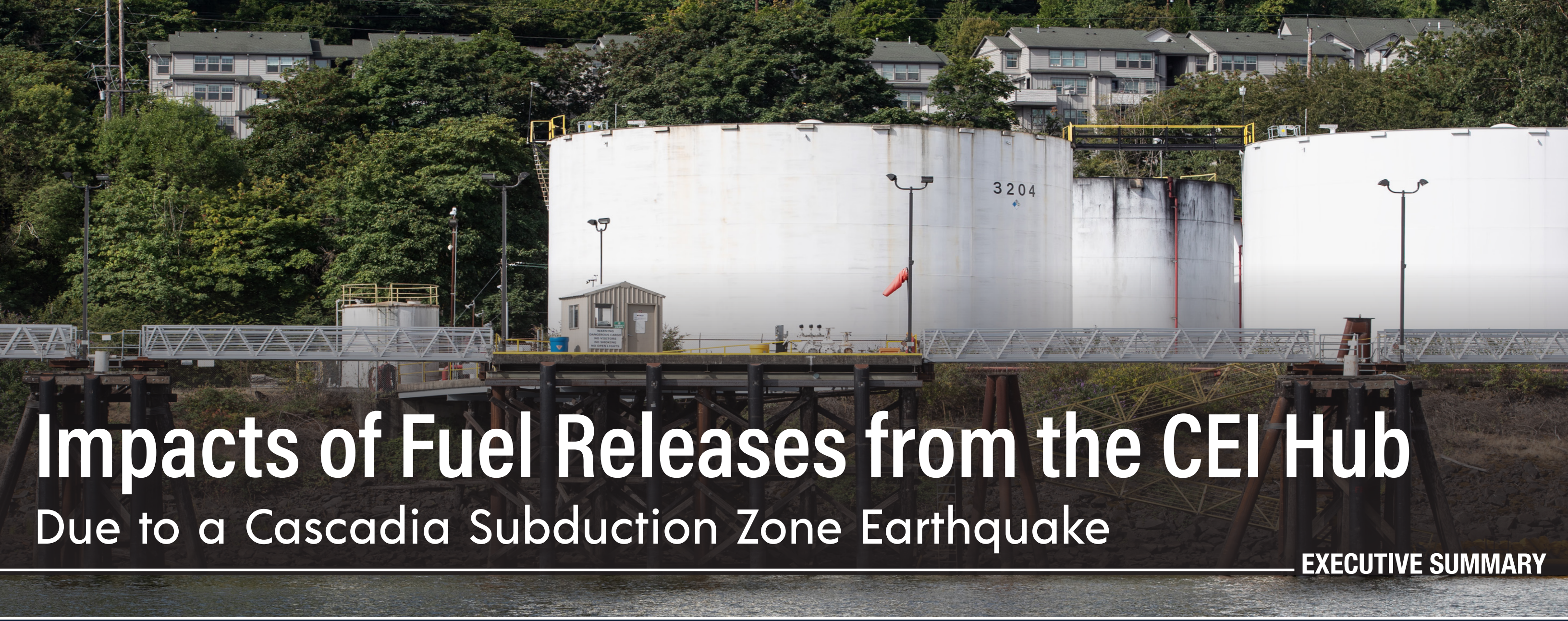


Impacts of Fuel Releases from the CEI Hub

Due to a Cascadia Subduction Zone Earthquake

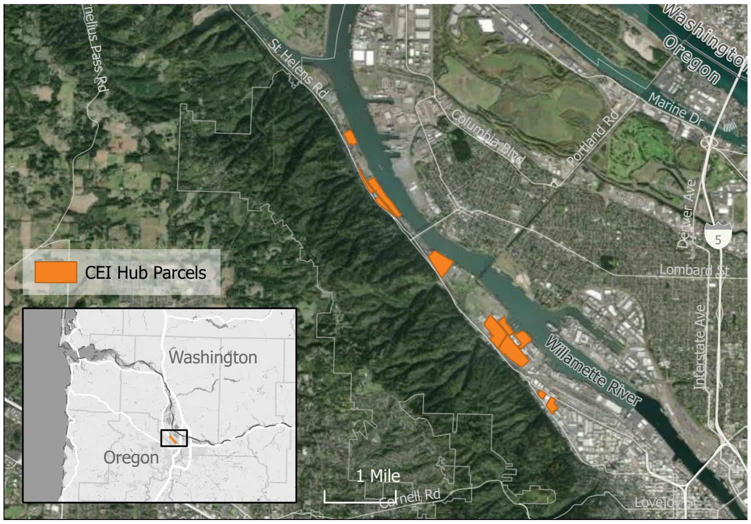
EXECUTIVE SUMMARY

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



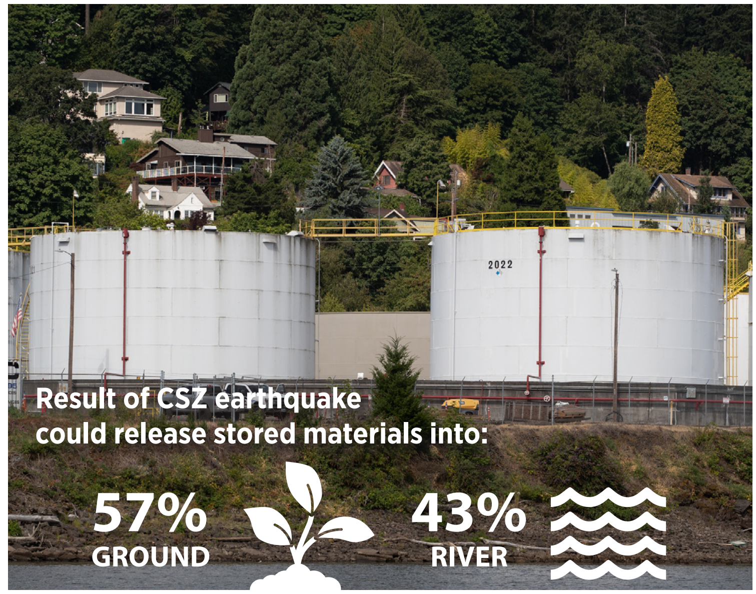
Source: Created by ECONorthwest.

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 build 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.[1] **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.



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

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 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
Total	**365**	**32**	**94,634,005**	**193,687,251**

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

[1] 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
Total Monetized Costs		**$359 million to $2.6 billion**

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
Multnomah County Office of Sustainability
PBEM

PREPARED BY
ECONorthwest
ECONOMICS • FINANCE • PLANNING

For over 40 years, ECONorthwest has helped clients make sound decisions based on rigorous economic, planning, and financial analysis. ECONorthwest works with public and private sector clients around the country answering questions through the lens of applied microeconomics. For more information about ECONorthwest, visit: www.econw.com.

SALUS RESILIENCE
Enduring Econometrics

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

January 2022

Prepared for:

Multnomah County Office of Sustainability

and City of Portland Bureau of Emergency Management

Prepared by:

ECONorthwest

ECONOMICS · FINANCE · PLANNING

SALUS RESILIENCE

Enduring Econometrics

Chapter 1: Table of Contents

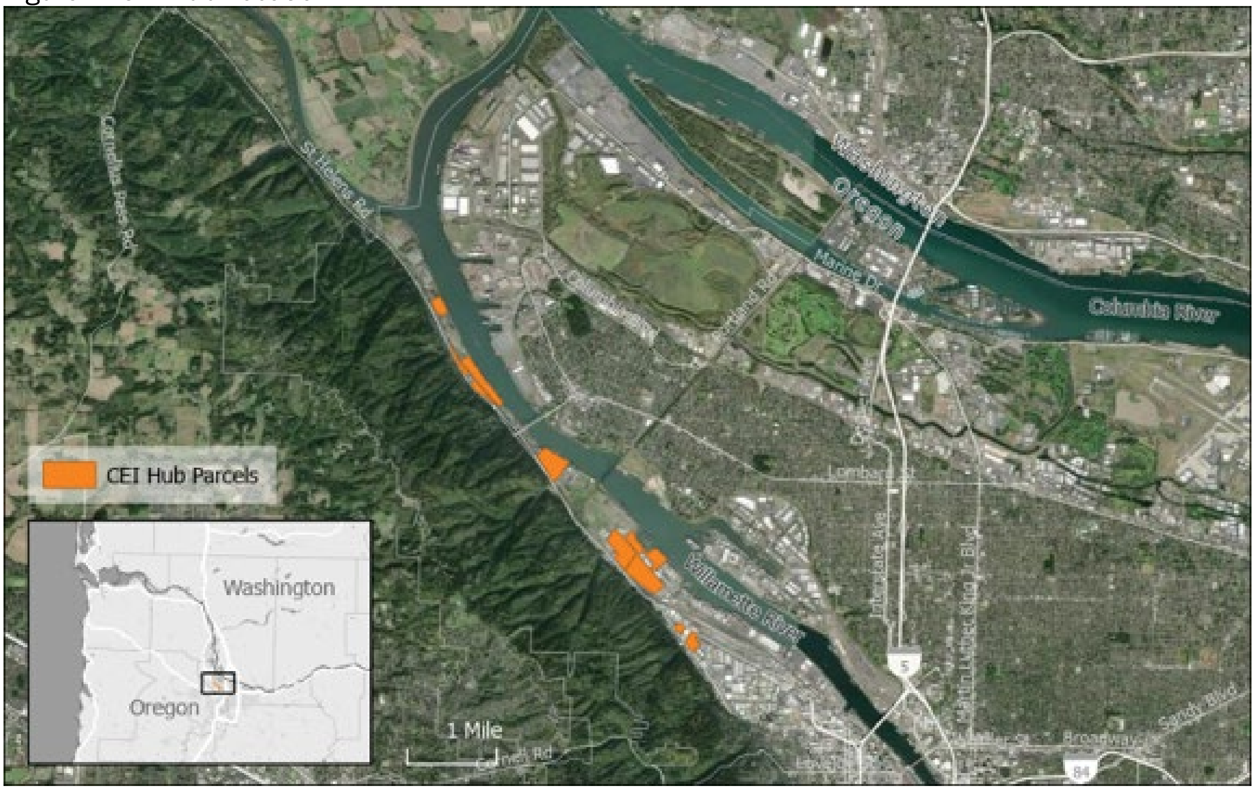
1-1 Introduction

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. [1] 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.

[1] 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.[2] 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

[2] 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.[3]

[3] 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

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.[4] 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.[5] 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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[4] Dusicka, P. and Norton, G. (2019). *Liquid Storage Tanks at the Critical Energy Infrastructure (CEI) Hub Seismic Assessment of Tank Inventory.* Mapleaf LLC and Portland State University. Prepared for Portland’s Bureau of Emergency Management. May.

[5] 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.[6] 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.[7] 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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[6] 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.

[7] 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. [8, 9]

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

[9] 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

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.[10, 11] 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.[12] 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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[10] 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.

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

[12] 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.[13] 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

	Damage Zone (distance from water in feet)		
Location	**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*.

[13] 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 at 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.[14] 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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[14] 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:[15]

- **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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[15] 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

- 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**.[16, 17] 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.[18] 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.

The 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%

[16] 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).

[17] 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.

[18] 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%
Total	**332,739,178**	**100%**	**415**	**100%**

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
Total	**233,460,422**

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).[19] Tank age drives the assumptions for which tanks will fail, as described in Section 3.1.

[19] 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
Total	**380**	**23**	**12**	**415**

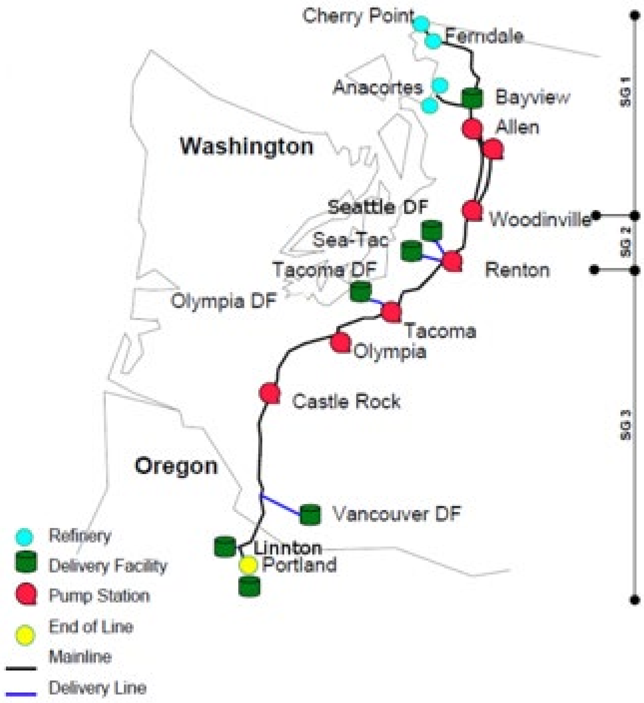
Source: Salus Resilience, Appendix B

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).[20] 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.

[20] 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

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

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.[21] 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.[22] 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

[21] 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

[22] 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
Total	**308**	**53,882,252**	**111,183,900**

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.[23] 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
Total	**107**	**40,751,753**	**82,503,352**

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.[24] 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

[23] A detailed table is provided in Appendix B.

[24] 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
Total	**365**	**32**	**94,634,005**	**193,687,251**

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 have 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
Total	**415**	**94,634,005**	**193,687,251**

Source: Created by Salus Resilience, Appendix B

1-4 Substance Information

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.[25] 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.[26]

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.[27] 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.[28]

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[25] 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

[26] 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

[27] 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

[28] 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).[29] 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.[30]

Table 9. Five Basic Groups of Oil

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

[29] Title 33, Chapter I, Subchapter O, Part 155, Subpart D. §155.1020.

[30] 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.[31] 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.[32]

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.[33]

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.[34] 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

[31] 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

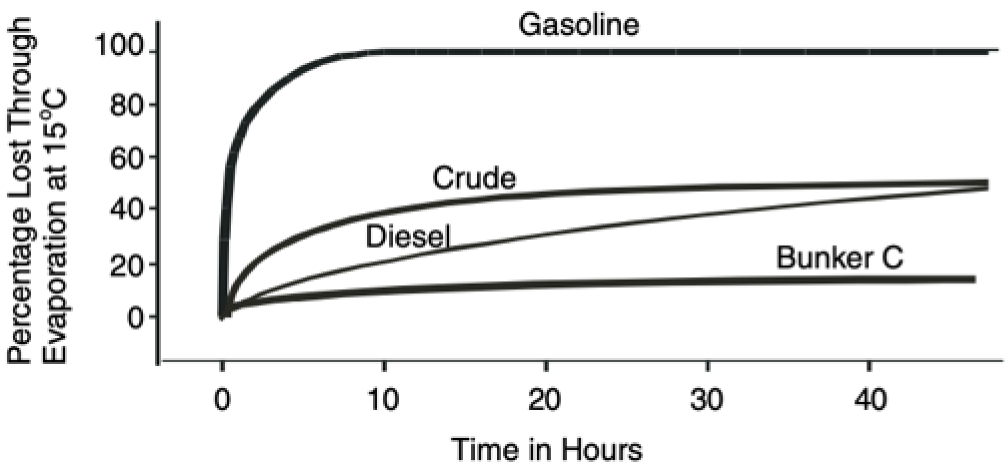
[32] NOAA, Office of Response and Restoration, *Non-Petroleum Oil Spills*. Available at: https://response.restoration.noaa.gov/sites/default/files/Non-Petroleum-Oil.pdf

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

[34] 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).[35]

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 (ADOIS) that uses location- and material-specific parameters to model the results of oil releases into water environments.[36] 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).

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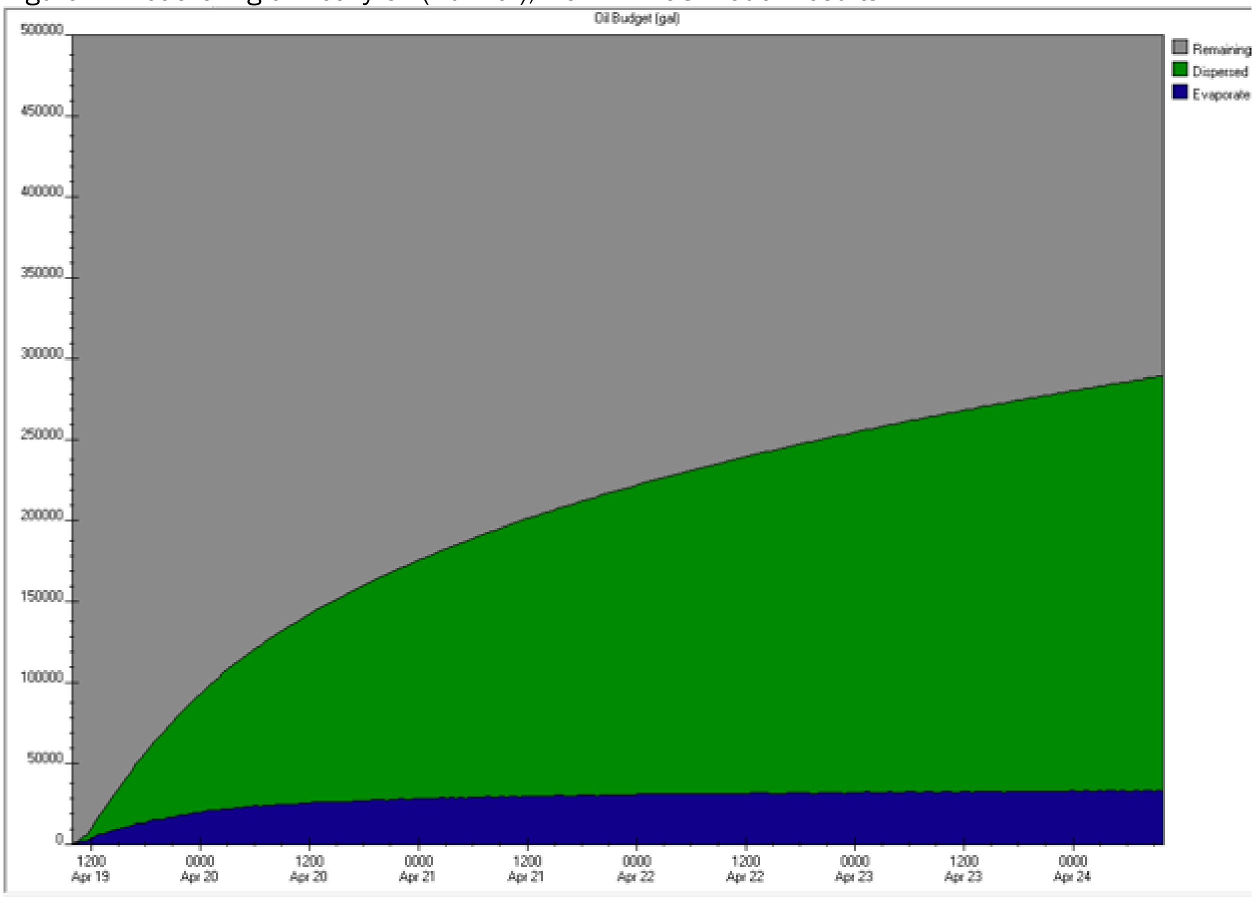
[35] National Research Council. (2003). *Oil in the Sea III: Inputs, Fates, and Effects*. Washington, DC: The National Academies Press.

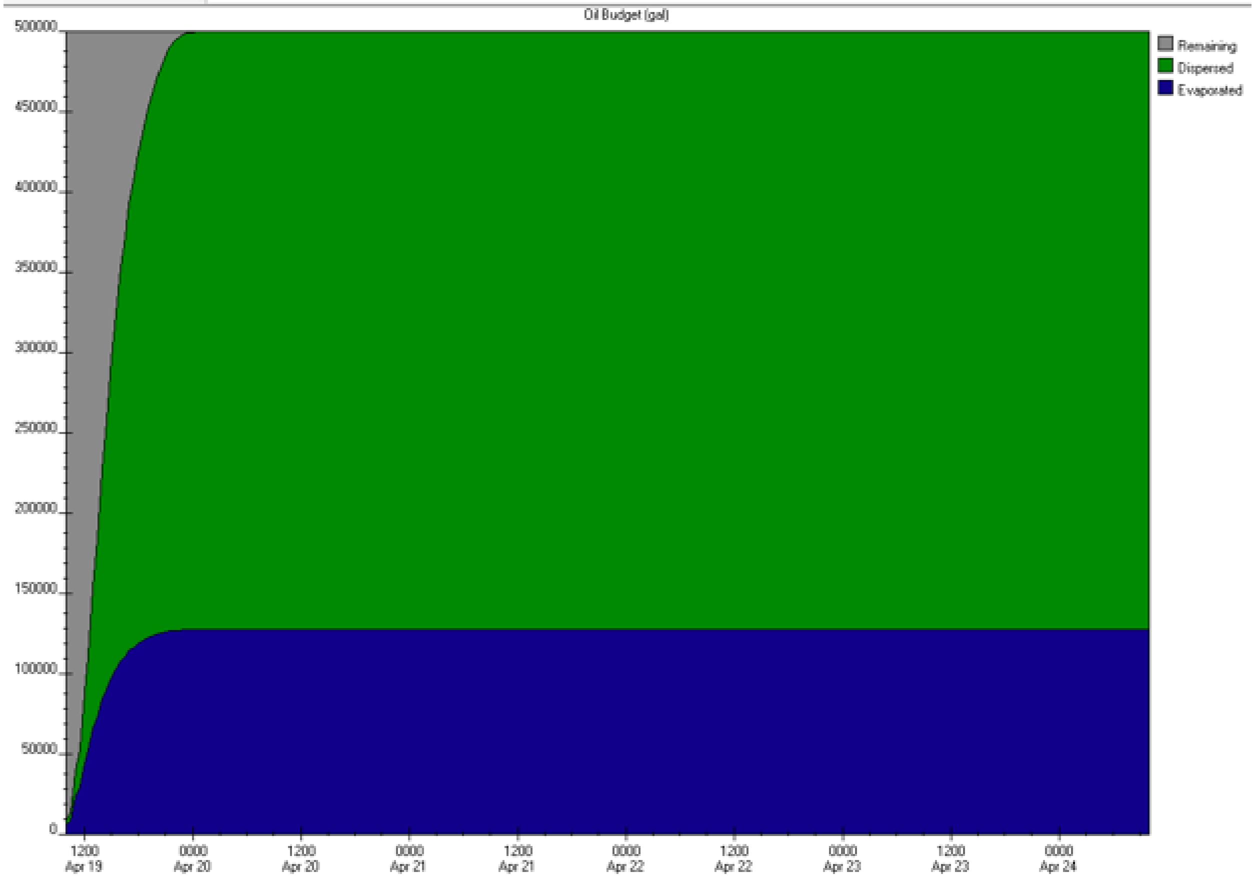
[36] More information about the ADIOS model can be found at: https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/adios.html

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:[37]

- **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

[37] 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.[38]
- **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.[39]

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[38] EPA Office of Emergency and Remedial Response. (1999). *Understanding Oil Spills and Oil Spill Responses*.

[39] 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

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.[40]

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

[40] 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.[41] 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.[42] 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.[43] As of October 22, 2019, the cleanup cost to date was $3.4 million.[44]

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.[45] 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.[46] Air quality monitoring began the day of the incident. In the immediate area of the derailment, there were detected levels of Benzene, Hexane, O_2, $PM_{2.5}$, and VOC.[47] More broadly, PM_{10}, O_2, $PM_{2.5}$, and VOCs were detected as far as 3 miles away.[48]

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[41] 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

[42] 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

[43] 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

[44] 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

[45] 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

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

[47] 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

[48] 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.[49] 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.[50] 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.[51] 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.[52] 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.[53] The oil reached

[49] 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

[50] U.S. Department of Energy Office of Scientific and Technical Information (1984). *Marine accident report - grounding of United States Tankship SS MOBILOIL, 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

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

[52] 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

[53] 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

other beaches as far south as Los Angeles County.[54] 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)[55] and El Capitán State Beach (2 months).[56] 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 (H2S).[57] 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.[58] Most of the discharged oil was on shorelines between Galveston and Matagorda Islands.[59] 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.[60] As of 2015, PAHs from the oil spill continue to pose environmental risks in the marine environment.[61] In 2016, Kirby Island Marine L.P. agreed to pay $4.9 million in Clean Water Act civil penalties due to the incident.[62]

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[54] NOAA. (2020). *Draft Restoration Plan to Support Recovery of Natural Resources Following Refugio Beach Oil Spill.* April 22.

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

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

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

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

[59] 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.

[60] 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

[61] 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.

[62] 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.[63] The initial explosion killed eleven men. The Deepwater Horizon oil spill killed thousands of marine mammals and sea turtles, and also contaminated their habitats.[64] 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.[65] 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 NOx 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.[66] In 2016, BP calculated their total cost for the oil spill, including both damages, fines, and economic loss, as $61.6 billion.[67]

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

[63] 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

[64] 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.

[65] 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.

[66] 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

[67] 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.[68] 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.[69] 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. [70] Response to the spill required 2,300 personnel, 130,000 feet of containment boom, 200 boats, and 35 skimmers.[71]

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[68] 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

[69] https://www.fws.gov/midwest/es/ec/nrda/MichiganEnbridge/pdf/FinalDARP_EA_EnbridgeOct2015.pdf

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

[71] 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.[72] 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.[73] 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 in-bound traffic one day later on November 30, 2000 and was opened to both up-river and down-river traffic on December 1, 2000.[74] 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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[72] 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

[73] 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.

[74] 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.[75] 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.[76] 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.[77] 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.[78] 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.[79] 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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[75] Alaska Department of Environmental Conservation. (2021). *Savoonga AVEC Tank Farm Diesel Oil Release*.

[76] 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/

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

[78] 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/

[79] 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.[80] 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.[81] 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.

[80] 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.

[81] 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
Fuel Releases in Oregon					
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
Fuel Releases into Shipping Channels and Water Resources					
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	Olmeca 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
Other Fuel Releases					
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[82] 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.[83] 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.[84]

[82] 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.

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

[84] 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

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.[85] 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

[85] 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. [86] 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)[87]**
> "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.[88] 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. [89] Chlorine gas and anhydrous ammonia are the most common TIH chemicals. Other TIH chemicals include sulfur dioxide,

[86] 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

[87] 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.

[88] Oregon Seismic Safety Policy Advisory Commission (OSSPAC). (2013). *The Oregon Resilience Plan: Chapter 5. Transportation*. February.

[89] 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.[90] On average there, are 0.8 full-year equivalent workers per acre,[91] 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.[92] 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.[93] There were 2,600 employees located on the 1,200 acre site at the time of the

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[90] See Appendix B for a fill list of properties and their characteristics.

[91] 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.

[92] IMPLAN 2019 Study Area Data for Combined Zip Codes 97231 and 97210.

[93] 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).[94] 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

		Estimate of People Affected in the CEI Hub Area (1,200 people on 1,500 acres)
BP Mortality Rate (Low)	0%	0
Exxon Mortality Rate (High)	0.6%	7
BP Injury Rate (Low)	0.2%	2
Exxon Injury Rate (High)	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.

