4.0 ENVIRONMENTAL ANALYSIS

The environmental consequences of constructing and operating the proposed Bradwood Landing Project would vary in duration and significance. Four levels of impact duration were considered: temporary, short term, long term, and permanent. A temporary impact generally occurs during construction with the resource returning to preconstruction condition almost immediately afterward. A short-term impact could continue for up to 3 years following construction. Impact was considered long term if the resource would require more than 3 years to recover. A permanent impact could occur as a result of any activity that modifies a resource to the extent that it would not return to preconstruction conditions during the life of the project. We considered an impact to be significant if it would result in a substantial adverse change in the physical environment.

In this section, we discuss the affected environment, general construction and operational impacts, and proposed measures to avoid, reduce, or mitigate impacts. Our discussion encompasses project-related impacts associated with the construction and operation of the LNG import terminal and the sendout pipeline. We also discuss the potential impacts on resources along the waterway for LNG marine traffic, extending to the Zones of Concern,[1] resulting from an accidental or intentional release of LNG from a ship in transit or at dock at the LNG terminal.

NorthernStar, as part of its proposal, agreed to implement certain measures to avoid, minimize, or mitigate impacts on specific resources. We evaluated NorthernStar's proposed measures to determine if they would adequately mitigate impacts. In cases where we felt that NorthernStar's proposed measures were less than adequate, where no mitigation measures were proposed, or where final design details requiring Commission review have yet to be developed, and to ensure that appropriate design requirements are implemented, we have added our recommendations to reduce impacts. These additional measures appear as bulleted, boldfaced paragraphs in the text. We will recommend that these measures be included as specific environmental conditions attached as an appendix to the Commission Order authorizing this project.

This EIS represents our independent analysis of the proposed action and the data submitted by NorthernStar. It includes the review of the proposal by the federal agencies cooperating in the production of the EIS: the Coast Guard and COE. Conclusions in this EIS are based on our analysis of environmental impacts, given the following assumptions:

- NorthernStar would comply with all applicable laws and regulations;
- the proposed facilities would be constructed as described in section 2.0 of this document; and
- NorthernStar would implement the mitigation measures included in the application and supplemental filings to the FERC.

[1] The "Zones of Concern" are described in Enclosure 11 of the Coast Guard's NVIC 05-05. These zones are based on the report entitled, Guidance on Risk Analysis and Safety Implications of a Large LNG Spill Over Water, produced by the U.S. Department of Energy, Sandia National Laboratories (2004). This "Sandia Report" and the Zones of Concern are discussed in more detail in section 4.11.5.3 of this EIS.

4.1 GEOLOGY

4.1.1 Regional Geologic Setting

The geology of the Pacific Northwest region is dominated by the Cascadian Subduction Zone (CSZ) driven by the convergence of the Juan de Fuca plate beneath the North American plate. The oblique northeast-trending subduction of the Juan de Fuca plate relative to the North American plate has created a seismically active margin, producing faulting, folding, and volcanic activity. The CSZ contains four distinct seismotectonic provinces: the Cascadia Accretionary Wedge, Rotating Block, Uplift and Transpression Zone, and Cascades (Wells et al., 1998). The proposed Bradwood Landing Project would be located within the Rotating Block, which includes the Oregon Coast Range and the Willapa Hills physiographic provinces.

The Coast Range province is bound by the western edge of the Willamette Valley to the east, the continental shelf to the west, the Columbia River to the north, and the Coquille River to the south. The province measures approximately 200 miles north to south, and ranges from 30 to 60 miles wide from east to west. Elevations of the Coast Range extend from sea level to an average crest elevation of 1,500 feet (Orr and Orr, 2000).

The Willapa Hills province is a portion of the Coast Range that extends north of the Columbia River into Washington. The Willapa Hills province extends west to the Pacific Ocean, southeast to the southern Cascades, northeast to the Puget Lowlands, and north to the Olympic Mountains (Livingston, 1978). The province measures nearly 100 miles north to south and approximately 80 miles east to west. Elevations of the Willapa Hills province range from sea level to approximately 3,100 feet.

Rock units of the northern Coast Range and the southern Willapa Hills physiographic provinces consist primarily of volcanic accreted terrain and tectonically uplifted sedimentary rocks. Portions of the provinces are covered with the Columbia River Basalt Group (CRBG), large scale basalt flow units originating from volcanic vents to the east. The CRBG units are exposed in 200-foot-high cliffs immediately southeast of the proposed LNG terminal. The most recent geologic units consist of stream deposited alluvium in the low-lying areas of the provinces (Orr and Orr, 2000).

Most of Oregon was below the surface of the Pacific Ocean at the beginning of the Tertiary Period, approximately 67 million years ago (mya). Topography in the western portions of Oregon and Washington began to take shape in the Tertiary Period as the Juan de Fuca plate accreted a series of volcanic islands onto the North American Continent. In addition, this tectonic activity uplifted the region, creating the mountains of the Coast Range. This regional uplift exposed the sedimentary rocks of the Coast Range in the middle to late Miocene (17 to 10.8 mya) (Orr and Orr, 2000; Newton and Van Atta, 1976).

During the same period of time, the Wanapum and Frenchman Springs members of the CRBG flowed into the low-lying areas along the Columbia River and the northern Oregon coast (Walsh, 1987). These basalt flows created rock units that are up to 500 feet thick and are believed to have formed intrusive dikes and sills in unconsolidated marine sediments of the Coast Range (Orr and Orr, 2000; Niem and Niem, 1985).

In recent time, the coastal regions of Oregon and Washington have continued to deform as a result of the Juan de Fuca plate subducting beneath the North American plate. Data suggests the coast range in the vicinity of the pipeline is deforming in a tilting manner, with uplift in the vicinity of Astoria, Oregon occurring at a rate similar to the depression rate in the vicinity of Rainier, Oregon (Orr and Orr, 2000). While published vertical deformation rates vary greatly, vertical uplift rates west of the LNG

terminal are believed to be on the order of 1 inch per 30 to 130 years (Orr and Orr, 2000; West and McCrumb, 1988). One study suggests the vertical deformation rate near Tillamook Head, Oregon is approximately 1 inch per 13 years (Kelsey et al., 1994).

The Columbia River has formed erosional features along the northern Coast Range and Willapa Hills exposing cliffs in the basalt and sedimentary rock units, and depositing alluvium on the order of 100 feet thick (Niem and Niem, 1985). Table 4.1.1-1 lists the stratigraphic units that underlie the Bradwood Landing Project area.

4.1.2 Waterway for LNG Marine Traffic

4.1.2.1 Stratigraphy

Rock units along the Oregon side of the waterway from east to west between the LNG terminal site and Youngs River are: the middle Miocene Gnat Creek Formation, consisting of nonmarine sandstones and mudstones; and the middle to lower Miocene Astoria Formation, consisting of deep marine mudstones and arkosic sandstones (Niem and Niem, 1985). Unconsolidated deposits along the waterway generally consist of Quaternary sand bars; islands; and estuarine clay, silt, and fine sand in low-lying coastal areas in and along the Columbia River. Unconsolidated deposits west of about Tansy Point consist of Quaternary dune sand and beach sand. Some of these deposits represent fill from dredged material placement. The Geologic Map of Washington (Schuster, 2002) also depicts primarily Tertiary sedimentary rocks along the Washington side of the waterway, with lower Tertiary volcanic rocks between Megler and Chinook.

4.1.2.2 Mineral Resources

Mineral resources in the area adjacent to the waterway include sand and gravel, as well as basalt rock, which can be crushed for construction material (Schlicker et al., 1972). With the possible exception of increased shoreline erosion (see section 4.1.2.3), LNG marine traffic would not effect mineral resources along the waterway. Because the LNG carriers would be restricted to the established navigation channel, where any mineral resource development is already precluded, the LNG marine traffic associated with the Bradwood Landing Project would not have an impact on future development of mineral resources.

4.1.2.3 Geologic Hazards

The only geologic hazard that would affect or be influenced by the LNG marine traffic along the waterway is shoreline erosion. The effect of LNG carriers on shoreline erosion at and in the vicinity of the proposed LNG terminal is discussed in section 4.1.3.3. Shoreline erosion along the remainder of the waterway is discussed below.

Shoreline erosion along the Columbia River is caused by river currents, wind waves, and ship wakes. River currents can erode banks and carry sediment away from the shoreline. Wind waves and ship wakes can also erode banks but they only move sediment locally within the shallow water zone near the shore. The amount of erosion that occurs at a particular location depends on the interaction between the eroding forces of river currents and waves and the resisting forces of the river bank (COE, 1999).

The Columbia River's natural shoreline consists of basalt outcrops and sand, silt, and clay deposits. Most of the natural shoreline is resistant to erosion, there has been little change in the river's location over the last 6,000 years. Erosion of the natural shoreline has only occurred at a few isolated locations. One such location is the upstream end of Price Island (CRM 34-35) where river currents are eroding a 1-mile stretch of bank at a rate of about 10 feet per year (COE, 1999).

TABLE 4.1.1-1

Generalized Stratigraphy in the Proposed Bradwood Landing Project Area

Age	Formation / Estimated Thickness	Aquifer	Lithology	Water Bearing Properties
Recent	Fill and spoil Variable	NA	Predominantly poorly graded fine sand with occasional silt, gravel, and construction debris.	NA
Quaternary Holocene to Pleistocene	Alluvium 100 feet	Quaternary sediment deposits	Unconsolidated flood plain deposits of clay, silt, sand, and basalt gravel.	Yields small to large supplies of water of variable quality sufficient for municipal, domestic, and stock use.
	Landslide debris Variable		Unconsolidated sand, silt, and clay.	Yields small supply of water, but is limited in aerial extent.
	Terraced sediments 25-100 feet		Silt, sand, and gravel of diverse compositions and origins, such as proglacial outwash, older alluvium, lahars, and uplifted coastal marine and estuary deposits.	Yields moderate to large supply of water, but is limited in aerial extent. Sufficient for municipal, domestic, and stock use.
Tertiary Middle to Upper Miocene	Saddle Mountain Basalt 300 feet	Undifferentiated	Fine grained, sparsely phyric tholeiitic and olivine flood basalt with sedimentary interbeds of tuffaceous sandstone, siltstone, and pumiceous conglomerate.	Rock formation yields small amounts of water, but joints and fissures within rock and coarse grained interbeds can produce large quantities of freshwater suitable for public, domestic, and stock use.
Tertiary Middle Miocene	Gnat Creek Formation 700 feet	Tertiary Rocks of the Coast Range	Massive, coarse to fine-grained, arkosic sandstone to siltstone.	Yields small to moderate supplies of water of variable quality sufficient for domestic and stock use.
Tertiary Middle Miocene	Wanapum Basalt, Frenchman Springs Member 500 feet	Undifferentiated	Sub-aerial, fine to medium basalt flows and associated pillow basalt breccias.	Rock formation yields small amounts of water, but joints and fissures within rock and coarse grained interbeds can produce large quantities of freshwater suitable for public, domestic, and stock use.
Tertiary Middle Miocene	Miocene Sandstone Interbed 200 feet		Arkosic, fine-grained sandstone interbedded between Frenchman Springs and Grande Ronde Formations.	
Tertiary Middle Miocene	Grande Ronde Basalt 500 feet		Mostly sub-aerial, columnar-jointed basalt flows and associated basal basalt breccias and pillow lavas.	
Tertiary Middle to Upper Eocene	Grays River Basalt Unknown		Aphyric to sparsely phyric basalt flows, flow breccias, aquagene tuff, pillow basalt, and interbedded siltstone and sandstone.	
Tertiary Eocene	Cowlitz Formation 2,000 feet		Very fine to coarse grained feldspathic sandstone, laminated siltstones, tuffaceous siltstone, and lignite.	Yields small, non-continuous supply of water.

NA Not Applicable

Sources: Beaulieu, 1973; Myers, 1970; Newton and Van Atta, 1976; Niem and Niem, 1985; McFarland, 1983; URS, 2005; Walsh et al., 1987.

About half of the Columbia River shoreline between CRMs 21 and 106 consists of material deposited in the course of earlier dredging. These dredged material placement sites are highly susceptible to erosion by river currents and waves. The rate of erosion at these sites depends on river bathymetry, time since placement of dredged materials, proximity to the navigation channel, wind fetch, current pattern, and the amount and type of bank protection (COE, 1999).

The only element of the proposed project with the potential to affect the rate of shoreline erosion along the waterway is the passage of LNG carriers. Little information is available on the degree to which erosion of the Columbia River shoreline can be attributed to ship wakes. A 1990 study measured erosion rates at three locations, Price Island (CRM 34-35), Puget Island (CRM 38-44), and Gull Island (CRM 55), in the first year after placement of dredged material and concluded that 4 to 24 percent of the erosion was attributable to ship wakes (COE, 1999).

Large waves contain more energy than small waves and thus, have a greater ability to erode river banks. The size of waves produced by a vessel passing through a channel depends on the characteristics and speed of the vessel and the characteristics of the channel. An analysis undertaken for the COE concluded that the size of ship-produced waves in the Columbia River depends on the blockage ratio, which is the ratio of the cross-sectional area of the ship to that of the channel (COE, 2003).

NorthernStar commissioned a study of wave generation by LNG carriers, which compared wave generation by an Aframax tanker, representative of a large ship that works the Columbia River, with an LNG tanker. The Aframax tanker had an overall length of 761.2 feet, a beam or breadth of 137.8 feet, a loaded draft of 39.7 feet and a submerged or blockage area of 5,471 square feet. The LNG carriers would have an overall length of 944.6 feet, a beam of 148.3 feet, a loaded draft of 38.4 feet and a submerged or blockage area of 5,695 square feet. The study indicated that waves generated by LNG carriers would be only slightly larger than those generated by an Aframax tanker operating at the same speed.

The proposed project would only increase ship traffic along the reach of the river between its mouth and the LNG terminal site by about 7 percent; however, deep-draft vessel traffic would increase by about 25 percent. The LNG carriers would be larger than most of the deep-draft ships currently using the Columbia River, although larger ships are expected to transit the Columbia River once the Columbia River Channel Improvement Project is completed. Because the blockage ratio of the LNG carriers would be greater than that of most of the deep-draft ships currently traveling the Columbia River, the LNG carriers could potentially produce larger waves than most of the current ships operating at the same speed. LNG carriers would travel at speeds between 8 and 12 knots while on the Columbia River.

In summary, the degree to which current ship traffic affects shorelines along the waterway is difficult to quantify due to the various other factors which contribute to shoreline erosion and accretion processes. Therefore, it is difficult to determine what additional impacts on shorelines the proposed LNG marine traffic would contribute. The FERC staff continues to study this issue and additional analysis regarding shoreline erosion will be included in the revised BA. The potential impacts of shoreline erosion on wetlands are discussed in section 4.4.1.1 and on aquatic resources in section 4.5.1.1.

4.1.2.4 Paleontological Resources

Although LNG marine traffic could contribute to the shoreline erosion caused by ship traffic in general, such erosion mainly affects unconsolidated recent sediments, which would not contain any significant paleontological resources. Therefore, LNG marine traffic would not have an impact on paleontological resources.

4.1.3 LNG Terminal

4.1.3.1 Stratigraphy

The Bradwood Landing LNG terminal site is currently covered by fill and native alluvium. Fill was originally placed at the site by the COE around 1930 to raise the land prior to construction of the former saw mill and town of Bradwood. After the mill was closed, between 1966 and 2002 the COE placed at Bradwood approximately 873,000 cubic yards of material dredged while maintaining the Columbia River navigation channel (AMEC, 2005). Recent alluvial deposits are present in the southwestern portion of the site along the banks of Hunt Creek. The site is relatively flat and level, with the exception of the dredged sand fill stockpiles, which are several feet in height. The average elevation of the site is approximately 14 feet above mean sea level (msl). The stratigraphic units at the proposed LNG terminal are briefly described below.

Fill. Fill material at the proposed Bradwood Landing LNG terminal site is mostly comprised of poorly graded fine sand with occasional silt, and gravel. One of the geotechnical soil borings placed at the site by NorthernStar indicates possible fill occurring from the surface to a depth of about 10 feet. The other soil borings do not distinguish subsurface fill material (URS Corporation (URS), 2005). The dredged material occurs in stockpiles at least 15 feet high.

Alluvium. Alluvium underlies the fill at the proposed LNG terminal and is present at the ground surface along the Columbia River. The alluvium consists of unconsolidated sands, silts, and clays that were stream deposited during recent geologic time as sorted or semi-sorted sediment in the stream bed, on its flood plain or delta, or as a cone or fan at the base of a mountain slope (Niem and Niem, 1985; Beaulieu, 1973).

The alluvial deposits at the proposed LNG terminal can be further broken down into the following stratigraphic units, based on soil borings conducted at the site (URS, 2005):

- *Near Surface Fine-Grained Soils.* A 20- to 25-foot-thick layer of silts, clays, and silty sands is present at the surface. These deposits represent the former surficial soils deposited on the Hunt Creek floodplain and consist predominantly of soft to clayey silts, elastic silts, and silty clays with interbedded layers of loose to medium dense silty sands and sandy silts.

- *Upper Alluvial Sand Sequence.* A 50- to 60-foot-thick layer of alluvial sands underlies the surficial floodplain deposits and consist predominantly of relatively uniform poorly graded sands and silty sands deposited by the Columbia River.

- *Estuarine Silts and Clays.* A thick package of relatively uniform silts and elastic silts ranging in thickness from 50 to 60 feet underlies the upper alluvial sands. These silts range from very soft to stiff in consistency and locally exhibit organics and interbeds of sandy and clayey silts as well as lean clays. This unit likely represents an estuary that formed adjacent to the ancient Columbia River. When sea level rose at the close of the last ice age, this estuary was buried by modern alluvial deposits.

- *Lower Alluvial Sand Sequence.* A 25- to 45-foot-thick layer of alluvial sands was encountered below the estuarine silts in the borings advanced to depths of 150 feet or greater at the site. These sediments were deposited by the ancient Columbia River when global sea levels were much lower than at present and consist predominantly of poorly graded sand with silt and silty sands.

Gnat Creek Formation. During periods between flood basalt eruptive sequences in the middle Miocene epoch, local streams and the ancient Columbia River system deposited micaceous and carbonaceous arkosic sandstone with minor siltstone beds known as the Gnat Creek Formation, which was eventually capped by subsequent flows of flood basalts. The Gnat Creek Formation unconformably overlies the Frenchman Springs Member of the CRBG, is overlain west of the proposed LNG terminal site by the Pomona Member of the CRBG, and can occur in thickness up to 650 feet (Niem and Niem, 1985). In outcrop the Gnat Creek Formation consists of a light brown, very weak, moderately to highly weathered friable sandstone that is poorly bedded. Exposures of the Gnat Creek Formation are visible along the base of the cliffs immediately southeast of the proposed LNG terminal, as well as along road cuts east of the site entrance. Sandstones along these cuts are complexly interbedded with siltstone and some conglomerates. These exposures of the Gnat Creek Formation in the vicinity of the proposed LNG terminal site are relatively devoid of joints, cleavage, or evidence of shears or faulting (URS, 2006a).

Columbia River Basalt Group. The CRBG represents Miocene age flood basalts that erupted from feeder dikes and vents in Northeastern Oregon and Southeastern Washington during Miocene time (between 6 and 17 mya), eventually mantling over 63,000 square miles of the Pacific Northwest with basalt flows. Some of these flows traveled down the ancestral Columbia River channels, eventually reaching the Pacific coastline. At the proposed LNG terminal, basalt flows exposed in the cliffs south of the site can be traced from southeast of the site to the west and past Hunt Creek. The waterfall near the mouth of Hunt Creek spills over this basalt outcrop, which appears to pinch out a few hundred feet to the west of the waterfall. In outcrop the basalt is dark gray, strong to very strong, and is slightly to moderately weathered. Specific units encountered in the vicinity of the proposed LNG terminal are discussed below.

- *Wanapum Basalt.* Outcrops of the Frenchman Springs Member of the middle Miocene Wanapum Basalt formation are located in cliffs to the southeast of the proposed LNG terminal. The Frenchman Springs basalt is fine to medium-textured and can contain extensive areas of pillow basalt breccias. The Frenchman Springs Member is approximately 500 feet thick in the vicinity of the proposed LNG terminal (Niem and Niem, 1985).

- *Miocene Sandstone Interbed.* The Miocene Sandstone Interbed separates the Wanapum Basalt and the underlying Grande Ronde Basalt. The sandstone is arkosic, fine grained, and can occur in thicknesses of up to 200 feet. A small outcrop is present approximately 2 miles to the south of the proposed Bradwood Landing LNG terminal (Niem and Niem, 1985).

- *Grande Ronde Basalt.* The Grande Ronde Basalt formation is located at depth below the proposed LNG terminal. Like the Wanapum Basalt, the Grande Ronde Basalt is a middle Miocene member of the CRBG. However, the Grande Ronde Basalt is approximately 300,000 years older than the Wanapum Basalt. The Grande Ronde formation is sub-aerial, columnar jointed, and includes some areas of basalt breccias and pillow lavas (Niem and Niem, 1985).

4.1.3.2 Mineral Resources

NorthernStar conducted a data search to identify any mineral resources or mining activity within 1,500 feet of the LNG terminal. Data on file with the Oregon Department of Geology and Mineral Industries (DOGAMI) and the BLM indicate that one permitted rock quarry is within the specified search radius. This small quarry, referred to as the Bradwood Quarry, is located within the 411-acre parcel under option to NorthernStar (see figure 2.3.2-1). The quarry was permitted in 1984 as a potential source of

basalt for construction purposes, and the soil overburden was removed from an area of about one-half acre in size. The quarry has never been actively worked; however, the permit has been kept current.

The current landowner (Ken Leahy) possesses the permits for and mineral rights to the Bradwood Quarry. These rights and permits (including DOGAMI Permit No. 04-0067) would transfer to NorthernStar with the sale of the property. NorthernStar may use the quarry as a source of basalt rock to be crushed for sand and aggregate during site construction. NorthernStar would obtain all necessary additional permits (e.g., Clatsop County development permit and NPDES stormwater discharge permit) and comply with applicable regulations associated with further development of the quarry. Before operation of the LNG terminal, the quarry would be decommissioned and reclaimed in accordance with DOGAMI regulations. The reclamation plan would be submitted with the operating permit application. Accordingly, there would be no risk to the operation of LNG terminal from mining activities related to the Bradwood Quarry, such as blasting, or other mining related impacts. Further, because any below-grade quarry excavations would be filled with appropriate fill material to site grade during reclamation, as required by DOGAMI regulations, no subsidence, slumping, landsliding, or other ground failure would occur in the quarry area during operation of the LNG terminal.

4.1.3.3 Geologic Hazards

Potential geologic hazards that could impact the terminal and pipeline facilities of this project can be separated into short-term and long-term events or conditions. Short-term events include:

- soil mass wasting and rock slope failure;
- seismicity and faulting;
- soil liquefaction and lateral spreading;
- volcanism and lahars; and
- flooding, tsunamis, seiches, and landslide-induced waves.

Long-term events or conditions include:

- slope instability and inadequate load bearing capacity of soils;
- shoreline erosion;
- subsidence;
- karst features; and
- corrosive soils.

These geologic hazards, their potential to occur in the project area, and proposed mitigation measures, where applicable, are further described below for the LNG terminal and the general project area. Geologic hazards that are specific to the pipeline are discussed in section 4.1.4.3. Geologic hazards as they relate to the waterway for LNG marine traffic were addressed in section 4.1.2.3. In general, the risk of damage resulting from geologic hazards would be avoided or reduced by specific engineering design criteria, ground modification, other construction techniques, and operating procedures to be implemented by NorthernStar.

Soil Mass Wasting and Rock Slope Failure

Mass wasting and rock fall result from the natural process of gravity acting upon a block of material over time. Mass wasting refers to all soil-related slope failures, including landslides, slumps, and debris flows. Rock slope failures include slab failures, wedge failures, falls, and toppling.

The existing topography at the proposed LNG terminal site does not present any slope geometry that would likely result in a soil mass wasting event that could reach the terminal facility. Debris flows or landslides initiated within the Hunt Creek drainage would proceed northward through the wetlands and mitigation areas west of the terminal and could not reach the terminal facilities.

Rock slopes near the site are relatively flatly bedded. Accordingly, slab and wedge failures are not anticipated in the vicinity of the terminal. However, the basalt cliff located south of the site contains many discontinuous joints, presenting a potential rock fall or toppling hazard at the base of the cliff. The rock fall may be produced by toppling, block failure, or planar and/or wedge failure.

The risk of rock fall runout proceeding north of the proposed railroad track realignment is not considered likely due to the beneficial energy dissipation characteristics of the on-site soils as well as site geometry. The separation distance between the cliffs and the nearest LNG storage tank is about 250 feet, greater than likely rock fall runout distances. Moreover, the sand deposits at the base of the cliff have excellent energy dissipation characteristics, and the construction of the proposed 5-foot-high tertiary containment berm would prevent rocks that overcame the first two conditions from reaching the facilities.

In 1965, a landslide occurred approximately one-half mile upriver of the Bradwood Landing site. The landslide created a wave in the Columbia River that resulted in the loss of one life and property damage on a small portion of Puget Island (Wahkiakum County Eagle, 1965).

The *Washington State Hazard Mitigation Plan* (Washington Emergency Management Division, 2004) indicates that in the 1890s, a poorly documented, landslide-triggered wave near Cathlamet killed one person on Puget Island. As described above, landslides in the vicinity of the proposed LNG terminal would be unlikely to reach the terminal facilities. Tsunami risks are discussed below.

Seismic-Related Hazards

Potential seismic-related hazards include earthquakes, surface faulting, soil liquefaction, and related soil failures. The Pacific Northwest coastal region of the United States is a tectonically active region that has significant potential for seismic activity. Northwestern Oregon and southwestern Washington comprise an area of diffuse seismicity with a few areas of concentrated seismicity. The Portland area is the most seismically active area in Oregon (URS, 2006a). Most events are not associated with known faults. Figure 4.1.3-1 depicts Quaternary faults, primarily from the USGS Quaternary faults and folds database (USGS, 2006).

Significant earthquakes that have occurred in the project region are described in the seismic hazard analysis for the LNG terminal (URS, 2006a).[2] The most recent of these are the 1993 Scotts Mills earthquake (magnitude 5.6), the 1999 Satsop earthquake (magnitude 5.9), and the 2001 Nisqually earthquake (magnitude 6.8).

According to URS (2006a), the seismogenic crust, typically 15 to 20 kilometers thick, may be significantly thicker (20 to 30 kilometers) within the project area, resulting in fewer surficial faults in the region. URS (2006a) estimates that in the vicinity of the LNG terminal site, an earthquake with a magnitude of 7.0 or greater would be required to cause surface rupture. As such, deep seated faults could potentially exist in the project area without showing visible signs of faulting or deformation at the ground surface.

[2] URS's Final Report, Seismic Hazard Analysis for LNG Import Terminal, Bradwood, Oregon dated February 2006 is available on the FERC's website. Using the "eLibrary" link, select "General Search" from the eLibrary menu and enter the docket number, excluding the last three digits, in the "Docket Number" field (i.e., CP06-365 and CP06-366). Be sure to select an appropriate date range.

Proposed Bradwood Landing Pipeline Route

Fault (USGS Quaternary Faults and Folds Database)

Fault (URS (2006a) Quaternary Faults and Seismic Source Zones)

Note: Locations approximate

Figure 4.1.3-1
Bradwood Landing Project
Quaternary Faults in the Bradwood Landing Project Area

URS (2006a) found no evidence of active faults within 1 mile of the proposed LNG terminal site based on: 1) review of relevant literature; 2) examination of aerial photographs; 3) review of boring logs and cross sections; and 4) site reconnaissance. Review of geologic maps indicated only one potential fault within 2 miles of the site (Niem and Niem, 1985). Site reconnaissance revealed no evidence of ground rupture or faulting. The closest mapped Quaternary faults to the LNG terminal site are the Doty fault, approximately 27 miles to the north, and the Gales Creek fault zone, approximately 25 miles to the south (see figure 4.1.3-1). Based on these observations, URS concluded the potential for ground rupture at the Bradwood Landing LNG terminal is negligible.

Since 1980, when seismograph coverage became adequate to record and locate smaller earthquakes, seismicity has occurred at a moderate level within 30 miles of the proposed LNG terminal (URS, 2006a). The largest recorded event was a local Richter magnitude 3.7 earthquake that occurred in 1984 about 21 miles east of the site.

As discussed in URS (2006a), the CSZ has experienced no significant earthquakes in the historical period (i.e., since about 1850) (Weaver and Shedlock, 1996; Personius and Nelson, 2003), with the possible exception of the 1992 magnitude 7.0 Petrolia, California, earthquake that may have occurred on the interface or within the overriding plate. The absence of seismicity, as well as geodetic (e.g., Flück et al., 1997; Savage et al., 2000) and geologic (e.g., Atwater, 1987; Atwater et al., 1995; Clague, 1997) studies, indicate that the interface is locked and storing strain that is released in great earthquakes. Some geologic investigations on and offshore suggest that the CSZ is segmented and ruptures in approximately 8 to 8.5 magnitude earthquakes. However, the most recent event is believed to have ruptured the entire length of the subduction zone in an earthquake estimated by Japanese tsunami records at a magnitude of 8.7 to 9.2 (Satake et al.; 1996, 2003). Paleoseismic studies indicate a range of recurrence interval estimates for megathrust events along the CSZ, but the most complete studies suggest an average recurrence interval of about 500 years (e.g., Adams, 1990; Atwater and Hemphill-Haley, 1997; Goldfinger et al., 2003; Witter et al., 2003).

DOT Seismic Design Requirements (NFPA 59A-2001)

The seismic design requirements for LNG facilities are contained in the U.S. Department of Transportation regulations at 49 CFR Part 193, which adopts the seismic design provisions of the NFPA 59A (2001). NFPA 59A (2001) defines two levels of earthquake motions, the Operating Basis Earthquake (OBE) and the Safe Shutdown Earthquake (SSE). The OBE and SSE ground motions must be determined by site-specific evaluations and are defined in terms of 5 percent damped response spectra with the following probability levels:

The OBE ground motions at the site are defined as the lesser of:

1. ground motion with a 10 percent probability of exceedance within a 50-year period (475-year return period); or
2. two-thirds (2/3) of the Maximum Considered Earthquake (MCE) ground motion

In NFPA 59A (2001) the MCE is defined as future potential ground motion with a 2 percent probability of exceedance within a 50-year period (2,475-year return period) with deterministic limits.

The SSE ground motions at the site are defined as the lesser of:

1. 1 percent probability of exceedance within a 50-year period (4,975-year return period); or
2. 2 times the OBE.

These motions would be used as the basis for the earthquake-resistant design of the LNG facility, applied to the following limited specific list of critical safety-related structures, systems, and components per NFPA 59A (2001) 4.1.3:

1. LNG storage containers and their impounding systems;

2. system components required to isolate the LNG container and maintain it in a safe shutdown condition; and

3. structures and systems, including fire protection systems, the failure of which could affect the integrity of (1) or (2) above.

NFPA 59A (2001) specifies that the above-referenced structures, systems, and components must be designed to remain operable during and after an OBE, and must provide for no loss of containment capability of the primary container during and after an SSE. The facility design must also provide for the ability to isolate and maintain the LNG container during and after an SSE. After an SSE event, the container must be emptied and inspected prior to resumption of container filling operations. At a minimum, the impounding system must be designed to withstand an SSE while empty, and an OBE while holding the maximum operating volume of the LNG container. Seismic recording instrumentation is also required.

FERC Seismic Design Guidelines for LNG Facilities

There are areas where NFPA 59A (2001) does not provide specific seismic design requirements to enable a comprehensive philosophical approach to the overall seismic safety of an LNG facility. Consequently there can be a wide range of opinions by technical experts on how various requirements are to be applied. In its "*Draft Seismic Design Guidelines and Data Submittal Requirements for LNG Facilities*" (FERC Seismic Guidelines), January 2007, FERC Staff gives specific guidance to applicants on its interpretation of the requirements of NFPA 59A (2001), providing consistent design specifications throughout the United States, and a basis for uniform reviews of various LNG terminal sites, structures, components, and systems under FERC jurisdiction.

In general, the FERC Seismic Guidelines are based on existing rules and procedures found in ASCE 7-05, ASCE 4-98, API 650 Appendix E, and other current standards documents applicable to LNG facilities. The guidelines also rely on the National Seismic Hazard Maps and the 2006 International Building Code (2006 IBC) MCE Ground Motion Maps, which were developed specifically for use in the design of buildings and other structures in the United States by the USGS.

The FERC Seismic Guidelines classifies the structures, components and systems identified in NFPA 59A (2001) 4.1.3. - ((1), (2), and (3) above), as "Seismic Category I." The remaining structures, systems and components are classified as either Seismic Category II or III.

Seismic Category II and III structures, systems and components are to be designed in accordance with the seismic design requirements of ASCE 7-05 (i.e., 2006 IBC). Category II structures, systems, and components must meet the seismic performance goals for "essential" facilities. Category II facilities are expected to survive the Design Earthquake (DE), which is two-thirds the MCE, with potential structural damage that would not be so severe as to preclude continued occupancy and function of the facility. An "Importance Factor" ("I" or "I_p") of 1.5 is specified for design of Category II facilities.

Category III facilities are considered "non-essential." Normal, non-essential facilities would be designed for the DE in accordance with ASCE 7-05, and are expected to sustain repairable damage when

subjected to DE ground motions, although it may not be economical to do so. An I_p of 1.0 is specified for design of Category III facilities.

The FERC Seismic Guidelines also provide guidance in determining the appropriate Site Class spectral amplification values and long-period spectra displacement cutoff transition period per ASCE 7-05, inelastic reduction factors for the SSE, minimum safety factors for tank foundation loading and settlement, minimum freeboard requirements for LNG sloshing heights, and selection and location of seismic recording devices.

Geotechnical Site Characterization

The surficial materials are primarily poorly graded dredged sands. Subsurface conditions generally consist of softer compressible soils that represent the larger historic log pond areas and surficial fills used in past site development. These soft soils mantle an upper alluvial sand unit consisting of relatively uniform, medium to fine grained, poorly graded sand ranging in depth up to 86 feet below the ground surface (bgs). This upper sand unit is in turn underlain by up to 59 feet of soft, compressible estuarine silts and clays (from approximately 85 to 135 feet bgs). This zone of silts and clays is in turn underlain by a lower (across the majority of the site) sand unit consisting of medium dense to dense sands. These materials are underlain by the weathered surface of the Columbia River Basalt bedrock at depths ranging from 113 to 181 feet across the site.

The site liquefaction potential was evaluated by URS and they determined that without soil improvement, the upper 75 to 85 feet of the loose to medium dense granular material materials below the water table would liquefy with estimated post-earthquake settlements on the order of 1 to 2 feet for the OBE and SSE events, respectively.

The measured shear velocity, Vs, of the soils profile varies non-uniformly between 220 feet per second (ft/s) at the surface to 740 ft/s at depth of 180 feet. Below a depth of 180 feet, basalt bedrock is encountered, which has a shear wave velocity that is greater than 2,500 ft/s. The average shear wave velocity in the upper 100 feet of the soil profile is about 500 ft/s. This shear wave velocity along with the observation that a significant portion of the overlying soil is susceptible to liquefaction potential characterizes the soil profile as Site Class F in accordance with the provisions of the 2006 IBC (and, by definition, 2007 Oregon State Structural Specialty Code) and ASCE 7-05.

Controlling Seismic Events

Based on deaggregation of seismic sources from the URS Probabilistic Seismic Hazard Analysis (PSHA), for earthquake return periods greater than 200 years, the controlling seismic source is the CSZ megathrust earthquake. The CSZ extends along the coasts of northern California, Oregon, Washington and southern Canada. Since the OBE, SSE, and the MCE all have return periods considerably greater than 200 years, earthquakes on the CSZ are the controlling seismic events for input design motions. The URS PSHA considered three different scenario events for the CSZ megathrust earthquake corresponding rupture distances of 63 km, 46 km and 37 km, respectively from the site. The URS PSHA has also considered three different maximum moment magnitudes (**M**), for the CSZ megathrust, of 8.5, 9.0 and 9.2 respectively, with the **M** 9.0 given the highest weighting.

Input Ground Motions

Input ground motions for the terminal site (also called Design Ground Motions) were determined based on site-specific seismic hazard analysis prepared for the project by URS. The input ground motions were developed prior to the publication of the FERC Seismic Design Guidelines and the adoption of the

2007 Oregon Structural Safety Specialty Code (2006 IBC). Conditions are provided as part of this EIS that will assure that both the FERC Seismic Guidelines (and consequently, the 2007 Oregon Structural Safety Specialty Code) are satisfied. The input ground motions for the project recommended by URS are as follows:

- The URS site-specific MCE ground motion parameters (not adjusted for site effects) are S_s = 0.80g and S_1 = 0.42g. The site specific MCE ground motion parameters based on site response analysis are S_{MS} = 0.817g and S_{M1} = 0.611g. The site-specific MCE peak horizontal ground acceleration (not adjusted for site effects) is 0.36g. The site-specific horizontal ground acceleration MCE adjusted for site effects is 0.33g.

- The site-specific DE ground motion parameters adjusted for site effects (which are two-thirds of the MCE value adjusted for site effects) are S_{DS} = 0.54g and S_{D1} = 0.41g. The site specific DE peak horizontal ground acceleration is 0.22g.

- The OBE was taken as the earthquake ground motion having a ground motion probability of exceedance of 10 percent in 50 years (Return Period = 475 years) at the Cascadia River Basalt bedrock level. Soil structure interaction analysis will be performed during detailed design to determine the OBE response of structures and foundations at the ground surface. The OBE design ground motion response spectra for the site at the Cascadia River Basalt bedrock level has a peak horizontal ground acceleration (i.e., zero period acceleration) of 0.20g. The vertical OBE design ground spectra (taken as two/thirds of the horizontal spectra for the site at the Cascadia River Basalt bedrock level has peak vertical ground acceleration for the site of 0.13g.

- The SSE was taken by URS as equal to twice as great as the OBE in accordance with NFPA59A-2001. The SSE design ground motion response spectra, therefore, has a SSE peak horizontal ground acceleration at the Cascadia River Basalt bedrock level of 0.40g. The vertical SSE design ground motion has a peak vertical ground acceleration for the site at the Cascadia River Basalt bedrock level of 0.27g.

Proposed Site Improvements

The LNG tanks would be supported on deep pile foundations. No site improvements are planned for under the LNG tanks. Other Category I and II structures would either be supported on deep pile foundations or would have an improved subgrade condition. The site improved subgrade condition would be a combination of removal, replacement, and compaction of the weak surface layer in combination with either vibroflotation or stone columns. The area of improvement would extend at least 10 feet beyond the edge of the foundations. Final design decisions for foundation improvements would be done during detailed engineering.

Category III structures are proposed to be supported on mat foundations. Subgrade improvement design decisions including removal, replacement, and compaction of the weak surface layer would be done during detailed engineering.

In addition, the project intends to construct a 60-feet-wide by 1,500-feet-long by 85-feet-deep vibroflotation improved zone along the terminal river bank to stabilize the site area and to prevent significant lateral spreading. The width of this zone is a preliminary estimate and the actual width would be determined during final design.

Conditions are recommended as part of this EIS that would assure that final site improvement designs would satisfy the FERC Seismic Guidelines. Therefore, the 2007 Oregon Structural Safety Specialty Code would also be satisfied.

Proposed Foundation Design

The LNG tanks would be supported on deep pile foundations. The piles would either be driven steel pipe piles, augercast piles or driven grout piles. The selection and depths of the piles would be determined following a pile test program. While not stated in the URS reports, it is expected the pile depths would be between 120 to 180 feet below the ground surface. Downdrag loads would be considered in the deep pile design.

