1,763       |             |
| 4    | Chevron  | CH18                 | Oloa 550006L            | 29,583         | 19,821   | 1913 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 9,910        | 19,821      |             |
| 4    | Chevron  | CH180                | Blended Oil             | 4,700          | 3,149  | 1993 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 315         |             |
| 4    | Chevron  | CH181                | Blended Oil             | 4,700          | 3,149  | 1993 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 315         |             |
| 4    | Chevron  | CH182                | Blended Oil             | 11,374         | 7,621  | 1994 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 762         |             |
| 4    | Chevron  | CH183                | Blended Oil             | 11,374         | 7,621  | 1994 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 762         |             |
| 4    | Chevron  | CH184                | Blended Oil             | 11,374         | 7,621  | 1994 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 762         |             |
| 4    | Chevron  | CH185                | Blended Oil             | 11,374         | 7,621  | 1994 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 762         |             |
| 4    | Chevron  | CH186                | Blended Oil             | 11,374         | 7,621  | 1994 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 762         |             |
| 4    | Chevron  | CH187                | Blended Oil             | 11,374         | 7,621  | 1994 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 762         |             |
| 4    | Chevron  | CH188                | Blended Oil             | 11,374         | 7,621  | 1994 | Fixed Roof | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | 0            | 762         |             |
| 4    | Chevron  | CH19                 | Empty                   | 29,071         | NA   | NA   | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH20                 | Pennzoil 75HC           | 29,071         | 19,478   | 1914 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 9,739        | 19,478      |             |
| 4    | Chevron  | CH21                 | Empty                   | 29,583         | NA   | 1992 | Fixed Roof | Group 2    | None                  | None               | On Land     | Tank Failure                 | 50% | 100%         | NA           | NA          |             |
| 4    | Chevron  | CH22                 | Clarity PM 220          | 13,982         | 9,368  | 1954 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 4,684        | 9,368       |             |
| 4    | Chevron  | CH23                 | Empty                   | 13,982         | NA   | 1997 | Fixed Roof | Group 3B   | None                  | None               | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | NA           | NA          |             |
| 4    | Chevron  | CH24                 | Empty                   | 8,859          | NA   | 1993 | Fixed Roof | Group 3B   | None                  | None               | On Land     | No Tank Failure <sup>8</sup> | 0%  | 10%          | NA           | NA          |             |
| 4    | Chevron  | CH25                 | Clarity PM 150          | 8,665          | 5,806  | 1913 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 2,903        | 5,806       |             |
| 4    | Chevron  | CH26                 | Ryton Prem 32           | 29,447         | 19,729   | 1913 | Fixed Roof | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure                 | 50% | 100%         | 9,865        | 19,729      |             |
| 4    | Chevron  | CH27                 | Chevron 7075F           | 29,613         | 19,841   | 1913 | Fixed Roof | Group 3A   | Unknown               | Yes                |             |                              |     |              |              |             |             |

| Area | Property            | Tank ID <sup>1</sup> | Contents                | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>9</sup> | Year | Type                   | Tank Group | Flammability Category | Hazardous Category | Damage Zone | Tank Age Failures | Percent Lost Min | Percent Lost Max | Volume Lost Min | Volume Lost Max |
|------|---------------------|----------------------|-------------------------|----------------|--|------|------------------------|------------|-----------------------|--------------------|-------------|-------------------|------------------|------------------|-----------------|-----------------|
| 4    | Chevron             | CH28                 | Blend Mix/ Line Wash    | 29,071         | 19,478   | 1913 | Fixed Roof             | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | 9,739           | 19,478          |
| 4    | Chevron             | CH28                 | Industrial EP 150       | 17,771         | 11,907   | 1949 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,953           | 11,907          |
| 4    | Chevron             | CH29                 | Empty                   | 11,750         | NA   | 1949 | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH29                 | Undefined Petroleum     | 17,724         | 11,875   | 1949 | Fixed Roof             | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | 5,938           | 11,875          |
| 4    | Chevron             | CH3                  | Unleaded Gasoline       | 2,392,178      | 1,602,759  | 1999 | Fixed Roof             | Group 3B   | Category 1            | Yes                | On Land     | No Tank Failure   | 0%               | 10%              | 0               | 160,276         |
| 4    | Chevron             | CH30                 | Empty                   | 11,750         | NA   | 1949 | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH31                 | SynFluid \$, 4CST       | 8,712          | 5,837  | 1953 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 2,919           | 5,837           |
| 4    | Chevron             | CH32                 | Viscoplex 7-305         | 13,918         | 9,325  | 1950 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 4,663           | 9,325           |
| 4    | Chevron             | CH33                 | Viscoplex 1-604         | 13,997         | 9,378  | NA   | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 4,689           | 9,378           |
| 4    | Chevron             | CH34                 | Empty                   | 25,379         | NA   | NA   | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH35                 | FAMM Tara 30 DP 30      | 25,379         | 17,004   | NA   | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 8,502           | 17,004          |
| 4    | Chevron             | CH36                 | Shell MV1 100           | 25,379         | 17,004   | NA   | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 8,502           | 17,004          |
| 4    | Chevron             | CH37                 | Drive Train Fluid HD 10 | 17,378         | 11,643   | 1949 | Fixed Roof             | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,822           | 11,643          |
| 4    | Chevron             | CH4                  | Neutral 220R            | 435,761        | 291,960  | 1913 | Fixed Roof             | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | 145,980         | 291,960         |
| 4    | Chevron             | CH40                 | Empty                   | 18,018         | NA   | NA   | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH41                 | Clarity Saw Guide 46    | 17,331         | 11,612   | 1949 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,806           | 11,612          |
| 4    | Chevron             | CH42                 | Empty                   | 29,583         | NA   | 1913 | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH43                 | Base Oil                | 837,085        | 560,847  | 1993 | Fixed Roof             | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure   | 0%               | 10%              | 0               | 56,085          |
| 4    | Chevron             | CH44                 | Base Oil                | 835,393        | 559,713  | 1920 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 279,857         | 559,713         |
| 4    | Chevron             | CH45                 | Ethanol                 | 958,693        | 642,324  | 1999 | Fixed Roof             | Group 3B   | Category 3            | Yes                | On Land     | No Tank Failure   | 0%               | 10%              | 0               | 64,232          |
| 4    | Chevron             | CH46                 | Red Chain Bar 150       | 11,750         | 7,873  | 1924 | Fixed Roof             | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 3,936           | 7,873           |
| 4    | Chevron             | CH47                 | Unleaded Gasoline       | 3,609,743      | 2,418,528  | 1929 | Fixed Roof             | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,209,264       | 2,418,528       |
| 4    | Chevron             | CH48                 | Water/Oil Slop          | 396,547        | 265,686  | 1979 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 132,843         | 265,686         |
| 4    | Chevron             | CH5                  | Neutral Oil             | 365,834        | 245,109  | 1913 | Fixed Roof             | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | 122,554         | 245,109         |
| 4    | Chevron             | CH51                 | Unavailable             | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH56                 | GST ISO 100             | 25,379         | 17,004   | NA   | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 8,502           | 17,004          |
| 4    | Chevron             | CH57                 | Citgo Brt Stock 150     | 152,433        | 102,130  | 1921 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 51,065          | 102,130         |
| 4    | Chevron             | CH6                  | GEO HDAX L ASH 40       | 100,277        | 67,186   | 1913 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 33,593          | 67,186          |
| 4    | Chevron             | CH60                 | Unleaded Gasoline       | 4,999,697      | 3,349,797  | 2001 | Fixed Roof             | Group 3B   | Category 1            | Yes                | On Land     | No Tank Failure   | 0%               | 10%              | 0               | 334,980         |
| 4    | Chevron             | CH61                 | Neutral 600R            | 400,379        | 268,254  | 1941 | Fixed Roof             | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | 134,127         | 268,254         |
| 4    | Chevron             | CH62                 | Unleaded Gasoline       | 6,812,135      | 4,564,130  | 2000 | Fixed Roof             | Group 3B   | Category 1            | Yes                | On Land     | No Tank Failure   | 0%               | 10%              | 0               | 456,413         |
| 4    | Chevron             | CH64                 | Diesel                  | 844,275        | 565,664  | 1947 | Fixed Roof             | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 282,832         | 565,664         |
| 4    | Chevron             | CH65                 | Lubrizol 4991           | 17,524         | 11,741   | 1938 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,871           | 11,741          |
| 4    | Chevron             | CH7                  | Fammn Tara Sepcial 70   | 100,594        | 67,398   | 1913 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 33,699          | 67,398          |
| 4    | Chevron             | CH72                 | Saw Guide 150           | 17,284         | 11,580   | 1959 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,790           | 11,580          |
| 4    | Chevron             | CH75                 | Jet Fuel                | 1,004,586      | 673,073  | 1952 | Fixed Roof             | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 336,536         | 673,073         |
| 4    | Chevron             | CH76                 | Base Oil                | 498,258        | 333,833  | 1960 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 166,916         | 333,833         |
| 4    | Chevron             | CH77                 | RPM HDMO 15W40          | 128,511        | 86,102   | 1960 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 43,051          | 86,102          |
| 4    | Chevron             | CH78                 | Paratone 8451           | 311,722        | 208,854  | 1960 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 104,427         | 208,854         |
| 4    | Chevron             | CH79                 | Empty                   | 17,378         | NA   | 1960 | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH8                  | Ryton Prem MV           | 104,897        | 70,281   | 1913 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 35,140          | 70,281          |
| 4    | Chevron             | CH80                 | Out of Service          | 17,378         | NA   | NA   | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH81                 | Empty                   | 17,724         | NA   | 1951 | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH82                 | Infineum M7038          | 17,624         | 11,808   | 1951 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,904           | 11,808          |
| 4    | Chevron             | CH83                 | RPM HDMO 15W40          | 17,331         | 11,612   | 1951 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,806           | 11,612          |
| 4    | Chevron             | CH84                 | Empty                   | 17,184         | NA   | 1952 | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH85                 | Oloa 44200              | 17,671         | 11,840   | 1952 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,920           | 11,840          |
| 4    | Chevron             | CH87                 | Lubrizol 4991           | 17,430         | 11,678   | 1913 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,839           | 11,678          |
| 4    | Chevron             | CH88                 | Empty                   | 17,624         | NA   | 1850 | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH89                 | Oil Stop                | 19,431         | 13,019   | 1952 | Fixed Roof             | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | 6,509           | 13,019          |
| 4    | Chevron             | CH9                  | Chevron 7075F           | 169,193        | 113,359  | 1949 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 56,680          | 113,359         |
| 4    | Chevron             | CH90                 | Delo 400-15W40          | 208,848        | 139,928  | 1954 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 69,964          | 139,928         |
| 4    | Chevron             | CH91                 | Oloa 9740C              | 17,671         | 11,840   | 1961 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 5,920           | 11,840          |
| 4    | Chevron             | CH92                 | Out of Service          | 17,577         | NA   | 1961 | Fixed Roof             | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Chevron             | CH94                 | Ryton Oil 68            | 67,419         | 45,171   | NA   | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 22,585          | 45,171          |
| 4    | Chevron             | CH96                 | Additive                | 17,624         | 11,808   | 1966 | Fixed Roof             | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | 5,904           | 11,808          |
| 4    | Chevron             | CH97                 | Additive                | 17,624         | 11,808   | 1966 | Fixed Roof             | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%              | 100%             | 5,904           | 11,808          |
| 4    | Chevron             | CH98                 | Ryton Oil 46            | 91,364         | 61,214   | 1968 | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 30,607          | 61,214          |
| 4    | Chevron             | CH99                 | RPM UGL 80W90           | 62,033         | 41,562   | NA   | Fixed Roof             | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 20,781          | 41,562          |
| 5    | Equilon             | T-13519              | Diesel                  | 560,112        | 375,275  | NA   | Cone Roof              | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 187,638         | 375,275         |
| 5    | Equilon             | T-13520              | Diesel                  | 558,852        | 374,431  | NA   | Cone Roof              | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 187,215         | 374,431         |
| 5    | Equilon             | T-13521              | Diesel                  | 559,986        | 375,191  | NA   | Cone Roof              | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 187,595         | 375,191         |
| 5    | Equilon             | T-13522              | Diesel                  | 558,432        | 374,149  | NA   | Cone Roof              | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 187,075         | 374,149         |
| 5    | Equilon             | T-13523              | Out of Service          | 565,320        | 378,764  | NA   | Cone Roof              | Group 3A   | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | 189,382         | 378,764         |
| 5    | Equilon             | T-13524              | Diesel                  | 559,146        | 374,628  | NA   | Cone Roof              | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 187,314         | 374,628         |
| 5    | Equilon             | T-36002              | Diesel                  | 1,537,704      | 1,030,262  | NA   | Cone Roof              | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 515,131         | 1,030,262       |
| 5    | Equilon             | T-55000              | Gasoline                | 1,986,264      | 1,330,797  | NA   | Internal Fixed Roof    | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 665,398         | 1,330,797       |
| 5    | Equilon             | T-55001              | Ethanol                 | 2,331,714      | 1,562,248  | NA   | Internal Fixed Roof    | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 781,124         | 1,562,248       |
| 5    | Equilon             | T-80103              | Diesel                  | 3,303,636      | 2,213,436  | NA   | Cone Roof              | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,106,718       | 2,213,436       |
| 5    | Equilon             | T-80104              | Gasoline                | 3,348,912      | 2,243,771  | NA   | Internal Fixed Roof    | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,121,886       | 2,243,771       |
| 5    | Equilon             | T-80110              | Gasoline                | 3,317,622      | 2,222,807  | NA   | Internal Fixed Roof    | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,111,403       | 2,222,807       |
| 5    | Equilon             | T-84200              | Gasoline                | 3,528,756      | 2,364,267  | NA   | Internal Fixed Roof    | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,182,133       | 2,364,267       |
| 5    | Equilon             | T-7017               | Water                   | 267,456        | 179,196  | NA   | External Fixed Roof    | Group 3A   | Not Flammable         | No                 | On Land     | Tank Failure      | 50%              | 100%             | 89,598          | 179,196         |
| 4    | Kinder Morgan South | KMW10                | Out of Service          | 22,722         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Kinder Morgan South | KMW100               | Diesel                  | 3,381,000      | 2,265,270  | 1949 | Vertical Fixed Roof    | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,132,635       | 2,265,270       |
| 4    | Kinder Morgan South | KMW101               | Gasoline                | 3,381,000      | 2,265,270  | 1949 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,132,635       | 2,265,270       |
| 4    | Kinder Morgan South | KMW102               | Out of Service          | 306,600        | NA   | 1951 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Kinder Morgan South | KMW103               | Out of Service          | 168,000        | NA   | 1950 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Kinder Morgan South | KMW104               | Lubricity Additive      | 168,000        | 112,560  | 1950 | Vertical Fixed Roof    | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 56,280          | 112,560         |
| 4    | Kinder Morgan South | KMW105               | Ethanol                 | 168,000        | 112,560  | 1951 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 56,280          | 112,560         |
| 4    | Kinder Morgan South | KMW106               | Out of Service          | 302,546        | NA   | 1951 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Kinder Morgan South | KMW11                | Out of service          | 22,722         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%              | 100%             | NA              | NA              |
| 4    | Kinder Morgan South | KMW116               | Gasoline                | 3,385,200      | 2,268,084  | 1961 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 1,134,042       | 2,268,084       |
| 4    | Kinder Morgan South | KMW117               | Biodiesel               | 567,000        | 379,890  | 1951 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%              | 100%             | 189,945         | 379,890         |
| 4    | Kinder Morgan South | KMW118               | Gasoline                | 2              |  |      |                        |            |                       |                    |             |                   |                  |                  |                 |                 |