[94] 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.[95] 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.[96]

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.[97] 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
Total	**1,011**

Source: Calculated by ECONorthwest using geospatial parcel data for each county
Note: Property counts include waterfront properties in the Multnomah Channel

[95] 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

[96] 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

[97] 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

1-6.3 Navigation and Commercial Activity Impacts

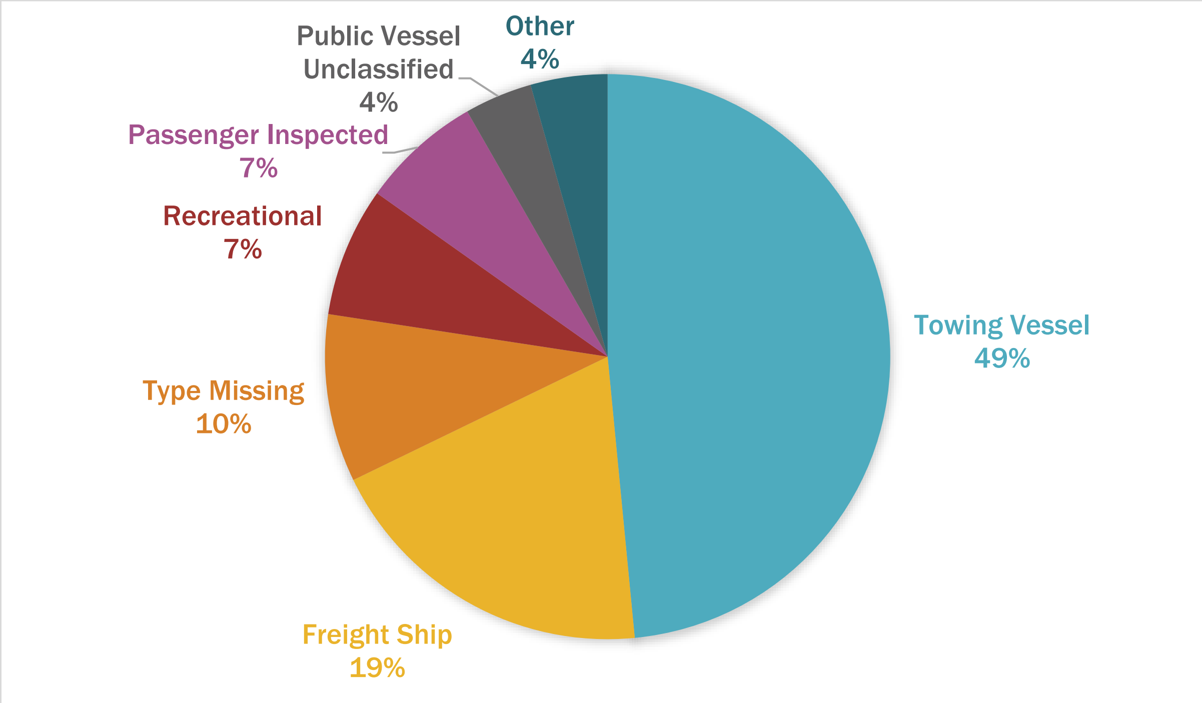
The navigation channel of the Willamette River is a critical shipping area for marine vessels that provides access to the CEI Hub as well as other nearby facilities, including Terminal 2, Terminal 4, the Swan Island Industrial Park, and other private businesses. To understand the extent of navigation 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.[98] 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.[99]

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 where 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).

[98] Automatic Identification System (AIS) data obtained from: https://marinecadastre.gov/data/

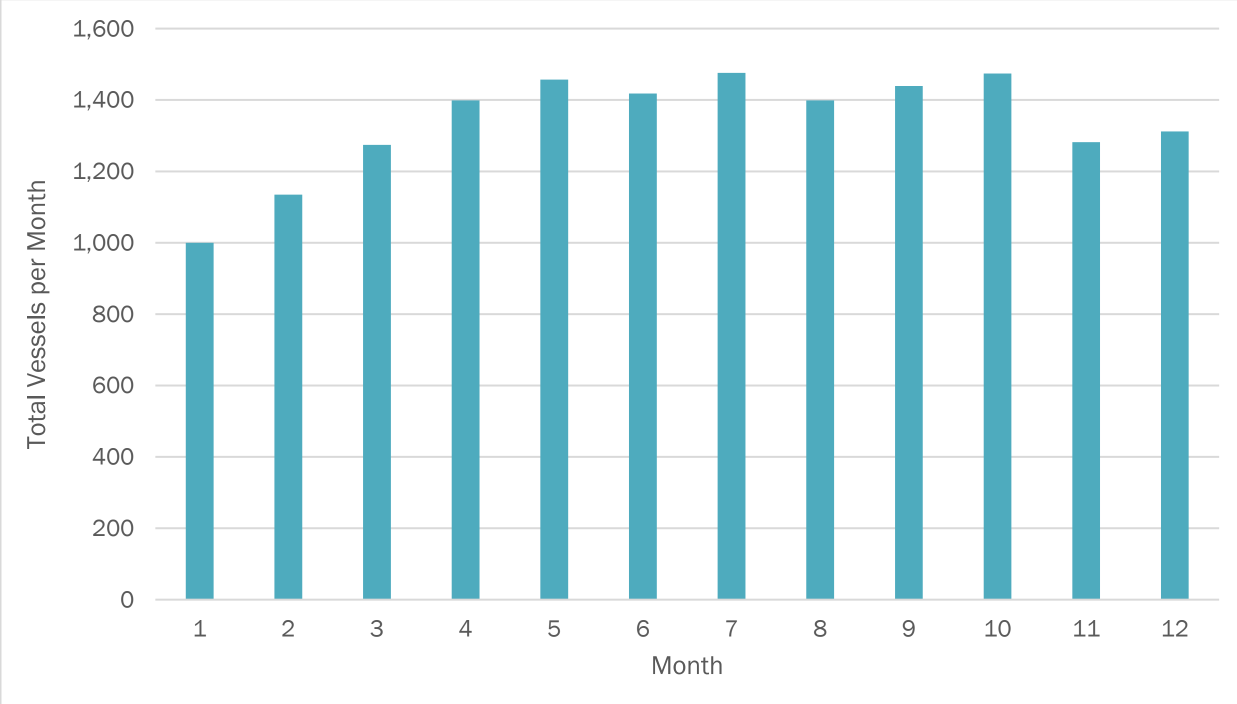
[99] More information on the classification of vessel types is available at: https://coast.noaa.gov/data/marinecadastre/ais/VesselTypeCodes2018.pdf

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/

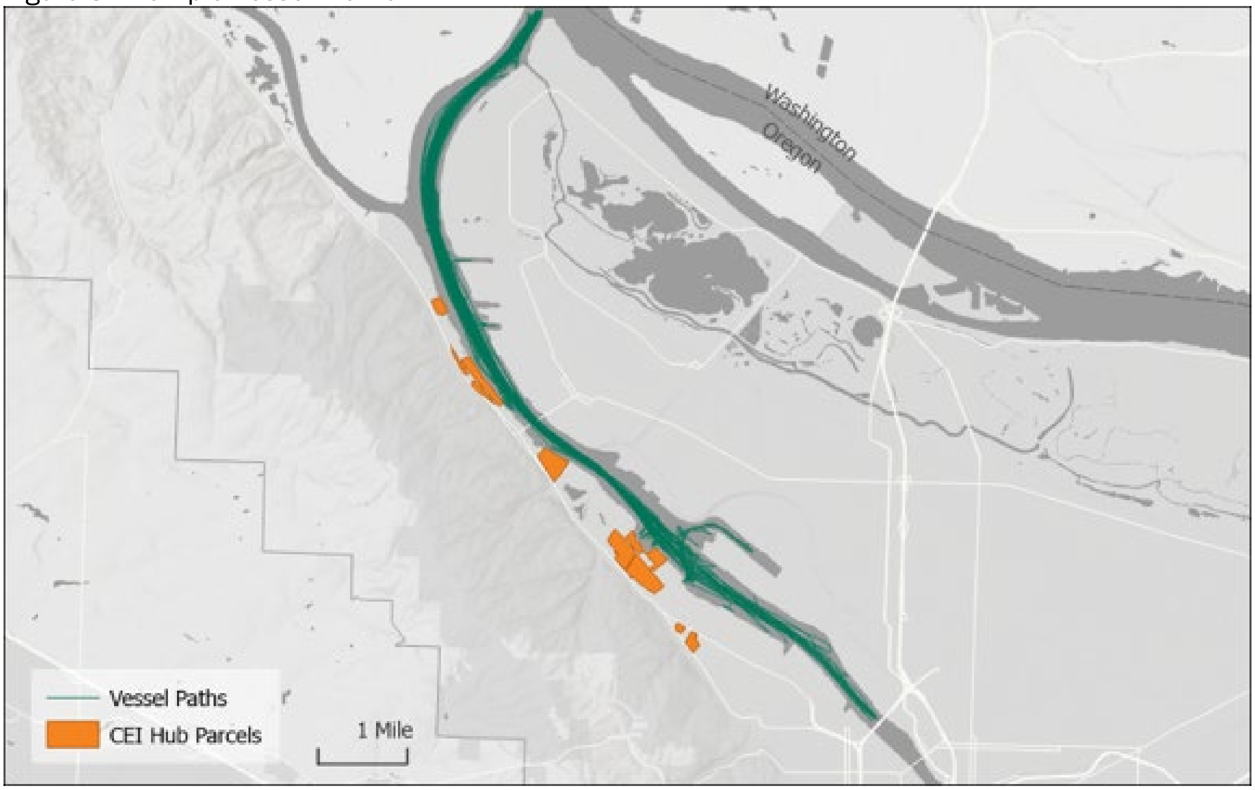
Figure 7. Total Vessel Traffic by Month, 2017, I-405 to Lewis and Clark Bridge



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.[100] 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.

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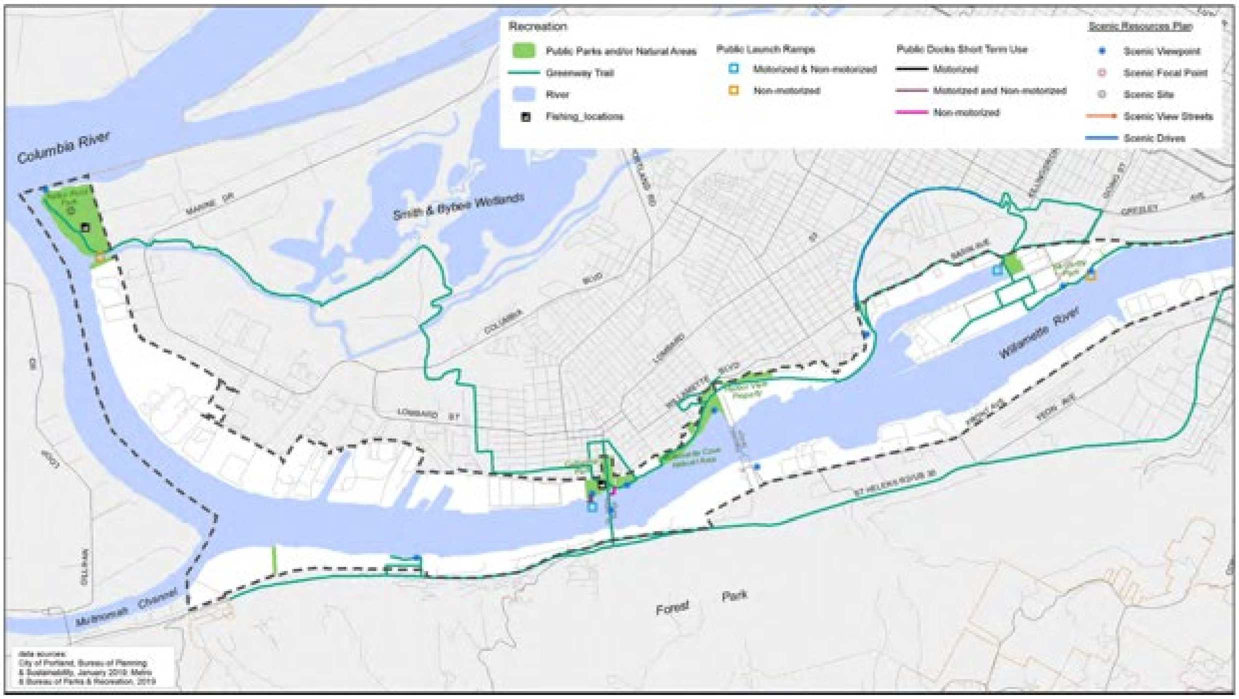
[100] For example, in the Texas City Y spill the shipping channel was open after 3 days.

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.[101]

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 dingeys from these locations.

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

	Columbia River		Willamette River	
Activity Type	**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%
Total	**382,949**	**100%**	**383,976**	**100%**

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).

[101] 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.[102] 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.

[102] 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),[103] as

[103] 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.[104] 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, NOx, sulfur dioxide (SO_2), and particulate matter ($PM_{2.5}$). 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.[105] 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.[106]

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.[107] 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[108].

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[109]. 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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[104] 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

[105] 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.

[106] 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.

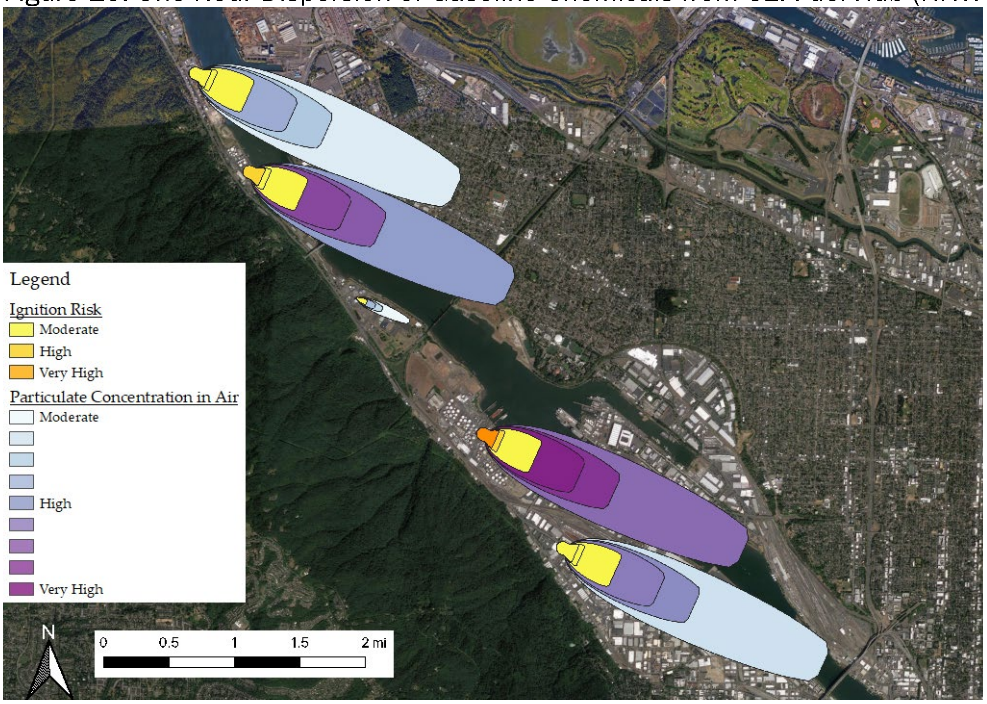
[107] U.S. Department of Health and Human Services. (1995). *Toxicological Profile for Gasoline*. Atlanta, GA: Agency for Toxic Substances and Disease Registry. https://www.atsdr.cdc.gov/toxprofiles/tp72.pdf.

[108] CFR 1910.1000: https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1000

[109] 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).

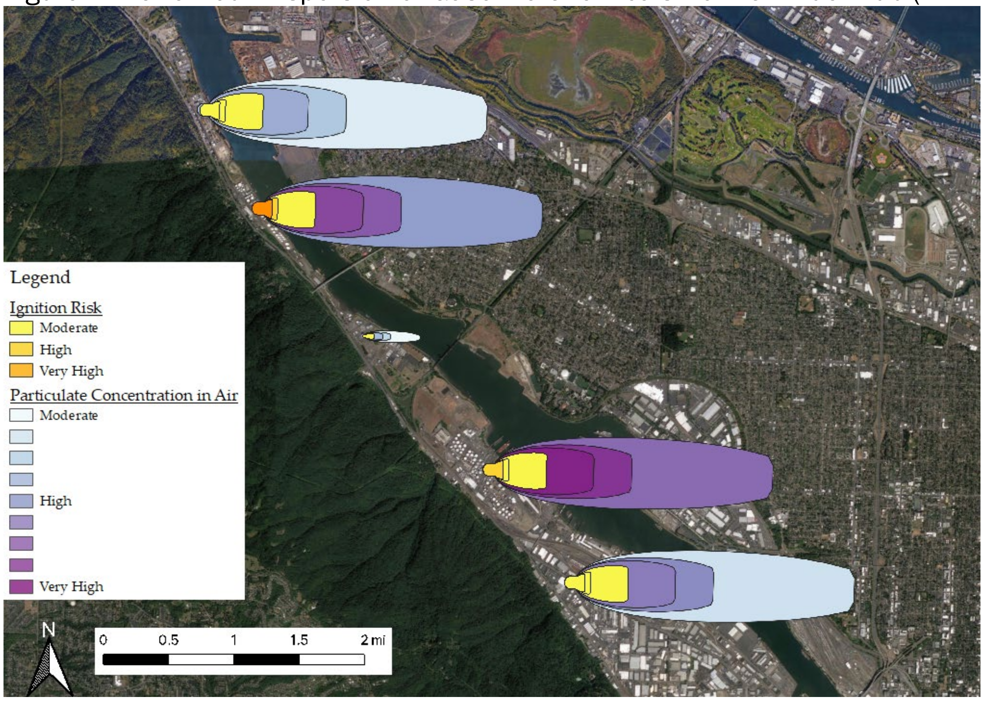
and spread of the spill, the concentration of hazardous gasoline vapor may extend beyond these regions. Figure 13 shows the levels of risk of mild to severe burns. The highest zone of risk from a burning gas fire represents a high probability of death within 60 seconds of exposure.

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



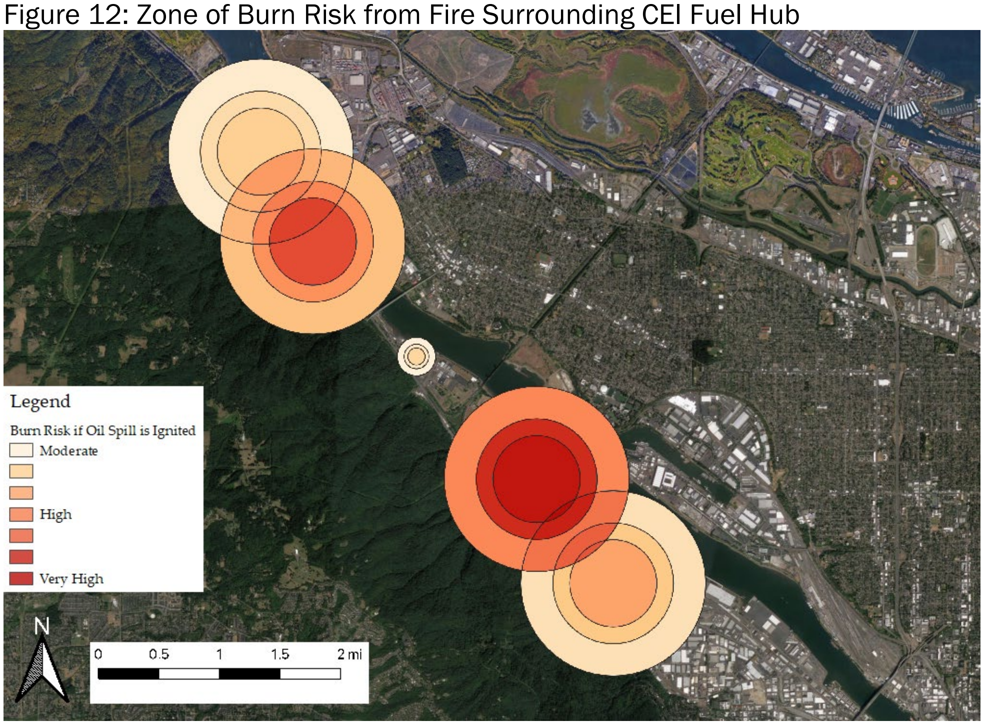
Source: NOAA and EPA ALOHA software, output created by ECONorthwest

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

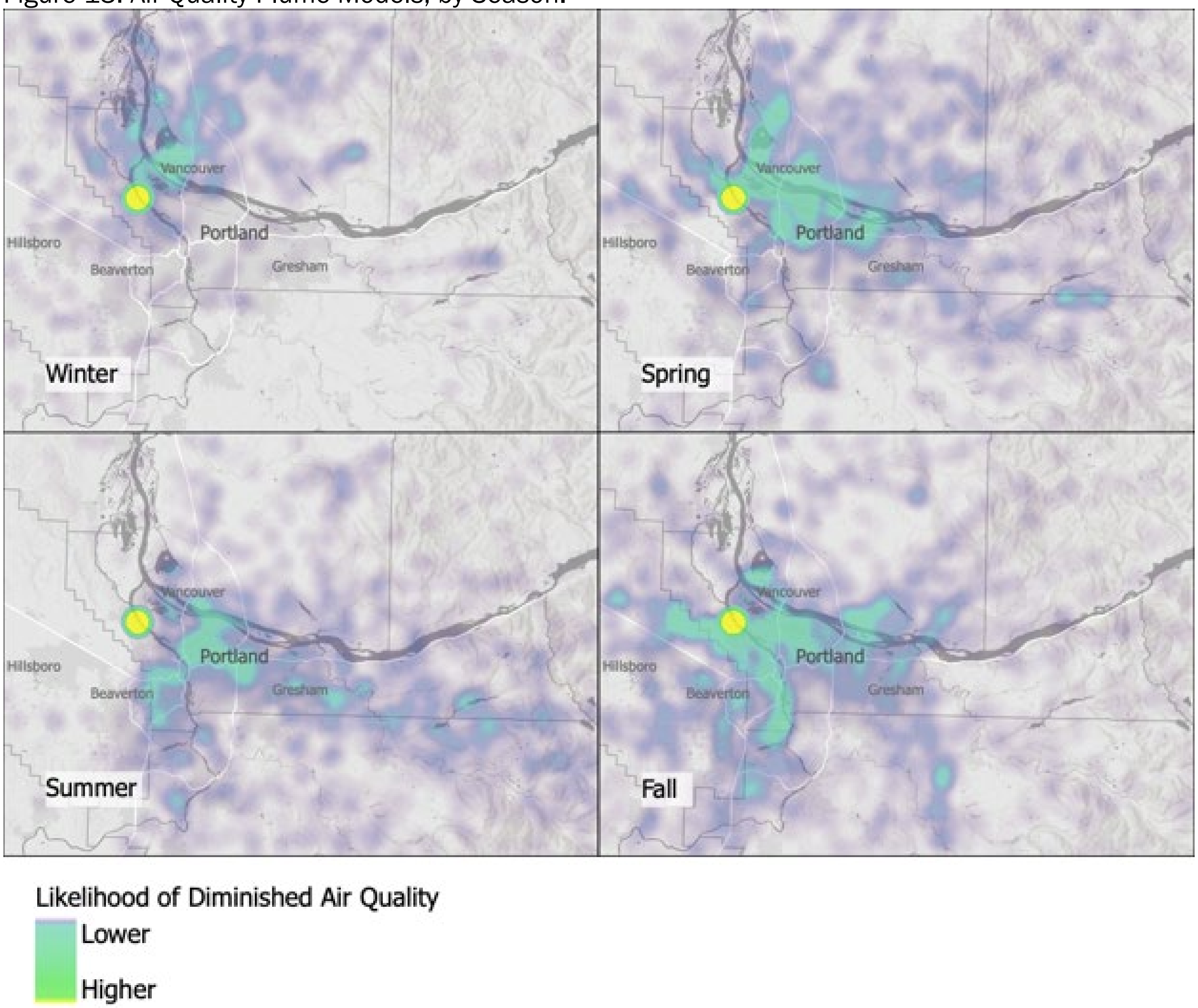
Figure 12: Zone of Burn Risk from Fire Surrounding CEI Fuel Hub



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.[110] 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

[110] 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.[111] These factors of toxicity and habitat impairment, as well as the physiological stress from oil spills, can also affect the reproductive success of species. [112] 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:[113]

- **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.[114] 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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[111] 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.

[112] 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

[113] U.S. Fish and Wildlife Department. (2010). *Effects of Oil on Wildlife and Habitat*.

[114] 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.[115] 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.[116] 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.[117, 118]

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.[119, 120] 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.[121] Because they are downstream of the CEI

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[115] The CEI Hub is mapped as "ESI20" for the Columbia River, available at: https://response.restoration.noaa.gov/esi_download#Oregon

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

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

[118] Counts include Chinook salmon (Adult and Jack), Coho salmon (Adult and Jack), Steelhead, Sockeye salmon, Pink salmon, Chum salmon, Lamprey, and Shad.

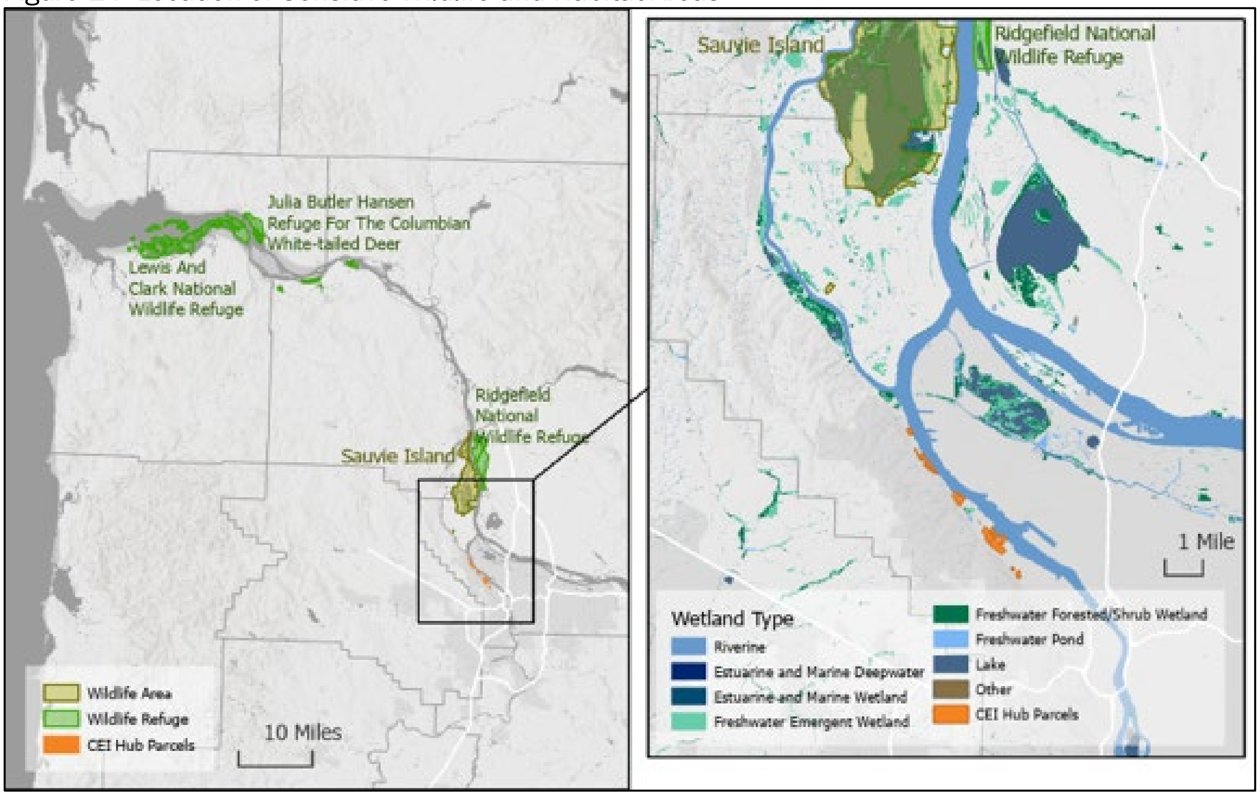
[119] Abt Associates Inc. and Bear Peak Economics. (2016). *Potential Fishing Impacts and Natural Resource Damages from Worst-Case Discharges of Oil on the Columbia River*. Submitted to: Matthew Kernutt, Assistant Attorney General Washington Attorney General's Office. May 12.