Other Category I and II structures would either be supported on deep pile foundations or would have an improved subgrade condition. Category III structures are proposed to be supported on mat foundations founded on an improved subgrade condition.

Conditions are recommended as part of this EIS that would assure that final foundation designs would satisfy the FERC Seismic Guidelines. Therefore, the 2007 Oregon Structural Safety Specialty Code would also be satisfied.

Board of Consultants

Given the high seismic risk associated with proximity of the proposed LNG site to the CSZ, the high seismic loads and performance criteria that the facility must accommodate in the event of an SSE, the special design measures required to mitigate the liquefaction potential and potential for lateral spreading, and the need to ensure that all the critical safety-related structures, systems, and components of the facility are properly designed, seismically qualified, and implemented as anticipated, it is essential that all of the required civil and structural design measures be assessed by a qualified independent entity. Therefore, **we recommend that**:

- **Prior to construction of the LNG terminal and pipeline, NorthernStar should retain a "Board of Consultants" (Board) composed of three or more qualified independent engineering consultants experienced in the critical disciplines of geotechnical, civil, structural, and mechanical engineering, to review the final design and to perform construction quality inspections of the civil and structural aspects of the project in accordance with the specifications contained in the FERC's Draft Seismic Design Guidelines and Data Submittal Requirements for LNG Facilities (FERC Seismic Guidelines) and other measures agreed to by NorthernStar. NorthernStar should file with the Secretary the names and qualifications of the Board members for approval by the Director of OEP.**

  The Board should certify that all civil and structural detailed design calculations, analyses, and construction documents are in compliance with all applicable codes and standards, project-specific civil, structural, and mechanical design criteria, and other engineering requirements of the Order, including the FERC Seismic Guidelines. The Board should further certify, based on construction inspections by the Board that all civil and structural construction of the terminal facilities is in conformance with the project construction documents. The Board should also certify that all procured equipment has been properly seismic qualified in conformance with the project-specific seismic qualification requirements, and the FERC Seismic Guidelines, that seismic detailing of structures has been properly

implemented, and the pipeline has been designed to minimize the hazard of rupture due to ground instability. Among other things, the Board should assess the adequacy of the following:

- **final geotechnical investigations necessary to support all final foundation designs in satisfying the FERC Seismic Guidelines, and final pipeline routing/mitigation measures through geologically hazardous areas;**
- **field tests and associated results used to verify ground improvement, pile driving, and all civil and structural construction;**
- **selection and implementation of the final seismic design categorization of all structures, systems, and components of the LNG terminal in satisfying the FERC Seismic Guidelines;**
- **proposed seismic recording instrumentation and shutdown alarms in satisfying the FERC Seismic Guidelines;**
- **construction procedures and progress; and**
- **continuous and/or periodic inspections made by the Board to ensure that the construction quality of all Seismic Category I, II, and III structures, systems, and components is acceptable.**

The Board should meet as necessary to allow the timely progress of the final design approvals and construction of the project in accordance with NorthernStar's production of acceptable interim and final design data. Before each meeting, NorthernStar should file the following material with the Commission and furnish copies to members of the Board, and other appropriate federal and/or state agencies at the request of the Director of OEP:

- **a statement of the specific level of review the Board is expected to provide;**
- **an agenda for the meeting;**
- **a list of the items to be discussed;**
- **a discussion of significant events in the design and construction that have occurred since the previous Board meeting;**
- **drawings of the design and construction features; and**
- **documentation of the details, calculations, and analyses of the design and construction features to be discussed.**

NorthernStar should ensure that the Commission and the Board has sufficient time to review all pertinent materials before each meeting.

<u>Within 30 days</u> of each Board meeting, NorthernStar should file with the Commission copies of the Board's report and a statement of intent to comply with the Board's recommendations or a statement of a plan to resolve the issue(s).

NorthernStar must provide detailed reasons for any recommendation of the Board not implemented.

The Board's review comments should be submitted prior to or simultaneously with NorthernStar's request(s) for approval to proceed with any specific construction-related activities that may be required by the Order. The Director of OEP must approve in writing all requests to proceed with construction.

- **<u>Prior to commissioning</u> of the LNG terminal or commencing service through the pipeline, NorthernStar should file the Board's final report, which should contain a statement indicating the Board's opinion with respect to the construction, safety, and adequacy of the LNG terminal structures and mitigation measures employed along the pipeline route in areas subject to ground instability.**

The design of the facility is currently at the "FEED" (Front-End Engineering Design) level of completion. A feasible design has been proposed but a significant amount of detailed design work still remains to be completed before NorthernStar would be authorized to proceed with any construction activities, if the Commission approves the project. The final engineering design for the LNG terminal would incorporate detailed seismic specifications and other measures to mitigate the impacts of seismic hazards. Information pertaining to the following specific recommendations would be filed with the Secretary for review and approval by the Director of OEP either: prior to commencing final design; prior to construction; or prior to commissioning as indicated by each specific recommendation. All detailed design documents (drawings, calculations, specifications, etc.) and design submittals should satisfy the requirements of Section 4, Part II of the FERC's draft "Seismic Design Guidelines and Data Submittal Requirements for LNG Facilities," January 2007 (FERC Seismic Guidelines). In addition to the above-mentioned recommendation regarding construction oversight by an independent Board of Consultants, **we recommend that:**

- **Seismic specifications to be used in conjunction with the procuring equipment as described in section 3.10 of Part II of the FERC Seismic Guidelines should be submitted for review <u>prior to commencing final design</u>.**

- **Quality Control and Assurance procedures as described in section 3.11 of Part II of the FERC Seismic Guidelines that will be used for design and construction should be submitted for review <u>prior to commencing final design</u> of the project.**

- **A list of Seismic Category assignments for all structures, systems and components should be submitted <u>prior to commencing final design</u> for review as described in section 3.6 of Part II of the FERC Seismic Guidelines.**

- **Seismic Design Criteria should be provided for all Seismic Design Category I, II, and III structures, systems, and components as described in section 3.7 of Part II of the FERC Seismic Guidelines <u>prior to commencing final design</u>. The Seismic Design Criteria should satisfy Part I of the FERC Seismic Guidelines.**

- **LNG Tank (including outer containment tank) and Foundation Preliminary Design should comply with Part I of the FERC Seismic Guidelines. In particular, site response analysis and soil structure interaction analysis should comply with section 6 of Part I and section 3.5.1 (10) and (11) of Part II of the FERC Seismic Guidelines. LNG tank preliminary design drawings and structural calculations as requested in Section 3.9 of Part II of FERC Seismic Guidelines should be submitted for review**

prior to commencing final design. Final LNG Tank (including outer tank) and foundation detailed design drawings and structural calculations that demonstrate compliance with Part I of FERC Seismic Guidelines should be submitted for review prior to construction.

- **MCE and DE seismic design ground motions should satisfy section 5 of Part I of the FERC Seismic Guidelines. Submittals that demonstrate compliance should be provided prior to commencing final design.**

- **SSE and OBE seismic design ground motions should satisfy section 5 of Part I of the FERC Seismic Guidelines. Submittals that demonstrate compliance should be provided prior to commencing final design.**

- **Details of the liquefaction mitigation method(s), procedures, plan extent, and verification methods proposed to verify mitigation of liquefaction potential should be provided prior to commencing final design.**

- **Detailed calculations of seismic slope stability and lateral movements anticipated after the liquefaction mitigation is implemented should be provided prior to commencing final design to verify the stability of critical structures for the project design earthquake motions.**

- **Details of the types of piles finally selected for supporting the LNG tanks and results of indicator pile program, including load tests, should be submitted for review and approval prior to construction/pile installation.**

- **Final foundation design recommendations including pile foundation design and/or liquefaction mitigation measures for all other structures should be submitted for review and approval prior to construction. The foundation design and/or liquefaction measures should satisfy the FERC Seismic Guidelines.**

- **All other items identified in the submitted geotechnical/seismic reports which were proposed to be addressed during the detailed design should be submitted for review and approval prior to construction.**

- **A seismic instrumentation plan as described in section 3.12 of Part II of the FERC Seismic Guidelines should be provided prior to commissioning.**

- **The results of the hydrostatic load tests on the LNG storage tanks, including settlement data as described in section 7.4.1 should be provided prior to commissioning.**

Volcanism and Lahars

The Cascade Range contains 13 volcanoes, of which Mount St. Helens, Mount Hood, and Mount Rainier are the closest in proximity to the proposed Bradwood Landing Project. Given their distance from the project facilities, direct impacts are not likely from the eruption of any of these volcanoes, should one occur. However, a secondary phenomenon that is commonly triggered by volcanic eruptions in the Cascade Range is the creation of massive mudflows, known as lahars, which pose a geologic hazard.

While active volcanoes are located within approximately 70 miles of Bradwood, blast zones, lahars, lava flows, or pyroclastic flows would not be likely to reach the proposed LNG terminal site. It is possible that volcanic ash outfall would present minor health hazards. However, due to predominantly westerly winds, ash outfall at the LNG terminal would be unlikely. Particles larger than ash (tephra) could potentially reach the LNG terminal; however, given the distance, the particle size would be relatively small and the chances of such tephra deposition occurring during the lifetime of the project is small. Accordingly, volcanism is not considered a significant geologic hazard that could adversely affect the proposed Bradwood Landing LNG terminal.

Flooding, Tsunamis, Seiches, and Landslide-induced Waves

Flooding, tsunamis, and seiches can cause surface waters to inundate land adjoining them. Tsunamis are caused by large-scale disturbances of the sea floor, typically from subduction zone earthquakes, or large subsea landslides, which can originate thousands of miles away from the tsunami runup area (Priest, 1995a). A seiche is a water wave that occurs in a closed or partially closed body of water, such as a lake or harbor, and is caused by vibratory motion of the ground beneath the water.

The DOGAMI has prepared tsunami hazard maps for the shoreline of the Columbia River up through the Knappa Quadrangle (Priest, 1995b). These maps indicate that tsunami runup elevations would reach approximately 8 feet above msl in the Knappa Quadrangle, and nominal inundation would occur due to a tsunami at a point approximately 4 miles downstream of the proposed Bradwood Landing LNG terminal as a result of a magnitude 8.8 to 8.9 undersea earthquake. The corresponding wave height at the site has been estimated to be less than 1 foot (URS, 2006a). Accordingly, the risk of damage to the proposed Bradwood Landing LNG terminal from a tsunami is considered negligible.

NorthernStar reviewed project-specific and USGS/Puget Sound Consortium Lidar to determine whether existing topography indicates the presence of potential source landslides capable of inducing a wave large enough to inundate the proposed LNG facility following failure into the Columbia River. Generation of a wave large enough to exceed the height of the site perimeter berm (minimum 25 feet NAVD) would require a moderate to large size, fast-moving landslide impacting the river near the terminal with few or no intervening energy dissipaters (islands, river bends, etc.) between the impact site and the facility. The Lidar images indicate local morphology consistent with small-sized, shallow landslides and earthflows. Thus, the likelihood of such small scale slope failures impacting the proposed LNG facility via tsunamis or seiches is believed to be extremely low. However, should one occur, the raised elevation of the site and the earthen berm surrounding the LNG facilities would provide protection against inundation.

Seiches can occur in lakes, rivers and bays, resulting in a larger-than normal wave height. Small seiches have been generated in these types of bounded waters in the Pacific Northwest during distant great magnitude earthquakes (e.g., the 1964 magnitude 9.2 Alaska Earthquake, 1949 magnitude 8.0 Queen Charlotte Islands, Canada Earthquake, and 2002 magnitude 7.9 Denali, Alaska Earthquake). However, no seiche was observed in the Columbia River downstream from the river's dams as a result of these events. Thus, given this history and the fact that the Columbia River is not effectively bounded in the site vicinity, the seiche hazard at the proposed LNG terminal site is negligible.

Federal Emergency Management Agency (FEMA) (1995) insurance rate maps indicate that approximately 70 percent of the Bradwood Landing LNG terminal is susceptible to a 100-year flood event. An additional 10 percent of the site is susceptible to a 500-year flood event. Several feet of dredged fill material has been placed on the site since this FEMA evaluation. NorthernStar proposes to deposit at the terminal up to 400,000 cubic yards of dredge material from the maneuvering area in the Columbia River and raise the final graded elevation of the site to 20 feet NAVD 88, higher than the 100-

year flood level of 13.2 feet. In addition, the LNG storage tanks and related process area would be enclosed by a tertiary earthern berm that would be 5 feet higher. Therefore, the LNG terminal would be protected from adverse effects resulting due to flooding.

URS obtained information from the ODWR on inundation studies performed by the COE for dam failure scenarios (i.e., "Lower Columbia River Inundation Mapping Studies - McNary, John Day, the Dalles and Bonneville Projects," NPDEN-WM HES September 1982.). The project was carried out in accordance with Hydrologic Engineering Center guidelines for flood emergency planning developed by the COE dated June 1980. The Columbia River stage elevation was compared for a design spillway flood (large peak flow event) versus peak associated and non-peak associated breaches of the dam. The results indicate no effect at CRMs 17.4 and 23.4. At CRM 41.6 there is a 0.1-foot difference in stage elevation between a rainy day design flood plus dam failure event and peak flow from a flood event alone. CRM 41.6 is approximately the location of Wauna on the Oregon side and Cathlamet on the Washington side. Bradwood is between CRMs 41.6 and 23.4 at CRM 38. Therefore, a dam break would not be a threat to Bradwood Landing.

Slope Stability and Load-Bearing Capacity

Finished slopes in the ship berth and maneuvering area at the proposed LNG terminal would be constructed with a 3 (horizontal) to 1 (vertical) ratio for stability. According to the COE (Proudfit, 2008), this is an acceptable slope for sediments in the area of the LNG terminal.

The geotechnical study conducted by URS (2005) indicated that settlement was anticipated within the surficial fills and soft, estuarine sediment layer between 85 and 135 feet below the ground surface at the site, resulting from pseudo-elastic processes, consolidation, and secondary consolidation. Therefore, soil improvements and engineering designs must be implemented to ensure the stability of the LNG tanks, process structures, and equipment associated with the facility. Mitigation measures recommended for the site include ground improvement such as vibroflotation of the liquefiable soils and replacement of the soft surficial soils with compacted engineered fills, and deep foundation support. In addition, the dredged materials proposed to be added to raise the site to the finished design grade would be vibrocompacted to ensure a stable base.

Shoreline Erosion

The shoreline at the proposed LNG terminal site consists of fill materials placed at the site more than 50 years ago and dredged material placed at the site between 1966 and 2002. The riverbank between mean low water and mean high water (MHW) primarily consists of older fill material and construction debris. Some small trees and shrubs have colonized portions of the riverbank. The riverbank appears to be moderately resistant to erosion.

The primary erosive forces affecting the shoreline at the site are produced by high river flows and the wakes of passing ships. During operation of the facility, erosive forces would likely be less than those currently experienced, because LNG carriers moored at the LNG terminal would protect the shoreline from waves generated by passing vessels about one-third of the time. Although the shoreline would be affected by waves generated by the LNG carriers, the ships would be moving very slowly in the vicinity of the LNG terminal and would consequently produce only small waves.

The berthing and unberthing of LNG tankers would be accomplished using tugboats. Conservatively, erosion of the shoreline during this process could be caused by waves generated by the vessels or from the high velocity field created by the tugboats. The potential for bank erosion from ship generated waves was investigated by evaluating the speed required to produce a wave height capable of

removing material from the shoreline, which was conservatively assumed to range between 3 and 6 inches. At present, wind generated waves greater than 6 inches typically occur at the proposed site. The proposed dock would be located about 330 feet away from the shoreline. Based on wave height modeling and the 330-foot distance from the dock to the shoreline, the ship would have to be traveling at 4.65 knots (7.9 feet per second (ft/s)) to generate a wave height of 3 inches at the shoreline from this distance, and 6.1 knots (10.2 ft/s) to generate a wave height of 6 inches at the shoreline from this distance. These speeds are more than twice the expected speed of the ship (less than 2 knots) during the berthing and unberthing processes (West Consultants (WEST), 2006). Thus, waves generated from the vessel would be minimal and the potential for erosion of the shoreline from vessel-generated waves would be low.

The potential for bank erosion from high velocity fields created by tugboats was investigated by evaluating the characteristics of a typical tugboat on the Columbia River. In general, tugboats would be operating within the proposed turning basin with their sterns directed away from the nearshore banks. Assuming the tugboat is operating parallel to the proposed dock, the wake velocities created from a tugboat near the shoreline would be less than 1 ft/s since the dock would be located about 330 feet from the shoreline. Compared to the results of hydrodynamic modeling, this value is significantly less than typical flow velocities along the present shore. This analysis is based on an assumption that berthing operations would occur at MLLW tide levels. However, it is most likely that berthing would occur only at MHW levels. Ship maneuvering operations at MHW conditions would further reduce the estimated tugboat wake velocities.

The maximum surface velocities created from a tugboat pointed directly at the various shoreline areas within the vicinity of the project site were also modeled. The results indicate that the potential for bank erosion due to the high velocity field created by a tugboat would be low for the shoreline along Puget and Tenasillahe Islands, but there is a high potential for bank erosion to occur along the shoreline of the project site under the following conditions:

- the tugboat is located within 1,000 feet of the shoreline;
- the propellers are pointing directly at the shoreline; and
- no object is present between the tugboat and the shoreline.

However, NorthernStar has indicated that it is unlikely these conditions would exist during the berthing and unberthing of a ship because the tugboats would be located along the side of the ship opposite the shoreline of the project site and the large draft of the ship (38 feet) would re-direct the high velocity field created by the tugs towards the invert of the turning basin and away from the shoreline at the terminal site.

Because NorthernStar anticipates erosive forces at the site with the proposed project in place would be no greater and probably less than those currently experienced, no shoreline protection or bank stabilization is proposed. The existing riverbank would be disturbed as little as possible. Some planting would occur between mean low water and MHW and would be extended upward from MHW where circumstances allow. Plantings would consist of low-growing species. Some grading may occur above MHW to facilitate plantings. No wetlands or waters of the United States would be filled along the shoreline, with the exception of the channel connecting the log pond to the Columbia River.

As a condition to the Clatsop County Conditional Use Permit, NorthernStar prepared a *Shoreline Monitoring Plan* for the LNG terminal. The purpose of the monitoring plan is to address the County's concern that dredging of the berth and turning basin could potentially result in changes to the Columbia River hydraulics, which in turn could potentially result in shoreline erosion. The plan identifies criteria for selecting specific monitoring sites, monitoring techniques, and approximate monitoring locations.

The plan also stipulates reporting requirements, which include the monitoring results and proposed measures to reduce erosion of downstream banks should such erosion increase as a result of the project.

Although modeling has indicated that significant shoreline erosion would not occur as a result of LNG carrier wakes and tugboat propeller wash, Puget Island with its residences is particularly sensitive to such impacts. Therefore **we recommend that:**

- **NorthernStar should prepare a Shoreline Monitoring Plan for the west end of Puget Island that is similar in scope to the monitoring plan prepared for the Clatsop County Conditional Use Permit. The plan should be filed with the Secretary for the review and written approval of the Director of OEP <u>prior to operation</u> of the LNG terminal.**

Subsidence

Regional subsidence is typically caused by significant groundwater usage, coal mine collapse, and petroleum mining. However, subsidence through settlement of soils can also occur, and is a potential geologic hazard for the proposed project.

The proposed LNG terminal site is underlain by an estimated 100 feet of normally consolidated sand, silt, and clay alluvium. Upon being subjected to large surface loads, this soil layer is susceptible to land surface subsidence in the form of consolidation of the clayey soils or elastic compression of the sandy soils. Consolidation manifests at the ground surface as settlement and occurs as a function of time proportional to the dissipation of pore water pressures in the normally consolidated clays and silts. Elastic compression occurs nearly instantaneously during loading. The project would not likely result in land surface subsidence and settlement because the large surface loads (i.e., the LNG storage tanks) would be supported by deep foundations that extend below the surficial alluvial deposits and bear into the deeper dense alluvial sands. Mitigation measures such as piling, ground improvements, or specialty foundations may be required depending on the anticipated loads of the structures. The specific mitigation measures to be employed would be developed as the foundation loading requirements of the LNG terminal facilities are developed.

The proposed on-site water well would not withdraw large volumes of water and the existing on-site quarry would be decommissioned and reclaimed in accordance with DOGAMI regulations by filling the below-grade quarry excavations to site grade before operation of the proposed LNG terminal. Therefore, subsidence is not likely to be caused by either of these activities.

Karst

Karst features are created through dissolution of limestone, dolomite, or other rock types from groundwater, creating sink holes, caves, and underground channels that are susceptible to collapse at the surface. The rock types typically associated with karst features are not present in the project area, and no karst conditions are documented at or in the vicinity of the proposed LNG terminal site. Therefore, karst is not a geologic hazard for this project.

Corrosion

Eight soil samples collected from the upper 15 feet at the LNG terminal site were analyzed to assess corrosivity potential for underground utilities and concrete foundations (URS, 2005). The soils were determined to be mildly corrosive to ferrous metals and to have negligible potential to adversely impact concrete. Mitigation measures for corrosion would not be required for the site.

Power Line

Significant geological hazards are unlikely to be present in the vicinity of the proposed electric power line tower sites. Seismic risks to the transmission towers with respect to ground shaking are anticipated to be similar to those present at the LNG terminal site (URS, 2006a). Final tower siting and design before construction would consider geological hazards and would seek to mitigate them through hazard avoidance. In addition, site-specific geotechnical foundation engineering analyses would be conducted as part of the preliminary or final project design.

4.1.3.4 Blasting

Blasting would be necessary during the widening of Clifton Road. Blasting at the existing on-site rock quarry may also be used to generate rock to be crushed for aggregate and sand to produce concrete and foundation bedding. Blasting would be conducted in accordance with all applicable federal, state, and local regulations. These regulations include *State of Oregon 2004 Fire Code Amendments*; *Explosives*, *Oregon's Revised Statutes, November 10, 2004*; and the Safe Explosives Act (27 CFR 555) or other more current regulations.

Blasting would not significantly disrupt or impact adjacent properties as no residential properties are located close to areas where blasting may be required. Furthermore, NorthernStar would employ mitigation measures, as necessary, to minimize potential fly rock (i.e., using blasting nets/curtains) and to minimize vibration, noise, and safety impacts (i.e., coordinating with land/property owners in the project area). These mitigation measures would be detailed in a Blasting Management Plan, which NorthernStar would develop prior to beginning construction.

4.1.3.5 Paleontological Resources

We are not aware of any fossil concentrations that would be affected by construction of the Bradwood Landing LNG terminal. Furthermore, available geologic data indicate that fossils have not been observed in the immediate vicinity of the site (Beaulieu, 1973; Steere, 1977; Warren et al., 1945).

4.1.4 Pipeline Facilities

4.1.4.1 Stratigraphy

The proposed Bradwood Landing pipeline would traverse the northern boundary of Oregon's Coast Range physiographic province from the proposed LNG terminal facility at Bradwood, Oregon to the point at which it crosses the Columbia River at Port Westward, Oregon. The pipeline would then extend to the west through the southern portion of Washington's Willapa Hills physiographic province to the pipeline terminus located north of Kelso, Washington. The proposed pipeline route also crosses alluvial lowlands from Wauna, Oregon to Port Westward, Oregon. These lowlands are nearly flat and consist primarily of unconsolidated alluvium from the Columbia River and dredged material.

The stratigraphic units in the area of the pipeline route include those described above in section 4.1.3.1 for the LNG terminal location, as well as the following:

Landslide Debris. Landslide debris is prominent in portions of Clatsop County, Oregon and Cowlitz County, Washington, occurring in areas along the proposed pipeline corridor. The most prominent landslide debris in Clatsop County is located in the vicinity of the community of Wauna between MPs 1.4 and 4.0. This landslide debris has been observed to depths of 156 feet and contains interbeds of alluvium, which suggests repeated movement events in the past (Beaulieu, 1973). The

landslide activity is believed to have occurred during times of lower sea level when the Columbia River was more deeply incised. This geological unit is comprised primarily of randomly oriented weathered mudstone clasts with occasional clasts of basalt and sandstone supported in a mudstone matrix. Hummocky topography, slumps, and slack water ponds are common within these landslide deposits.

Cowlitz Formation. The Cowlitz Formation can be found near the eastern portion of the proposed pipeline route north of Longview. This formation is comprised of upper Eocene thickly-bedded, micaceous, arkosic sandstone with interbeds of siltstone. Localized areas contain cross-bedded, hummocky, or laminated sediments with limited amounts of sub-bituminous coal strata (Walsh, 1987; Newton and Van Atta, 1976).

Steep slopes and thick beds of unconsolidated sediments, comprised of colluvium and alluvium of the Columbia River and its tributaries, form the predominant landforms along the proposed pipeline route. Large basalt cliffs are present southeast of the proposed Bradwood Landing LNG terminal, west of the community of Wauna, west of Abernathy Point, and along Abernathy Creek. The small tributaries of the Columbia and Cowlitz Rivers have carved numerous steep slopes in the tertiary sedimentary and igneous rocks located between Bradwood and Wauna, and between Abernathy Point and the eastern extent of the proposed alignment near Interstate Highway 5. A large Quaternary alluvial plain extends from Wauna to Port Westward. The alluvium consists primarily of unconsolidated silt and fine sand with minor constituents of clay, gravel, cobbles, and boulders.

Table 4.1.4-1 indicates the surface geologic formations crossed by the proposed pipeline by milepost.

TABLE 4.1.4-1

Geologic Units Crossed by Proposed Pipeline

MP	Stratigraphic Unit	Age	Lithology
0.0 - 1.4	CRBG	Middle Miocene	Sub-aerial, fine to medium basalt flows layered with Gnat Creek Formation (massive, fine-to coarse-grained, arkosic sandstone and siltstone).
1.4 - 4.0	Wauna Landslide Debris	Quaternary	Ancient landslide deposits of mass wasting processes ranging from surface creep to slump blocks; overlain by Columbia River alluvial deposits.
4.0 – 19.0	Alluvium	Quaternary	Unconsolidated river and estuary deposits of sand, silt, and clay.
19.0 – 19.5	Columbia River	Not applicable	Not applicable
19.5 – 21.6	Grande Ronde Basalt	Middle Miocene	Aphanitic to fine-grained, basaltic andesite flows with associated flow breccia.
19.7 – 23.0	Grande Ronde Basalt, Basalt Gravels and Conglomerates	Middle Miocene	Aphanitic to fine-grained, basaltic andesite flows with associated flow breccia with previously unmapped basalt-clast gravels and conglomerate infilling river channel.
23.0 – 27.0	Grande Ronde Basalt	Middle Miocene	Aphanitic to fine-grained, basaltic andesite flows with associated flow breccia.
27.0 – 31.3	Cowlitz Formation	Upper to Middle Eocene	Massive to thin-bedded, fine to coarse-grained, feldspathic sandstone and carbonaceous siltstone.
31.3 – 32.5	Grande Ronde Basalt	Middle Miocene	Aphanitic to fine-grained, basaltic andesite flows with associated flow breccia.
32.5 – 34.2	Cowlitz Formation	Upper to Middle Eocene	Massive to thin-bedded, fine to coarse-grained, feldspathic sandstone and carbonaceous siltstone.
34.2 – 34.7	Alluvium	Quaternary	Unconsolidated sand, silt, and clay deposited by the Cowlitz River as fluvial and overbank deposits.
34.7 – 36.3	Cowlitz Formation	Upper to Middle Eocene	Massive to thin-bedded, fine to coarse-grained, feldspathic sandstone and carbonaceous siltstone.

4.1.4.2 Mineral Resources

Data on file with the DOGAMI (2005) and WDNR (2005) indicate the only permitted rock quarry within the proposed pipeline right-of-way is the one located at the proposed LNG terminal site. Other mined resources located within 1,500 feet of the pipeline, as identified by USGS topographic maps and discussions with state and federal geologic survey personnel, are listed in table 4.1.4-2.

TABLE 4.1.4-2

Mines Located within 1,500 feet of the Proposed Bradwood Landing Pipeline

Facility	MP	Mining Operation	Approximate Distance and Direction from Pipeline
Bradwood Quarry	0.0	Basalt	intersects
Wauna Pit 2	3.2	Basalt	1,500 feet southwest
Weyerhauser	24.5	Rock	800 feet south
Westside Quarry	33.5	Rock	1,300 feet north
Fiorito	34.5	Sand and gravel	500 feet north

In addition to the mines listed above, URS (2007b) identified an active basalt quarry located 1,000 to 2,000 feet south of the proposed pipeline route between MPs 32.4 and 33.1. NorthernStar has discussed all mine locations with the corresponding landowners and determined that no hazards associated with past, current, or future mining activities, including subsidence, blasting, slumping, or other ground failure would impact the pipeline. Furthermore, pipeline construction is unlikely to have any significant impacts on current or future mining operations.

Coal mine hazard maps (Culver, 1919; Beikman et al., 1961) indicate that coal deposits exist near Kelso and Castle Rock, Washington. The coal beds are located in the Cowlitz and Toutle Formations and are late Eocene and late Eocene/Oligocene in age, respectively. However, because these coal deposits are limited in extent (Culver, 1919) and are poor in quality (Beikman et al., 1961), we do not anticipate future mining of these coal beds near the proposed pipeline route.

4.1.4.3 Geologic Hazards

Geologic hazards along the proposed pipeline route are described in detail in *Geohazards Report, Proposed Northern Star Natural Gas Pipeline, Bradwood, Oregon to Kelso, Washington*, (URS, 2007a). A second report titled, *Supplemental Geohazards Assessment for Cowlitz County* (URS, 2007b) addresses requirements of the county's Critical Areas Ordinance. These reports are summarized below and are included as part of the public record for the Bradwood Landing Project.[3]

Resources used to assess the geologic hazards along the pipeline route included published literature, aerial photographs, Light Detection and Ranging (LiDAR) imaging, data from the HDD feasibility assessment (URS, 2006b), and field mapping.

Soil Mass Wasting and Rock Slope Failure

In Oregon, the only portions of the proposed pipeline that would be on or near slopes are within the first 4 miles of the route. The pipeline would be installed using the HDD method between MPs 0.1 and 1.3, thus avoiding potential hazards related to slopes in this area. The Wauna Landslide occurs

[3] NorthernStar filed with the FERC its *Geohazards Report for the Proposed Bradwood Landing Pipeline* on March 2, 2007, and filed a *Supplemental Geohazards Assessment for Cowlitz County* on March 22, 2007. These reports are available to the public through the FERC's Internet website at www.ferc.gov. Using the "eLibrary" link, select "General Search," enter the docket number, excluding the last three digits in the field (i.e., CP06-365 and CP06-366), and put in the appropriate date range.

between MPs 1.4 and 4.0. NorthernStar indicated it would install automated vibrating wire strain meters on the pipeline between MPs 1.5 and 4.0 to monitor the landslide debris for movement, which it believes would be the most effective form of mitigation for this landslide area, given its size, age, and lack of recent activity. Maintenance could be performed on the pipeline if strain is detected.

The primary areas for concern relative to slope failure for the proposed pipeline are along the Washington portion of the route (i.e., between MPs 19.6 and 36.3). To evaluate these areas, URS first reviewed landslide data compiled by Cowlitz County for its Critical Areas Ordinance, examined stereo aerial photographs, and then obtained high density LiDAR coverage of a 2-mile-wide corridor centered over the pipeline. The advantage of LiDAR is that it provides a highly detailed digital image of surface topography without the forest canopy. The LiDAR data was also used to run the WDNR Slope Morphology Model, which delineates areas that may be susceptible to slope failure.

NorthernStar identified 110 potential landslide areas in table 4-1 of NorthernStar's Geohazards Report, and ranked each feature by the confidence level that it may be a significant area of unstable slopes. The proposed pipeline would cross 31 potential landslide areas; however, some of these are considered lower confidence features that may require no mitigation following field confirmation. The remaining areas would require mitigation, which may include: relocation of the pipeline route; HDD crossing of the feature to place the pipeline below potential failure surfaces; and instrumentation of the pipe and/or the surrounding rock or soil to monitor strain in the pipe and movement of the surrounding ground. Table 4.1.4-3 summarizes the potential landslide areas crossed by the proposed pipeline route along with preliminary mitigation recommendations. Before final design and construction of the pipeline, additional field mapping and subsurface investigations would be necessary to refine these results and provide data for a final pipeline design geotechnical report. Results of the additional geotechnical studies and proposed mitigation measures would be subject to review by the Board of Consultants prior to construction, as previously recommended.

Seismic-Related Hazards

According to the USGS (2006), the nearest active fault to the proposed pipeline facilities would be the Willapa Bay fault zone, located approximately 27 to 40 miles northwest of the beginning of the pipeline route at Bradwood and the Gales Creek fault zone 25 miles and greater to the south (see figure 4.1.3-1). URS (2006a) also reports the Doty fault, located approximately 25 miles to the north (see figure 4.1.3-1). Other active faults include the Nehalem Bank fault and the Cascadia fold and thrust belt to the west. URS (2006a) reviewed aerial photographs from 1948, 1957, 1966, 1983, and 2001 for indications of possible surface faults in the vicinity of the proposed pipeline route but did not observe any such features.

The pipeline would cross four bedrock faults in Cowlitz County between MPs 22.3 and 24.6; however, these faults are not thought to be active (URS, 2007a). As mapped, these faults are not large enough to produce earthquakes of surface rupture offsets greater than several inches to a few feet. If these faults, or additionally identified faults are found to be potentially active based on future field investigation, the pipeline can be designed to accommodate these small to moderate differential movements across the faults using such mitigation methods as: 1) deformable trench backfill; 2) large diameter, sacrificial carrier pipe; and 3) altering the angle of the pipeline/fault intersection to minimize compressional forces acting on the pipeline.

TABLE 4.1.4-3

Potential Landslide Areas Crossed by the Proposed Bradwood Landing Pipeline in Washington

Landslide No(s).	MPs	Confidence Level [a]	Proposed Mitigation
4	19.8 – 20.1	high	One or more of the following: (1) reroute to the west to stay on ridge; (2) extend the Columbia River HDD crossing by about 0.5 mile to MP 20.3; or (3) install the pipe by the HDD method between MPs 19.8 and 20.3.
12	20.6 – 20.8	low	The landslide is entirely spanned by the HDD crossing for Cameron Creek. Adjust the depth of the HDD borehole if necessary to assure that the landslide is avoided.
13	20.8 – 20.9	high	The landslide is almost entirely spanned by the HDD crossing for Abernathy Creek. Add 0.2 mile to the southwest end and adjust the depth, if necessary.
24, 34, 35	21.3 -22.1	medium – high	Reroute the pipeline between MPs 21.3 and 21.7 to avoid the toe of Landslide 34. Install automated vibrating wire strain meters on the pipeline between MPs 21.5 and 22.1 to monitor the landslides for movement, and maintain the pipeline if strain is detected.
25B	22.2 – 22.4	medium	About half of the landslide is spanned by the HDD crossing for Germany Creek. Extend the Germany Creek HDD borehole approximately 0.15 mile west and adjust the depth, if necessary.
29, 30	22.5 – 22.7	low – medium	Install automated vibrating wire strain meters on the pipeline between MPs 22.5 and 22.6 to monitor the landslides for movement, and maintain the pipeline if strain is detected. Possibly reroute the portion of the pipeline between 22. 6 and 22.7 to avoid Landslide 30.
43	23.4 – 23.9	high	Install automated vibrating wire strain meters on the pipeline between MPs 23.4 and 23.9 to monitor the landslides for movement, and maintain the pipeline if strain is detected; or install using the HDD method.
53, 54, 56, 57	24.6 – 25.3	low – medium	Install automated vibrating wire strain meters on the pipeline between MPs 24.7 and 24.9 to monitor Landslides 53 and 54 for movement, and maintain the pipeline if strain is detected. Reroute the pipeline to the north between MPs 24.9 and 25.6 to minimize exposure to Landslide 56 and avoid Landslide 57. Install automated vibrating wire strain meters on the pipeline along the portion that crosses Landslide 56.
62	26.5 – 26.7	low	If confirmed in field, install automated vibrating wire strain meters on the pipeline along the portion that crosses the landslide.
67	26.9 – 27.5	high	Conduct additional subsurface investigations to determine the depth of the slide mass. Install the pipeline using the HDD method between MPs 26.9 and 27.5.
71	27.5 – 27.7	low	If confirmed in field, install automated vibrating wire strain meters on the pipeline between MPs 27.5 and 27.7.
73, 74	28.0 – 28.3	low – medium	If confirmed in field, install automated vibrating wire strain meters on the pipeline between MPs 28.0 and 28.3 to monitor Landslides 73 and 74 for movement, and maintain the pipeline if strain is detected.
77	28.6 – 28.7	low	If confirmed in field, install automated vibrating wire strain meters on the pipeline between MPs 28.6 and 28.7.
78	28.9 – 29.2	medium – high	The pipeline has been routed to avoid this landslide but crosses a corner of the feature. If the area of concern is confirmed in field, reroute to avoid.
84, 85	29.8 – 30.4	high	Install the pipeline using the HDD method between MPs 29.8 and 30.4.
86	30.7 – 30.8	Low	If confirmed in field, reroute the pipeline or install automated vibrating wire strain meters on the pipeline between MPs 30.7 and 30.8.
89, 91, 104, 104B	32.0 – 33.2	medium – high	One or more of the following: 1) reroute to avoid portions of the more recently active slides; 2) install with the HDD method; and 3) install automated vibrating wire strain meters on the pipeline to monitor the landslides for movement, and maintain the pipeline if strain is detected.
94	33.9 – 34.0	medium	Install automated vibrating wire strain meters on the pipeline to monitor the landslide for movement, and maintain the pipeline if strain is detected.
103	35.3 – 35.6	medium	If confirmed in the field, one or both of the following: 1) install automated vibrating wire strain meters on the pipeline to monitor the landslide for movement, and maintain the pipeline if strain is detected; and 2) extend the HDD borehole for Interstate Highway 5 to span Landslide 103.
99	35.6 – 35.8	medium	Reroute the pipeline between MPs 35.6 and 35.8 to avoid the landslide.

[a] A measure of how certain the investigators are that the feature is an actual landslide, based on the quality of the data.

Empirical reviews of historical earthquakes demonstrate that pipelines are not prone to failure due to earthquakes. A 1996 study of earthquake performance data for steel transmission lines and distribution supply lines operated by SoCal over a 61-year period found that post-1945 arc-welded transmission pipelines in good repair have never experienced a break or leak during a southern California earthquake and are the most resistant type of piping, vulnerable only to very large and abrupt ground displacement (e.g., severe landslides), and are generally highly resistant to traveling ground wave effects and moderate amounts of permanent deformation (O'Rourke and Palmer, 1994). Given that the proposed pipeline route does not cross any known active faults, earthquakes and associated seismic risk are not anticipated to have a significant impact on the proposed pipeline.

The potential for liquefaction along the proposed pipeline route was initially evaluated using liquefaction hazard maps for Cowlitz County, Washington (Palmer et al., 2004) and geologic maps for Clatsop and Columbia County in Oregon (Newton and Van Atta, 1976; Walsh, 1987). Based on these sources, soils with liquefaction potential would be crossed by the pipeline between MPs 0.0 and 19.1, 22.4 and 22.6, 27.9 and 28.0, and 34.1 and 35.5; and at MP 36.2. Geotechnical borings for the HDD feasibility assessment (URS, 2006b) confirmed a high potential for liquefaction exists in the sands and silts of the alluvial deposits south of the Columbia River and in the alluvial deposits on both banks of the Cowlitz River. Furthermore, a Cowlitz County map titled, *Seismic Hazards, Cowlitz County, WA*, indicates the proposed pipeline would cross a seismic hazard area between MPs 34.0 and 35.0, which is the Cowlitz River valley. This area is likely delineated as a seismic hazard area based on the potential for liquefaction of soils within the floodplain.