| Area | Property            | Tank ID <sup>1</sup> | Contents       | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>2</sup> | Year | Type                   | Tank Group | Flammability Category | Hazardous Category | Damage Zone | Tank Age Failures | Percent Lost |      | Volume Lost |           |
|------|---------------------|----------------------|----------------|----------------|--|------|------------------------|------------|-----------------------|--------------------|-------------|-------------------|--------------|------|-------------|-----------|
|      |                     |                      |                |                |  |      |                        |            |                       |                    |             |                   | Min          | Max  | Min         | Max       |
| 4    | Kinder Morgan South | KMW12002             | Diesel         | 5,040,000      | 3,376,800  | 2012 | Internal Floating Roof | Group 3C   | Category 3            | Yes                | On Land     | No Tank Failure   | 0%           | 10%  | 0           | 337,680   |
| 4    | Kinder Morgan South | KMW12003             | Gasoline       | 5,040,000      | 3,376,800  | 2012 | Internal Floating Roof | Group 3C   | Category 1            | Yes                | On Land     | No Tank Failure   | 0%           | 10%  | 0           | 337,680   |
| 4    | Kinder Morgan South | KMW123               | Gasoline       | 3,322,200      | 2,225,874  | 1952 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,112,937   | 2,225,874 |
| 4    | Kinder Morgan South | KMW124               | Gasoline       | 3,393,600      | 2,273,712  | 1952 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,136,856   | 2,273,712 |
| 4    | Kinder Morgan South | KMW125               | Out of service | 12,525         | NA   | 1946 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW126               | Out of service | 24,703         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW127               | Out of service | 24,703         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW128               | Gasoline       | 2,347,800      | 1,573,026  | 1953 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 786,513     | 1,573,026 |
| 4    | Kinder Morgan South | KMW129               | Out of service | 7,728          | NA   | 1927 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW13                | Out of service | 2,856          | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW131               | Out of service | 4,737          | NA   | 1954 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW134               | Gasoline       | 2,364,600      | 1,584,282  | 1955 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 792,141     | 1,584,282 |
| 4    | Kinder Morgan South | KMW137               | Out of Service | 222,936        | NA   | 1956 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW138               | Avgas          | 571,830        | 383,126  | 1956 | Internal Floating Roof | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 191,563     | 383,126   |
| 4    | Kinder Morgan South | KMW139               | Out of Service | 572,628        | NA   | 1956 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW14                | Out of service | 2,856          | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW140               | Storm Water    | 630,000        | 422,100  | 1956 | Vertical Fixed Roof    | Group 3A   | Not Flammable         | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 211,050     | 422,100   |
| 4    | Kinder Morgan South | KMW141               | Out of Service | 730,800        | NA   | 1956 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW143               | Out of Service | 252,927        | NA   | 1959 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW145               | Out of service | 7,980          | NA   | 1960 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW146               | Out of service | 7,980          | NA   | 1960 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW147               | Out of service | 7,980          | NA   | 1961 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW148               | Out of service | 7,980          | NA   | 1961 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW15                | Out of service | 2,856          | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW152               | Ethanol        | 47,800         | 32,026   | 1964 | Internal Floating Roof | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 16,013      | 32,026    |
| 4    | Kinder Morgan South | KMW153               | Out of service | 7,637          | NA   | 1965 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW154               | Out of service | 7,637          | NA   | 1965 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW155               | Out of Service | 4,200          | NA   | 1965 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW156               | Out of Service | 7,667          | NA   | 1965 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW157               | Out of Service | 24,868         | NA   | 1969 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW158               | Out of Service | 24,851         | NA   | 1969 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW159               | Out of Service | 21,000         | NA   | 1969 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW16                | Out of service | 2,814          | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW160               | Out of Service | 24,860         | NA   | 1969 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW161               | Out of Service | 24,863         | NA   | 1969 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW162               | Out of Service | 24,850         | NA   | 1969 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW163               | Out of Service | 24,856         | NA   | 1969 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW166               | Contact Water  | 33,600         | 22,512   | 1970 | Vertical Fixed Roof    | Group 3A   | Not Flammable         | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 11,256      | 22,512    |
| 4    | Kinder Morgan South | KMW167               | Contact Water  | 24,024         | 16,096   | 1928 | Vertical Fixed Roof    | Group 3A   | Not Flammable         | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 8,048       | 16,096    |
| 4    | Kinder Morgan South | KMW169               | Out of Service | 24,990         | NA   | 1928 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW17                | Out of service | 2,814          | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW170               | Out of Service | 24,990         | NA   | 1928 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW171               | Out of Service | 24,990         | NA   | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW172               | Out of Service | 24,990         | NA   | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW173               | Jet A          | 49,980         | 33,487   | 1972 | Vertical Fixed Roof    | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 16,743      | 33,487    |
| 4    | Kinder Morgan South | KMW176               | Out of Service | 25,353         | NA   | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW177               | Out of Service | 24,457         | NA   | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW18                | Out of Service | 2,814          | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW186               | Out of Service | 25,604         | NA   | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW187               | Out of Service | 24,000         | NA   | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW188               | Out of Service | 24,600         | NA   | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW189               | Out of Service | 24,035         | NA   | NA   | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW190               | Additive       | 8,400          | 5,628  | NA   | Horizontal Tank        | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 2,814       | 5,628     |
| 4    | Kinder Morgan South | KMW192               | Additive       | 8,064          | 5,403  | NA   | Horizontal Tank        | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 2,701       | 5,403     |
| 4    | Kinder Morgan South | KMW193               | Additive       | 10,080         | 6,754  | NA   | Horizontal Tank        | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 3,377       | 6,754     |
| 4    | Kinder Morgan South | KMW194               | Slop Water     | 6,300          | 4,221  | NA   | Horizontal Tank        | Group 3A   | Not Flammable         | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 2,111       | 4,221     |
| 4    | Kinder Morgan South | KMW2                 | Jet A          | 3,175,200      | 2,127,384  | 1915 | Vertical Fixed Roof    | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,063,692   | 2,127,384 |
| 4    | Kinder Morgan South | KMW22                | Out of Service | 11,760         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW23                | Out of Service | 11,718         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW25                | Out of Service | 11,760         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW26                | Out of Service | 22,806         | NA   | 1916 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW3                 | Out of Service | 553,350        | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW30                | Out of Service | 11,718         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW31                | Out of Service | 11,760         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW32                | Out of Service | 11,472         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW33                | Out of Service | 17,472         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW34                | Out of Service | 17,481         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW35                | Out of Service | 4,397          | NA   | 1924 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW36                | Out of Service | 4,368          | NA   | 1924 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW37                | Out of Service | 4,368          | NA   | 1924 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW38                | Out of Service | 4,368          | NA   | 1924 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW39                | Out of Service | 4,397          | NA   | 1924 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW4                 | Out of Service | 215,754        | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW40                | Out of Service | 5,544          | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW41                | Out of Service | 5,502          | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW42                | Out of Service | 5,502          | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW43                | Out of Service | 5,502          | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW44                | Out of Service | 5,515          | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW45                | Out of Service | 5,540          | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW46                | Out of Service | 11,642         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW47                | Out of Service | 11,600         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW48                | Out of Service | 11,642         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW49                | Out of Service | 11,677         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW5                 | Out of Service | 439,605        | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW50                | Out of Service | 11,507         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW51                | Out of Service | 11,634         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South | KMW52                | Jet A          | 3,229,800      | 2,163,966  | 1923 | Vertical Fixed Roof    | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,081,983   | 2,163,966 |

| Area | Property              | Tank ID <sup>4</sup> | Contents                       | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>5</sup> | Year | Type                   | Tank Group | Flammability Category | Hazardous Category | Damage Zone | Tank Age Failures | Percent Lost |      | Volume Lost |           |
|------|-----------------------|----------------------|--------------------------------|----------------|--|------|------------------------|------------|-----------------------|--------------------|-------------|-------------------|--------------|------|-------------|-----------|
|      |                       |                      |                                |                |  |      |                        |            |                       |                    |             |                   | Min          | Max  | Min         | Max       |
| 4    | Kinder Morgan South   | KMW54                | Diesel                         | 3,435,600      | 2,301,852  | 1929 | Vertical Fixed Roof    | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,150,926   | 2,301,852 |
| 4    | Kinder Morgan South   | KMW56                | Out of Service                 | 19,867         | NA   | 1929 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW57                | Out of Service                 | 19,800         | NA   | 1929 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW58                | Out of Service                 | 19,800         | NA   | 1929 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW59                | Out of Service                 | 19,855         | NA   | 1929 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW6                 | Out of Service                 | 215,166        | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW60                | Out of Service                 | 19,824         | NA   | 1929 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW61                | Out of Service                 | 25,200         | NA   | 1929 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW62                | Out of Service                 | 11,676         | NA   | 1929 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW63                | Out of Service                 | 24,766         | NA   | 1929 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW65                | Jet A                          | 861,336        | 577,095  | 1930 | Vertical Fixed Roof    | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 288,548     | 577,095   |
| 4    | Kinder Morgan South   | KMW66                | Out of Service                 | 856,800        | NA   | 1930 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW69                | Jet A                          | 3,431,400      | 2,299,038  | 1937 | Vertical Fixed Roof    | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,149,519   | 2,299,038 |
| 4    | Kinder Morgan South   | KMW7                 | Out of Service                 | 440,538        | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW70                | Jet A                          | 1,461,600      | 979,272  | 1938 | Vertical Fixed Roof    | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 489,636     | 979,272   |
| 4    | Kinder Morgan South   | KMW71                | Transmix                       | 862,260        | 577,714  | 1937 | Vertical Fixed Roof    | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 288,857     | 577,714   |
| 4    | Kinder Morgan South   | KMW72                | Out of Service                 | 549,024        | NA   | 1937 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW73                | Transmix                       | 546,714        | 366,298  | 1937 | Vertical Fixed Roof    | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 183,149     | 366,298   |
| 4    | Kinder Morgan South   | KMW74                | Out of Service                 | 305,712        | NA   | 1937 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW75                | Out of Service                 | 25,000         | NA   | 1938 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW76                | Out of Service                 | 25,000         | NA   | 1938 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW77                | Out of Service                 | 25,741         | NA   | 1938 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW8                 | Out of Service                 | 216,804        | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW82                | Out of Service                 | 11,642         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW83                | Out of Service                 | 19,867         | NA   | 1923 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW84                | Gasoline                       | 2,356,200      | 1,578,654  | 1948 | Internal Floating Roof | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 789,327     | 1,578,654 |
| 4    | Kinder Morgan South   | KMW85                | Diesel                         | 2,347,800      | 1,573,026  | 1948 | Vertical Fixed Roof    | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 786,513     | 1,573,026 |
| 4    | Kinder Morgan South   | KMW86                | Out of Service                 | 222,805        | NA   | 1948 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW87                | Out of Service                 | 222,469        | NA   | 1948 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW88                | Out of Service                 | 222,574        | NA   | 1948 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW89                | Out of Service                 | 222,919        | NA   | 1948 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW9                 | Out of Service                 | 22,722         | NA   | 1915 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Kinder Morgan South   | KMW90                | Out of Service                 | 2,982          | NA   | 1946 | Vertical Fixed Roof    | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | McCall Oil            | MC22                 | Asphalt                        | 18,942         | 12,691   | 1954 | Cone Roof              | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 6,346       | 12,691    |
| 3    | Northwest Natural Gas | NWN-Tank 001         | Liquefied Natural Gas          | 7,100,000      | 4,757,000  | NA   | NA                     | Group 3C   | Category 1            | Yes                | On Land     | No Tank Failure   | 0%           | 10%  | 0           | 475,700   |
| 4    | Conoco Phillips       | PH1471               | Hydraulic Tractor Oil          | 17,300         | 11,591   | 1921 | Riveted Steel          | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,796       | 11,591    |
| 4    | Conoco Phillips       | PH2561               | Marine Fuel Oil                | 1,569,582      | 1,051,620  | 1929 | Riveted Steel          | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 525,810     | 1,051,620 |
| 4    | Conoco Phillips       | PH2579               | Hydraulic Tractor Oil          | 1,800          | 1,206  | 1929 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 603         | 1,206     |
| 4    | Conoco Phillips       | PH2669               | Marine Diesel                  | 449,694        | 301,295  | 1931 | Riveted Steel          | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 150,647     | 301,295   |
| 4    | Conoco Phillips       | PH2713               | Unax AW 46                     | 109,000        | 73,030   | 1937 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 36,515      | 73,030    |
| 4    | Conoco Phillips       | PH2714               | Guardol 15W/40                 | 109,000        | 73,030   | 1937 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 36,515      | 73,030    |
| 4    | Conoco Phillips       | PH2783               | Decant Oil                     | 948,066        | 635,204  | 1937 | Riveted Steel          | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 317,602     | 635,204   |
| 4    | Conoco Phillips       | PH2784               | Diesel #2                      | 1,439,130      | 964,217  | 1937 | Riveted Steel          | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 482,109     | 964,217   |
| 4    | Conoco Phillips       | PH2915               | Unleaded Gasoline              | 3,262,056      | 2,185,578  | 1938 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,092,789   | 2,185,578 |
| 4    | Conoco Phillips       | PH2916               | Diesel #2                      | 1,652,196      | 1,106,971  | 1938 | Welded Steel           | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 553,486     | 1,106,971 |
| 4    | Conoco Phillips       | PH2917               | RLOP 220 N                     | 612,000        | 410,040  | 1938 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 205,020     | 410,040   |
| 4    | Conoco Phillips       | PH2982               | Diesel #1                      | 416,262        | 278,896  | 1941 | Welded Steel           | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 139,448     | 278,896   |
| 4    | Conoco Phillips       | PH2983               | RLOP 220 N                     | 304,000        | 203,680  | 1941 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 101,840     | 203,680   |
| 4    | Conoco Phillips       | PH3408               | Unleaded Gasoline              | 1,639,680      | 1,098,586  | 1949 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 549,293     | 1,098,586 |
| 4    | Conoco Phillips       | PH3409               | Unleaded Gasoline              | 948,654        | 635,598  | 1949 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 317,799     | 635,598   |
| 4    | Conoco Phillips       | PH3410               | Ethanol                        | 278,964        | 186,906  | 1949 | Welded Steel           | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 93,453      | 186,906   |
| 4    | Conoco Phillips       | PH3411               | Unleaded Gasoline              | 259,350        | 173,765  | 1949 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 86,882      | 173,765   |
| 4    | Conoco Phillips       | PH3412               | Diesel #1                      | 279,426        | 187,215  | 1949 | Welded Steel           | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 93,608      | 187,215   |
| 4    | Conoco Phillips       | PH3413               | Unleaded Gasoline              | 259,560        | 173,905  | 1949 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 86,953      | 173,905   |
| 4    | Conoco Phillips       | PH3414               | RLOP 220 N                     | 200,000        | 134,000  | 1949 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 67,000      | 134,000   |
| 4    | Conoco Phillips       | PH3415               | SUN 525                        | 200,000        | 134,000  | 1949 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 67,000      | 134,000   |
| 4    | Conoco Phillips       | PH3416               | RLOP 100N                      | 200,000        | 134,000  | 1949 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 67,000      | 134,000   |
| 4    | Conoco Phillips       | PH3417               | ULTRA S-4                      | 200,000        | 134,000  | 1949 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 67,000      | 134,000   |
| 4    | Conoco Phillips       | PH3579               | Industrial Fuel Oil            | 3,307,668      | 2,216,138  | 1950 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,108,069   | 2,216,138 |
| 4    | Conoco Phillips       | PH36                 | Stop Oil                       | 20,496         | 13,732   | 1907 | Riveted Steel          | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 6,886       | 13,732    |
| 4    | Conoco Phillips       | PH3623               | HiTech 6576                    | 18,228         | 12,213   | 1950 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 6,106       | 12,213    |
| 4    | Conoco Phillips       | PH3639               | SUP SYN BL 5W/30               | 120,000        | 80,400   | 1951 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 40,200      | 80,400    |
| 4    | Conoco Phillips       | PH3739               | SUN 150 B/S                    | 200,000        | 134,000  | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 67,000      | 134,000   |
| 4    | Conoco Phillips       | PH3740               | RLOP 600 N                     | 277,000        | 185,590  | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 92,795      | 185,590   |
| 4    | Conoco Phillips       | PH3741               | Ramar CLF 17E                  | 17,500         | 11,725   | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH3742               | MP Gear Lube 80/90             | 17,500         | 11,725   | 1954 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH3743               | Utility                        | 18,600         | 12,462   | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 6,231       | 12,462    |
| 4    | Conoco Phillips       | PH3744               | HYNAP N100                     | 17,500         | 11,725   | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH3745               | HITEC 5751                     | 17,500         | 11,725   | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH3746               | Lubrizol 4998C                 | 17,500         | 11,725   | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH3747               | Lubrizol 4990CH                | 17,500         | 11,725   | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH3757               | HITEC 1193                     | 17,500         | 11,725   | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH3760               | Raffene 750L                   | 17,500         | 11,725   | 1954 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH3761               | Diesel #2                      | 3,240,342      | 2,171,029  | 1954 | Welded Steel           | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,085,515   | 2,171,029 |
| 4    | Conoco Phillips       | PH4191               | Lubrizol 48254                 | 17,500         | 11,725   | 1964 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH4192               | Lubrizol 7075F                 | 17,500         | 11,725   | 1964 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH4223               | Slop Oil                       | 18,690         | 12,522   | 1968 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 6,261       | 12,522    |
| 4    | Conoco Phillips       | PH4241               | UNAX AW 68                     | 17,500         | 11,725   | 1968 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH4242               | UNAX AW 68                     | 17,500         | 11,725   | 1968 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH4243               | HT4/10W                        | 17,500         | 11,725   | 1968 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH4244               | Mohawk 450                     | 17,500         | 11,725   | 1968 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH425                | SUN 525                        | 17,500         | 11,725   | 1968 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips       | PH4252               | Residual Fuel Oil <sup>6</sup> | 458,640        | 307,289  | 196  |                        |            |                       |                    |             |                   |              |      |             |           |