[120] 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/

[121] 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)

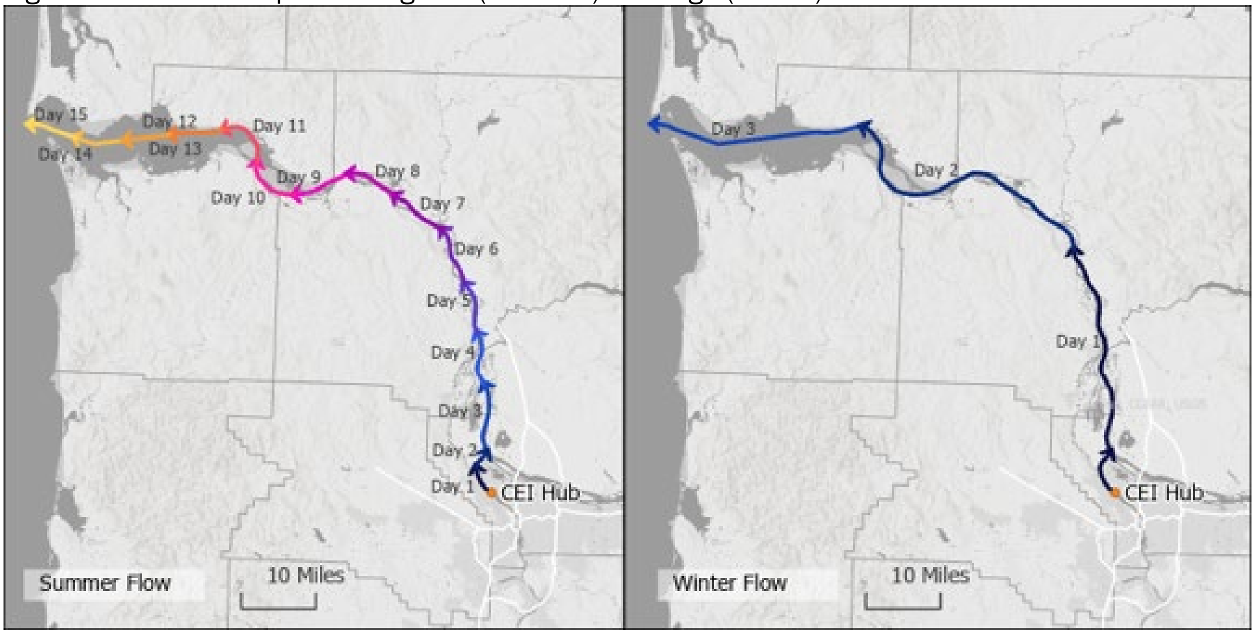
	Willamette River at Broadway Bridge, Portland, OR	Columbia River at Vancouver, Washington
Winter	1.58	2.45
Spring	0.48	1.20
Summer	0.24	0.47
Fall	0.56	1.09

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



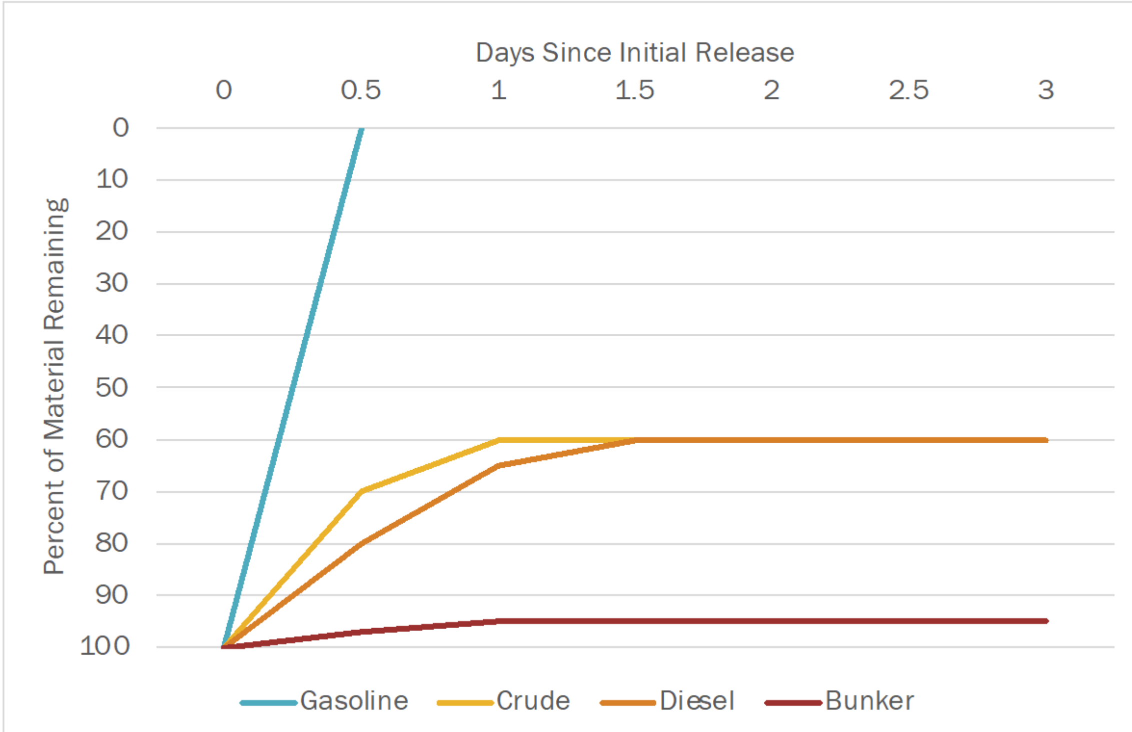
Source: Created by ECONorthwest using data from USGS

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.[122] Diesel and crude oil will evaporate in part, but up to 60 percent could be remaining when the materials reach the Pacific Ocean.[123] 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.

[122] 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.

[123] 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:[124]

> "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.[125]

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.[126]

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

[125] The legal precedent for compensation was established in "Confederated Tribes of the Umatilla Reservation v. Alexander" in 1977.

[126] 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,[127] 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.

[127] 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

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

January 2022

Prepared for:

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Enduring Econometrics

Chapter 2: Table of Contents

2-1 Introduction

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 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.[1] 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 difficult 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

[1] 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

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.[2] 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.[3] The values also do not include instances of suicide or mental health, which have been seen after other oil spills.[4,5] 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.[6,7]

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.[8]

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[2] Other potential harms to people from impacts to air quality and water quality are discussed in later sections.

[3] Health effects from air quality are discussed in Section 2-7 of this Chapter.

[4] 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

[5] Rung, A. L., Oral, E., Fontham, 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.

[6] U.S. Environmental Protection Agency. (2016). *Guidelines for Preparing Economic Analyses*.

[7] 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.

[8] 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
Total	**$49,800**	**$74,092,000**

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.[9] 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.[10,11,12] Persistent drops in home values after a spill cleanup may be attributable to changes in perceived risk of future spills.[13,14] 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.

[9] 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.

[10] 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.

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

[12] 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.

[13] 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.

[14] 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.[15] 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.[16]

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.[17] 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.[18] 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.[19] 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.[20]

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	**$11,793,000**
6%	$2,047,000	$10,511,000	$1,722,000	$1,936,000	**$16,216,000**
8%	$2,977,000	$15,288,000	$2,505,000	$2,816,000	**$23,587,000**
10%	$3,722,000	$19,110,000	$3,132,000	$3,520,000	**$29,483,000**
12%	$4,466,000	$22,932,000	$3,758,000	$4,224,000	**$35,380,000**

[15] 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.

[16] 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.

[17] 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.

[18] 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.

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

[20] 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 post 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.[21] 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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[21] 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

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.[22] 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)[23] 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.

[22] 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.

[23] 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

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.[24]

Coastal commercial fisheries in Oregon have an annual harvest value of $153.8 million (2017 dollars, excluding distant water fisheries).[25] Washington commercial fisheries generate approximately $65.1 million in sales (2006 dollars).[26] This economic activity supports personal income for employees and owners who patriciate 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.[27] Cowlitz County, which includes the Port of Longview on the Columbia River, had a commercial fishing value of $380,000 in 2006.[28] 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.[29] 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

[24] Impacts of fuel releases to recreational fishing is discussed in Section 2-6, impacts to tribal fisheries are discussed in Section 2-10.

[25] ECONorthwest. (2019). *Economic Contributions of Oregon's Commercial Marine Fisheries*. Prepared for Oregon Department of Fish and Wildlife. October.

[26] 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.

[27] ECONorthwest. (2019). *Economic Contributions of Oregon's Commercial Marine Fisheries*. Prepared for Oregon Department of Fish and Wildlife. October.

[28] 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.

[29] 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.[30] 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.

[30] 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
Average	**$80.13**

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.[31,32]

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.

[31] 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.

[32] 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

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.[33] 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.[34]

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.[35] 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.

[33] More information about the GuLFSTUDY is available at: https://gulfstudy.nih.gov/en/index.html

[34] 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.

[35] 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.[36] There are report of lump-sum values not being sufficient, difficultly navigating the process to submit medical claims, long timeframes to receive compensation, and difficultly 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.[37] 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.[38] 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.[39]

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).[40] Other mental health effects can include stress, suicide, domestic violence, and substance abuse.[41] There is also evidence of inequities in how mental

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[36] 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

[37] 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.

[38] 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.

[39] 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.

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

[41] 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.[42]

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.[43]

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.[44]

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 $PM_{2.5}$ 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

[42] 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.

[43] 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.

[44] 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
Total Avoided Morbidity Benefit			**$8,898,000**

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 $PM_{2.5}$ 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.[45] 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.[46] 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

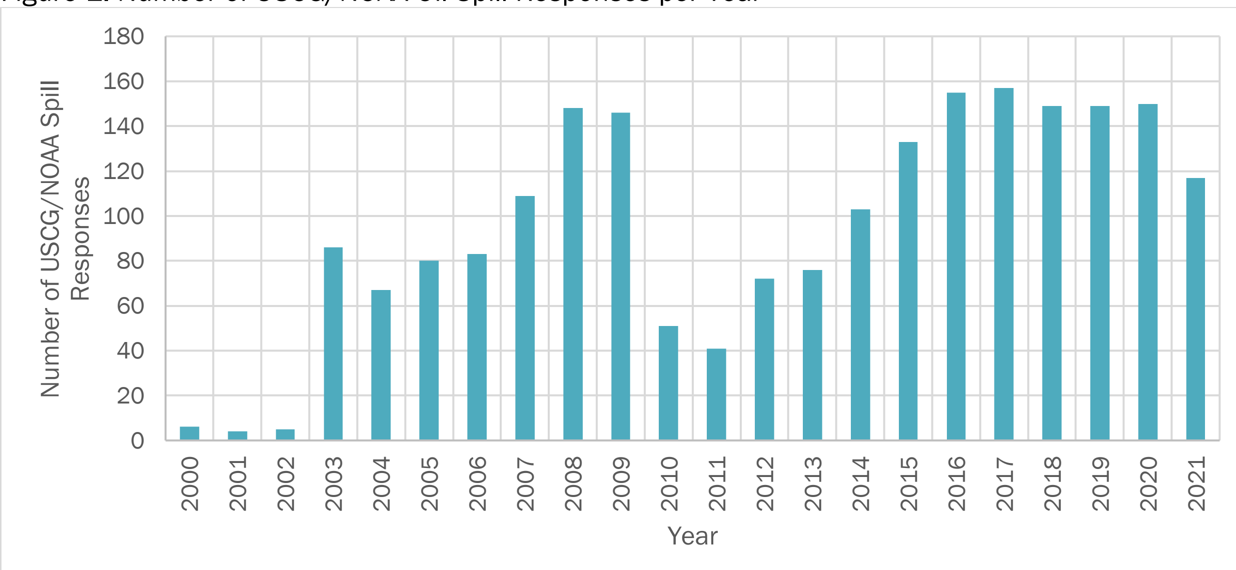
[45] Whitehead, J. C. (2003). One million dollars per mile? The opportunity costs of hurricane evacuation. *Ocean & coastal management*, 46(11-12), 1069-1083.

[46] 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).[47]

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 NRDAs 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

[47] 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."[48] 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.[49] 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.[50] This value, for a given habitat, is referred to as discounted service acre years ($DSAYs_h$) and is calculated as:

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

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

48 15 CFR Part 990.53(c)(2)

49 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).

50 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:

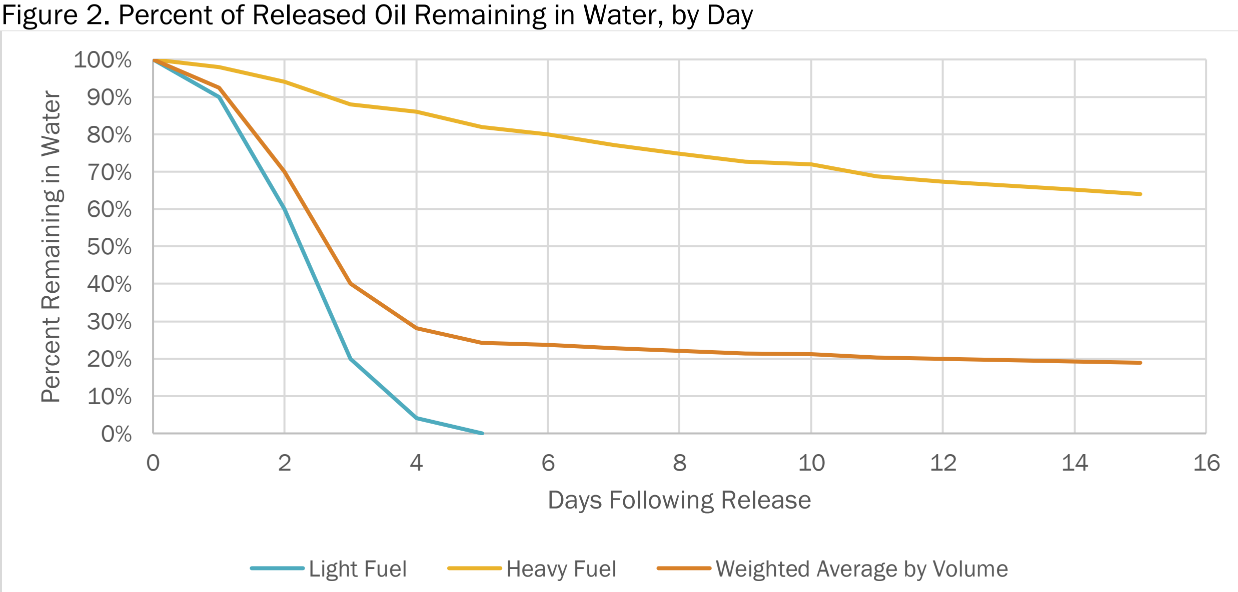
$$DSYs_a = \int_t^T e^{-rt} \cdot \left(Q_{a,0}(t) - Q_{a,1}(t)\right) dt$$

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.[51]

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

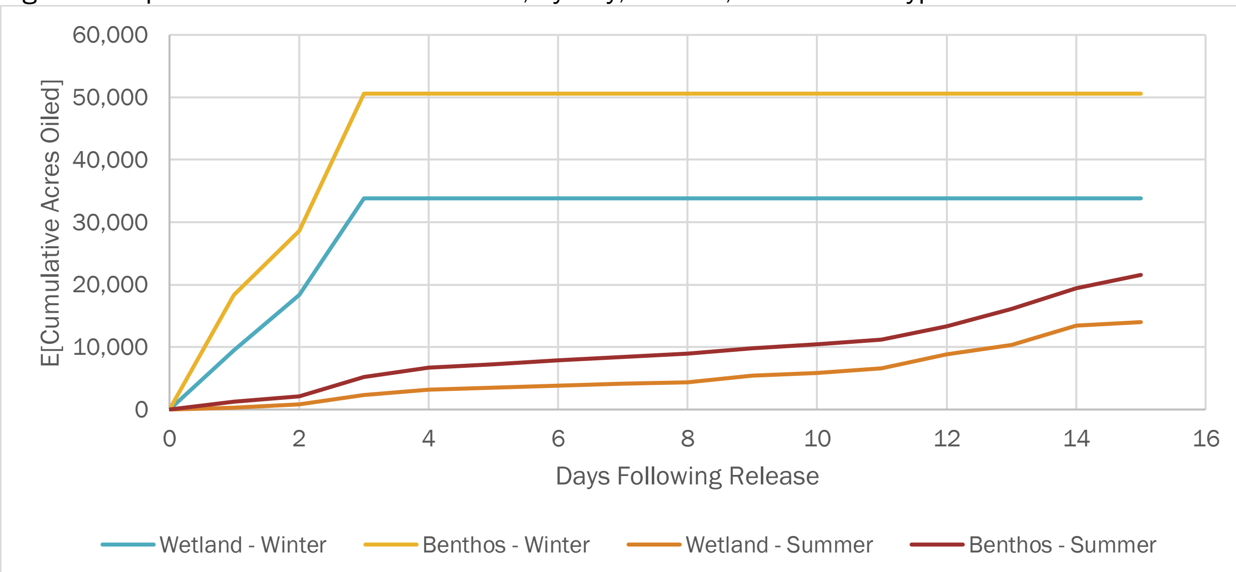
Source: Created by ECONorthwest using information from U.S. Fish and Wildlife Service, National Wetland Inventory mapper

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

[51] 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

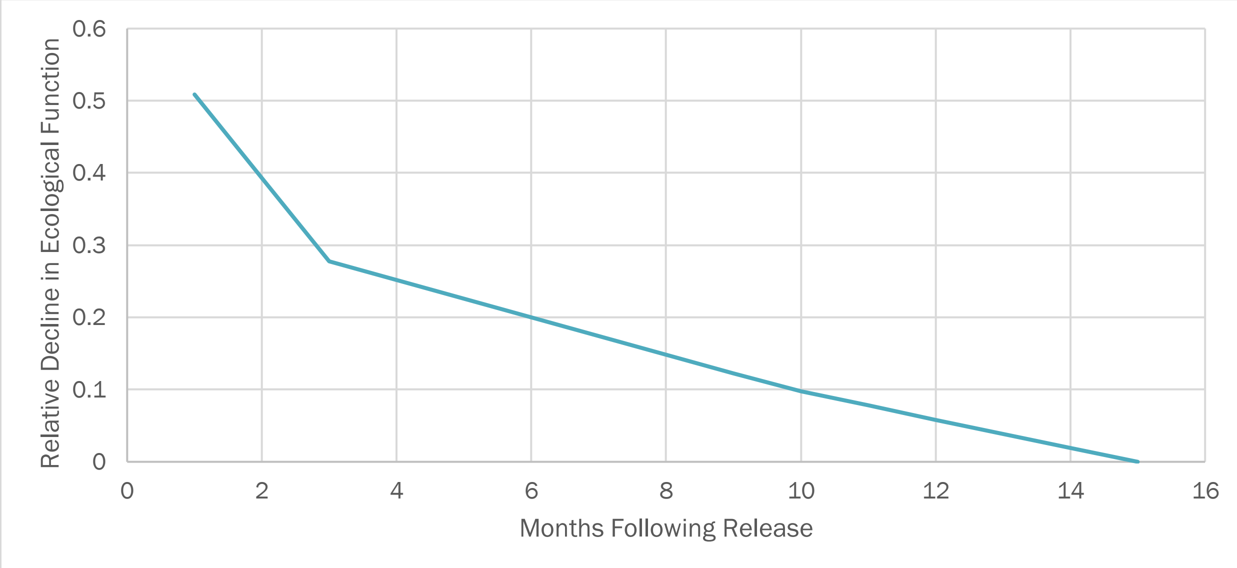


Source: Enduring Econometrics

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.[52] These effects can be exacerbated or mitigated by the initial baseline function of the habitat and other co-occurring anthropogenic stressors or cleanup activity.

[52] 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.[53] 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.[54] These

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[53] 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.*

[54] 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.[55] 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

[55] 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.[56] 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.[57, 58, 59]

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

[57] 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

[58] 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;

[59] 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%
Population Potentially Exposed															
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
Herons	-	-	-	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%
Population Potentially Exposed			
Ducks	595,700	42,550	155,100
Gulls	-	-	22,850
Cormorants	-	-	18,340
Herons	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.[60] 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	Herons	Bald Eagle
Direct Injury	826	645	261	17	2
Discounted Lost Productivity - Mortality	1,621	929	519	24	3
Discounted Lost Productivity - Reproductive Failure	788	199	76	5	-

Source: Enduring Econometrics

Table 15. Expected Bird Injury, Winter

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

Source: Enduring Econometrics

[60] 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).[61] 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.[62] 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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[61] 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.

[62] 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.[63]

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.[64] 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

[63] 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.

[64] 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

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.[65,66] 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).[67]

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

[65] 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.

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

[67] 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.[68] 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.[69]

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.[70] 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.[71,72] 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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68 NOAA ESI Maps and Data. https://www.fisheries.noaa.gov/inport/item/40258. Accessed 11/19/21.

69 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.

70 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.

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

72 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	
Total Restoration Costs				**$39,782,012**	**$304,313,798**

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).[73] 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
Total Habitat and Resource Damages	**$87,520,425**	**$669,490,356**

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

[73] 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.[74] 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.[75] 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.[76] In addition to volume, the length of the shoreline oiled also has a dramatic, non-linear effect on cleanup costs for the same reasons.[77]

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.[78]

Empirically analyses have evaluated past spills by volume and shoreline extent of oiling to determine a per-gallon cost of fuel spilled.[79] 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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[74] 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.
[75] 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.
[76] 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.
[77] 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.
[78] 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.
[79] 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

		Volume Estimate		Total Response Cost	
Source of Cost Estimate	**Cost per Gallon**	**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).[80] The Portland International Airport requires approximately 500,000 gallons of jet fuel per day and has limited storage on site.[81] 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.[82]

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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[80] 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).*

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

[82] 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.[83] 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.[84] 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.

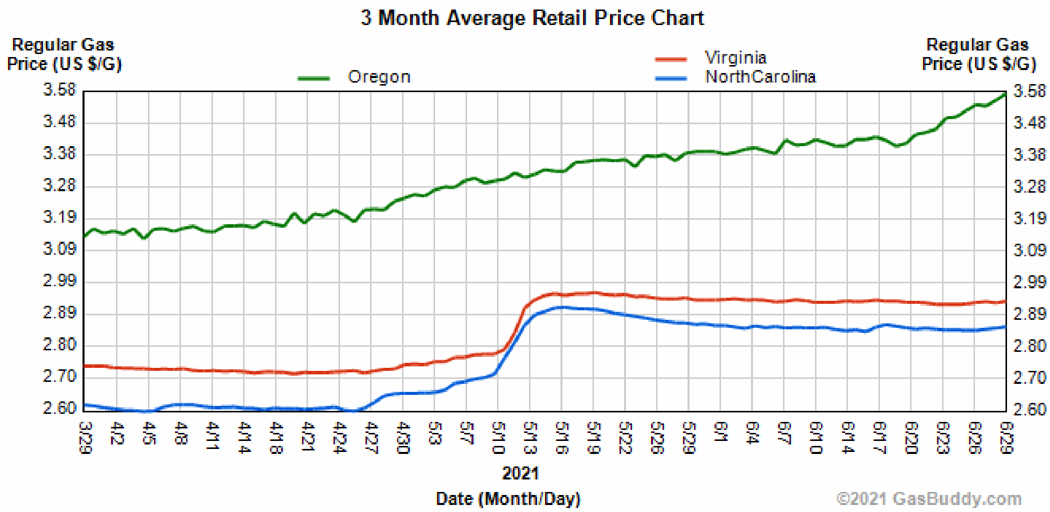
Many East Coast states experienced acute price jumps in gasoline in the week or and week following the Colonial Pipeline service outage. Figure 5 shows data from Gas Buddy, a fuel price tracking app that publishes daily price data at the state- and metro-level for retail gasoline. Prices in Virginia 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.[85] Oregon prices, which were unaffected by the shortage, are shown for reference.

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

[84] 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

[85] 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[86] (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

[86] 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[87].

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[88]. 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[89]. 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

[87] 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

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

[89] 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	*Two-Week Interruption*		*Three Month Interruption*	
		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
Total	$0.20	93,980,000	$18,796,000	604,159,000	$120,832,000

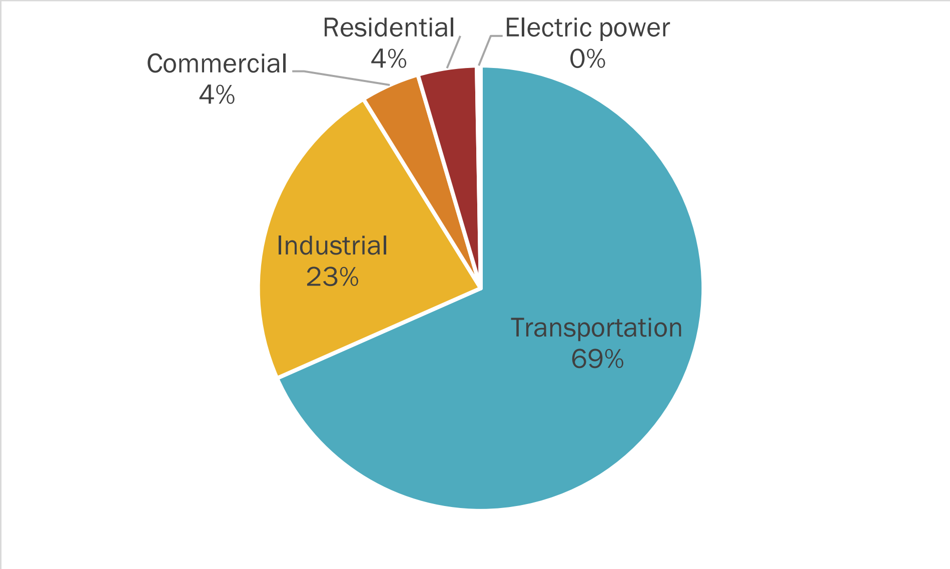
Source: ECONorthwest analysis of data from GasBuddy for states impacted by the Colonial Pipeline Shutoff and the 2021 Clean Fuels Forecast by the Oregon Office of Economic Analysis and Oregon Department of Environmental Quality, available at: https://www.oregon.gov/deq/ghgp/Documents/cfp-Forecast2021.pdf.

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[90]. 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[91]. 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.

[90] 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

[91] 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.[92] 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.

[92] 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.[93] 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

[93] 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
Total Monetized Costs		**$359 million to $2.6 billion**

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

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Chapter 3: Table of Contents

3-1 Introduction

Each of the categories of damages that result from a spill at the CEI Hub occur directly to individuals and businesses.[1] 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

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 are 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.[2] 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

[1] 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.

[2] 33 CRF 138.

or substantial threat of discharge into navigable waters or adjoining shoreline is called an "incident."[3]

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.[4] 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.[5]
- **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."[6]
- **Lost Profits and Earning Capacity** – "loss of profits or impairment of earning capacity" is claimable by anyone with loss of profits or income.[7]
- **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.[8]
- **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.[9]

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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[3] 33 CFR 138.20.

[4] 33 USC 2702(B2a).

[5] 33 USC 2702(B2b).

[6] 33 USC 2702(B2c).

[7] 33 USC 2702(B2e).

[8] 33 USC 2702(B2d).

[9] 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.[10, 11] 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.[12]

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.[13] As of 2020, the OSLTF carries a balance of approximately $7.3 billion.[14] The OSLTF makes up to $50 million available per year to Federal On-Scene Coordinators to respond to spills and initiate NRDAs.[15] The remaining balance of the OSLTF is available to any person or entity that incurs removal costs or damages due to a spill.

