4.7 Impacts on Resources

Implementation of the regulatory requirements identified in Section 4.2, *Applicable Regulations*, and the mitigation measures described for environmental health risks at the terminal (onsite), related to rail transport, and related to vessel transport (Sections 4.4.3, 4.5.3, and 4.6.3, respectively), would reduce the chances of a spill occurring and would improve emergency response in the event that a spill did occur. However, some risks would remain and it is possible that the proposed bulk liquids, including crude oil could still enter the environment.

This section addresses the potential impacts of the proposed bulk liquids, including crude oil on the human and natural environment. More specifically, this section addresses the types of impacts that could occur if oil spills or fires affected water, plants, or animals, or aesthetic, recreational, cultural, or tribal resources. This section also generally describes the potential impacts of spills, fires, or explosions on human health. The extent of the damage would depend on various unpredictable factors; however, due to the sensitivity of natural and human resources in the study area, depending on the extent of the environmental damage, the potential impacts on the sensitive resources identified below could be significant.

4.7.1 What would be the environmental impacts of a spill?

The impacts of a spill would be most affected by the magnitude of the spill (small, slow leak in a contained area or a large, uncontained amount), the type of liquid, the location (on land or in water). The greatest potential for environmental harm could occur when larger releases enter or directly occur in waterways. In water, spilled materials can spread quickly, depending on the weather and geography. As discussed previously, cleanup and recovery actions would vary based on the spill and resources affected.

4.7.1.1 Water

Surface Waters

Spills into adjacent surface waters or onto the ground at the project site, along the PS&P line, or in the harbor could contaminate marine and inland waters, associated wetlands, and underlying groundwater. The spilled material could expose aquatic and terrestrial plants and animals, aquatic habitats, shorelines, sediments, and humans to contamination.

With respect to the proposed bulk liquids, their behavior in water depends on whether they are crude oil and refined petroleum fuels, or nonpetroleum and primarily plant-based fuels. Unrefined fuels would consist of crude oil and refined petroleum fuels would consist of gasoline, kerosene, naphtha, jet fuels, no. 2 fuel oils, no. 6 fuel oils, and vacuum gas oil. Plant-based fuels would be those that were purely plant-based or that were blended with plant-based materials, such as ethanol, renewable jet fuel, renewable diesel, or used cooking oil or animal fat.

The type, duration, and extent of water resource impacts caused by releases of these potential contaminants depend on numerous factors. These include the type and quantity of the spilled material, location of the release, physical and biological features of the affected environment, sensitivity of various species to the hazardous material, and the material that is encountered (International Tanker Owners Pollution Federation Limited 2011a).

Groundwater

Spills could enter groundwater by infiltration (percolating through the soil column to the water table). This could contaminate municipal and private drinking water wells and other types of wells (e.g., irrigation, industrial supply). Contaminants dissolved in groundwater can also be transported into down-gradient surface waters that are fed by groundwater discharge, degrading surface water quality and potentially affecting aquatic life in those resources (Heath 1989:66–67).

In the study area, the highest risk of groundwater contamination from spilled crude oil and other petroleum and nonpetroleum products would be along the PS&P rail line, which runs through several areas underlain by largely unconfined surficial[1] aquifers. These aquifers are known to interact with surficial water features (e.g., rivers, streams), generally receiving discharge from these features during the winter when river stages are high and discharging to rivers and stream during the summer when river stages are low (Gendaszek 2011:10). Several wells within 0.25 mile of the PS&P rail line provide drinking water for private residences and municipalities, as well as water for irrigation and industrial uses (Washington State Department of Ecology 2015). The PS&P rail line also crosses through a mapped Critical Aquifer Recharge Area[2] around the Black River and Scatter Creek in Thurston County (Thurston County Washington 2010).

4.7.1.2 Plants

The primary impacts on plants from exposure to oil or the other proposed bulk liquids would occur through direct physical and chemical mechanisms as well as through chronic or more persistent mechanisms if a prolonged exposure occurred. These mechanisms are summarized in Table 4.7-1.

The nature and duration of these effects would depend on factors such as the type and quantity of the material released, location of the release (e.g., land or in water), the potential for ignition, physical and biological features of the affected environment (e.g., topography), sensitivity of various species to pollution, and the form of the material that is encountered. In addition to the effects of exposure to released materials, organisms can be damaged by physical and chemical aspects of spill response and cleanup efforts.

The greatest potential for the most extensive environmental exposure would involve a large spill directly to surface waters because the oil could be transported to a much wider geographic area. For these reasons, the subsequent discussion focuses on the potential for impacts on plants for a larger-scale release within Grays Harbor or the Chehalis River.

If a plant comes into direct contact with crude oil or the other contaminants, constituent compounds (e.g., polycyclic aromatic hydrocarbons) can cause acute toxicity, resulting in tissue necrosis and loss

[1] Surficial aquifers are defined as the uppermost saturated zone, typically an unconfined aquifer, or mappable extreme (Washington State Department of Ecology 1998:v). Surficial aquifers in the Chehalis River watershed typically lie only a few feet below land surface and extend to a depth no more than 100 feet.

[2] The Washington State Growth Management Act defines CARAs as areas that have a critical recharging effect on aquifers used as drinking water sources where the aquifer is vulnerable to contamination that could affect the potability of the water (WAC 365-190-030[3]).

of photosynthetic ability. Releases of light refined oils (e.g., jet fuel, kerosene, no. 2 fuel oil, diesel) in confined water bodies or directly into marshes can also result in high direct mortality of marsh vegetation (Michel and Rutherford 2013:2-2–2-5). These materials are generally volatile and highly flammable, but also evaporate and dissolve in water more quickly than crude oil. However, their generally low viscosity also allows them to easily migrate into sediments.

Depending on the amount of a plant's surface that is coated, crude oils and heavy refined oils can destroy plant tissues through direct toxicity and can reduce photosynthesis, oxygen transfer to the roots, and respiration to the point where the aboveground portion of the plant dies. Regrowth from below ground roots and rhizomes is possible within one to two growing seasons, although 3 to 5 years is a typical recovery period for salt marshes such as are present along the shores of Grays Harbor and the lower Chehalis River (International Tanker Owners Pollution Federation Limited 2011a:4; Michel and Rutherford 2013:2-21). Subacute effects on plants can also include reductions in growth or reproductive success, and reduced resistance to environmental stressors.

The specific impacts in the study area would also depend on the time of year and would vary by plant species. In the Grays Harbor area, perennial marsh and shoreline vegetation species begin resprouting from underground roots and rhizomes in early spring and continue to grow through summer, reaching maximum biomass in early autumn. Coating on stems and leaves and reductions in photosynthetic ability in the beginning of the growing season can affect perennial species more than would otherwise occur during the dormant winter season. Recovery of marsh vegetation is more rapid if a release were to occur during the nongrowing season (Michel and Rutherford 2013:2-15). Annual species (which grow each year from seed) are generally more vulnerable than perennial species, but also are typically the first species to recolonize heavily damaged areas (Michel and Rutherford 2013:2-16). If the roots or rhizomes die due to contact with spilled oils, the plant would die, and recovery would depend on the spread and regrowth of plants from outside the affected area.

Dispersed oil in the water column can also affect floating plants (phytoplankton), nonfloating kelp, and primary consumers (zooplankton) typically through direct toxicity. This affects, at least temporarily, the base of the estuarine and marine food web, which, depending on the extent (in size and duration) of the damage, can result in broader ecological damage.