| Area | Property        | Tank ID <sup>1</sup> | Contents                    | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>2</sup> | Year | Type                   | Tank Group | Flammability Category | Hazardous Category | Damage Zone | Tank Age Failures | Percent Lost |      | Volume Lost |           |
|------|-----------------|----------------------|-----------------------------|----------------|--|------|------------------------|------------|-----------------------|--------------------|-------------|-------------------|--------------|------|-------------|-----------|
|      |                 |                      |                             |                |  |      |                        |            |                       |                    |             |                   | Min          | Max  | Min         | Max       |
| 4    | Conoco Phillips | PH4257               | Out of Service              | 38,367         | NA   | 1968 | Welded Steel           | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Conoco Phillips | PH4258               | Line Clippings              | 18,000         | 12,060   | 1968 | Welded Steel           | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 6,030       | 12,060    |
| 4    | Conoco Phillips | PH4259               | Transmix                    | 205,506        | 137,689  | 1968 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 68,845      | 137,689   |
| 4    | Conoco Phillips | PH4266               | Flush                       | 17,500         | 11,725   | 1968 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips | PH4281               | Versa Tran ATF              | 17,500         | 11,725   | 1969 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips | PH4300               | Ramar CLF 17E               | 25,500         | 17,085   | 1969 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 8,543       | 17,085    |
| 4    | Conoco Phillips | PH4302               | RLOP 600N                   | 17,500         | 11,725   | 1971 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips | PH4303               | RLOP 100N                   | 17,500         | 11,725   | 1971 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips | PH4305               | Out of Service              | 8,900          | NA   | 1971 | Welded Steel           | Group 2    | None                  | None               | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Conoco Phillips | PH4306               | RLOP 100N                   | 200,000        | 134,000  | 1971 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 67,000      | 134,000   |
| 4    | Conoco Phillips | PH4318               | Diesel #2                   | 1,422,456      | 953,046  | 1973 | Welded Steel           | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 476,523     | 953,046   |
| 4    | Conoco Phillips | PH4320               | Sup Syn BL 10W/30           | 35,000         | 23,450   | 1973 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 11,725      | 23,450    |
| 4    | Conoco Phillips | PH4321               | Uniguide II 100             | 35,000         | 23,450   | 1973 | Welded Steel           | Group 3A   | Category 1            | No                 | On Land     | Tank Failure      | 50%          | 100% | 11,725      | 23,450    |
| 4    | Conoco Phillips | PH4322               | TSX HD 15W/40               | 35,000         | 23,450   | 1973 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 11,725      | 23,450    |
| 4    | Conoco Phillips | PH4323               | Super ATF                   | 35,000         | 23,450   | 1973 | Welded Steel           | Group 3A   | Category 2            | No                 | On Land     | Tank Failure      | 50%          | 100% | 11,725      | 23,450    |
| 4    | Conoco Phillips | PH4327               | Gasoline Slops <sup>5</sup> | 10,080         | 6,754  | 1974 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 3,377       | 6,754     |
| 4    | Conoco Phillips | PH4331               | Ethyl HITEC 6888E           | 25,500         | 17,085   | 1973 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 17,085    |
| 4    | Conoco Phillips | PH4332               | Super ATF                   | 17,500         | 11,725   | 1973 | Welded Steel           | Group 3A   | Category 2            | No                 | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips | PH4333               | Point Premier 10W/30        | 17,500         | 11,725   | 1973 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips | PH4334               | Super 5W/20                 | 17,500         | 11,725   | 1973 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips | PH4369               | RLOP 220 N                  | 17,500         | 11,725   | 1979 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Conoco Phillips | PH4388               | Utility                     | 13,500         | 9,045  | 1984 | Welded Steel           | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4389               | Utility                     | 13,500         | 9,045  | 1984 | Welded Steel           | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4390               | Bar & Chain 150             | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4391               | Utility                     | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4392               | Utility                     | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4393               | Utility                     | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4394               | Utility                     | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4395               | Utility                     | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4397               | Lubrizol 9692A              | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4398               | HITEC 1193A                 | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4399               | Firebird 15W/40             | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4400               | Guardol 30                  | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4401               | Mohawk 150                  | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4402               | TSX HD10                    | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4403               | HT4/30W                     | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4404               | Fleet Sup EC 15W/40         | 13,500         | 9,045  | 1985 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4405               | HITEC 3472                  | 13,500         | 9,045  | 1987 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4406               | Lubrizol 9990A              | 13,500         | 9,045  | 1987 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4407               | Ethyl HITEC 388             | 13,500         | 9,045  | 1987 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4408               | Ethyl HITEC 5756            | 13,500         | 9,045  | 1987 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 4,523       | 9,045     |
| 4    | Conoco Phillips | PH4441               | Octel 9056                  | 18,648         | 12,494   | 1993 | Welded Steel           | Group 3B   | Unknown               | Yes                | On Land     | No Tank Failure   | 0%           | 10%  | 0           | 1,249     |
| 4    | Conoco Phillips | PHF103               | UTRA 58                     | 25,500         | 17,085   | 1973 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 8,543       | 17,085    |
| 4    | Conoco Phillips | PHF104               | UTRA 59                     | 17,500         | 11,725   | 1973 | Welded Steel           | Group 3A   | Unknown               | Yes                | On Land     | Tank Failure      | 50%          | 100% | 5,863       | 11,725    |
| 4    | Zenith Energy   | Tank 129             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 128             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 127             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 70              | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 125             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 124             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 123             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 122             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 121             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 120             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 112             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 110             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 101             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 126             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 003             | Asphalt                     | NA             | NA   | NA   | NA                     | Group 3A   | Category 1            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 71              | Avgas                       | NA             | 1,402,380  | NA   | Internal Floating Roof | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 701,190     | 1,402,380 |
| 4    | Zenith Energy   | Tank 184             | Biodiesel                   | NA             | 222,000  | NA   | NA                     | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 111,000     | 222,000   |
| 4    | Zenith Energy   | Tank 307             | Caustic                     | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 74              | Charge Stock                | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 100             | Charge Stock                | NA             | NA   | NA   | NA                     | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 102             | Charge Stock                | NA             | NA   | NA   | NA                     | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 106             | Crude Oil                   | NA             | 5,611,788  | NA   | External Floating Roof | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 2,805,894   | 5,611,788 |
| 4    | Zenith Energy   | Tank 67              | Crude Oil                   | NA             | 3,234,000  | NA   | NA                     | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,617,000   | 3,234,000 |
| 4    | Zenith Energy   | Tank 93              | Crude Oil                   | NA             | 2,829,918  | NA   | NA                     | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,414,959   | 2,829,918 |
| 4    | Zenith Energy   | Tank 69              | Crude Oil                   | NA             | NA   | NA   | NA                     | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 130             | Crude Oil                   | NA             | 3,200,000  | NA   | Internal Floating Roof | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,600,000   | 3,200,000 |
| 4    | Zenith Energy   | Tank 68              | Crude Oil                   | NA             | 2,900,000  | NA   | NA                     | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,450,000   | 2,900,000 |
| 4    | Zenith Energy   | Tank 63              | Crude Oil                   | NA             | 4,763,472  | NA   | Internal Floating Roof | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 2,381,736   | 4,763,472 |
| 4    | Zenith Energy   | Tank 104             | Crude Oil                   | NA             | NA   | NA   | NA                     | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 105             | Crude Oil                   | NA             | 5,241,684  | NA   | External Floating Roof | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 2,620,842   | 5,241,684 |
| 4    | Zenith Energy   | Tank 001             | Crude Oil                   | NA             | NA   | NA   | NA                     | Group 3A   | Category 2            | Yes                | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 308             | Muroil                      | NA             | NA   | NA   | NA                     | Group 3A   | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 182             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 183             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 185             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 202             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 203             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 209             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 213             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 208             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 211             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tank 306             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy   | Tanks 95             | NA                          | NA             | NA   | NA   | NA                     | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |

| Area | Property      | Tank ID <sup>1</sup> | Contents                    | Capacity (Gal) | Expected Fill (Gal) (67% of Capacity) <sup>9</sup> | Year | Type | Tank Group | Flammability Category | Hazardous Category | Damage Zone | Tank Age Failures | Percent Lost |      | Volume Lost |           |
|------|---------------|----------------------|-----------------------------|----------------|--|------|------|------------|-----------------------|--------------------|-------------|-------------------|--------------|------|-------------|-----------|
|      |               |                      |                             |                |  |      |      |            |                       |                    |             |                   | Min          | Max  | Min         | Max       |
| 4    | Zenith Energy | Tank 114             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 302             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 162             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 166             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 167             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 168             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 169             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 170             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 171             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 172             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 20              | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 173             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 174             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 180             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 179             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 206             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 210             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 177             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 176             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 178             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 181             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 200             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 201             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | N2                   | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 317             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | BAS #2               | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | KO T#5               | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | BAS #3               | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | BAS #4               | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 160             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 161             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 314             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 002             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | KO T#2               | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | CAS #5               | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | BAS #1               | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 305             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | KO T#1               | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 163             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 164             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 165             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 152             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 151             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 158             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 157             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 156             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 148             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 149             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 150             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 142             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 143             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 144             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 147             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 146             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 145             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 140             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 141             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 300             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | K-23                 | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | TW-2                 | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 207             | NA                          | NA             | NA   | NA   | NA   | Group 1    | Unknown               | Unknown            | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 66              | Universal Low-Sulfur Diesel | NA             | 3,188,598  | NA   | NA   | Group 3A   | Category 3            | Yes                | On Land     | Tank Failure      | 50%          | 100% | 1,594,299   | 3,188,598 |
| 4    | Zenith Energy | Tank 111             | Wastewater                  | NA             | NA   | NA   | NA   | Group 3A   | Not Flammable         | No                 | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |
| 4    | Zenith Energy | Tank 113             | Wastewater                  | NA             | NA   | NA   | NA   | Group 3A   | Not Flammable         | No                 | On Land     | Tank Failure      | 50%          | 100% | NA          | NA        |

Notes:

<sup>1</sup>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: Kinder Morgan North = \*KML-Tank 1\*

<sup>2</sup>Tank contents were listed as both gasoline and ethanol; flammability and hazard category are for gasoline.

<sup>3</sup>Tank contents were listed as both gasoline and diesel; flammability and hazard category are for gasoline.

<sup>4</sup>Tank contents were listed as both gasoline and diesel additives; flammability and hazard category are for gasoline.

<sup>5</sup>Tank contents were listed as gasoline slops; flammability and hazard category are for gasoline.

<sup>6</sup>Residual Oil and Residual Fuel Oil is a general classification for heavier oils that remain after the distillate fuel oil and lighter hydrocarbons are removed. The type of lighter hydrocarbon is unknown and therefore defaulted to the most flammable category.

<sup>7</sup>Tank contents were listed as biodiesel additive; flammability and hazard category are for biodiesel.

<sup>8</sup>Tank data provided by COP without geographic location; failure assumption made from satellite imagery.

<sup>9</sup>Zenith Energy tank fill provided directly from Portland Fire and Rescue.

Category 1 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or below 95°F (35°C).  
Category 2 - Liquids with flashpoints below 73.4°F (23°C) and boiling points at or above 95°F (35°C).  
Category 3 - Liquids with flashpoints at or above 73.4°F (23°C) and at or below 140°F (60°C).  
Category 4 - Liquids having flashpoints above 140°F (60°C) and at or below 199.4°F (93°C).