[10] 33 CFR 138.230.

[11] 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).

[12] 33 USC 2704(c).

[13] National Pollution Fund Center. About the OSLTF. https://www.uscg.mil/Mariners/National-Pollution-Funds-Center/about_npfc/osltf/. Accessed December 7, 2021.

[14] 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. Accessed December 7, 2021.

[15] 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. 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 exceed their liability limits and they are recoverable from the OSLTF.[16]

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”.[17] 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.[18] 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.[19] These penalties are generally deposited back into the OSLTF. There is no strict definition of when gross negligence occurs,[20] 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.[21] 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

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

[17] 33 USC 210(1)

[18] Henry, E.M., and Holden, R. (2021). Hurricane Ida and OPA’s Acts of God. *The National Law Review.* September 16.

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

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

[21] 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.[22]

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.[23]

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.[24] 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."[25] The Oregon State NRDA statue 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.[26] The net economic value of lost or affected species must consider the "commercial, recreational, nonuse and other values associated with the resource."[27]

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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[22] 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.

[23] Ibid.

[24] ORS 468B.060.

[25] OAR 635-410-0000.

[26] Ibid.

[27] 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

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.[28] 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.

[28] 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."[29] 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.[30] 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.[31] However, in 2016 (six years after the spill), federal and state natural resource trustees settled natural resource damage claims for $8.1 billion.[32] A substantial portion of that award has yet to be spent on restoration.[33] 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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[29] 15 CFR 990.30.

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

[31] 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.

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

[33] NOAA, *Gulf Spill Restoration*, available at: https://www.gulfspillrestoration.noaa.gov/.

extensive public comment period.[34] 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.[35]

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".[36] 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

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.

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

[35] *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.

[36] 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.[37]

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.[38] 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

[37] Clean-up costs are not subject to liability limits under OPA.

[38] 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. Accessed December 13, 2021.

million for a three-day period.[39] 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

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.[40] 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.[41]

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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[39] 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.

[40] Attorney fees of claimants can be awarded under OPA. Non-monetary transaction costs to file and monitor claims cannot be awarded.

[41] 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

All categories of damages outlined in this report – apart from personal injury/wrongful death – are potentially recoverable under OPA.[42] 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:[43]

- 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.[44] 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

[42] Personal injury/wrongful death claims would be submitted through the civil claims process, not OPA.

[43] 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.

[44] 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.[45] 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 actuarily 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.[46] 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.

[45] 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/

[46] See Section 3-2.2 for more information on ORS 468B.405.

3-7 Opportunities for Future Research

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

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APPENDIX A (PROVIDED ELECTRONICALLY ONLY FOR CONFIDENTIALITY)

1.0 INTRODUCTION AND PROJECT UNDERSTANDING

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

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

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

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

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

1.1 Geologic Setting of the CEI Hub

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

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

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

1.2 Seismic Setting of the CSZ

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

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

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

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

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

1.3 History of the Oregon CEI Hub

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

Table 1.1 - CEI Hub Areas

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

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

1.3.1 Area 1 - Kinder Morgan North

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

1.3.2 Area 2 - Linnton

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

1.3.2.1 BP West Coast

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

1.3.2.2 Shore Terminals/Nustar

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

1.3.3 Area 3 - NW Natural

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

1.3.4 Area 4 - Willbridge

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

1.3.4.1 Kinder Morgan South

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

1.3.4.2 Chevron

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

1.3.4.3 Conoco Phillips

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

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

1.3.4.4 McCall Oil

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

1.3.4.5 Zenith Energy

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

1.3.5 Area 5 - Equilon

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

2.0 DATA REVIEW

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

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

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

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

2.1 Tank Data Collection and Review

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

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

3.0 TANKS AND INFRASTRUCTURE OF THE CEI HUB

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

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

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

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

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

4.0 GEOLOGIC RISK OF THE CEI HUB IN A CSZ EARTHQUAKE

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

4.1 CSZ Earthquake Ground Motion Shaking Intensity

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

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

4.1.1 NGA-Subduction Ground Motion Models

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

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

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

4.1.2 Frankel et al. (2019) Simulations

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

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

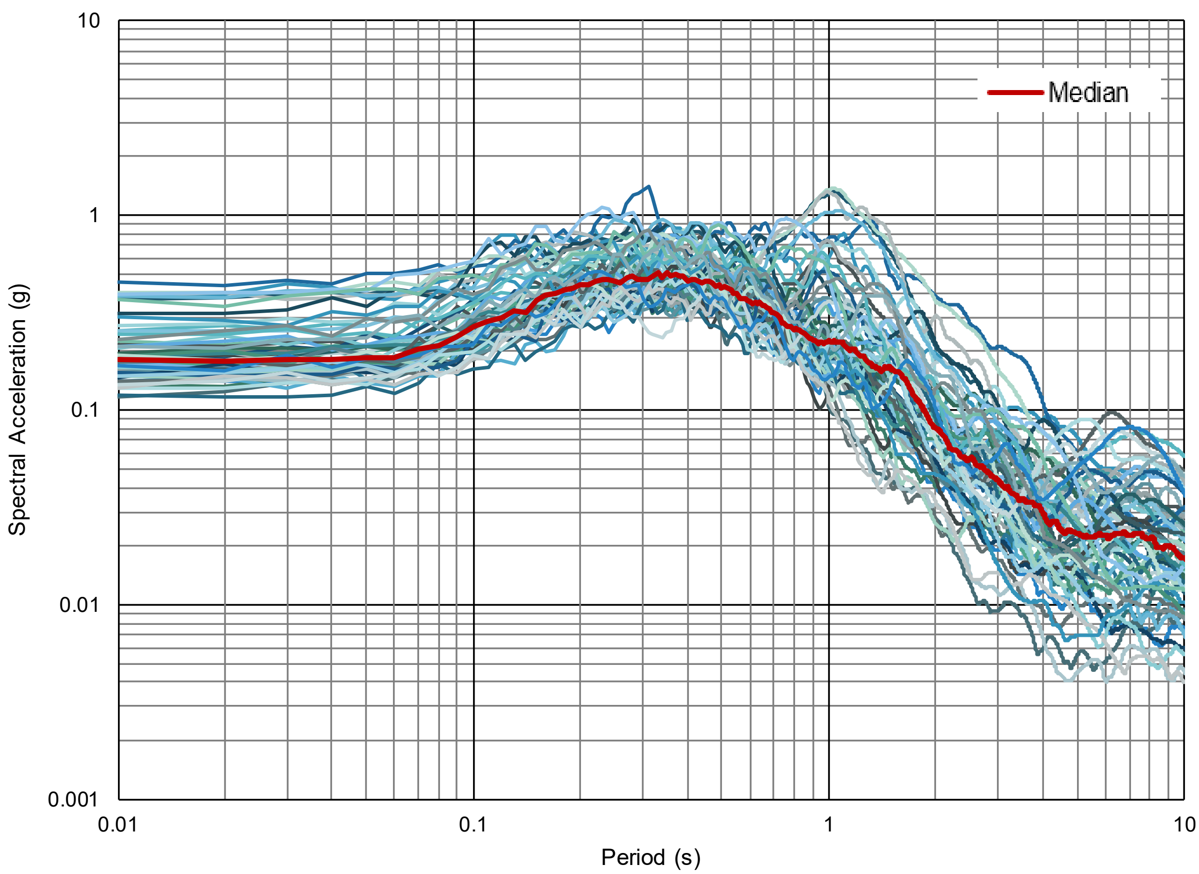

Figure 4.1 CSZ Ground Motion Components (Frankel et al. 2019)

4.1.3 Ground Motion Intensity Comparison

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

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

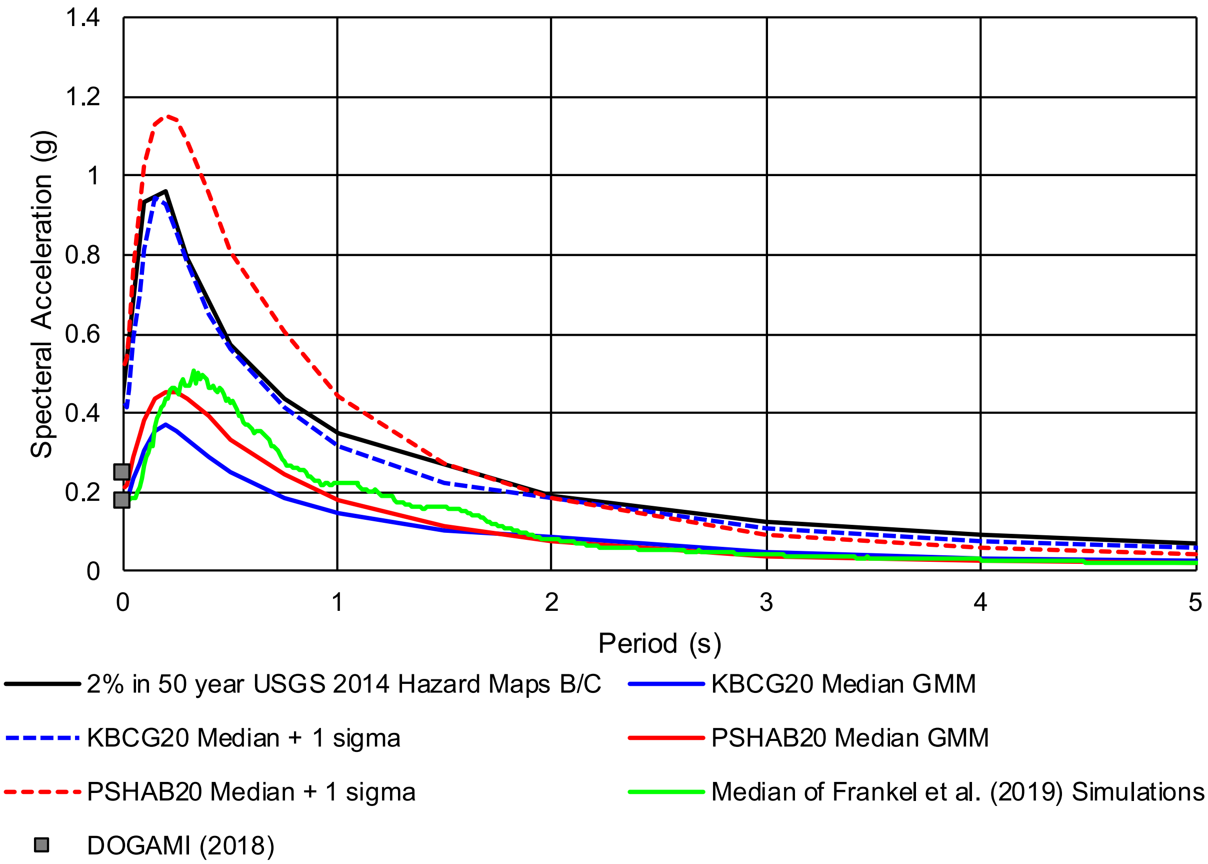

Figure 4.2 CSZ Spectral Response

Table 4.1 - KBCG20 and PSHAB20 Earthquake Parameters

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

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

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

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

4.2 Representative Soil Information and Liquefaction Analysis

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

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

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

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

4.2.1 Area 1 - Kinder Morgan North

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

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

Table 4.2 - Kinder Morgan North Area Soil Stratigraphy

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

4.2.2 Area 2 - Linnton

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

4.2.2.1 North Area 2 - Linnton

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

Table 4.3 - Linnton Northern Area Soil Stratigraphy

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

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

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

4.2.2.2 South Area 2 - Linnton

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

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

Table 4.4 - Linnton Southern Area Soil Stratigraphy

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

4.2.3 Area 3 - NW Natural

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

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

Table 4.5 - NW Natural Northern Area Soil Stratigraphy

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

4.2.4 Area 4 - Willbridge

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

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

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

Table 4.6 - Willbridge Area Soil Stratigraphy

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

4.2.5 Area 5 - Equilon

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

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

Table 4.7 - Equilon Area Soil Stratigraphy

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

4.3 Surface Settlement Due to Liquefaction of Coarse-Grained Soil

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

Table 4.8 - Estimated Surface Settlement due to Liquefaction

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

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

Table 4.9 - Reported Surface Settlement in Reviewed Historical Reports

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

4.4 Lateral Spread Potential

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

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

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

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

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

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

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

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

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

Table 4.11 - Reported Surface Settlement in Reviewed Historical Reports

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

5.0 TECHNICAL REFERENCES

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

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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 City of Portland	CEI Hub analysis	Updated December 4, 2020	Web Map	Web map of the CEI Hub based of data gathered during the 2019 PSU study.
17	Dames & Moore	Final Report, Extended Soils Investigation and Oil Seepage Control Scheme, Portland Terminal, Portland, Oregon	January 13, 1981	Report	Subsurface information related to the design and construction of a cement-bentonite cutoff wall.
18	Dames & Moore	Foundation Investigation, Proposed Whirly Crane, 3450 N.W. Front Street, Portland, Oregon	August 1972	Report Excerpt	Only Plate 1 and Boring 2

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

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

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

Table 3.1 - CEI Hub Tank Inventory
Portland, Oregon

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

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

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

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

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

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

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

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

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

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

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

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

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

Notes:

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

NA - Data not available

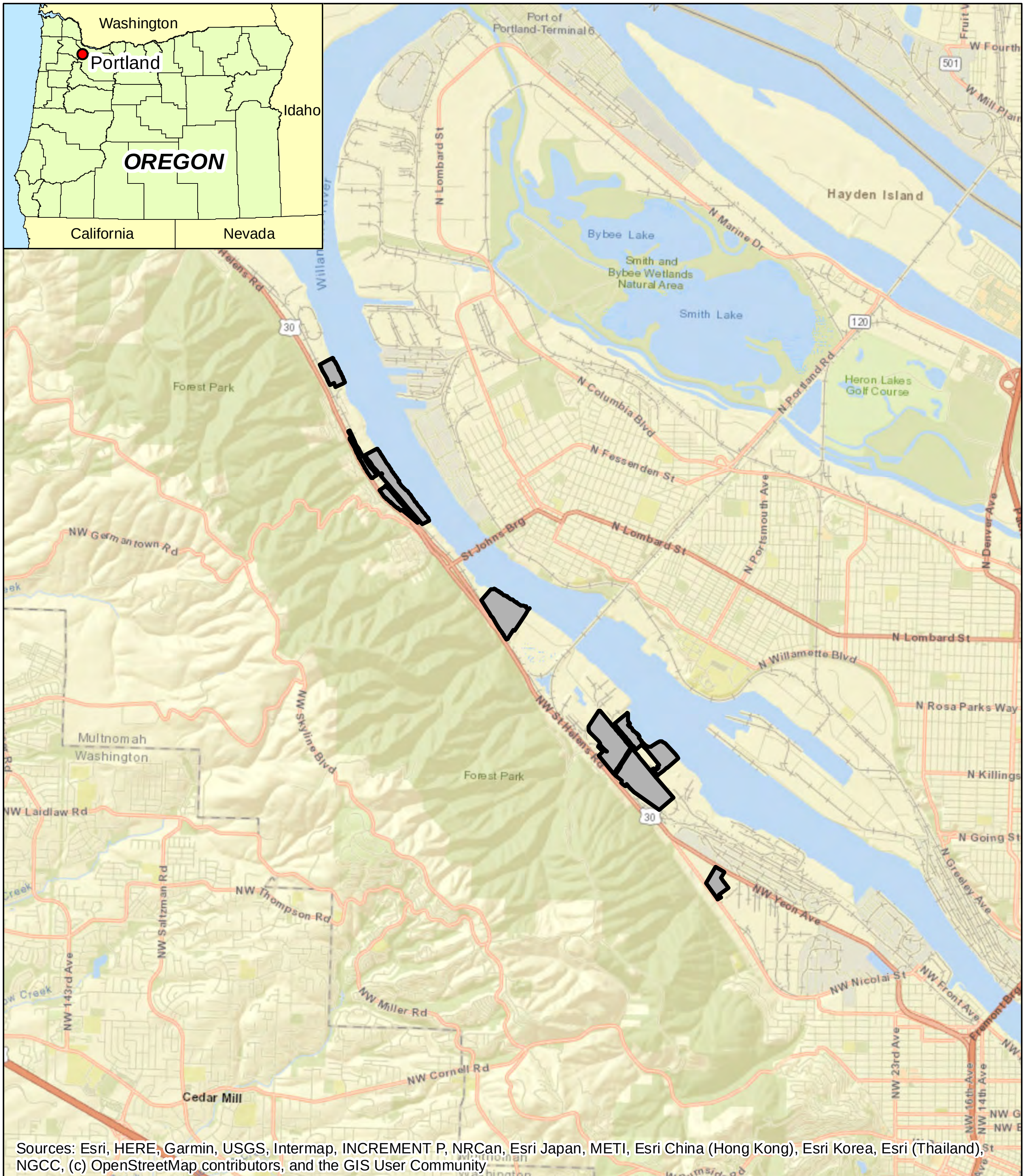
Table 3.2 - CEI Hub Supporting Infrastructure
Portland, Oregon

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

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

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

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



Legend

Project Areas

0 0.5 1 2 Miles

N

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

CEI Hub Location Map

154-035-019 04/21

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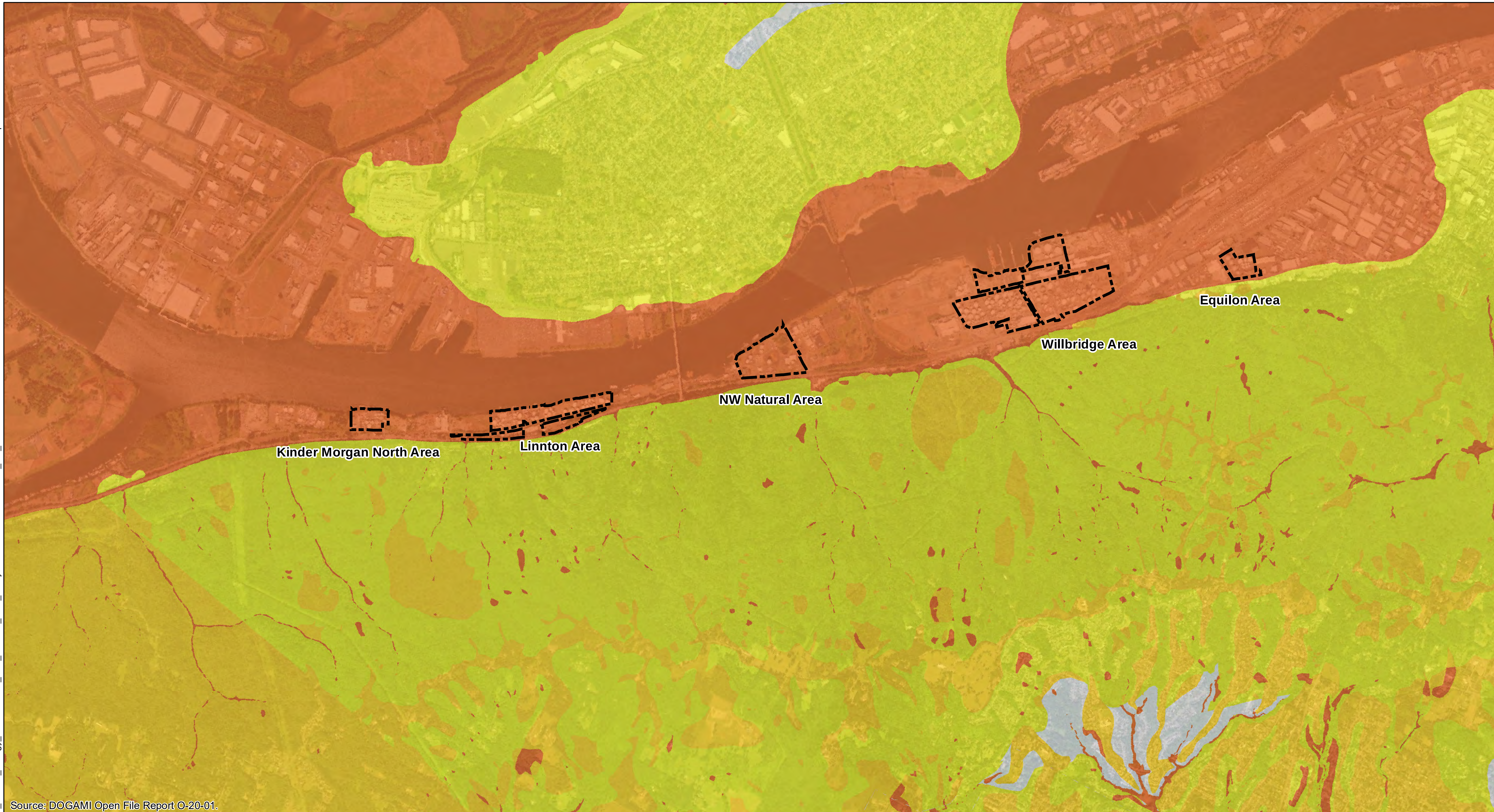
Figure
1.1



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Legend

Potential Permanent Ground Deformation

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

Project Areas

N

0 0.25 0.5 1 Miles

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

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

154-035-019 04/21

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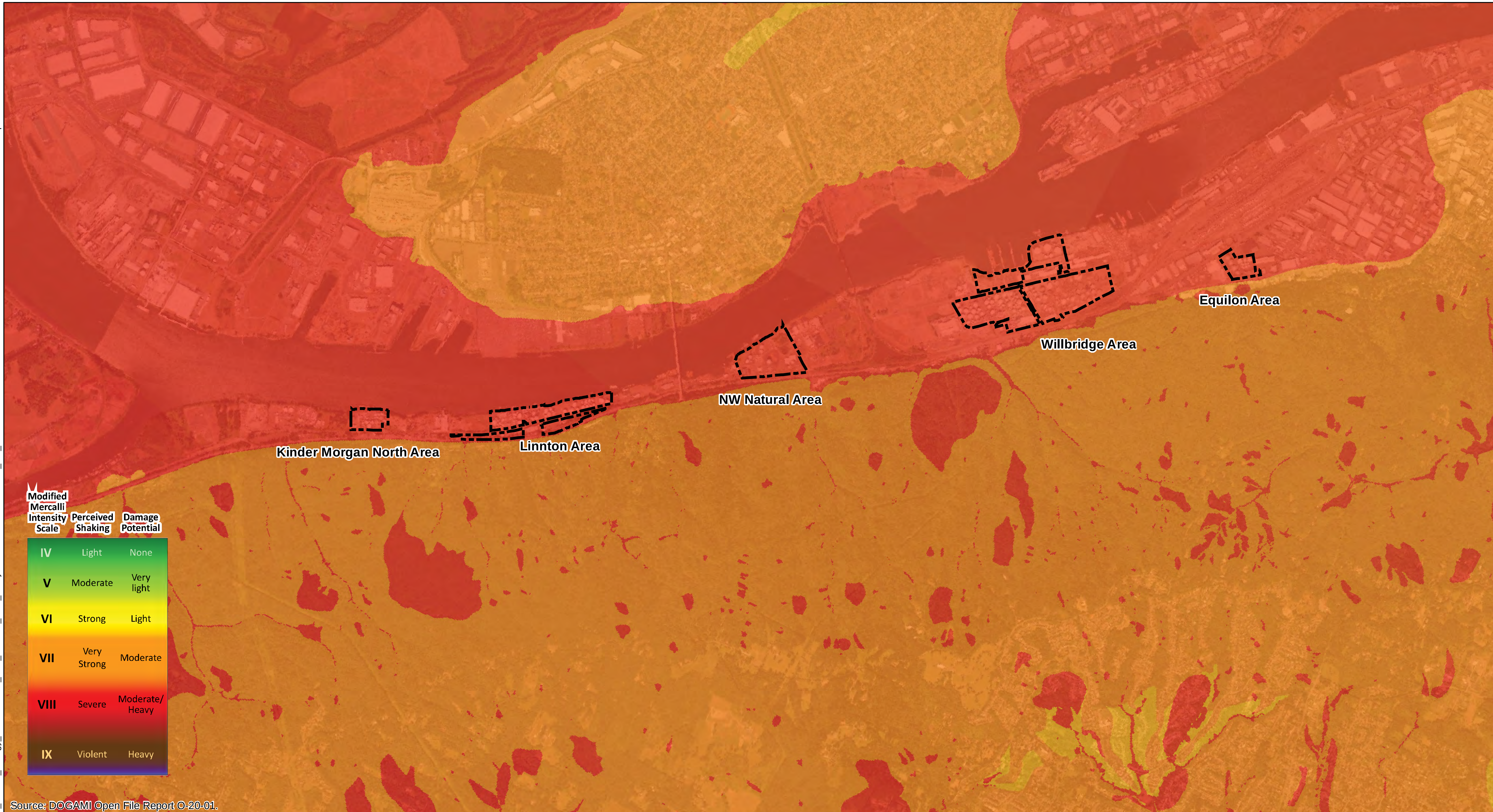
Figure
1.4



Legend

Project Areas

0 0.25 0.5 1 Miles

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

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

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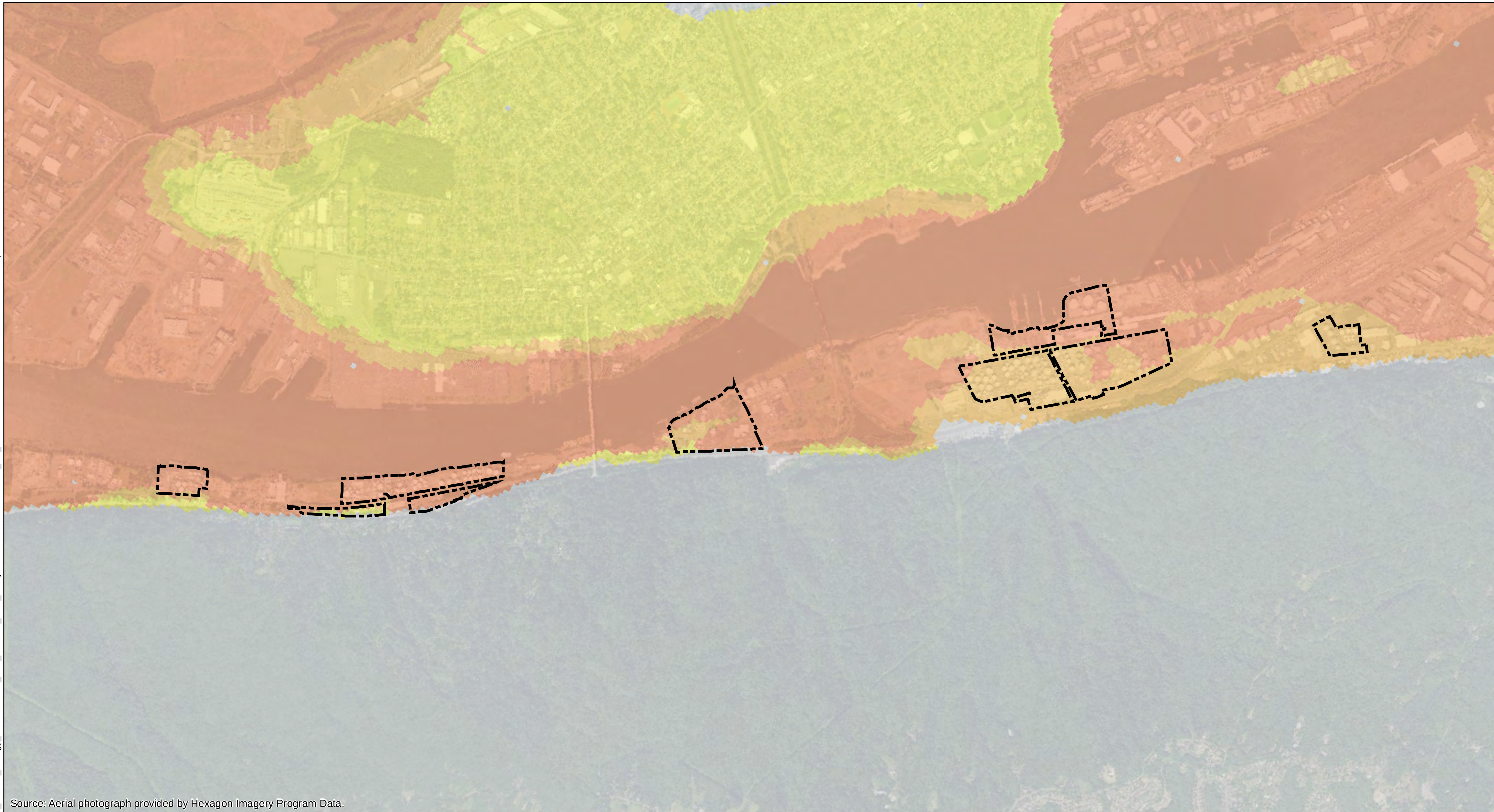
Figure **1.2**