Because of the horizontal displacement involved, lateral spreading associated with liquefaction can be destructive to linear features such as pipelines. In recent history, no accounts of damage to any existing pipelines have been documented in the project area. Along the proposed pipeline route, potential liquefaction-induced lateral spreading would be largely confined to areas adjacent to the banks of rivers and streams, as soil moves toward the waterbody channels (URS, 2007a). URS conducted a lateral spread analysis at several of the proposed HDD waterbody crossings as part of the HDD feasibility assessment (URS, 2006b) and determined that lateral spreading would be greatest along the banks of the Columbia River during maximum probable earthquake shaking. The stresses and strains on the pipeline resulting from such an event would be less than recommended limiting strains using established pipeline design methodology. Therefore, further mitigation would not be required (URS, 2007a).

Buoyancy induced by liquefaction is generally not a concern for pipelines due to their flexibility but would be addressed if required by placing additional confining weights along the pipeline. Likewise, liquefaction-induced settlement would not impose significant stresses on the pipeline.

Volcanism and Lahars

Historic eruptions of Mount St. Helens produced lahars that traveled to the Columbia River, approximately 20 miles upriver from the proposed LNG terminal site, but did not produce appreciable changes in river elevation. Lava flows and pyroclastic flows terminated within 5 miles of the eruption source. During the 1980 eruption of Mount St. Helens, lahars inundated the Toutle and Cowlitz Rivers. The recurrence interval of a similar lahar or lahar related mudflows is estimated to be approximately 100 years. Sediment profiles in the lower Cowlitz River indicate previous lahar related mudflows were nearly 4.3 feet thick with an estimated over-bank flow thickness of 10.5 feet (Scott, 1989), although geologic maps of the pipeline route area do not depict lahar deposits (Phillips, 1987).

The western portion of the planned pipeline alignment, in the vicinity of the Cowlitz River is mapped as flow hazard Zone 3 (Wolfe and Pierson, 1995). Cowlitz County classifies volcanic hazard areas as coincident with the 500-year floodplain of the Cowlitz River. The scenario with the greatest

potential to impact the area of the proposed Bradwood Landing pipeline would be if a lahar inundated Castle Lake, increasing the water level and resulting in a failure of the natural dam at Castle Lake (Wolfe and Pierson, 1995). The pipeline may potentially be exposed to lahar hazards at river crossings of the Columbia and Cowlitz Rivers. At the Cowlitz River location, the pipeline would be installed at a depth sufficient to be unaffected by scour due to lahars. From the Columbia River crossing and beyond, lahars would be primarily depositional in nature. Sediment deposition would not significantly affect pipeline operations.

Ash was also deposited in the area of the proposed Bradwood Landing pipeline route during the 1980 eruption of Mount St. Helens. Ash and tephra deposition is not anticipated to be a significant geologic hazard for the pipeline due to its underground installation. Furthermore, according to Hoblitt et al. (1998), the annual probability of deposition of 0.4 inch or more of ash is 0.01 percent.

Flooding, Tsunamis, and Seiches

Flooding is possible along the proposed pipeline route between MPs 0.0 and 19.1; at MP 21.1; and between MPs 22.4 and 22.6, 27.9 and 28.0, and 34.1 and 35.0. Because the pipeline would be buried at a depth below expected levels of scour, the only potential impact of flooding would be a tendency for the pipeline to float. In these areas, weighting methods would be used, such as coating the pipe with concrete, to overcome buoyancy hazards during periods of flooding.

According to the DOGAMI (Priest, 1995a), the majority of the proposed pipeline would not be located within the tsunami risk zone. Landslide-induced waves have occurred in the vicinity of the proposed pipeline route, such as the poorly documented 1890 event and the 1965 event at Puget Island. Standardized methods for predicting the occurrence and magnitude of landslide-induced tsunamis do not exist. However, portions of the pipeline located immediately adjacent to the Columbia and Cowlitz Rivers at elevations within a few feet of the river elevation are only at a slight risk of being inundated by a landslide-induced tsunami.

Similar to the LNG terminal, the pipeline segment in the area of the proposed LNG terminal would experience an estimated tsunami wave height of less than 1 foot (URS, 2006a). Other areas that are adjacent to the Columbia River are fairly well protected by Puget, Welch, Tenasillahe, and other islands that would disrupt and disperse the energy of a tsunami or seiche. Therefore, tsunamis and seiches represent a low hazard risk to the pipeline.

Slope Stability

Side slopes during trenching for the pipeline would be maintained in accordance with established engineering and Occupational Safety & Health Administration (OSHA) guidelines, with the steepness of slope at a given location based on the soil type. Soil improvement is not necessary for pipelines due to their linear configuration, strength, and ductility.

Shoreline Erosion

Areas along the Columbia and Cowlitz Rivers are continuously modified by depositional and erosional stream processes. Bank erosion can adversely affect the stability of the pipeline and any associated structures. The risk of shoreline erosion varies from low to high long the proposed pipeline route, depending on the pipeline location relative to the intersection streams. See table 4.3.2-5 for an assessment of the erosion potential at waterbody crossings along the proposed pipeline route. Shoreline erosion would be mitigated through the use of the HDD or conventional bore construction method at waterbody crossings and through revegetation of affected areas.

Subsidence

Because there are no significant aquifers beneath the proposed pipeline route and no petroleum production, risk of subsidence caused by these factors appears negligible. NorthernStar reviewed Beikman et al. (1961), Culver (1919), and Landes (1901, 1902), for possible abandoned coal mines and shafts beneath the proposed pipeline route. No coal mines and/or shafts were identified near the proposed alignment, and the risk of subsidence due to the collapse of coal mine workings would be negligible.

Karst

As indicated in section 4.1.3.3, the rock types typically associated with karst features are not present in the project area. No karst conditions are documented in the area crossed by the pipeline route. Therefore, karst is not a geologic hazard for this project.

Corrosion

NorthernStar would follow the DOT Minimum Federal Safety Standards in 49 CFR 192, which include protection of the pipeline from internal, external, and atmospheric corrosion. The use of both an external protective coating and a cathodic protection system has been required on all pipelines installed after July 1971. The interior of the pipe would be periodically monitored for corrosion using internal corrosion probes and/or in-line pigging tools.

Cowlitz County's Critical Areas Ordinance Considerations

Cowlitz County's Critical Areas Ordinance contains development standards for landslide hazard areas and erosion hazard areas. The standards applicable to the Bradwood Landing Project pertain to grading, erosion control, and buffers. NorthernStar would implement measures designed to meet these development standards. For example, all trenched pipeline installation in geologic hazard areas would be conducted during the dry summer season to minimize short-term erosion issues caused by precipitation runoff and wet ground conditions. Clearing and grading would be done so as to disturb the minimum possible corridor width necessary. Disturbance of trees and vegetation would be restricted to the pipeline construction corridor and access routes into the corridor. Vegetation (slash) would be removed from the construction corridor prior to trench excavation and would not be placed as backfill in any of the pipeline trench excavations.

The trench backfill would consist of native excavated materials except where alternative imported backfill materials are specified in the final pipeline geotechnical report. The trench spoils would be segregated to allow topsoil and organic–rich horizons to be placed in the upper portion of the backfill sequence. Vegetative or engineered ground cover would be placed following completion of pipeline installation in all areas disturbed by the construction activities.

Over 14,000 feet of pipeline along the Cowlitz County portion would be installed using HDD methods. This construction technique would allow construction activities to avoid disturbing areas between ordinary high water and bank tops at waterbody crossings, thus minimizing the potential for erosion.

The development standards in Cowlitz County's Critical Areas Ordinance require an undisturbed 50-foot buffer, as measured on the surface, from the top, toe, and along all sides of any existing landslide or erosion hazard, within a critical area. This buffer may be increased or decreased based on the results of a geotechnical assessment. Construction of the proposed pipeline would require disturbance within the 50-foot buffer surrounding several areas of known landslide or erosion hazard areas. Each of these areas

would be identified, and any necessary remediation or special construction provision would be provided in the final pipeline geotechnical report.

The Critical Areas Ordinance defines actions designed to mitigate project-induced impacts, including avoidance, minimization, restoration, and long-term maintenance. The currently proposed HDD installations are intended primarily for crossing wetlands, waterbodies, and infrastructure; but they also serve to avoid or minimize impacts in erosion hazard and landslide areas. NorthernStar would likely use additional or extended HDD installations to avoid some of the other identified landslide hazard areas (see table 4.1.4-3). Where the pipeline is proposed to traverse steep slopes using trenching installation methods, the alignment has been oriented as close to the fall line of the slope as possible to reduce exposure of the pipeline to lateral strain due to slope creep and to shorten the total slope distance that the pipeline would cross.

All construction and access rights-of-way, including in erosion hazard and landslide areas, would be rehabilitated following completion of construction. The permanent pipeline right-of-way would be maintained as a utility easement for the lifetime of the facility. Temporary easement areas would be rehabilitated to a state that matches or improves the preconstruction conditions. The pipeline would be inspected routinely both on the ground along the alignment and on the interior of the pipe, and maintenance would be performed as needed.

4.1.4.4 Blasting

Shallow bedrock may be encountered along several portions of the proposed pipeline route. However, the near-surface rock is generally weathered and highly jointed. Therefore, the pipeline could likely be installed using conventional trenching and ripping methods. NorthernStar does not anticipate blasting would be required. However, if blasting becomes necessary, it would be conducted in the same manner described for the LNG terminal above.

4.1.4.5 Paleontological Resources

William Orr, Ph.D., Curator of the Condon Museum at the University of Oregon indicated it is likely that significant fossils of vertebrates could be found during excavation of the pipeline. Should paleontological resources be encountered during the project, NorthernStar would implement mitigation procedures based on the recommendations of Dr. Orr and other appropriate authorities, including but not limited to field data recovery.

4.2 SOILS AND SEDIMENTS

4.2.1 Waterway for LNG Marine Traffic

4.2.1.1 Soil Resources

Other than the potential for shoreline erosion, which is addressed in section 4.1.2.3, LNG marine traffic would not have a significant impact on soils along the waterway from the territorial seas to the LNG terminal site. Furthermore, a release of LNG from an LNG carrier as a result of an accident or intentional breach would not have an impact on soil resources.

4.2.1.2 Sediments

The existing sediment conditions and impacts of the proposed project on sediments within the waterway at and in the vicinity of the LNG terminal site are discussed in section 4.2.2.2. Because the LNG carriers would be operating within an existing dredged navigation channel along with other ship traffic, LNG marine traffic would not be likely to have a significant impact on sediments within the remainder of the waterway. Furthermore, a release of LNG from an LNG carrier as a result of an accident or intentional breach would not have an impact on sediments because it is not soluble in water and would float on the water surface before vaporizing.

4.2.2 LNG Terminal

4.2.2.1 Soil Resources

Information regarding soils in the proposed LNG terminal area is based on the Soil Survey of Clatsop County, Oregon (U.S. Department of Agriculture - Soil Conservation Survey (USDA-SCS), 1988) and the Soil Survey Geographic Database (SSURGO) (USDA-Natural Resources Conservation Service (NRCS), 2003). Additional information about the soils was obtained from Official Soil Series Descriptions (USDA-NRCS, 2004).

Existing Soil Resources

The proposed LNG terminal would be located in the Northern Pacific Coast Range, Foothills, and Valleys Major Land Resource Area (MLRA). The dominant soils in this MLRA are Umbrepts and Ochrepts. These well drained, gently sloping to very steep soils have a mesic temperature regime and mixed mineralogy.

The proposed LNG terminal would be located within a 411-acre parcel which contains Braun, Harslow, Kilchis, Locoda, Scaponia, and Udipsamment soils. Approximately 70 acres would be disturbed by construction of the LNG terminal and associated elements, including the parking lot and power line. The dominant soil type at the LNG terminal is Udipsamments, covering about 86 percent of the construction work area. Other soils at the terminal include Locoda silt loams, Harslow-Kilchis very gravelly loams, and Scaponia-Braun silt loams. Following construction, about 31.2 acres of Udipsamments, 4.5 acres of Locoda silt loams, and 0.01 acre of Scaponia-Braun silt loams would be encompassed within the footprint of the facility components (e.g., marine facilities, structures, process areas, roads, etc.).

A parking lot would be provided for construction workers southeast of the Taylorville interchange at Highway 30. This location for the construction worker parking lot has been changed from the original location proposed by NorthernStar and no information has been provided about the new site

regarding soils or other resources. In addition, modifications are now being proposed to Bradwood Road and Clifton Road that would disturb areas outside the current footprint. Therefore **we recommend that:**

- **<u>Prior to construction</u> of the LNG terminal, NorthernStar should file with the Secretary the following information regarding the new proposed construction worker parking lot, Bradwood Road, and Clifton Road: map of disturbed area; soils; impacts on upland vegetation, waterbodies and wetlands, and wildlife habitat; occurrence of state- or federally listed species; land use and zoning; cultural resources, and restoration plans. NorthernStar should include status and copies of agency clearances for wetlands, threatened and endangered species, and cultural resources, as applicable.**

Non-jurisdictional facilities associated with the proposed LNG terminal include a 1.5-mile-long power line and three lateral pipelines. As discussed in section 2.2.2, the lateral pipelines would be constructed by entities other than NorthernStar and are tentative at this time. The power line would require a 100-foot-wide right-of-way for construction and operation. Approximately 0.3 mile of the power line would be located with the terminal site discussed above. Soils within the remainder of the power line corridor consist of 8.3 acres of Braun-Scaponia silt loams, 5.8 acres of Scaponia-Braun silt loams, 1.2 acres of Harslow-Kilchis very gravelly loams, and less than 0.1 acre of Udipsamments.

According to the soil survey of Clatsop County, Oregon (USDA-SCS, 1988), the Udipsamments consist of sandy soils that formed in stratified dredged materials along the Columbia River. Udipsamments are very deep, excessively drained soils with slopes ranging from 0 to 15 percent. The Locoda soils are finer textured soils formed in mixed alluvium located on tidally influenced flood plains. These are very deep, very poorly drained soils with slopes ranging from 0 to 3 percent. The Harslow and Kilchis soils consist of very gravelly loams formed in mixed colluvium along mountainsides. These are shallow to moderately deep, well drained soils with slopes ranging from 60 to 90 percent. The Braun and Scaponia soils consist of silt loams formed in colluvium weathered from siltstone. These are moderately deep, well drained soils with slopes ranging from 3 to 60 percent. The Alstony soils consist of gravelly loams formed in colluvium weathered from igneous rock. These are deep, well drained soils with slopes ranging from 30 to 60 percent. The Anunde soils consist of silt loams formed in colluvium weathered for siltstone. These soils are very deep and well drained with slopes ranging from 3 to 30 percent.

Contaminated Soils

In August 2005, AMEC Earth and Environmental, Inc. (AMEC) prepared a revised Phase I Environmental Site Assessment for the proposed terminal site. The Environmental Site Assessment included a review of regulatory databases and a site inspection to identify known contaminated sites on or near the proposed LNG terminal. No contaminated sites were identified within 0.25 mile of the proposed LNG terminal site. However, the Environmental Site Assessment did identify several Recognized Environmental Concerns (REC) on the property, including two gasoline underground storage tanks (UST), an area where a former train/maintenance shop building was located, asbestos containing cement board, solid waste disposal and burn areas, and the potential presence of polychlorinated biphenyls (PCB) and dioxins in dredged sand deposited at the site. The power line corridor was not examined in the Environmental Site Assessment; however, the search radius used for the review of regulatory databases included portions of the proposed power line route. In addition, surveys of the corridor and construction parking area did not identify any features that would constitute RECs.

Based on historical site activities, the potential exists that contaminated soils are present at the LNG terminal site. Improper handling of contaminated materials encountered during construction could spread contaminants to surface and groundwater and other sensitive resources, as well as represent a

health risk to workers. NorthernStar does not anticipate encountering potentially contaminated material during the construction of the terminal. If final design results in the need to advance deep excavations within the footprint of particular RECs, NorthernStar would prepare a *Contaminated Materials Management Plan* (CMMP) that would specify the procedures to identify, characterize, and properly manage potentially contaminated materials. The CMMP would be submitted to the appropriate agencies for approval before construction. To ensure that personnel working on the project are prepared to appropriately handle an unanticipated encounter with contaminated soils, a CMMP should be prepared regardless of whether or not the final design includes deep excavations. Therefore, **we recommend that:**

- **NorthernStar should prepare its CMMP to address the discovery and management of contaminated soils and groundwater. This plan should comply with applicable state and federal regulations and should include procedures for the identification and management of unknown contaminants if any are encountered during construction of the proposed LNG terminal and pipeline facilities. The plan should be filed with the Secretary for the review and written approval of the Director of OEP <u>prior to construction</u>.**

Impacts and Mitigation

Construction activities such as clearing, grading, and the movement of construction equipment over work areas may affect soil resources. Clearing removes protective cover and exposes the soil to the effects of wind, sun, and precipitation, which may increase the potential for soil erosion and the movement of sediments to sensitive areas. Grading and equipment traffic may compact soil, reducing porosity and percolation rates, which would result in increased runoff potential. Contamination from spills or leaks of fuels, lubricants, and coolants from construction equipment could also impact soils.

Operation of the LNG terminal would permanently convert 35.7 acres of soil to a commercial/industrial use. Project-related impacts on soils would be minor. There are no prime farmland soils at the LNG terminal. The majority (98 percent) of the soils within the proposed LNG terminal site are not considered to be highly erodible land (HEL) or potentially highly erodible land (PHEL) and are therefore not susceptible to erosion by water. However, the Udipsamments have a wind erodibility group (WEG) classification of 2 and are considered to be susceptible to wind erosion.

Maintenance of the 100-foot-wide power line corridor would permanently convert approximately 15 acres of soil outside the terminal site to commercial/industrial uses. None of the soils within the corridor that would potentially be affected are considered prime farmland. Less than 1 percent of the soils within the corridor are considered to be susceptible to wind erosion. However, essentially all (greater than 99 percent) of the soils within the power line corridor are considered HEL and susceptible to water erosion.

NorthernStar would mitigate impacts on soils at the proposed terminal and associated work areas by implementing the measures specified in its terminal ESC Plan. NorthernStar's terminal ESC Plan includes measures to control erosion and sedimentation during construction, ensure revegetation to prevent erosion following construction, and prevent and control spills.

4.2.2.2 Sediments

As discussed in sections 2.1.3.1 and 2.4.1.2, the construction and operation of the proposed LNG terminal would require dredging of subsurface sediments in the Columbia River adjacent to the facility to safely navigate vessels from the river channel to the berth at the terminal. Current water depths within the proposed dredge footprint range from -21 to -51 feet CRD. The proposed design depth is -42 foot CRD

with a 1-foot overdredge allowance, for a total project depth of -43 feet CRD. NorthernStar anticipates that up to 700,000 cubic yards of sediment would be dredged to obtain the proposed design depth and overdredge allowance.

In accordance with the Lower Columbia River Management Area Dredged Material Evaluation Framework (DMEF) developed by the Regional Management Team (RMT), an inter-agency task force[4] that studies dredging on the Columbia River, NorthernStar conducted a Tier I evaluation of the project area. Because the Tier I evaluation indicated the presence of generally low levels of some chemicals of concern, a DMEF Tier IIB analysis (physical and chemical analyses) was selected as the most appropriate level of evaluation for the proposed dredged materials.

Sediment Sampling

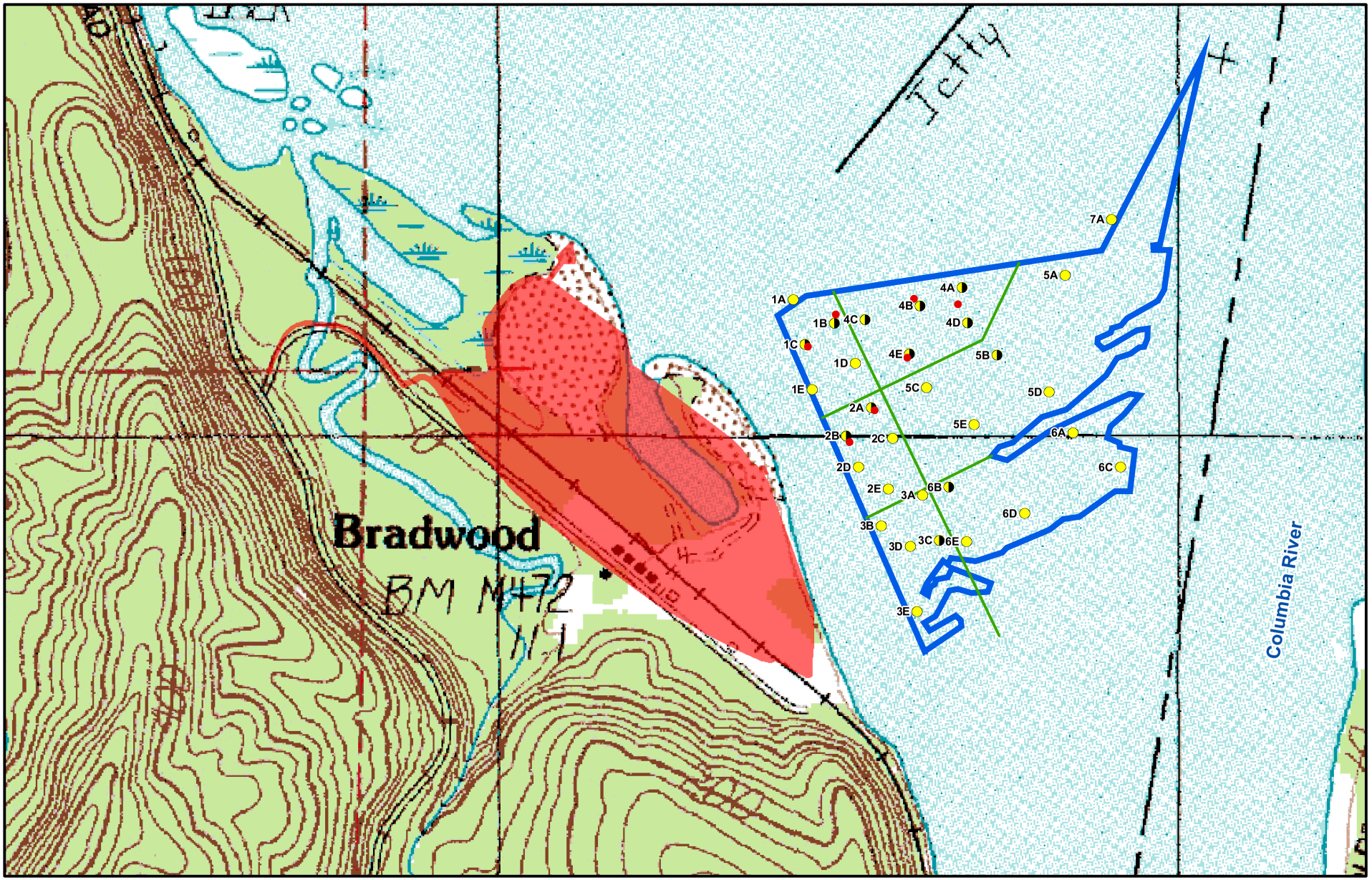
Sampling and Analysis Plan

NorthernStar developed a *Sampling and Analysis Plan* (SAP) (AMEC, 2006) that details the sediment collection and testing program conducted on the proposed dredged material. The SAP was developed based on procedures outlined in the Lower Columbia River Management Area DMEF (COE et al., 1998). The sediment sampling and analysis program followed the DMEF Tier IIB approach (physical and chemical analysis) for evaluation of the proposed dredged material. The SAP received conditional approval from the RMT in early February 2006 (AMEC, 2006).

Seven horizontally delineated areas were selected within the proposed dredging footprint to characterize the nearshore and offshore sediments (see figure 4.2.2-1). Areas 1 through 3 were closest to the shoreline, whereas areas 4 through 7 were offshore parallel to the navigation channel. Generally, five core locations were designated within each area in locations with the thickest deposits of proposed dredged materials (dredge prism). The exception was area 7, with only a single core location. Area 7, a small triangular area at the northeast corner of the proposed dredging area, was added before the last SAP revision at the suggestion of the local river pilots. This sample point was intended to provide additional data for an area to be dredged to provide better navigational maneuvering for carriers approaching the turning basin from the main channel.

Dredged Material Management Units (DMMU) were designated based on the DMEF ranking protocol, although different rankings were established for different areas of the dredge prism because sediments are believed to be heterogeneous across the site. Top, middle, and bottom strata DMMUs were designated for each horizontal area, where sediments were sufficiently thick. For all areas, the top 4 feet was considered the top stratum, the core segment from 4 to 10 feet was considered the middle stratum, and material below 10 feet to the project depth (including overdredge) was designated the bottom stratum. The leave surface horizon (1 foot below the maximum overdredge depth—termed the "Z" stratum) was also to be sampled. Sediments from the top, middle, and bottom DMMUs were to be composited by sample area yielding a total of 18 sediment samples for analysis from the proposed dredge prism. Samples from the leave surface were not to be composited. Two additional samples from designated reference cores were also to be analyzed.

[4] Included in the RMT are representatives of the COE, EPA, ODEQ, WDE, and WDNR.



0 200 400 600 800 1,000 Feet

Figure 4.2.2-1
Bradwood Landing Project
Dredging Footprint and Sediment Sampling Locations

February 2007 Rotary Drill Location
DMMU Boundaries
Dredge Footprint

2006 Vibracore Sampling Location
Full Target Depth
PartialTarget Depth

February 2006 Sampling Event

Between February 9 and February 26, 2006, vibracore samples were collected at all 33 locations specified in the revised SAP, including 31 cores in the dredge prism and 2 reference site cores. Sample processing was conducted onboard an SWCA Environmental Consultants (SWCA) research vessel moored alongside the sampling vessel. Collected samples were stored in iced coolers, or kept in a secured refrigeration unit at 39.2 ºF. Methods and materials used for each physical and chemical analysis performed at the lab are detailed in *Sediment Characterization Report*, dated May 24, 2006 (SWCA, 2006). Deviations from the SAP are described below.

Core sediments collected for DMMU composite samples were not mixed together in the field using a drill operated stainless steel impeller as specified in the SAP. Under field conditions, the use of an electric drill was determined to pose an unacceptable potential for external contamination as a result of wear from the drill's copper bushings. Mixing of the composite samples was conducted in the analytical laboratory, where controlled conditions minimized the potential for contamination. Equal amounts of material from specific strata within the DMMU were stored in a sealed composite sample jar with instructions for the laboratory staff to mix well before running analyses. NorthernStar does not believe the analytical results were affected by this deviation from the SAP.

Full penetration to target depth was achieved at 19 core locations. Partial cores were collected at 12 locations (see figure 4.2.2-1). The vibracore sampler was not able to penetrate the substrate to the target depth specified in the SAP at these 12 sites. Refusal was declared if core advancement stopped at the same depth on subsequent attempts, repeatedly showed similar obstructing bottom material, and/or equipment showed damage from attempting to core into impenetrable materials. Apparent reasons for these refusals included dense gravel layers, wood, and densely packed sands (SWCA, 2006). An acoustic survey conducted in June 2005 found a distinct sub-bottom layer of "consolidated sediments." This consolidated layer slopes upwards in the northwestern portion of the dredge area, where most of the partial core penetrations occurred.

Partial refusals resulted in a change in the compositing scheme for some bottom (B) DMMU composites (see table 4.2.2-1). As a result, the number of constituent core locations for a composite was reduced if one or more cores within a sampling area was not attained due to refusal. In DMMU 2, for example, only core locations 2A and 2B were targeted constituents of the bottom composite. However, at core location 2B the bottom stratum was not obtained and thus, the "composite" consists only of material from core location 2A. Similarly, in area 4 the targeted B strata was not attained at core locations 4A, 4B, 4D, and 4E, leaving only core 4C to fill the DMMU composite for the B strata. All B strata constituents were obtained for the targeted DMMU composites from sites 3, 5, and 6. Top (T) and middle (M) DMUU strata were collected at all core locations in keeping with the SAP. Samples from the "leave surface" collected during this sampling event were placed in archival storage at the analytical laboratory pending agency responses to the submitted results.

NorthernStar indicated that tributyl tin analysis of pore water was not feasible because the highly sandy nature of the sediment resulted in very limited pore water recovery. As discussed in the SAP, bulk sediment analysis for tributyl tin was performed on DMMU composite samples.

May 2006 Sampling Event

On May 24-25, 2006, a truck-mounted rotary mud drill rig was deployed from a barge to obtain samples at 7 of the 12 sites where partial refusal during the original sampling effort prevented sampling of the bottom and/or leave surface. These sampling sites were chosen in consultation with NMFS (SWCA, 2007). All 12 samples from these 7 cores were placed in archival storage at the analytical laboratory pending analysis instructions.

TABLE 4.2.2-1

Estimated and Actual Compositing of DMMUs Sampled for the Bradwood Landing Project

DMMU	Target Core Segments to be Composited	Actual Core Segments Composited
1T	5	5
1M	5	5
1B	4	3
2T	5	5
2M	5	5
2B	2	1
3T	5	5
3M	5	5
4T	5	5
4M	5	5
4B	5	1
5T	5	5
5M	5	5
5B	1	1
6T	5	5
6M	5	5
7T	1	1
7M	1	1
Reference 1	1	1
Reference 2	1	1

February 2007 Sampling Event

In a letter dated June 30, 2006 NMFS staff requested retene analysis for the 10 DMMUs in areas 4 through 7, full analysis of May 2006 samples, and full analysis of individual leave surface samples. In a memorandum dated October 3, 2006, NMFS staff reiterated their previous request and further specified mercury, VOCs, and DMEF Tier IIA analysis be performed. When NorthernStar requested additional laboratory analysis of the May 2006 samples placed on hold at the analytical laboratory, it learned that the samples had been inadvertently discarded by laboratory staff. Therefore, on February 6-7, 2007, replacement samples were collected by mud rotary drilling techniques at the same seven core locations.

Sampling generally followed the SAP except as described for the February 2006 sampling event relative to composite sample mixing and number of fractions. Because of poor sample recovery, composite samples 1B and 2B each consisted of only one fraction rather than the four and two fractions, respectively, specified in the SAP. Composite sample 4B consisted of three fractions compared to the five intended in the SAP. Additionally the sampling deviated from the SAP in that the sampling depth for bottom and leave surface strata were modified to reflect new potential maximum dredging depths. Bottom strata were extended downward 2 feet and Z strata were shifted 2 feet lower than specified in the SAP.

Physical and Chemical Analyses

Grain size analysis was performed on 18 DMMU composite samples and 2 reference samples following agency approved methods. The sediment sampled from the proposed dredge prism contained very small quantities of fines. Fines are sediments that are smaller than 0.65 mm, equivalent to material that passes through a standard series 230 sieve. Fines are important due to the tendency of contaminants to adhere to fine grained particles. Composite cores from each DMMU contained over 93 percent

material retained on a 230 sieve, and 15 of the 18 samples contained over 97 percent material retained on a 230 sieve. The results of the grain size analyses indicated that the sediments in the proposed dredging area generally consist of sands.

Sediment samples were chemically analyzed according to agency approved methods for the constituents listed in the DMEF. Additional analyses included guaiacols, resins, and phytosterols. These analytes were included due to concerns expressed by NMFS staff resulting from the site's former use as a lumber mill.

Details of the chemical analyses are available in SWCA (2006, 2007). The results of the chemical analyses presented below are summary discussions by contaminant class. The laboratory results summarized below are reported to method reporting limits (MRL). A not detected result for a given compound was defined by the laboratory as "analyzed for, but not detected at or above the MRL."

The NOAA Squirt (Screening Quick Reference Tables) tables provide a listing of chemical concentrations for inorganic and organic contaminants in various environmental media. The tables can be used to initially identify substances that may threaten aquatic resources of concern to NOAA. The results of chemical tests conducted for proposed projects may be compared to values listed in the Squirt tables to provide initial screening for potential contaminants of concern. The tables are intended for preliminary screening purposes only, and do not represent criteria or clean-up levels.

Total Organic Carbon

In the dredge prism samples, total organic carbon (TOC) ranged from not detected (in eight DMMUs) to 0.78 percent at DMMU 1M. TOC in the leave surface samples ranged from 0.14 to 1.79 percent. Reference sites ranged from not detected to 0.05 percent. These values are consistent with the highly sandy nature of the sediments.

Total Volatile Solids

Total volatile solids in the dredge prism ranged from 0.56 percent in DMMU 5T to 1.61 percent in DMMU 6T and the reference sites had 0.7 and 0.8 percent total volatile solids. Total volatile solids in the leave surface samples ranged from 0.67 to 2.11 percent. As with TOC, the percentage of volatile solids is consistent with the highly sandy nature of the proposed dredged sediments.

Metals

The sediment samples were analyzed for 10 heavy metals. The results are summarized in table 4.2.2-2 along with several screening, threshold effects, and background levels for comparison.

Arsenic, chromium, copper, lead, nickel, and zinc were detected in all samples. Mercury and selenium were each detected in only one dredge prism sample and no leave surface samples. The concentrations detected were all below the Lower Columbia River Management Area DMEF screening levels, the draft Sediment Evaluation Framework (SEF) SL1 levels, and the lowest NOAA Squirt table Threshold Effects Level (TEL). The concentrations were also either below or very near the highest NOAA Squirt table "background" levels. Some of the chromium concentrations in both dredge prism samples and leave surface samples exceeded typical background levels near the site in the Columbia River, but the concentrations of all other metals were less than or within the range of nearby background levels.

TABLE 4.2.2-2

Summary of Results for Heavy Metals in Sediments

Metal	Dredge Prism	Leave Surface	Reference Site 1	Reference Site 2	DMEF Screen [a]	SEF SL1 [b]	Squirt Back-ground[c]	TEL [d]	SEDQUAL Levels [e]
Arsenic	1.1 – 1.9	1.2 – 1.7	1.3	1.4	57	20	1.1	5.900	1.4 – 2.5
Cadmium	ND – 0.14	ND – 0.19	0.07	0.07	5.1	1.1	0.30	0.583	0.8 – 5.5
Chromium	3.1 – 13.3	3.4 – 16.8	5.7	7.6	NA	95	13.0	36.286	6 – 8
Copper	5.0 – 9.5	5.6 – 8.3	5.8	6.0	390	80	25.0	28.012	6 – 30
Lead	1.26 – 2.98	1.15 – 2.67	2.08	2.40	450	340	7.0	37.000	2 – 14.8
Mercury	ND – 0.09	ND	ND	ND	0.41	0.28	0.051	NA	NA
Nickel	5.9 – 11.9	6.3 – 12.5	8.1	9.3	140	60	9.9	19.514	10 – 17
Selenium	ND – 1.1	ND	ND	ND	NA	NA	0.29	NA	NA
Silver	ND – 0.15	ND – 0.13	ND	ND	6.1	2.0	<0.50	NA	NA
Zinc	15.4 – 32.4	15.2 – 34.8	24.4	28.5	410	130	38.0	98.000	36 – 130

Notes: All concentrations in parts per million.
Results for dredge prism and leave surface samples reflect the range of concentrations measured in the samples.
[a] Lower Columbia River Management Area DMEF (COE et al., 1998) screening level.
[b] Draft SEF (COE et al., 2005) SL1 level.
[c] Highest NOAA Squirt "background" level.
[d] NOAA Squirt TEL (Buchman, 1999).
[e] Typical Columbia River concentrations (upstream and downstream in vicinity of site) from Sediment Quality Information System (SEDQUAL) Release 5 (WDE, 2004).
NA Not Applicable
ND Not Detected

Butyl tins are organometallic compounds associated with marine vessel maintenance and construction activities or sources. Tributyl tin was not detected in any of the dredged prism samples or the reference samples but was detected in four leave surface samples at concentrations ranging from 1.6 parts per million (ppm) to 5.4 ppm. These concentrations are below the draft SEF SL1 (dry weight) level of 75 ppm.

Organic Compounds

NorthernStar analyzed the proposed dredge sediments for a suite of standard volatile and semi-volatile organic compounds. None of the eight volatile organics analyzed for were identified at or above the MRL in the samples from the dredge prism, leave surface, or the reference sites. Of the 39 semi-volatile organic compounds for which the samples were analyzed, only 4 polycyclic aromatic hydrocarbons (PAH) and 2 phthalates were detected above the MRLs. During the February 2006 sampling event, the PAHs fluoranthene and pyrene were identified at 13 and 15 parts per billion (ppb), respectively, in one DMMU (3M); and acenaphthene, phenanthrene, and pyrene were detected at similar concentrations in one leave surface sample (3DZ). The concentrations of these compounds were at one to two orders of magnitude below their respective DMEF screening levels and SEF SL1s. The concentrations were also below the applicable lowest NOAA Squirt table TELs. These PAHs are recognized byproducts of petroleum combustion and the low levels identified in isolated samples may represent contamination from sampling vessel diesel exhaust.

Bis(2-ethylhexyl)phthalate was detected in leave surface sample 4BZ at a concentration of 110 ppb, which compares to the DMEF screening level of 8,300 ppb and the SEF SL1 level of 220 ppb. Diethyl phthalate was detected only in the Reference Site 2 sample. The concentration of 18 ppb was

below the DMEF screening level of 1,200 ppb. No NOAA Squirt table guidelines or other SEF screening levels have been established for these compounds.

Pesticides

None of the 21 pesticides analyzed for were identified at or above their respective MRLs in samples from the proposed dredged materials or the reference site samples. Methoxychlor was detected in leave surface samples 3BZ (1.1 ppb) and 7AZ (8.0 ppb). Neither sediment screening levels nor TELs are established for this pesticide in current versions of the DMEF, SEF, or NOAA Squirt tables.

Polychlorinated Biphenyls

NorthernStar analyzed the sediments for seven individual PCBs. None of the PCBs were detected at or above the MRL in any of the samples.

Dioxin and Furans

Samples from each DMMU and the reference sites were analyzed for 7 dioxins and 10 furans. In addition, samples were analyzed for total tetra-dioxins, penta-dioxins, hexa-dioxins, hepta-dioxins, tetra-furans, penta-furans, hexa-furans, and hepta-furans. Results for the parameters that were detected above the MRL in at least one sample are summarized in table 4.2.2-3.

TABLE 4.2.2-3

Summary of Results for Dioxins and Furans in Sediments

Parameter	Dredge Prism	Leave Surface	Reference Site 1	Reference Site 2	UET [a]
2,3,6,7,8-HxCDD	ND – 0.883	ND – 0.257	ND	ND	--
1,2,3,7,8,9-HxCDD	ND – 0.171	ND – 0.112	ND	ND	--
1,2,3,4,6,7,8-HpCDD	ND – 15.362	ND – 10.828	ND	ND	--
OCDD	ND – 85.845	0.899 – 157.794	ND	ND	--
1,2,3,7,8-PeCDF	ND – 0.122	ND	ND	ND	--
2,3,4,7,8-PeCDF	ND – 0.090	ND	ND	ND	--
1,2,3,4,7,8-HxCDF	ND – 0.266	ND – 0.150	ND	ND	--
1,2,3,6,7,8-HxCDF	ND – 0.127	ND – 0.056	ND	ND	--
2,3,4,6,7,8-HxCDF	ND – 0.173	ND	ND	ND	--
1,2,3,4,6,7,8-HpCDF	ND – 1.788	ND – 0.788	ND	ND	--
1,2,3,4,7,8,9-HpCDF	ND – 0.307	ND	ND	ND	--
OCDF	ND – 72.678	ND – 6.962	ND	ND	--
Total Tetra-Dioxins	ND	ND – 0.200	ND	3.758	--
Total Penta-Dioxins	ND – 0.069	ND	ND	ND	--
Total Hexa-Dioxins	ND – 2.568	ND – 1.081	ND	ND	--
Total Hepta-Dioxins	ND – 25.449	ND – 15.842	ND	ND	--
Total Penta-Furans	ND – 0.673	ND	ND	ND	--
Total Hexa-Furans	ND – 3.864	ND – 0.519	ND	ND	--
Total Hepta-Furans	ND – 8.125	ND – 3.213	ND	ND	--
2,3,7,8-TCDD Equivalent Total [b]	0 – 0.397	0.0001 – 0.173	0	0	8.8

Notes: All concentrations in parts per trillion.
Results for dredge prism and leave surface samples reflect the range of concentrations measured in the samples.
[a] NOAA Squirt table Upper Effects Threshold (UET) for 2,3,7,8-TCDD.
[b] World Health Organization toxic equivalency factor totals.