NA - Data not available  
No - Tank substance is not hazardous.  
None - Flammability category and/or hazard category is not applicable due to tank status of Out of Service.  
Not Flammable - Tank contents are not flammable and do not fall into Category 1-4.  
Unknown - Flammability category or hazard category unknown due to unknown tank contents, or tank contents not defined in a suitable way to ascertain flammability or hazard categories.  
Yes - Tank substance is hazardous.



**APPENDIX E**  
**Tanks with Potential to Release to Unknown Locations**



| FID | TANK ID | Owner   | Facility                            | Facility_S | Container | Substance                    | Average FI | Capacity | Contains      | Year Built | Area ft 2 | Radius ft | Perimeter | Height ft | Longitude | Latitude  | Flammabil | Hazardous | Year_cat    | damagzone         | fail         | Concern      |              |  |
|-----|---------|---------|-------------------------------------|------------|-----------|------------------------------|------------|----------|---------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-------------------|--------------|--------------|--------------|--|
| 9   | BP19    | BP      | British Petroleum South Tank Farm   | BP         | 19        | Oily Wastewater              | 184000     | 198828   | Internal Flo. | 1961       | 1006.89   | 17.902599 | 112.48535 | 26.3976   | -122.7785 | 45.593761 | NA        | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 10  | BP2     | BP      | British Petroleum North Tank Farm   | BP         | 2         | Groundwater Remediation      | n/a        | 1231000  | Internal Flo. | 1957       | 1141.61   | 19.0627   | 119.77448 | 144.148   | -122.7807 | 45.594645 | NA        | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 11  | BP21    | BP      | British Petroleum South Tank Farm   | BP         | 21        | Gasoline additive            | 204960     | 220080   | Fixed Roof    | 1961       | 1580.65   | 22.4307   | 140.93625 | 18.6129   | -122.7783 | 45.593529 | NA        | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 14  | BP24    | BP      | British Petroleum North Tank Farm   | BP         | 24        | Gasoline additive            | 15960      | 20286    | Fixed Roof    | 1970       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 15  | BP25    | BP      | British Petroleum North Tank Farm   | BP         | 25        | Gasoline additive            | 15960      | 20241    | Fixed Roof    | 1966       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 16  | BP26    | BP      | British Petroleum BioDiesel Tanks   | BP         | 26        | Diesel Conductivity Additive | n/a        | 450      | Tote          | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 19  | BP40    | BP      | British Petroleum BioDiesel Tanks   | BP         | 40        | Unavailable                  | 0          | 0        | Fixed Roof    | 1954       | 1006.89   | 17.902599 | 112.48535 | 0         | -122.7794 | 45.594105 | NA        | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 20  | BP41    | BP      | British Petroleum BioDiesel Tanks   | BP         | 41        | Out of service               | 0          | 0        | Fixed Roof    | 1954       | 1006.89   | 17.902599 | 112.48535 | 0         | -122.7792 | 45.594158 | None      | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 21  | BP42    | BP      | British Petroleum BioDiesel Tanks   | BP         | 42        | Out of service               | 0          | 0        | Fixed Roof    | 1954       | 1006.89   | 17.902599 | 112.48535 | 0         | -122.7791 | 45.594209 | None      | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 22  | BP43    | BP      | British Petroleum BioDiesel Tanks   | BP         | 43        | Out of service               | 0          | 0        | Fixed Roof    | 1954       | 1006.89   | 17.902599 | 112.48535 | 0         | -122.7789 | 45.594263 | None      | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 23  | BP44    | BP      | British Petroleum BioDiesel Tanks   | BP         | 44        | Out of service               | 0          | 0        | Fixed Roof    | 1954       | 1006.89   | 17.902599 | 112.48535 | 0         | -122.779  | 45.594108 | None      | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 24  | BP45    | BP      | British Petroleum BioDiesel Tanks   | BP         | 45        | Unavailable                  | 0          | 0        | Fixed Roof    | 1954       | 1006.89   | 17.902599 | 112.48535 | 0         | -122.7791 | 45.594056 | NA        | NA        | Pre-1993 or | Material in Water | Tank Failure |              |              |  |
| 31  | BPs     | BP      | British Petroleum Outside Tank Farm | BP         | s         | Diesel Conductivity Additive | n/a        | 450      | Tote          | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 33  | CH10    | Chevron | Chevron Willbridge                  | CH         | 10        | Paratone 8451                | 153719     | 169616   | Fx            | 1950       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 34  | CH100   | Chevron | Chevron Willbridge                  | CH         | 100       | Gear Lube                    | 17448      | 17624    | Fixed Roof    | 1946       | 114.719   | 6.04287   | 37.968472 | 20.5371   | -122.7429 | 45.564268 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 36  | CH102   | Chevron | Chevron Willbridge                  | CH         | 102       | Out of Service               | 0          | 12954    | Fx            | 1978       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 37  | CH103   | Chevron | Chevron Willbridge                  | CH         | 103       | Out of Service               | 0          | 13006    | Fx            | 1978       | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 38  | CH104   | Chevron | Chevron Willbridge                  | CH         | 104       | Texaco Havoline 5S30         | 18000      | 17331    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 39  | CH105   | Chevron | Chevron Willbridge                  | CH         | 105       | Empty                        | 0          | 17624    | Fx            | 1969       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 40  | CH106   | Chevron | Chevron Willbridge                  | CH         | 106       | Delo G/L 80/90               | 23700      | 17818    | Fx            | 1969       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 41  | CH108   | Chevron | Chevron Willbridge                  | CH         | 108       | Techron Additive             | 196854     | 208425   | Fixed Roof    | 1970       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 42  | CH109   | Chevron | Chevron Willbridge                  | CH         | 109       | Delo GL 80/90                | 17490      | 17624    | Fixed Roof    | 1946       | 114.719   | 6.04287   | 37.968472 | 20.5371   | -122.743  | 45.564195 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 43  | CH11    | Chevron | Chevron Willbridge                  | CH         | 11        | Lubrizol 4991D               | 195801     | 211915   | Fx            | 1950       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 44  | CH110   | Chevron | Chevron Willbridge                  | CH         | 110       | GST ISO 32                   | 18500      | 17624    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 45  | CH112   | Chevron | Chevron Willbridge                  | CH         | 112       | Oloa 60721F                  | 18400      | 17818    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 46  | CH113   | Chevron | Chevron Willbridge                  | CH         | 113       | Hybase C414                  | 16632      | 17378    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 47  | CH114   | Chevron | Chevron Willbridge                  | CH         | 114       | Industrial EP 220            | 18300      | 17624    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 48  | CH116   | Chevron | Chevron Willbridge                  | CH         | 116       | Empty                        | 0          | 17724    | Fx            | 1976       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 49  | CH117   | Chevron | Chevron Willbridge                  | CH         | 117       | Raffene 2000L                | 18000      | 17624    | Fx            | 1976       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 50  | CH118   | Chevron | Chevron Willbridge                  | CH         | 118       | Blend Mix/ Line Wash         | 17800      | 17577    | Fx            | 1976       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 51  | CH119   | Chevron | Chevron Willbridge                  | CH         | 119       | Out of Service               | 0          | 19593    | Fx            | 1977       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 52  | CH12    | Chevron | Chevron Willbridge                  | CH         | 12        | ExxonMobil EM-100            | 540311     | 58302    | Fx            | 1950       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 53  | CH120   | Chevron | Chevron Willbridge                  | CH         | 120       | Out of Service               | 0          | 19593    | Fx            | 1977       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 54  | CH121   | Chevron | Chevron Willbridge                  | CH         | 121       | Out of Service               | 25379      | 0        | Fx            | 1978       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 55  | CH122   | Chevron | Chevron Willbridge                  | CH         | 122       | LUCK THT                     | 1000       | 61864    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 56  | CH123   | Chevron | Chevron Willbridge                  | CH         | 123       | Delo 400-40                  | 37600      | 61864    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 57  | CH127   | Chevron | Chevron Willbridge                  | CH         | 127       | ATF dex 111                  | 96500      | 109976   | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 58  | CH128   | Chevron | Chevron Willbridge                  | CH         | 128       | Rykon Prem 32                | 99448      | 74586    | AST           | 1976       | 860.7903  | 16.5529   | 104.00494 | 11.583201 | -122.7425 | 45.563455 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 60  | CH13    | Chevron | Chevron Willbridge                  | CH         | 13        | Raffene 750L                 | 39752      | 45682    | Fx            | 1976       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 62  | CH131   | Chevron | Chevron Willbridge                  | CH         | 131       | Hybase C414                  | 18400      | 17577    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 63  | CH132   | Chevron | Chevron Willbridge                  | CH         | 132       | Empty                        | 0          | 18165    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 64  | CH133   | Chevron | Chevron Willbridge                  | CH         | 133       | CVX 3105                     | 19300      | 17577    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 65  | CH135   | Chevron | Chevron Willbridge                  | CH         | 135       | Out of Service               | 0          | 19379    | Fx            | 1982       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 66  | CH136   | Chevron | Chevron Willbridge                  | CH         | 136       | Out of Service               | 0          | 20303    | Fx            | 1982       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 67  | CH137   | Chevron | Chevron Willbridge                  | CH         | 137       | Oloa 2000                    | 96500      | 60727    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 69  | CH139   | Chevron | Chevron Willbridge                  | CH         | 139       | Blend Mix/ Line Wash         | 23500      | 25591    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 70  | CH14    | Chevron | Chevron Willbridge                  | CH         | 14        | Delo 6170 CFO 20W40          | Varies     | 190343   | Fx            | 1950       | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 71  | CH140   | Chevron | Chevron Willbridge                  | CH         | 140       | Out of Service               | 0          | 83234    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 72  | CH141   | Chevron | Chevron Willbridge                  | CH         | 141       | Out of Service               | 0          | 140308   | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 74  | CH143   | Chevron | Chevron Willbridge                  | CH         | 143       | Supreme 5W30                 | 55448      | 62033    | Fixed Roof    | 1976       | 332.155   | 10.2824   | 64.606225 | 24.9662   | -122.7423 | 45.564871 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 75  | CH144   | Chevron | Chevron Willbridge                  | CH         | 144       | Havoline 10W30               | 55672      | 61864    | Fixed Roof    | 1976       | 332.155   | 10.2824   | 64.606225 | 24.8981   | -122.7423 | 45.564931 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 76  | CH145   | Chevron | Chevron Willbridge                  | CH         | 145       | Out of Service               | 0          | 61864    | Fixed Roof    | 1976       | 332.155   | 10.2824   | 64.606225 | 24.8981   | -122.7422 | 45.565046 | None      | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 78  | CH147   | Chevron | Chevron Willbridge                  | CH         | 147       | Delo 100-40                  | 23700      | 25523    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 79  | CH148   | Chevron | Chevron Willbridge                  | CH         | 148       | VER 800 Mar 30               | 32100      | 33839    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 80  | CH149   | Chevron | Chevron Willbridge                  | CH         | 149       | RPM HD40 30                  | 23700      | 26311    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 81  | CH15    | Chevron | Chevron Willbridge                  | CH         | 15        | Rykon Prem 32                | 26900      | 26900    | Fx            | 1913       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 82  | CH150   | Chevron | Chevron Willbridge                  | CH         | 150       | Delo 400-10                  | 22792      | 25311    | Fixed Roof    | 1976       | 332.155   | 10.2824   | 64.606225 | 10.1868   | -122.7422 | 45.564985 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 83  | CH151   | Chevron | Chevron Willbridge                  | CH         | 151       | MAR EO 9250-40               | 18200      | 17724    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA        | Pre-1993 or | No Data           | Tank Failure |              |              |  |
| 84  | CH152   | Chevron | Chevron Willbridge                  | CH         | 152       | Empty                        | 0          | 17624    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None        | NA                | Pre-1993 or  | No Data      | Tank Failure |  |
| 85  | CH154   | Chevron | Chevron Willbridge                  | CH         | 154       | Map 100                      | 76548      | 83422    | Fixed Roof    | 1976       | 393.561   | 11.1926   | 70.325182 | 28.336    | -122.7431 | 45.563846 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 86  | CH155   | Chevron | Chevron Willbridge                  | CH         | 155       | Delo 400-15W40               | 75400      | 83422    | Fixed Roof    | 1976       | 393.561   | 11.1926   | 70.325182 | 28.336    | -122.743  | 45.563782 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 87  | CH156   | Chevron | Chevron Willbridge                  | CH         | 156       | Delo 400-30                  | 75442      | 83022    | Fixed Roof    | 1976       | 393.561   | 11.1926   | 70.325182 | 28.2001   | -122.7429 | 45.563724 | NA        | NA        | Pre-1993 or | On Land           | Tank Failure |              |              |  |
| 88  | CH157   | Chevron | Chevron Willbridge                  | CH         | 157       | Turbine Oil                  | 70497      | 52872    | AST           | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | NA        | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 89  | CH158   | Chevron | Chevron Willbridge                  | CH         | 158       | Out of Service               | 83422      | 0        | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 90  | CH159   | Chevron | Chevron Willbridge                  | CH         | 159       | Out of Service               | N/A        | 25379    | AST           | 1987       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 91  | CH16    | Chevron | Chevron Willbridge                  | CH         | 16        | Clarity PM 220               | 26900      | 29447    | Fx            | 1913       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None      | NA          | Pre-1993 or       | No Data      | Tank Failure |              |  |
| 92  | CH160   | Chevron | Chevron Willbridge                  | CH         | 160       | Empty                        | 0          |          |               |            |           |           |           |           |           |           |           |           |             |                   |              |              |              |  |