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



Legend

DOGAMI Liquefaction Susceptibility

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

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

Liquefaction Hazard Mapping

154-035-019 04/21

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Figure **1.3**

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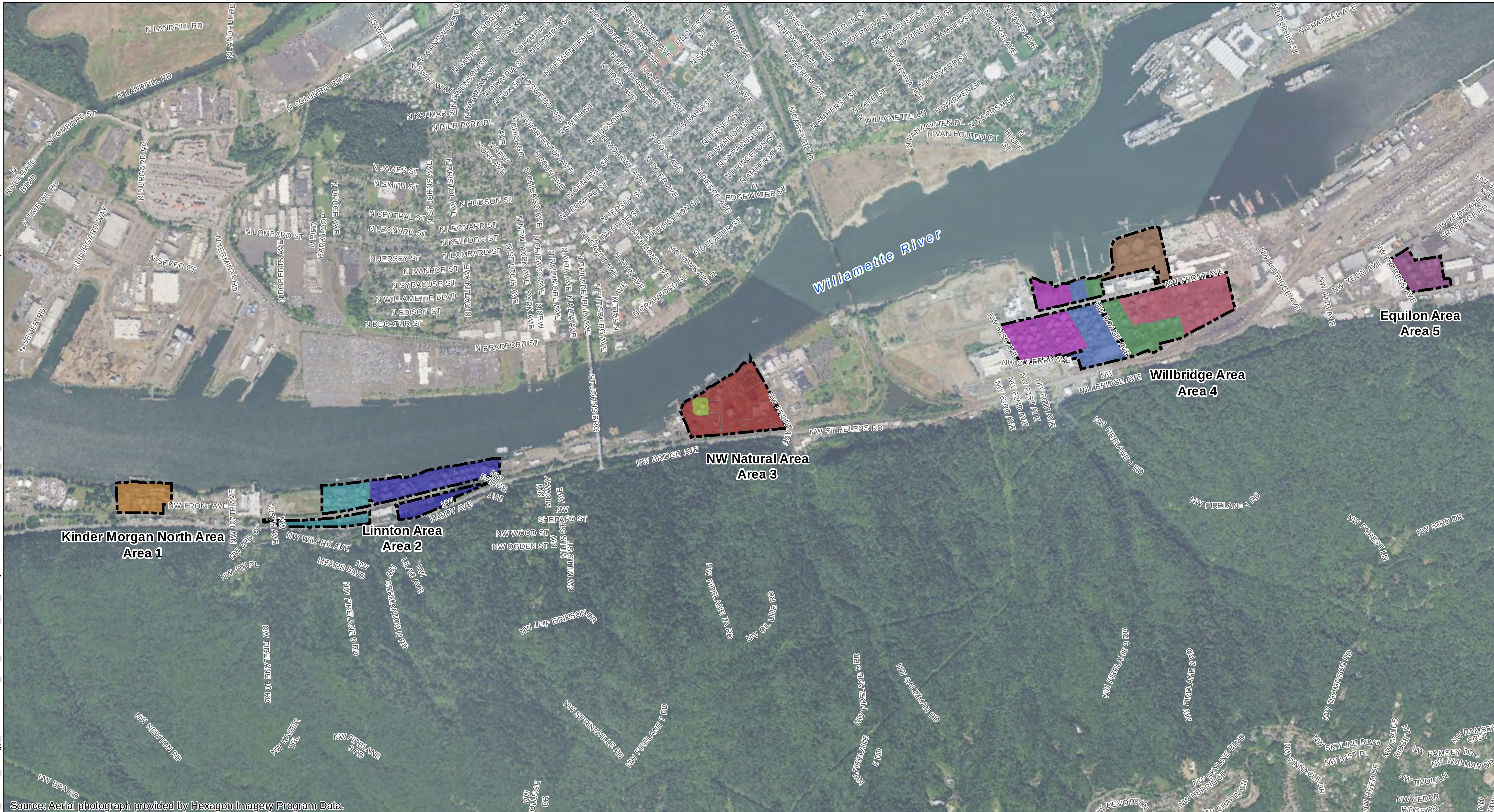

Legend

Project Areas

Kinder Morgan North Area Owners
- Kinder Morgan

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

NW Natural Area Owners
- NW Natural
- Pacific Terminal Services

Equilon Area Owners
- Equilon

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

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

CEI Hub Map

154-035-019 04/21

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Figure
1.5

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Legend

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

N

0 125 250 500 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 1 – Kinder Morgan North

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Figure **1.6**

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Legend

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

N

0 200 400 800 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 2 – Linnton

154-035-019

04/21

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Figure **1.7**

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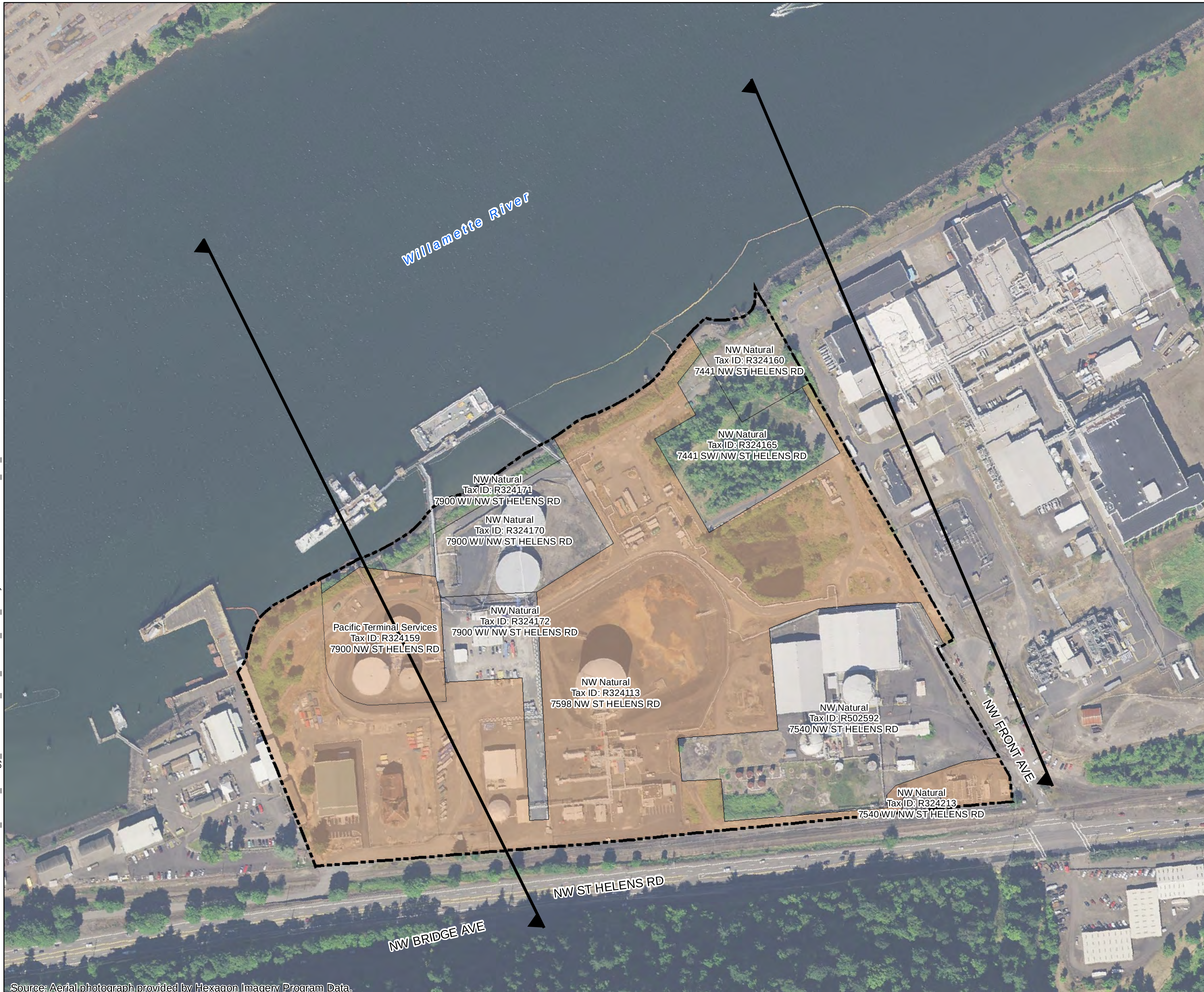

Legend

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

N

0 125 250 500 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 3 – NW Natural

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Figure **1.8**

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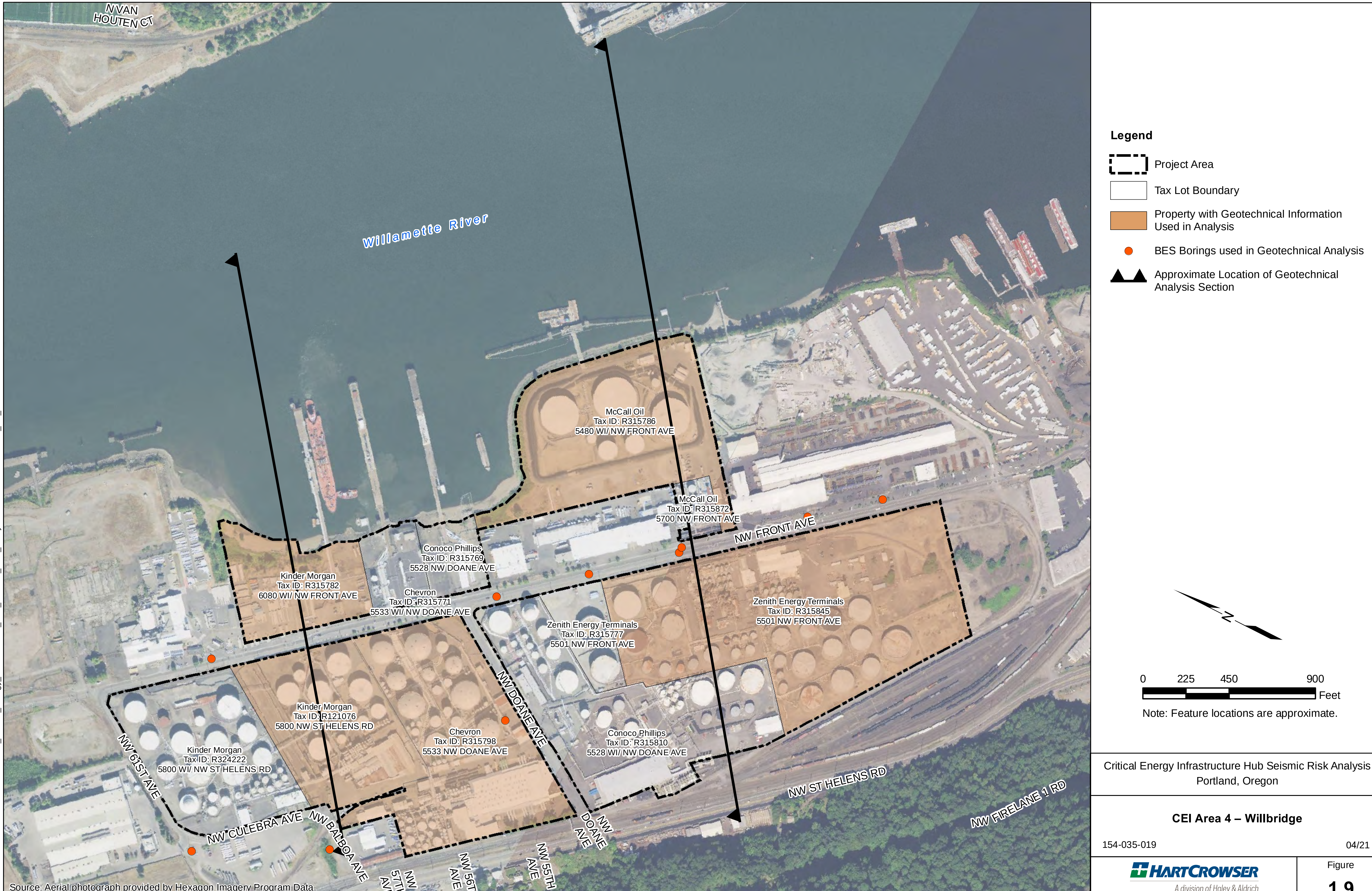

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Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 4 – Willbridge

154-035-019 04/21

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Figure
1.9

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Legend

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

N

0 90 180 360 Feet

Note: Feature locations are approximate.

Critical Energy Infrastructure Hub Seismic Risk Analysis
Portland, Oregon

CEI Area 5 – Equilon

154-035-019 04/21

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Figure
1.10

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

APPENDIX A

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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

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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[7]	NA	NA
		Cutter	103,682	207,364
		Diesel	1,907,140	3,814,279
		Ethanol	911,472	1,822,944
		Ethanol/Gasoline[2]	131,705	263,410
		Gasoline	3,504,071	7,008,142
		Gasoline/Diesel Additive[4]	5,941	11,881
		Gasoline/Diesel[3]	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[6]	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[3]	562,800
3	Pacific Terminal Services	Residual Oil[6]	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[6]	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[5]	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[6]	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-Sulfer 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.

4.0 REFERENCES

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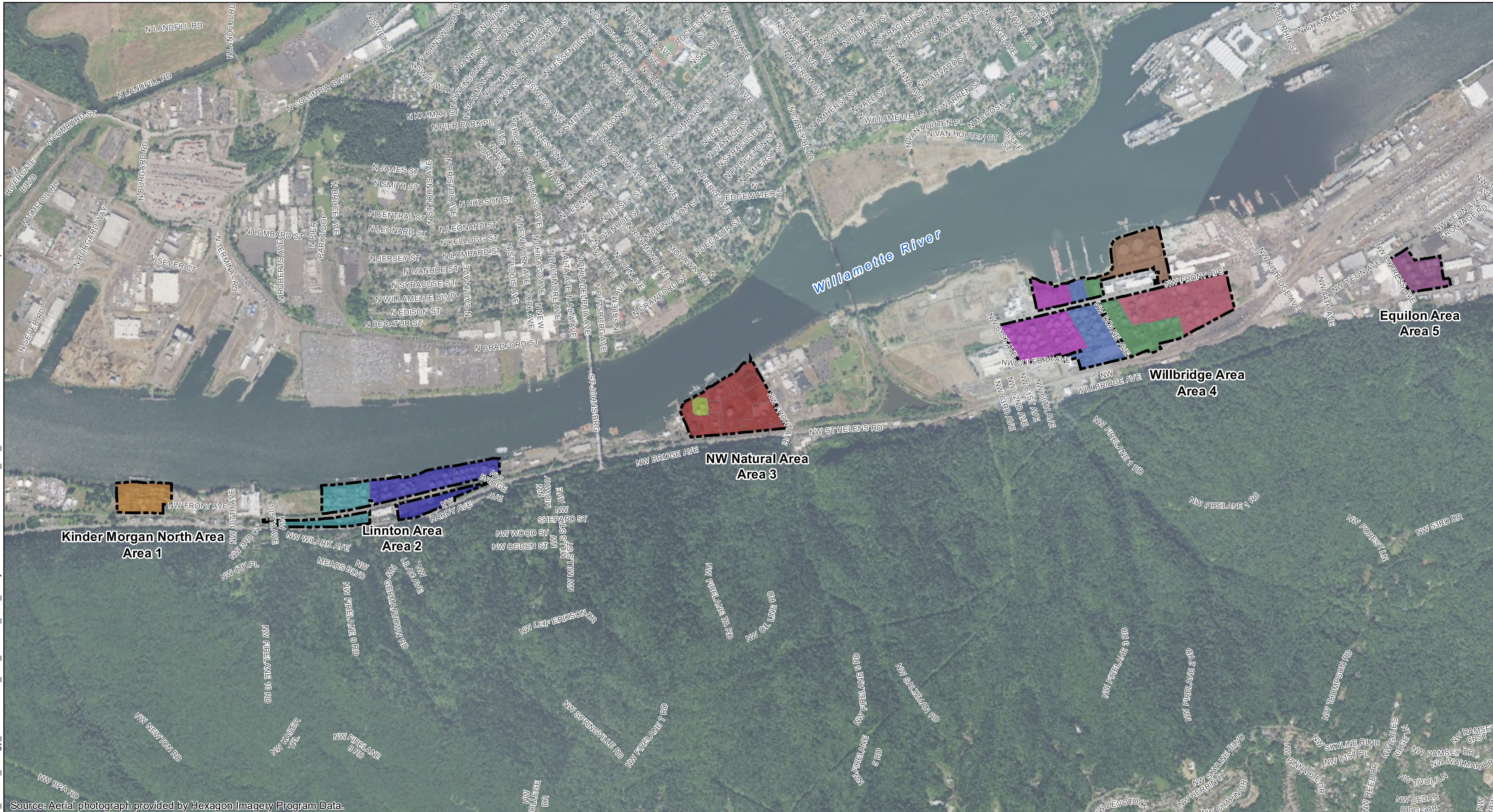

Legend

Project Areas

Kinder Morgan North Area Owners
- Kinder Morgan

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

NW Natural Area Owners
- NW Natural
- Pacific Terminal Services

Equilon Area Owners
- Equilon

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

N

0 900 1,800 3,600 Feet

Note: Feature locations are approximate.

Oregon Critical Energy Infrastructure Hub
Portland, Oregon

CEI Hub Map

154-035-019 04/21

HARTCROWSER
A division of Haley & Aldrich

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

ECONorthwest ECONOMICS · FINANCE · PLANNING
HARTCROWSER A division of Haley & Aldrich

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

N

FIGURE 2B
LINNTON

FEBRUARY 2022
GIS FIGURE PROVIDED BY ECONORTHWEST

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HARTCROWSER A division of Haley & Aldrich

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

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HARTCROWSER A division of Haley & Aldrich

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

N

FIGURE 2D
WILLBRIDGE

FEBRUARY 2022
GIS FIGURE PROVIDED BY ECONORTHWEST

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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

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APPENDIX A
Full Tank Data

Appendix A: Full Tank Data

Area	Property	Tank ID[1]	Latitude	Longitude	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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
2	BP	BP1	-122.7806873	45.59494967	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	-122.7788011	45.59386607	Diesel	1,008,840	675,923	1941	Fixed Roof	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	337,961	675,923
2	BP	BP11	-122.7800489	45.59444227	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	-122.7802194	45.59496165	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	-122.7804499	45.59525087	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	-122.7794397	45.59361625	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	-122.7791647	45.59373755	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	-122.7786956	45.5935232	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	-122.7797157	45.5935084	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	-122.7785286	45.59376099	Oily 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	-122.780702	45.5946449	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	-122.7782544	45.59352925	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	-122.7813045	45.59482967	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	-122.7810795	45.59457546	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	-122.7793826	45.59410523	Unavailable	0	0	1954	Fixed Roof	Group 1	Unknown	Unknown	Material in Water	Tank Failure	50%	100%	0	0
2	BP	BP41	-122.7792266	45.59415752	Out of Service	0	0	1954	Fixed Roof	Group 2	None	None	Material in Water	Tank Failure	50%	100%	NA	NA
2	BP	BP42	-122.7790785	45.59420894	Out of Service	0	0	1954	Fixed Roof	Group 2	None	None	Material in Water	Tank Failure	50%	100%	NA	NA
2	BP	BP43	-122.778926	45.59426297	Out of Service	0	0	1954	Fixed Roof	Group 2	None	None	Material in Water	Tank Failure	50%	100%	NA	NA
2	BP	BP44	-122.7789974	45.59410785	Out of Service	0	0	1954	Fixed Roof	Group 2	None	None	Material in Water	Tank Failure	50%	100%	NA	NA
2	BP	BP45	-122.7791499	45.59405643	Unavailable	0	0	1954	Fixed Roof	Group 1	Unknown	Unknown	Material in Water	Tank Failure	50%	100%	0	0
2	BP	BP46	-122.7793016	45.59400501	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	-122.7807976	45.59434127	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	-122.7804436	45.5945153	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	-122.7803002	45.59476875	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	-122.7803993	45.59427087	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	-122.7792567	45.59324486	Diesel	2,295,636	1,538,076	1940	Fixed Roof	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	769,038	1,538,076
4	Chevron	CH1	-122.7414229	45.56525743	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	Chevron	CH10	Unknown	Unknown	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	-122.7429011	45.5642678	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	-122.7429342	45.56422771	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	Unknown	Unknown	Out of Service	12,954	8,679	1978	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH103	Unknown	Unknown	Out of Service	13,006	8,714	1978	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH104	Unknown	Unknown	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	Unknown	Unknown	Empty	17,624	11,808	1969	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH106	Unknown	Unknown	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	Unknown	Unknown	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	-122.7429586	45.56419459	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Empty	17,724	11,875	1976	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH117	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Out of Service	19,593	13,127	1977	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH12	Unknown	Unknown	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	Unknown	Unknown	Out of Service	19,593	13,127	1977	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH121	Unknown	Unknown	Out of Service	NA	NA	1978	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH122	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	-122.7425148	45.56345508	Rykon 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	-122.7425998	45.56357042	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	Unknown	Unknown	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	-122.7424451	45.56367296	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	Unknown	Unknown	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	Unknown	Unknown	Empty	18,165	12,171	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH133	Unknown	Unknown	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	Unknown	Unknown	Out of Service	19,379	12,984	1982	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH136	Unknown	Unknown	Out of Service	20,303	13,603	1982	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH137	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Out of Service	83,234	55,767	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH141	Unknown	Unknown	Out of Service	140,308	94,006	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH142	-122.7419897	45.56398912	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	-122.7423285	45.56487029	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	-122.7422762	45.56493129	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	-122.7421647	45.56504633	Out of Service	61,864	41,449	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH146	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Rykon 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	-122.7422169	45.56498533	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	Unknown	Unknown	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	Unknown	Unknown	Empty	17,624	11,808	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH154	-122.7430858	45.5638464	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	-122.7430004	45.56378191	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	-122.7429184	45.56372439	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	Unknown	Unknown	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	Unknown	Unknown	Out of Service	NA	NA	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH159	Unknown	Unknown	Out of Service	25,379	17,004	1987	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH16	Unknown	Unknown	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	Unknown	Unknown	Empty	25,447	17,049	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH163	Unknown	Unknown	Swing Tank	6,354,155	4,257,284	2009	AST	Group 3C	Unknown	Unknown	On Land	No Tank Failure	0%	10%	0	425,728
4	Chevron	CH164	-122.7410379	45.56490644	Swing Tank	6,354,155	4,257,284	2009	AST	Group 3C	Unknown	Unknown	On Land	No Tank Failure	0%	10%	0	425,728
4	Chevron	CH17	Unknown	Unknown	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	Unknown	Unknown	Blended Oil	2,632	1,763	NA	Fixed Roof	Group 3A	Unknown	Yes	On Land	Tank Failure	50%	100%	882	1,763

Area	Property	Tank ID[1]	Latitude	Longitude	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	CH177	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Blended Oil	4,700	3,149	1993	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	315
4	Chevron	CH181	Unknown	Unknown	Blended Oil	4,700	3,149	1993	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	315
4	Chevron	CH182	Unknown	Unknown	Blended Oil	11,374	7,621	1994	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	762
4	Chevron	CH183	Unknown	Unknown	Blended Oil	11,374	7,621	1994	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	762
4	Chevron	CH184	Unknown	Unknown	Blended Oil	11,374	7,621	1994	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	762
4	Chevron	CH185	Unknown	Unknown	Blended Oil	11,374	7,621	1994	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	762
4	Chevron	CH186	Unknown	Unknown	Blended Oil	11,374	7,621	1994	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	762
4	Chevron	CH187	Unknown	Unknown	Blended Oil	11,374	7,621	1994	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	762
4	Chevron	CH188	Unknown	Unknown	Blended Oil	11,374	7,621	1994	Fixed Roof	Group 3B	Unknown	Yes	On Land	No Tank Failure[8]	0%	10%	0	762
4	Chevron	CH19	Unknown	Unknown	Empty	29,071	19,478	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH20	Unknown	Unknown	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	Unknown	Unknown	Empty	29,583	19,821	1992	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH22	Unknown	Unknown	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	Unknown	Unknown	Empty	13,982	9,368	1997	Fixed Roof	Group 2	None	None	On Land	No Tank Failure[8]	0%	10%	NA	NA
4	Chevron	CH24	Unknown	Unknown	Empty	8,859	5,936	1993	Fixed Roof	Group 2	None	None	On Land	No Tank Failure[8]	0%	10%	NA	NA
4	Chevron	CH25	Unknown	Unknown	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	Unknown	Unknown	Rykon 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	Unknown	Unknown	Chevron 7075F	29,613	19,841	1913	Fixed Roof	Group 3A	Unknown	Yes	On Land	Tank Failure	50%	100%	9,920	19,841
4	Chevron	CH28	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Empty	11,750	7,873	1949	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH29	Unknown	Unknown	Unavailable	17,724	11,875	1949	Fixed Roof	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	5,938	11,875
4	Chevron	CH3	-122.7417869	45.56487609	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	Unknown	Unknown	Empty	11,750	7,873	1949	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH31	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Empty	25,379	17,004	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH35	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Empty	18,018	12,072	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH41	Unknown	Unknown	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	Unknown	Unknown	Empty	29,583	19,821	1913	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH43	-122.7420833	45.56380088	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	-122.7423374	45.56351791	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	-122.7413834	45.56448431	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	Unknown	Unknown	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	-122.7427205	45.56392263	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	-122.7416967	45.56427618	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	Unknown	Unknown	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	-122.7411057	45.56422328	Unavailable	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH56	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	-122.7419626	45.56331505	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	Unknown	Unknown	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	-122.741521	45.56385926	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	-122.7407524	45.56450931	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	Unknown	Unknown	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	Unknown	Unknown	Famm Taro 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	Unknown	Unknown	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	-122.7422779	45.56410059	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	-122.7414661	45.56418238	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Empty	17,378	11,643	1960	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH8	Unknown	Unknown	Rykon 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	Unknown	Unknown	Out of Service	17,378	11,643	NA	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH81	Unknown	Unknown	Empty	17,724	11,875	1951	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH82	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Empty	17,184	11,513	1952	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH85	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Empty	17,624	11,808	1850	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH89	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Out of Service	17,577	11,777	1961	Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Chevron	CH94	Unknown	Unknown	Rykon 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	-122.7427141	45.56429393	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	Unknown	Unknown	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	Unknown	Unknown	Rykon 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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Out of Service	565,320	378,764	NA	Cone Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	189,382	378,764
5	Equilon	T-13524	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Water	267,456	179,196	NA	External Fixed Roof	Group 3A	Not Flammable	No	On Land	Tank Failure	50%	100%	89,598	179,196