Persistence in the environment and prolonged impacts on vegetation would also depend on the location of the release. Crude oil that reaches the shoreline could coat the physical substrates of the intertidal zone and shoreline. Rocky substrates (e.g., jetties at the mouth of Grays Harbor), once coated, can be cleaned by the mechanical action of waves. In contrast, pebble and sand beaches, such as line the Pacific shoreline north and south of the mouth of Grays Harbor, the substrates that support nonfloating kelp areas, and the mudflats and tidal marshes that are the dominant intertidal habitat in Grays Harbor, are at a higher risk of contamination from persistent effects in the event of a larger-scale release. If such an event were to happen, oil could seep into pore spaces and reach plant stem and root channels and benthic invertebrate burrows. Once oil enters these small pores, it can be very difficult to access and clean up contaminated areas. Heavier and more viscous oils, such as bitumen, may be more likely to remain trapped in pore spaces and thus be more difficult to remove (International Tanker Owners Pollution Federation Limited 2011a:6). High viscosity oils can also form "asphalt pavements"—the oil oxidizes in small pore spaces into hard pavement that can persist for decades (International Tanker Owners Pollution Federation Limited 2011b:7).

Sensitive Areas in the Study Area

Grays Harbor Shoreline, Chehalis River Surge Plain Natural Area and Grays Harbor National Wildlife Refuge (Bowerman Basin)

If a large-scale release were to occur in Grays Harbor or the Chehalis River, the various species of tidal salt marsh plants that fringe the shoreline of Grays Harbor, as well as the tidal surge plain wetland plant communities that characterize the Chehalis River Surge Plain Natural Area Preserve (Figure 3.4-2) and Bowerman Basin, could be affected. Depending on the circumstances, these sensitive areas could be affected through the specific mechanisms discussed above.

Any hazardous materials reaching the shoreline of Grays Harbor could affect macroalgae, nonfloating kelp, tidal marsh plants, aquatic plants, and shoreline/riparian plants directly through coating (as described for floating oil), as well as through acute contact with toxic components of the hazardous materials and sub-acute effects described above.

Tidal marshes and mudflats in the study area are particularly vulnerable to coating and retention of contaminants in sediments and to secondary effects related to increased erosion resulting in changes to the dynamics of the tidal zone that can affect plant species diversity. Depending on the circumstances, releases can be swiftly transported deep into tidal marshes and mudflats by tidal channels. Once trapped in low-energy, sheltered areas, contaminants can permeate the fine-grained mud and sand sediments and can persist in buried layers for long periods (International Tanker Owners Pollution Federation Limited 2011b:6–7; 2011a:7). If extensive areas of tidal marsh are affected, such as might occur in the case of a catastrophic spill, the plants stems and roots could cease to collect and hold sediments, which can lead to increased erosion of the marsh surface. Through this secondary mechanism of sediment loss, catastrophic hazardous materials releases can indirectly result in broader losses of marsh area that persist over time; this phenomenon has been observed in *Spartina* marshes in Louisiana oiled during the British Petroleum Deepwater Horizon crude oil spill (Silliman et al. 2012). Because tidal marsh species dominance and diversity in Grays Harbor (and other Pacific Northwest estuaries) is partially driven by elevation of the tidal zone, changes in erosion and sedimentation could also alter the amount and configuration of high marsh and low marsh plant communities.

Recovery time of tidal marshes is generally fastest in warmer climates, when the released materials are less persistent (e.g., lighter to medium crude oils), and when primarily sediments and not plants are coated. Recovery of tidal marshes is generally the longest in colder climates, when releases occur near sheltered settings, and when the released materials are more persistent (e.g., light refined products with heavy crude oils) (Michel and Rutherford 2013:2-21).

Vegetation along the PS&P Rail Line

If a larger-scale spill occurred along the PS&P rail line, contaminants could enter waterways at numerous crossings and drain to the Chehalis River, and eventually into Grays Harbor. Although it is not possible to know where a release might occur, the environmental outcome of such an event would be worse if it occurred in areas that supported unique or sensitive plant populations. For example, if a spill occurred along the north side of the PS&P rail line near Rochester and to the east of Scatter Creek, it could affect populations of the white-topped aster (U.S. Fish and Wildlife Species of Concern, Washington Natural Heritage Program Sensitive Species), previously recorded in two locations adjacent to the rail line. Similarly, a spill near the Centralia PS&P rail yard or along the rail line near US Route 2 (US 2) and Prairie Creek could affect multiple recently documented occurrences of the small-flowered trillium (Washington Natural Heritage Program Sensitive Species).

As discussed in Sections, 4.4, *Environmental Health Risks—Terminal (Onsite)*, 4.5, *Environmental Health Risks—Rail Transport*, and 4.6, *Environmental Health Risks—Vessel Transport*, numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for adverse impacts on plants. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill.

4.7.1.3 Animals

Spills can affect animals because of both physical surface oiling or smothering and toxic effects of constituents in oil. Animals can also be injured by physical and chemical aspects of response and cleanup efforts. The potential impacts on animals are discussed in the context of floating spills, contact in the water column, contact along the shoreline, and contact on land. The mechanisms of impact are summarized in Table 4.7-1.

Marine Animals

Impacts from Oil at the Water Surface

Animals that would most likely be affected by floating oil in the study area include common diving birds that frequent Grays Harbor, such as double-crested cormorants, pied-billed grebe, belted kingfisher, Caspian tern, and common mergansers (Grays Harbor Audubon Society 2008), as well as common marine mammals such as harbor seals and California sea lions. Federally protected species such as killer whales, humpback whales, and sea turtles such as leatherback and green sea turtles might visit Grays Harbor (although rarely) and can be seasonally present in adjacent Pacific coast waters. Because sea turtles must come to the surface to breath, they could suffer the toxic affects by breathing in or ingesting floating oil, and adults could suffer mucous membrane inflammation (increasing susceptibility to infection) from the oil or its fumes (International Tanker Owners Pollution Federation Limited 2011b:6). Similarly, pelagic bird species commonly found off the coastline of Grays Harbor, such as pink-footed shearwater, black footed albatross, and northern fulmar (Grays Harbor Audubon Society 2008), would most likely be affected by floating oil in Pacific coastal waters. Semiaquatic mammals present in the Chehalis River such as beavers and river otters are examples of fur-covered animals that feed by diving through the water's surface and would most likely be affected by floating oil through loss of insulation, oil ingestion, or inhalation of toxic fumes (Crosby et al. 2013:79).

Oil floating on the water surface would pose the greatest risk to animals that are completely dependent on the marine or estuarine environment (such as seabirds and aquatic species, including marine mammals) and that come to the water surface to breath or dive through the surface to forage for food. Aquatic animals that breach the water surface or birds that land on water in an area with floating oil could ingest oil, inhale oil, or inhale its vapors and become physically coated with oil. Constituent compounds within oil (e.g., polycyclic aromatic hydrocarbons) can be acutely toxic to animals and cause death by contact or ingestion. Many birds and mammals, including harbor seals, California sea lions and possibly, killer whales and humpback whales could ingest oil in their efforts to clean themselves or as they are feeding, which could result in rapid mortality or organ damage and subsequent death. Ingestion of crude oils and other petroleum products also can suppress the immune system of animals and cause skin irritation or ulceration, adrenal system damage, and behavioral changes, which could ultimately lead to death (U.S. Fish and Wildlife Service 2004, 2010). Physical coating (oiling) of an animal with floating oil can cause animals to suffocate if it coats or enters the respiratory tract. Oil coating can also cause a loss of thermoregulatory ability, ultimately leading to hypothermia, as well as loss of buoyancy and lift, which can drown animals or prevent them from flying or feeding successfully (Cedre 2008:49–50; Crosby et al. 2013:79–80). Other aquatic animals and birds that have not been directly exposed to a floating oil spill, such as scavengers (e.g., bald eagles), can be exposed to oil by feeding on injured or dead aquatic animals (e.g., fish) that have been in contact with and contaminated by oil floating on the water surface.