| FID | TANK ID  | Owner         | Facility                          | Facility_S | Container | Substance            | Average FI     | Capacity      | Contains      | Year Built | Area ft 2 | Radius ft | Perimeter | Height ft | Longitude | Latitude  | Flammabil | Hazardous   | Year cat    | damagezone        | Fail         | Concern      |              |              |  |
|-----|----------|---------------|-----------------------------------|------------|-----------|----------------------|----------------|---------------|---------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-------------|-------------------|--------------|--------------|--------------|--------------|--|
| 135 | CH42     | Chevron       | Chevron Willbridge                | CH         | 42        | Empty                | 0              | 29583         | Fx            | 1913       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | None        | NA          | Pre-1993 or       | No Data      | Tank Failure |              |              |  |
| 139 | CH46     | Chevron       | Chevron Willbridge                | CH         | 46        | Rd Chain Bar 150     | Varies         | 11750         | Fx            | 1924       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | NA          | NA          | Pre-1993 or       | No Data      | Tank Failure |              |              |  |
| 141 | CH48     | Chevron       | Chevron Willbridge                | CH         | 48        | Water/Oil Stop       | 384175         | 396547        | Fixed Roof    | 1979       | 2030.3    | 25.421699 | 159.72925 | 26.1098   | -122.7417 | 45.564276 | NA        | NA          | Pre-1993 or | On Land           | Tank Failure |              |              |              |  |
| 142 | CH5      | Chevron       | Chevron Willbridge                | CH         | 5         | Neutral Oil          | 336997         | 365834        | Fx            | 1913       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | NA          | NA          | Pre-1993 or       | No Data      | Tank Failure |              |              |  |
| 144 | CH56     | Chevron       | Chevron Willbridge                | CH         | 56        | GGT ISO 100          | Varies         | 25239         | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 144 | CH57     | Chevron       | Chevron Willbridge                | CH         | 57        | Cargo Bkt Stock 150  | Varies         | 15273         | Fx            | 1921       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 146 | CH6      | Chevron       | Chevron Willbridge                | CH         | 6         | GEO HDX1 ASH 40      | 88565          | 100277        | Fx            | 1913       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 148 | CH61     | Chevron       | Chevron Willbridge                | CH         | 61        | Neutral 600R         | Varies         | 400379        | Fx            | 1941       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 151 | CH65     | Chevron       | Chevron Willbridge                | CH         | 65        | Lubrizol 4991        | Varies         | 17524         | Fx            | 1998       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 152 | CH7      | Chevron       | Chevron Willbridge                | CH         | 7         | Famm Taro Sepcial 70 | 89107          | 100594        | Fx            | 1913       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 153 | CH72     | Chevron       | Chevron Willbridge                | CH         | 72        | Saw Guide 150        | Varies         | 17284         | Fx            | 1959       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 156 | CH77     | Chevron       | Chevron Willbridge                | CH         | 77        | RPM HDMO 15W40       | Varies         | 128511        | Fx            | 1960       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 157 | CH78     | Chevron       | Chevron Willbridge                | CH         | 78        | Paratone 8451        | Varies         | 311722        | Fx            | 1960       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | NA          | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 158 | CH79     | Chevron       | Chevron Willbridge                | CH         | 79        | Empty                | 0              | 17378         | Fx            | 1960       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | None        | NA                | Pre-1993 or  | No Data      | Tank Failure |              |  |
| 159 | CH8      | Chevron       | Chevron Willbridge                | CH         | 8         | Bykon Prem MV        | 91510          | 104897        | Fx            | 1913       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 160 | CH80     | Chevron       | Chevron Willbridge                | CH         | 80        | Out of Service       | Out of Service | 17378         | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 161 | CH81     | Chevron       | Chevron Willbridge                | CH         | 81        | Empty                | 0              | 17724         | Fx            | 1951       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 162 | CH82     | Chevron       | Chevron Willbridge                | CH         | 82        | Infineum M7038       | 18000          | 17624         | Fx            | 1951       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 163 | CH83     | Chevron       | Chevron Willbridge                | CH         | 83        | RPM HDMO 15W40       | 18100          | 17331         | Fx            | 1951       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 164 | CH84     | Chevron       | Chevron Willbridge                | CH         | 84        | Empty                | 0              | 17184         | Fx            | 1952       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 165 | CH85     | Chevron       | Chevron Willbridge                | CH         | 85        | Oloa 44200           | 18000          | 17671         | Fx            | 1952       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 166 | CH87     | Chevron       | Chevron Willbridge                | CH         | 87        | Lubrizol 4991        | 18100          | 17430         | Fx            | 1913       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 167 | CH88     | Chevron       | Chevron Willbridge                | CH         | 88        | Empty                | 0              | 17624         | Fx            | 1850       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 168 | CH89     | Chevron       | Chevron Willbridge                | CH         | 89        | Oil Stop             | 17459          | 19421         | Fx            | 1952       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 169 | CH9      | Chevron       | Chevron Willbridge                | CH         | 9         | Chevron 7075F        | 169193         | 169193        | Fx            | 1949       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 170 | CH90     | Chevron       | Chevron Willbridge                | CH         | 90        | Delo 400-15W40       | 190000         | 208848        | Fx            | 1954       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 171 | CH91     | Chevron       | Chevron Willbridge                | CH         | 91        | Oloa 9740C           | 16758          | 17671         | Fx            | 1961       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 172 | CH92     | Chevron       | Chevron Willbridge                | CH         | 92        | Out of Service       | Out of Service | 17577         | Fx            | 1961       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 174 | CH96     | Chevron       | Chevron Willbridge                | CH         | 96        | Additive             | 17624          | Fixed Roof    | 1966          | 1426.89    | 21.3118   | 133.90599 | 1.65114   | -122.7427 | 45.564294 | NA        | NA        | Pre-1993 or | On Land     | Tank Failure      |              |              |              |              |  |
| 175 | CH97     | Chevron       | Chevron Willbridge                | CH         | 97        | Additive             | 17624          | Fx            | 1966          | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 176 | CH98     | Chevron       | Chevron Willbridge                | CH         | 98        | Bykon Oil 46         | 469140         | 91364         | Fx            | 1968       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 177 | CH99     | Chevron       | Chevron Willbridge                | CH         | 99        | RPM UGI 80W90        | 55656          | 62033         | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | NA                | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 178 | KML10007 | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 10007     | Out of service       | 250967         | 418278        | Vertical fixe | 1922       | 3078.0801 | 31.3015   | 196.67313 | 18.1658   | -122.7875 | 45.603921 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 179 | KML11017 | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 11017     | Out of service       | 281963         | 469938        | Internal floa | 1941       | 1784.79   | 23.835199 | 149.76097 | 35.198399 | -122.7863 | 45.603122 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 180 | KML11018 | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 11018     | Out of service       | 281938         | 468986        | Internal floa | 1941       | 1784.79   | 23.835199 | 149.76097 | 35.195301 | -122.7864 | 45.603258 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 181 | KML12024 | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 2024      | Out of service       | 65138          | 0             | Vertical fixe | 1937       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 186 | KML2501  | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 2501      | Out of service       | 61841          | 103068        | Internal floa | 1958       | 1141.61   | 19.0627   | 119.77448 | 12.0691   | -122.7877 | 45.603684 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 187 | KML2502  | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 2502      | Out of service       | 62546          | 104224        | Vertical fixe | 1914       | 1141.61   | 19.0627   | 119.77448 | 12.206801 | -122.7877 | 45.603813 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 188 | KML2503  | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 2503      | Out of service       | 63202          | 105336        | Vertical fixe | 1915       | 1141.61   | 19.0627   | 119.77448 | 12.3347   | -122.7879 | 45.603818 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 190 | KML3034  | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 3034      | Storm water          | 82228          | 137046        | Vertical fixe | 1925       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 191 | KML305   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 305       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 192 | KML306   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 306       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 193 | KML309   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 309       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 194 | KML310   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 310       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 195 | KML312   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 312       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 196 | KML313   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 313       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 197 | KML314   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 314       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 198 | KML315   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 315       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 199 | KML326   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 326       | Out of service       | 7560           | 12600         | Vertical fixe | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 200 | KML330   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 330       | Out of service       | 7207           | 12012         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 201 | KML331   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 331       | Out of service       | 7762           | 12936         | Vertical fixe | 1926       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 203 | KML5004  | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 5004      | Out of service       | 126580         | 210966        | Vertical fixe | 1916       | 1784.79   | 23.835199 | 149.76097 | 15.8014   | -122.7879 | 45.603683 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 204 | KML532   | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 532       | Out of service       | 11945          | 29908         | Vertical fixe | 1965       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 205 | KML55008 | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 55008     | Out of service       | 1373299        | 2288322       | Vertical fixe | 1933       | 10371.9   | 57.4585   | 361.0224  | 29.5002   | -122.7868 | 45.603011 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 207 | KML55023 | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 55023     | Out of service       | 1387210        | 2313016       | Internal floa | 1944       | 10371.9   | 57.4585   | 361.0224  | 29.799    | -122.7872 | 45.603675 | None      | NA          | Pre-1993 or | Material in Water | Tank Failure |              |              |              |  |
| 211 | KML1017  | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 1017      | Contact water        | 13734          | 0             | Vertical fixe | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 211 | KMW10    | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 10        | Out of service       | 0              | 22722         | Vertical fixe | 1915       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 214 | KMW102   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 102       | Out of service       | 0              | 306600        | Vertical fixe | 1951       | 1133.92   | 18.9984   | 119.37047 | 36.145901 | -122.7449 | 45.565812 | None      | NA          | Pre-1993 or | On Land           | Tank Failure |              |              |              |  |
| 215 | KMW103   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 103       | Out of service       | 0              | 168000        | Vertical fixe | 1950       | 579.185   | 13.5779   | 85.312461 | 38.775902 | -122.7451 | 45.565895 | None      | NA          | Pre-1993 or | On Land           | Tank Failure |              |              |              |  |
| 216 | KMW104   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 104       | Lubricity additive   | 100800         | 168000        | Vertical fixe | 1950       | 625.34198 | 14.1086   | 88.646946 | 35.913799 | -122.7452 | 45.565895 | None      | NA          | Pre-1993 or | On Land           | Tank Failure |              |              |              |  |
| 218 | KMW106   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 106       | Out of service       | 302546         | Vertical fixe | 1951          | 1353.04    | 20.753    | 130.39495 | 29.891701 | -122.745  | 45.565695 | None      | NA        | Pre-1993 or | On Land     | Tank Failure      |              |              |              |              |  |
| 219 | KMW11    | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 11        | Out of service       | 0              | 22722         | Vertical fixe | 1915       | 0         | 0         | 0         | 0         | 0         | 0         | 0         | 0           | 0           | None              | NA           | Pre-1993 or  | No Data      | Tank Failure |  |
| 223 | KMW12    | Kinder Morgan | Kinder Morgan Willbridge Terminal |            |           |                      |                |               |               |            |           |           |           |           |           |           |           |             |             |                   |              |              |              |              |  |

| FID | TANK ID | Owner         | Facility                          | Facility_S | Container | Substance      | Average FI | Capacity | Containe   | Year Built | Area ft 2   | Radius ft | Perimeter | Height ft | Longitude | Latitude  | Flammabili | Hazardous | Year_cat    | damagezone | Fail         | Concern |
|-----|---------|---------------|-----------------------------------|------------|-----------|----------------|------------|----------|------------|------------|-------------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-------------|------------|--------------|---------|
| 265 | KMW17   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 17        | Out of service | 0          | 2814     | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 266 | KMW170  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 170       | Out of service | 0          | 24990    | Vertical   | 1928       | 128.702     | 6.4005599 | 40.215904 | 25.956801 | -122.7429 | 45.564766 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 267 | KMW171  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 171       | Out of service | 0          | 24990    | Vertical   | 1915       | 81.9217     | 5.1065202 | 32.085213 | 40.778999 | -122.7428 | 45.564804 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 268 | KMW172  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 172       | Out of service | 0          | 24990    | Vertical   | 1915       | 105.765     | 5.8022499 | 36.456611 | 31.586    | -122.7429 | 45.564824 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 270 | KMW176  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 176       | Out of service | 0          | 25353    | Vertical   | 1915       | 106.921     | 5.8338699 | 36.655286 | 31.698299 | -122.7428 | 45.564781 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 271 | KMW177  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 177       | Out of service | 0          | 24457    | Vertical   | 1915       | 98.250503   | 5.59252   | 35.137646 | 33.276501 | -122.7428 | 45.564781 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 272 | KMW18   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 18        | Out of service | 0          | 2814     | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 273 | KMW186  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 186       | Out of service | 0          | 25604    | Vertical   | 1915       | 112.875     | 5.9941001 | 37.662042 | 30.3235   | -122.7428 | 45.564746 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 274 | KMW187  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 187       | Out of service | 0          | 24000    | Vertical   | 1915       | 114.719     | 6.04287   | 37.968472 | 27.966999 | -122.7428 | 45.564709 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 275 | KMW188  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 188       | Out of service | 0          | 24600    | Vertical   | 1915       | 113.765     | 6.0176902 | 37.810263 | 28.9065   | -122.7427 | 45.564724 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 276 | KMW189  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 189       | Out of service | 0          | 24035    | Vertical   | 1915       | 99.280998   | 5.6215801 | 35.321429 | 32.3629   | -122.7427 | 45.564688 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 277 | KMW190  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 190       | Additive       | 5040       | 8400     | Horizontal | Unknown    | 0           | 0         | 0         | 0         | 0         | 0         | NA         | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 278 | KMW192  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 192       | Additive       | 4838       | 8064     | Horizontal | Unknown    | 0           | 0         | 0         | 0         | 0         | 0         | NA         | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 279 | KMW193  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 193       | Additive       | 6048       | 10080    | Horizontal | Unknown    | 0           | 0         | 0         | 0         | 0         | 0         | NA         | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 280 | KMW194  | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 194       | Slop water     | 3780       | 6300     | Horizontal | Unknown    | 0           | 0         | 0         | 0         | 0         | 0         | NA         | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 282 | KMW22   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 22        | Out of service | 0          | 11760    | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 283 | KMW23   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 23        | Out of service | 0          | 11718    | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 284 | KMW25   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 25        | Out of service | 0          | 11760    | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 285 | KMW26   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 26        | Out of service | 0          | 22806    | Vertical   | 1916       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 286 | KMW3    | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 3         | Out of service | 0          | 55350    | Vertical   | 1915       | 2835.3601   | 30.042    | 188.75945 | 26.089199 | -122.7434 | 45.565155 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 287 | KMW30   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 30        | Out of service | 0          | 11718    | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 288 | KMW31   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 31        | Out of service | 0          | 11760    | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 289 | KMW32   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 32        | Out of service | 0          | 11472    | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 290 | KMW33   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 33        | Out of service | 0          | 17472    | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 291 | KMW34   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 34        | Out of service | 0          | 17481    | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 292 | KMW35   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 35        | Out of service | 0          | 4397     | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 293 | KMW36   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 36        | Out of service | 0          | 4368     | Vertical   | 1924       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 294 | KMW37   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 37        | Out of service | 0          | 4368     | Vertical   | 1924       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 295 | KMW38   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 38        | Out of service | 0          | 4368     | Vertical   | 1924       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 296 | KMW39   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 39        | Out of service | 0          | 4397     | Vertical   | 1924       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 297 | KMW4    | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 4         | Out of service | 0          | 215754   | Vertical   | 1915       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 298 | KMW40   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 40        | Out of service | 0          | 5544     | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 299 | KMW41   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 41        | Out of service | 0          | 5502     | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 300 | KMW42   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 42        | Out of service | 0          | 5502     | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 301 | KMW43   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 43        | Out of service | 0          | 5502     | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 302 | KMW44   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 44        | Out of service | 0          | 5515     | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 303 | KMW45   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 45        | Out of service | 0          | 5540     | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 304 | KMW46   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 46        | Out of service | 0          | 11642    | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 305 | KMW47   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 47        | Out of service | 0          | 11600    | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 306 | KMW48   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 48        | Out of service | 0          | 11642    | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 307 | KMW49   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 49        | Out of service | 0          | 11677    | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 308 | KMW5    | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 5         | Out of service | 0          | 439605   | Vertical   | 1915       | 1745.9      | 23.574101 | 148.12044 | 33.659901 | -122.7433 | 45.565342 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 309 | KMW50   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 50        | Out of service | 0          | 11507    | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 310 | KMW51   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 51        | Out of service | 0          | 11634    | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 313 | KMW56   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 56        | Out of service | 0          | 12987    | Vertical   | 1928       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 314 | KMW57   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 57        | Out of service | 0          | 13800    | Vertical   | 1928       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 315 | KMW58   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 58        | Out of service | 0          | 13800    | Vertical   | 1928       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 316 | KMW59   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 59        | Out of service | 0          | 19855    | Vertical   | 1929       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 317 | KMW6    | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 6         | Out of service | 0          | 215166   | Vertical   | 1915       | 1092.09     | 18.644699 | 117.3481  | 26.3381   | -122.7431 | 45.565153 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 318 | KMW60   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 60        | Out of service | 0          | 19824    | Vertical   | 1929       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 319 | KMW61   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 61        | Out of service | 0          | 25200    | Vertical   | 1929       | 147.17101   | 6.84442   | 43.004759 | 22.8901   | -122.7439 | 45.56518  | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 320 | KMW62   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 62        | Out of service | 0          | 11676    | Vertical   | 1929       | 73.015503   | 4.82095   | 30.290922 | 21.3771   | -122.7438 | 45.56515  | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 321 | KMW63   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 63        | Out of service | 0          | 24766    | Vertical   | 1929       | 99.280998   | 5.6215801 | 35.321429 | 33.347198 | -122.7431 | 45.564875 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 323 | KMW66   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 66        | Out of service | 0          | 85680    | Vertical   | 1930       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 325 | KMW7    | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 7         | Out of service | 0          | 440538   | Vertical   | 1915       | 2565.3799   | 28.576    | 179.5483  | 22.956301 | -122.7431 | 45.565529 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 327 | KMW72   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 72        | Out of service | 0          | 59032    | Vertical   | 1927       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 330 | KMW74   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 74        | Out of service | 0          | 305712   | Vertical   | 1937       | 1092.09     | 18.644699 | 117.3481  | 37.4217   | -122.7428 | 45.565453 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 331 | KMW75   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 75        | Out of service | 0          | 25000    | Vertical   | 1938       | 119.016     | 6.1550002 | 38.673007 | 28.0805   | -122.7431 | 45.564924 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 332 | KMW76   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 76        | Out of service | 0          | 25000    | Vertical   | 1938       | 147.17101   | 6.84442   | 43.004759 | 22.708401 | -122.7434 | 45.564991 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 333 | KMW77   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 77        | Out of service | 0          | 25741    | Vertical   | 1938       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 334 | KMW8    | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 8         | Out of service | 0          | 216804   | Vertical   | 1915       | 1092.09     | 18.644699 | 117.3481  | 26.3381   | -122.743  | 45.565331 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 335 | KMW82   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 82        | Out of service | 0          | 11642    | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 336 | KMW83   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 83        | Out of service | 0          | 19867    | Vertical   | 1923       | 0           | 0         | 0         | 0         | 0         | 0         | None       | NA        | Pre-1993 of | No Data    | Tank Failure |         |
| 339 | KMW86   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 86        | Out of service | 0          | 227805   | Vertical   | 1948       | 843.57397   | 16.386499 | 102.95941 | 35.307899 | -122.7446 | 45.565659 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 340 | KMW87   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 87        | Out of service | 0          | 222469   | Vertical   | 1948       | 843.54401   | 16.3862   | 102.95753 | 35.255901 | -122.7448 | 45.565731 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 341 | KMW88   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 88        | Out of service | 0          | 222574   | Vertical   | 1948       | 862.8602    | 17.5068   | 109.99847 | 30.901699 | -122.7447 | 45.565559 | None       | NA        | Pre-1993 of | On Land    | Tank Failure |         |
| 342 | KMW89   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 89        | Out of service | 0          | 222919   | Vertical   | 1948       | 923.59003</ |           |           |           |           |           |            |           |             |            |              |         |