Area	Property	Tank ID[1]	Latitude	Longitude	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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
1	Kinder Morgan North	KML10007	-122.7874617	45.60392099	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	-122.7862918	45.60312207	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	-122.7863772	45.60325802	Out of Service	469,896	179,196	1941	Internal Floating Roof	Group 2	None	None	Material in Water	Tank Failure	50%	100%	NA	NA
1	Kinder Morgan North	KML17018	-122.7859262	45.6031471	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	-122.7860185	45.60333534	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	-122.7857571	45.60292581	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	-122.7866833	45.60270641	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	-122.7876809	45.603684	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	-122.7861755	45.60285543	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	-122.7858017	45.60266188	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	Unknown	Unknown	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	-122.7868222	45.60301106	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	-122.7869825	45.60331957	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	-122.7872335	45.60367514	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	-122.7863092	45.60250695	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	-122.7875141	45.60336489	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	Unknown	Unknown	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	Kinder Morgan South	KMW10	Unknown	Unknown	Out of Service	22,722	15,224	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW100	-122.7450631	45.56630332	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	-122.7446768	45.56671985	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	-122.7449134	45.56581185	Out of Service	306,600	205,422	1951	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW103	-122.7450576	45.5658951	Out of Service	168,000	112,560	1950	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW104	-122.7452213	45.56589451	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	-122.7451319	45.5657998	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	-122.7450207	45.56569496	Out of Service	302,546	202,706	1951	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW11	Unknown	Unknown	Out of Service	22,722	15,224	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW116	-122.7449925	45.56714896	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	-122.7457153	45.56637261	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	-122.7460259	45.56666204	Gasoline	2,360,400	1,581,468	1951	Internal Floating Roof	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	790,734	1,581,468
4	Kinder Morgan South	KMW12	Unknown	Unknown	Out of Service	22,722	15,224	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW12001	-122.7420717	45.56569288	Jet A	5,040,000	3,376,800	2012	Internal Floating Roof	Group 3C	Category 2	Yes	On Land	No Tank Failure	0%	10%	0	337,680
4	Kinder Morgan South	KMW12002	-122.7428327	45.56573364	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	-122.7438959	45.56671288	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	-122.7449048	45.5679582	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	-122.7453868	45.56674273	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	Unknown	Unknown	Out of Service	12,525	8,392	1946	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW126	Unknown	Unknown	Out of Service	24,703	16,551	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW127	Unknown	Unknown	Out of Service	24,703	16,551	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW128	-122.745293	45.56757832	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	Unknown	Unknown	Out of Service	7,728	5,178	1927	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW13	Unknown	Unknown	Out of Service	2,856	1,914	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW131	Unknown	Unknown	Out of Service	4,737	3,174	1954	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW134	-122.7456716	45.5671514	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	-122.7453716	45.56593857	Out of Service	222,936	149,367	1956	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW138	-122.7456704	45.56616745	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	-122.7459749	45.56627102	Out of Service	572,628	383,661	1956	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW14	Unknown	Unknown	Out of Service	2,856	1,914	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW140	-122.7444371	45.56708638	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	-122.7448053	45.5675197	Out of Service	730,800	489,636	1956	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW143	-122.7454429	45.56604664	Out of Service	252,927	169,461	1959	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW145	Unknown	Unknown	Out of Service	7,980	5,347	1960	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW146	Unknown	Unknown	Out of Service	7,980	5,347	1960	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW147	Unknown	Unknown	Out of Service	7,980	5,347	1961	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW148	Unknown	Unknown	Out of Service	7,980	5,347	1961	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW15	Unknown	Unknown	Out of Service	2,856	1,914	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW152	-122.7446024	45.56640741	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	Unknown	Unknown	Out of Service	7,637	5,117	1965	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW154	Unknown	Unknown	Out of Service	7,637	5,117	1965	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW155	-122.7435566	45.56503165	Out of Service	4,200	2,814	1965	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW156	-122.7435017	45.56501857	Out of Service	7,667	5,137	1965	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW157	-122.7430586	45.56489556	Out of Service	24,868	16,662	1969	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW158	-122.7430072	45.56487726	Out of Service	24,851	16,650	1969	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW159	-122.7429628	45.56485983	Out of Service	21,000	14,070	1969	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW16	Unknown	Unknown	Out of Service	2,814	1,885	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW160	-122.7429305	45.56484327	Out of Service	24,860	16,656	1969	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW161	-122.7430843	45.56485752	Out of Service	24,863	16,658	1969	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW162	-122.7430344	45.56484154	Out of Service	24,850	16,650	1969	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW163	-122.7429882	45.56481757	Out of Service	24,856	16,654	1969	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW166	Unknown	Unknown	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	Unknown	Unknown	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	-122.7429258	45.56478793	Out of Service	24,990	16,743	1928	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW17	Unknown	Unknown	Out of Service	2,814	1,885	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW170	-122.7428713	45.56476642	Out of Service	24,990	16,743	1928	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW171	-122.7428392	45.56480378	Out of Service	24,990	16,743	NA	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW172	-122.742892	45.56482416	Out of Service	24,990	16,743	NA	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW173	Unknown	Unknown	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	-122.7427958	45.56478098	Out of Service	25,353	16,987	NA	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW177	-122.7428246	45.56474361	Out of Service	24,457	16,386	NA	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW18	Unknown	Unknown	Out of Service	2,814	1,885	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW186	-122.7427577	45.56474615	Out of Service	25,604	17,155	NA	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW187	-122.7427878	45.56470877	Out of Service	24,000	16,080	NA	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW188	-122.7427039	45.56472388	Out of Service	24,600	16,482	NA	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW189	-122.7427401	45.56468845	Out of Service	24,035	16,103	NA	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA

Area	Property	Tank ID[1]	Latitude	Longitude	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	Kinder Morgan South	KMW190	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	-122.7437849	45.56538264	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	Unknown	Unknown	Out of Service	11,760	7,879	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW23	Unknown	Unknown	Out of Service	11,718	7,851	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW25	Unknown	Unknown	Out of Service	11,760	7,879	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW26	Unknown	Unknown	Out of Service	22,806	15,280	1916	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW3	-122.7434053	45.56515531	Out of Service	553,350	370,745	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW30	Unknown	Unknown	Out of Service	11,718	7,851	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW31	Unknown	Unknown	Out of Service	11,760	7,879	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW32	Unknown	Unknown	Out of Service	11,472	7,686	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW33	Unknown	Unknown	Out of Service	17,472	11,706	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW34	Unknown	Unknown	Out of Service	17,481	11,712	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW35	Unknown	Unknown	Out of Service	4,397	2,946	1924	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW36	Unknown	Unknown	Out of Service	4,368	2,927	1924	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW37	Unknown	Unknown	Out of Service	4,368	2,927	1924	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW38	Unknown	Unknown	Out of Service	4,368	2,927	1924	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW39	Unknown	Unknown	Out of Service	4,397	2,946	1924	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW4	Unknown	Unknown	Out of Service	215,754	144,555	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW40	Unknown	Unknown	Out of Service	5,544	3,714	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW41	Unknown	Unknown	Out of Service	5,502	3,686	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW42	Unknown	Unknown	Out of Service	5,502	3,686	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW43	Unknown	Unknown	Out of Service	5,502	3,686	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW44	Unknown	Unknown	Out of Service	5,515	3,695	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW45	Unknown	Unknown	Out of Service	5,540	3,712	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW46	Unknown	Unknown	Out of Service	11,642	7,800	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW47	Unknown	Unknown	Out of Service	11,600	7,772	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW48	Unknown	Unknown	Out of Service	11,642	7,800	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW49	Unknown	Unknown	Out of Service	11,677	7,824	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW5	-122.7432504	45.56534229	Out of Service	439,605	294,535	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW50	Unknown	Unknown	Out of Service	11,507	7,710	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW51	Unknown	Unknown	Out of Service	11,634	7,795	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW52	-122.743387	45.56582216	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
4	Kinder Morgan South	KMW54	-122.7430861	45.56614789	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	Unknown	Unknown	Out of Service	19,867	13,311	1929	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW57	Unknown	Unknown	Out of Service	19,800	13,266	1929	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW58	Unknown	Unknown	Out of Service	19,800	13,266	1929	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW59	Unknown	Unknown	Out of Service	19,855	13,303	1929	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW6	-122.7431268	45.56515305	Out of Service	215,166	144,161	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW60	Unknown	Unknown	Out of Service	19,824	13,282	1929	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW61	-122.7438671	45.56518029	Out of Service	25,200	16,884	1929	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW62	-122.7437893	45.56515017	Out of Service	11,676	7,823	1929	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW63	-122.7431296	45.56487495	Out of Service	24,766	16,593	1929	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW65	Unknown	Unknown	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	Unknown	Unknown	Out of Service	856,800	574,056	1930	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW69	-122.7423084	45.56526554	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	-122.7430954	45.56552925	Out of Service	440,538	295,160	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW70	-122.7425286	45.56489969	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	-122.7426672	45.56612458	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	Unknown	Unknown	Out of Service	549,024	367,846	1937	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW73	-122.7427748	45.56519298	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	-122.7427851	45.56545285	Out of Service	305,712	204,827	1937	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW75	-122.7431136	45.56492422	Out of Service	25,000	16,750	1938	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW76	-122.7434435	45.56499117	Out of Service	25,000	16,750	1938	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW77	Unknown	Unknown	Out of Service	25,741	17,246	1938	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW8	-122.7429629	45.56533084	Out of Service	216,804	145,259	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW82	Unknown	Unknown	Out of Service	11,642	7,800	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW83	Unknown	Unknown	Out of Service	19,867	13,311	1923	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW84	-122.7444933	45.56604701	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	-122.7442008	45.56638834	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	-122.7445855	45.56569038	Out of Service	222,805	149,279	1948	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW87	-122.7447579	45.56573139	Out of Service	222,469	149,054	1948	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW88	-122.7446782	45.5655895	Out of Service	222,574	149,125	1948	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW89	-122.7448503	45.56562528	Out of Service	222,919	149,356	1948	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW9	Unknown	Unknown	Out of Service	22,722	15,224	1915	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Kinder Morgan South	KMW90	Unknown	Unknown	Out of Service	2,982	1,998	1946	Vertical Fixed Roof	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	McCall Oil	MC1	-122.7355852	45.5646169	Asphalt	11,247,180	7,535,611	1976	Cone Roof	Group 3A	Category 1	Yes	Material in Water	Tank Failure	50%	100%	3,767,805	7,535,611
4	McCall Oil	MC10	-122.7356888	45.56405291	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	-122.7339086	45.56372321	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	-122.734043	45.56382734	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	MC15	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	-122.7356113	45.56250143	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	-122.734734	45.56402897	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	-122.7357784	45.56237886	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	-122.7359904	45.56226527	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	MC22	-122.7359969	45.56203989	Asphalt	18,942	12,691	1954	Cone Roof	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	6,346	12,691
4	McCall Oil	MC23	Unknown	Unknown	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	Unknown	Unknown	Asphalt	19,068	12,776	2000	Cone Roof	Group 3B	Category 1	Yes	Potentially in Water	No Tank Failure[8]	0%	10%	0	1,278
4	McCall Oil	MC25	Unknown	Unknown	Asphalt	79,800	53,466	2000	Cone Roof	Group 3B	Category 1	Yes	Potentially in Water	No Tank Failure[8]	0%	10%	0	5,347
4	McCall Oil	MC26	Unknown	Unknown	Asphalt	79,800	53,466	2000	Cone Roof	Group 3B	Category 1	Yes	Potentially in Water	No Tank Failure[8]	0%	10%	0	5,347
4	McCall Oil	MC27	Unknown	Unknown	Asphalt	79,800	53,466	2000	Cone Roof	Group 3B	Category 1	Yes	Potentially in Water	No Tank Failure[8]	0%	10%	0	5,347
4	McCall Oil	MC28	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Polyphosphoric Acid	5,405	3,621	2005	Cone Roof	Group 3C	Not Flammable	Yes	Potentially in Water	No Tank Failure	0%	10%	0	362
4	McCall Oil	MC4	-122.7345227	45.56321617	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	-122.7339134	45.56356388	Biodiesel	27,216	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	-122.7339333	45.56345972	Biodiesel	27,216	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	-122.7357425	45.56376754	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	-122.7353491	45.56346153	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	-122.7340625	45.5636368	Biodiesel	473,004	316,913	1979	Cone Roof	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	158,456	316,913

Area	Property	Tank ID[1]	Latitude	Longitude	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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
3	Northwest Natural Gas	*NWN-Tank 001*	Unknown	Unknown	Liquefied Natural Gas	7,100,000	4,757,000	2005	NA	Group 3C	Category 1	Yes	On Land	No Tank Failure	0%	10%	0	475,700
2	Shore Terminals	NU10026	-122.7726379	45.58809999	Gasoline/Diesel[3]	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	-122.7727619	45.58853083	Gasoline/Diesel[3]	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	-122.7741313	45.58949818	Gasoline/Diesel[3]	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	-122.773869	45.58924206	Gasoline/Diesel[3]	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	-122.7736576	45.58905227	Ethanol/Gasoline[2]	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Gasoline/Diesel Additive[4]	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	Unknown	Unknown	Unavailable	NA	NA	NA	NA	Group 1	Unknown	Unknown	Material in Water	Tank Failure	50%	100%	NA	NA
2	Shore Terminals	NU2020	-122.7766875	45.59125128	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	-122.7764639	45.59143329	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	-122.776409	45.59161904	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	-122.7783372	45.59310793	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	Unknown	Unknown	Unavailable	NA	NA	NA	NA	Group 1	Unknown	Unknown	Material in Water	Tank Failure	50%	100%	NA	NA
2	Shore Terminals	NU23	Unknown	Unknown	Gasoline/Diesel Additive[4]	10,048	6,732	NA	Cone	Group 3A	Category 2	Yes	Material in Water	Tank Failure	50%	100%	3,366	6,732
2	Shore Terminals	NU24	Unknown	Unknown	Biodiesel Additive[7]	NA	NA	NA	Horizontal Tank	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	NA	NA
2	Shore Terminals	NU2511	-122.7777244	45.59261216	Marine Fuel Oil	1,060,587	710,593	1925	Cone	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	355,297	710,593
2	Shore Terminals	NU2512	-122.7774697	45.59239859	Marine Fuel Oil	1,049,587	703,223	1925	Cone	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	351,612	703,223
2	Shore Terminals	NU2705	-122.7737092	45.58884477	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	-122.7739516	45.58904652	Gasoline/Diesel[3]	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	Unknown	Unknown	Unavailable	NA	NA	NA	NA	Group 1	Unknown	Unknown	Material in Water	Tank Failure	50%	100%	NA	NA
2	Shore Terminals	NU3201	-122.7740642	45.58976931	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	-122.7735485	45.58932425	Gasoline/Diesel[3]	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	-122.7732816	45.5891061	Gasoline/Diesel[3]	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	-122.7788207	45.5928867	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	-122.7781073	45.59288672	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	-122.7773272	45.59172431	Gasoline/Diesel[3]	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	-122.7738333	45.58953782	Gasoline/Diesel[3]	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	-122.7742007	45.58926922	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	Unknown	Unknown	Gasoline/Diesel[3]	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	-122.7768358	45.59187153	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	-122.7779346	45.59221306	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	-122.7782457	45.59245726	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	-122.7769585	45.59154822	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	-122.7744878	45.58954172	Gasoline/Diesel[3]	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	-122.7784691	45.59276671	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	-122.7758206	45.59059861	Gasoline/Diesel[3]	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	-122.7753257	45.59022907	Gasoline	3,338,748	2,236,961	1953	Internal Floating Roof	Group 3A	Category 1	Yes	Material in Water	Tank Failure	50%	100%	1,118,481	2,236,961
2	Shore Terminals	NU8308	-122.774695	45.59022889	Gasoline/Diesel[3]	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	-122.760951	45.58009285	Residual Oil[6]	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	-122.7614372	45.5801335	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	PA3	-122.7612778	45.57987482	Residual Oil[6]	20,000	13,400	1980	NA	Group 3A	Category 1	Yes	Potentially in Water	Tank Failure	50%	100%	6,700	13,400
3	Pacific Terminal Services	PA4	-122.7593325	45.57970575	Residual Oil[6]	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	-122.7598176	45.57956533	Residual Oil[6]	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	Unknown	Unknown	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	Unknown	Unknown	Residual Oil[6]	475	318	1993	NA	Group 3B	Category 1	Yes	Material in Water	No Tank Failure[8]	0%	10%	0	32
4	Conoco Phillips	PH1471	Unknown	Unknown	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	-122.7406622	45.56199187	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	-122.7409117	45.56141165	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	-122.7408642	45.56177225	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	-122.7407984	45.56149485	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	-122.740692	45.56143945	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	-122.7402992	45.56190648	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	-122.7405757	45.56158066	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	-122.740277	45.5627496	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	-122.7398776	45.56312098	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	-122.7407079	45.56226216	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	-122.7402796	45.56314045	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	-122.7400919	45.5633032	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	PH3407	-122.7398529	45.56395207	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
4	Conoco Phillips	PH3408	-122.739388	45.56361948	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	-122.7395889	45.56334027	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	-122.7402231	45.56349476	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	-122.7401167	45.56361542	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	-122.7399924	45.56340515	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	-122.7398959	45.56351805	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	-122.7396817	45.56134632	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	-122.7395902	45.56145247	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	-122.7395377	45.56128538	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	-122.7394374	45.56138948	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	-122.7392115	45.56094009	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	-122.7411435	45.56199381	Stop Oil	20,496	13,732	1907	Riveted Steel	Group 3A	Unknown	Yes	On Land	Tank Failure	50%	100%	6,866	13,732
4	Conoco Phillips	PH3623	-122.7409866	45.56259514	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	-122.7405906	45.56137658	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	-122.7397933	45.56123003	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	-122.7396297	45.56115996	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	-122.7409459	45.56055917	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	-122.7409159	45.56059316	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	-122.7408862	45.56062497	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	-122.7408949	45.56053695	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	-122.7408657	45.56056919	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	-122.7408383	45.56060274	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	-122.7407864	45.5605766	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	-122.7408161	45.56054566	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	-122.7408457	45.56051211	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	-122.7385003	45.56040356	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	-122.7407385	45.56055481	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	-122.7407651	45.56052213	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	Unknown	Unknown	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	20.3925991	-122.740796	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	20.3925991	-122.7407481	UNAX AW 68	17,500	11,725	1968	Welded Steel	Group 3A	Unknown	Yes	On Land	Tank Failure	50%	100%	5,863	11,725

Area	Property	Tank ID[1]	Latitude	Longitude	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	Conoco Phillips	PH4243	20.3925991	-122.7407215	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	20.3925991	-122.7395284	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	PH4245	20.3925991	-122.7394836	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	27.0837994	-122.7396113	Residual Fuel Oil[6]	458,640	307,289	1968	Welded Steel	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	153,644	307,289
4	Conoco Phillips	PH4253	24.6357994	-122.7394345	Residual Fuel Oil[6]	451,290	302,364	1968	Welded Steel	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	151,182	302,364
4	Conoco Phillips	PH4254	25.1194992	-122.7392325	PS 300	459,312	307,739	1968	Welded Steel	Group 3A	Category 1	No	On Land	Tank Failure	50%	100%	153,870	307,739
4	Conoco Phillips	PH4255	22.1005993	-122.739039	Biodiesel	404,250	270,848	1968	Welded Steel	Group 3A	Category 3	Yes	On Land	Tank Failure	50%	100%	135,424	270,848
4	Conoco Phillips	PH4256	35.1484985	-122.7390611	Out of Service	195,408	130,923	1968	Welded Steel	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Conoco Phillips	PH4257	6.8944898	-122.7389296	Out of Service	38,367	25,706	1968	Welded Steel	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Conoco Phillips	PH4258	20.9752007	-122.7394522	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	22.4150009	-122.740323	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	20.3925991	-122.7394953	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	20.3925991	-122.7406945	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	29.7148991	-122.7410065	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	20.3925991	-122.7393842	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	20.3925991	-122.7393433	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	10.3711004	-122.7392923	Out of Service	8,900	5,963	1971	Welded Steel	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA
4	Conoco Phillips	PH4306	35.9230995	-122.7393363	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	28.8628006	-122.7387696	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	24.1548004	-122.7390204	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	24.1548004	-122.7389672	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	18.7318001	-122.7389181	T5X 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	24.6152992	-122.7388612	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	Unknown	Unknown	Gasoline Slops[5]	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	29.7148991	-122.7409703	Ethyl HITEC 6888E	25,500	17,085	1973	Welded Steel	Group 3A	Unknown	Yes	On Land	Tank Failure	50%	100%	8,543	17,085
4	Conoco Phillips	PH4332	20.3925991	-122.7406396	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	20.3925991	-122.7406705	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	20.3925991	-122.740698	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	12.0774002	-122.7408036	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	15.7313995	-122.7410139	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	15.7313995	-122.7410435	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	15.7313995	-122.741078	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	15.7313995	-122.7411106	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	15.7313995	-122.7410505	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	15.7313995	-122.7410832	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	15.7313995	-122.7411133	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	15.7313995	-122.7411464	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	15.7313995	-122.7410945	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	15.7313995	-122.741125	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	15.7313995	-122.7411564	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	15.7313995	-122.7411847	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	Unknown	Unknown	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	Unknown	Unknown	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	15.7313995	-122.7411917	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	15.7313995	-122.7412239	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	15.7313995	-122.7411642	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	15.7313995	-122.741196	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	15.7313995	-122.7412283	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	15.7313995	-122.741261	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	12.8697004	-122.741032	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 128	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 127	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 70	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 125	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 124	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 123	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 122	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 121	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 120	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 112	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 110	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 101	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 126	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 003	Unknown	Unknown	Asphalt	NA	NA	NA	NA	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 71	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Caustic	NA	NA	NA	NA	Group 3A	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 74	Unknown	Unknown	Charge Stock	NA	NA	NA	NA	Group 3A	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 100	Unknown	Unknown	Charge Stock	NA	NA	NA	NA	Group 3A	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 102	Unknown	Unknown	Charge Stock	NA	NA	NA	NA	Group 3A	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 106	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Crude Oil	NA	NA	NA	NA	Group 3A	Category 2	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 130	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	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	Unknown	Unknown	Crude Oil	NA	NA	NA	NA	Group 3A	Category 2	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 105	Unknown	Unknown	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	Unknown	Unknown	Crude Oil	NA	NA	NA	NA	Group 3A	Category 2	Yes	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 308	Unknown	Unknown	Murol	NA	NA	NA	NA	Group 3A	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 182	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 183	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 185	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 202	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 203	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 209	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 213	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 208	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 211	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tank 306	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA
4	Zenith Energy	Tanks 95	Unknown	Unknown	NA	NA	NA	NA	NA	Group 1	Unknown	Unknown	On Land	Tank Failure	50%	100%	NA	NA

Area	Property	Tank ID[1]	Latitude	Longitude	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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 181	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 T#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 T#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 T#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-Sulfer 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:

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

[2] Tank contents were listed as both gasoline and ethanol; flammability and hazard category are for gasoline.

[3] Tank contents were listed as both gasoline and diesel; flammability and hazard category are for gasoline.

[4] Tank contents were listed as both gasoline and diesel additives; flammability and hazard category are for gasoline.

[5] Tank contents were listed as gasoline slops; flammability and hazard category are for gasoline.

[6] 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.

[7] Tank contents were listed as biodiesel additive; flammability and hazard category are for biodiesel.

[8] Tank data provided by COP without geographic location; failure assumption made from satellite imagry.

[9] 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[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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
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%	337,961	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	Oily 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%	769,038	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	469,896	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%	3,767,805	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	27,216	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	27,216	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[3]	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[3]	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[3]	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[3]	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[2]	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[4]	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	NU2020	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	Material in Water	Tank Failure	50%	100%	NA	NA
2	Shore Terminals	NU23	Gasoline/Diesel Additive[4]	10,048	6,732	NA	Cone	Group 3A	Category 2	Yes	Material in Water	Tank Failure	50%	100%	3,366	6,732
2	Shore Terminals	NU24	Biodiesel Additive[7]	NA	NA	NA	Horizontal Tank	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	NA	NA
2	Shore Terminals	NU2511	Marine Fuel Oil	1,060,587	710,593	1925	Cone	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	355,297	710,593
2	Shore Terminals	NU2512	Marine Fuel Oil	1,049,587	703,223	1925	Cone	Group 3A	Category 3	Yes	Material in Water	Tank Failure	50%	100%	351,612	703,223

Area	Property	Tank ID[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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
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[3]	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[3]	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[3]	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[3]	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[3]	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[3]	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[3]	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[3]	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%	1,118,481	2,236,961
2	Shore Terminals	NU8308	Gasoline/Diesel[3]	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[6]	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[6]	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[6]	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[6]	475	318	1993	NA	Group 3B	Category 1	Yes	Material in Water	No Tank Failure[8]	0%	10%	0	32

Notes:

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

[2] Tank contents were listed as both gasoline and ethanol; flammability and hazard category are for gasoline.

[3] Tank contents were listed as both gasoline and diesel; flammability and hazard category are for gasoline.

[4] Tank contents were listed as both gasoline and diesel additives; flammability and hazard category are for gasoline.

[5] Tank contents were listed as gasoline slops; flammability and hazard category are for gasoline.

[6] 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.

[7] Tank contents were listed as biodiesel additive; flammability and hazard category are for biodiesel.

[8] Tank data provided by COP without geographic location; failure assumption made from satellite imagry.

[9] 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[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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[8]	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[8]	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[8]	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[8]	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[6]	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:

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

[2] Tank contents were listed as both gasoline and ethanol; flammability and hazard category are for gasoline.

[3] Tank contents were listed as both gasoline and diesel; flammability and hazard category are for gasoline.

[4] Tank contents were listed as both gasoline and diesel additives; flammability and hazard category are for gasoline.

[5] Tank contents were listed as gasoline slops; flammability and hazard category are for gasoline.

[6] 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.

[7] Tank contents were listed as biodiesel additive; flammability and hazard category are for biodiesel.

[8] Tank data provided by COP without geographic location; failure assumption made from satellite imagry.

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[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	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	Rykon 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 CF0 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	Rykon 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 E0 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	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	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[8]	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[8]	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[8]	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[8]	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[8]	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[8]	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[8]	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[8]	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[8]	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[8]	0%	10%	NA	NA
4	Chevron	CH24	Empty	8,859	NA	1993	Fixed Roof	Group 3B	None	None	On Land	No Tank Failure[8]	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	Rykon 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	On Land	Tank Failure	50%	100%	9,920	19,841

Area	Property	Tank ID[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	Famm Taro 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	Rykon 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	Rykon 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	Rykon 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	2,360,400	1,581,468	1951	Internal Floating Roof	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	790,734	1,581,468
4	Kinder Morgan South	KMW12	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	KMW12001	Jet A	5,040,000	3,376,800	2012	Internal Floating Roof	Group 3C	Category 2	Yes	On Land	No Tank Failure	0%	10%	0	337,680

Area	Property	Tank ID[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	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[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	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%	6,866	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	PH4245	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[6]	458,640	307,289	1968	Welded Steel	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	153,644	307,289
4	Conoco Phillips	PH4253	Residual Fuel Oil[6]	451,290	302,364	1968	Welded Steel	Group 3A	Category 1	Yes	On Land	Tank Failure	50%	100%	151,182	302,364
4	Conoco Phillips	PH4254	PS 300	459,312	307,739	1968	Welded Steel	Group 3A	Category 1	No	On Land	Tank Failure	50%	100%	153,870	307,739
4	Conoco Phillips	PH4255	Biodiesel	404,250	270,848	1968	Welded Steel	Group 3A	Category 3	Yes	On Land	Tank Failure	50%	100%	135,424	270,848
4	Conoco Phillips	PH4256	Out of Service	195,408	NA	1968	Welded Steel	Group 2	None	None	On Land	Tank Failure	50%	100%	NA	NA

Area	Property	Tank ID[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	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	T5X 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[5]	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%	8,543	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	Murol	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[1]	Contents	Capacity (Gal)	Expected Fill (Gal) (67% of Capacity)[9]	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	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-Sulfer 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:

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

[2] Tank contents were listed as both gasoline and ethanol; flammability and hazard category are for gasoline.