Impacts from Oil in the Water Column

Animals that feed or respire directly in the water (below the surface) are most at risk from impacts of submerged oil dispersed in the water column, particularly if natural or chemical dispersion causes the oil to persist in the water column for multiple days. The animals in the study area that would be most affected by submerged oil include marine mammals, invertebrates, and fish, as described in Chapter 3, Section 3.5, *Animals*.

Constituent compounds within oil can be acutely toxic to animals in the water column and cause death by contact with gills or ingestion. Submerged and dispersed oil that comes into contact with animals can clog and destroy sensitive tissues such as gills and mucous membranes necessary for respiration (e.g., fish and marine mammals) and filtering organs necessary for feeding (e.g., sessile organisms like barnacles, clams, and mussels) (Cedre 2008:50). Other potential effects of oil on fish include reduced growth, enlarged livers, changes in heart and respiration rates, fin erosion, and impaired reproduction and development (U.S. Fish and Wildlife Service 2004, 2010). Recent field and laboratory studies of Gulf killifish that reside in the Gulf of Mexico showed a variety of sublethal responses to oiled sediments. These responses include developmental abnormalities in larval and adult fish, cardiovascular defects in embryonic fish, and delayed hatching and smaller size at hatching of juveniles (Michel and Rutherford 2013:2–18). Those effects in turn increase the chances of direct mortality or capture by predators.

Potential oil effects on invertebrates include physical smothering, altering metabolic and feeding rates, and altering shell formation (U.S. Fish and Wildlife Service 2004). In addition, oil can contaminate plankton (microscopic floating organisms), which includes algae, fish eggs, and the larvae of various invertebrates; fish that feed on these organisms can subsequently become contaminated (U.S. Fish and Wildlife Service 2004).

Oil spilled into Grays Harbor or the Chehalis River or tributaries that cross the PS&P rail line could affect the survival of eggs and larvae, including salmonids protected under the Endangered Species Act. Fish mortalities have been associated with spills that result in localized concentrations of oil in the water column, large quantities of highly toxic light oils into breaking surf along a shoreline, and spills in rivers (International Tanker Owners Pollution Federation Limited 2011b:5). Salmon eggs and larvae are highly sensitive to oil toxins, which could result in reduced spawning success (U.S. Fish and Wildlife Service 2004, 2010). Subacute effects on animals can include reduced feeding, increased larval or juvenile mortality, delayed or reduced reproduction, or increased risk of predation due to behavioral changes.

Impacts from Oil along Shoreline and Intertidal Habitats

Oil spilled close to shorelines and intertidal habitats or floating oil that reaches these areas can affect animals that inhabit or transit shoreline and intertidal habitats (e.g., shorebirds, river otters, seals). Oils along the shorelines can also affect invertebrates (e.g., shellfish) that live in the sand on rocks, in mudflats and transitional wetland areas. The toxic and smothering effects of oil on animals described above for oil on the water surface and in the water column would generally be the same for animals along the shoreline and intertidal environment that could be exposed to oil.

Common benthic invertebrates in Grays Harbor marshes and intertidal mudflats include various species of clams and snails, as well as intertidal crabs (e.g., red rock crabs and Dungeness crabs), which burrow in the substrates of these habitats. Oil that sinks and binds with sediments in these habitats can become trapped, resulting in smothering or toxic effects in benthic invertebrates. High rates of intertidal crab mortality have been documented following oil spills the reached salt marshes in Massachusetts, New York, New Jersey, and Nigeria (Michel and Rutherford 2013:2-17). Potential oil effects on invertebrates can include mortality or injury from physical smothering, altering metabolic and feeding rates, and altering shell formation (U.S. Fish and Wildlife Service 2004). Birds that forage for benthic invertebrates along beaches, shorelines, and mudflats would also be exposed to oil and contaminated invertebrates; common bird species in Grays Harbor that feed on invertebrates on the beach and mudflats include shorebirds such as western sandpiper, dunlin, and sanderling (Grays Harbor Audubon Society 2008). Common diving ducks such as bufflehead and common goldeneye also feed on invertebrates several feet under water (Grays Harbor Audubon Society 2008).

Oil spills could pose a higher risk to migrating or nesting birds in the study area because populations may concentrate in one area (e.g., migratory flocks of shorebirds). A much wider range and larger number of species would potentially be affected if an oil spill were to occur along the shoreline beyond Grays Harbor and intertidal habitats during the nesting season and the spring and fall migrations. Salt marsh, mudflat, and beaches of Grays Harbor and the Grays Harbor National Wildlife Refuge support a seasonal concentration of hundreds of thousands of shorebirds migrating north between late April and early May each year (U.S. Fish and Wildlife Service 2014). Birds that forage along the shoreline and intertidal environment could be exposed to oil and could suffer the same effects as birds that encounter oil on the surface of the water, although they might be less likely to be fully coated by oil. Birds foraging on invertebrates in these areas would ingest oils along with contaminated prey, resulting in the same toxic effects as described above (e.g., immunosuppression, skin irritation or ulceration, adrenal system damage, and behavioral changes, which could ultimately lead to death [U.S. Fish and Wildlife Service 2004, 2010]). Other animals and birds that have not been directly exposed to an oil spill, such as scavengers, can be exposed to oil by feeding on injured or dead birds that have been in contact with and contaminated by oil along the shoreline environment.

Animals that transit shoreline and intertidal habitats in the study area, such as harbor seals and river otters, also could be exposed to an oil spill along these habitats. These animals could ingest oil, inhale oil or its vapors, and physically be coated with oil. These mammals could suffer the same toxic effects as described above for marine mammals and birds (e.g., acute mortality and sub-lethal effects such as immunosuppression and behavioral changes, which could ultimately lead to death). Harbor seals could accumulate some of the oil constituents (e.g., polycyclic aromatic hydrocarbons) in their blubber and pass them along to their pups in maternal milkfats. Physical coating of river otters could cause hypothermia. Ingestion of oils from self-grooming or consumption of contaminated prey could lead to similar toxic effects, as noted for birds and other mammals above.

Persistent effects of oil retained in sediments along shoreline and intertidal habitats, such as marsh plant death and consequent sediment loss, can concurrently change the diversity and abundance of animal species that use these habitats. Changes or loss of plant community structure can alter the ecological services of those communities, such as nursery areas for fish, until such time as the original or similar community structure can redevelop (International Tanker Owners Pollution Federation Limited 2011b: 3-4). Persistent or chronic effects on animal life also can result when oil strongly affects key animals that create physical habitat structure (e.g., mussels). This can lead to changes in the structure and functioning of both plant and animal communities. For example, high mortality of ribbed mussels was noted in several spills along the east coast in Spartina marshes, including the 1969 spill of almost 200,000 gallons of No. 2 fuel oil from the fuel barge Florida in Buzzards Bay Massachusetts. The mussels bind the root mat of east coast Spartina marshes together, and heavy mortality can accelerate local marsh erosion; persistent oil was still present in the soil 30 years after the spill and continued to affect ribbed mussel, fiddler crab, and marsh vegetation (Michel and Rutherford 2013:2-18, A-1).