| FID | TANK ID | Owner               | Facility                                   | Facility_S | Container | Substance           | Average FI | Capacity | Contains      | Year Built | Area ft 2 | Radius ft | Perimeter | Height ft | Longitude | Latitude  | Flammabil | Hazardous | Year cat    | Damagezone           | Fail         | Concern |
|-----|---------|---------------------|--|------------|-----------|---------------------|------------|----------|---------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|----------------------|--------------|---------|
| 394 | NU3204  | NuStar              | Nustar Portland Terminal                   | NU         | 3204      | Gasoline/Diesel     | 1249542    | 1267302  | Internal floa | 1979       | 4629.21   | 38.386501 | 241.1895  | 36.596802 | -122.7733 | 45.589106 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 396 | NU3605  | NuStar              | Nustar Portland Terminal                   | NU         | 3605      | MFO                 | 4620.8398  | 1442470  | Conc          | 1938       | 4620.8398 | 38.351799 | 240.97146 | 41.730701 | -122.7771 | 45.592887 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 397 | NU3614  | NuStar              | Nustar Portland Terminal                   | NU         | 3614      | Gasoline/Diesel     | 5336.3398  | 139810   | Internal floa | 1958       | 5336.3398 | 41.214199 | 258.95645 | 35.041699 | -122.7773 | 45.591724 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 398 | NU4402  | NuStar              | Nustar Portland Terminal                   | NU         | 4402      | Gasoline/Diesel     | 1738800    | 1761801  | Internal floa | 1979       | 6412.9399 | 45.180801 | 283.87935 | 36.725601 | -122.7738 | 45.589538 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 399 | NU4507  | NuStar              | Nustar Portland Terminal                   | NU         | 4507      | Out of Service      | 182740     | 184963   | Internal floa | 1980       | 6499.3797 | 45.484299 | 285.78628 | 38.044998 | -122.7742 | 45.589269 | None      | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 400 | NU5209  | NuStar              | Nustar Portland Terminal                   | NU         | 5209      | Gasoline/Diesel     | 1997100    | 2190678  | Internal floa | 1971       | 0         | 0         | 0         | 0         | -122.7742 | 45.589269 | None      | NA        | Pre-1993 or | No Data              | Tank Failure |         |
| 401 | NU6408  | NuStar              | Nustar Portland Terminal                   | NU         | 6408      | Gasoline/Diesel     | 2594466    | 2648782  | Internal floa | 1981       | 8075.1699 | 50.6992   | 318.5247  | 43.866001 | -122.7745 | 45.589542 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 406 | NU703   | NuStar              | Nustar Portland Terminal                   | NU         | 703       | Cutter              | 242718     | 309498   | Internal floa | 1938       | 1247.26   | 19.9252   | 125.19372 | 33.171902 | -122.7785 | 45.592767 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 407 | NU8006  | NuStar              | Nustar Portland Terminal                   | NU         | 8006      | Gasoline/Diesel     | 3004722    | 3373968  | Internal floa | 1953       | 9108.3096 | 53.844799 | 338.31685 | 49.603199 | -122.7758 | 45.590599 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 409 | NU8308  | NuStar              | Nustar Portland Terminal                   | NU         | 8308      | Gasoline/Diesel     | 3061632    | 3352746  | Internal floa | 1969       | 8486.1201 | 51.973202 | 326.55726 | 52.815498 | -122.7747 | 45.590229 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 410 | PA1     | Pacific Terminal Se | Pacific Terminal Services Portland Termina | PA         | 1         | Residual oil        | 3000       | 6000     |               | 1980       | 6915.0498 | 46.916199 | 294.78317 | 1.15991   | -122.761  | 45.580093 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 411 | PA2     | Pacific Terminal Se | Pacific Terminal Services Portland Termina | PA         | 2         | Diesel oil          | 10000      | 6000     |               | 1980       | 7594.0898 | 49.165798 | 308.91782 | 1.0562    | -122.7614 | 45.580134 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 412 | PA3     | Pacific Terminal Se | Pacific Terminal Services Portland Termina | PA         | 3         | Residual oil        | 10000      | 2000     |               | 1980       | 2769.5701 | 29.6915   | 186.55719 | 0.96356   | -122.7613 | 45.579875 | NA        | NA        | Pre-1993 or | Potentially in Water | Tank Failure |         |
| 413 | PA4     | Pacific Terminal Se | Pacific Terminal Services Portland Termina | PA         | 4         | Residual oil        | 4000       | 8000     |               | 1940       | 11006.4   | 59.189899 | 371.90111 | 0.9716    | -122.7593 | 45.579706 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 414 | PA5     | Pacific Terminal Se | Pacific Terminal Services Portland Termina | PA         | 5         | Residual oil        | 8000       | 5000     |               | 1940       | 10811.7   | 58.664101 | 368.59741 | 0.680046  | -122.7598 | 45.579565 | NA        | NA        | Pre-1993 or | Material in Water    | Tank Failure |         |
| 415 | PA6     | Pacific Terminal Se | Pacific Terminal Services Portland Termina | PA         | 6         | Diesel oil          | 6          | 12       |               | 1988       | 0         | 0         | 0         | 0         | -122.7613 | 45.579875 | NA        | NA        | Pre-1993 or | No Data              | Tank Failure |         |
| 421 | PH2713  | Phillips 66         | Phillips 66                                | PH         | 2713      | UNAX AW 46          | Not listed | 109000   | Welded Stee   | 1937       | 603.45099 | 13.8595   | 87.081806 | 24.1465   | -122.7408 | 45.561495 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 422 | PH2714  | Phillips 66         | Phillips 66                                | PH         | 2714      | Guardol 15W/40      | Not listed | 109000   | Welded Stee   | 1937       | 603.45099 | 13.8595   | 87.081806 | 24.1465   | -122.7407 | 45.561439 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 423 | PH2783  | Phillips 66         | Phillips 66                                | PH         | 2783      | Decant Oil          | Not listed | 948066   | Riveted Stee  | 1937       | 3357.1899 | 32.689899 | 205.3967  | 37.751301 | -122.7403 | 45.561906 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 427 | PH2917  | Phillips 66         | Phillips 66                                | PH         | 2917      | RLOP 220 N          | Not listed | 612000   | Welded Stee   | 1938       | 2487.24   | 28.1374   | 176.7925  | 32.893002 | -122.7407 | 45.562262 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 429 | PH2983  | Phillips 66         | Phillips 66                                | PH         | 2983      | RLOP 220 N          | Not listed | 304000   | Welded Stee   | 1941       | 1120.48   | 18.885401 | 118.66047 | 36.269299 | -122.7401 | 45.563303 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 437 | PH3414  | Phillips 66         | Phillips 66                                | PH         | 3414      | RLOP 220 N          | Not listed | 200000   | Welded Stee   | 1949       | 782.82501 | 15.7855   | 99.183219 | 34.1535   | -122.7397 | 45.561346 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 438 | PH3415  | Phillips 66         | Phillips 66                                | PH         | 3415      | SUN S25             | Not listed | 200000   | Welded Stee   | 1949       | 772.41000 | 15.6802   | 98.5216   | 34.613602 | -122.7396 | 45.561452 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 439 | PH3416  | Phillips 66         | Phillips 66                                | PH         | 3416      | RLOP 100N           | Not listed | 200000   | Welded Stee   | 1949       | 588.65399 | 13.6885   | 86.007385 | 45.419201 | -122.7395 | 45.561285 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 441 | PH3417  | Phillips 66         | Phillips 66                                | PH         | 3417      | UL TRA S 4          | Not listed | 200500   | Welded Stee   | 1949       | 821.435   | 16.00989  | 101.59973 | 32.548195 | -122.7394 | 45.561389 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 442 | PH3579  | Phillips 66         | Phillips 66                                | PH         | 3579      | Industrial Fuel Oil | Not listed | 3307668  | Welded Stee   | 1950       | 1291.67   | 64.121101 | 402.88476 | 34.23601  | -122.7392 | 45.560994 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 443 | PH36    | Phillips 66         | Phillips 66                                | PH         | 36        | Stop Oil            | Not listed | 20496    | Riveted Stee  | 1907       | 193.702   | 7.8522201 | 49.336954 | 14.1451   | -122.7411 | 45.561994 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 443 | PH3623  | Phillips 66         | Phillips 66                                | PH         | 3623      | HiTec 6576          | Not listed | 18228    | Welded Stee   | 1950       | 193.702   | 7.8522201 | 49.336954 | 12.5798   | -122.741  | 45.562595 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 444 | PH3639  | Phillips 66         | Phillips 66                                | PH         | 3639      | SUP SYN BL 5W/30    | Not listed | 120000   | Welded Stee   | 1951       | 598.82501 | 13.8062   | 86.746913 | 26.7887   | -122.7406 | 45.561377 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 445 | PH3739  | Phillips 66         | Phillips 66                                | PH         | 3739      | SUN 150 B/S         | Not listed | 200000   | Welded Stee   | 1954       | 757.995   | 15.5331   | 97.597346 | 35.272301 | -122.7398 | 45.56123  | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 446 | PH3740  | Phillips 66         | Phillips 66                                | PH         | 3740      | RLOP 600N           | Not listed | 277000   | Welded Stee   | 1954       | 935.18402 | 17.253401 | 108.40631 | 39.5961   | -122.7396 | 45.56116  | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 447 | PH3741  | Phillips 66         | Phillips 66                                | PH         | 3741      | Ramar CLF 17E       | Not listed | 17500    | Welded Stee   | 1954       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7409 | 45.560559 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 449 | PH3743  | Phillips 66         | Phillips 66                                | PH         | 3743      | Utility             | Not listed | 18600    | Welded Stee   | 1954       | 114.719   | 6.04287   | 37.968472 | 21.6744   | -122.7409 | 45.560625 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 450 | PH3744  | Phillips 66         | Phillips 66                                | PH         | 3744      | HYNAP N100          | Not listed | 17500    | Welded Stee   | 1954       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7409 | 45.560537 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 451 | PH3745  | Phillips 66         | Phillips 66                                | PH         | 3745      | HiTEC 5751          | Not listed | 17500    | Welded Stee   | 1954       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7409 | 45.560569 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 452 | PH3746  | Phillips 66         | Phillips 66                                | PH         | 3746      | Lubrizol 4998C      | Not listed | 17500    | Welded Stee   | 1954       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7408 | 45.560648 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 453 | PH3747  | Phillips 66         | Phillips 66                                | PH         | 3747      | Lubrizol 4990HC     | Not listed | 17500    | Welded Stee   | 1954       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7408 | 45.560577 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 454 | PH3757  | Phillips 66         | Phillips 66                                | PH         | 3757      | HiTEC 1193          | Not listed | 17500    | Welded Stee   | 1954       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7408 | 45.560546 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 455 | PH3760  | Phillips 66         | Phillips 66                                | PH         | 3760      | Raffene 750L        | Not listed | 17500    | Welded Stee   | 1954       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7408 | 45.560512 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 457 | PH4191  | Phillips 66         | Phillips 66                                | PH         | 4191      | Lubrizol 4825.4     | Not listed | 17500    | Welded Stee   | 1964       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7407 | 45.560555 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 458 | PH4192  | Phillips 66         | Phillips 66                                | PH         | 4192      | Lubrizol 7075F      | Not listed | 17500    | Welded Stee   | 1964       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7408 | 45.560522 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 459 | PH4223  | Phillips 66         | Phillips 66                                | PH         | 4223      | Slop Oil            | Not listed | 18690    | Welded Stee   | 1968       | 0         | 0         | 0         | 0         | -122.7408 | 45.560522 | NA        | NA        | Pre-1993 or | No Data              | Tank Failure |         |
| 460 | PH4241  | Phillips 66         | Phillips 66                                | PH         | 4241      | UNAX AW 68          | Not listed | 17500    | Welded Stee   | 1968       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7408 | 45.56049  | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 461 | PH4242  | Phillips 66         | Phillips 66                                | PH         | 4242      | UNAX AW 68          | Not listed | 17500    | Welded Stee   | 1968       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7407 | 45.560469 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 462 | PH4243  | Phillips 66         | Phillips 66                                | PH         | 4243      | Ramar CLF 17E       | Not listed | 17500    | Welded Stee   | 1968       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7407 | 45.560504 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 463 | PH4244  | Phillips 66         | Phillips 66                                | PH         | 4244      | Mohawk 450          | Not listed | 17500    | Welded Stee   | 1968       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7395 | 45.561506 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 464 | PH4245  | Phillips 66         | Phillips 66                                | PH         | 4245      | SUN S25             | Not listed | 17500    | Welded Stee   | 1968       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7395 | 45.561479 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 465 | PH4252  | Phillips 66         | Phillips 66                                | PH         | 4252      | Residual Fuel Oil   | Not listed | 458640   | Welded Stee   | 1968       | 2263.77   | 26.843599 | 168.66331 | 27.083799 | -122.7396 | 45.560726 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |
| 466 | PH4253  | Phillips 66         | Phillips 66                                | PH         | 4253      | Residual Fuel Oil   | Not listed | 451290   | Welded Stee   | 1968       | 2448.8301 | 27.9193   | 175.42214 | 24.635799 | -122.7394 | 45.560553 | NA        | NA        | Pre-1993 or | On Land              | Tank Failure |         |