Totals for 2,3,7,8-TCDD equivalents, calculated using World Health Organization toxic equivalency factors, ranged from zero to 0.173 parts per trillion. These 2,3,7,8-TCDD equivalent totals are well below the NOAA Squirt table upper effects threshold (UET) for 2,3,7,8-TCDD of 8.8 parts per trillion.

Sulfide and Ammonia

Total sulfide was detected at only one DMMU (1AM at 0.7 percent); it was not detected in the reference samples. None of the leave surface samples were analyzed for total sulfide. Ammonia as nitrogen ranged from 0.5 to 17.2 ppm in the dredge prism samples and from 8.0 to 18.0 ppm in the leave surface samples. Reference sample results for ammonia were 7.9 and 3.3 ppm at sites 1 and 2, respectively.

Guaiacols and Resins

Analysis for guaiacols, retene, and resin acids was requested by the NMFS due to concerns related to the site's history as a lumber mill. The following compounds were tested for, but not detected at or above the MRL in any of the dredge prism or leave surface samples: pimaric acid; 3,4,5-trichloroguaiacol; tetrachloroguaiacol; 9,10-dichlorostearic acid; 12-chlorodehydroabietic acid; 14-chlorodehydroabietic acid; and dichlorodehydroabietic acid. The reference site samples were not analyzed for these compounds. Table 4.2.2-4 summarizes the results for the remaining compounds.

TABLE 4.2.2-4

Summary of Results for Guaiacols, Retene, and Resin Acids in Sediments

Compound	Dredge Prism	Leave Surface
Linoleic Acid	ND – 0.13	ND – 0.043
Oleic Acid/Linolenic Acid	ND – 0.16	ND – 0.18
Retene	ND – 0.55	ND – 3.2
Isopimaric Acid	ND – 0.077	ND – 0.061
Dehydroabietic Acid	ND – 0.16	ND – 0.034
Abietic Acid	ND – 0.041	ND – 0.057

Notes: All concentrations in ppm.
Results for dredge prism and leave surface samples reflect the range of concentrations measured in the samples.
NA Not Analyzed

Neither sediment screening levels nor TELs are established for these compounds in current versions of the DMEF, SEF, or NOAA Squirt tables. However, in a memo to the Commission dated June 30, 2006, NMFS staff indicated that the agency has used an estimated sediment toxicity benchmark for retene of 1.1 milligrams of retene per gram of TOC (mg/g). Using this benchmark, TOC-adjusted retene concentrations in the four dredge prism samples where the compound was identified and TOC was analyzed are 0.012 mg/g, 0.018 mg/g, 0.38 mg/g, and 0.61 mg/g. TOC data was available for only two of the five leave surface samples in which retene was detected: in sample 2AZ, which also had the highest retene concentration, and in sample 1BZ. The TOC-adjusted retene concentrations in these samples are 0.58 mg/g and 0.084 (mg/g), respectively.

Phytosterols

Phytosterols, also known as plant sterols, are a naturally occurring class of compounds found in the cells and membranes of plants. There are approximately 250 different sterols and related compounds

in plant and marine materials with the most common ones being beta-sitosterol, stigmasterol, and campesterol (Forbes Medi-Tech, 2006). In fish, they may have reproductive effects and could be responsible for some types of reproductive dysfunction observed in fish exposed to pulp mill effluents (Tana et al., 1994 as cited in NMFS, 2004a). Sediment concentrations of phytosterols vary widely. Phytosterol concentrations in sediments from sites that are not specifically associated with pulp mills range from less than 1 to approximately 30 micrograms per gram (µg/g) dry weight (Hasset and Lee, 1977; Mudge et al., 1999 as cited in NMFS, 2004a). Data regarding phytosterol concentrations in sediments associated with pulp mills are limited. Leeming and Nichols (1998) reported total sterol concentrations from the Upper Derwent Estuary in Tasmania in the 30-110 µg/g dry weight range in sediments that were closest to pulp mill discharges, and from 0.6 to 8.1 µg/g dry weight at sites farther from mill sites (NMFS, 2004a). Phytosterols were analyzed in the proposed dredge sediments for the Bradwood Landing Project because of the site's history as a former lumber mill.

Dredge prism and leave surface samples were analyzed for four phytosterols and each was detected in at least several samples. The results are summarized in table 4.2.2-5. As might be expected, phytosterol concentrations were highest in both DMMU and leave surface samples nearest shore. Beta-sitosterol was the most commonly identified compound, occurring in 19 of the 26 leave surface samples and 13 of the 15 DMMU samples collected in 2007. Stigmastanol was identified in about 30 percent of the DMMU and leave surface samples. Campesterol was found in 19 percent of the leave surface samples and 13 percent of the DMMUs. Stigmasterol was identified in only two samples from the leave surface. Phytosterol contents of the sediments in the proposed dredging footprint were within the range of concentrations reported for sediments not specifically associated with paper or pulp mills cited above.

TABLE 4.2.2-5

Summary of Results for Phytosterols in Sediments

Compound	Dredge Prism	Leave Surface
Stigmastanol	ND – 0.44	ND – 2.3
Campesterol	ND – 0.33	ND – 0.87
Beta-Sitosterol	ND – 4.1	ND – 15.0
Stigmasterol	ND – 3.30	ND – 0.29

Notes: All concentrations in ppm (µg/g).
Results for dredge prism and leave surface samples reflect the range of concentrations measured in the samples.

There are neither sediment screening levels nor TELs for these compounds in current versions of the DMEF, SEF, or NOAA Squirt tables. Because these compounds are not routinely tested for in Columbia River sediments, a database of background levels has not been established to which these concentrations can be compared.

Phytosterols are relatively insoluble in water. In laboratory studies assessing the effects of phytosterols on fish, these compounds were dissolved in ethanol or acetone before being added to the test waters (Lehtinen et al., 1999; Tremblay and Van Der Kraak, 1999). The mean TOC content in sediments from the DMMU samples was 0.25 percent (SWCA, 2006). The mean TOC content from the leave surface samples was 0.47 percent. The relatively low TOC content of the sediments within the dredge prism suggests a limited potential to mobilize phytosterols from the sediments during dredging or from the leave surface during operation of the facility.

Summary of Physical and Chemical Analysis of Sediments

Results for the physical and chemical analysis of the sediment from the proposed dredge prism and the two reference sites are summarized below.

- All sediment samples in the proposed dredge area consisted of at least 90.4 percent sand or gravel, and contained less than 1.8 percent TOC and less than 2.2 percent total volatile solids.

- Metals results were all well below DMEF, SEF, and NOAA Squirt screening and TELs, and were generally within background levels. The concentrations were generally evenly dispersed horizontally and vertically throughout the dredge prism.

- No VOCs or PCBs were detected.

- The only semi-volatile organic compounds detected were several PAHs, which were detected in two samples. The detected concentrations of these compounds were relatively low compared to applicable screening and TELs. The presence of the PAHs in the samples may be the result of accidental contamination during sampling by vessel diesel exhaust.

- Toxicity equivalency factor totals for dioxins and furans were well below the NOAA Squirt table UET level of 8.8 parts per trillion.

- Analytical results for guaiacols, resin acids, and phytosterols were variable across the samples with positive correlations observed between the concentrations and the presence of woody debris in the core samples. There are no sediment screening levels or TELs for these compounds in current versions of the DMEF, SEF, or NOAA Squirt tables.

Potential Dredging Impacts

Sediment Resuspension

NorthernStar would use hydraulic cutterhead dredging to excavate the berth area. Studies by the COE indicate that cutterhead dredging generally results in lower sediment resuspension than other forms of dredging (e.g., clamshell or hopper barge) (COE, 1986; COE, 1988). Dredging operations to excavate the ship berth would suspend sediments and affect water quality. In general, dredging-related water quality impacts would include both the physical effects of suspended sediment and alterations of water chemistry due to the release of various chemical constituents associated with the sediment (see sections 4.3.2.2 and 4.3.2.3 for further discussion of water quality impacts). Additional discussion of potential sediment resuspension effects is included below.

Hydrodynamic and Sediment Transport Alterations

During initial scoping discussions, the NMFS raised a number of concerns related to potential impacts resulting from erosion, sedimentation, and changes in channel stability that could result from dredging of the proposed berth area at the LNG terminal. These issues included the potential for:

- changes in the morphology and hydraulics of the Clifton Channel;

- alteration of sediment transport in the main navigation channel and impacts on downstream Tenasillahe Island (in particular, the Lewis and Clark National Wildlife Refuge (LCNWR));

- changes in water circulation in the dock area to adversely affect shallow water habitat;

- scour at the shoreline from altered depth contours and from vessel berthing and unberthing movements at the terminal (including wave wash); and

- turbidity from dredge activity, including suspended solids concentration, size and duration of the plume.

Additionally, the NMFS requested information on the expected frequency and volume of maintenance dredging. To address the concerns of the NMFS, NorthernStar conducted hydraulic and sediment transport analyses using a combination of the RMA2 hydrodynamic model and the SED2D-WES sediment transport model (WEST, 2006). The RMA2 model is a two-dimensional, depth-averaged, finite element hydrodynamic numerical model developed by the COE. The SED2D-WES model is also a two-dimensional numerical model for calculating depth-averaged transport, deposition, erosion, and formation of stream-bed deposits in non-cohesive (i.e., sandy) sediments. The models were calibrated using measured data for a period in mid-March 2006. The calibrated models were then used to evaluate the hydrodynamic and sedimentation characteristics for a range of potential river flows. Based on historical stage and flow data, NorthernStar modeled four river flow conditions including:

- a low flow condition (discharge rate of 125,000 cubic feet per second (cfs));
- a 50 percent exceedance flow (210,000 cfs);
- a high winter or spring freshet condition (545,000 cfs); and
- an extremely high flow condition, equivalent to the 1996 flood event (846,000 cfs).

The results of the modeling show that changes in the hydraulic characteristics of the Columbia River and its channels caused by the proposed project would generally be minor. Specific responses for each of the NMFS initial concerns are presented below.

Based on the modeling conducted by NorthernStar, the proposed project would cause a reduction in stream flow through the Clifton Channel, resulting in a reduction of the water surface profile, shear stresses, and flow velocities through the channel. The changes in hydraulic conditions would occur over a 1.5-hour period at the peak of flood and ebb tides for low to average flows, and over the entire tidal cycle for high flows. This trend would increase slightly with a ship docked at the proposed terminal. The SED2D-WES results indicate that minor deposition may occur for the 50 percent exceedance flow along the Clifton Channel. However, the results do not show significant changes to the overall bed conditions in the Clifton Channel for the range of flows modeled. The small changes in the hydraulic characteristics associated with the proposed project are not expected to alter the form of the Clifton Channel. The reduction in flow through the Clifton Channel as a result of the proposed project also makes it unlikely that Clifton Channel would become the primary flow channel in the future.

Based on the SED2-WES results, the proposed project would have an influence on flow and sediment transport within the main navigation channel. The proposed turning basin would not cause a change in the velocities, depths, or sediment transport capacity within the area near the Lewis and Clark National Wildlife Refuge. However, modeling indicates that minor changes would occur north of this area and near the navigation channel. A comparison of the change in bed elevations after 90 days simulation of the 50 percent exceedance discharge indicates that the change in bed elevation within this

area would be minor (0.05 to -0.05 feet). However, the change would be more pronounced within the Columbia River near the navigation channel.

The results of the RMA2 hydrodynamic modeling indicate that the proposed project would cause a reduction of the velocities and shear stresses along the shoreline near the project site. Because of the reduction in the shear stresses and velocities along the shoreline, the proposed project would not cause increased bank erosion due to changes in depth contours resulting from dredging to construct the turning basin and mooring facilities. The potential for bank erosion from ship generated waves was investigated by NorthernStar and is discussed in detail in sections 4.1.2.3 and 4.1.3.3.

NorthernStar's design for the maneuvering basin includes side slopes of 3 (horizontal) to 1 (vertical), which is a reasonable slope for sediments in the area of the LNG terminal (Proudfit, 2008). However, we received comments on the draft EIS expressing concerns that lateral side slope migration could occur, resulting in impacts on critical shallow water habitat. Therefore, **we recommend that:**

- **NorthernStar should prepare a plan to monitor the side slopes of the maneuvering area after dredging. The plan should include slope protection measures, should such mitigation be necessary. The plan should be filed with the Secretary for the review and written approval of the Director of OEP <u>prior to construction</u> of the LNG terminal.**

Dredging activities would resuspend sediments and result in increases in total suspended solids (TSS) and turbidity. NorthernStar proposes to use hydraulic cutterhead dredging to excavate the proposed turning basin and berthing facilities. The maximum additional suspended solids concentration in the water column resulting from dredging activities would range from a high of 1 milligram per liter (mg/L) at the dredge site to less than 0.1 mg/L before reaching either Tenasillahe Island or Hunt Creek. These values are significantly less than the background concentration of 10 mg/L measured in the Clifton Channel as part of the field measurements for the hydrodynamic and sediment modeling study, and would generally be imperceptible. The size of the material introduced in the water column during the dredging activities would be almost entirely sand, ranging in diameter between 0.065 and 0.4 mm. As a result, the size of the sediment plume would be very small and confined to an area immediately surrounding the proposed dredging site. Additionally, the plume would diminish very quickly once the dredging activities are concluded. Based on recent monitoring of dredging operations for the Columbia River Channel Improvement Project, the COE has observed background turbidity values of 3 to 8 nephelometric turbidity units (NTU), and turbidity plumes from dredging operations returning to within 1 NTU of background within 45 seconds of the end of dredging (WEST, 2006).

Based on the sediment transport modeling, NorthernStar estimated the frequency and volume of required maintenance dredging. The modeling indicated that sediment deposition would occur uniformly over the entire turning basin. The average annual change in stream bed depth would be about 0.25 foot per year. Using this rate of deposition, the frequency and volume of maintenance dredging was determined for various target dredging depths. Generally, maintenance dredging would occur when the turning basin depth is raised by sediment additions to -42 feet CRD (1 foot above the project depth of -43 feet CRD). If dredging to maintain the turning basin occurred only when the target depth of -42 feet CRD was reached, the volume of sediment that would likely need to be removed would be about 80,000 cubic yards. Based on the hydrodynamic modeling NorthernStar conducted, this would occur about every 4 years under average conditions. If the river flows are abnormally high, maintenance dredging would be required more frequently.

All of the analyses discussed above were based on an assumption of uniform deposition within the turning basin. NorthernStar indicated that uniform deposition would be unlikely, and that greater

deposition would probably occur along the eastern part of the proposed turning basin, adjacent to the federal navigation channel. Additionally, maintenance dredging could be required more frequently as a result of large flood events. Although these events occur infrequently, they cannot be ignored because of the significantly larger volumes of sediment transported during these events. The results of the sediment transport modeling indicated that about 0.5 foot of deposition could occur from a flow rate of 864,000 cfs over a period of 10 days, similar to the 1996 flood event.

4.2.3 Pipeline Facilities

4.2.3.1 Existing Soil Resources

Information regarding soils along the proposed pipeline route is based on the Soil Surveys of Clatsop County, Oregon (USDA-SCS, 1988), Columbia County, Oregon (USDA-SCS, 1986), and Cowlitz County, Washington (USDA-NRCS, 2006) and SSURGO (USDA-NRCS, 2003). Additional information about the soils was obtained from Official Soil Series Descriptions (USDA-NRCS, 2004).

Detailed soil characteristics along the pipeline route and aboveground facilities were identified and assessed using SSURGO (USDA-NRCS, 2003). The SSURGO database is a digital version of the original county soil surveys developed by the NRCS for use with geographic information systems. It provides the most detailed level of soils information for natural resource planning and management. The mapping scale in the project area is generally 1:20,000, with a minimum delineation size of 4.0 acres. SSURGO is linked to an attribute database that gives the proportionate extent of the component soils and their properties for each map unit (USDA-NRCS, 1995).

SSURGO attribute data consist of physical properties, chemical properties, and interpretive groupings. Attribute data apply to the whole soil (e.g., listed hydric, prime farmland soils, or slope class) as well as to layer data for soil horizons (e.g., texture or permeability). The soil attribute data can be used in conjunction with spatial data to describe the soils in a particular area.

The proposed pipeline would be located in the Northern Pacific Coast Range, Foothills, and Valleys MLRA (see section 4.2.2.1) and the Willamette and Puget Sound Valleys MLRA. The dominant soils in the Willamette and Puget Sound Valleys MLRA are Xerolls. These moderately deep to deep, moderately fine to fine textured soils have a mesic temperature regime and mixed mineralogy. Thirty-nine percent of the soils that would be crossed by the pipeline are somewhat poorly drained or wetter. The majority of these soils are located in the low-lying areas on the Oregon side of the Columbia River. More well drained soils (61 percent) are located in the areas to the north and south of the river. The percentages calculated for the drainage classes do not include waterbody crossings which account for approximately 3 percent (0.9 mile) of the pipeline route.

Soil Characteristics

The soils along the proposed pipeline route and additional temporary work spaces were evaluated for characteristics that could affect pipeline construction or increase the potential for construction-related soil impacts. Appendix E lists by milepost the soil map units crossed by the proposed route and table 4.2.3-1 summarizes the miles of each soil series crossed in each county. Table 4.2.3-2 provides a summary of the significant soil characteristics that would be crossed by the proposed pipeline route in each county. Individual soil characteristics are discussed separately below.

TABLE 4.2.3-1

Soil Series Crossed by the Proposed Pipeline Route

County/Soil Series	Total Miles Crossed
Clatsop County, Oregon	
Alstony gravelly loam	2.28
Braun-Scaponia silt loam	0.70
Harslow-Kilchis very gravelly loam	0.35
Locoda silt loam	1.96
Scaponia-Braun silt loam	0.13
Udipsamments	0.62
Columbia County, Oregon	
Crims silt loam	1.62
Locoda silt loam	4.68
Udipsamments	0.79
Wauna silt loam	2.33
Wauna-Locoda silt loam	3.32
Cowlitz County, Washington	
Buckpeak silt loam	0.21
Camas cobbly loam	0.11
Carrolls loamy sand	0.08
Centralia silt loam	4.43
Clato silt loam	0.45
Cowlitz extremely gravelly sand	0.08
Edgewick silt loam	0.26
Germany silt loam	4.77
Hazeldell gravelly silt loam	0.39
Kalama gravelly loam	0.23
Kelso silt loam	0.72
Lithic Haplumbrepts	0.12
Newberg fine sandy loam	0.18
Olequa silt loam	0.15
Olympic silt loam	3.96
Riverwash	0.02
Rose valley silt loam	0.01
Sara silt loam	0.38
Sauvola loam	0.05

TABLE 4.2.3-2

Acreages and Characteristics of Soils Affected by Construction of the Bradwood Landing Pipeline [a]

County/State	Total Crossed [b]	Highly Water Erodible [c]	Highly Wind Erodible [d]	Prime Farmland [e]	Hydric Soils [e]	Compaction Prone [f]	Stony/ Rocky [g]	Shallow to Bedrock [h]	Revegetation Concerns [i]
Clatsop, Oregon	92.2 (6.2)	46.3 (3.5)	16.2 (0.6)	0.0 (0.0)	28.1 (2.0)	28.1 (2.0)	36.3 (2.6)	46.3 (3.5)	62.3 (4.1)
Columbia, Oregon	177.8 (13.2)	12.2 (0.8)	12.2 (0.8)	0.0 (0.0)	112.5 (8.1)	159.8 (12.0)	0.0 (0.0)	0.0 (0.0)	12.2 (0.8)
Cowlitz, Washington	223.7 (16.9)	193.1 (15.0)	2.4 (0.1)	43.3 (2.9)	2.6 (0.1)	0.1 (0.0)	12.4 (0.9)	1.5 (0.1)	178.7 (13.7)
Pipeline Total	493.7 (36.3)	251.7 (19.2)	30.8 (1.5)	43.3 (2.9)	143.2 (10.2)	188.0 (13.9)	48.7 (3.6)	47.8 (3.6)	253.5 (18.6)

[a] Quantities represent acres based on a 100-foot-wide construction right-of-way and additional temporary workspace. The crossing length in miles is provided in parentheses. The area affected does not include access roads or open water. NorthernStar would use existing access roads that would not require modification or improvement and would, therefore, not represent additional soil impacts.

[b] Represents total acres of soil affected in each county.

[c] Soils designated by the NRCS as highly erodible or potentially highly erodible land.

[d] Soils with a WEG classification of 2 or less.

[e] As designated by the NRCS.

[f] Includes soils in somewhat poor to very poor drainage classes with surface textures of sandy clay loam and finer.

[g] Soils with a cobbley, stony, bouldery, shaly, very gravelly, or extremely gravelly modifier to the textural class of the surface layer and/or having a surface layer that contains greater than 5 percent by weight stones larger than 3 inches.

[h] Soils identified as containing bedrock at a depth of 5 feet or less from the surface.

[i] Soils with a slope of greater than 8 percent and/or having a surface texture of sandy loam or coarser and moderately well to excessively drained.

Erosion

Erosion is a continuing natural process that can be accelerated by human disturbance. Factors that influence the degree of erosion include soil texture, soil structure, length and percent of slope, vegetative cover, and rainfall or wind intensity. Soils most susceptible to erosion by water are typified by bare or sparse vegetative cover, noncohesive soil particles with low infiltration rates, and moderate to steep slopes. Wind erosion processes are less affected by slope angles. Clearing, grading, and equipment movement would expose soils to water and wind erosion and, without adequate protection, result in discharge of sediment to adjacent waterbodies and wetlands. Soil loss due to erosion could also reduce soil fertility and impair revegetation as a result of topsoil loss.

Approximately 25 percent (121.1 acres) of the soils along the proposed pipeline route are designated as HEL that is susceptible to erosion by water. The majority of these soils are located in the Clatsop County and Cowlitz County portions of the proposed route where approximately 70 percent of the soils have an average slope of greater than 8 percent. In addition, 26 percent (130.6 acres) of the soils, all of which are located in Cowlitz County, are considered PHEL. PHEL consists of those soils that have the potential to be highly erodible, but cannot be designated as HEL without a field determination of slope percent and length. Ninety-four percent (462.9 acres) of the soils that would be crossed by the proposed pipeline have a WEG classification of 3 or higher and are therefore not susceptible to wind erosion. The susceptibility of the remaining soils to wind erosion could result in the loss of topsoil and potential dust hazards.

NorthernStar would use prescribed erosion control devices (e.g., silt fence, hay bales) and construction practices as specified in its pipeline ESC Plan for Oregon and SWPPP for Washington to minimize erosion during and after construction activities (see section 2.4). Temporary erosion control

devices would be installed immediately after initial ground disturbance and monitored as required throughout construction (e.g., daily in areas of active construction, weekly in areas with no active construction, within 24 hours of each 0.5 inch of rainfall). Erosion and sedimentation controls on the pipeline right-of-way would be inspected and maintained as necessary until final stabilization is achieved. NorthernStar would also implement dust mitigation measures, including the use of water trucks to moisten the right-of-way, to reduce impacts from wind erosion. Permanent revegetation of the disturbed soils would control erosion after construction is completed.

Prime Farmland

The USDA defines prime farmland as "land that is best suited to food, feed, fiber, and oilseed crops" (USDA-Soil Survey Division Staff, 1993). This designation includes cultivated land, pasture, woodland, or other lands that are either used for food or fiber crops or are available for these uses. Urbanized land and open water are excluded from prime farmland. Prime farmland typically contains few or no rocks, is permeable to water and air, is not excessively erodible or saturated with water for long periods, and is not subject to frequent, prolonged flooding during the growing season. Soils that do not meet the above criteria may be considered prime farmland if the limiting factor is mitigated (e.g., artificial drainage).

Approximately 8 percent (37.2 acres) of the soils that would be crossed by the proposed pipeline route are considered to be prime farmland. An additional 1 percent (6.1 acres) is considered prime farmland if a limiting factor is mitigated. Essentially all of the soils considered to be prime farmland along the proposed route are located in Cowlitz County (see table 4.2.3-2).

Potential impacts on prime farmland would include interference with agricultural drainage (if present), mixing of topsoil and subsoil, and compaction and rutting. These impacts would result primarily from trench excavation and backfilling, and vehicular traffic along the construction right-of-way. Impacts would be temporary and would not result in permanent conversion of prime farmland to non-agricultural uses. NorthernStar would minimize impacts on prime farmland by constructing the pipelines in accordance with its ESC Plan and SWPPP.

Hydric Soils

Hydric soils are defined as "soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part" (Federal Register, 1994). Soils that are artificially drained or protected from flooding (e.g., by levees) are still considered hydric if the soil in its undisturbed state would meet the definition of a hydric soil. Hydric soils include very poorly, poorly, and some somewhat poorly drained soils.

Pipeline construction would affect approximately 143.2 acres of hydric soils. The majority (79 percent) of these soils would be located in Columbia County within the low-lying areas adjacent to the Columbia River. According to the Cowlitz County's Critical Areas Ordinance map depicting NRCS hydric soils, these soil types also appear to be located adjacent to the Washington side of the Columbia River as well as around MP 28.0 and between MPs 34.0 and 35.0. Due to extended periods of saturation, hydric soils can be prone to compaction and rutting as discussed below. In addition, high groundwater levels associated with hydric soils could create a buoyancy hazard for the pipeline. NorthernStar would minimize rutting of hydric soils by using construction mats where hydric soils cannot support equipment and/or by employing low-ground-weight equipment according to its ESC Plan and SWPPP and our Procedures. Special construction methods such as concrete coating of pipe and other weighting methods would be used to overcome buoyancy hazards during operation of the pipeline.

Excavation of the pipeline trench in saturated soils could result in an increased trench width due to sloughing of unstable trench walls. In addition, larger spoil storage areas could be needed to accommodate the saturated material being removed and stockpiled along the right-of-way. NorthernStar has requested a variance from our Procedures to allow for a wider construction right-of-way through wetlands. While a wider construction right-of-way through wetlands may have additional impacts on hydric soils, we agree with NorthernStar that their request for a variance is justified to ensure the safe installation of the pipeline, because of the potential for a larger trench width due to slumping saturated soils in wetlands and the need to separate spoil piles (see section 4.4.1.3 for the FERC staff's conclusions regarding proposed modifications to our Procedures).

Compaction Potential

Soil compaction modifies the structure and reduces the porosity and moisture-holding capacity of soils. Construction equipment traveling over wet soils could compact and disrupt the soil structure, reduce pore space, increase runoff potential, and cause rutting. The degree of compaction depends on moisture content and soil texture. Fine-textured soils with poor internal drainage that are moist or saturated during construction are the most susceptible to compaction and rutting.

Approximately 38 percent (188.0 acres) of the proposed pipeline would cross soils prone to compaction. The majority of these soils are located in Columbia County in the low-lying areas adjacent to the Columbia River (see table 4.2.3-2). NorthernStar would minimize compaction and rutting impacts by using measures outlined in its pipeline ESC Plan and SWPPP and our Procedures (e.g., construction from timber mats, or low-ground-weight equipment) during construction in soft or saturated soils. As outlined in the FERC staff's Plan, one of the responsibilities of the environmental inspector is to advise the chief construction inspector when conditions (such as wet weather) make it advisable to restrict construction activities to avoid excessive rutting. In residential and agricultural areas, the environmental inspector also ensures compaction testing is performed to assess the need for corrective action. In residential and agricultural areas, subsoil compacted by construction would be disked prior to returning the segregated topsoil.

Stony/Rocky and Shallow to Bedrock Soil

Introducing rocks to surface layers may reduce soil moisture-holding capacity, resulting in a reduction of soil productivity. Additionally, some agricultural equipment may be damaged by contact with large rocks. The presence of rocks within the surface horizons and/or shallow bedrock may also create poor revegetation conditions.

Approximately 10 percent (47.8 acres) of soils crossed contain bedrock within 5 feet of the surface. The majority of these soils are located in Clatsop County (see table 4.2.3-2). About 10.1 acres of these soils contain bedrock classified as paralithic (weathered) that would not likely require special construction techniques. However, the proposed route would cross 37.7 acres of soils with a lithic contact (unweathered bedrock) within 5 feet of the surface that may require blasting or other special construction techniques during installation of the proposed pipeline (see section 4.1.4.4 for more details regarding blasting). Approximately 48.7 acres of stony/rocky soils would be crossed by the proposed route in Clatsop and Cowlitz Counties.

Revegetation Potential

Successful restoration and revegetation are important for maintaining soil productivity and protecting the underlying soil from potential damage, such as erosion. Soils crossed by the proposed project were identified as having a poor revegetation potential based on the surface texture, slope, and

drainage class. Revegetation in soils that have a coarse surface texture and are moderately well to excessively drained may prove to be difficult to revegetate. The drier soils have less water to aid in the germination and eventual establishment of new vegetation. The coarser textured soils also have a lower water holding capacity following precipitation, which could result in moisture deficiencies in the root zone and creating unfavorable conditions for many plants. In addition, steep slopes along the pipeline route may make the establishment of vegetation difficult. The clearing and grading of soils with poor revegetation potential could result in a lack of adequate vegetation following construction and restoration of the right-of-way, which could lead to increased erosion, a reduction in wildlife habitat, and negative visual impacts.

About 51 percent (253.5 acres) of the proposed pipeline would cross soils with revegetation concerns. The majority of these soils are located in Clatsop and Cowlitz Counties (see table 4.2.3-2). This is due to the fact that approximately 70 percent of the soils crossed in these counties have a slope of greater than 8 percent. In accordance with its ESC Plan and SWPPP, NorthernStar would mitigate the effects of poor revegetation potential by applying fertilizer, pH modifiers, and using mulch (where appropriate) to create a favorable environment for the re-establishment of vegetation. A seed mixture, developed through consultation with the ODFW, Washington Department of Fish and Wildlife (WDFW), and NRCS, and in accordance with landowner agreements, would be applied to re-establish vegetation following final grading. Revegetation in non-agricultural areas would be considered successful if, upon visual survey, the density and cover of non-nuisance vegetation are similar to adjacent undisturbed areas. In agricultural areas, revegetation would be considered successful if crop yields are similar to adjacent undisturbed portions of the same field.

Soil Contamination

Contamination from spills or leaks of fuels, lubricants, and coolant from construction equipment could adversely affect soils. The effects of contamination are typically minor because of the low frequency and volumes of spills and leaks. NorthernStar's pipeline ESC Plan and SWPPP contain measures to prevent and contain, if necessary, accidental spills of any material that may contaminate soils, and to ensure that inadvertent spills of fuels, lubricants, or solvents are contained and cleaned up in an appropriate manner.

A search of numerous federal, state, and tribal environmental records identified 10 potentially contaminated sites within 1,500 feet of the proposed project facilities (see table 4.2.3-3). Based on the distance of these sites from the proposed project area and the fact that soil and groundwater contamination either has not been reported or has been cleaned up for each facility, NorthernStar does not expect to encounter contamination from these sites during pipeline construction. Although the potential to encounter contaminated soils is relatively low, mismanagement of contaminated materials encountered during construction could result in serious impacts on soils and other sensitive resources. To ensure that personnel working on the project are prepared to deal appropriately with an unanticipated encounter with contaminated soils, we have recommended that NorthernStar prepare a CMMP for the proposed Bradwood Landing Project (see section 4.2.2.1).

TABLE 4.2.3-3 **Potential Contaminated Sites within 1,500 feet of the Bradwood Landing Pipeline**		
Location	Description	Proximity to the Project Work Area
OP&R – Bradley State Wayside UIC, Highway 30, Clatsop, Oregon	Two septic fields and a greywater injection well.	1,100 feet west of MP 1.6
Former Koppers Wood Treating Site, Taylorville Road, Clatskanie, Oregon	Various contaminants from a former wood treating operation.	1,500 feet north of MPs 3.6 to 4.0
Westmart Foodstore, Columbia River Highway, Westport, Oregon	Gasoline spill from an UST in 1996. Cleanup complete in 1997.	The town of Westport is located 1,300 feet south of MP 5.6
River Front Road, Clatskanie, Oregon	Identified in the ODEQ spill records. Specific material or quantity not identified.	600 feet north of MP 10.6
Lammi Sand & Rock Products, Midland District Road, Clatskanie, Oregon	One UST decommissioned on site.	1,300 feet south of MP 10.1
Kynsi Construction, Inc., Midland District Road, Clatskanie, Oregon	Aboveground storage of antifreeze, unleaded gasoline and diesel fuel.	1,400 feet south of MP 10.1
Beaver Plant, Kallunki Road, Clatskanie, Oregon	Waste oil released during decommissioning of a UST in 1997. Cleanup completed in 2001.	1,000 feet east of MPs 18.0 and 18.4 1,200 feet south of MPs 18.3 and 18.9
Slide Creek Road, Longview, Washington	VOCs derived from an illegal drug lab.	500 feet north of MP 21.1
Interstate Highway 5, Kelso, Washington	100 gallons of diesel fuel spilled in 2003.	1,500 feet from MP 35.3
Watkins Explosive Co., Inc., Ostrander Road, Kelso, Washington	Tier 2 hazardous waste generating facility.	1,500 feet south of MP 36.0

Aboveground Facilities

Construction of aboveground facilities associated with the proposed pipeline would temporarily impact a total of about 5.0 acres of soil, of which 1.4 acres would be permanently converted to commercial industrial uses by operation of the facilities. Only about 2 percent (0.1 acre) of the soils within the aboveground facilities are considered prime farmland. An additional 12 percent (0.6 acre) of the soils within the proposed facilities are considered prime farmland only if they are artificially drained. However, the prime farmland soils within these facilities are not currently actively cultivated. Approximately 50 percent (2.5 acres) of the soils are considered PHEL or HEL that is susceptible to erosion by water. Forty-nine percent (2.5 acres) of the soils within the proposed facilities have a WEG of 2 or less and are therefore considered susceptible to wind erosion. NorthernStar would implement measures described in its pipeline ESC Plan and SWPPP to minimize potential soil impacts associated with the construction and operation of the proposed aboveground facilities.

Pipe Storage and Contractor Yards

NorthernStar has identified two pipe storage and contractor staging yards that would be used during the construction of the proposed pipeline. These yards would affect a combined 18.5 acres of land. This land has been previously developed so no additional impacts on the soils would be expected. The 9.1 acres of soil within Yard A in Columbia County are not considered prime farmland, susceptible to erosion by water, hydric, or prone to compaction. These soils are considered to be susceptible to wind erosion and have revegetation concerns. The 9.3 acres of soil within Yard B in Cowlitz County are considered prime farmland. However, these soils have been previously developed and are not currently used for active cultivation. In addition, the site would be returned to preconstruction conditions, so no permanent impacts on prime farmland would result from use of the site. These soils are not considered to be susceptible to erosion by wind or water or to have revegetation concerns. All of the soils at this pipe storage yard are considered hydric and prone to compaction. NorthernStar would implement measures

described in its pipeline ESC Plan and SWPPP to minimize potential soil impacts associated with the use of the two pipe storage and contractor yards.

4.2.3.2 General Impacts and Mitigation

Construction activities such as clearing, grading, trench excavation, backfilling, and the movement of construction equipment over work areas may result in adverse impacts on soil resources. Clearing removes protective cover and exposes the soil to the effects of wind, sun, and precipitation, which may increase the potential for soil erosion and the movement of sediments to sensitive areas. Grading and equipment traffic may compact soil, reducing porosity and percolation rates, which would result in increased runoff potential and decreased agricultural productivity. Trench excavation and backfilling could lead to mixing of topsoil and subsoil and may introduce rocks to the soil surface from deeper soil horizons. Contamination from spills or leaks of fuels, lubricants, and coolants from construction equipment could also impact soils.

NorthernStar's pipeline ESC Plan and SWPPP[5] incorporate elements of the FERC's Plan and Procedures, state and county regulations and provisions, stormwater pollution prevention plans, and spill prevention and response procedures. Drafts of these plans were included in NorthernStar's JPA and JARPA. Final versions of these plans would be developed after a construction contractor has been selected prior to construction. We have reviewed NorthernStar's pipeline ESC Plan and its SWPPP and find that in many cases they lack specific procedures, and are less detailed than or do not provide equivalent or greater protections to the environment compared to our Plan. On the other hand, the pipeline ESC Plan and SWPPP contain BMPs and mitigation measures for items outside the scope of our Plan, such as spills prevention and cleanup, wind erosion and dust control, and project-specific seasonal work restrictions. To ensure that potential impacts on soils as well as vegetation are effectively minimized, **we recommend that:**

- **NorthernStar should revise its pipeline ESC Plan and SWPPP to include the measures from the FERC's Plan that provide greater protections. NorthernStar's revised plans should be filed with the Secretary for the review and written approval of the Director of OEP <u>prior to construction</u> of the pipeline.**

[5] NorthernStar included its terminal ESC Plan and pipeline ESC Plan as part of its JPA, and included its SWPPP as part of its JARPA. NorthernStar's JARPA was filed with the FERC on November 6, 2006, and supplemented with a filing on November 22, 2006. NorthernStar also filed its JPA on November 22, 2006, and filed revisions to the JPA with the FERC on April 5, 2007. These documents are available for viewing by the public on the FERC's Internet web page at www.ferc.gov, through the eLibrary link, selecting "General Search," entering the docket number minus the last three digits (i.e., CP06-365), and putting in the proper date range. The FERC's Plan and Procedures are also available to the public on the FERC's Internet web page by clicking on Industries, Gas, Environment, Guidelines.

4.3 WATER RESOURCES

4.3.1 Groundwater

4.3.1.1 Regional Hydrogeologic Setting

According to USGS (2005a) there are three aquifer systems in the project vicinity: 1) the Unconsolidated Sediment Aquifer of the Holocene, Pleistocene, Pliocene, and Miocene; 2) the Miocene Basaltic Rock Aquifer System; and 3) the Pre-Miocene Rock Aquifer System. The stratigraphy of these aquifer systems is detailed in section 4.1.1. The coastal region of Oregon and Washington receives large amounts of precipitation, 40 to 80 inches per year (USGS, 2005a), that recharge the aquifers in the area.

The Unconsolidated Sediment Aquifer System underlies the western half of the project area and is also part of the Pacific Northwest Basin-Fill Aquifer System (USGS, 2005b), a system comprised of unconsolidated deposits that are largely alluvial in nature. In the vicinity of the proposed project, this system consists primarily of unconsolidated sand and gravel and is associated with lowland areas along the Columbia River. These unconsolidated deposits are the most prolific aquifers and are important sources of water for public supply, domestic, commercial, agricultural, and industrial demands (USGS, 2005a).