Terrestrial Animals

Oil spills in the vegetated terrestrial environment could occur during rail transport and could affect terrestrial animals and their habitats. Similar to species that depend on the aquatic environment, oil spills can affect terrestrial animals as a result of both physical smothering and toxic effects. Animals that contact oil could be physically coated, inhale its vapors, or ingest oil when foraging or grooming. Effects similar to those described above for aquatic and semiaquatic animals could occur. Common terrestrial animal species that could be affected by an oil spill along the PS&P rail line are described in Chapter 3, Section 3.5, *Animals.* In addition, any degradation of habitat from oil could displace animals by forcing them to abandon the area in search of more suitable habitat. This could result in significant impairment of normal behavioral patterns, and could reduce reproduction and survival, as individuals would expend energy looking for other habitat and attempting to insert into areas already defended by other animals of the same species.

An oil spill to land, however, is likely to cover a much smaller geographic area than a spill of the same quantity of oil to surface waters. Thus, a smaller proportion of local terrestrial animal populations might be impacted, possibly without long-term obvious impacts on local populations of birds or mammals. Frogs and other amphibians, however, might suffer localized mortality and reduced reproductive success if oil spills to land reach freshwater pools and ponds used for breeding.

Sensitive Areas in the Study Area

Sensitive areas within the study area where there would be concern for oil spills include areas identified as having important habitat characteristics that support sensitive species or refuge and preserve areas designated by a state or federal agency that support a high diversity of animals. The U.S. Fish and Wildlife Service designated critical habitat in several areas along the PS&P rail line for the federally listed bull trout (fish) and marbled murrelet (bird), and has proposed critical habitat for the Oregon spotted frog.

The PS&P rail line crosses three streams designated as critical habitat for bull trout: the Wishkah, Satsop, and Wynoochee Rivers. In addition, the PS&P rail line runs adjacent to the Chehalis River (also designated as critical habitat for bull trout), and is particularly close to the river between Oakville to just south of Elma. In the study area, all four rivers provide important foraging, migration, and overwintering critical habitats for bull trout.

The PS&P rail line is also adjacent to three areas of marbled murrelet critical habitat around the Oakville area and is adjacent to proposed critical habitat for Oregon spotted frog near the Black River crossing. An oil spill from a train that reached one or more of these critical habitats could cause adverse effects on survival and reproduction that could further compromise the existing populations.

The Washington State Department of Natural Resources' Chehalis River Surge Plain Natural Area and the U.S. Fish and Wildlife Service's Grays Harbor National Wildlife Refuge are higher quality ecosystems in the study area that support a variety of animals, including several sensitive species. The PS&P rail line runs along the northern boundary of the Chehalis River Surge Plain Natural Area, and the Grays Harbor National Wildlife Refuge is part of Grays Harbor. An oil spill from a train along this area that would be exposed to animals could result in physical smothering and toxic effects; the resulting impacts would be the same as what has already been described above. In addition, any degradation of habitat in this area from oil could displace uncontaminated animals, possibly causing reduced survival and reproduction as described above. Similar impacts would be expected if a vessel were to spill oil in Grays Harbor that would reach the Grays Harbor National Wildlife Refuge.

The U.S. Fish and Wildlife Service has designated critical habitat for the federally listed bull trout and the National Marine Fisheries Service has designated critical habitat for the federally listed green sturgeon in Grays Harbor. An oil spill from a vessel that would be exposed to these species in Grays Harbor could result in physical smothering and toxic effects, with increased mortality and reduced reproduction for affected animals as described above. As noted in Chapter 3, Section 3.5, *Animals*, Grays Harbor estuary is located along the Pacific Flyway, a migratory flight corridor between Alaska and South America. It is one of four major staging areas for migrating shorebirds in North America, with shorebirds congregating in the mudflats to feed and rest during spring and fall migrations. Approximately 24 species of shorebirds use the Grays Harbor National Wildlife Refuge during migrations, which begin in late April and continue through mid-May. The applicant has committed to cease all vessel-loading operations for a 2-week period each year during the Grays Harbor Shorebird Festival. This would reduce the potential risks of affecting shorebirds during this key migratory period.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for adverse impacts on animals. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill.

Table 4.7-1. Chemical Properties and Mechanisms of Impact on Plants and Animals

State or Condition	Products	Density	Properties and Potential Release Behavior	General Types of Acute Physical and Chemical Impacts		Potential Persistent/Chronic Impacts	
				Plants	Animals	Plants	Animals
Petroleum-Based Fuels							
Refined	Gasoline Kerosene Naphtha Jet fuels	Specific gravity 0.79; API 46-49 Specific gravity <0.8; API 45 Specific gravity <0.8; API 55 Specific gravity 0.76 - 0.82	These materials typically float based on their specific gravity; generally volatile and highly flammable; evaporate and dissolve relatively rapidly in water; low viscosity and can migrate into sediments; direct contact can cause acute toxicity to plants and animals	Leaf/stem/root necrosis and death due to toxicity of material	· Inhalation of toxic fumes · Ingestion inhalation · Organ damage · Skin ulcerations	· Plant death and physical disturbance changes dominant plant species and community structure · Fires can heat soil to point of near sterilization · Can produce methanogenic compounds in the subsurface	Biodegradation may decrease the dissolved oxygen in surface water resulting in fish kills
	No. 2 Fuel Oils	Specific gravity 0.86; API	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)
	No.6 Fuel Oils	Specific gravity 0.95 - 1.03; API 5.2 - 23.1	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)
	Vacuum gas oil	Specific gravity 0.93; API NA	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)	Behaves more like crude oil (see below)
Unrefined	Crude Oil - Bakken origin	Specific gravity 0.8 - 0.86; API 45	Typically floats on water; acute toxic in undiluted form; higher gas content, higher vapor pressure, lower flash point and boiling point, and higher degree of volatility than most other crude oils; increased ignitability and flammability	· Physical smothering of leaves and soil (loss of photosynthesis and respiration) · Photosynthetic reduction and reduced carbohydrate storage in roots · Leaf/stem/root	· Smothering/ drowning · Drowning due to lost buoyancy · Lost insulation and hypothermia · Inhalation of toxic fumes · Ingestion inhalation	· Increased marsh and shoreline erosion due to plant death/reduced stem density · Increased erosion changes sediment elevation and community structure (e.g. high marsh, low marsh)	· Behavioral changes and increased predation risk · Reduced growth · Long-term toxicity from oil retained in sediments · Genetic

State or Condition	Products	Density	Properties and Potential Release Behavior	General Types of Acute Physical and Chemical Impacts		Potential Persistent/Chronic Impacts	
				Plants	Animals	Plants	Animals
				necrosis and death due to toxicity of material	· Organ damage · Skin ulcerations	· Increased erosion changes sediment grain size and turbidity (e.g. suitability for eelgrass) · Plant death and physical disturbance changes dominant plant species and community structure	changes and reproductive impairment
	Bitumen	Specific gravity and API (highly variable)	Low evaporation and dissolution; Floats, submerges, and/or sinks depending on temperature, and specific gravity/AVI value of the particular oil shipment and type of diluent added; diluent typically volatile and acutely toxic	Similar mechanisms of effect as Bakken oil	Similar mechanisms of effect as Bakken oil	· Similar to Bakken in potential chronic mechanisms · Possible higher potential to penetrate into sediments · If sinks and binds to sediments, residue can persist	Similar mechanisms of effect as crude oil