| FID | TANK ID  | Owner                     | Facility                                    | Facility_S | Container | Substance         | Average FI | Capacity | Contains      | Year Built | Area ft 2 | Radius ft | Perimeter | Height ft | Longitude | Latitude  | Flammabil  | Hazardous | Year cat    | damagzone         | Fail            | Concern            |                    |                    |  |
|-----|----------|---------------------------|---|------------|-----------|-------------------|------------|----------|---------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-------------|-------------------|-----------------|--------------------|--------------------|--------------------|--|
| 371 | NU10026  | NuStar                    | Nustar Portland Terminal                    | NU         | 10026     | Gasoline/diesel   | 4200000    | 4200000  | Internal floa | 2007       | 12047.4   | 61.9258   | 389.09128 | 46.604301 | -122.7726 | 45.5881   | NA         | NA        | Post 2004   | Material in Water | No Tank Failure |                    |                    |                    |  |
| 372 | NU10027  | NuStar                    | Nustar Portland Terminal                    | NU         | 10027     | Gasoline/diesel   | 4200000    | 4200000  | Internal floa | 2007       | 12047.4   | 61.9258   | 389.09128 | 46.604301 | -122.7728 | 45.588531 | NA         | NA        | Post 2004   | Material in Water | No Tank Failure |                    |                    |                    |  |
| 102 | CH181    | Chevron                   | Chevron Willbridge                          | CH         | 181       | Blended Oil       | 5000       | 4700     | Fx            | 1993       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | NA        | NA          | 1993 - 2004       | No Data         | Uncertain Location |                    |                    |  |
| 103 | CH182    | Chevron                   | Chevron Willbridge                          | CH         | 182       | Blended Oil       | 10000      | 11374    | Fx            | 1994       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | NA          | NA                | 1993 - 2004     | No Data            | Uncertain Location |                    |  |
| 104 | CH183    | Chevron                   | Chevron Willbridge                          | CH         | 183       | Blended Oil       | 10000      | 11374    | Fx            | 1994       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 107 | CH184    | Chevron                   | Chevron Willbridge                          | CH         | 184       | Blended Oil       | 10000      | 11374    | Fx            | 1994       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 106 | CH185    | Chevron                   | Chevron Willbridge                          | CH         | 185       | Blended Oil       | 10000      | 11374    | Fx            | 1994       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 107 | CH186    | Chevron                   | Chevron Willbridge                          | CH         | 186       | Blended Oil       | 10000      | 11374    | Fx            | 1994       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 108 | CH187    | Chevron                   | Chevron Willbridge                          | CH         | 187       | Blended Oil       | 10000      | 11374    | Fx            | 1994       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 109 | CH188    | Chevron                   | Chevron Willbridge                          | CH         | 188       | Blended Oil       | 10000      | 11374    | Fx            | 1994       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 114 | CH23     | Chevron                   | Chevron Willbridge                          | CH         | 23        | Empty             | 0          | 13982    | Fx            | 1997       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | None        | NA                | 1993 - 2004     | No Data            | Uncertain Location |                    |  |
| 115 | CH24     | Chevron                   | Chevron Willbridge                          | CH         | 24        | Empty             | 0          | 8859     | Fx            | 1993       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | None        | NA                | 1993 - 2004     | No Data            | Uncertain Location |                    |  |
| 358 | MC24     | McCall                    | McCall Portland Terminal                    | MC         | 24        | Asphalt           | 28336      | 19068    | Cone roof     | 2000       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 359 | MC25     | McCall                    | McCall Portland Terminal                    | MC         | 25        | Asphalt           | 28252      | 79800    | Cone roof     | 2000       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 360 | MC26     | McCall                    | McCall Portland Terminal                    | MC         | 26        | Asphalt           | 28336      | 79800    | Cone roof     | 2000       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 361 | MC27     | McCall                    | McCall Portland Terminal                    | MC         | 27        | Asphalt           | 27552      | 79800    | Cone roof     | 2000       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 416 | PA7      | Pacific Terminal Services | Pacific Terminal Services Portland Terminal | PA         | 7         | Residual oil      | 250        | 475      | Fx            | 1993       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 101 | CH180    | Chevron                   | Chevron Willbridge                          | CH         | 180       | Blended Oil       | 5000       | 4700     | Fx            | 1993       | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | NA                | NA              | 1993 - 2004        | No Data            | Uncertain Location |  |
| 0   | BP1      | BP                        | British Petroleum North Tank Farm           | BP         | 1         | Gasoline          | 3641610    | 3808434  | Internal Floa | 1940       | 17351.4   | 74.317703 | 466.9519  | 29.341499 | -122.7807 | 45.59495  | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 1   | BP10     | BP                        | British Petroleum South Tank Farm           | BP         | 10        | Diesel            | 931980     | 1000840  | Fixed Roof    | 1941       | 4362.7798 | 37.265499 | 234.14604 | 30.9121   | -122.7788 | 45.593866 | Category 3 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 2   | BP11     | BP                        | British Petroleum North Tank Farm           | BP         | 11        | Gasoline          | 1129926    | 1354122  | Internal Floa | 1940       | 4632.2002 | 38.998899 | 241.2674  | 39.078701 | -122.78   | 45.594442 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 3   | BP12     | BP                        | British Petroleum North Tank Farm           | BP         | 12        | Ethanol           | 561204     | 563466   | Internal Floa | 1961       | 1678.34   | 23.113501 | 145.22641 | 48.216301 | -122.7802 | 45.594962 | Category 2 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 4   | BP13     | BP                        | British Petroleum North Tank Farm           | BP         | 13        | Ethanol           | 559482     | 569498   | Internal Floa | 1961       | 1944.0699 | 24.875999 | 156.30051 | 41.464001 | -122.7804 | 45.59251  | Category 2 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 5   | BP14     | BP                        | British Petroleum South Tank Farm           | BP         | 14        | Diesel            | 1046388    | 1121736  | Fixed Roof    | 1942       | 3466.8301 | 33.219998 | 208.72364 | 43.2542   | -122.7794 | 45.593616 | Category 3 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 6   | BP17     | BP                        | British Petroleum South Tank Farm           | BP         | 17        | Diesel            | 3225472    | 3225472  | Fixed Roof    | 1940       | 11533.18  | 69.588999 | 380.67493 | 38.566001 | -122.7787 | 45.593233 | Category 3 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 6   | BP18     | BP                        | British Petroleum South Tank Farm           | BP         | 18        | Diesel            | 1046262    | 1104776  | Fixed Roof    | 1945       | 3610.9099 | 33.902599 | 213.01631 | 40.898499 | -122.7797 | 45.593508 | Category 3 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 17  | BP3      | BP                        | British Petroleum North Tank Farm           | BP         | 3         | Gasoline          | 1505448    | 1584366  | Internal Floa | 1957       | 4845.5    | 39.272999 | 246.75953 | 43.710602 | -122.7813 | 45.59483  | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 18  | BP4      | BP                        | British Petroleum North Tank Farm           | BP         | 4         | Gasoline          | 939918     | 1105860  | Internal Floa | 1957       | 2970.8601 | 30.751499 | 193.21737 | 49.760799 | -122.7811 | 45.594575 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 25  | BP46     | BP                        | British Petroleum BtoDiesel Tanks           | BP         | 46        | Biodeisel         | 125571     | 221970   | Fixed Roof    | 1954       | 1006.89   | 17.902599 | 112.48535 | 29.4701   | -122.7793 | 45.594005 | Category 3 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 26  | BP5      | BP                        | British Petroleum North Tank Farm           | BP         | 5         | Gasoline          | 741300     | 895314   | Internal Floa | 1957       | 2557.47   | 28.5319   | 179.27122 | 46.798801 | -122.7808 | 45.594341 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 27  | BP6      | BP                        | British Petroleum North Tank Farm           | BP         | 6         | Gasoline          | 803040     | 1014384  | Internal Floa | 1957       | 2937.49   | 30.578301 | 192.12913 | 46.1632   | -122.7804 | 45.594515 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 28  | BP7      | BP                        | British Petroleum North Tank Farm           | BP         | 7         | Gasoline          | 450492     | 648018   | Internal Floa | 1957       | 1851.48   | 24.2764   | 152.53312 | 46.7883   | -122.7803 | 45.594769 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 29  | BP8      | BP                        | British Petroleum North Tank Farm           | BP         | 8         | Gasoline          | 616938     | 790272   | Internal Floa | 1957       | 2404.8501 | 27.6675   | 173.84003 | 43.926999 | -122.7804 | 45.594271 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 30  | BP9      | BP                        | British Petroleum South Tank Farm           | BP         | 9         | Diesel            | 2161404    | 2295366  | Fixed Roof    | 1940       | 10673.9   | 58.289001 | 366.2466  | 28.750799 | -122.7793 | 45.592425 | Category 3 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 35  | CH101    | Chevron                   | Chevron Willbridge                          | CH         | 101       | Compressor Oil    | 171128     | 11274    | Fixed Roof    | 1958       | 114.719   | 6.04287   | 37.968472 | 20.1409   | -122.7474 | 45.564228 | Category 1 | Yes       | Pre-1993 of | On Land           | Tank Failure    | Flammable          |                    |                    |  |
| 68  | CH138    | Chevron                   | Drive Train Fluid HD 10                     | CH         | 138       | Oil               | 11278      | 0        | Unknown       | 0          | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | 0                 | 0               | 0                  |                    |                    |  |
| 77  | CH146    | Chevron                   | Chevron Willbridge                          | CH         | 146       | Transmix          | 227105     | 25447    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | 0                 | 0               | 0                  |                    |                    |  |
| 140 | CH47     | Chevron                   | Chevron Willbridge                          | CH         | 47        | Unleaded Gasoline | 3237046    | 3609743  | Fixed Roof    | 1929       | 11940.8   | 61.651299 | 387.36653 | 40.412201 | -122.7427 | 45.563923 | Category 2 | Yes       | Pre-1993 of | On Land           | Tank Failure    | Flammable          |                    |                    |  |
| 150 | CH64     | Chevron                   | Chevron Willbridge                          | CH         | 64        | Diesel            | 754034     | 842275   | Fixed Roof    | 1947       | 2902.78   | 30.3971   | 190.99061 | 38.81199  | -122.7408 | 45.564509 | Category 3 | Yes       | Pre-1993 of | On Land           | Tank Failure    | Flammable          |                    |                    |  |
| 154 | CH75     | Chevron                   | Chevron Willbridge                          | CH         | 75        | Jet Fuel          | 861104     | 1004586  | Fixed Roof    | 1952       | 3238.1399 | 32.104999 | 201.72166 | 41.472599 | -122.7423 | 45.56401  | Category 3 | Yes       | Pre-1993 of | On Land           | Tank Failure    | Flammable          |                    |                    |  |
| 173 | CH94     | Chevron                   | Chevron Willbridge                          | CH         | 94        | Rykon Oil 68      | 63000      | 67419    | Fx            | Unknown    | 0         | 0         | 0         | 0         | 0         | 0         | 0          | 0         | 0           | 0                 | 0               | 0                  |                    |                    |  |
| 181 | KML17018 | Kinder Morgan             | Kinder Morgan Linnton Terminal              | KML        | 17018     | Gasoline          | 441428     | 735714   | Internal floa | 1941       | 3078.0801 | 31.3015   | 196.67313 | 31.952101 | -122.7859 | 45.603147 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 182 | KML17020 | Kinder Morgan             | Kinder Morgan Linnton Terminal              | KML        | 17020     | Gasoline          | 445738     | 742986   | Internal floa | 1941       | 3078.0801 | 31.3015   | 196.67313 | 32.264    | -122.786  | 45.603335 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 183 | KML17027 | Kinder Morgan             | Kinder Morgan Linnton Terminal              | KML        | 17027     | Gasoline          | 443444     | 739074   | Internal floa | 1954       | 2884.6599 | 30.302099 | 190.3937  | 34.250198 | -122.7858 | 45.602936 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 184 | KML20011 | Kinder Morgan             | Kinder Morgan Linnton Terminal              | KML        | 20011     | Diesel            | 355996     | 455996   | Vertical fixe | 1932       | 3956.53   | 62.52884  | 223.32162 | 28.873501 | -122.7862 | 45.602706 | Category 3 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 187 | KML20016 | Kinder Morgan             | Kinder Morgan Linnton Terminal              | KML        | 20016     | Diesel            | 752770     | 125740   | Vertical fixe | 1941       | 6522.72   | 45.585899 | 266.28899 | 35.6959   | -122.7882 | 45.602855 | Category 3 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 190 | KML45028 | Kinder Morgan             | Kinder Morgan Linnton Terminal              | KML        | 45028     | Gasoline          | 1133723    | 1853484  | External floa | 1955       | 5517.6699 | 41.9086   | 283.3195  | 45.779301 | -122.7858 | 45.602652 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 206 | KML55022 | Kinder Morgan             | Kinder Morgan Linnton Terminal              | KML        | 55022     | Gasoline          | 1385572    | 2309286  | Vertical fixe | 1928       | 10374.19  | 57.4585   | 361.0224  | 29.7638   | -122.787  | 45.60332  | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 208 | KML59029 | Kinder Morgan             | Kinder Morgan Linnton Terminal              | KML        | 59029     | Gasoline          | 1472436    | 2454060  | Vertical fixe | 1955       | 9125.6504 | 53.896099 | 338.63918 | 35.949299 | -122.7863 | 45.602507 | Category 1 | Yes       | Pre-1993 of | Material in Water | Tank Failure    | Flammable          |                    |                    |  |
| 212 | KMW100   | Kinder Morgan             | Kinder Morgan Willbridge Terminal           | KMW        | 100       | Diesel            | 2028600    | 3381000  | Vertical fixe | 1949       | 11039.6   | 59.279099 | 372.46156 | 40.941299 | -122.7451 | 45.566303 | Category 3 | Yes       | Pre-1993 of | On Land           | Tank Failure    | Flammable          |                    |                    |  |
| 213 | KMW101   | Kinder Morgan             | Kinder Morgan Willbridge Terminal           | KMW        | 101       | Gasoline          | 2028600    | 3381000  | Internal floa | 1949       | 10881.1   | 58.8521   | 369.77865 | 41.537701 | -122.7447 | 45.56672  | Category 1 | Yes       | Pre-1993 of | On Land           | Tank Failure    | Flammable          |                    |                    |  |
| 217 | KMW105   | Kinder Morgan             | Kinder Morgan Willbridge Terminal           | KMW        | 105       | Ethanol           | 100800     | 168000   | Internal floa | 1951       |           |           |           |           |           |           |            |           |             |                   |                 |                    |                    |                    |  |