The Miocene Basaltic Rock Aquifer System occurs where more resistant uplands consist of thick basaltic lava flows (USGS, 2005a) and also underlies the terminal facility and much of the proposed pipeline route. Basaltic rock aquifers tend to have open spaces filled with secondary clay minerals, calcite, silica, or unconsolidated alluvium deposited by streams or in lakes. Except where such fill materials are coarse grained, they tend to markedly decrease the permeability of these aquifer systems.

Aquifers in pre-Miocene rocks are distributed along the coast of Oregon and Washington. These aquifers consist of several types of igneous and metamorphic rocks, consolidated sedimentary rocks, and volcanic rocks. Permeability varies greatly in these aquifers. The eastern half of the Cowlitz County segment of the proposed pipeline crosses over the Pre-Miocene Rock Aquifer System. The aquifers of this system are in mountainous areas, and the water is used mostly for domestic and agricultural supplies.

4.3.1.2 Waterway for LNG Marine Traffic

LNG carriers would not use groundwater and the LNG marine traffic would not have an impact on groundwater resources along the waterway.

4.3.1.3 LNG Terminal

The presence of alluvial sediments of the Unconsolidated Sediment Aquifer at the proposed LNG terminal site was confirmed by the geotechnical investigation (URS, 2005), which characterized local conditions based on site reconnaissance and soil borings (see section 4.1.3.1). The soil borings encountered groundwater beginning at depths ranging from 12 to 15 feet below the ground surface. The Upper Alluvial Sand sequence is interpreted as the first aquifer occurring beneath the site. Because alluvial sand and gravel aquifers are typically the most productive and widespread aquifers in the Pacific Northwest (Whitehead, 1994), both of the alluvial sand aquifers are expected to have water production potential.

Public Water Supply and Wells

To assess the expected productivity of the shallow alluvial aquifer underlying the proposed LNG terminal site, Groundwater Solutions, Inc. (GSI) compared the results of the soil borings with the Columbia River bathymetry data for the channel near the site. Based on the soil borings completed at the site, the relative depth of the Upper Alluvial Sand Sequence (approximately 0 to 60 feet below msl) is consistent with the elevation range of the Columbia River channel bottom (20 to 50 feet below msl). The Upper Alluvial Sand Sequence is also relatively uniform in thickness and laterally extensive; therefore, the permeability and thickness of the aquifer unit should be adequate to supply more than 150 gpm (the proposed water use from the well during construction and operation) to a properly constructed well at the site (GSI, 2006a). In addition, the observation that groundwater levels at the site fluctuate with the river and tidal elevations suggests the Upper Alluvial Sand Sequence extends laterally beneath the river channel, maintains connectivity with the Columbia River, and provides for an unlimited source of aquifer recharge (GSI, 2006a).

According to data provided online through the Drinking Water Program of the Oregon Department of Human Services (ODHS), no public groundwater supplies near the proposed Bradwood Landing LNG terminal site are currently impacted by contamination (ODHS, 2005). The closest community groundwater systems are for the Knappa Water Association, Westport Heights, and Wauna Water District. The closest of these communities is Wauna, about 3 miles south-southeast of the proposed LNG terminal site. The Wauna Water District system is operated by the local government, while the other two are privately operated but have completed source water assessments.

Overall, the proposed LNG terminal would avoid water supply wells and springs. A search of all wells in Clatsop County within a 2-mile radius of the LNG terminal site identified only one water supply well (however, some wells may not be included in the database – particularly older wells). This well is privately owned and it is believed to be about 0.5 mile from the LNG terminal. No springs were identified within 150 feet of the construction areas based on topographic maps or web-based information. Furthermore, the ODHS database of wellhead protection areas (ODHS, 2006) indicated that the LNG terminal site is not located within any wellhead protection areas.

The proposed project would not be located near any EPA-designated sole source aquifers listed under section 1424(e) of the Safe Drinking Water Act (EPA, 2006). The EPA defines a sole or principal source aquifer as one that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer, and for which there are no other reasonably available alternative drinking water source(s) that could physically, legally, and economically supply all those who depend upon the aquifer for drinking water should the aquifer become contaminated. Of the 13 sole source aquifers that have been designated in EPA Region 10 (i.e., Alaska, Idaho, Oregon, and Washington), none are near the proposed LNG terminal facilities. No petitions for sole source aquifers are currently under EPA review in Region 10.

Groundwater Quality

In general, groundwater quality in coastal Oregon and Washington is fresh, with low concentrations of dissolved solids (less than 1,000 milligrams per liter (mg/L)) and is normally suitable for most uses. However, in coastal areas, more saline waters can be found in some aquifers at depth (McFarland, 1983). Additionally, saltwater can contaminate freshwater aquifers by entering from the ocean through river estuaries, such as the Columbia River, or along faults (USGS, 2005a). This is particularly true of the Pre-Miocene Rock Aquifers. Groundwater quality in the alluvial aquifers would be expected to have low dissolved solids, but no site-specific evaluation has been conducted. No further water quality information is available for these shallow, discontinuous aquifers.

No potential sources of groundwater contamination in the immediate vicinity of the LNG terminal site were found in published literature (Cole, 2004) or on an interactive website maintained by the ODEQ (ODEQ, 2005a). The nearest site where groundwater contamination has been documented is the former Koppers Wood Treating Site, located approximately 3 miles south-southeast of the Bradwood Landing LNG terminal site along the Columbia River. Groundwater beneath the former Koppers Wood Treating Site is flowing toward the Columbia River and, therefore, would not impact the LNG terminal site.

The ODEQ's Leaking Underground Storage Tank Cleanup Site Database (ODEQ, 2005b) shows no sites in the vicinity of the proposed Bradwood Landing LNG terminal. Of the closest three sites, two were located in Knappa and one in Westport, all several miles from the proposed LNG terminal site. Since cleanup was completed and the status of all three sites is "closed," these sites are not expected to have an impact on the groundwater at the Bradwood Landing LNG terminal.

Two industrial solid waste facilities were found in Clatsop County (ODEQ, 2005c). The Wauna Cogeneration Project and Wauna Mill Landfill, which are both apparently associated with a pulp and paper mill that operates on the former Koppers Wood Treating Site. The Wauna Cogeneration Project is not expected to have any impact on groundwater conditions beneath the LNG terminal site for the same reasons as those discussed above for the former Koppers Wood Treating Site.

Oregon's Underground Injection Control (UIC) database (ODEQ, 2005d) lists sites that involve placement of fluid below the ground or subsurface. The closest UIC site to the Bradwood Landing LNG terminal is found in Knappa, at least 3 miles away. Therefore, it is not expected to have any impact on the groundwater beneath the facility.

It is not known whether past activities at the former sawmill facility at Bradwood have affected groundwater conditions at the site. As described in section 4.2.2.1, AMEC conducted a Phase 1 Environmental Site Assessment in August 2005 that identified several RECs that could potentially affect or have already impacted groundwater conditions at the site (AMEC, 2005). However, groundwater at the site would not be used for drinking.

Groundwater Uses and Withdrawals

Groundwater would be used at the LNG terminal site during construction and operation (see table 4.3.1-1). An application for a limited water use license to use groundwater during construction of the LNG terminal has been submitted by NorthernStar to the ODWR.

To supply water to the LNG terminal, a single, 6-inch-diameter water well with a total depth of approximately 90 feet would be installed at the location shown on figure 2.1.3-1 (GSI, 2006b). A submersible pump would be installed in the well to supply water at a rate not to exceed 150 gpm. Water from the well would be pumped to an 180,000-gallon tank for storage and would be delivered from the tank to the construction site through approximately 1,000 feet of 3-inch-diameter steel pipe.

TABLE 4.3.1-1

Potential Water Intakes and Discharges Associated with the Bradwood Landing Project

Purpose	Volume (millions of gallons)	Timeframe	Rate	Structure/Location Source
Construction				
Water Intake				
Personal/sanitary [a, b]	7.7	Intermittent	Variable	Groundwater well
Vehicle wheel washing [b]	2.0	Intermittent	Variable	Groundwater well
Hydrostatic testing of piping within LNG terminal	1.5	One-time use	Variable	Groundwater well
Concrete making [b]	0.9	Intermittent	Variable	Groundwater well
Initial charging of SCVs	0.2	One-time use	Variable	Groundwater well
Hydrostatic testing of LNG tanks	60.0 [c]	One-time use	4,000 gpm	Columbia River
Soil compaction and ground improvements	15.0	Intermittent	160 gpm	Columbia River
Hydrostatic testing of pipeline	9.0	One-time use	2,000 gpm	Columbia River
Water Discharge				
Personal/sanitary [a, b]	7.7	Intermittent	Variable	Septic system
Vehicle wheel washing [b]	2.0	Intermittent	Variable	Groundwater
Hydrostatic testing of piping within LNG terminal	1.5	One-time use	Variable	Groundwater or Columbia River
Hydrostatic testing of LNG tanks	60.0 [c]	One-time use	5,000 gpm	Columbia River
Soil compaction and ground improvements	15.0	Intermittent	Variable	Columbia River via log pond
Hydrostatic testing of pipeline	9.0	One-time use	Up to 1,000 gpm	Upland site in straw bale enclosure
Pipeline trench dewatering	Minimal	Intermittent	Variable	Upland site (vegetated area or to a dewatering structure)
Operation				
Water Intake				
Personal/sanitary	0.64	Annually	Variable	Groundwater well
Landscape irrigation	0.41	Annually	Variable	Groundwater well
Ballast water and ship engine cooling [d]	20 - 50	About every 3 days	Up to 35,000 gpm	Columbia River
Testing of fire suppression system	0.26	Weekly	4,400 gpm	Columbia River
Water Discharge				
Personal/sanitary	0.64	Annually	Variable	Septic system
Landscape irrigation	0.41	Annually	Variable	Groundwater
Ship engine cooling [d, e]	20 - 50	About every 3 days	Variable	Columbia River
Condensate water from SCVs	0.23	Daily	160 gpm	Columbia River
Testing of fire suppression system	0.26	Weekly	Up to 4,400 gpm	Columbia River

[a] NorthernStar currently plans to use portable bathrooms during construction, which would eliminate the need for groundwater withdrawal for personal/sanitary use.

[b] Water appropriation and discharge would occur over a period of 3 years.

[c] Assumes that hydrostatic test water for the LNG tanks would not be recycled; however, NorthernStar plans to schedule construction activities to enable water used to test the first tank to be reused to test the second tank.

[d] NorthernStar proposes to offer incentives to retrofit LNG carriers with a water intake system that would allow the water supplied to the carriers to be first used to cool the engines and then used to fill the ballast tanks, which would result in the total volume of water withdrawn and discharged being less than that presented in this table.

[e] In the case that ships arriving at the LNG terminal have not been retrofitted to use the screened water intake system, water used to cool the engines would be discharged to the Columbia River.

NorthernStar estimates the maximum volume of groundwater required during the 3-year construction period would be 12.3 million gallons, although the rate of water use is not expected to be constant throughout the entire construction period. To provide 12.3 million gallons of water during the 3-year construction period, the well would be operated about 5 percent of the time. Water use associated with general construction activities such as dust suppression, road grading, concrete making, personal/sanitary use, and truck wheel washing would occur at varying rates depending on the intensity of construction activities; however, the maximum volume of groundwater needed for these uses is estimated to be 10.6 million gallons. Initial charging of the vaporizers and hydrostatic testing of the piping would be done during the last year of construction. The volume of groundwater needed for charging vaporizers and testing piping is estimated to be 1.7 million gallons. Actual groundwater use during the construction period is expected to be less than the estimated maximum. Currently, NorthernStar is planning to contract with a vendor for supply and maintenance of portable bathrooms during the construction period. If portable bathrooms are used, then groundwater use could be reduced by as much as 7.7 million gallons. Small volumes of groundwater also may be pumped on a temporary basis for dewatering during construction of the terminal facility.

The well and the 180,000-gallon storage tank used to supply water for the temporary construction activities would also be used to supply non-potable water during LNG terminal operations. Water would be pumped from the well to the storage tank and then distributed around the LNG terminal facility. Annual use of groundwater at the LNG terminal is estimated to be 1.05 million gallons. Of this amount, 0.41 million gallons would be used annually for landscape irrigation and 0.64 million gallons would be used annually for personal/sanitary purposes. Annual groundwater use during operations at the LNG terminal would be much lower than the maximum capacity of the well, and the well would operate about 1.3 percent of the time.

The on-site water well would be about 200 feet from the Columbia River, about 900 feet from Hunt Creek, and 800 feet from any wetlands. The mean sustained discharge from the well would only be about 2.0 gpm, and because the soils surrounding the well are very permeable, the cone of depression produced by the well would be small. During the geotechnical study, water levels in the boreholes were observed to vary with the tide, suggesting that river water would be readily drawn into the aquifer and would minimize drawdown at the well. The well would be unlikely to have an effect on Hunt Creek or the wetlands, and any effect on flow in the Columbia River would be negligible.

Disposal of Water to the Ground

The elevation of the LNG terminal site would be raised by the placement of dredged material from the ship berth and maneuvering area. The dredged material would be piped to the site from a hydraulic cutterhead dredge. All or most of the dredge water is expected to infiltrate into the ground. During terminal construction, stormwater and water used for vehicle wheel washing, hydrostatic testing of the LNG storage tanks, and soil compaction would be disposed of by infiltration into the ground. During LNG terminal operation, excess irrigation water, sanitary wastewater, and most stormwater would be disposed of by infiltration into the ground. The soils at the site would be sufficiently permeable, even after compaction, for effective infiltration of water without major ponding or surface runoff. The water table would be 22 to 30 feet below the finished grade, depending on the final site elevation.

Vehicle wheel washing would occur on a paved wash pad near the point where the access road crosses the realigned railroad. No soaps or surfactants would be used for vehicle wheel washing and the temperature of water used for washing would be equal to that of water being stored in the on-site storage tank (no hot water would be used). Excess water from the pad would be discharged to a two-cell sedimentation/infiltration pond. The first cell of the pond would provide treatment by allowing settling of

sediment. Clarified water from the first cell would be conveyed to the second cell and infiltrated into the ground. A total of 2 million gallons of vehicle wheel washing water would be discharged.

During construction, all stormwater runoff would be infiltrated into the ground in accordance with the conditions contained in the NPDES permit issued by the ODEQ. NorthernStar has stated that it anticipates discharging approximately 1.5 million gallons of hydrostatic test water from testing the piping to the ground at an upland location that has not yet been determined. This discharge would occur once during the third year of construction. However, NorthernStar has stated that this discharge may be to the Columbia River. For this reason, potential impacts from the discharge of hydrostatic test water from the piping to the Columbia River are also discussed in section 4.3.2.3.

Once operations begin at the LNG terminal, sanitary wastewater from toilets, sinks, and showers in the office and maintenance/service buildings would be conveyed to an underground septic tank and drainfield or other approved secondary treatment and disposal configuration, if site conditions are not appropriate for a drainfield (see figure 2.1.3-1). A permit would be obtained from the ODEQ for the septic system, which would be sited and sized in accordance with the ODEQ requirements and recommendations. The septic system would be sized according to the number of employees on site during any given day (although 65 permanent employees would be hired for operation of the LNG terminal, NorthernStar anticipates that 50 employees would be on site during an average day), assuming a water use rate of 35 gallons per person per day, and shower facilities on site (Cox, 2006). An estimated 0.64 million gallons per year would be discharged to the septic system.

The drainfield or other approved secondary treatment and disposal system would be designed and installed based on the results of permit requirements and a site evaluation, which cannot be conducted until fill has been added to bring the site to final grade. The location of the system would follow the minimum separation distances specified in table 1 of OAR 340-71-0220. If a drainfield is not recommended for treatment and disposal of wastewater, other alternatives would be considered and could include the use of a pretreatment system, a sand filter, or a holding tank. There would be no potential for surface water contamination because the system would comply with the ODEQ's requirements.

If a septic tank and drainfield system are used, the tank outlet and the drainfield would be 3 to 5 feet below grade. The finished site elevation would be at least 20 feet NAVD, so the tank outlet and drainfield would be at an elevation of at least 15 feet NAVD. The 500-year flood elevation is 13.83 feet NAVD. Therefore, it is highly unlikely that the septic system would be inundated by surface waters. Other septic treatment alternatives may require installation of systems at grade instead of below grade, which would further reduce the potential for inundation.

Most water applied to landscaped areas would evaporate or be used by plants. A portion of the water used for irrigation, approximately 0.08 million gallons per year, would infiltrate into the ground. During operation, stormwater runoff would be collected in shallow infiltration ditches and routed to unlined settling ponds for infiltration into the ground in accordance with the conditions contained in the NPDES permit issued by the ODEQ. The stormwater retention ponds would be large enough to hold the volume of runoff generated from a 100-year storm.

Impacts and Mitigation

In general, construction and operation of the LNG terminal would have little or no adverse effect on groundwater resources. Potential impacts that could occur would be avoided or minimized through appropriate construction and hazardous material handling practices.

Construction and operation activities that could adversely impact groundwater quality include inadvertent releases from the refueling of construction equipment and the transportation and storage of petroleum and hazardous materials. In order to minimize potential impacts on groundwater resources resulting from the construction of the LNG terminal, NorthernStar has developed a terminal ESC Plan that contains BMPs for management of stormwater during construction as well as containment and management of fuels, lubricants, and other hazardous materials that may be used during construction. For example, fuel for construction vehicles would be stored in aboveground tanks located over a concrete slab with a perimeter curb to provide secondary containment. If chlorination and dechlorination of hydrostatic test water is required, the tanks containing sodium hypochlorite and sodium bisulfite would be stored on containment pallets. To avoid any potential impacts on groundwater quality as a result of the infiltration of stormwater runoff during construction, stormwater runoff from the wheel washing pad would be treated before disposal.

Blasting is currently proposed at the extreme southwestern part of the LNG terminal, where basalt may be mined to make aggregate material for use during on-site construction and along Clifton Road, as described in section 2.4.1.1. Blasting carried out at the LNG terminal site would be conducted before installation of the on-site water well.

Although the potential to encounter contaminated groundwater is relatively low during terminal construction, mismanagement of contaminated groundwater encountered during construction could result in impacts on surface water and other sensitive resources. In addition, the identification of RECs at the proposed LNG terminal site indicates that contaminated groundwater could be present at the site. We have recommended that NorthernStar prepare a CMMP that would specify the procedures to be followed to identify, characterize, and properly manage potentially contaminated materials, including groundwater (see section 4.2.2.1). The CMMP would be submitted to the appropriate agencies for approval before construction.

The overall effects on the groundwater system from dewatering during the construction of the LNG terminal would likely be small and temporary. Based on the relatively low volumes expected to be withdrawn and the proximity of the site to the Columbia River, a potential source of groundwater recharge, the likelihood of drawing off-site groundwater contaminants to the site through such dewatering activities is considered to be low.

4.3.1.4 Pipeline Facilities

On-line water well databases for Oregon (ODEQ, 2006a) and Washington (WDE, 2006a) were reviewed to identify aquifers within the excavation depth of the pipeline. More than 90 percent of the water well reports indicated that first-encountered groundwater was deeper than the pipeline excavation depth; however, some water well reports indicated that first-encountered groundwater was within pipeline excavation depth. Groundwater within the pipeline excavation depth occurs in small, discontinuous aquifers encountered as shallow as 3 feet below ground surface. The lithology of the sediment within the pipeline excavation depth is generally silty or clayey, and groundwater yields are, therefore, low. The wells where groundwater was encountered within pipeline excavation depths are screened in deeper aquifers; therefore, groundwater within the pipeline excavation depth is not used for domestic, irrigation, or municipal purposes.

Public Water Supply and Wells

NorthernStar conducted a search for records of public and private water wells along the proposed pipeline route (ODEQ, 2006a; WDE, 2005a). The water well databases do not provide exact coordinates for each well but instead give the location by township, range, section, and quarter-quarter section. The

well location is specified as the center of the quarter-quarter section. The wells identified within any quarter-quarter section crossed by the pipeline are listed in table 4.3.1-2.

TABLE 4.3.1-2

Private Water Wells Potentially within 150 feet of the Bradwood Landing Pipeline Construction Workspace

Location (MP)	Well Number	Primary Use
20.87	270618	Domestic
21.03	346986	Domestic
21.03	356385	Domestic
21.03	270240	Domestic
21.03	10172	Domestic
27.57	271657	Domestic
31.72	1913	Domestic
31.72	1914	Domestic
31.72	8049	Domestic
31.72	1395	Domestic
31.72	8050	Domestic
31.72	1394	Domestic
31.72	3029	Domestic
31.72	3030	Domestic
33.70	314350	Domestic
33.70	326653	Domestic
33.87	10043	Domestic
34.11	387597	Domestic
35.80	10193	Domestic
35.80	60589	Domestic

No private wells potentially within 150 feet of the proposed pipeline construction right-of-way were identified in Oregon. Twenty private wells were identified in Cowlitz County, Washington. The database contained no municipal water wells potentially within 400 feet of the construction workspace of the proposed pipeline in either Oregon or Washington. NorthernStar would work with property owners along the pipeline route to identify new or unregistered wells located within or near the right-of-way that are not included in the above table.

No springs were identified within 150 feet of the proposed pipeline construction areas based on topographic maps or web-based information. The original pipeline alignment was adjusted to avoid a water supply spring identified by a landowner at approximate MP 31.1 (see table 3.1.8-2). If additional springs are identified as discussions with landowners proceed, NorthernStar would work with the landowner to minimize impacts on any springs located near the pipeline construction work space.

The State of Washington Department of Health (WDOH) has identified wellhead protection areas to keep groundwater recharge areas directly contributing to the water being withdrawn from a public water supply well safe from potential sources of contamination. A review of a database of wellhead protection areas (WDOH, 2006) indicated that seven wellhead protection areas in Cowlitz County are located within 0.25 mile of the proposed pipeline. The seven wellhead protection areas were defined by the default 1,000-foot radius approach (WDOH, 2006). The wellhead protection areas are:

- Robertson Road Water #1 – 1,000-foot wellhead buffer is at or near the proposed pipeline centerline at approximate MP 20.5;

- Crow Butte – essentially the same location as Robertson Road Water #1; 1,000-foot wellhead buffer is at or near the proposed pipeline centerline at approximate MP 20.5;

- Illahee Water – 1,000-foot wellhead buffer is within approximately 1,000 feet of the proposed pipeline centerline, at approximate MP 21.5;

- Allen Creek Water – 1,000 foot wellhead buffer intersects the northern edge of the 0.25-mile search corridor at approximate MP 33.0;

- Lone Fir Tavern Inc. – 1,000-foot wellhead buffer crosses the proposed pipeline centerline at approximate MP 35.0, and an HDD exit hole location is within this range;

- All Season Landscapes & Nursery – 1,000-foot wellhead buffer crosses the proposed pipeline centerline at approximate MP 35.2, and an HDD exit hole location is within this range; and

- LDS Church – 1,000-foot wellhead buffer crosses the proposed pipeline centerline at approximate MP 35.4.

The ODHS database of wellhead protection areas (ODHS, 2006) indicated that no wellhead protection areas are located within 0.25 mile of the proposed pipeline centerline in Clatsop or Columbia Counties, Oregon. The proposed pipeline would not be located near any EPA-designated sole source aquifers. Sole source aquifers are further described in section 4.3.1.3.

In areas where nonpoint source activities have resulted in groundwater contamination, a Groundwater Management Area (GWMA) is declared. No GWMAs are located near the proposed Bradwood Landing pipeline route in Washington or Oregon. Oregon has three declared GWMAs, the nearest of which is the Southern Willamette Valley GWMA, located over 100 miles south of the project area (ODEQ, 2005e). Additionally, the only GWMA designated in Washington, the Columbia Basin GWMA, is in southeast Washington and would not be affected by the pipeline facilities (Columbia Basin GWMA, 2005).

No declared critical groundwater areas are present within Clatsop and Columbia Counties (ODWR, 2005). However, Sweet et al. (as cited in ODEQ, 2003) reported that the aquifer that occurs in the alluvium between Wauna and Port Westward along the Columbia River is a "sensitive aquifer" of the North Coast Basin. The Bradwood Landing pipeline would pass over this aquifer, close to the Columbia River in this area. Between approximate MPs 33.8 and 34.9 the pipeline appears to cross an area designated as an aquifer recharge area in Cowlitz County's Critical Areas Ordinance.

Groundwater Quality

The Wauna Mill Landfill is located adjacent to the proposed pipeline between MPs 2.4 and 2.6. The landfill was permitted and began operations in the early 1980s. Between the early 1980s and early 1990s, the landfill was primarily utilized as a receptacle for pulp sludge. The sludge stream was then diverted to boilers to produce steam and energy for the plant's operation. Since the 1990s, the primary material for the landfill site has been the plant's residual lime and ash spoils. The landfill is situated downgradient from the proposed pipeline right-of-way and the water table is likely below the lowest portion of the landfill, which is situated about 500 feet from the proposed easement. All but one of the landfill's monitoring wells are situated downgradient and are not currently monitored for methane gas. According to Georgia-Pacific personnel, there are no reported groundwater contamination issues.

To avoid any potential wicking or flow of groundwater down or through the pipeline ditch, NorthernStar proposes to install a combination of sandbag dams and bentonite plugs at appropriate intervals along the ditch line where it parallels the existing landfill. This would effectively prevent the pipeline excavation from providing a conduit for groundwater flow.

Since the early 1990s, the landfill has not received waste that has the potential to produce methane gas. While the sludge has some potential for producing methane, the addition of lime and ash would have significantly impaired the potential for methane production by elevating the pH, lowering the moisture content of the soils, decreasing soil permeability, and creating an aerobic environment.

The landfill is located within a former clay quarry that was used by Georgia-Pacific to excavate clay for use within their paper making processes. This indicates that the soils nearby are likely fine-grained as well and are also relatively impermeable. In addition to the lack of porosity/permeability required for migration of landfill gasses any appreciable distance, methane gas production typically peaks within 2 years of placement and cover of the organic waste (Tchobanoglous et al., 1993). Combining these factors with the distance between the pipeline and landfill (in excess of 700 feet) indicates that the potential for the pipeline trench to act as a conduit for gas migration is very low.

As described in section 4.2.3.1, a search of environmental records (Environmental Data Resources, 2006) identified 10 potentially contaminated sites within 1,500 feet of the proposed project facilities (see table 4.2.3-3). The distance of these sites from the proposed project area, the groundwater flow direction, and the fact that soil and groundwater contamination either has not been reported or has been cleaned up for each facility suggest they would be very unlikely to have an impact on groundwater in the pipeline project area. Therefore, it is unlikely that NorthernStar would encounter contamination from these sites during pipeline construction.

Groundwater Uses and Withdrawals

Some groundwater withdrawals may occur as a result of dewatering operations during construction of the pipeline. Temporary trench dewatering may be necessary at limited areas along the pipeline corridor where the water table is near the ground surface.

Impacts and Mitigation

In general, construction and operation of the Bradwood Landing pipeline would have little or no adverse effect on groundwater resources, including designated wellhead protection areas. Potential impacts from accidential spills associated with construction equipment would be avoided or minimized through appropriate construction and hazardous material handling practices.

Construction and operation activities that could adversely impact groundwater quality include inadvertent releases from the refueling of construction equipment and the transportation and storage of petroleum and hazardous materials. In order to minimize potential impacts on groundwater resources resulting from the construction of the pipeline, NorthernStar has developed a pipeline ESC Plan (Oregon), a SWPPP (Washington), and a *Waterbody and Wetland Construction and Mitigation Procedures Plan* containing BMPs for management of stormwater during construction as well as containment and management of fuels, lubricants, and other hazardous materials that may be used during construction.

A cluster of private water wells is apparently located in close proximity to the proposed pipeline centerline at MP 31.7. NorthernStar would work with the owners of these wells and the other wells listed in table 4.3.1-2, as well as other property owners along the pipeline route, to confirm the exact locations of any wells within 150 feet of the construction area, and would identify and mark, as appropriate, any

undocumented water wells during preconstruction surveys. NorthernStar has prepared a preliminary well protection plan to address the effects of HDD and trenching activities. In addition, NorthernStar would develop a final well protection plan that would include at least the following activities, actions, or prohibitions: 1) fueling of vehicles and storage of fuel or hazardous materials would be prohibited within 200 feet of the wells; 2) blasting activities would be prohibited within 100 feet of the wells; and 3) monitoring would be performed before, during, and after construction within 150 feet of the wells. In the event a water well is damaged as a result of the construction, NorthernStar would arrange for an immediate temporary source of potable water, if required, and provide for the repair of the well or replacement of the water supply.

During pipeline construction activities, it is possible that HDD boreholes could penetrate local shallow aquifers. However, these activities are not expected to impact groundwater conditions other than in the immediate vicinity of the borehole, where bentonite drilling mud could result in localized alteration of aquifer hydraulic properties. Additionally and as mentioned in the preceding paragraph, wells located within 150 feet of the construction area would be monitored to evaluate water quality, which would detect any localized changes that might occur in response to the HDD activities.

Shallow groundwater can lead to the problem of pipeline buoyancy (i.e., the pipeline "floats" to the surface). NorthernStar would mitigate this impact by coating the pipe with a minimum of 4 inches of concrete to maintain negative buoyancy in areas of shallow groundwater (typically wetlands).

Blasting is not expected to be necessary for pipeline installation. However, in the event that blasting is required for pipe trench excavation, care would be taken to prevent damage to underground structures such as well casings. NorthernStar would work with the landowners of nearby wells to establish a well monitoring program, such as described above, for wells that might be affected by the vibrations generated by blasting.

Although the potential to encounter contaminated groundwater is relatively low during pipeline construction, mismanagement of contaminated groundwater encountered during construction could result in impacts on surface water and other sensitive resources. Before construction, we have recommended that NorthernStar prepare a CMMP that would specify the procedures to be followed to identify, characterize, and properly manage potentially contaminated materials, including groundwater (see section 4.2.2.1). The CMMP would be submitted to the appropriate agencies for approval before construction.

Any trench dewatering operations conducted for pipeline construction would be brief, typically lasting several days or less. Potential impacts on the groundwater would include minor fluctuations in groundwater levels and/or increased turbidity within the aquifer adjacent to the activity. Most alluvial aquifers exhibit moderate to rapid recharge and groundwater movement. Therefore, such effects would be temporary. If there is adequate vegetation to function as a filter medium, discharge would be directed to the vegetated land surface to control erosion. Where adequate vegetation is absent or in the vicinity of waterbodies or wetlands, trench water would be pumped into a filter bag or settling basin constructed of hay bales or silt fence so that silt-laden water would be filtered before release from the construction right-of-way. These practices would minimize the impacts on groundwater quality as the water removed from open trenches would be allowed to infiltrate back into the aquifer in the immediate vicinity of trenching activities.

If contaminated groundwater is encountered during trench dewatering activities, in addition to implementing the CMMP, the groundwater removed from the trench would be stored in Baker tanks, tested, and disposed of in accordance with local and state regulations. Trench dewatering would be conducted in compliance with applicable permits. As a result, impacts on groundwater associated with trench dewatering are not expected to be significant.

4.3.2 Surface Water

4.3.2.1 Surface Water Regulations and Standards

Federal Regulations

Construction of project facilities that affect waters of the United States would be regulated by the COE under section 10 of the RHA and section 404 of the CWA. Section 10 of the RHA prohibits the creation of any obstruction to the navigable capacity of any waters of the United States without specific approval of the COE. Section 404 of the CWA regulates the discharge of dredged or fill material into waters of the United States.

In addition to the COE permitting requirements, NorthernStar's proposed pipeline installation, LNG terminal development, and dredging activities would need to comply with section 401 of the CWA. NorthernStar would be required to obtain a section 401 water quality certificate demonstrating that the discharges associated with the project comply with federal and state water quality standards. The state agencies responsible for section 401 water quality certifications are the ODEQ and the WDE. NorthernStar would also need to certify that its project is consistent with the enforceable policies of the CZMA (see section 4.7.2.4).

Oregon Water Quality Regulations and Standards

Pursuant to the federal CWA, the ODEQ lists Oregon waterbodies that remain out of compliance with ambient water quality standards after conventional water pollution controls have been implemented. The lower Columbia River is listed as out of compliance for PCBs, arsenic, and water temperature (ODEQ, 2007).

The mainstem Columbia River has its own set of standards and policies that the ODEQ designed and enforces (under OAR 340-41), which include the following:

- the 7-day-average maximum temperature must not exceed 68.0 °F;
- coldwater refugia must be distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the waterbody;
- the seasonal thermal pattern in the Columbia River must follow the natural seasonal thermal pattern;
- pH values must be in the range of 7.0 - 8.5 (from the mouth of the river to CRM 309); and
- unless authorized by the ODEQ, total dissolved solids should not exceed 200 mg/L on the mainstem Columbia River (CRMs 120 - 147 and 210 - 309), or 500 mg/L for all other parts of the mainstem.

<u>Water Quality Limited Waters (OAR 340-041-0046)</u>

The state of Oregon identifies receiving streams as water quality limited through the biennial assessment report, as required by 305(b) of the CWA. The report gives details of the area of waterbody or segment of stream that is limited, the time of year water quality standards violations occur, and the

parameter(s) of concern. The water quality limited list is placed on public notice and reviewed through a public hearing process. ODEQ may add waterbodies to the list between status assessment reports by following the same process of placing the action on public notice and conducting a public hearing.

In the case of interstate waterbodies, the portion of the waterbody within Oregon's border is assessed. For waterbodies designated as "water quality limited," requests for load increases may be considered using the process set out in OAR 340-041-0004(9)(b).

Section 303(d) List

Section 303(d) of the CWA requires that states periodically prepare a list of all surface waters in the state for which beneficial uses, such as drinking, recreation, aquatic habitat, and industrial use are impaired by pollutants. This list is prepared by the ODEQ and typically provided biennially to the EPA as required under section 305(b) of the CWA. The 2004/2006 list is the most recent list that was approved by the EPA for Oregon.

The water quality standards are not being met for the Columbia River's beneficial use of fish habitat. The portion of the Columbia River between CRMs 0 and 306.1 is on ODEQ's 303(d) water quality-limited list for temperature (year-round, non-spawning). In addition, between CRMs 35.2 and 98.0, the Columbia River is listed for exceeding total maximum daily loads (TMDL) for arsenic, dichloro-diphenyl-trichloroethane (DDT), and PCBs year-round. Although previously listed for dissolved oxygen levels, fecal coliform, and temperature, the Clatskanie River has been removed from the 303(d) list.

Outstanding Resource Waters

Outstanding Resource Waters (ORW) are existing high quality waters that constitute an outstanding state or national resource. Oregon's rules establish a classification of ORWs. Oregon's Environmental Quality Commission has the authority to classify waterbodies as ORWs but has not yet developed procedures for classifying waterbodies using this system.

Washington Water Quality Regulations and Standards

The WDE is responsible for water quality standards for all surface waters within the state as required under section 303(c) of the CWA. The WDE has developed a classification system to describe the highest designated use(s) and associated minimum water quality requirements for surface waters in Washington. The purpose of the WDE's Water Quality Standards for Surface Waters (WAC 173-201A) is to establish water quality standards consistent with public health and public enjoyment, and the propagation and protection of fish, shellfish, and wildlife. The water use and quality standards are established in conformance with present and potential uses of the surface waters and in consideration of natural water quality potential and limitations. The Water Quality Program in WAC 173-201A refers to "existing and designated uses" of waterbodies. Existing uses are defined as "those uses actually attained in fresh or marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of nonself-replicating introduced native species, do not need to receive full support as an existing use." Designated uses are defined as "those uses specified in this chapter (WAC 173-201A) for each waterbody or segment, regardless of whether or not the uses are currently attained." Designated uses for those waterbodies crossed by the Bradwood Landing Project include aquatic life, recreational, water supply, and miscellaneous uses (e.g., wildlife habitat, harvesting, commerce/navigation, boating, and aesthetics). Like Oregon, the State of Washington also designates certain waterbodies as ORWs.

WDNR Stream Typing

On March 1, 2006, the WDNR implemented a new statewide water typing system. Although the maps used by the WDNR are new, the existing Forest Practices rule (WAC 222-16-031) was used to define water types. The new classification types are described below.

- Type S Water – Includes all waters, within their ordinary high-water mark (OHWM), inventoried as "shoreline of the state" under the RCW Chapter 90.58 and the rules promulgated pursuant to RCW Chapter 90.58, but not including those waters' associated wetlands as defined in RCW Chapter 90.58.

- Type F Water – Includes segments of natural waters that are not classified as Type S Water and have a high fish, wildlife, or human use.

- Type N (Np or Ns) Water – Includes segments of natural waters within the bankfull width of defined channels that are not classified as Type S or F Waters, and which are perennial (Np) or seasonal (Ns) waters of nonfish-bearing streams.

- Type U Water – Because most stream typing for the state was done with photos, any streams or drainages showing up on the photos that have not yet been designated because field evaluation is still pending are listed as Type U. After the completion of field evaluations, most Type U Waters are designated as Type Ns Waters.

The waterbodies impacted by the proposed pipeline route are designated, in descending order of prevalence, as follows: 15 Type N Waters, 7 Type S Waters, 6 Type F Waters, and 1 Type U Water.

Section 303(d) List

Section 303(d) of the CWA requires that states periodically prepare a list of all surface waters in the state for which beneficial uses, such as for drinking, recreation, aquatic habitat, and industrial use are impaired by pollutants. This list is prepared by the WDE and typically provided biennially to the EPA as required under section 305(b) of the CWA. The surface waters are classified according to the most beneficial existing and potential future uses of the waterbody and to provide protection for a variety of uses. Water quality is classified as impaired if it exceeds the state-designated TMDL for various pollutants such as fecal coliform, temperature, pH, and dissolved oxygen-consuming compounds. A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet the intended or designated water quality use standards. The current section 303(d) list for Washington is the 2002/2004 list, which simply lists impaired waters and does not further categorize other waters in the state. The 2002/2004 list is the most recent list that was approved by the EPA.

Table 4.3.2-1 summarizes the section 303(d)-listed waterbodies in Washington and their status relative to each list, including the water quality parameters that are considered impaired in each waterbody. Seven waterbodies crossed by the portion of the proposed pipeline route in Washington are listed as section 303(d) waterbodies. The portion of the Columbia River in the vicinity of the proposed project is listed for temperature variations and mercury and arsenic levels outside of the water quality standards. Cameron Creek, Abernathy Creek, Germany Creek, Tributary 5 to Coal Creek, Coal Creek, and Ostrander Creek are listed for temperature variations outside the water quality standards. A discussion of the potential impacts on waterbodies that would be crossed by the proposed pipeline route is provided in section 4.3.2.4.

TABLE 4.3.2-1

Summary of Section 303(d)-Listed Waterbodies Crossed by the Bradwood Landing Project in Washington

Waterbody Name	MP	2002/2004 Section 303(d) Listed Impairments	Proposed Crossing Method
Columbia River	19.0 - 19.6	Temperature, Mercury, Arsenic	HDD
Cameron Creek	20.6	Temperature	HDD
Abernathy Creek	21.1	Temperature	HDD
Germany Creek	22.4	Temperature	HDD
Tributary 5 to Coal Creek	27.5	Temperature	Bore
Coal Creek	28.0	Temperature	HDD
Ostrander Creek	36.2	Temperature	Bore

Source: WDE, 2005b

Designated Shorelines

As discussed in section 1.3.11, the Shoreline Management Act requires cities and counties to develop SMPs that regulate development along larger streams, lakes, and marine waters. The areas regulated include lands within 200 feet of a shoreline. The general management designations for shorelines in the state include: Natural, Rural and/or Conservancy, Aquatic, High-intensity, Urban Conservancy, and Shoreline Residential. Individual cities and counties may have slightly modified designations. A summary of the designated shorelines that would be affected by the proposed pipeline is provided in table 4.3.2-2.