State or Condition	Products	Density	Properties and Potential Release Behavior	General Types of Acute Physical and Chemical Impacts		Potential Persistent/Chronic Impacts	
				Plants	Animals	Plants	Animals
Plant-Based Fuels							
Pure (unblended)	Ethanol	Specific gravity 0.79; API 46-49	Float on water; generally readily metabolized by bacteria that break down fats and oils in the environment. Less acutely toxic that petroleum fuels and crude oils due to high proportion of plant-based oils.	· Physical smothering of leaves and soil (loss of photosynthesis and respiration) · Photosynthetic reduction and reduced carbohydrate storage in roots	· Smothering/drowning/suffocate /coat exposed gills of fish · Drowning due to lost buoyancy · Lost insulation and hypothermia · Less toxic to animals · High oxygen demand can reduce available oxygen in aquatic environments	Similar potential mechanisms as crude oil if large areas of plant mortality occur, but less toxicity and faster biodegradation	Similar mechanisms of effect as crude oil, but less toxicity and faster biodegradation
Can be composed of 20 - 80% of plant-based fuel	Renewable jet fuel	Specific gravity 0.76 - 0.82					
Can be composed of 20 - 80% of plant-based fuel	Renewable diesel	Specific gravity 0.86 - 0.90 ; API (variable)					
Variable composition	Used cooking oil/animal fat	Specific gravity - corn oil (0092), animal fat (0.92 - 0.94)					

Sources: BATTELLE 2007; California Environmental Protection Agency 2007; Edema 2012; Onwurah et al. 2007; Renewable Fuels Association 2003; U.S. Environmental Protection Agency 1999

4.7.1.4 Aesthetics

As discussed in Chapter 3, Section 3.9, *Aesthetics, Light, and Glare*, the aesthetic value of an area is based on the visual character and quality of its natural and human-made features. The aesthetic value of the study area varies from low to moderate visual quality at the project site (due to greater extent of industrial uses) to high visual quality in areas with fewer encroaching features (industrial facilities) and increased views of natural landscapes. The areas of high visual quality would be more susceptible to effects from spills.

A spill could degrade the visual quality of surrounding landscapes including both terrain and waterways. The degree of impact depends on factors including location of the spill, spill size, type of material spilled, weather and water current conditions, vegetation sensitivity, and effectiveness of spill response (containment and cleanup efforts). The greatest potential for impacts on the viewshed would involve a large spill of crude or other heavy oils in areas where the spill could be easily viewed from the land- and water-based vantages. The presence of this type of oil on the terrain and water would substantially alter the existing viewscapes, as described below.

A large spill of crude or other oils could negatively alter the viewshed by initially coating or covering topographical features in oil that can later result in broader ecological damage. The appearance of a large oil spill on natural landscapes is unsightly with thick oily sludge (a sticky, gooey, or tarry substance) enveloping widespread areas over relatively long periods. As noted above, ecological impacts related to vegetation could also occur from direct contact with oil that could result in smothering of leaves and soil and cause acute toxicity to plants. This would alter the existing visual landscape until vegetation regrew.

A large spill directly to water would have greater potential for extensive environmental exposure than a spill on land since oil could be transported via the waterway to a much wider geographic area. Visible effects of this type of spill can occur on the water surface, shorelines, beaches, and sensitive ecological areas including wetlands, marshes, and mudflats. The presence of crude or other heavy oils in the water could temporarily change the color and textural appearance of the water's surface to a brownish or blackish covering or sheen. Along the shorelines, beaches, wetlands, etc., dark oil slicks and sludges can accumulate over widespread areas resulting in a negative impression of the viewshed for relatively long periods.

Removal of oil and cleanup efforts on land and water is difficult and time-sensitive, and residual visual effects (e.g., leftover oil slicks or sheens, increased erosion from void of vegetation) may remain after cleanup operations. Additionally, the labor and equipment involved in cleanup itself could also affect the visual quality of the landscape.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for adverse impacts on aesthetics. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill.

4.7.1.5 Recreation

As discussed in Chapter 3, Section 3.10, *Recreation*, a number of recreational resources (i.e., city and state parks and natural areas) offering a variety of recreational opportunities (e.g., fishing, birdwatching, boating, etc.) are available throughout the study area. Impacts from a spill would occur if the event results in conflicts with the existing recreational use or access to recreational areas. The degree of impact would be influenced by a number of factors (e.g., location of the spill, spill size, type of material spilled, topography, ecological sensitivity, effectiveness of spill response). The greatest potential for impacts on recreation resources could occur in the event of a large spill near a park or natural area, particularly in or near a waterway. Potential impacts on recreation in the event of a large spill are explained below.

A large oil spill could degrade the environment and preclude the use of recreational resources from the site of the release to throughout the extent of the spill. Affected recreational areas would be prohibited to the public during oil spill response and cleanup efforts until the affected areas are no longer impaired. Recreational activities could be restricted from the affected area for months, and in some cases years. In the case of the grounding of the *New Carissa*,[3] recreation radically declined as beaches and other recreational areas were closed for months resulting in an estimated 30,000 recreational trips reduction in the affected areas (U.S. Fish and Wildlife Service 2012).

In addition to the closure of recreational areas due to spill recovery efforts, other effects of an oil spill, such as impacts on natural resources, views, and wildlife, may conflict with the existing usage of the affected recreational area and deter recreational activities. In the case of the *Exxon Valdez* oil spill[4], recreation and tourism in the spill area dramatically declined as damage to natural resources limited access to hunting and fishing areas and beaches that harbored oil could not be visited. Recreational activities have increased since the spill; however, complete recreational use is still recovering as some beaches, localized areas, and natural resources are still impaired (Exxon Valdez Oil Spill Trustee Council 2015).

Recreational activities could be affected if the impacts of a large spill on aesthetic and wildlife resources disrupt recreational use associated with these resources. Regarding aesthetic resources, the study area includes several areas of high visual quality where many recreationalists visit to enjoy views of the natural landscapes and wildlife. If these resources are affected, activities could be discouraged due to the altered condition of the affected area from the spill's negative visual effect on the landscape. A large oil spill's impact on wildlife resources could also result in a decline of recreational activities. A majority of the study area's recreational activities are reliant on wildlife resources that provide opportunities to fish, shellfish, hunt, and watch wildlife. A large spill event could severely affect these resources, which could halt fishing, hunting, and wildlife viewing until fish and wildlife have recovered. In some cases, such as the *Exxon Valdez* oil spill, recovery of these resources could take years. Recreational attendance would return over time, and how quickly depends on the effectiveness of recovery efforts and period of impairment.

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[3] "On February 4, 1999, the 640-foot freighter *New Carissa* ran aground on the Oregon coast during a major winter storm. The vessel was carrying nearly 400,000 gallons of fuel oil and diesel onboard. After 4 days in the heavy surf, the *New Carissa* began leaking oil. On 11 February, the *New Carissa* broke in half, releasing an estimated 70,000-140,000 gallons of fuel into the marine environment" (U.S. Fish and Wildlife Service 2012).

[4] On March 24, 1989, the 986-foot vessel *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska spilling approximately 11 million gallons of crude oil that covered 1,300 miles of coastline and 11,000 square miles of ocean (Exxon Valdez Oil Spill Trustee Council 2015).