[3] Tank contents were listed as both gasoline and diesel; flammability and hazard category are for gasoline.

[4] Tank contents were listed as both gasoline and diesel additives; flammability and hazard category are for gasoline.

[5] Tank contents were listed as gasoline slops; flammability and hazard category are for gasoline.

[6] 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.

[7] Tank contents were listed as biodiesel additive; flammability and hazard category are for biodiesel.

[8] Tank data provided by COP without geographic location; failure assumption made from satellite imagry.

[9] 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__	Containe_1	Year_Built	Area__ft_2	Radius__ft	Perimeter	Height__ft	Longitude	Latitude	Flammabili	Hazardous	Year_cat	damagezone	fail	Concern
9	BP19	BP	British Petroleum South Tank Farm	BP	19	Oily Wastewater	184000	198828	Internal Floa	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 Floa	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	None	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	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	Fx	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		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 6073EV	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	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	None	NA	Pre-1993 or	No Data	Tank Failure	
52	CH12	Chevron	Chevron Willbridge	CH	12	ExxonMobil EM-100	540311	586302	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	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	None	NA	Pre-1993 or	No Data	Tank Failure	
55	CH122	Chevron	Chevron Willbridge	CH	122	1000 THF	57600	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	57600	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		860.79303	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		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	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	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	None	NA	Pre-1993 or	No Data	Tank Failure	
67	CH137	Chevron	Chevron Willbridge	CH	137	Oloa 2000	96500	60757	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	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	None	NA	Pre-1993 or	No Data	Tank Failure	
74	CH143	Chevron	Chevron Willbridge	CH	143	Supreme 5W30	55448	62033	Fixed Roof		332.155	10.2824	64.606225	24.9662	-122.7423	45.56487	NA	NA	Pre-1993 or	On Land	Tank Failure	
75	CH144	Chevron	Chevron Willbridge	CH	144	Havoline 10W30	55672	61864	Fixed Roof		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		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 HDMO 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	28951	Fx	1913	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
82	CH150	Chevron	Chevron Willbridge	CH	150	Delo 400-10	22792	25311	Fixed Roof		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	None	NA	Pre-1993 or	No Data	Tank Failure	
85	CH154	Chevron	Chevron Willbridge	CH	154	Map 100	76548	83422	Fixed Roof		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		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		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	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	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	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	None	NA	Pre-1993 or	No Data	Tank Failure	
92	CH160	Chevron	Chevron Willbridge	CH	160	Empty	0	25447	Fx	Unknown	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
95	CH17	Chevron	Chevron Willbridge	CH	17	ExxonMobile EHC45	26900	29327	Fx	1913	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
96	CH176	Chevron	Chevron Willbridge	CH	176	Blended Oil	2250	2632	Fx	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
97	CH177	Chevron	Chevron Willbridge	CH	177	Blended Oil	2250	2632	Fx	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
98	CH178	Chevron	Chevron Willbridge	CH	178	Blended Oil	2250	2632	Fx	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
99	CH179	Chevron	Chevron Willbridge	CH	179	Blended Oil	2250	2632	Fx	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
100	CH18	Chevron	Chevron Willbridge	CH	18	Oloa 550006L	27342	29583	Fx	1913	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
110	CH19	Chevron	Chevron Willbridge	CH	19	Empty	27342	29071	Fx	Unknown	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
111	CH20	Chevron	Chevron Willbridge	CH	20	Pennzoil 75HC	26900	29071	Fx	1914	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
112	CH21	Chevron	Chevron Willbridge	CH	21	Empty	26900	29583	Fx	1992	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
113	CH22	Chevron	Chevron Willbridge	CH	22	Clarity PM 220	12700	13982	Fx	1954	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
116	CH25	Chevron	Chevron Willbridge	CH	25	Clarity PM 150	8143	8665	Fx	1913	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
117	CH26	Chevron	Chevron Willbridge	CH	26	Rykon Prem 32	Varies	29447	Fx	1913	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
118	CH27	Chevron	Chevron Willbridge	CH	27	Chevron 7075F	Varies	29613	Fx	1913	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
119	CH28	Chevron	Chevron Willbridge	CH	28	Blend Mix/ Line Wash	Varies	29071	Fx	1913	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
120	CH28	Chevron	Chevron Willbridge	CH	28	Industrial EP 150	Varies	17771	Fx	1949	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
121	CH29	Chevron	Chevron Willbridge	CH	29		Varies	17724	Fx	1949	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
122	CH29	Chevron	Chevron Willbridge	CH	29	Empty	0	11750	Fx	1949	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
124	CH30	Chevron	Chevron Willbridge	CH	30	Empty	0	11750	Fx	1949	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
125	CH31	Chevron	Chevron Willbridge	CH	31	SynFluid $, 4CST	11100	8712	Fx	1953	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
126	CH32	Chevron	Chevron Willbridge	CH	32	Viscoplex 7-305	19900	13918	Fx	1950	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
127	CH33	Chevron	Chevron Willbridge	CH	33	Viscoplex 1-604	23900	13997	Fx	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
128	CH34	Chevron	Chevron Willbridge	CH	34	Empty	0	25379	Fx	Unknown	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
129	CH35	Chevron	Chevron Willbridge	CH	35	FAMM Tara 30 DP 30	23400	25379	Fx	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
130	CH36	Chevron	Chevron Willbridge	CH	36	Shell MV1 100	23400	25379	Fx	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
131	CH37	Chevron	Chevron Willbridge	CH	37	Drive Train Fluid HD 10	Varies	17378	Fx	1949	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
132	CH4	Chevron	Chevron Willbridge	CH	4	Neutral 220R	390348	435761	Fx	1913	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
133	CH40	Chevron	Chevron Willbridge	CH	40	Empty	0	18018	Fx	Unknown	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
134	CH41	Chevron	Chevron Willbridge	CH	41	Clarity Saw Guide 46	Varies	17331	Fx	1949	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	

FID	TANK_ID	Owner	Facility	Facility_S	Container	Substance	Average_Fi	Capacity__	Containe_1	Year_Built	Area__ft_2	Radius__ft	Perimeter	Height__ft	Longitude	Latitude	Flammabili	Hazardous	Year_cat	damagezone	fail	Concern
135	CH42	Chevron	Chevron Willbridge	CH	42	Empty	0	29583	Fx	1913	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
139	CH46	Chevron	Chevron Willbridge	CH	46	Red Chain Bar 150	Varies	11750	Fx	1924	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
141	CH48	Chevron	Chevron Willbridge	CH	48	Water/Oil Slop	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	NA	NA	Pre-1993 or	No Data	Tank Failure	
144	CH56	Chevron	Chevron Willbridge	CH	56	GST ISO 100	Varies	25379	Fx	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
145	CH57	Chevron	Chevron Willbridge	CH	57	Citgo Brt Stock 150	Varies	152433	Fx	1921	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
146	CH6	Chevron	Chevron Willbridge	CH	6	GEO HDAX L ASH 40	88565	100277	Fx	1913	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	NA	NA	Pre-1993 or	No Data	Tank Failure	
151	CH65	Chevron	Chevron Willbridge	CH	65	Lubrizol 4991	Varies	17524	Fx	1938	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	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	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	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	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	None	NA	Pre-1993 or	No Data	Tank Failure	
159	CH8	Chevron	Chevron Willbridge	CH	8	Rykon Prem MV	91510	104897	Fx	1913	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	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	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	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	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	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	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	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	None	NA	Pre-1993 or	No Data	Tank Failure	
168	CH89	Chevron	Chevron Willbridge	CH	89	Oil Stop	17459	19431	Fx	1952	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
169	CH9	Chevron	Chevron Willbridge	CH	9	Chevron 7075F	153277	169193	Fx	1949	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	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	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	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	NA	NA	Pre-1993 or	No Data	Tank Failure	
176	CH98	Chevron	Chevron Willbridge	CH	98	Rykon Oil 46	469140	91364	Fx	1968	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
177	CH99	Chevron	Chevron Willbridge	CH	99	RPM UGL 80W90	55656	62033	Fx	Unknown	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	KML11019	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	11019	Out of service	281938	469896	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	
185	KML2024	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	2024	Out of service	55138	92896	Vertical fixe	1937	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	104244	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	None	No	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	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	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	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	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	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	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	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	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	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	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	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	None	NA	Pre-1993 or	No Data	Tank Failure	
205	KML55008	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	55008	Out of service	1373299	2288832	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	2312016	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	
210	KMLSalt towe	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	Salt tower	Contact water	13734	22890	Vertical fixe	Unknown	0	0	0	0	0	0	None	No	Pre-1993 or	No Data	Tank Failure	
211	KMW10	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	10	Out of service		22722	Vertical fixe	1915	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	NA	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		22722	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
223	KMW12	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	12	Out of service		22722	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
229	KMW125	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	125	Out of service		12525	Vertical fixe	1946	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
230	KMW126	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	126	Out of service		24703	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
231	KMW127	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	127	Out of service		24703	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
233	KMW129	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	129	Out of service		7728	Vertical fixe	1927	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
234	KMW13	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	13	Out of service		2856	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
235	KMW131	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	131	Out of service		4737	Vertical fixe	1954	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
237	KMW137	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	137	Out of service	0	222936	Vertical fixe	1956	866.76202	16.610201	104.36497	34.383499	-122.7454	45.565939	None	NA	Pre-1993 or	On Land	Tank Failure	
239	KMW139	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	139	Out of service	0	572628	Vertical fixe	1956	2056.52	25.5854	160.75781	37.222801	-122.746	45.566271	None	NA	Pre-1993 or	On Land	Tank Failure	
240	KMW14	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	14	Out of service		2856	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
241	KMW140	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	140	Storm water	378000	630000	Vertical fixe	1956	2040.55	25.4858	160.132	41.272701	-122.7444	45.567086	None	No	Pre-1993 or	On Land	Tank Failure	
242	KMW141	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	141	Out of service		730800	Vertical fixe	1956	2944.97	30.617201	192.37355	33.173199	-122.7448	45.56752	None	NA	Pre-1993 or	On Land	Tank Failure	
243	KMW143	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	143	Out of service	0	252927	Vertical fixe	1959	1091.72	18.6415	117.128	30.9709	-122.7454	45.566047	None	NA	Pre-1993 or	On Land	Tank Failure	
244	KMW145	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	145	Out of service		7980	Vertical fixe	1960	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
245	KMW146	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	146	Out of service		7980	Vertical fixe	1960	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
246	KMW147	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	147	Out of service		7980	Vertical fixe	1961	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
247	KMW148	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	148	Out of service		7980	Vertical fixe	1961	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
248	KMW15	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	15	Out of service		2856	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
250	KMW153	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	153	Out of service		7637	Vertical fixe	1965	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
251	KMW154	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	154	Out of service		7637	Vertical fixe	1965	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
252	KMW155	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	155	Out of service		4200	Vertical fixe	1965	73.015503	4.82095	30.290922	7.6896	-122.7436	45.565032	None	NA	Pre-1993 or	On Land	Tank Failure	
253	KMW156	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	156	Out of service	0	7667	Vertical fixe	1965	73.015503	4.82095	30.290922	14.0372	-122.7435	45.565019	None	NA	Pre-1993 or	On Land	Tank Failure	
254	KMW157	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	157	Out of service		24868	Vertical fixe	1969	113.765	6.0176902	37.810263	29.2215	-122.7431	45.564896	None	NA	Pre-1993 or	On Land	Tank Failure	
255	KMW158	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	158	Out of service	0	24851	Vertical fixe	1969	113.765	6.0176902	37.810263	29.2015	-122.743	45.564877	None	NA	Pre-1993 or	On Land	Tank Failure	
256	KMW159	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	159	Out of service	0	21000	Vertical fixe	1969	113.765	6.0176902	37.810263	24.6763	-122.743	45.56486	None	NA	Pre-1993 or	On Land	Tank Failure	
257	KMW16	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	16	Out of service		2814	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
258	KMW160	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	160	Out of service	0	24860	Vertical fixe	1969	113.765	6.0176902	37.810263	29.212099	-122.7429	45.564843	None	NA	Pre-1993 or	On Land	Tank Failure	
259	KMW161	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	161	Out of service	0	24863	Vertical fixe	1969	99.280998	5.6215801	35.321429	33.477798	-122.7431	45.564858	None	NA	Pre-1993 or	On Land	Tank Failure	
260	KMW162	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	162	Out of service	0	24850	Vertical fixe	1969	104.796	5.77561	36.289228	31.6994	-122.743	45.564842	None	NA	Pre-1993 or	On Land	Tank Failure	
261	KMW163	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	163	Out of service	0	24856	Vertical fixe	1969	117.422	6.1136398	38.413132	28.297701	-122.743	45.564818	None	NA	Pre-1993 or	On Land	Tank Failure	
262	KMW166	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	166	Contact water	20160	33600	Vertical fixe	1970	0	0	0	0	0	0	None	No	Pre-1993 or	No Data	Tank Failure	
263	KMW167	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	167	Contact water	14414	24024	Vertical fixe	1928	0	0	0	0	0	0	None	No	Pre-1993 or	No Data	Tank Failure	
264	KMW169	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	169	Out of service	0	24990	Vertical fixe	1928	96.093102	5.5305901	34.749722	34.765099	-122.7429	45.564788	None	NA	Pre-1993 or	On Land	Tank Failure	

FID	TANK_ID	Owner	Facility	Facility_S	Container	Substance	Average_Fi	Capacity__	Containe_1	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		2814	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
266	KMW170	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	170	Out of service	0	24990	Vertical fixe	1928	128.702	6.4005599	40.215904	25.956801	-122.7429	45.564766	None	NA	Pre-1993 or	On Land	Tank Failure	
267	KMW171	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	171	Out of service	0	24990	Vertical fixe		81.9217	5.1065202	32.085213	40.778999	-122.7428	45.564804	None	NA	Pre-1993 or	On Land	Tank Failure	
268	KMW172	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	172	Out of service	0	24990	Vertical fixe		105.765	5.8022499	36.456611	31.586	-122.7429	45.564824	None	NA	Pre-1993 or	On Land	Tank Failure	
270	KMW176	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	176	Out of service	0	25353	Vertical fixe		106.921	5.8338699	36.655286	31.698299	-122.7428	45.564781	None	NA	Pre-1993 or	On Land	Tank Failure	
271	KMW177	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	177	Out of service	0	24457	Vertical fixe		98.250503	5.59233	35.137646	33.276501	-122.7428	45.564744	None	NA	Pre-1993 or	On Land	Tank Failure	
272	KMW18	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	18	Out of service		2814	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
273	KMW186	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	186	Out of service		25604	Vertical fixe		112.875	5.9941001	37.662042	30.3235	-122.7428	45.564746	None	NA	Pre-1993 or	On Land	Tank Failure	
274	KMW187	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	187	Out of service	0	24000	Vertical fixe		114.719	6.04287	37.968472	27.966999	-122.7428	45.564709	None	NA	Pre-1993 or	On Land	Tank Failure	
275	KMW188	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	188	Out of service	0	24600	Vertical fixe		113.765	6.0176902	37.810263	28.9065	-122.7427	45.564724	None	NA	Pre-1993 or	On Land	Tank Failure	
276	KMW189	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	189	Out of service	0	24035	Vertical fixe		99.280998	5.6215801	35.321429	32.3629	-122.7427	45.564688	None	NA	Pre-1993 or	On Land	Tank Failure	
277	KMW190	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	190	Additive	5040	8400	Horizontal T	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
278	KMW192	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	192	Additive	4838	8064	Horizontal T	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
279	KMW193	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	193	Additive	6048	10080	Horizontal T	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
280	KMW194	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	194	Slop water	3780	6300	Horizontal T	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
282	KMW22	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	22	Out of service		11760	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
283	KMW23	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	23	Out of service		11718	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
284	KMW25	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	25	Out of service		11760	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
285	KMW26	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	26	Out of service		22806	Vertical fixe	1916	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
286	KMW3	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	3	Out of service	0	553350	Vertical fixe	1915	2835.3601	30.042	188.75945	26.089199	-122.7434	45.565155	None	NA	Pre-1993 or	On Land	Tank Failure	
287	KMW30	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	30	Out of service		11718	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
288	KMW31	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	31	Out of service		11760	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
289	KMW32	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	32	Out of service		11472	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
290	KMW33	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	33	Out of service		17472	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
291	KMW34	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	34	Out of service		17481	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
292	KMW35	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	35	Out of service		4397	Vertical fixe	1924	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
293	KMW36	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	36	Out of service		4368	Vertical fixe	1924	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
294	KMW37	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	37	Out of service		4368	Vertical fixe	1924	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
295	KMW38	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	38	Out of service		4368	Vertical fixe	1924	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
296	KMW39	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	39	Out of service		4397	Vertical fixe	1924	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
297	KMW4	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	4	Out of service		215754	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
298	KMW40	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	40	Out of service		5544	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
299	KMW41	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	41	Out of service		5502	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
300	KMW42	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	42	Out of service		5502	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
301	KMW43	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	43	Out of service		5502	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
302	KMW44	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	44	Out of service		5515	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
303	KMW45	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	45	Out of service		5540	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
304	KMW46	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	46	Out of service		11642	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
305	KMW47	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	47	Out of service		11600	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
306	KMW48	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	48	Out of service		11642	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
307	KMW49	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	49	Out of service		11677	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
308	KMW5	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	5	Out of service	0	439605	Vertical fixe	1915	1745.9	23.574101	148.12044	33.659901	-122.7433	45.565342	None	NA	Pre-1993 or	On Land	Tank Failure	
309	KMW50	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	50	Out of service		11507	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
310	KMW51	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	51	Out of service		11634	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
313	KMW56	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	56	Out of service		19867	Vertical fixe	1929	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
314	KMW57	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	57	Out of service		19800	Vertical fixe	1929	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
315	KMW58	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	58	Out of service		19800	Vertical fixe	1929	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
316	KMW59	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	59	Out of service		19855	Vertical fixe	1929	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
317	KMW6	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	6	Out of service	0	215166	Vertical fixe	1915	1092.09	18.644699	117.1481	26.3381	-122.7431	45.565153	None	NA	Pre-1993 or	On Land	Tank Failure	
318	KMW60	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	60	Out of service		19824	Vertical fixe	1929	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
319	KMW61	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	61	Out of Service	0	25200	Vertical fixe	1929	147.17101	6.84442	43.004759	22.8901	-122.7439	45.56518	None	NA	Pre-1993 or	On Land	Tank Failure	
320	KMW62	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	62	Out of service	0	11676	Vertical fixe	1929	73.015503	4.82095	30.290922	21.3771	-122.7438	45.56515	None	NA	Pre-1993 or	On Land	Tank Failure	
321	KMW63	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	63	Out of service	0	24766	Vertical fixe	1929	99.280998	5.6215801	35.321429	33.347198	-122.7431	45.564875	None	NA	Pre-1993 or	On Land	Tank Failure	
323	KMW66	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	66	Out of service		856800	Vertical fixe	1930	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
325	KMW7	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	7	Out of service	0	440538	Vertical fixe	1915	2565.3799	28.576	179.5483	22.956301	-122.7431	45.565529	None	NA	Pre-1993 or	On Land	Tank Failure	
328	KMW72	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	72	Out of service		549024	Vertical fixe	1937	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
330	KMW74	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	74	Out of service	0	305712	Vertical fixe	1937	1092.09	18.644699	117.1481	37.4217	-122.7428	45.565453	None	NA	Pre-1993 or	On Land	Tank Failure	
331	KMW75	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	75	Out of service		25000	Vertical fixe	1938	119.016	6.1550002	38.673007	28.0805	-122.7431	45.564924	None	NA	Pre-1993 or	On Land	Tank Failure	
332	KMW76	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	76	Out of service	0	25000	Vertical fixe	1938	147.17101	6.84442	43.004759	22.708401	-122.7434	45.564991	None	NA	Pre-1993 or	On Land	Tank Failure	
333	KMW77	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	77	Out of service		25741	Vertical fixe	1938	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
334	KMW8	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	8	Out of service	0	216804	Vertical fixe	1915	1092.09	18.644699	117.1481	26.538601	-122.743	45.565331	None	NA	Pre-1993 or	On Land	Tank Failure	
335	KMW82	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	82	Out of service		11642	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
336	KMW83	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	83	Out of service		19867	Vertical fixe	1923	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
339	KMW86	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	86	Out of service	0	222805	Vertical fixe	1948	843.57397	16.386499	102.95941	35.307899	-122.7446	45.56569	None	NA	Pre-1993 or	On Land	Tank Failure	
340	KMW87	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	87	Out of service		222469	Vertical fixe	1948	843.54401	16.3862	102.95753	35.255901	-122.7448	45.565731	None	NA	Pre-1993 or	On Land	Tank Failure	
341	KMW88	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	88	Out of service		222574	Vertical fixe	1948	962.85602	17.5068	109.99847	30.901699	-122.7447	45.56559	None	NA	Pre-1993 or	On Land	Tank Failure	
342	KMW89	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	89	Out of service	0	222919	Vertical fixe	1948	923.59003	17.146099	107.73212	32.2654	-122.7449	45.565625	None	NA	Pre-1993 or	On Land	Tank Failure	
343	KMW9	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	9	Out of service		22722	Vertical fixe	1915	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
344	KMW90	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	90	Out of service		2982	Vertical fixe	1946	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
345	MC1	McCall	McCall Portland Terminal	MC	1	Asphalt	2021124	11247180	Cone roof	1976	33247.5	102.874	646.37641	45.2225	-122.7356	45.564617	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
347	MC11	McCall	McCall Portland Terminal	MC	11	Oil and water	5000	20160	Cone roof	1974	171.76601	7.3942499	46.459442	15.69	-122.7339	45.563723	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
348	MC12	McCall	McCall Portland Terminal	MC	12	Oil and water	5000	10080	Cone roof	1974	171.76601	7.3942499	46.459442	7.8449998	-122.734	45.563827	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
351	MC18	McCall	McCall Portland Terminal	MC	18	Anti-strip	3276	4914	Cone roof	1989	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
352	MC19	McCall	McCall Portland Terminal	MC	19	Asphalt	285180	427770	Cone roof	1954	1650.62	22.921801	144.02192	34.644402	-122.7356	45.562501	NA	NA	Pre-1993 or	On Land	Tank Failure	
353	MC2	McCall	McCall Portland Terminal	MC	2	Asphalt	1577184	11787300	Cone roof	1973	40071.801	112.939	709.61668	39.322899	-122.7347	45.564029	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
354	MC20	McCall	McCall Portland Terminal	MC	20	Asphalt	285180	427770	Cone roof	1954	1672.0699	23.070299	144.95496	34.200001	-122.7358	45.562379	NA	NA	Pre-1993 or	On Land	Tank Failure	
355	MC21	McCall	McCall Portland Terminal	MC	21	Asphalt	285376	428064	Cone roof	1954	1672.0699	23.070299	144.95496	34.223499	-122.736	45.562265	NA	NA	Pre-1993 or	On Land	Tank Failure	
356	MC22	McCall	McCall Portland Terminal	MC	22	Asphalt	12628	18942	Cone roof	1954	171.76601	7.3942499	46.459442	14.7421	-122.736	45.56204	NA	NA	Pre-1993 or	On Land	Tank Failure	
357	MC23	McCall	McCall Portland Terminal	MC	23	Asphalt	12712	18942	Cone roof	1954	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
362	MC28	McCall	McCall Portland Terminal	MC	28	Boiler fuel	5472	8358	Cone roof	1954	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
363	MC29	McCall	McCall Portland Terminal	MC	29	Unichem	5000	11000	Cone roof	1974	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
373	NU1009	NuStar	Nustar Portland Terminal	NU	1009	Gasoline/Diesel	366366	392887	Internal floa	1981	926.26202	17.1709	107.88795	56.702702	-122.7741	45.589498	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
374	NU1010	NuStar	Nustar Portland Terminal	NU	1010	Gasoline/Diesel	342636	393264	Internal floa	1980	1217.3199	19.684601	123.68199	43.1866	-122.7739	45.589242	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
376	NU1315	NuStar	Nustar Portland Terminal	NU	1315	Out of service	51366	56124	Cone	1938	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
377	NU1316	NuStar	Nustar Portland Terminal	NU	1316	Out of service	51366	56112	Cone	1938	0	0	0	0	0	0	None	NA	Pre-1993 or	No Data	Tank Failure	
378	NU181	NuStar	Nustar Portland Terminal	NU	181	Gasoline/Diesel additive	3000	7685	Cone	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
379	NU195	NuStar	Nustar Portland Terminal	NU	195	N/A	0	0			0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
384	NU212	NuStar	Nustar Portland Terminal	NU	212	N/A	0				0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
385	NU23	NuStar	Nustar Portland Terminal	NU	23	Gasoline/Diesel additive	7500	10048	Cone	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
386	NU24	NuStar	Nustar Portland Terminal	NU	24	Biodiesel additive	700	0	Horizontal	Unknown	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
387	NU2511	NuStar	Nustar Portland Terminal	NU	2511	MFO	1001742	1060587	Cone	1925	5070.3701	40.174	252.42069	27.9625	-122.7777	45.592612	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
388	NU2512	NuStar	Nustar Portland Terminal	NU	2512	MFO	1003926	1049587	Cone	1925	4620.2998	38.349602	240.95765	30.368099	-122.7775	45.592399	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
390	NU2706	NuStar	Nustar Portland Terminal	NU	2706	Gasoline/Diesel	1071000	1085895	Internal floa	1980	4450.9302	37.640099	236.49971	32.614201	-122.774	45.589047	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
391	NU30	NuStar	Nustar Portland Terminal	NU	30	N/A	0	0			0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
393	NU3203	NuStar	Nustar Portland Terminal	NU	3203	Gasoline/Diesel	1250071	1265942	Internal floa	1979	4631.6099	38.3965	241.25232	36.538601	-122.7735	45.589324	NA	NA	Pre-1993 or	Material in Water	Tank Failure	