| FID | TANK ID  | Owner         | Facility                          | Facility_S | Container | Substance            | Average FI | Capacity | Contain       | Year Built | Area ft 2 | Radius ft | Perimeter | Height ft | Longitude | Latitude  | Flammabil  | Hazardous | Year cat    | damagezone           | fail            | Concern                     |
|-----|----------|---------------|-----------------------------------|------------|-----------|----------------------|------------|----------|---------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-------------|----------------------|-----------------|-----------------------------|
| 432 | PH3409   | Phillips 66   | Phillips 66                       | PH         | 3409      | Unleaded Gasoline    | Not listed | 948654   | Welded Ste    | 1949       | 4178.0601 | 36.468102 | 229.13584 | 30.3531   | -122.7396 | 45.56334  | Category 2 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 433 | PH3410   | Phillips 66   | Phillips 66                       | PH         | 3410      | Ethanol              | Not listed | 278964   | Welded Ste    | 1949       | 1225.84   | 19.753401 | 124.11428 | 30.421699 | -122.7402 | 45.563495 | Category 2 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 434 | PH3411   | Phillips 66   | Phillips 66                       | PH         | 3411      | Unleaded Gasoline    | Not listed | 259350   | Welded Ste    | 1949       | 1155.14   | 19.175301 | 120.48197 | 30.0138   | -122.7401 | 45.563515 | Category 2 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 435 | PH3412   | Phillips 66   | Phillips 66                       | PH         | 3412      | Diesel #1            | Not listed | 279426   | Welded Ste    | 1949       | 1410.63   | 21.190001 | 133.1407  | 26.480301 | -122.74   | 45.563405 | Category 3 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 436 | PH3413   | Phillips 66   | Phillips 66                       | PH         | 3413      | Unleaded Gasoline    | Not listed | 259560   | Welded Ste    | 1949       | 979.86503 | 17.6616   | 110.97111 | 35.4076   | -122.7399 | 45.563518 | Category 2 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 448 | PH3742   | Phillips 66   | Phillips 66                       | PH         | 3742      | MP Gear Lube 80/90   | Not listed | 17500    | Welded Ste    | 1954       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7409 | 45.560593 | Category 1 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 456 | PH3761   | Phillips 66   | Phillips 66                       | PH         | 3761      | Diesel #2            | Not listed | 3240342  | Welded Ste    | 1954       | 12915.1   | 64.117104 | 402.85964 | 33.540001 | -122.7385 | 45.564004 | Category 3 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 472 | PH4259   | Phillips 66   | Phillips 66                       | PH         | 4259      | Transmix             | Not listed | 205506   | Welded Ste    | 1968       | 1225.62   | 19.7516   | 124.10296 | 22.415001 | -122.7403 | 45.5637   | Category 2 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 480 | PH4318   | Phillips 66   | Phillips 66                       | PH         | 4318      | Diesel #2            | Not listed | 1422456  | Welded Ste    | 1973       | 6588.2402 | 45.794102 | 287.73283 | 28.862801 | -122.7388 | 45.560751 | Category 3 | Yes       | Pre-1993 or | On Land              | Tank Failure    | Flammable                   |
| 32  | CH1      | Chevron       | Chevron Willbridge                | CH         | 1         | Unleaded Gasoline    | 3265616    | 3412315  | Internal floa | 1997       | 12260     | 62.469898 | 392.50995 | 37.207298 | -122.7414 | 45.565257 | Category 2 | Yes       | 1993 - 2004 | Potentially in Water | Tank Failure    | Flammable                   |
| 123 | CH3      | Chevron       | Chevron Willbridge                | CH         | 3         | Unleaded Gasoline    | 2056421    | 2392178  | Fixed Roof    | 1999       | 8141.1099 | 50.9058   | 319.85057 | 39.280701 | -122.7418 | 45.564876 | Category 2 | Yes       | 1993 - 2004 | On Land              | No Tank Failure | Flammable                   |
| 138 | CH45     | Chevron       | Chevron Willbridge                | CH         | 45        | Ethanol              | 803510     | 958693   | Fixed Roof    | 1999       | 3441.5701 | 33.098999 | 207.96149 | 37.238499 | -122.7414 | 45.564484 | Category 2 | Yes       | 1993 - 2004 | On Land              | No Tank Failure | Flammable                   |
| 143 | CH51     | Chevron       | Chevron Willbridge                | CH         | 51        | Ethanol              | 2366078    | 2613405  | Fixed Roof    | 2000       | 7943.1401 | 50.283001 | 315.93741 | 43.982899 | -122.7411 | 45.564223 | Category 2 | Yes       | 1993 - 2004 | On Land              | No Tank Failure | Flammable                   |
| 147 | CH60     | Chevron       | Chevron Willbridge                | CH         | 60        | Unleaded Gasoline    | 4625739    | 4999697  | Fixed Roof    | 2001       | 12515.9   | 63.118401 | 396.58461 | 53.401199 | -122.742  | 45.563315 | Category 2 | Yes       | 1993 - 2004 | On Land              | No Tank Failure | Flammable                   |
| 149 | CH62     | Chevron       | Chevron Willbridge                | CH         | 62        | Unleaded Gasoline    | 6054327    | 6812135  | Fixed Roof    | 2000       | 19327     | 78.454803 | 492.94607 | 47.0938   | -122.7415 | 45.563859 | Category 2 | Yes       | 1993 - 2004 | On Land              | No Tank Failure | Flammable                   |
| 209 | KML72021 | Kinder Morgan | Kinder Morgan Linnton Terminal    | KML        | 72021     | Diesel               | 1705378    | 2842297  | Vertical fixe | 2011       | 10371.9   | 57.4585   | 361.0224  | 36.633701 | -122.7875 | 45.603365 | Category 3 | Yes       | Post 2004   | Material in Water    | No Tank Failure | Flammable                   |
| 224 | KMW12001 | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 12001     | Jet A                | 3024000    | 5040000  | Internal floa | 2012       | 19337     | 78.454803 | 492.94607 | 34.842602 | -122.7421 | 45.565693 | Category 3 | Yes       | Post 2004   | On Land              | No Tank Failure | Flammable                   |
| 225 | KMW12002 | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 12002     | Diesel               | 3024000    | 5040000  | Internal floa | 2012       | 8141.1099 | 50.9058   | 319.85057 | 82.7593   | -122.7428 | 45.565734 | Category 3 | Yes       | Post 2004   | On Land              | No Tank Failure | Flammable                   |
| 226 | KMW12003 | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 12003     | Gasoline             | 3024000    | 5040000  | Internal floa | 2012       | 10881.1   | 58.8521   | 369.77865 | 61.919498 | -122.7439 | 45.566713 | Category 1 | Yes       | Post 2004   | On Land              | No Tank Failure | Flammable                   |
| 349 | MC15     | McCall        | McCall Portland Terminal          | MC         | 15        | Flux                 | 14560      | 21840    | Cone roof     | 1986       | 0         | 0         | 0         | 0         | 0         | 0         | NA         | Yes       | Pre-1993 or | No Data              | Tank Failure    | Hazardous but not Flammable |
| 350 | MC16     | McCall        | McCall Portland Terminal          | MC         | 16        | Flux                 | 20132      | 30198    | Cone roof     | 1989       | 0         | 0         | 0         | 0         | 0         | 0         | NA         | Yes       | Pre-1993 or | No Data              | Tank Failure    | Hazardous but not Flammable |
| 375 | NU1011   | NuStar        | NuStar Portland Terminal          | NU         | 1011      | Ethanol/Gasoline     | 348510     | 393149   | Internal floa | 1980       | 1332      | 20.591    | 129.37707 | 39.456902 | -122.7737 | 45.589052 | NA         | Yes       | Pre-1993 or | Material in Water    | Tank Failure    | Hazardous but not Flammable |
| 364 | MC33     | McCall        | McCall Portland Terminal          | MC         | 33        | Poly phosphoric acid | 4054       | 5405     | Cone roof     | 2005       | 0         | 0         | 0         | 0         | 0         | 0         | NA         | Yes       | Post 2004   | No Data              | No Tank Failure | Hazardous but not Flammable |
| 6   | BP15     | BP            | British Petroleum South Tank Farm | BP         | 15        | Biodiesel            | 743400     | 804972   | Fixed Roof    | 1943       | 3310.75   | 32.463001 | 203.97105 | 32.502998 | -122.7792 | 45.593738 | Category 3 | No        | Pre-1993 or | Material in Water    | Tank Failure    | Flammable Not Hazardous     |
| 59  | CH129    | Chevron       | Chevron Willbridge                | CH         | 129       | Base Oil             | 601107     | 647935   | Fixed Roof    | 1943       | 1919.3101 | 24.7174   | 155.30212 | 44.7808   | -122.7426 | 45.56357  | Category 1 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 61  | CH130    | Chevron       | Chevron Willbridge                | CH         | 130       | Base Oil             | 239477     | 255112   | Fixed Roof    | 1943       | 860.79203 | 16.5529   | 104.00494 | 39.618801 | -122.7424 | 45.563673 | Category 1 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 73  | CH142    | Chevron       | Chevron Willbridge                | CH         | 142       | Base Oil             | 607148     | 648620   | Ex            | 1984       | 1965.16   | 25.010599 | 157.14623 | 44.1227   | -122.742  | 45.563989 | Category 1 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 137 | CH44     | Chevron       | Chevron Willbridge                | CH         | 44        | Base Oil             | 771264     | 835393   | Fixed Roof    | 1920       | 2612.55   | 28.8375   | 181.19135 | 42.745998 | -122.7423 | 45.563518 | Category 1 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 155 | CH76     | Chevron       | Chevron Willbridge                | CH         | 76        | Base Oil             | 467832     | 492598   | Fixed Roof    | 1960       | 1426.89   | 21.3118   | 133.90599 | 46.680302 | -122.7415 | 45.564182 | Category 1 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 221 | KMW117   | Kinder Morgan | Kinder Morgan Willbridge Terminal | KMW        | 117       | Biodiesel            | 340200     | 567000   | Internal floa | 1951       | 2115.3501 | 25.9487   | 163.04049 | 35.832001 | -122.7457 | 45.566373 | Category 3 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 346 | MC10     | McCall        | McCall Portland Terminal          | MC         | 10        | Biodiesel            | 157248     | 469392   | Internal floa | 1974       | 1780.05   | 23.803499 | 149.5618  | 35.251099 | -122.7357 | 45.564053 | Category 3 | No        | Pre-1993 or | Material in Water    | Tank Failure    | Flammable Not Hazardous     |
| 366 | MC5      | McCall        | McCall Portland Terminal          | MC         | 5         | Biodiesel            | 5000       | 27216    | Cone roof     | 1974       | 402.138   | 11.3139   | 71.08733  | 9.0473003 | -122.7339 | 45.563564 | Category 3 | No        | Pre-1993 or | Material in Water    | Tank Failure    | Flammable Not Hazardous     |
| 367 | MC6      | McCall        | McCall Portland Terminal          | MC         | 6         | Biodiesel            | 5000       | 27216    | Cone roof     | 1974       | 402.138   | 11.3139   | 71.08733  | 9.0473003 | -122.7339 | 45.563564 | Category 3 | No        | Pre-1993 or | Material in Water    | Tank Failure    | Flammable Not Hazardous     |
| 370 | MC9      | McCall        | McCall Portland Terminal          | MC         | 9         | Biodiesel            | 140658     | 473004   | Cone roof     | 1979       | 1604.5699 | 22.5998   | 141.99873 | 39.4072   | -122.7341 | 45.563637 | Category 3 | No        | Pre-1993 or | Material in Water    | Tank Failure    | Flammable Not Hazardous     |
| 383 | NU2113   | NuStar        | NuStar Portland Terminal          | NU         | 2113      | Biodiesel            | 698922     | 865857   | Internal floa | 1938       | 2293.6799 | 27.020399 | 169.7417  | 50.464195 | -122.7783 | 45.593108 | Category 3 | No        | Pre-1993 or | Material in Water    | Tank Failure    | Flammable Not Hazardous     |
| 467 | PH4254   | Phillips 66   | Phillips 66                       | PH         | 4254      | PS 300               | Not listed | 459312   | Welded Ste    | 1968       | 2444.3701 | 27.8939   | 175.26254 | 25.119499 | -122.7392 | 45.560289 | Category 1 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 468 | PH4255   | Phillips 66   | Phillips 66                       | PH         | 4255      | Biodiesel            | Not listed | 404250   | Welded Ste    | 1968       | 2445.21   | 27.898701 | 175.29271 | 22.100599 | -122.739  | 45.560238 | Category 3 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 487 | PH4332   | Phillips 66   | Phillips 66                       | PH         | 4332      | Super ATF            | Not listed | 17500    | Welded Ste    | 1973       | 114.719   | 6.04287   | 37.968472 | 20.392599 | -122.7406 | 45.560507 | Category 1 | No        | Pre-1993 or | On Land              | Tank Failure    | Flammable Not Hazardous     |
| 136 | CH43     | Chevron       | Chevron Willbridge                | CH         | 43        | Base Oil             | 770334     | 837085   | Fixed Roof    | 1993       | 2761.1101 | 29.646099 | 186.27193 | 40.528    | -122.7421 | 45.563801 | Category 1 | No        | 1993 - 2004 | On Land              | No Tank Failure | Flammable Not Hazardous     |