TABLE 4.3.2-2

Designated Shorelines Crossed by the Bradwood Landing Project in Washington [a]

Waterbody Name	MP	Shoreline Designation	Proposed Crossing Method
Columbia River	19.0 - 19.6	Conservancy & Urban	HDD
Cameron Creek	20.6	Conservancy	HDD
Abernathy Creek	21.1	Conservancy	HDD
Germany Creek	22.4	Conservancy	HDD
Coal Creek	28.0	Conservancy	HDD
Cowlitz River	34.3	Conservancy & Urban	HDD
Ostrander Creek	36.2	Rural or No Designation	Bore

[a] Designated as a stream/river constituting shorelines of the state per the Shoreline Management Act (Chapter 173-18 WAC).

Seven waterbodies crossed in Cowlitz County are designated as streams/rivers constituting shorelines of the state per the Shoreline Management Act. Based on a review of Cowlitz County's SMP, the shorelines of five of these waterbodies are designated as "Conservancy" (Columbia River, Cameron Creek, Abernathy Creek, Germany Creek, and Coal Creek), one is designated as "Urban" (Cowlitz River), and one as "Rural" (Ostrander Creek). Utilities including gas pipelines are permitted within the Conservancy, Urban, and Rural Districts (Cowlitz County, 1977).

Critical Areas Ordinance

As discussed in section 1.3.11, the Growth Management Act requires local governments to identify and protect critical areas, including frequently flooded areas. Frequently flooded areas include, at a minimum, the 100-year floodplain designations of FEMA and the National Flood Insurance Program

(Washington State Department of Community, Trade, and Economic Development, 2003). Floodplain permits are issued wherever a pipeline crosses a mapped floodplain, which is referred to as a Special Flood Hazard Area on the FEMA maps. In some instances, the floodplain permit is administered through the Frequently Flooded Areas Section of the Critical Areas Ordinance, while in others it may be separate from the critical areas ordinance and governed by a stand-alone flood chapter of the county code. In Cowlitz County, development within designated frequently flooded areas is subject to the Cowlitz County Floodplain Management Ordinance (Chapter 16.25 CCC). Development is defined as a construction project involving property improvement or a change of physical character within the site and the act of using land for building or extractive purposes. Placement of a pipeline is included in this definition. A review of the Cowlitz County FEMA Flood Zone maps indicates that that pipeline would cross frequently flooded areas at the Columbia River (MP 19.6), Germany Creek (MP 22.4), Cowlitz River (MP 34.3), Tributary to Ostrander Creek (MP 35.0), and Ostrander Creek (MP 36.2).

4.3.2.2 Waterway for LNG Marine Traffic

Existing Surface Water Resources

As described in section 2.1.2, the waterway for LNG marine traffic associated with the Bradwood Landing Project extends from the territorial seas boundary to the proposed LNG terminal site at CRM 38 on the Columbia River. The Columbia River Basin is bound by the Rocky Mountain system on the east and north, the Cascade Range on the west, and the Great Basin on the south. Including upland areas, the total area of this drainage basin is 258,000 square miles. Waterways and lakes in the Columbia River Basin account for approximately 3,000 square miles, of which 2,500 square miles are within the United States.

The majority of the precipitation in the Columbia River Basin is in the mountainous areas during the winter season in the form of snow. These deep snowpacks provide significant runoff during spring snowmelt, with approximately 60 percent of the natural runoff occurring in May, June, and July. Due to this seasonal fluctuation in runoff, streams within this basin have low flows during the winter months and sustained, high flows during the spring and early summer.

The Columbia River begins at Columbia Lake in the Canadian Selkirk Mountains. It crosses the Canada-United States border near Spokane and is joined by the Snake River in central Washington. It continues to flow for approximately 1,214 miles before entering the Pacific Ocean near Astoria, Oregon. Average runoff at the mouth of the Columbia is about 275,000 cfs (COE, 2002). The Columbia River is tidally influenced, but considered freshwater because the extent of significant saltwater intrusion is generally limited to the lower reach of the river, where the salinity level ranges from 32 parts per thousand at the mouth of the river to 1 part per thousand at CRM 30, which is about 8 miles downstream of the proposed Bradwood Landing LNG terminal site (COE, 1999).

Temperature in the lower Columbia River is at risk from changes in the flow regime created by the federal dam system and from changes associated with global warming. Natural sediment loads have been decreased by the storage of fine sediment behind the dams. The dams have also significantly altered the natural hydrology of the Lower Columbia River by flattening out the peak flows during winter and spring and contributing to lower water levels during the summer and fall when water is withheld behind the dams. Chemical contamination (e.g., PCBs) and excess nutrient loading are issues in the lower Columbia River generally.

The lower Columbia River displays appropriate wetted width to maximum depth ratio. Stream banks are in relatively good and stable condition, with riparian vegetation present at most locations.

However, dikes and bank armoring with riprap have dramatically reduced the floodplain connectivity. This condition is exacerbated by the lack of significant flooding since the construction of upstream dams.

Parts of the Columbia River have been dredged periodically for more than 128 years to allow ships and barges carrying cargo to reach ports along the river. The mainstem of the river recently underwent channel deepening by the COE as part of the Columbia River Channel Improvement Project. As a result of the COE's dredging project, the main channel depth increased from 40 to 43 feet from the mouth of the river to the City of Portland.

Past the mouth of the Columbia River, the waterway extends 12 nautical miles across the continental shelf of the Pacific Ocean. The run off of the Columbia River is one of the largest in the United States, discharging approximately 244 billion cubic meters per year (at 275,000 cfs) (Federal Columbia River Power System, 2001). The coastal waters off northern Oregon and southern Washington are highly influenced by this freshwater run off (DeRobertis et al., 2005). Where the Columbia River meets the Pacific Ocean, a freshwater plume develops offshore. This plume is influenced by the mixed semi-diurnal tides, and therefore it is a transient feature (Morgan et al., 2005). Average sea temperatures from 1984 to 2001 ranged between a maximum of 59 °F and a low of 48 °F (NOAA, National Data Buoy Center, 2005).

Impacts and Mitigation

Dredging of the Ship Berth and Maneuvering Area

Impacts and mitigation associated with construction and maintenance dredging of the ship berth and maneuvering area are described in detail in section 4.3.2.3. Water quality impacts associated with dredging are expected to be temporary and minor.

Shoreline Erosion and Propeller Wash from LNG Carriers and Tugs

Propeller wash from LNG carriers associated with the project, as well as ship wakes breaking on shore could cause increased erosion along the shoreline and resuspend the eroded material within the water column. Shoreline erosion is discussed in more detail in sections 4.1.2.3, 4.1.3.3, and 4.5.2.1. During operation of the proposed LNG terminal, propeller wash and wakes from LNG carriers and tugs could temporarily increase suspended sediments and turbidity within the ship berth and maneuvering area and along the LNG carrier transit route. As a vessel navigates through a waterway, it generates hydraulic disturbances in the form of waves and currents, mainly drawdown, return current, slope supply currents, wash waves, and jet wash (Wolter and Arlinghaus, 2003). These activities have the potential to resuspend, and subsequently redeposit, sediments, resulting in impacts similar to those for dredging. Impacts associated with propeller wash would occur more frequently than dredging because as many as 125 LNG carriers may unload their cargos at the LNG terminal annually. Given the regular vessel traffic along the Columbia River, regular maintenance dredging of the navigation channel, the proposed location of the LNG terminal adjacent to the navigation channel, and the relatively coarse particles that make up the sediments at the ship berth and maneuvering area, we do not anticipate that propeller wash from LNG carriers and tugs would result in a significant degradation of water quality in the Columbia River.

Ballast Water and Ship Engine Cooling

Because the LNG carriers would be fully loaded when arriving at the proposed terminal, no ballast water would be discharged into the Columbia River. However, as the LNG cargo is unloaded, a carrier would take on water to maintain trim and stability and for cooling engines while docked at the

terminal. Potential impacts on water quality and aquatic resources due to ballast water intake and engine cooling water appropriations and discharges are discussed in sections 4.3.2.3 and 4.5.2.1, respectively.

Release of LNG or Fuel

In the unlikely event that LNG is spilled into the water from an accidental or intentional breach of an LNG carrier during transit, the cryogenic liquid would vaporize rapidly upon contact with the warm air and water. Being less dense than water, LNG would float on the surface before vaporizing. Because LNG is not soluble in water and would completely vaporize shortly after being spilled, the LNG could not mix with or contaminate the water.

Fuel (e.g., diesel) used for vessel propulsion or auxiliary/emergency generators on an LNG carrier could potentially spill or leak. However, fuel on each carrier is protected by the vessel's double hull. Furthermore, each LNG carrier would maintain a *Shipboard Oil Pollution Emergency Plan* (SOPEP) as required by international convention. The SOPEP would comply with MARPOL [marine pollution] 73/78 Consolidated Edition 2002 Annex 1 Regulation 26, which requires every oil tanker of 150 tons gross and above, and every vessel of 400 tons gross and above to carry an approved SOPEP. All LNG carriers would also be required to comply with state spill prevention and contingency plans, including the applicable requirements in Chapter 317-40 of the WAC – Bunkering Operations.

4.3.2.3 LNG Terminal

Existing Surface Water Resources

Two waterbodies within the Columbia River Basin would be affected by construction of the LNG terminal, the Columbia River and Hunt Creek. Existing conditions within these waterbodies are discussed below. Based on the wetland and other waters delineation report prepared for the project, nine small streams are located within the proposed 100-foot-wide construction corridor for the power line (URS, 2006c). These streams are intermittent; however, because most of the streams are fed, at least in part, by springs and seeps, they likely contain flows for much of the year. The majority of these streams eventually flow northwest from the proposed power line corridor to the Columbia River via Hunt Creek.

Columbia River

Columbia River water near the proposed LNG terminal site contains low concentrations of total dissolved solids (typically 80 to 100 mg/L), nitrates, carbonates, phosphates, and metals. Dissolved oxygen concentrations are usually close to saturation and turbidity levels are moderate. Typical total suspended solids (TSS) concentrations are 12 to 30 mg/L. Water temperatures are cool most of the year but can rise to 73 °F in the summer.

Currently, the water quality of the Columbia River is considered "marginally healthy" (COE, 2003). The segment of the Columbia River that would be impacted by the proposed project is an anadromous coldwater and warmwater fishery. It is designated as EFH for coho and Chinook salmon by the NMFS, as critical habitat for 12 salmonid evolutionary significant units (ESU) or distinct population segments (DPS) by the NMFS, and as Aquatic Natural or Aquatic Conservation areas by Clatsop County. The LNG terminal site location is also included in the Lower Columbia River Estuary, which belongs to the EPA's National Estuary Program. The EPA is working in coordination with the states of Idaho, Oregon, and Washington as well as the Columbia Basin Tribes to reduce pollutant loads within the river and to meet federal water quality standards.

Hunt Creek

The lower reaches of Hunt Creek are located immediately adjacent to the proposed LNG terminal site. The lower reach of Hunt Creek begins where an approximately 40-foot-high waterfall descends to the Columbia River floodplain and is characterized by low gradient meanders, tidally influenced backwater ponds, and freshwater tidal estuary at its junction with the Columbia River. Bottom sediments appear to be alluvial fine silt/sand, with a short section of gravel-bottom pool-riffle sequences near the waterfall. Upstream of the waterfall, Hunt Creek is characterized by high-gradient riffle/pool complexes confined to a deeply incised valley.

The water quality of Hunt Creek is not currently listed as either water quality limited or impaired by the ODEQ, due in part to the intact canopy and lack of recent disturbances. There is some sedimentation in the stream and evidence of turbidity during high flows, but the stream also contains a sizable proportion of clean gravels. Chemical contamination and excess nutrient loading are not a problem in the watershed.

Although Hunt Creek is designated a coldwater residential recreational fishery, angling is not currently permitted. Hunt Creek provides habitat for resident coldwater fish species, such as coastal cutthroat trout, and has been designated as EFH for coho and Chinook salmon and as critical habitat for federally listed salmonids (see section 4.6.2.2). Hunt Creek has been designated as Essential Salmonid Habitat by the ODFW.

Stormwater runoff from Clifton Road generally flows into a series of roadside ditches along the eastern side of Clifton Road. From the roadside channels, runoff flows west under Clifton Road via culverts, where it outfalls and sheet flows (or infiltrates) over dense native riparian vegetation towards Hunt Creek. Generally, the roadside ditches combine with streams conveying runoff from the upland areas along Clifton Road. A perennial stream is located east of the Highway 30 and Clifton Road intersection that conveys runoff from the southern portion of Clifton Road towards Hunt Creek. Based on a wetland/waterway survey conducted by NorthernStar in August 2006, 19 individual roadside ditches were identified along the 2.4-mile stretch of Clifton Road from Highway 30 to Bradwood Road. Table 4.3.2-3 summarizes the discharge locations along Clifton Road, along with the approximate milepost location (MP 0.0 represents the intersection of Highway 30 and Clifton Road).

TABLE 4.3.2-3

Stormwater Runoff Discharge Locations from Clifton Road

MP	Type of Discharge	MP	Type of Discharge
0.3	Stream	1.4	Stream/culvert
0.3	Stream	1.5	Stream/culvert
0.6	Culvert	1.6	Culvert
0.8	Culvert	1.6	Stream/culvert
0.9	Culvert	1.7	Stream/culvert
1.0	Stream/culvert	1.8	Culvert
1.2	Stream/culvert	2.0	Stream/culvert
1.2	Stream/culvert	2.2	Culvert
1.3	Stream/culvert	2.4	Stream/culvert

Construction Impacts and Mitigation

Activities associated with construction of the LNG terminal that could affect surface water resources include dredging of the ship berth and maneuvering area, dredged material placement, water

appropriation and discharge, stormwater runoff, electric power line, modifications to access roads and the Hunt Creek Bridge replacement, railroad realignment, and accidental spills or leaks of hazardous materials.

Dredging of the Ship Berth and Maneuvering Area

The primary impact of the project on surface water quality would result from using a hydraulic cutterhead dredge to remove approximately 700,000 cubic yards of material from the proposed ship berth and maneuvering area. Details of NorthernStar's proposed dredging are described in section 2.4.1.2. The effects of dredging on hydraulics in the Clifton Channel and main channel of the Columbia River are described in the discussion of NorthernStar's hydraulic and sediment transport modeling presented in section 4.2.2.2.

Dredging would result in a temporary increase in suspended solids in the water around the dredged area and the subsequent settling of the suspended particles, or sedimentation. The suspended sediment would temporarily reduce light penetration and could lower the rate of photosynthesis and aquatic productivity of the area. The introduction of sediment could also increase the amount of organic material and/or nutrients in the affected areas, which could lead to an increase in biological oxygen demand. This could reduce dissolved oxygen levels or cause a release of chemical constituents, such as metals, PCBs, pesticides, or PAHs, if present in the sediments. NorthernStar collected and tested sediment samples from the proposed dredge area to evaluate the quality and characteristics of the sediments that would be disturbed during construction of the project. As discussed in section 4.2.2.2, samples were collected in accordance with a SAP that was approved by the COE, EPA, and ODEQ through the RMT.

NorthernStar contracted WEST to conduct a hydrodynamic and sediment transport assessment for the dredging of the ship berth and maneuvering area (WEST, 2006). The assessment indicates that the proposed cutterhead dredge would spill approximately 0.5 percent of dredged materials. The total volume of material to be dredged for the berthing area and turning basin was estimated at 700,000 cubic yards. Based upon 0.5 percent spillage, the project would spill about 3,500 cubic yards of sediment during dredging activities. Based on their modeling, WEST concluded that the maximum sediment concentration would occur within 10 feet of the cutterhead.

Sediment spilled during dredging would create a plume of suspended sediment, reducing in-water visibility through increased turbidity. The size and duration of the sediment plume is highly dependent upon the grain size of the material being dredged. SWCA conducted a sediment analysis of the material which would be dredged as part of the proposed project. Within the dredge footprint, the substrate is almost exclusively sand, with very low silt and clay component (SWCA, 2006). Sand settles rapidly in the water column. Modeling by WEST shows that only particles smaller than 0.4 mm diameter are likely to be transported to areas outside the dredge footprint, while larger particles would settle within 10 feet from the cutterhead dredge. WEST's hydrodynamic model predicts that project-related suspended sediment loads would not exceed 1 mg/L at the dredge site and would diminish to 0.1 mg/L before reaching either Tenasillahe Island or Hunt Creek. By comparison, the typical TSS concentrations described above ranged between 12 and 30 mg/L and background levels of TSS measured in the field were on the order of 10 mg/L. Therefore, even assuming a considerable level of uncertainty in any of the model parameters, the impacts of the dredging operation would be very small and confined to an area immediately surrounding the proposed facility.

Background levels of turbidity in the Columbia River range from 3 to 10 NTUs. The WEST study demonstrates that turbidity plumes from dredging for the Bradwood Landing Project would return to within 1 NTU of background levels within 1 minute after suspension (WEST, 2006).

Dredging and all other in-water work in the Columbia River would be done during the in-water work window of November 1 to February 28. Additional information regarding impacts associated with dredging activities on sediment transport, aquatic resources, and special status species are provided in sections 4.2.2.2, 4.5.2.1, and 4.6.2.2, respectively.

Dredged Material Placement

As described in section 2.4.1.1, NorthernStar proposes to place up to 700,000 cubic yards of dredged material on the LNG terminal site to raise the base of the LNG terminal site to an elevation of 20 to 25 feet NAVD 88. As a result of the added fill, approximately 856,607 square feet (19.7 acres) of the LNG terminal site, including areas associated with Bradwood Road and Hunt Creek Bridge, that are currently below the 100-year floodplain would be raised above the 100-year floodplain. Before dredged material placement, a perimeter berm would be constructed around the area receiving dredged materials, forming a basin into which the dredged material would be placed. After fish and other aquatic life have been removed from the log pond (see section 4.5.2.1), the channel connecting the log pond to the Columbia River would be filled to complete the perimeter berm and isolate the pond from the river.[6]

As it is deposited on site, the water would separate from the dredged materials. Based on the relatively high permeability of the existing soils at the site and the dredged materials to be applied, infiltration rates are expected to be greater than the rate at which water would be applied during dredging. Therefore, NorthernStar anticipates that all of the water would percolate into the sandy soil at the site. However, during rainfall events, where the infiltration capacity of the soil may be more limited, the log pond would serve as a temporary holding area for excess water that would be generated. The pond would have approximately 50,000 cubic yards of storage volume, assuming a full depth of 20 feet. It is likely that water may continually be present that would reduce the capacity. Water from the dredged materials would not be allowed to overtop the perimeter berm and discharge to the river untreated.

Although it is expected that most of the water that accumulates in the pond would percolate into the ground, the log pond would be equipped with an overflow structure. The overflow structure would allow clarified water in excess of the storage capacity of the pond to drain to the Columbia River, and would be designed to have sufficient capacity to transport large volumes of water to the river through a temporary outfall discharge. This discharge would be located below the surface of the river a minimum of 20 feet from the shoreline. The residence time of any water that accumulates in the pond would be such that sediment would settle to the bottom of the pond and would not discharge to the river through the overflow structure. This water would not be expected to carry a high silt load because almost all the dredged material would be coarse and medium sand (see section 4.2.2.2).

Oregon's water quality standards require that discharges not increase the turbidity of river water more than 10 percent above background concentration. It is expected that this standard would be met at the point of discharge or outside a mixing zone that extends no more than 10 feet from the outfall.

Given the infiltration rate of the soils on site and the capacity of the holding pond for additional storage, NorthernStar expects discharge from the overflow structure to be very intermittent and only during periods of extremely high rainfall in conjunction with dredge material application. Water conveyed with the dredge material, as it is deposited on site, would separate fairly rapidly given the relative large grain size associated with the dredge material. It is anticipated that any water that would overflow would be low in sediment and of equal quality as Columbia River water.

[6] NorthernStar included its *Work Area Isolation and Fish Salvage Plan* as part of its JPA. NorthernStar filed its JPA with the FERC on November 22, 2006, and filed revisions to the JPA on April 5, 2007. This document is available for viewing by the public on the FERC's Internet web page at www.ferc.gov, through the eLibrary link, selecting "General Search," entering the docket number minus the last three digits (i.e., CP06-365), and putting in the proper date range.

The overflow structure is expected to be a stand pipe-type system with a downturned elbow that would allow discharge of water that has had the greatest amount of time to allow for separation and settlement of any particulates. The log pond itself would be the last area to be filled on site, during which the stand pipe would either be removed or sealed in place.

In its May 11, 2007 letter to the FERC, the NMFS asked us to explain why the log pond could not be filled with existing dredged material stored at the western end of the LNG terminal site where no infrastructure except the stormwater treatment and infiltration gallery (which appears could be moved eastward) is proposed. The NMFS stated that such a modification would appear to minimize the volume of fill needed, reduce the terminal footprint, and provide the opportunity for some on-site wetland restoration. In response, all of the existing dredged material currently stored on the site would first be graded as the initial step in raising the site grade to an elevation of 20 to 25 feet NAVD. Additional fill would be supplied from the material dredged from the ship berth and maneuvering basin. Because the log pond would be used as a dewatering basin to collect water drained from the dredged sediments, it would be the last area filled. The western end of the site would be used during construction as a staging and storage area. NorthernStar has already aggressively minimized the layout during operation (see section 3.1.6.2) and no changes to the location of the stormwater treatment system could be made that would significantly reduce the facility footprint.

The material that is dredged from the ship berth and maneuvering area that is not placed at the LNG terminal site would be placed at the Wahkiakum County Sand Pit site, located at the northern end of Puget Island. This site currently includes a settling basin consisting of earthen fill levees designed to contain the dredged material and hold the return water while allowing sand and suspended sediment to settle. Weirs would be used to regulate the return of water to the river. Water returned to the river through weirs would be subject to applicable water quality standards, after dilution, at an appropriate point of compliance. Once the pipeline dredge deposits the material and the water is drained, the sand would be spread evenly around the holding area. The de-watered sand would then be distributed and graded by earthmoving equipment along the eroding shoreline on Puget Island and pushed into scour holes adjacent to the shoreline. These activities could potentially increase suspended sediments and turbidity in the vicinity of the dredged material placement site. A specific model has not been run to determine the anticipated turbidity levels resulting from placement of dredged materials at the Wahkiakum County Sand Pit site. However, given the coarse grain size of the sediments, the materials are expected to rapidly settle out of the water and water quality impacts would be similar to that at the LNG terminal site during dredging operations (see *Dredging of the Ship Berth and Maneuvering Area*). Therefore, water quality impacts are expected to be temporary and minor.

<u>Water Appropriation and Discharge</u>

NorthernStar has applied for a temporary water use permit from the ODWR for the maximum quantity of water that would be needed during construction of the proposed LNG terminal. As indicated in table 4.3.1-1, water would be appropriated from the Columbia River for multiple uses during construction of the LNG terminal, including:

- up to 60 million gallons for testing of the LNG tanks; and
- 15 million gallons for soil compaction and ground improvements.

Figure 2.1.3-3 shows the proposed intake and discharge locations. No potable water intakes were identified within 3 miles downstream of the proposed LNG terminal, although several are located upstream. NorthernStar would obtain up to 60 million gallons of water from the Columbia River for hydrostatic testing of the LNG storage tanks. Testing of a single LNG storage tank would require 30 million gallons of water. NorthernStar plans to schedule construction activities to enable water used to

test the first tank to be reused to test the second tank, which would reduce the amount of water needed for hydrostatic testing of the tanks to 30 million gallons. However, if construction does not proceed as planned, the two tanks may need to be tested at different times, in which case, twice the amount of water would be needed. Hydrostatic testing of the LNG tanks is expected to take approximately 1 month per tank; however, the timing is dependent on the construction of the tanks themselves so a specific time that the activity would occur is not known yet. For additional information on water appropriations for construction of the LNG terminal, see sections 4.3.1.3 and 4.5.2.1.

River water used for hydrostatic testing of the tanks would be filtered before use to remove suspended solids and tested for bacteria. If bacteria concentrations are high enough to cause corrosion of the 9 percent nickel steel tanks and stainless steel surfaces within the tanks, then a sodium hypochlorite solution would be used to chlorinate the water before hydrostatic testing. After use, the hydrostatic test water from the tanks would be discharged to the Columbia River through a temporary outfall extending approximately 300 feet offshore. If the water has been chlorinated, it would be tested for chlorine residual before discharge. If chlorine residual exceeds applicable effluent limits, the spent hydrostatic test water would be dechlorinated using a sodium bisulfite solution before discharge. The sodium bisulfite dose rate would be established based on the level of chlorine residual. Sodium bisulfite solution would be introduced into the discharge pipeline close to the storage tanks, and the dechlorination reaction would be complete before discharging the water to the river.

It is expected that the hydrostatic test water from the tanks would not need treatment, other than possible dechlorination, before it is discharged to the river. However, all batches of hydrostatic test water would be sampled and analyzed before discharge to determine whether they contain any substances that would not meet Oregon's water quality standards. If such substances are detected, the hydrostatic test water would be treated as necessary to enable safe discharge to the river. Assuming that the hydrostatic test water does not need treatment beyond dechlorination, it is expected that it would meet Oregon's ambient water quality standards at the point of discharge.

Water used for hydrostatic testing of piping at the LNG terminal (approximately 1.5 million gallons) may be discharged to the Columbia River through a temporary outfall. Similar to water used to hydrostatically test the storage tanks, it is expected that the hydrostatic test water from the piping would not need to be treated before discharge to the river. However, all batches of water used for hydrostatic testing of piping would be sampled, analyzed, and treated, if necessary, to enable safe discharge to the river.

During construction, NorthernStar would also appropriate approximately 15 million gallons of water from the Columbia River for soil compaction and ground improvements. This work would occur over a period of 3 to 4 months and likely between the months of July and December. The water would not be discharged to surface waters, and is discussed further in section 4.3.1.3.

No water would be either appropriated from or discharged to Hunt Creek.

Stormwater Runoff

Stormwater runoff during construction of the LNG terminal could potentially affect water quality in both the Columbia River and Hunt Creek. To minimize these potential affects, NorthernStar has developed a terminal ESC Plan that contains BMPs for management of stormwater during construction. Additional information on NorthernStar's terminal ESC Plan is provided in section 4.3.1.3.

Electric Power Line

The proposed electric power line route and associated 100-foot-wide right-of-way would impact 0.6 acre of habitat within nine waterbodies. Based on the information provided by NorthernStar, these waterbodies are relatively narrow and occur in steep areas. In some cases, these waterbodies are intermittent and/or flow underground for portions of their length.

The impacts of power line construction on the minor intermittent and perennial streams along the route would generally be localized and short term. It is expected that the power line would span the tributaries so as to avoid impacts on surface waters. However, if required, clearing trees and vegetation adjacent to these waterbodies would have the greatest effect on water quality, including potential increases in water temperature. Sediments could be resuspended by in-stream construction activities or by erosion of cleared stream banks and riparian areas. Turbidity resulting from the resuspended sediments could reduce light penetration and the corresponding photosynthetic oxygen production. Resuspension of deposited organic material and inorganic sediments could cause an increase in consumption of biological and chemical oxygen, decreasing available dissolved oxygen. However, the potential impacts on surface waters would be minimized through the implementation of BMPs by PacifiCorp and the requirements of state and local permits and approvals.

Access Roads and Hunt Creek Bridge Replacement

To accommodate vehicle traffic associated with construction and operation of the project, Clifton Road would need to be paved and widened to 28 feet, including shoulders (based on engineering drawings submitted by NorthernStar). In addition, a drainage ditch would be constructed on the west side of the road. Impacts on Hunt Creek would be minimized through the implementation of NorthernStar's terminal ESC plan and our Plan and Procedures. To this end, NorthernStar has indicated that construction on the eastern side of the road (adjacent to Hunt Creek) would be completed in a manner that would not allow any sediment to wash into Hunt Creek. Because Hunt Creek has been designated as both EFH and critical habitat for federally listed salmonids, potential impacts on water quality due to construction of Clifton Road will be analyzed in additional detail in the revised BA and EFH Assessment.

As discussed in section 2.1.3.6, Bradwood Road enters the LNG terminal site from Clifton Road over a bridge that crosses Hunt Creek. Although most of the existing roadway is above the 100-year flood elevation (13.23 NAVD), the portions below the 100-year flood elevation would be raised. Following construction, the elevation of Bradwood Road would vary, but would generally exceed 14 NAVD. Bradwood Road would also need to be paved and widened to 24 feet for use during construction and operation of the proposed project. Similarly, the existing bridge over Hunt Creek is not adequate to withstand the anticipated loadings associated with construction-related traffic and would be replaced with a 24-foot-wide bridge.

The new Hunt Creek Bridge would be built from four pre-cast concrete deck bulb T-girders. These would be supported on 12-inch-diameter concrete-filled steel piles that would be placed above the mean higher high water (MHHW) elevation and then vibrated into place. The new Hunt Creek Bridge deck would be 2.4 feet above the 100-year flood elevation. Each side of the bridge would be curbed and have curb-mount rails. Cast-in-place concrete aprons would be added at the ends of the bridge to match the existing grade. The bridge would be sloped to one side, and an additional 25 feet of extruded concrete curb would be constructed beyond the concrete apron on the downslope side of the bridge from both the west and the east. This curb is designed to guide stormwater to vegetated roadside areas before draining to Hunt Creek.

Bridge demolition, activities below the OHWM, and construction of over-water portions of the bridge would occur during the in-water work period for Columbia River tributaries between Big Creek and St. Helens of July 1 – September 15. NorthernStar would implement its terminal ESC Plan to avoid or minimize impacts on water quality during construction of the Hunt Creek Bridge (see Attachment B-1). In addition, NorthernStar would apply the following bridge demolition and construction BMPs:

- Existing pilings would be left in place unless they interfere with the proposed bridge. In-water work would be very limited, consisting of cutting off existing bridge piers and piles that would interfere with the new bridge.

- Excavation required for the installation of the concrete abutments would be conducted from up-bank, and would be minimized to the amount necessary to place the structure. NorthernStar does not expect placement of the abutments to result in any measurable turbidity during construction.

- A temporary erosion and sediment control plan would be developed prior to beginning any construction work. The plan would include erosion control methods to prevent silt or toxic material-laden water generated from any land-disturbed areas or construction equipment servicing areas from entering Hunt Creek. These methods may include silt fences, filter fabric, straw bales, dust suppression, temporary sediment ponds, check dams of pea gravel-filled burlap bags or other material, diversion dams with flexible drainage pipe outfalls and pumps as necessary to divert flows, a controlled construction entrance, and mulching of exposed areas upon completion.

- Equipment servicing and fueling would be conducted a minimum of 100 feet upland from Hunt Creek. Any heavy equipment operating over (or within) Hunt Creek would be inspected for lubrication or fuel leaks. Any leaks detected would be corrected prior to commencing work.

- During bridge demolition and construction work, water quality monitoring would be conducted at a point 100 feet downstream from the bridge. A baseline observation for water clarity would be taken at a point upstream from the work area past the prominent meander loop. The final location of the sites would be determined as a condition of the 1200-C permit issued by the ODEQ. NorthernStar would use a turbidity meter to determine turbidity levels at both the background site and the downstream monitoring site.

- In the event that turbidity at the downstream monitoring site exceeds a level approximately 10 percent above turbidity at the background site, work would stop until either the turbidity was cleared or it could be ascertained that the difference in turbidity levels was not due to construction activities.[7] During periods of low turbidity, fluctuations of 10 percent could occur naturally due to complex interactions between Hunt Creek and the Columbia River.

- The areas where the demolition activity would involve bank-side disturbances would be revegetated with native vegetation that is typical to the area. Revegetation is described in detail in section 4.4.2.2.

[7] Note that short-term exceedance of the 10 percent turbidity threshold is allowed for construction if all available BMPs have been used and the potential for exceedance is recognized in the section 401 Water Quality Certification for the Joint Permit issued by the ODEQ.

- During activities associated with paving of the Hunt Creek Bridge deck, NorthernStar would employ the following additional BMPs developed by the ODEQ:
    - Selection and deployment of oil-absorbing materials and pads as well as a complete spill kit for use in response to accidental discharges and/or spills of petroleum or chemical products.
    - Prevention of stormwater pollution through the proper disposal of waste, control of stormwater run on, and minimization of stormwater runoff.
    - Elimination of discharge litter and/or other discarded debris by providing appropriate, labeled, and accessible containers for solid waste disposal.

Improvements to Bradwood Road and the Hunt Creek Bridge could potentially increase turbidity and suspended sediment levels within Hunt Creek. However, turbidity associated with bridge construction is expected to be of very short duration and would be associated primarily with removing the supports from the old bridge that interfere with construction of the new bridge. Any turbidity that would develop would be minimized by implementation of the BMPs described above, very localized (e.g., within 50 to 100 feet of the bridge), and expected to clear within a tidal cycle or sooner. If the supports are cut above the water line, turbidity associated with their removal would be negligible. However, in its May 11, 2007 letter to the FERC, the NMFS raised concerns regarding the level of monitoring proposed at Hunt Creek during demolition and construction, and specifically the absence of an upstream (as opposed to merely a background) monitoring point. Hunt Creek is tidally influenced and contains high-quality habitat for federally listed salmonids. Therefore, in addition to placing its baseline monitoring site upstream from the proposed bridge replacement, **we recommend that:**

- **NorthernStar should conduct water quality monitoring at points both 100 feet downstream and 100 feet upstream from the Hunt Creek Bridge <u>during demolition or construction activities</u>. In the event that water clarity exceeds a level approximately 10 percent above the baseline observation at either monitoring point, work would cease <u>until</u> either the turbidity was cleared or it could be ascertained that the difference in turbidity levels was not due to construction activities.**

<u>Railroad Line Realignment</u>

During construction, the existing railroad line would be rerouted and would parallel Hunt Creek for approximately 2,000 feet. For most of this length, the creek and the edge of the railroad right-of-way would be between 50 and 400 feet apart. Hunt Creek would not be directly affected by railroad construction; however, for about 50 feet, the edge of the railroad right-of-way and Hunt Creek would be less than 50 feet apart. The railroad tracks would occupy approximately 22 feet at the center of the 100-foot-wide railroad right-of-way, and would have approximately 5-foot-wide ditches maintained along both sides of the railroad tracks. To minimize potential impacts on Hunt Creek, a 2-foot-high berm of earth covered with native grass would be constructed between the Hunt Creek oxbow and the railroad tracks. The berm would extend for 100 feet centered on the apex of the oxbow. In addition, NorthernStar would use concrete railroad ties in place of treated railroad ties within 100 feet of any wetland or waterbody, including Hunt Creek. NorthernStar's terminal ESC Plan describes measures that would be taken to prevent railroad bed ballast, other construction materials, or eroded soil from entering Hunt Creek during construction.

Accidental Spills and/or Leaks of Hazardous Materials

Water quality in the Columbia River and Hunt Creek could also be adversely affected by a spill, leak, or other release of hazardous materials during construction activities. NorthernStar would minimize potential impacts associated with spills or leaks of hazardous materials during construction by implementing the spill prevention and response procedures in its terminal ESC Plan. Among these procedures are paving operation controls developed by the ODEQ that NorthernStar would implement during construction of the Hunt Creek Bridge. These include proper disposal of waste, controlling stormwater run on, and minimizing stormwater runoff.

The only area where uncured concrete would potentially come in contact with surface water is during construction of the wharf. During dock construction, expandable foam would be used to seal the forms and ensure that uncured concrete is fully contained. The forms used for concrete work would be built taller than the necessary height to ensure that uncured concrete (and any rainwater that collects on top) could not discharge to surface water. Any water generated as the result of concrete curing and/or rainwater collected in the concrete forms would be pumped to the terminal for treatment as necessary to meet water quality standards.

Operation Impacts and Mitigation

Operation of the LNG terminal could potentially impact water resources through stormwater runoff, maintenance dredging of the ship berth and maneuvering area, shoreline erosion, propeller wash from LNG carriers and tugs, water appropriations and discharges, and accidental spills or leaks of hazardous materials during operation of the LNG terminal.

Stormwater Runoff

During operation of the proposed project, there is potential for stormwater runoff to affect water quality in the Columbia River and Hunt Creek. As part of its Removal-Fill Permit application to the ODSL and COE, NorthernStar has developed a *Stormwater Management Plan for Removal/Fill Permit Applications* for the LNG terminal.[8] Given the limited guidelines for stormwater facility design in Clatsop County, NorthernStar referenced the City of Portland's Stormwater Management Manual for calculating stormwater runoff volumes, flow rates, and for initial facility design (City of Portland, 2004). Current site and soil characteristics promote the use of infiltration for disposal of stormwater generated from impervious surfaces. Based on final grade elevation, NorthernStar divided the proposed LNG terminal facility into three primary drainage basins. The drainage basins would be maintained regularly to remove any accumulated debris and sediment that would reduce their effectiveness. Because stormwater would be managed on site via infiltration, there would be no overflow into either Hunt Creek or the Columbia River.

Relative to stormwater runoff from Clifton Road, the total existing impervious surface associated with Clifton Road is approximately 5.8 acres, assuming an average width of 20 feet along its 2.4-mile length. Widening of the paved roadway to 24 feet plus 2-foot-wide shoulders on either side (see section 2.4.1.1) is expected to result in an increase of approximately 2.3 acres of impervious surface. Additional culverts and drainage ditches would be installed to improve the drainage. Permanent erosion and sediment control for the road will be analyzed in additional detail in the revised BA and EFH Assessment.

[8] NorthernStar included its *Stormwater Management Plan for Removal/Fill Permit Applications* as part of its JPA. NorthernStar filed its JPA with the FERC on November 22, 2006, and filed revisions to the JPA on April 5, 2007. This document is available for viewing by the public on the FERC's Internet web page at www.ferc.gov, through the eLibrary link, selecting "General Search," entering the docket number minus the last three digits (i.e., CP06-365), and putting in the proper date range.

Improvements to Bradwood Road and the Hunt Creek Bridge would result in slight increases to the total impervious surface. The existing site access road varies from 15 to 19.5 feet wide and the existing bridge ranges from 20 to 21.5 feet wide. The existing road is graveled, with an asphalt layer underneath approximately 75 percent of the roadway. The total impervious surface (including gravel area) associated with the existing road and bridge is about 0.4 acre. Current drainage from the existing roadway is directed onto adjacent heavily vegetated roadside areas (the site is relatively flat along Bradwood Road) and primarily infiltrates into the sandy substrate. The existing bridge discharges to Hunt Creek because the deck is made of timber members with gaps between them.

As described in section 2.4.1.1, the proposed roadway and bridge alignment generally follows the existing alignment, except immediately west of the Hunt Creek Bridge, where the road swings wider onto the old second bridge alignment. The proposed roadway and bridge would be surfaced in asphalt. The total impervious surface associated with the proposed modifications to Bradwood Road and the new Hunt Creek Bridge is approximately 0.6 acre.

Of the total modified roadway and new bridge area, approximately 0.3 acre would be area associated with the existing roadway and bridge alignment. Approximately 0.1 acre of area associated with the existing roadway and bridge alignment at the east end would be removed and revegetated as a result of the new, shorter proposed roadway and bridge alignment. Therefore, the total impervious surface associated with the proposed roadway and bridge alignment is 0.6 acre, where 0.3 acre is redeveloped impervious surface and 0.3 acre is new impervious surface. Accounting for the existing impervious surface that would be removed, the net new impervious surface is 0.2 acre.