A subsequent effect on recreational resources resulting from limited use and access of affected recreational areas could include increased use of recreational areas in the study area that were not affected by the oil spill. Although there are numerous and large recreational areas provided in and around the study area, it should be noted that changes in recreational use in response to a spill could occur since areas that were not affected become more heavily used as activities are displaced from the affected areas.

As proven by past oil spill recovery and cleanup efforts (*Exxon Valdez* and *New Carissa*), removal of oil and cleanup efforts on land and water are difficult and can take months to years to complete. Additionally, the labor and equipment involved in cleanup itself could also affect the recovery period of natural resources.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for adverse impacts on recreation. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill.

4.7.1.6 Cultural Resources

A spill could result in a variety of impacts to cultural resources in the study area. These impacts might include the fouling of historic resources (such as buildings and structures), oil seepage into soils containing archaeological sites, the contamination of historic landscapes or cultural significant properties, and the potential for secondary impacts caused by incident response or cleanup activities. The nature and duration of these impacts would depend on a variety of factors, including the type and quantity of material released, location of the release, and physical and biological features in the affected environment.

Oil that comes in contact with historic resources could potentially require the cleaning, repair, or replacement of features. The manner in which these activities were undertaken could adversely affect a historic resource by physically affecting those character-defining features that convey its historical significance.

Archaeological resources would likely not be directly affected by an oil spill but could be affected by any excavation or other ground disturbing activities that would occur because of cleanup or site remediation activities.

Historic landscapes or culturally significant properties could also be affected in this manner. In addition, the defining characteristics of a historic landscape or culturally significant property could be directly affected by an oil spill, causing physical damage or contaminating features or characteristics deemed significant. These features or characteristics could include vegetation or wildlife, the traditional use of a location, or aspects of the resource's location and setting.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for adverse impacts on cultural resources. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill.

4.7.1.7 Tribal Resources

As discussed in Chapter 3, Section 3.12, *Tribal Resources*, tribal resources include the traditional areas used for gathering of plants and fishing for economic, subsistence and ceremonial purposes. Traditional areas and the natural resources therein provide for spiritual and physical sustenance of tribal members. Treaty-reserved fishing and gathering rights provide a means for economic self-sufficiency and income (commercial harvest), dietary sustenance (subsistence harvest), and support cultural practices (ceremonial harvest).

Tribal fishing resources include the associated catch in fresh water, Grays Harbor, and ocean fisheries. Quinault Indian Nation members fish in Grays Harbor for salmon, steelhead, sturgeon, and Dungeness crab. Ocean fisheries adjacent to Grays Harbor are fished for Dungeness crab, halibut, sablefish, groundfish, ocean Chinook and coho salmon. Grays Harbor is home port for fishing vessels in ocean fisheries and is where fishers offload catch for these fisheries. The Quinault also manage razor clams for commercial and subsistence harvest on beaches on and off the reservation adjacent to Grays Harbor, and gather plant materials (such as sweetgrass and cattail stems) for production of woven materials. The Chehalis Tribe members harvest salmon and steelhead from the Chehalis River within the reservation boundaries and use tidal lands in Grays Harbor for shellfish harvest.

Potential impacts from a spill on plants in the study area including in shoreline habitats, the Chehalis River Surge Plain Natural Area, and Bowerman Basin are described in Section 4.7.1.2, *Plants*. Potential impacts of an oil spill on animals in the study area, including fish, shellfish, and invertebrates are described in Section 4.7.1.3, *Animals*.

A large-scale spill in Grays Harbor or the Chehalis River could affect the various species of tidal salt marsh plants that fringe the shoreline of Grays Harbor and the tidal surge plain wetland plant communities that characterize the Chehalis River Surge Plain Natural Area Preserve (Figure 3.4-2). Freshwater, Grays Harbor, and ocean fisheries could be affected. Constituent compounds in oil can be acutely toxic to animals resulting in mortality, reduced growth and vigor, or impaired reproduction and development (Sections 4.7.1.2, *Plants*, and 4.7.1.3, *Animals*).

The nature and duration of these impacts would depend on a variety of factors, including the type and quantity of the material released, location of the release (e.g., land or in water), the potential for ignition, physical and biological features of the affected environment, sensitivity of various species to pollution, and the form of the material that is released. In addition to the effects of exposure to released materials, organisms can also be damaged by physical and chemical aspects of spill response and cleanup efforts.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for adverse impacts on tribal resources. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill.

4.7.1.8 Human Health

Similar to the potential impacts that could occur on the natural environment, spills of hazardous materials can adversely affect human health through increased exposure to hazardous air pollutants. In the event that a release occurred in a populated area, the following adverse impacts can occur. Inhalation of vapors resulting from exposure to a fresh release can cause irritation of the respiratory system. This can cause dizziness, rapid heart rate, headaches, confusion, nausea, and/or vomiting. Inhalation hazards from weathered materials are much less of a concern as the toxic volatile hydrocarbons are at much lower concentration following weathering. The toxicity of crude oil depends mainly on the volatility of the constituents: benzene, toluene, ethylbenzene, xylene, hydrogen sulfide, and polycyclic aromatic hydrocarbons. These constituents represent the most toxic of the components of crude oil. These are generally found in lower percentages than in refined petroleum products such as gasoline and diesel.

Bakken oil is generally considered a light “sweet” crude oil having a sulfur content of less than 0.3% by weight and a benzene content ranging from 0.1 to 1.0% by volume (Congressional Research Service 2014). Bitumen is a heavy crude oil. Fuel oils and lubricating oils are refined byproducts from the distillation of crude oil. The sulfur and benzene content of these products depends on the crude oil from which they are refined. Slightly more volatile distillates of crude oil are diesel and gas oil, followed by heating fuel oil and kerosene (jet fuel). Naptha is the next most volatile distillate, followed by gasoline, which is flammable at room temperature. The toxicity of gasoline is primarily a function of the benzene content, to a lesser extent the sulfur content, and to an even lesser extent toluene, ethylbenzene, and xylene content. Federal regulations require that by January 2017 gasoline not contain more than 10 ppm of sulfur on an annual basis. Gasoline sold today must have an annual average gasoline benzene content of 0.62 volume %.

The compounds with the potential for acute exposure health effects are hydrogen sulfide and benzene. Hydrogen sulfide is a colorless gas with a pungent, rotten egg odor smell. The odor threshold varies in individuals but is generally detectable by most people at 0.008 parts per million (ppm) (Amoore and Hautala, 1983). Starting at about 50 ppm, olfactory fatigue sets in and the odor is no longer detectible (Office of Environmental Health Hazard Assessment 2008). Human health risk from exposure to elevated levels of hydrogen sulfide depends on the concentration of the gas and length of exposure. Exposure at 10 ppm for more than 10 minutes causes eye and throat injuries, at 500 ppm for 3 to 5 minutes results in unconsciousness. A potential health risk is posed from the inhalation of high concentrations of hydrogen sulfide released into the air from an oil spill.

An oil spill trajectory and fate model assessed the potential exposure from a 10,000-barrel medium crude oil spill in typical southern waters (air 80°F and water 70ºF) under worst-case wind and current speeds (calm winds, 1 knot currents) (Thayer and Tell 1999). Results showed that modeled concentrations (well in excess of 10 ppm) could be immediately dangerous to workers due to respiratory paralysis. However, modeled hydrogen sulfide concentrations drop below toxic levels in less than 4 minutes. However, the volatility of hydrogen sulfide is temperature-dependent and would be released at rate about 20% lower (Yongsiri et al. 2004) and over a longer duration in the colder air and water temperatures found in Grays Harbor (Appendix D, *Air Data*). The maximum area affected was less than 400 meters from the spill. Thus, hydrogen sulfide concentrations are not expected to pose a health concern to first responders after a very short period. However, air monitoring should be conducted to determine the appropriate actions to take.