FID	TANK_ID	Owner	Facility	Facility_S	Container	Substance	Average_Fi	Capacity	Containe_1	Year_Built	Area__ft_2	Radius__ft	Perimeter	Height__ft	Longitude	Latitude	Flammabili	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	1376886	1442470	Cone	1938	4620.8398	38.351799	240.97146	41.730701	-122.7781	45.592887	NA	NA	Pre-1993 or	Material in Water	Tank Failure	
397	NU3614	NuStar	Nustar Portland Terminal	NU	3614	Gasoline/Diesel	1295238	1398810	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	1825740	1849692	Internal floa	1980	6499.3799	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	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
405	NU6408	NuStar	Nustar Portland Terminal	NU	6408	Gasoline/Diesel	2594466	2649782	Internal floa	1981	8075.1699	50.6992	318.55247	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	3379698	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	30000	60000		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	60000		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	20000		1980	2769.5701	29.6915	186.55719	0.965356	-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	40000	80000		1940	11006.4	59.189899	371.90111	0.97166	-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	55000		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	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
421	PH2713	Phillips 66	Phillips 66	PH	2713	Unax AW 46	Not listed	109000	Welded Ste	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 Ste	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 Ste	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 Ste	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 Ste	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 Ste	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 525	Not listed	200000	Welded Ste	1949	772.41803	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 Ste	1949	588.65399	13.6885	86.007385	45.419201	-122.7395	45.561285	NA	NA	Pre-1993 or	On Land	Tank Failure	
440	PH3417	Phillips 66	Phillips 66	PH	3417	ULTRA S-4	Not listed	200000	Welded Ste	1949	821.435	16.170099	101.59973	32.548199	-122.7394	45.561389	NA	NA	Pre-1993 or	On Land	Tank Failure	
441	PH3579	Phillips 66	Phillips 66	PH	3579	Industrial Fuel Oil	Not listed	3307668	Welded Ste	1950	12916.7	64.121101	402.88476	34.232601	-122.7392	45.56094	NA	NA	Pre-1993 or	On Land	Tank Failure	
442	PH36	Phillips 66	Phillips 66	PH	36	Stop Oil	Not listed	20496	Riveted Ste	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	HiTech 6576	Not listed	18228	Welded Ste	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 Ste	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 Ste	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 600 N	Not listed	277000	Welded Ste	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 Ste	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 Ste	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 Ste	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 Ste	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 Ste	1954	114.719	6.04287	37.968472	20.392599	-122.7408	45.560603	NA	NA	Pre-1993 or	On Land	Tank Failure	
453	PH3747	Phillips 66	Phillips 66	PH	3747	Lubrizol 4990CH	Not listed	17500	Welded Ste	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 Ste	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 Ste	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 48254	Not listed	17500	Welded Ste	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 Ste	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 Ste	1968	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
460	PH4241	Phillips 66	Phillips 66	PH	4241	UNAX AW 68	Not listed	17500	Welded Ste	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 Ste	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	HT4/10W	Not listed	17500	Welded Ste	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 Ste	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 525	Not listed	17500	Welded Ste	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 Ste	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 Ste	1968	2448.8301	27.9193	175.42214	24.635799	-122.7394	45.560553	NA	NA	Pre-1993 or	On Land	Tank Failure	
469	PH4256	Phillips 66	Phillips 66	PH	4256	Out of Service	Not listed	195408	Welded Ste	1968	743.20001	15.3808	96.640418	35.148499	-122.7391	45.56059	None	NA	Pre-1993 or	On Land	Tank Failure	
470	PH4257	Phillips 66	Phillips 66	PH	4257	Out of Service	Not listed	38367	Welded Ste	1968	743.91901	15.3882	96.686911	6.8944898	-122.7389	45.560485	None	NA	Pre-1993 or	On Land	Tank Failure	
471	PH4258	Phillips 66	Phillips 66	PH	4258	Line Clippings	Not listed	18000	Welded Ste	1968	114.719	6.04287	37.968472	20.975201	-122.7395	45.561511	NA	NA	Pre-1993 or	On Land	Tank Failure	
473	PH4266	Phillips 66	Phillips 66	PH	4266	Flush	Not listed	17500	Welded Ste	1968	114.719	6.04287	37.968472	20.392599	-122.7395	45.561538	NA	NA	Pre-1993 or	On Land	Tank Failure	
474	PH4281	Phillips 66	Phillips 66	PH	4281	Versa Tran ATF	Not listed	17500	Welded Ste	1969	114.719	6.04287	37.968472	20.392599	-122.7407	45.560534	NA	NA	Pre-1993 or	On Land	Tank Failure	
475	PH4300	Phillips 66	Phillips 66	PH	4300	Ramar CLF 17E	Not listed	25500	Welded Ste	1969	114.719	6.04287	37.968472	29.714899	-122.741	45.560593	NA	NA	Pre-1993 or	On Land	Tank Failure	
476	PH4302	Phillips 66	Phillips 66	PH	4302	RLOP 600N	Not listed	17500	Welded Ste	1971	114.719	6.04287	37.968472	20.392599	-122.7394	45.561448	NA	NA	Pre-1993 or	On Land	Tank Failure	
477	PH4303	Phillips 66	Phillips 66	PH	4303	RLOP 100N	Not listed	17500	Welded Ste	1971	114.719	6.04287	37.968472	20.392599	-122.7393	45.561419	NA	NA	Pre-1993 or	On Land	Tank Failure	
478	PH4305	Phillips 66	Phillips 66	PH	4305	Out of Service	Not listed	8900	Welded Ste	1971	114.719	6.04287	37.968472	10.3711	-122.7393	45.561392	None	NA	Pre-1993 or	On Land	Tank Failure	
479	PH4306	Phillips 66	Phillips 66	PH	4306	RLOP 100N	Not listed	200000	Welded Ste	1971	744.26202	15.3918	96.709531	35.923099	-122.7393	45.561303	NA	NA	Pre-1993 or	On Land	Tank Failure	
481	PH4320	Phillips 66	Phillips 66	PH	4320	Sup Syn BL 10W/30	Not listed	35000	Welded Ste	1973	193.702	7.8522201	49.336954	24.1548	-122.739	45.561162	NA	NA	Pre-1993 or	On Land	Tank Failure	
482	PH4321	Phillips 66	Phillips 66	PH	4321	Uniguide II 100	Not listed	35000	Welded Ste	1973	193.702	7.8522201	49.336954	24.1548	-122.739	45.561127	NA	NA	Pre-1993 or	On Land	Tank Failure	
483	PH4322	Phillips 66	Phillips 66	PH	4322	T5X HD 15W/40	Not listed	35000	Welded Ste	1973	249.78	8.9167004	56.025281	18.7318	-122.7389	45.561085	NA	NA	Pre-1993 or	On Land	Tank Failure	
484	PH4323	Phillips 66	Phillips 66	PH	4323	Super ATF	Not listed	35000	Welded Ste	1973	190.078	7.77842	48.873254	24.615299	-122.7389	45.561043	NA	NA	Pre-1993 or	On Land	Tank Failure	
485	PH4327	Phillips 66	Phillips 66	PH	4327	Gasoline Slops	Not listed	10080	Welded Ste	1974	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
486	PH4331	Phillips 66	Phillips 66	PH	4331	Ethyl HITEC 6888E	Not listed	25500	Welded Ste	1973	114.719	6.04287	37.968472	29.714899	-122.741	45.560631	NA	NA	Pre-1993 or	On Land	Tank Failure	
488	PH4333	Phillips 66	Phillips 66	PH	4333	Point Premier 10W/30	Not listed	17500	Welded Ste	1973	114.719	6.04287	37.968472	20.392599	-122.7407	45.560477	NA	NA	Pre-1993 or	On Land	Tank Failure	
489	PH4334	Phillips 66	Phillips 66	PH	4334	Super 5W/20	Not listed	17500	Welded Ste	1973	114.719	6.04287	37.968472	20.392599	-122.7407	45.560444	NA	NA	Pre-1993 or	On Land	Tank Failure	
490	PH4369	Phillips 66	Phillips 66	PH	4369	RLOP 220 N	Not listed	17500	Welded Ste	1979	193.702	7.8522201	49.336954	12.0774	-122.7408	45.562184	NA	NA	Pre-1993 or	On Land	Tank Failure	
491	PH4388	Phillips 66	Phillips 66	PH	4388	Utility	Not listed	13500	Welded Ste	1984	114.719	6.04287	37.968472	15.7314	-122.741	45.560695	NA	NA	Pre-1993 or	On Land	Tank Failure	
492	PH4389	Phillips 66	Phillips 66	PH	4389	Utility	Not listed	13500	Welded Ste	1984	114.719	6.04287	37.968472	15.7314	-122.741	45.56067	NA	NA	Pre-1993 or	On Land	Tank Failure	
493	PH4390	Phillips 66	Phillips 66	PH	4390	Bar & Chain 150	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7411	45.560641	NA	NA	Pre-1993 or	On Land	Tank Failure	
494	PH4391	Phillips 66	Phillips 66	PH	4391	Utility	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7411	45.560612	NA	NA	Pre-1993 or	On Land	Tank Failure	
495	PH4392	Phillips 66	Phillips 66	PH	4392	Utility	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7411	45.560724	NA	NA	Pre-1993 or	On Land	Tank Failure	
496	PH4393	Phillips 66	Phillips 66	PH	4393	Utility	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7411	45.560698	NA	NA	Pre-1993 or	On Land	Tank Failure	
497	PH4394	Phillips 66	Phillips 66	PH	4394	Utility	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7411	45.560668	NA	NA	Pre-1993 or	On Land	Tank Failure	
498	PH4395	Phillips 66	Phillips 66	PH	4395	Utility	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7411	45.560639	NA	NA	Pre-1993 or	On Land	Tank Failure	
499	PH4397	Phillips 66	Phillips 66	PH	4397	Lubrizol 9692A	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7411	45.560747	NA	NA	Pre-1993 or	On Land	Tank Failure	
500	PH4398	Phillips 66	Phillips 66	PH	4398	HITEC 1193A	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7411	45.560719	NA	NA	Pre-1993 or	On Land	Tank Failure	
501	PH4399	Phillips 66	Phillips 66	PH	4399	Firebird 15W/40	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7412	45.560693	NA	NA	Pre-1993 or	On Land	Tank Failure	
502	PH4400	Phillips 66	Phillips 66	PH	4400	Guardol 30	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7412	45.560664	NA	NA	Pre-1993 or	On Land	Tank Failure	
503	PH4401	Phillips 66	Phillips 66	PH	4401	Mohawk 150	Not listed	13500	Welded Ste	1985	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
504	PH4402	Phillips 66	Phillips 66	PH	4402	TSX HD10	Not listed	13500	Welded Ste	1985	0	0	0	0	0	0	NA	NA	Pre-1993 or	No Data	Tank Failure	
505	PH4403	Phillips 66	Phillips 66	PH	4403	HT4/30W	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7412	45.560719	NA	NA	Pre-1993 or	On Land	Tank Failure	
506	PH4404	Phillips 66	Phillips 66	PH	4404	Fleet Sup EC 15W/40	Not listed	13500	Welded Ste	1985	114.719	6.04287	37.968472	15.7314	-122.7412	45.560692	NA	NA	Pre-1993 or	On Land	Tank Failure	
507	PH4405	Phillips 66	Phillips 66	PH	4405	HITEC 3472	Not listed	13500	Welded Ste	1987	114.719	6.04287	37.968472	15.7314	-122.7412	45.560801	NA	NA	Pre-1993 or	On Land	Tank Failure	
508	PH4406	Phillips 66	Phillips 66	PH	4406	Lubrizol 9990A	Not listed	13500	Welded Ste	1987	114.719	6.04287	37.968472	15.7314	-122.7412	45.560773	NA	NA	Pre-1993 or	On Land	Tank Failure	
509	PH4407	Phillips 66	Phillips 66	PH	4407	Ethyl HITEC 388	Not listed	13500	Welded Ste	1987	114.719	6.04287	37.968472	15.7314	-122.7412	45.560747	NA	NA	Pre-1993 or	On Land	Tank Failure	
510	PH4408	Phillips 66	Phillips 66	PH	4408	Ethyl HITEC 5756	Not listed	13500	Welded Ste	1987	114.719	6.04287	37.968472	15.7314	-122.7413	45.560717	NA	NA	Pre-1993 or	On Land	Tank Failure	
512	PHF103	Phillips 66	Phillips 66	PH	F103	UTRA 58	Not listed	25500	Welded Ste	1973	0	0	0	0	0	0			Pre-1993 or	No Data	Tank Failure	
513	PHF104	Phillips 66	Phillips 66	PH	F104	UTRA 59	Not listed	17500	Welded Ste	1973	0	0	0	0	0	0			Pre-1993 or	No Data	Tank Failure	
511	PH4441	Phillips 66	Phillips 66	PH	4441	Octel 9056	Not listed	18648	Welded Ste	1993	193.702	7.8522201	49.336954	12.8697	-122.741	45.562543	NA	NA	1993 - 2004	On Land	No Tank Failure	
12	BP23a	BP	British Petroleum South Tank Farm	BP	23	Diesel additive	1800	2000	Fixed Roof	2005	0	0	0	0	0	0	NA	NA	Post 2004	No Data	No Tank Failure	
13	BP23b	BP	British Petroleum Outside Tank Farm	BP	23	Diesel Lubricity Additive	2100	2100	Horizontal T	2005	0	0	0	0	0	0	NA	NA	Post 2004	No Data	No Tank Failure	
93	CH163	Chevron	Chevron Willbridge	CH	163	Swing Tank	5684255	6354155	AST	2009	0	0	0	0	0	0	NA	NA	Post 2004	No Data	No Tank Failure	
94	CH164	Chevron	NUChevron WillbridgeLL	CH	163	Swing Tank	5684255	6354155	AST	2009	13583.1	65.754402	413.14709	62.535801	-122.741	45.564906	NA	NA	Post 2004	On Land	No Tank Failure	

FID	TANK_ID	Owner	Facility	Facility_S	Container	Substance	Average_Fi	Capacity	Containe_1	Year_Built	Area__ft_2	Radius__ft	Perimeter	Height__ft	Longitude	Latitude	Flammabili	Hazardous	Year_cat	damagezone	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	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	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	NA	NA	1993 - 2004	No Data	Uncertain Location	
105	CH184	Chevron	Chevron Willbridge	CH	184	Blended Oil	10000	11374	Fx	1994	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	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	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	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	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	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	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	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	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	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	NA	NA	1993 - 2004	No Data	Uncertain Location	
416	PA7	Pacific Terminal Se	Pacific Terminal Services Portland Terminal	PA	7	Residual oil	250	475		1993	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	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 or	Material in Water	Tank Failure	Flammable
1	BP10	BP	British Petroleum South Tank Farm	BP	10	Diesel	931980	1008840	Fixed Roof	1941	4362.7798	37.265499	234.14604	30.9121	-122.7788	45.593866	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
2	BP11	BP	British Petroleum North Tank Farm	BP	11	Gasoline	1129926	1354122	Internal Floa	1940	4632.2002	38.398899	241.2674	39.078701	-122.78	45.594442	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
3	BP12	BP	British Petroleum North Tank Farm	BP	12	Ethanol	561204	605346	Internal Floa	1961	1678.34	23.113501	145.22641	48.216301	-122.7802	45.594962	Category 2	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
4	BP13	BP	British Petroleum North Tank Farm	BP	13	Ethanol	559482	602994	Internal Floa	1961	1944.0699	24.875999	156.30051	41.464001	-122.7804	45.595251	Category 2	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
5	BP14	BP	British Petroleum South Tank Farm	BP	14	Diesel	1046388	1121736	Fixed Roof	1942	3466.8301	33.219398	208.72364	43.2542	-122.7794	45.593616	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
7	BP17	BP	British Petroleum South Tank Farm	BP	17	Diesel	3125472	3329340	Fixed Roof	1940	11531.8	60.586201	380.67433	38.595001	-122.7787	45.593523	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
8	BP18	BP	British Petroleum South Tank Farm	BP	18	Diesel	1046262	1104726	Fixed Roof	1945	3610.9099	33.902599	213.01631	40.898499	-122.7797	45.593508	Category 3	Yes	Pre-1993 or	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 or	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 or	Material in Water	Tank Failure	Flammable
25	BP46	BP	British Petroleum BioDiesel Tanks	BP	46	Biodiesel	125571	221970	Fixed Roof	1954	1006.89	17.902599	112.48535	29.4701	-122.7793	45.594005	Category 3	Yes	Pre-1993 or	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 or	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 or	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 or	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	43.929699	-122.7804	45.594271	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
30	BP9	BP	British Petroleum South Tank Farm	BP	9	Diesel	2161404	2295636	Fixed Roof	1940	10673.9	58.289001	366.2406	28.750799	-122.7793	45.593245	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
35	CH101	Chevron	Chevron Willbridge	CH	101	Compressor Oil	17128	17284	Fixed Roof	1958	114.719	6.04287	37.968472	20.1409	-122.7429	45.564228	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
68	CH138	Chevron	Chevron Willbridge	CH	138	Drive Train Fluid HD 10	18000	17378	Fx	Unknown	0	0	0	0	0	0	Category 1	Yes	Pre-1993 or	No Data	Tank Failure	Flammable
77	CH146	Chevron	Chevron Willbridge	CH	146	Transmix	22715	25447	Fx	Unknown	0	0	0	0	0	0	Category 2	Yes	Pre-1993 or	No Data	Tank Failure	Flammable
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 or	On Land	Tank Failure	Flammable
150	CH64	Chevron	Chevron Willbridge	CH	64	Diesel	754034	844275	Fixed Roof	1947	2902.78	30.3971	190.99061	38.881199	-122.7408	45.564509	Category 3	Yes	Pre-1993 or	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	45.564101	Category 3	Yes	Pre-1993 or	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	Category 1	Yes	Pre-1993 or	No Data	Tank Failure	Flammable
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 or	Material in Water	Tank Failure	Flammable
182	KML17020	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	17020	Gasoline	445738	742896	Internal floa	1941	3078.0801	31.3015	196.67313	32.264	-122.786	45.603335	Category 1	Yes	Pre-1993 or	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	45.602926	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
184	KML20011	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	20011	Diesel	513904	856506	Vertical fixe	1932	3965.53	35.5284	223.23152	28.873501	-122.7867	45.602706	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
189	KML30016	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	30016	Deisel	752270	1253784	Vertical fixe	1941	6522.73	45.565899	286.29899	25.6959	-122.7862	45.602855	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
202	KML45028	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	45028	Gasoline	1133723	1889538	External floa	1955	5517.6699	41.9086	263.3195	45.779301	-122.7858	45.602662	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
206	KML55022	Kinder Morgan	Kinder Morgan Linnton Terminal	KML	55022	Gasoline	1385572	2309286	Vertical fixe	1928	10371.9	57.4585	361.0224	29.7638	-122.787	45.60332	Category 1	Yes	Pre-1993 or	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 or	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 or	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 or	On Land	Tank Failure	Flammable
217	KMW105	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	105	Ethanol	100800	168000	Internal floa	1951	477.67001	12.3307	77.476072	47.016602	-122.7451	45.5658	Category 2	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
220	KMW116	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	116	Gasoline	2031120	3385200	Internal floa	1961	12590.2	63.3055	397.76019	35.9436	-122.745	45.567149	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
222	KMW118	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	118	Gasoline	1416240	2360400	Internal floa	1951	9557.9004	55.1577	346.56605	33.013599	-122.746	45.566662	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
227	KMW123	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	123	Gasoline	1993320	3322200	Internal floa	1952	11855.1	61.4296	385.97356	37.461899	-122.7449	45.567958	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
228	KMW124	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	124	Gasoline	2036160	3393600	Internal floa	1952	13821.9	66.329903	416.76307	32.8218	-122.7454	45.566743	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
232	KMW128	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	128	Gasoline	1408680	2347800	Internal floa	1953	7758.3398	49.694698	312.241	40.453999	-122.7453	45.567578	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
236	KMW134	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	134	Gasoline	1418760	2364600	Internal floa	1955	9553.7402	55.145699	346.49064	33.0867	-122.7457	45.567151	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
238	KMW138	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	138	Avgas	343098	571830	Internal floa	1956	2069.01	25.662901	161.24476	36.946602	-122.7457	45.566167	Category 2	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
249	KMW152	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	152	Ethanol	287280	47800	Internal floa	1964	1770.41	23.739	149.15654	3.6093099	-122.7446	45.566407	Category 2	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
269	KMW173	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	173	Jet A	29988	49980	Vertical fixe	1972	0	0	0	0	0	0	Category 3	Yes	Pre-1993 or	No Data	Tank Failure	Flammable
281	KMW2	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	2	Jet A	1905120	3175200	Vertical fixe	1915	12419.4	62.8746	395.05276	34.177502	-122.7438	45.565383	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
311	KMW52	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	52	Jet A	1937880	3229800	Vertical fixe	1923	10887.1	58.868301	369.88045	39.658199	-122.7434	45.565822	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
312	KMW54	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	54	Diesel	2061360	3435600	Vertical fixe	1929	4297.3198	36.984901	232.38299	106.875	-122.7431	45.566148	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
322	KMW65	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	65	Jet A	516802	861336	Vertical fixe	1930	0	0	0	0	0	0	Category 3	Yes	Pre-1993 or	No Data	Tank Failure	Flammable
324	KMW69	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	69	Jet A	2058840	3431400	Vertical fixe	1937	13583.1	65.754402	413.14709	33.770901	-122.7423	45.565266	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
326	KMW70	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	70	Jet A	876960	1461600	Vertical fixe	1938	4865.6099	39.3545	247.27161	40.157002	-122.7425	45.5649	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
327	KMW71	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	71	Transmix	517356	862260	Vertical fixe	1937	2432.77	27.8276	174.84597	47.381302	-122.7427	45.566125	Category 2	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
329	KMW73	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	73	Transmix	328028	546714	Vertical fixe	1937	2447.27	27.9104	175.36622	29.864	-122.7428	45.565193	Category 2	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
337	KMW84	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	84	Gasoline	1413720	2356200	Internal floa	1948	8923.8096	53.2967	334.87304	35.296501	-122.7445	45.566047	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
338	KMW85	Kinder Morgan	Kinder Morgan Willbridge Terminal	KMW	85	Diesel	1408680	2347800	Vertical fixe	1948	7903.8901	50.1586	315.15578	39.709099	-122.7442	45.566388	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
365	MC4	McCall	McCall Portland Terminal	MC	4	Bunker	3629766	9357936	Cone roof	1976	32350.699	101.477	637.59878	38.6693	-122.7345	45.563216	Category 2	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
368	MC7	McCall	McCall Portland Terminal	MC	7	Diesel	480942	2658726	Internal floa	1978	9039.71	53.641701	337.04075	39.317799	-122.7357	45.563768	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
369	MC8	McCall	McCall Portland Terminal	MC	8	Diesel	369348	2680482	Internal floa	1977	8936.2598	53.3339	335.10678	40.0984	-122.7353	45.563462	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
380	NU2020	NuStar	Nustar Portland Terminal	NU	2020	Gasoline	750960	821940	Internal floa	1935	2986.05	30.83	193.7106	36.797001	-122.7767	45.591251	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
381	NU2021	NuStar	Nustar Portland Terminal	NU	2021	Gasoline	743148	832032	Internal floa	1935	2953.3601	30.660801	192.64749	37.661099	-122.7765	45.591433	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
382	NU2022	NuStar	Nustar Portland Terminal	NU	2022	Gasoline	751748	832032	Internal floa	1935	3323.05	32.523201	204.3493	33.471298	-122.7764	45.591619	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
389	NU2705	NuStar	Nustar Portland Terminal	NU	2705	Diesel	981246	1158532	Internal floa	1980	4338.5898	37.161999	233.49572	35.6968	-122.7737	45.588845	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
392	NU3201	NuStar	Nustar Portland Terminal	NU	3201	Ethanol	1243998	1264793	Internal floa	1979	4008.3401	35.7197	224.43349	42.181702	-122.7741	45.589769	Category 2	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
395	NU3510	NuStar	Nustar Portland Terminal	NU	3510	Ethanol	1172430	1456019	Internal floa	1937	5692.1699	42.566101	267.4507	34.194698	-122.7788	45.592887	Category 2	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
401	NU5618	NuStar	Nustar Portland Terminal	NU	5618	Gasoline	2142294	2220204	Internal floa	1958	8305.7305	51.4179	323.06819	35.734299	-122.7768	45.591872	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
402	NU5901	NuStar	Nustar Portland Terminal	NU	5901	Gasoline	2032182	2414958	Internal floa	1929	9201.9902	54.120998	340.05226	35.083099	-122.7779	45.592213	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
403	NU5902	NuStar	Nustar Portland Terminal	NU	5902	Diesel	2006802	2386734	Internal floa	1929	9177.79	54.049801	339.60491	34.7645	-122.7782	45.592457	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
404	NU5919	NuStar	Nustar Portland Terminal	NU	5919	Diesel	2259642	2147688	Cone	1935	10791.8	58.6101	368.25812	26.604	-122.777	45.591548	Category 3	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
408	NU8007	NuStar	Nustar Portland Terminal	NU	8007	Gasoline	2662044	3338748	Internal floa	1953	12047.4	61.9258	389.09128	37.0476	-122.7753	45.590229	Category 1	Yes	Pre-1993 or	Material in Water	Tank Failure	Flammable
417	PH1471	Phillips 66	Phillips 66	PH	1471	Hydraulic Tractor Oil	Not listed	17300	Riveted Stee	1921	0	0	0	0	0	0	Category 1	Yes	Pre-1993 or	No Data	Tank Failure	Flammable
418	PH2561	Phillips 66	Phillips 66	PH	2561	Marine Fuel Oil	Not listed	1569582	Riveted Stee	1929	5733.29	42.719601	268.41517	36.597401	-122.7407	45.561992	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
419	PH2579	Phillips 66	Phillips 66	PH	2579	Hydraulic Tractor Oil	Not listed	1800	Welded Stee	1929	193.702	7.8522201	49.336954	1.24225	-122.7409	45.561412	Category 1	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
420	PH2669	Phillips 66	Phillips 66	PH	2669	Marine Diesel	Not listed	449694	Riveted Stee	1931	2692.1299	29.273399	183.93019	22.330099	-122.7409	45.561772	Category 4	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
424	PH2784	Phillips 66	Phillips 66	PH	2784	Diesel #2	Not listed	1439130	Riveted Stee	1937	6162.3198	44.2892	278.27725	31.2195	-122.7406	45.561581	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
425	PH2915	Phillips 66	Phillips 66	PH	2915	Unleaded Gasoline	Not listed	3262056	Welded Stee	1938	12501	63.080898	396.34897	34.883202	-122.7403	45.56275	Category 2	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
426	PH2916	Phillips 66	Phillips 66	PH	2916	Diesel #2	Not listed	1652196	Welded Stee	1938	5695.3398	42.577999	267.52546	38.7803	-122.7399	45.563121	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
428	PH2982	Phillips 66	Phillips 66	PH	2982	Diesel #1	Not listed	416262	Welded Stee	1941	2254.1599	26.7866	168.30517	24.6861	-122.7403	45.56314	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
430	PH3407	Phillips 66	Phillips 66	PH	3407	Unleaded Gasoline	Not listed	2955540	Welded Stee	1949	13851.3	66.400398	417.20601	28.524401	-122.7399	45.563952	Category 2	Yes	Pre-1993 or	Potentially in Water	Tank Failure	Flammable
431	PH3408	Phillips 66	Phillips 66	PH	3408	Unleaded Gasoline	Not listed	1639680	Welded Stee	1949	7671.2798	49.415001	310.48361	28.573299	-122.7394	45.563619	Category 2	Yes	Pre-1993 or	On Land	Tank Failure	Flammable

FID	TANK_ID	Owner	Facility	Facility_S	Container	Substance	Average_Fi	Capacity__	Containe_1	Year_Built	Area__ft_2	Radius__ft	Perimeter	Height__ft	Longitude	Latitude	Flammabili	Hazardous	Year_cat	damagezone	fail	Concern
432	PH3409	Phillips 66	Phillips 66	PH	3409	Unleaded Gasoline	Not listed	948654	Welded Stee	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 Stee	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 Stee	1949	1155.14	19.175301	120.48197	30.0138	-122.7401	45.563615	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 Stee	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 Stee	1949	979.96503	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 Stee	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 Stee	1954	12915.1	64.117104	402.85964	33.540001	-122.7385	45.560404	Category 3	Yes	Pre-1993 or	On Land	Tank Failure	Flammable
472	PH4259	Phillips 66	Phillips 66	PH	4259	Transmix	Not listed	205506	Welded Stee	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 Stee	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	33.098099	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	19337	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	642935	Fixed Roof		1919.3101	24.7171	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		860.79303	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	Fx	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	498258	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	45.56346	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	169.77417	50.464199	-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 Stee	1968	2444.3701	27.8939	175.26254	25.119499	-122.7392	45.560389	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 Stee	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 Stee	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