Although the new Hunt Creek Bridge would increase the total impervious surface, it would have a solid surface decking and curbing that would prevent untreated stormwater from discharging directly into Hunt Creek. Existing topography and vegetation would be used for stormwater management as much as possible. Stormwater would discharge from the end of the curb extensions into small rock flow spreader structures before flowing through vegetation. On the east side of the bridge, the over-ground flow distance between the discharge site and Hunt Creek is about 45 feet, vegetation is dense, and the slope is relatively gentle. In addition, during site restoration, there would be an opportunity to add additional native vegetation next to the road edge to improve dissipation of stormwater. On the west side of the bridge, the curb would discharge to the former road bed, which has an over-ground flow distance to Hunt Creek of about 30 feet (see figure 2.1.3-2). This area would be revegetated with native species after construction. A bioswale placed on the west side of the bridge would be designed to increase this flow distance and provide storage necessary to promote infiltration. Any roadside swale used for erosion and sediment control during construction-phase activities could be retained to provide treatment via infiltration, and control overflow to the relatively steeper slope leading to Hunt Creek.

Based on the design parameters outlined in NorthernStar's SWMP, the discharge sites described above would be adequate to provide water quality treatment for at least the 2-year 24-hour storm. The impervious area that would drain to the curb ends is approximately 10,125 square feet, with half of this drainage going to each end. The 2-year 24-hour storm, approximately 3.8 inches, would produce about 1,600 cubic feet of precipitation over the bridge and adjacent curbed area. Assuming that 98 percent of that precipitation is runoff, and using a conservative (i.e., low) infiltration rate of 0.3 feet per hour, about 225 square feet would be required on each side of the bridge to fully infiltrate such a storm. However, as described by the NMFS (2003a), no detention is needed because flow in Hunt Creek discharges almost immediately into the Columbia River, which is large compared to the runoff expected from with the small amount of impervious surface area associated with the bridge. Sediment discharged from the road would not be expected to markedly alter infiltration rates, as it would not be enough to damage established woody vegetation.

The proposed roadway would continue to direct stormwater into heavily vegetated roadside areas where the sandy substrate would allow rapid infiltration. Existing contours indicate that the area associated with the extended portion of the roadway (which runs 170 feet farther east than the existing alignment) currently drains towards a ditch that eventually discharges to Hunt Creek. Drainage of the roadway extension is expected to follow the same flow patterns and discharge location as the existing bridge. In summary, no significant change in the drainage area discharging to Hunt Creek is expected as a result of the improvements to Bradwood Road and the Hunt Creek Bridge.

In its May 11, 2007 letter to the FERC, the NMFS inquired why inundation would not threaten bridge integrity. In response, NorthernStar filed additional information stating that the bridge design calls for the use of pre-cast concrete sections that cannot float. Therefore, regardless of water stage, the weight of the bridge would cause it to remain on the abutments. Debris at the site has been of negligible consequence for the existing bridge, which is many decades old, made of wood, has in-water supports, and experiences twice-daily inundation (the bottom of the deck gets wet) from Columbia River high tide backwater effects. This bridge survived the 1996-1997 floods with no such damage. Because the new bridge would have no in-water supports, it would be able to convey debris much more easily. The new bridge would also be higher than at least the existing 10-year flow water surface elevation. In addition, flow velocities in Hunt Creek during floods are typically very low, as the downstream portion of the creek is backwatered from high water on the Columbia River. Therefore, lateral forces from debris loads necessary to displace the bridge are highly unlikely to develop.

Maintenance Dredging of the Ship Berth and Maneuvering Area

NorthernStar estimates about 80,000 cubic yards of material would be removed from the ship berth and maneuvering area approximately every 2 to 4 years as part of maintenance dredging. Material from maintenance dredging would be deposited at the Wahkiakum County Sand Pit site located at the northern end of Puget Island or some other approved dredge disposal site. If placement is at the Wahkiakum County Sand Pit site, NorthernStar anticipates using a cutterhead section dredge with a 30-inch discharge pipe and a 4,950 HP pump, which would be consistent with the size used to complete the initial dredging of the ship berth and maneuvering area. NorthernStar is currently proposing to use the Port of Portland's dredge "Oregon" for maintenance dredging. The operation rate of this dredge is 1,500 cubic yards per hour (WEST, 2006). Therefore, with time for initiation and set up, it is expected that maintenance dredging would occur over a 2-week time frame. If a different dredge material disposal site is used, a clamshell/barge or hopper dredge would be necessary and the dredging time frame may vary depending on the disposal location.

A specific model has not been run to determine the anticipated turbidity levels resulting from placement of dredged materials at the Wahkiakum County Sand Pit site or other approved disposal site. However, given the coarse grain size of the sediments, the materials are expected to rapidly settle out of the water and water quality impacts would be similar to that at the LNG terminal site during dredging operations (see *Construction Impacts and Mitigation, Dredging of the Ship Berth and Maneuvering Area*). Therefore, water quality impacts are expected to be temporary and minor.

Water Appropriation and Discharge

As indicated in table 4.3.1-1, water would be appropriated from and discharged to the Columbia River for multiple uses during operation of the LNG terminal, including ballast water and ship engine cooling, testing of the fire suppression system, and condensate water from the SCVs. Potential impacts on water quality from these appropriations and discharges are discussed below.

Ballast Water and Ship Engine Cooling

LNG carriers unloading at the LNG terminal would appropriate water from the Columbia River for ballast and ship engine cooling. LNG carriers would not discharge any ballast or onboard wastewater during off-loading operations at the LNG terminal site. As described in section 2.1.1.5, NorthernStar has stated that it would construct and install a system capable of delivering filtered river water to the LNG carriers. This system would use a screened water intake located at the wharf (see figure 2.1.3-3) that would minimize the entrainment and impingement of juvenile fish. NorthernStar's design plans require that LNG carriers be retrofitted to utilize the system and to cycle engine cooling water into the ballast tanks to avoid the discharge of warm water to the Columbia River.

We recommended in the draft EIS that NorthernStar prepare a plan to ensure that only LNG carriers that have been retrofitted to use the screened water supply system at the wharf are allowed to unload cargo at the Bradwood Landing LNG terminal. The FERC received numerous comments on the draft EIS in support of the recommendation. We also received comments questioning the engineering feasibility of the screened water supply system to accommodate various ship designs, the engineering feasibility of the necessary retrofitting to allow LNG carriers to utilize the system, and the feasibility of enforcement. In filings to the FERC on March 24 and April 9, 2008, NorthernStar stated that it could not guarantee that all LNG carriers that arrive at the terminal would have the necessary retrofitting in place to allow the use of the screened water supply system. NorthernStar described that its proposed project could require the use of various types of shipping contracts, such that some LNG carriers calling on the LNG terminal would not use the terminal on a regular basis (e.g., spot market contracts, short term contracts, and the occasional use of replacement carriers for long-term contracts). Because LNG carriers could only be retrofitted to use the screened water supply system when in dry-dock (something that happens only twice over a five year period), or during new construction, NorthernStar stated that some carriers using the LNG terminal would not be retrofitted to use NorthernStar's screened water supply system.

NorthernStar has stated that it would continue to offer incentive-based contractual agreements for vessels to accommodate the screened water supply system, but that performance standards should be used to address regulatory gaps and bolster the mitigation potential of the LNG terminal's onsite water system. NorthernStar proposes to develop a performance standard for the temperature of all cooling water discharges at the wharf and a performance standard for entrainment of juvenile fish at the wharf. Both performance standards would have a monitoring component. To date, we have not been provided any information on these potential performance standards.

To minimize impacts on aquatic resources, we are recommending in section 4.5.2.1 that NorthernStar adhere to the condition requiring LNG carriers to be retrofitted, as recommended in the draft EIS, or develop an alternative system meeting the same standard that does not require vessel retrofitting. We recognize that an alternative system design may not eliminate cooling water discharge. Therefore, we have included a discussion below of potential impacts on water quality in the case that LNG carriers arriving at the LNG terminal have not been retrofitted to use the proposed screened water intake system and therefore, discharge cooling water in a traditional mode of ship operation.

NorthernStar estimates that LNG cariers unloading cargo at the terminal would appropriate between 20 and 50 million gallons of water for ballast and ship engine cooling, combined. NorthernStar has not provided a break down of the water requirements for engine cooling and ballast separately, which is necessary to determine the potential volume of water discharge from LNG carriers and the volume of water that would be removed from the system. Therefore, table 4.3.2-4 presents the typical intakes and discharges associated with LNG carrier ballast and engine cooling that were provided in the final EIS for the Broadwater LNG Project (FERC, 2008). The estimates are for 145,000 m^3 and 250,000 m^3 capacity LNG carriers, and thus represent an approximation since NorthernStar expects that LNG carriers ranging

in capacity from 100,000 m^3 to 200,000 m^3 would service its terminal. We note that the Coast Guard would restrict the size of the LNG carriers operating on the Columbia River to a maximum cargo size of 148,000 m^3 until additional risk analyses addressing larger vessels have been completed.

TABLE 4.3.2-4

LNG Carrier Intakes and Discharges while Berthed at the LNG Terminal Wharf

Type of Intake or Discharge	Volume of Intake (million gallons)	Volume of Discharge (million gallons)
Ballast Water		
145,000 m^3 LNG carrier (steam powered)	13.2	Not expected
250,000 m^3 LNG carrier (diesel powered)	25.6	Not expected
Cooling Water		
145,000 m^3 LNG carrier (steam powered)	57.2	57.2
250,000 m^3 LNG carrier (diesel powered)	18.6	18.6

As with other large cargo ships, LNG carriers would take on ballast water to maintain stability and trim as cargo is off-loaded. The amount of ballast water required varies according to vessel size, weather conditions, cargo load, water salinity, sea state, and the ship master's discretion. A typical 145,000 m^3 LNG carrier would require approximately 13.2 million gallons of ballast water, which also would support routine operational needs such as generation of freshwater and fire suppression systems. This is comparable to ballast requirements of the average large oil tanker operating on the lower Columbia River, which may take on between 8.3 and 13.8 million gallons of water for ballast while at port. In the future, larger diesel powered LNG carriers (250,000 m^3 capacity) would require nearly twice as much ballast water (25.6 million gallons) as the smaller steam powered LNG carriers. There are currently 218 LNG carriers operating world-wide, ranging in capacity from 1,100 m^3 to 154,000 m^3, and nearly all of them are steam powered. Approximately 15 percent of LNG carriers under construction will be diesel powered.

Ballast water obtained from the Columbia River is transported out of the river when the carrier departs. Based on the normal flow rate used by WEST in the Hydrodynamic and Sediment Transport Assessment (210,000 cfs), about 136 billion gallons of water per day would pass the LNG terminal. Thus, the amount of water removed by a typical LNG carrier for ballast would be less than 0.01 percent of the total volume of water present at any given time. The impact of removing this water volume from the lower Columbia River system would be minor. Furthermore, we do not expect the reduction in flow to significantly affect aquatic habitats, discussed further in section 4.5.2.1.

In addition to ballast water, LNG carriers would appropriate and discharge water for ship engine cooling while docked at the wharf. Based on the estimates provided in the final EIS for the Broadwater, LNG Project (FERC, 2008), a steam powered LNG carrier would intake and discharge a total of about 57.2 million gallons of water while berthed at the proposed LNG terminal (less than 24 hours). The next generation of LNG carriers (larger and diesel powered) are estimated to require approximately 18.6 million gallons of cooling water while berthed at the proposed LNG terminal, about one-third of the cooling water needed for steam powered carriers. Because none of these diesel powered LNG carriers have been constructed, all information regarding water use is an approximation.

LNG carriers would discharge cooling water throughout the transit route from the territorial seas to the proposed LNG terminal location. Although various types of LNG carriers could offload at the proposed site, the greatest cooling water discharge would be associated with steam powered carriers. Based on the estimates provided in the final EIS for the Broadwater LNG Project (FERC, 2008), the cooling water discharged from a 150,000 m^3 steam powered LNG carrier could initially be 19.4 °F higher than ambient water temperatures. Because the cooling water intake would be at ambient temperature,

which is seasonally dependent (ranging between 42 °F and 68 °F in Astoria, Oregon), the water discharge temperature would be expected to range between about 61 °F and 87 °F at the immediate discharge location. Impacts associated with cooling water discharge from the larger diesel powered LNG carriers would be expected to be comparable to or less than those described above for steam powered LNG carriers.

As described above (see *Oregon Water Quality, Section 303(d) List* and *Washington Water Quality, Section 303(d) List*), the Columbia River is currently listed as impaired for water temperature. LNG carriers that have not been retrofitted to use the screened water intake system could temporarily exacerbate elevated water temperatures in the immediate vicinity of the wharf. NorthernStar has indicated that it would develop a performance standard for the temperature of all cooling water discharges at the wharf, which would have a monitoring component. The impacts of LNG carrier water discharges at the terminal would be mitigated to a less than significant level after detailed modeling and the establishment of appropriate performance standards and a detailed set of operating procedures that would reasonably assure that the standards could be met.

The cooling water for the LNG carriers may be injected with a low dose of biocide (expected to be sodium hypochlorite for LNG carriers). This is standard practice in the shipping industry to prevent the growth of marine organisms. This residual chlorine concentration is not expected to significantly affect water quality, due to the low concentration of sodium hypochlorite that may be present in the discharge. Mixing upon discharge would occur rapidly due to the volume of water in Columbia River and mixing by the tides and currents.

LNG carrier operations and any resulting impacts on water quality would be comparable to typical shipping traffic, and would need to comply with international and U.S. shipping regulations. Impacts on water quality from current and future LNG carriers would be minor, but a recurring and incremental impact on the water resources of the lower Columbia River. The potential impacts on aquatic resources as a result of LNG carrier water intakes and discharges are discussed further in section 4.5.2.1. To ensure development of performance standards that minimize impacts on water quality from LNG carrier water withdrawals and discharges at the wharf, **we recommend that:**

- **<u>Within 30 days</u> after the issuance of the final EIS, NorthernStar should develop the following performance standards for water discharges at the Bradwood Landing terminal wharf:**

  a. standards for water temperature impacts due to discharging cooling water from LNG carriers into the Columbia River that should include modeling to determine the temporal and spatial extent of impacts on water quality and salmonids; and

  b. standards for impacts from biocide use that should include specific forms and concentrations of biocide that would be used, the anticipated concentration of biocide at the discharge location, and modeling to determine the temporal and spatial extent of toxicity to aquatic resources.

Testing of the Fire Suppression System

About 13.7 million gallons of water would be withdrawn from the Columbia River every year to test the fire suppression system at the LNG terminal. Although the fire suppression system would only be used in emergencies, water would be required weekly for system testing. After completion of the weekly test, the test water would be returned directly to the Columbia River without any other use. The quality of the water discharged from the fire suppression system would be essentially the same as the quality of

water withdrawn from the river. Fire suppression water would be obtained from the Columbia River at a rate of 4,400 gpm for 1 hour each week using the permanent water intake and pump station on the dock as shown on figure 2.1.3-3. It would be returned to the Columbia River at rate up to 4,400 gpm via outlets on the fire suppression system piping on the north end of the dock approximately 300 feet from the shoreline. The return of fire suppression water to the Columbia River would have no adverse effects on water quality and would meet ambient water quality standards at the point of discharge. Because the discharge outlets would be located over 300 feet from the shoreline in an area with an approximate water depth of 42 feet, the potential for scour would be negligible and diffusers would not be necessary.

Condensate Water from the SCVs

Water is produced as a by-product in the LNG vaporization process proposed by NorthernStar. Under the proposed design, the SCVs would generate up to 160 gpm (0.23 mgd) of condensate water. Because this water condensate is typically acidic, it must be neutralized with alkaline chemicals before discharge. Table 4.3.2-5 shows the results of chemical analysis of neutralized condensate from two existing LNG terminals. Condensate from the proposed terminal would be expected to have similar characteristics. NorthernStar proposes to discharge the excess SCV water directly to the Columbia River under an NPDES permit following pH adjustment. Sampling and analysis of the SCV discharge would be carried out in accordance with the requirements of the NPDES permit issued by the ODEQ. The ODEQ began the NPDES permit process on October 18, 2007 when the COE published its Public Notice for Permit Application associated with the JPA and JARPA, which included the ODEQ's 401 Water Quality Certification Public Notice.

The SCV condensate water would be discharged using an outfall/diffuser system mounted about 15 feet below the water surface in water approximately 25 feet deep (MLLW), with its main alignment parallel to shore at a distance of about 150 feet from shore on the main pipe trestle. This location would take advantage of better water circulation in the mainstem of the Columbia River. The proposed diffuser would be 40 feet long, 31/32 inch in diameter, and would have nine ports. The outfall/diffuser system would be designed to rapidly mix the discharged condensate with river water.

The pH of the water bath in an SCV is typically maintained at 5.6 standard units and the temperature of the discharge water would be 68 °F. Before discharge, the pH of the SCV discharge water would be increased in a neutralization tank. An allowable discharge pH would be established during the NPDES permit review process. The average water temperature in the Columbia River measured in Astoria between December 2005 and 2006 was 54.4 °F, ranging between 42 °F and 68 °F, depending on the season (NOAA National Oceanographic Data Center, 2006). On average, the SCV discharge water would generally be warmer than the ambient water temperatures but would not exceed a maximum of 68 °F, which is the ODEQ's lower Columbia River water quality criterion for temperature (Coast & Harbor Engineering, Inc. (CHE), 2007). Furthermore, the Columbia River flows at a rate of more than 45,000,000 gpm more than 95 percent of the time. Given the volume of discharge (160 gpm) in relation to the volume of flow, we anticipate that water temperatures near the outfall would rapidly return to ambient conditions.

In its May 11, 2007 letter to the FERC, the NMFS questioned whether LNG could be used to cool the SCV condensate water to more closely approximate the temperature of the Columbia River water. In response, NorthernStar explained that such a heat exchange process, while theoretically possible, would not be economically feasible or practicable due to the extreme temperature difference between the LNG (at -260 °F) and the condensate (at 68 °F).

TABLE 4.3.2-5

Constituent Data for Vaporizer Condensate

Parameter	Sample Site 1 Concentration (mg/L unless specified)	Sample Site 2 Concentration (mg/L unless specified)
pH (liquid)	7.17 (Standard Units)	
Total Dissolved Solids	1,074	
Alkalinity	987 mg/L as $CaCO_3$	832 mg/L as $CaCO_3$
Chloride	5.7	
Fluoride	<0.5	
Nitrate-Nitrogen	3.8	
Nitrite	0.6	
Specific Conductance	1,700 µmhos/cm	1,494 µmhos/cm
Sulfate	<0.5	
TOC		22
Turbidity	0.3 NTU	
Aluminum	<0.02	
Arsenic	<0.005	
Barium	<0.01	Below reporting limit
Beryllium	<0.002	
Chromium	0.03	
Copper	<0.005	
Iron	<0.05	Below reporting limit
Magnesium	<0.005	0.02
Manganese	<0.05	
Nickel	<0.005	
Selenium	<0.005	
Silica		0.15
Silver	<0.002	
Strontium		Below reporting limit
Zinc	<0.05	

As part of the NPDES permit application process, CHE modeled the mixing zone created by the SCV discharge using the CORMIX computer model (Jirka el al., 1996). The results were provided in a technical memorandum titled *Mixing Zone Analysis for Bradwood Landing Point Source Discharges – NorthernStar Natural Gas*, which was submitted by NorthernStar in response to our recommendation in the draft EIS.[9] The goal of the analysis was to provide the approximate lateral extents of the acute and chronic mixing zones within which discharge concentrations and temperatures may be above the State of Oregon acute and chronic water quality criteria. The modeling was based on conservative assumptions (i.e., very low flow conditions with an ambient current velocity of 0.0 ft/s and maximum rather than average constituent concentrations).

Prior to mixing, the SCV condensate discharge would meet the acute and chronic water quality criteria for temperature and all modeled constituents except chromium VI, copper, and silver. Of these, the highest level of acute mixing would be required for chromium VI (16.9 times) and the highest level of chronic mixing would be required for silver (150 times). Therefore, these constituents determine the size of the acute and chronic mixing zones, which were calculated by the model to extend 2 feet and 100 feet

[9] NorthernStar filed its Mixing Zone Analysis for Bradwood Landing Point Source Discharges – NorthernStar Natural Gas with the FERC on October 15, 2007. This document is available for viewing by the public on the FERC's Internet web page at www.ferc.gov, through the eLibrary link, selecting "General Search," entering the docket number minus the last three digits (i.e., CP06-365), and putting in the proper date range.

from the discharge, respectively. In other words, for some constituents under the conservative conditions modeled, concentrations within 2 feet of the discharge would be above acute water quality standards and concentrations within 100 feet of the discharge would be above chronic water standards. Total chromium data from an existing LNG facility was used for the mixing zone analysis but was conservatively assumed to be chromium VI, although chromium VI was not specifically detected. Also it is important to note that the input data used for the silver was based on a laboratory detection limit, because no silver was actually detected in the SCV discharge.

Accidental Spills or Leaks of Hazardous Materials

Spills, leaks, or other releases of hazardous materials during operation of the proposed project could also adversely affect surface water quality. As discussed above, a 5-foot-high perimeter berm would surround the portion of the LNG terminal containing the LNG storage tanks and vaporization units. The berm would provide containment in the unlikely event of a tank rupture. Within the bermed area, any equipment that has the potential to leak oil and grease would be isolated from the rest of the site with curbing so any leakage can be contained and cleaned up. In the unlikely event that LNG is spilled into the water from the terminal, the cryogenic liquid would vaporize rapidly upon contact with the warm air and water. Being less dense than water, LNG would float on the surface before vaporizing. Because LNG is not soluble in water and would completely vaporize shortly after being spilled, the LNG could not mix with or contaminate the water.

4.3.2.4 Pipeline Facilities

Existing Surface Water Resources

The proposed pipeline route would impact 94 waterbodies in Oregon and Washington. Of these, 65 are located in Oregon and 28 are located in Washington; the remaining waterbody is the Columbia River, which is located in both states. These waterbodies and their proposed crossing methods are listed in table 4.3.2-6. In addition, levees are located adjacent to several waterbodies in Oregon.

Between MPs 0.0 and 19.4, the proposed pipeline would be located in the State of Oregon. Based on information from the ODEQ, there are currently no state waters listed as ORWs as defined under the anti-degradation statutes of the State of Oregon. Any waters that meet or exceed all the listed beneficial uses for that waterbody are considered High Quality Waters. Thus, any waterbodies along the Oregon portion of the pipeline route that are not listed as impaired waters are High Quality Waters. Also, waterbodies containing federally listed threatened and endangered species or their designated critical habitat can be qualified as sensitive surface waters (see section 4.6.2.3). Along the portion of the proposed pipeline route in Oregon, four waterbodies qualify as sensitive surface waters, including the Westport Slough (MP 5.2), Westport Slough/Midland Canal (MP 10.0), Clatskanie River (MP 13.2), and Columbia River (MP 19.0). NorthernStar would use the HDD construction method at each of these crossings to avoid impacts on waterbody banks and beds. These waterbodies, and the federally listed species occurring in them, are discussed in section 4.6.2.3.

TABLE 4.3.2-6

Waterbodies Impacted by the Bradwood Landing Project

Waterbody	MP	Type/Flow Conditions	Wetted Width (feet)	Soil Stability	Substrate [a]	NMFS/WDNR Classification [b]	Proposed Crossing Method
OREGON - Clatsop County							
Tributary 1 to Driscoll Slough	4.1	Perennial	<10 [c]	High	Silt loam	F	HDD
Driscoll Slough	4.2	Perennial	82 [c]	High	Silt loam	F	HDD
Tributary to Westport Slough	5.0	Intermittent	<10	High	Silt loam	F	HDD
Westport Slough	5.2	Perennial	328	High	Silt loam	F	HDD
- Columbia County							
Whiskey Joe Slough	6.1	Perennial	17	High	Silt loam, protected	N	Dam and Pump
Ludviksen Slough	6.9	Perennial	50	High	Silt loam, protected	N	Dam and Pump or Flume
Unnamed Ditch	7.0	Intermittent	24	High	Silt loam, protected	N	Dam and Pump or Flume
Ditch 1 to Ludviksen Slough	7.2	Intermittent	30	High	Silt loam, protected	N	Dam and Pump or Flume
Ditch 2 to Ludviksen Slough	7.4	Intermittent	17	High	Silt loam, protected	N	Dam and Pump
Ditch 3 to Ludviksen Slough	7.5	Intermittent	18	High	Silt loam, protected	N	Dam and Pump
Ditch 4 to Ludviksen Slough	7.8	Intermittent	19	High	Silt loam, protected	N	Dam and Pump
Ditch 1 to Randa Slough	8.1	Intermittent	17	High	Silt loam, protected	N	Dam and Pump
Ditch 2 to Randa Slough	8.4	Intermittent	11	High	Silt loam, protected	N	Dam and Pump
Ditch 1 to Kelli Slough	8.4	Intermittent	<10 [c]	High	Silt loam, protected	N	HDD or bore
Kelli Slough	8.5	Perennial	66 [c]	High	Silt loam, protected	N	HDD or bore
Ditch 1 to Tributary of Kelli Slough	8.6	Intermittent	<10	High	Silt loam, protected	N	HDD or bore
Ditch 2 to Tributary of Kelli Slough	8.7	Intermittent	12	High	Silt loam, protected	N	Dam and Pump
Ditch 3 to Tributary of Kelli Slough	8.8	Intermittent	10	High	Silt loam, protected	N	Dam and Pump
Tributary 1 to Kelli Slough	8.8	Perennial	28	High	Silt loam, protected	N	Dam and Pump or Bore
Ditch 1 to Tributary of Westport Slough	8.9	Intermittent	15	High	Silt loam, protected	N	Dam and Pump
Ditch 2 to Tributary of Westport Slough	9.0	Intermittent	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 3 to Tributary of Westport Slough	9.1	Perennial	<10	High	Silt loam, protected	N	Dam and Pump
Tributary to Tributary of Westport Slough	9.2	Intermittent	15	High	Silt loam, protected	N	Dam and Pump
Ditch 4 to Tributary of Westport Slough	9.3	Perennial	15	High	Silt loam, protected	N	Dam and Pump
Ditch 6 to Tributary of Westport Slough	9.4	Intermittent	<10 [c]	High	Silt loam, protected	N	Dam and Pump
Ditch 5 to Tributary of Westport Slough	9.5	Perennial	20	High	Silt loam, protected	N	Dam and Pump
Ditch 7 to Tributary of Westport Slough	9.8	Intermittent	<10 [c]	High	Silt loam, protected	N	Dam and Pump
Westport Slough/ Midland Canal	10.0	Perennial	164 [c]	High	Silt loam, protected	F	HDD

TABLE 4.3.2-6 (cont'd)

Waterbodies Impacted by the Bradwood Landing Project

Waterbody	MP	Type/Flow Conditions	Wetted Width (feet)	Soil Stability	Substrate [a]	NMFS/WDNR Classification [b]	Proposed Crossing Method
Ditch 1 to Uncle Tom Slough	10.3	Intermittent	<10	High	Silt loam, protected	N	Dam and Pump
Uncle Tom Slough 1	10.6	Perennial	54	High	Silt loam, protected	N	Bore
Uncle Tom Slough 2	11.2	Perennial	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 4 to Uncle Tom Slough	11.3	Perennial	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 5 to Uncle Tom Slough	11.4	Perennial	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 6 to Uncle Tom Slough	11.5	Perennial	15	High	Silt loam, protected	N	Dam and Pump
Ditch 7 to Uncle Tom Slough	11.6	Perennial	10	High	Silt loam, protected	N	Dam and Pump
Ditch 8 to Uncle Tom Slough	11.7	Perennial	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 9 to Uncle Tom Slough	11.8	Perennial	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 10 to Uncle Tom Slough	11.8	Perennial	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 11 to Uncle Tom Slough	11.9	Intermittent	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 12 to Uncle Tom Slough	11.9	Intermittent	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 13 to Uncle Tom Slough	12.0	Intermittent	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 14 to Uncle Tom Slough	12.2	Intermittent	<10 [c]	High	Silt loam, protected	N	Dam and Pump
Ditch 15 to Uncle Tom Slough	12.3	Intermittent	10	High	Silt loam, protected	N	Dam and Pump
Ditch 16 to Uncle Tom Slough	12.4	Intermittent	11	High	Silt loam, protected	N	Dam and Pump
Ditch 17 to Uncle Tom Slough	12.6	Perennial	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 19 to Uncle Tom Slough	12.7	Intermittent	<10 [c]	High	Silt loam, protected	N	Dam and Pump
Clatskanie River	13.2	Perennial	487	High	Silt loam, protected	F	HDD
Ditch 1 to Beaver Slough	13.4	Intermittent	<10 [c]	High	Silt loam, protected	N	Dam and Pump
Ditch 2 to Beaver Slough	13.7	Intermittent	<10 [c]	High	Silt loam, protected	N	N/A [d]
Ditch 3 to Beaver Slough	13.9	Intermittent	<10 [c]	High	Silt loam, protected	N	Dam and Pump
Ditch 1 to Larson Slough	14.2	Perennial	<10 [c]	High	Silt loam, protected	N	N/A [d]
Larson Slough	15.0	Perennial	22	High	Silt loam, protected	F	Dam and Pump
Ditch 1 to McLean Slough	15.8	Intermittent	<10	High	Silt loam, protected	N	Dam and Pump
Ditch 2 to McLean Slough	16.2	Intermittent	10	High	Silt loam, protected	N	Dam and Pump
Ditch 3 to McLean Slough	16.4	Intermittent	11	High	Silt loam, protected	N	Dam and Pump
McLean Slough 1	16.9	Intermittent	12	High	Silt loam, protected	F	Dam and Pump
Ditch 4 to McLean Slough	16.9	Intermittent	10	High	Silt loam, protected	N	Dam and Pump
Ditch 5 to McLean Slough	17.0	Intermittent	13	High	Silt loam, protected	N	Dam and Pump
Ditch 7 to McLean Slough	17.2	Intermittent	14	High	Silt loam, protected	N	Dam and Pump
Ditch 9 to McLean Slough	17.4	Intermittent	<10	High	Silt loam, protected	N	Dam and Pump

TABLE 4.3.2-6 (cont'd)

Waterbodies Impacted by the Bradwood Landing Project

Waterbody	MP	Type/Flow Conditions	Wetted Width (feet)	Soil Stability	Substrate [a]	NMFS/WDNR Classification [b]	Proposed Crossing Method
McLean Slough 2	17.7	Intermittent	<10 [c]	Low	Silt loam, protected	F	N/A [d]
Ditch 10 to McLean Slough	18.2	Intermittent	<10 [c]	High	Silt loam, protected	N	Dam and Pump
Ditch 11 to McLean Slough	18.3	Intermittent	<10 [c]	High	Silt loam, protected	N	N/A [d]
Columbia River	19.0	Perennial	1,700	High	Sandy soils	F	HDD
WASHINGTON - Cowlitz County							
Columbia River	19.6	Perennial	1,300	Low	Gravelly sandy loam	S	HDD
Tributary 1 to Abernathy Creek	20.2	Perennial	21	High	Gravelly silt loam	N	Dam and Pump or Flume
Tributary to Cameron Creek	20.5	Perennial	17	High	Gravelly silt loam	N	HDD
Cameron Creek	20.6	Perennial	29	High	Gravelly silt loam	S	HDD
Abernathy Creek	21.1	Perennial	35	High	Silt loam	S	HDD
Tributary 2 to Abernathy Creek	21.4	Perennial	14	Low	Silt loam	N	Dam and Pump
Germany Creek	22.4	Perennial	19	Low	Silt loam	S	HDD
Fall Creek	23.2	Perennial	38	High	Silt loam	F	Dam and Pump or Flume
Tributary to Harmony Creek	24.5	Perennial	<10 [c]	High	Silt loam	N	Dam and Pump or Flume
Harmony Creek	24.7	Perennial	17	Moderate	Silt loam	F	Bore
Brock Creek	26.0	Perennial	28	Moderate	Silt loam	F	Dam and Pump or Flume
Tributary 3 to Brock Creek	26.6	Intermittent	<10[c]	Low	Cobble, sand, silt	N	Dam and Pump
Tributary 2 to Brock Creek	26.7	Intermittent	3	Low	Sand, silt	N	Dam and Pump
Tributary 5 to Coal Creek	27.5	Perennial	10	High	Silt loam	N [e]	Bore
Tributary 1 to Coal Creek	27.7	Intermittent	<10 [c]	Low	Silt loam	F	N/A [d]
Coal Creek	28.0	Perennial	34	High	Silt loam	S	HDD
Tributary 1 to Clark Creek	30.3	Intermittent	<10 [c]	Low	Silt loam	F	Dam and Pump
Clark Creek	30.4	Perennial	22	Moderate	Silt loam	F	Dam and Pump or Flume
Tributary 2 to Clark Creek	30.7	Intermittent	15	High	Silt loam	U	Dam and Pump
Tributary 7 to Leckler Creek	31.5	Intermittent	<10 [c]	High	Silt loam	N	Dam and Pump
Tributary 6 to Leckler Creek	31.7	Intermittent	<10[c]	High	Silt loam	N	Dam and Pump
Tributary 2 to Leckler Creek	32.4	Intermittent	<10 [c]	High	Silt loam	N	Dam and Pump

TABLE 4.3.2-6 (cont'd)

Waterbodies Impacted by the Bradwood Landing Project

Waterbody	MP	Type/Flow Conditions	Wetted Width (feet)	Soil Stability	Substrate [a]	NMFS/WDNR Classification [b]	Proposed Crossing Method
Tributary 3 to Leckler Creek	33.1	Intermittent	<10 [c]	Moderate	Silt loam	N	Dam and Pump
Tributary 4 to Leckler Creek	33.4	Intermittent	<10[c]	Low	Silt loam	N	Dam and Pump
Tributary 5 to Leckler Creek	33.7	Intermittent	<10 [c]	Low	Silt loam	N	Dam and Pump
Cowlitz River	34.3	Perennial	429	High	Sand, silt	S	HDD
Tributary 1 to Ostrander Creek	35.0	Intermittent	10	Low	Loamy sand	N	HDD
Tributary 2 to Ostrander Creek	35.2	Intermittent	<10 [c]	High	Silt loam	N	HDD
Ostrander Creek	36.2	Perennial	28	High	Silt loam	S	Bore

[a] Protected substrates describe areas that have been protected from flooding, often referring to agricultural areas.

[b] NMFS, Northwest Fisheries Science Center, 2005

- F Fishbearing.
- N Nonfish-bearing streams, may be perennial or intermittent.

WDNR, 2006

- S Shoreline, fish-bearing streams.
- F Waters that have a high fish, wildlife, or human use, and are not classified as Type S.
- N Nonfish-bearing streams, may be perennial or intermittent.
- U Undetermined.

[c] Approximate width.

[d] Not crossed by proposed centerline. No crossing method proposed.

[e] Tributary 5 to Coal Creek is designated as a nonfish-bearing stream by the WDNR; however, this waterbody is known to contain coho salmon.

Between MPs 19.4 and 36.3, the proposed pipeline would be located in Cowlitz County, Washington. No ORWs are currently listed in Cowlitz County. Waterbodies that contain threatened and endangered species or their designated critical habitat can also be qualified as sensitive surface waters. Nine sensitive surface waters occur along the portion of the proposed route in Washington, including: Columbia River (MP 19.6), Cameron Creek (MP 20.6), Abernathy Creek (MP 21.1), Germany Creek (MP 22.4), Tributary 5 to Coal Creek (MP 27.5), Coal Creek (MP 28.0), Cowlitz River (MP 34.3), Tributary 1 to Ostrander Creek (MP 35.0), and Ostrander Creek (MP 36.2). As is the case in sensitive waterbodies in Oregon, NorthernStar would use the HDD or bore method to cross each of these sensitive surface waters. These waterbodies and the federally listed species known to occur in them are further discussed in section 4.6.2.3.

Source Water Assessment reports and maps from the ODEQ show that there are five drinking water protection areas (DWPA) in the general vicinity of the Oregon portion of the pipeline route. The Westport Water Association, the City of Clatskanie, and the Midland Water Association DWPAs are all upstream from the pipeline route and would not be affected by the project construction or operation. However, the proposed pipeline route would cross the Wauna Mill and PGE Beaver Power Plant DWPAs.

Wauna Mill has a water intake on the Columbia River. This water supply serves the mill and about 750 citizens with public water. The intake on the Columbia River is within 3 miles of the proposed pipeline route but more than 10 miles downstream of the proposed crossing of the Columbia River. The DWPA for this water intake stretches along the Columbia River east from Wauna to Port Westward. The pipeline route would also cross Driscoll and Westport Sloughs, whose confluences with the Columbia River are each less than 3 miles upstream from the Wauna Mill intake. Because NorthernStar plans to cross these waterbodies using the HDD method, construction of the proposed pipeline would not be expected to affect this DWPA.

The Beaver Power Plant also has a water intake on the Columbia River. The proposed pipeline route would cross the Columbia River just downstream of the intake structure, but the proposed right-of-way would pass through a small portion of the Beaver Power Plant DWPA along the Columbia River. The construction and operation of the pipeline should not affect the DWPA.

Impacts and Mitigation

Activities associated with the proposed pipeline route that could affect surface water resources include waterbody crossings, water appropriation and discharge associated with hydrostatic testing, stormwater runoff, accidental spills or leaks of hazardous materials, and operation and maintenance of the pipeline. These activities and their potential impacts on surface waters are discussed below.

Waterbody and Levee Crossings

To minimize impacts on surface waters, NorthernStar would adhere to the protective measures specified in its *Waterbody and Wetland Construction and Mitigation Procedures Plan*, pipeline ESC Plan for construction in Oregon and SWPPP for construction in Washington, and our Procedures. The method used for installing the pipeline across waterbodies is determined, at least in part, by the size of the waterbody (i.e., minor, intermediate, or major) and on the condition of each waterbody at the time of crossing. Minor waterbodies include all waterbodies with a width less than or equal to 10 feet at the water's edge at the time of crossing, intermediate waterbodies include all waterbodies with a width greater than 10 feet but less than or equal to 100 feet at the water's edge at the time of crossing, and major waterbodies include all waterbodies with a width greater than 100 feet at the water's edge at the time of crossing.

Several waterbody crossings would also include levees that are located adjacent to the waterbody. Levees are owned and managed by local levee districts that are recognized by the state. If construction activities occur within the levee district's easement, the district will review the construction plans and send them to the COE for a structural integrity review. The COE has technical guidance in place regarding the construction of pipelines under levees that would be taken into account in its structural integrity permit. NorthernStar would complete construction of its pipeline across levees in accordance with the local levee district's construction easement and the COE's technical guidance.

All waterbody crossings that involve open trenching would occur during established in-water work windows. HDD or conventional bores may be performed outside of the in-water work times as they do not involve construction below the OHWM or MHHW.

In general, NorthernStar intends to segregate and store topsoil separately during pipeline construction, except in saturated wetlands. However, topsoil segregation takes up more construction right-of-way and, near a waterbody, it may require clearing more riparian vegetation or driving back and forth in a riparian area. To avoid these additional adverse impacts, NorthernStar may not segregate topsoil within 50 feet of waterbody crossings, depending on the vegetation and land use present.