Benzene is a colorless liquid at room temperatures, with a slightly sweet smell. The odor threshold is 0.875 ppm (Haley 1977); at levels between 700 and 3,000 ppm, benzene can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Central nervous system symptoms of toxicity are apparent immediately after inhalation of high concentrations of benzene (3,000 ppm for 5 minutes). The Occupational Safety and Health Administration set a permissible exposure levels for workers at 1 ppm for 8-hour daily exposure. While benzene is less volatile than hydrogen sulfide, the release occurs over a longer period and may pose a risk of high concentrations of benzene released into the air from an oil spill.

The Thayer and Tell (1999) study also examined exposure to the potential concentration levels for benzene with a benzene content of 0.2% by weight. Results showed that the initial concentration can be well over 1 ppm but decreases rapidly within 1 hour and a distance of 350 meters from the spill. Over the course of 6 hours, the concentration dropped below 1 ppm everywhere, even under calm wind conditions. Again, dissipation would likely occur over a slightly longer duration in the Grays Harbor area because of colder air and water temperatures but benzene would be at lower concentrations. Thus, benzene concentrations are unlikely to pose a health concern to first responders, especially after 1 hour after the spill, unless there is a continuous spill of crude oil. However, air monitoring should be conducted to determine the appropriate actions to take.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for adverse impacts on human health. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill.

4.7.2 What would be the environmental impacts of a fire or explosion?

The proposed action would result in the potential for more frequent spills of bulk liquids relative to the no-action alternative, although the risk of very large releases remains relatively low. A fire with or without an explosion could result from a spill, although the chance of a fire or explosion is lower than the overall chance of a spill. In general, a fire or explosion will only occur as the result of some, not all, oil spills. Heavier oils that would be handled at the project sites more commonly pool and do not generate many flammable vapors. Lighter materials, like diesel and gasoline, present a greater risk for a fire or explosion and are handled with precautions to prevent ignition. The potential risk of a fire or explosion resulting from a facility, train, or vessel spill is described in the following sections. The potential extent and the nature of the environmental damage can be quite varied. Because of these variables, the impacts of a fire or explosion on resource areas are described here in general terms.

4.7.2.1 Recent Fires and Explosions Involving Crude Oil Trains

Fires or explosions of crude oil are most likely to occur during transport when higher speeds provide enough energy to generate a spark. Recent incidents involving rail transport provide information about the potential impacts on human health related to incidents involving fires and in some cases, explosions. Typically, evacuations protect nearby residents from adverse health impacts. Many of these incidents involved trains traveling at speeds greater than speeds allowed on the PS&P rail line (25 miles per hour) but are provide for information.

- On July 16, 2015, an incident involving at least three train cars were leaking crude oil after 21 cars derailed near Culbertson, Montana. There were no reports of injuries or fires although some residents were evacuated. An estimated 35,000 gallons (830 barrels) of oil were spilled.
- On May 6, 2015, a 109-car crude oil train derailed near Heimdal, North Dakota. Six cars exploded and an estimated 60,000 gallons (1,430 barrels) of oil spilled. Due to the resulting fire, 27 people were evacuated.
- On March 10, 2015, 21 cars of a 105-car-long crude oil train derailed about 3 miles outside of Galena, Illinois. No one was injured; however, several fires erupted lasting several days.
- On March 7, 2015, a crude oil train derailed about 3 miles outside of Gogama, Ontario. The resulting fire destroyed a bridge.
- On February 16, 2015, a crude oil train derailed and caught fire near Mount Carbon, West Virginia, leaking oil into the Kanawha River tributary and burning one home. The resulting fire lasted for almost one week and resulted in the evacuation of hundreds of families and the closure of two water treatment plants.
- On February 14, 2015, a 100-car train hauling crude oil and petroleum distillates derailed in a remote part of Ontario, Canada, causing a fire but no reported injuries.
- On January 20, 2014, seven cars derailed, with six containing Bakken oil on a bridge over the Schuylkill River in Philadelphia. No oil was spilled and no one was injured.
- On January 7th, 2014, an 8,400-foot freight train traveling at a speed of 47 miles per hour. Nineteen cars and one locomotive were derailed near Plaster Rock, New Brunswick. Of the 19 cars derailed, five were carrying crude oil, another five were carrying butane, and one was carrying ethanol. Other cars were not carrying hydrocarbons. The train had 122 cars, of which 66 were loaded and 56 were empty. About 60,900 gallons (1,450 barrels) of crude oil were spilled from two tank cars and caught fire, but without explosions. Approximately 150 residents were evacuated within a 1- mile radius. There were no injuries or deaths.
- On April 30, 2014, an incident occurred where 17 oil cars derailed. One car failed, leading to a fire. Three of the derailed cars ended up in the James River, spilling up to 30,000 gallons (714 barrels) of crude oil into the river. Later clarification noted that the fire involved a CPC-1232 rail car.
- On December 30, 2013, an accident involving a westbound grain train and an eastbound crude oil train occurred near Casselton, North Dakota.[5] Twenty tank cars carrying crude oil derailed when the crude oil train hit a derailed grain car going approximately 42 miles per hour. Eighteen of the tank cars were punctured spilling an estimated 400,000 gallons (9,520 barrels) of crude oil. The crude oil from the ruptured tank cars was ignited with multiple explosions. A voluntary evacuation of about 1,400 people followed the accident. No injuries or deaths were reported.

[5] The PS&P rail line is a single-track railroad and would not include risks associated with double-track railroads.

- November 7, 2013, an oil train traveling 38 miles per hour derailed near Aliceville, Alabama, resulting in 26 cars derailing and spilling approximately 749,000 gallons (17,830 barrels), contaminating some wetlands.
- On April 3, 2013 a freight train traveling at 35 miles per hour, near White River, Ontario experienced an emergency brake application, resulting in the derailment of 22 cars (19 loaded and three empty). Seven of the cars contained petroleum crude oil. During the derailment, a number of cars rolled down an embankment. Two of the crude oil tank cars released about 31,000 gallons (740 barrels) of crude oil and 4,800 gallons (114 barrels) of canola oil were spilled. A fire was reported, but no explosions. There were no injuries or deaths because of the accident.
- On July 6, 2013, in an accident in Lac-Mégantic, Quebec, a train transporting crude oil had a runaway tank car. The runaway car gained speed and derailed at 65 miles per hour in the town of Lac-Mégantic, Quebec. As a result, 47 people were killed and 40 buildings were damaged when 63 tank cars spilled approximately 1.6 million gallons (38,100 barrels) of crude oil and ignited.

4.7.2.2 Human Health

For a fire or explosion, evacuations could be used to protect nearby residents. Emergency responders would determine if evacuations are needed. In addition to potential direct damage from fires or explosions, when crude oil is burned it emits chemicals that affect human health. The primary air pollutants of concern are carbon monoxide, lead, nitrogen dioxide, particulate matter, sulfur dioxide, and polycyclic aromatic hydrocarbons. Inhalation of these byproducts can cause irritation of the respiratory system. This may harm the nose, air passages, and lungs by causing difficulty in breathing, coughing, and itching. Similar types of air pollutants would be found from the burning of refined crude oil distillates (gasoline, naptha, heating fuel, jet fuel, diesel).

Most information about the health impacts associated with burning crude oil come from peer-reviewed conference proceedings where the level of air pollutants are measured during a controlled burn using air monitoring equipment. Many studies have been conducted to identify what hazardous air pollutants are emitted when oil burns, mainly to assess if burning crude oil is a viable method for reducing the environmental impacts of an oil spill.

One of the most extensive studies was the Newfoundland Offshore Burn Experiment (Fingas et al. 1994, Campagna and Humphrey 1992, Fingas 2014, National Oceanic and Atmospheric Administration 1995), which found that particulate concentrations in the smoke plume remained the chief air pollutant of concern with levels remaining above background more than a mile or two downwind of the incident. The smoke emitted from burning oil contains gases and particulates that may have toxic effects on human health, much like exhaust emissions from motor vehicles or smoke from wood stoves (National Oceanic and Atmospheric Administration 1995). The actual health risks depend on the actual exposure (concentration level and the duration of exposure) to the air contaminant. In most cases, exposure to smoke particulate would occur when the smoke plume occurs relatively close to the ground level.

Particulates in the smoke plume are considered by most health professionals to be the main combustion product to investigate and monitor (National Oceanic and Atmospheric Administration 1995). During burning, elemental carbon (soot) and hydrocarbons are emitted and since these particulates absorb light to a high degree, the smoke plume from crude oil burning is usually black. The most recent compendium of results (Fingas 2014) has further expanded the compounds assessed and the concentration levels observed based on additional experiments. These studies continue to support the finding that particulate matter remains the pollutant of chief concern, but would not be expected to exceed levels of public health concern within 1,000 yards of the fire unless a strong temperature inversion was present at the time of the incident.

While the majority of the burned oil would be converted to carbon dioxide and water, particulates, mostly soot, typically comprise 10 to 15% of the emissions. In addition, small amounts of polynuclear aromatic hydrocarbons are emitted from the fire, mostly as residues attached to the particulates. Some polynuclear aromatic hydrocarbons are known or suspected carcinogens. Exposure of the skin (from chronic skin contact with oils) or the lungs from inhalation of these chemicals can be harmful. Based on data from the Newfoundland Offshore Burn Experiment, most polynuclear aromatic hydrocarbons are burned in the fire, and their concentration in the oil residue is higher than in the air emissions (Fingas et al. 1994).

In other studies that examined air impacts of burns that occurred over longer time periods, concentrations of polynuclear aromatic hydrocarbons were found to be barely detectable in air emissions (Campagna and Humphrey 1992). Low levels have also been detected in experimental oil burns (Fingas et al. 1994).

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for a fire or explosion and adverse impacts on human health. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill or fire or explosion, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill, fire, or explosion.

4.7.2.3 Plants

Impacts of a fire or explosion would depend on the conditions as well as the characteristics of the vegetation species and communities exposed. The likelihood of a plant being killed by fire depends on a combination of time and temperature. High, sustained temperatures are most likely to result in plant mortality, especially when several different parts of the plant have been injured. The aboveground portions of herbaceous plants, shrubs, and trees are the most likely to be destroyed. Trees may survive as long as the fire does not spread into the canopy. However, trees that survive the fire may later succumb to disease, fungus, or insects due to their decreased resistance caused by injuries sustained in the fire. Belowground roots and rhizomes may survive depending on the intensity, duration, and extent of the fire and its effect on the soil. The effect of fire on soil is related to the amount of heat transferred into the ground due to the severity of the fire.

High intensity fire can sterilize the soil and delay vegetation recovery, affecting community structure and function. Reduced vegetation cover after a fire can accelerate soil erosion and sedimentation.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for a fire or explosion and adverse impacts on plants. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, fire, or explosion, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill, fire, or explosion.

4.7.2.4 Animals

Animals' immediate responses to fire are influenced by intensity, severity, rate of spread, uniformity, and size of the fire. Responses may include injury, mortality, immigration, or emigration. Animals with limited mobility, such as young, are more vulnerable to injury and mortality than mature animals. Many animal-fire studies depict a reorganization of animal communities in response to fire, with increases in some species accompanied by decreases in others.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for explosion and adverse impacts on animals. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, fire, or explosion, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill, fire, or explosion.

4.7.2.5 Aesthetics

A fire or explosion from an oil spill could substantially degrade the visual quality of surrounding landscapes. The degree of impact is contingent on the size and location of the fire or explosion with the greatest potential for impacts on the viewshed in areas where the effects could be easily viewed from the land- and water-based vantages. Visual effects of a fire or explosion can include areas with extensive burn damage to structures, facilities, property, or natural features such as forests, vegetation, wildlife habitats. This type of physical damage would substantially alter and degrade the visual quality of the study area's existing viewsheds until the landscape is restored.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for a fire or explosion and adverse impacts on aesthetics. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, fire, or explosion, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill, fire, or explosion.

4.7.2.6 Recreation

A fire or explosion from an oil spill could substantially degrade the environment and preclude the use of recreational resources in affected areas. The degree of impact would be influenced by the location and magnitude of the fire or explosion. The greatest potential for impacts would occur if the fire or explosion was within or close to a recreational facility (e.g., boating facilities, campgrounds, trails, etc.), park, or natural area. Impacts on recreational resources would include the destruction or physical damage by the fire or explosion to the resource itself. Recreational visitation and activities would dramatically decline if recreational resources such as viewsheds and wildlife resources were substantially damaged by fire or explosion. Visitation could also be reduced as access to recreational sites could be destroyed or interrupted during fire related closures. Some areas could be affected by the presence of fire camps during suppression of the fire or explosion.

A subsequent impact on recreational resources resulting from limited use and access of affected recreational areas could be increased use of recreational areas in the study area that were not affected by the fire or explosion. Although there are numerous and large recreational areas in and around the study area, changes in recreational use in response to a fire or explosion could occur since areas that were not affected become more heavily used as activities are displaced from the affected areas.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for a fire or explosion and adverse impacts on recreation. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, fire, or explosion, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill, fire, or explosion.

4.7.2.7 Cultural Resources

A fire or explosion from an oil spill could result in the partial or complete destruction of historic resources and cultural significant properties adjacent to or near the study area. The severity of the impacts would depend on the proximity of such resources to the study area, the extent and severity of the fire or explosion, and measures taken during the incident response and cleanup activities. Such events would not be expected to affect archaeological resources unless the fire, explosion, incident response, or cleanup activities resulted in the disturbance or excavation of soils within or near an archaeological site.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for a fire or explosion and adverse impacts on cultural resources. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, fire, or explosion, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill, fire, or explosion.

4.7.2.8 Tribal Resources

An explosion or fire from a spill could affect tribal resources such as plants and animals, as described above. It could also result in the exclusion of tribal members from traditional areas during incident response. The duration of these impacts would depend on the severity of the fire and duration of the incident response and cleanup activities.

Numerous measures and protocols are in place to prevent and minimize the extent of a spill once it occurs. These measures aimed at minimizing the frequency of a potential spill and the extent of the spill would reduce the potential for a fire or explosion and adverse impacts on tribal resources. However, no mitigation measures can be implemented that will completely eliminate the possibility of a large spill, fire, or explosion, nor are there any mitigation measures that will completely eliminate the adverse consequences of a large spill, fire, or explosion.