NorthernStar proposes to install the pipeline across up to 18 waterbodies using the HDD method (see table 4.3.2-3). As shown on figure 2.4.2-4, the HDD method eliminates the need to excavate a trench through the stream or river channel, and would minimize or eliminate the impacts associated with sedimentation and turbidity from the standard wet open-cut methods of pipeline construction. NorthernStar has agreed to follow our Procedures, which require submittal of a plan prior to construction containing site-specific construction diagrams showing the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction. In addition, the Procedures require a contingency plan for an alternative crossing method at each HDD location in the event that the HDD method is unsuccessful. Such alternative methods may require permits and approvals, which would be needed in advance to avoid significant construction delays. NorthernStar has indicated in its *HDD Contingency Plan* that it would have approved alternative crossing methods for implementation in the event of HDD borehole failure.[10]

A loss of drilling mud to the waterbody during the HDD procedure (referred to as a "frac-out") would introduce sediment into the waterbody. Frac-outs occur when the path of least resistance for the drilling mud is to the surface, rather than back along the borehole to the entry or exit pits. This may happen if a fault or fracture zone is encountered, or if the driller fails to keep the borehole clear of cuttings. Drilling mud, which is composed of approximately 5 percent bentonite clay and 95 percent water, may frac-out to the ground surface or into the waterbody being crossed. The highest potential for a frac-out typically occurs at the beginning or the end of the HDD where the separation between the borehole and ground surface is the least. NorthernStar's *HDD Contingency Plan* provides procedures and measures to be taken during an inadvertent release of drilling mud. NorthernStar would station the necessary equipment and supplies to respond to a release of drilling mud upon discovery of loss of drilling fluid. At the time of a release of drilling mud, NorthernStar would stop drilling immediately, contain drilling fluids, and notify appropriate agencies. Appropriate resource experts, such as fisheries biologists and wetland scientists would be on site to monitor resources and effects of the release.

In its December 19, 2007 letter providing comments on the draft EIS, the EPA recommended that the *HDD Contingency Plan* include mitigation measures for frac-outs to water, marsh, and uplands.

[10] NorthernStar included its revised *HDD Contingency Plan* (Frac-out Plan) as Attachment B of its *Waterbody and Wetland Construction and Mitigation Procedures Plan*. NorthernStar filed this plan with the FERC on December 21, 2007. This document is available for viewing by the public on the FERC's Internet web page at www.ferc.gov, through the eLibrary link, selecting "General Search," entering the docket number minus the last three digits (i.e., CP06-365), and putting in the proper date range.

Although NorthernStar's *HDD Contingency Plan* provides mitigation measures for frac-outs to waterbodies and wetlands, mitigation measures for frac-outs to uplands are not addressed. To assure that adequate protection is provided to uplands in the event of a frac-out, **we recommend that:**

- **NorthernStar should revise its *HDD Contingency Plan* to include mitigation measures for frac-outs to uplands. <u>Prior to pipeline construction</u>, the revised *HDD Contingency Plan* should be filed with the Secretary for the review and written approval of the Director of OEP.**

Geotechnical investigations were conducted at 13 proposed HDD waterbody crossing locations (URS, 2006b). The results indicated that the assessed HDD alignments were generally feasible from a geologic standpoint and presented little risk of frac-out. URS recommended additional investigation after project approval to refine the subsurface conditions beneath difficult geometries and/or sensitive watersheds prior to final HDD design. Also see our recommendation in section 4.1.4.3 regarding additional site-specific geotechnical studies that would be required.

NorthernStar is also proposing to use the conventional bore method for up to eight waterbody crossings (see table 4.3.2-3). The bore method is similar to the HDD method in that the pipeline is installed beneath a waterbody without disturbing the bed and bank of the waterbody. Boring requires the excavation of pits on each side of the feature. Potential impacts on water quality resulting from boring operations would be due to the relatively large work areas and continuous pumping in order to manage groundwater during pipeline installation. NorthernStar would implement the FERC staff's Procedures in order to minimize impacts on water quality. In addition, trench boxes or sheet piling may be used to support the pit walls and to help cut off groundwater inflows. Dewatering systems using deep wells or well points are frequently employed. The specific type of bore (e.g., jack and bore, slick bore, hammer bore) that would be utilized in a given area depends on the construction site characteristics, the type of soils present, and the contractor's familiarity with available methods.

In addition to using the HDD or bore methods for crossing waterbodies, NorthernStar also would use an open-cut technique for waterbody crossings. Clearing and grading of streambanks, in-stream trenching, backfilling, and trench dewatering could affect surface water quality through increased sedimentation, increased turbidity, decreased dissolved oxygen concentrations, and stream warming. Open-cut crossings would use a standard dry-trench method including either the dam and pump or flume method. As described in section 2.4.2.2, the dam and pump method is a dry-crossing technique that uses pumps to isolate water from the construction work area, thereby avoiding in-stream activities (see figure 2.4.2-3). The flume method is similar to the dam and pump method except that dams and flumes are used instead of pumps to move water across the construction work area (see figure 2.4.2-2). Use of these waterbody crossing methods in flowing streams would reduce exposure of waterbodies to erosion and sedimentation, and thus reduce the overall impact on the waterbody.

The impacts of the open-cut construction method on the minor intermittent and perennial streams along the pipeline routes would generally be localized and short term. Clearing, grading, and trenching within and adjacent to these streams would have the greatest effect on water quality. Clearing of trees, vegetation, and large woody debris (LWD) in and around streams could lead to an increase in water temperature. Sediments would be resuspended by in-stream construction activities or by erosion of cleared stream banks and riparian areas. Turbidity resulting from the resuspended sediments could reduce light penetration and the corresponding photosynthetic oxygen production. Resuspension of deposited organic material and inorganic sediments could cause an increase in consumption of biological and chemical oxygen, decreasing available dissolved oxygen. To minimize impacts on surface waters, NorthernStar would implement its *Waterbody and Wetland Construction and Mitigation Procedures Plan*, pipeline ESC Plan for Oregon and SWPPP for Washington, and our Procedures. The stream bed

substrate would be conserved at each crossing and restored. If additional material is needed, matching material would be used. Most in-stream work within minor waterbodies would be completed within 24 hours, and stabilization and restoration of the stream banks would begin within 24 hours of construction, or before returning flow to the waterbody for dry crossings. However, due to the importance of numerous waterbodies along the proposed route for federally listed species, **we recommend that:**

- **NorthernStar should continue to consult with the COE, NMFS, FWS, and other appropriate federal and state agencies to finalize its *Waterbody and Wetland Construction and Mitigation Procedures Plan*. The final plan should include the following:**

  a. a description of the specific methods of in-water habitat mitigation to be conducted;

  b. measures to prevent the spread of invasive species due to construction activities within waterbodies and wetlands; and

  c. procedures for monitoring the success of the revegetation and weed control efforts.

  The plan, including agency comments on the plan, should be filed with the Secretary for review and written approval by the Director of OEP <u>prior to pipeline construction</u>.

With the implementation of the proposed measures, impacts on water quality would be temporary and would be expected to return to preconstruction levels soon after the stream crossing is completed.

The seven waterbodies impacted in Cowlitz County designated as shorelines of the state would be crossed using either the HDD or bore method. As previously discussed, utilities including gas pipelines are permitted within the Conservancy, Urban, and Rural Districts (Cowlitz County, 1977); however, typically the county places the following restrictions on utilities in these districts:

- All utility systems shall be underground unless such undergrounding would not be feasible;
- Where utility systems occupy shoreline areas, clearing necessary for installation or maintenance shall be kept to the minimum width necessary to prevent interference by trees and other vegetation with the proposed transmission facilities; and
- Upon completion of installation of such utility systems or of any maintenance project that disrupts the environment, the disturbed area shall be regraded to compatibility with the natural terrain and replanted to prevent erosion and provide an attractive, harmonious vegetation cover.

NorthernStar's proposed pipeline facilities within shoreline areas in Cowlitz County would be located underground. At some waterbodies, use of the HDD or bore method (with bore pads set back from the OHWM and associated wetlands by at least 200 feet) would minimize vegetation clearing (see section 4.4.2.3). To reduce impacts on vegetation within the construction and permanent rights-of-way and improve revegetation potential for open-cut waterbody crossings, NorthernStar would implement its SWPPP and *Waterbody and Wetland Construction and Mitigation Procedures Plan* in Washington. Following construction, all work areas would be restored, seeded with conservation grasses (a mixture of grasses, legumes, and forbs), native plant species, or other standard erosion control/cover species, where

required, and allowed to naturally revegetate to preconstruction conditions. Additional information on operation and maintenance of the pipeline is provided below. For these reasons, it appears that the proposed pipeline segment through Cowlitz County would be consistent with the substantial development and conditional use provisions of the SMP.

Water Appropriation and Discharge Associated with Hydrostatic Testing

Following backfilling of the trench, the pipeline would be hydrostatically tested to ensure it is capable of safely operating at the design pressures. As indicated in table 4.3.1-1, approximately 9 million gallons of water would be required for hydrostatic testing of the proposed pipeline. In order to account for any water losses and make-up water, NorthernStar obtained a Limited Use License from the ODWR for approximately 9.5 million gallons of water. The water would be supplied via temporary piping connections or transported by tanker truck. Water temperature in the Columbia River would not be impacted from this diversion of water.

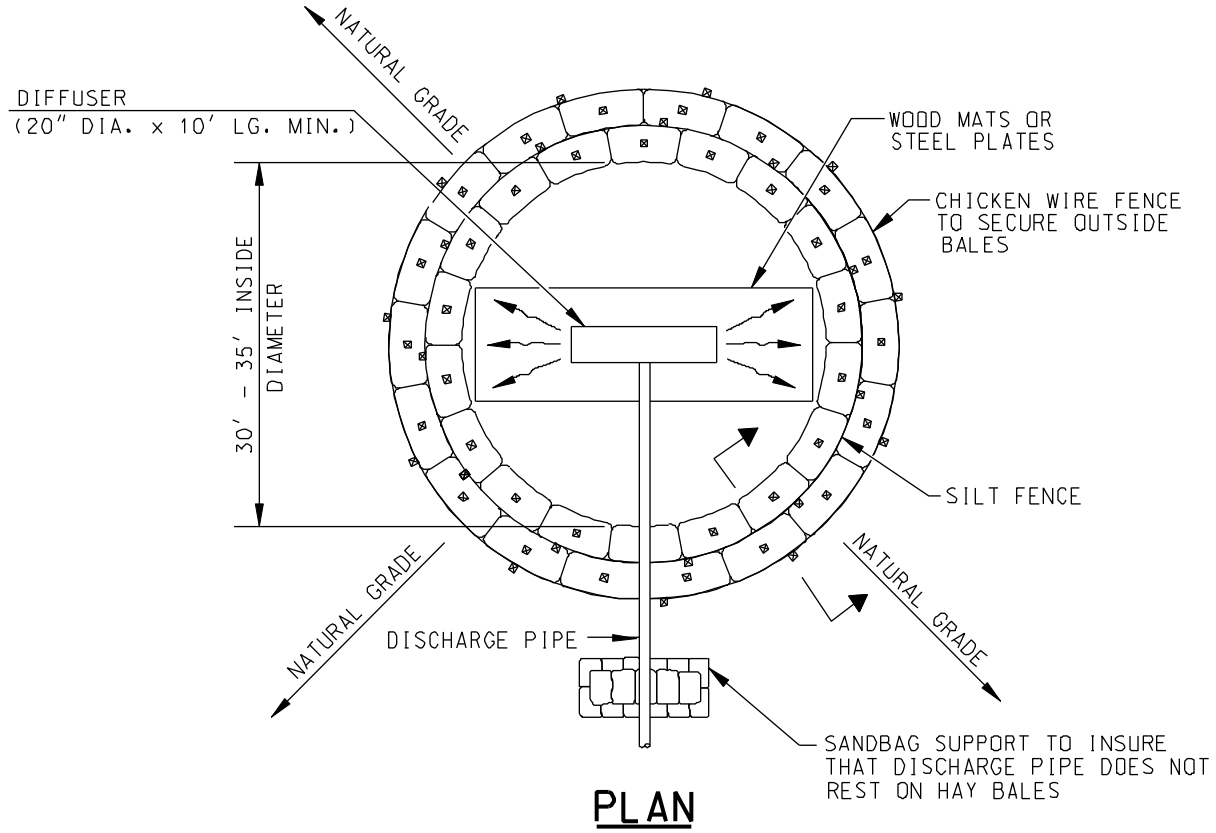
Water for project use would be acquired from the Columbia River at the location where the pipeline construction right-of-way meets the river on the Oregon side of the project. The method of diversion would be a single diesel-fired pump via an 8-inch-diameter intake hose equipped with a fish screen that complies with the NMFS screen design requirements. The maximum rate at which water would be diverted from the Columbia River for hydrostatic testing of the pipeline is 2,000 gpm.

NorthernStar anticipates that the completed pipeline would be tested in multiple segments, reusing the test water, including separate tests for each HDD pull section before and after being pulled into the borehole. Following each HDD hydrostatic test, the water would be collected and reused as water for the drilling mud or subsequent HDD hydrostatic test sites. Make-up water would be trucked from the Columbia River. At the completion of the last HDD testing cycle, which would probably be the Columbia River HDD, the final test water would be discharged to the ground at an upland site. Discharge rates may be up to 1,000 gpm and would be through a straw bale enclosure designed to reduce the discharge velocity in order to prevent erosion, and to filter the water to reduce turbidity. The discharge would have no direct overland contact with any waterbody. The water would be discharged at an upland location near the point of diversion to ensure a cross-watershed disposal would not occur. A general design for the straw bale enclosure is shown on figure 4.3.2-1. This design would be modified as appropriate to fit conditions specific to the discharge site.

Testing would not be required for the pipeline hydrostatic test water discharge as no contaminants (e.g., oil, grease, solvents,) are used in the construction procedures for the pipeline. The only addition to the water would be dirt and some scale from the pipe, which would be filtered out of the discharged water by the straw bale enclosure.

Stormwater Runoff

Stormwater runoff during construction of the proposed pipeline could affect surface water quality in the vicinity of the project. To minimize these potential effects, NorthernStar has developed a *Waterbody and Wetland Construction and Mitigation Procedures Plan*, a pipeline ESC Plan for Oregon, and SWPPP for Washington.



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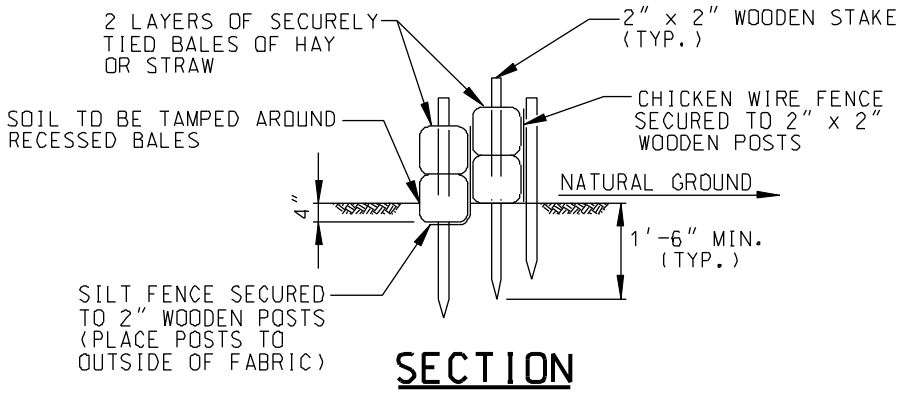


SECTION

NOTE:
STAKES SECURING SILT FENCE BETWEEN
HAY BALES ARE NOT SHOWN FOR CLARITY

NOTES:

1. STRUCTURE SHALL BE PLACED ON A LEVEL WELL VEGETATED SITE SUCH THAT WATER WILL FLOW AWAY FROM STRUCTURE AND ANY WORK AREAS.
2. FLOW RATES THROUGH DISCHARGE AND DIFFUSER PIPE SHALL BE SUCH THAT STRUCTURE WILL NOT OVERFLOW.
3. A 30' x 30' RECTANGULAR STRUCTURE MAY BE SUBSTITUTED FOR THE CIRCULAR CONFIGURATION SHOWN.
4. DIMENSIONS SHOWN ARE THE MINIMUM ACCEPTABLE AND MAY BE VARIED DEPENDING UPON SPECIFIC LOCATION.

Figure 4.3.2-1

Bradwood Landing Project

Straw Bale Enclosure General Design

Accidental Spills or Leaks of Hazardous Materials

Surface water quality could also be adversely affected by a spill, leak, or other releases of hazardous materials during construction activities. NorthernStar would minimize potential impacts associated with spills or leaks of hazardous materials during construction by implementing spill avoidance and response procedures included in its pipeline ESC Plan, SWPPP, and *Waterbody and Wetland Construction and Mitigation Procedures Plan*.

Operation and Maintenance of the Pipeline

The proposed pipeline would be operated and continuously monitored by a remote control center to be located at the LNG terminal. Operational activities with the potential to impact water quality would be limited to maintenance of the permanent right-of-way and repair of the pipeline. To minimize impacts on water quality and riparian vegetation, NorthernStar would allow a riparian buffer at least 25 feet wide, as measured from the waterbody's MHW mark, to permanently revegetate with native plant species across the entire right-of-way after construction is completed. However, trees greater than 15 feet tall, or deep-rooted shrubs that could damage the pipeline's protective coating, obscure periodic surveillance, or interfere with potential repairs, would not be allowed to grow within 15 feet of the pipeline. The frequency of the vegetation maintenance would depend upon the vegetation growth rate. This ongoing maintenance may have a discountable effect on stream temperature where large trees are not allowed to establish, and may reduce localized cover.

Periodic inspections by pipeline personnel may identify soil erosion that may expose the pipe, stressed vegetation that may indicate a leak in the line, or other conditions that require preventive maintenance or repairs. Impacts on water quality due to pipeline maintenance would be similar to those described above for waterbody crossings and would be subject to additional state and federal permitting.

4.4 WETLANDS AND TERRESTRIAL VEGETATION

4.4.1 Wetlands

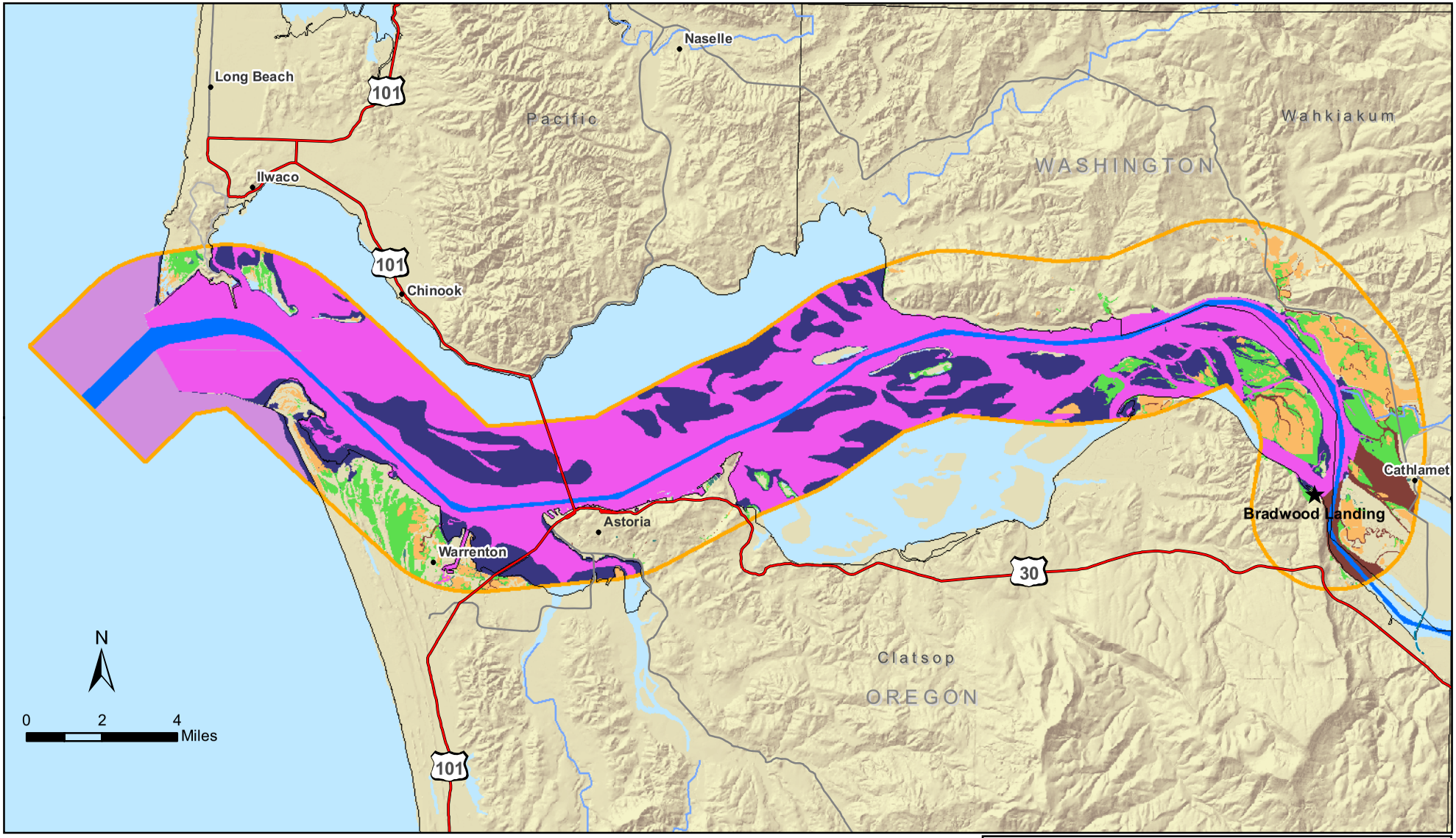
Wetlands are defined by the COE and the EPA as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of wetland vegetation typically adapted for life in saturated soil conditions (Environmental Laboratory, 1987). Wetlands can be a source of substantial biodiversity and serve a variety of functions that include providing wildlife habitat, recreational opportunities, and flood control, as well as naturally improving water quality.

Wetlands in the project area are regulated at the federal, state, and local levels. On the federal level, the COE has authority under section 404 of the CWA to review and issue permits for activities that would result in the discharge of dredged or fill material into waters of the United States, including wetlands. Wetlands are also regulated at the state level by the ODSL and WDE, and at the local level by counties and some cities. For example, wetlands are considered critical areas and included in the Critical Areas Ordinance of Cowlitz County. Section 404 of the CWA requires that proposed dredge and fill activities be issued section 401 Water Quality Certification by the designated state agency, in this case the ODSL or WDE. The WDE also has authority to regulate wetlands under two state laws, the State Water Pollution Control Act and the Shoreline Management Act. The ODSL has authority to regulate wetlands under the Oregon Removal-Fill Law.

Wetlands within the project area were classified according to the Cowardin et al. (1979) system which classifies wetlands based on specific shared characteristics. Cowardin defines five systems: 1) the marine system includes open ocean and its associated high energy coastline; 2) the estuarine system includes semi-enclosed salt and brackish marshes, non-vegetated tidal shores, and brackish waters of coastal rivers and embayments; 3) the riverine system includes freshwater rivers and streams with flowing water; 4) the lacustrine system includes large open water fresh lakes and ponds; and 5) the palustrine system includes freshwater marshes, bogs, swamps, and shallow ponds. In the Cowardin system, wetlands are further defined by cover type. Emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes. Emergent wetlands are often associated with waterbodies, such as lakes or rivers, and are characterized by intermittent and seasonal inundation. Scrub-shrub wetlands are dominated by woody vegetation, including shrubs and small trees generally less than 20 feet tall. Forested wetlands are dominated by woody vegetation that is at least 20 feet tall. Unconsolidated shores and bottoms are characterized by areas with less than 30 percent vegetative cover and at least 25 percent cover of particles smaller than stones.

4.4.1.1 Waterway for LNG Marine Traffic

Wetlands located along the waterway to the LNG terminal are shown on the maps included in Appendix C and wetlands within the Zones of Concern are shown on figure 4.4.1-1. Major aquatic habitat types in the upper estuary section of the Columbia River include estuarine tidal scrub-shrub and emergent wetlands, shallow water/flats, medium depth water, and deep water (LCFRB, 2004). Tidal scrub-shrub and emergent wetlands in this portion of the river typically occur between MHW and the line of non-aquatic vegetation. Tidal scrub-shrub consists of dense forest and shrub thickets, while emergent wetlands are most often found on floodplain margins and in backwater sloughs. Shallow water/flats are defined as being between elevations slightly above the MLLW to 6 feet below MLLW (LCFRB, 2004). Shallow water/flats often contain emergent vegetation where water levels are shallow and submerged aquatic vegetation such as Canadian waterweed (*Elodea canadensis*) in areas of deeper water. Medium depth water is between 6 and 18 feet below MLLW, while deep water is defined as 18 feet and deeper. Emergent vegetation is absent in medium and deep open water areas, with the river bottom providing rocky, sandy, or occasionally submerged aquatic vegetative habitats.



Combined Zones of Concern
Estuarine and Marine Deepwater
Estuarine and Marine Wetland
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake/Open Water/River
Other
Riverine
Navigation Channel

Data Source:
Wetlands: U.S. Fish & Wildlife Service, National Wetlands
InventoryDate: Ranges from Oct. 1981 to present;

Figure 4.4.1-1
Bradwood Landing Project
Wetland Areas in Zones of Concern

Estuarine scrub-shrub, estuarine emergent, palustrine scrub-shrub, and palustrine emergent wetlands are present along the waterway. Estuarine scrub-shrub wetlands are characterized by wetland-associated shrubs, including red-osier dogwood (C*ornus stolonifera)*, Sitka willow (*Salix sitchensis)*, and rose spiraea (*Spiraea douglasii)*. Estuarine emergent wetlands are characterized by mudflats and shallow water areas that support emergent vegetation. Dominant vegetation includes Canadian waterweed and non-natives reed canary-grass *(Phalaris arundinacea)* and Himalayan blackberry (*Rubus discolor)*. Palustrine scrub-shrub wetlands are primarily comprised of red-osier dogwood and Sitka willow. Palustrine emergent wetlands are of relatively low quality, with dominant vegetation consisting of reed canary-grass and other nonnative weedy species.

The wetlands located nearer to the navigation channel have some potential to be affected by vessel transit, although not measurably above baseline conditions due to the altered nature of much of the shoreline. That is, the depth of the navigation channel prevents wetland formation immediately adjacent to it and much of the steeper shoreline areas are armored, diked, or otherwise hardened. Furthermore, because of the sheer size of the Columbia estuary area (i.e., the width of the channel in the lower river), wave energy dissipates more before reaching shoreline areas. The wetlands are created and maintained by dynamic riverine and geomorphic processes and are more influenced by changes in river flow affecting water levels and adjacent land use practices than they are by industrial river traffic. Many, if not most, of the wetlands are located adjacent to very shallow water side channels and sloughs and around islands in the estuary, such that any vessel with steerage problems would run aground of these shallows and sand shoals long before encountering fringe wetlands. There are a few exceptions where the deeper navigation channel is closer to upland areas with wetlands inside well-maintained dike and levy systems, but again the wetlands are protected by the dikes and isolated to some extent from the river. However, limited impacts on wetland habitats attributed to shoreline erosion may occur as a result of the proposed project. As described in section 4.1.2.3, FERC staff continues to study this issue and additional analysis regarding shoreline erosion will be included in the revised BA and EFH Assessment. If applicable, mitigation for impacts on wetlands along the waterway would be included in NorthernStar's final Compensatory Mitigation Plan. Because NorthernStar's Compensatory Mitigation Plan has not been finalized, we recommended in section 2.1.5 that NorthernStar continue to consult with the COE, NMFS, FWS, ODFW, ODSL, WDE, and other appropriate agencies to finalize its Compensatory Mitigation Plan.

During transit to the LNG terminal, the potential exists for an accidental or intentional breach of an LNG carrier resulting in a release of LNG. However, LNG is less dense than freshwater or saltwater so it would float on the surface. Immediately upon contact with any warmer substance such as water or air, it would begin to evaporate. Because LNG is not soluble in water and the LNG would completely vaporize shortly after being spilled, there would be no liquid left that could mix with and/or contaminate the water or sediments. As the LNG vaporizes, a vapor cloud may form that is initially heavier than air and may be dispersed by wind. An LNG vapor cloud cannot explode in the open atmosphere, but can burn. If the LNG vapor cloud were to burn, wetland vegetation along the Columbia River could be damaged. However, the area of effect of an LNG release and any resulting fire would be fairly limited and short-lived, unless conditions were such that a forest fire was triggered (see section 4.4.2.1). Affected areas would likely revegetate naturally except in the immediate vicinity of the breach. With implementation of the mitigation measures described in the Coast Guard's WSR (Appendix G), a release would be highly unlikely, and therefore, the potential impacts on wetlands would be less than significant.

4.4.1.2 LNG Terminal

Wetlands within the proposed LNG terminal area were delineated in accordance with the 1987 COE Wetland Delineation Manual (Environmental Laboratory, 1987) and Oregon State Wetland Delineation Report Guidance (ODSL, 2000). Wetland delineations were conducted at the proposed terminal site by the Columbia River Estuary Study Taskforce (CREST) in July, 2003. Wetland

boundaries delineated by the CREST were subsequently approved by the ODSL in July 2005. Additional field surveys were conducted by Rhea Environmental Consulting, LLC (Rhea) and URS in 2005 to include expanded areas outside the original survey area. In September 2006, all wetlands previously delineated by the CREST within the study area were verified and, in many cases, expanded by URS. The 2006 URS delineation reclassified the estuarine wetlands at the LNG terminal site as palustrine. An explanation was not provided for the change.

Common wetland vegetation identified during the field surveys of the proposed LNG terminal site is presented in table 4.4.1-1.

TABLE 4.4.1-1

Common Wetland Species Identified in Delineations Within the Bradwood Landing LNG Terminal Site

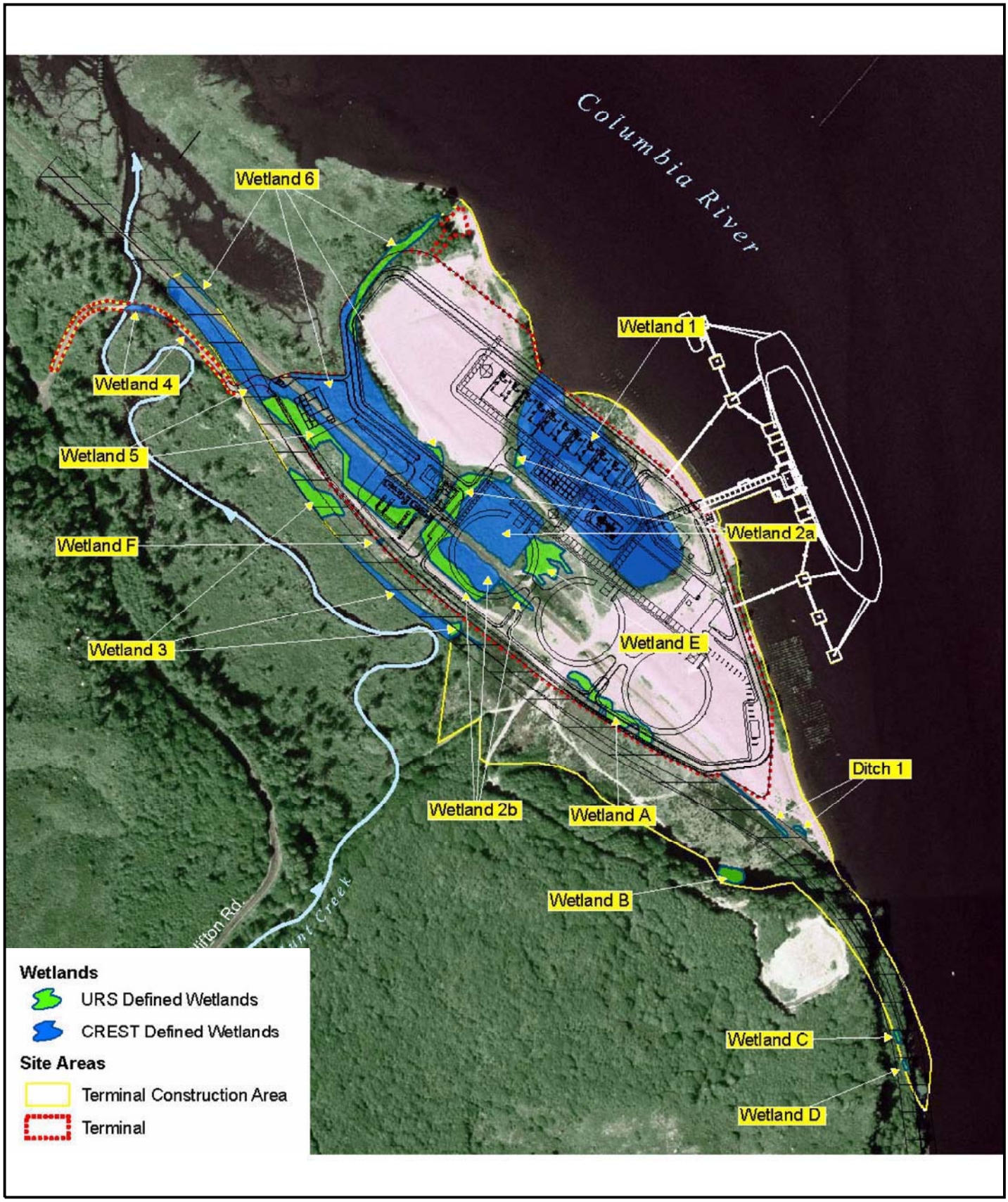
Common Name	Scientific Name	Common Name	Scientific Name
Red alder	*Alnus rubra*	Reed canary-grass	*Phalaris arundinacea*
Slough sedge	*Carex obnupta*	Creeping buttercup	*Ranunculus repens*
Giant horsetail	*Equisetum arvense*	Himalayan blackberry	*Rubus discolor*
Common velvetgrass	*Holcus lanatus*	Sitka willow	*Salix sitchensis*
Paleyellow iris	*Iris Pseudacorus*	Small-fruited bulrush	*Scirpus microcarpus*
Common rush	*Juncus effuses*	Rose spiraea	*Spiraea douglasii*
Purple loosestrife	*Lythrum salicaria*	Skunk cabbage	*Symplocarpus foetidus*
Water parsely	*Oenanthe sarmentosa*	Cattail	*Typha latifolia*

Impacts and Mitigation

A total of 13 wetlands were identified within the proposed LNG terminal site, including forested, scrub-shrub, and emergent wetlands as well as unconsolidated shores and bottoms. In addition, 3,000 feet of unconsolidated shore along the Columbia River would also be affected by the proposed project. Construction of the LNG terminal facilities would result in temporary impacts on 14.8 acres of wetlands. Permanent wetland impacts at the LNG terminal would include: 2.7 acres of scrub-shrub wetlands, 5.7 acres of emergent wetlands, and 4.5 acres of area that includes multiple wetland types. The majority of these wetlands have been previously disturbed by industrial activities, including the installation of a railroad, site grading, excavation, and road construction.

Since the issuance of the draft EIS, NorthernStar has proposed modifications to Bradwood and Clifton Roads and has stated that a parking lot would be provided for construction workers southeast of the Taylorville interchange at Highway 30. NorthernStar has not submitted information to the FERC regarding vegetation or other resource impacts at these locations. Therefore we recommended in section 4.2.2.1 that NorthernStar quantify and file impacts on wetlands associated with the modifications to Bradwood and Clifton Roads as well as the new proposed construction worker parking lot prior to construction.

Table 4.4.1-2 summarizes the potential impacts on wetlands associated with the construction and operation of the proposed LNG terminal. Figure 4.4.1-2 depicts the wetlands delineated within the proposed LNG terminal site.



0 300 600 Feet

Figure 4.4.1-2
Bradwood Landing Project
Wetlands Delineated within the LNG Terminal Site

TABLE 4.4.1-2

Wetlands Affected by the Bradwood Landing LNG Terminal

Wetland ID	Wetland Classification [a]	Temporary Construction Impact (acres) [b]	Permanent Operational Impact (acres) [c]
Wetland A	PEM	0.3	0.3
Wetland B	PSS	0.1	0.0
Wetland C	PFO	0.0	0.0
Wetland D	PFO/PEM	0.0	0.0
Wetland E	PEM	0.4	0.4
Wetland F	PEM	0.0	0.0
Wetland 1	PEM	5.0	5.0
Wetland 2a	PSS	1.6	1.6
Wetland 2b	PSS	1.0	1.0
Wetland 3	PSS	0.6	0.0
Wetland 4	PSS	0.1	0.1
Wetland 5	PSS/PEM	2.8	1.9
Wetland 6	PFO/PEM	2.8	2.6
TOTAL [d]		14.8	12.9

[a] Cowardin Classification System:
PEM = Palustrine emergent
PSS = Palustrine scrub-shrub
PFO = Palustrine forested wetland

[b] Construction impacts include temporary disturbances related to construction of the LNG terminal and associated facilities.

[c] Operational impacts include the permanent loss of wetlands within the footprint of the facility.

[d] Sum of addends may not equal total due to rounding.

Nonjurisdictional facilities associated with the proposed LNG terminal include a 1.5-mile-long power line and three lateral pipelines. As discussed in section 2.2.2, the lateral pipelines would be constructed by entities other than NorthernStar and are tentative at this time. The power line would require a 100-foot-wide right-of-way for construction and operation. A 400-foot-wide corridor centered over the proposed route was examined to allow for some flexibility in the final routing of the power line. Approximately 2.2 acres of wetlands were identified within the 400-foot-wide corridor, including 1.7 acres of forested wetlands, 0.3 acre of scrub-shrub wetlands, and 0.2 acre of emergent wetlands. Table 4.4.1-3 lists the wetlands identified within the 400-foot-wide corridor.

The impacts of project-related construction and operation activities on wetlands would vary depending on the timing of construction, construction techniques used, the sensitivity of the resources disturbed, and the length of time required for wetlands to be restored. Soil disturbance and removal of wetland vegetation within the project area could temporarily affect the capacity of wetlands to buffer flood flows and could increase the potential for erosion. Removal of wetland vegetation could also deprive wildlife of a valuable habitat component and encourage the recruitment of less desirable invasive species. Rutting of soils from construction equipment could result in soil mixing and a disruption of surface water flow, which could also affect the success of post-construction restoration. Uncontrolled surface runoff from adjacent disturbed upland areas could transfer sediment into off-site wetlands. Accidental spills and leaks from construction equipment could also result in wetland contamination and some loss of wetland values/functions as wildlife habitat could be diminished during construction.

The majority of impacts related to the operation of the LNG terminal would be permanent and result in the conversion of wetlands to commercial/industrial uses. NorthernStar would mitigate construction-related impacts by implementing its terminal ESC Plan and our Procedures, and by complying with the COE's section 404 and ODSL's section 401 permit conditions.

TABLE 4.4.1-3

Wetlands Within the 400-foot-wide Study Area Associated with the Power Line

Wetland ID	Wetland Classification [a]	Acres within the Study Area [b]
Wetland C	PFO	0.9
Wetland D	PEM	<0.1
Wetland E	PSS	0.1
Wetland F	PEM	<0.1
Wetland G	PEM	0.1
Wetland H	PSS	<0.1
Wetland I	PFO	0.1
Wetland J	PFO	<0.1
Wetland K	PSS	<0.1
Wetland L	PSS	<0.1
Wetland M	PEM	<0.1
Wetland N	PSS	<0.1
Wetland O	PFO	<0.1
Wetland P	PFO	0.1
Wetland Q	PFO	0.1
Wetland R	PFO	0.2
Wetland S	PFO	0.1
Wetland T	PFO	<0.1
Wetland U	PFO	<0.1
Wetland V	PFO	<0.1
Wetland W	PFO	<0.1
Wetland X	PSS	<0.1
Wetland Y	PSS	0.1
Wetland Z	PSS	0.1
Wetland AZ	PFO	0.1
Wetland BZ	PEM	<0.1
Wetland CZ	PEM	<0.1
Wetland DZ	PSS	<0.1

[a] Cowardin Classification System:
PEM = Palustrine emergent
PSS = Palustrine scrub-shrub
PFO = Palustrine forested

[b] Values represent the acreage of each wetland within the 400-foot-wide study area. The 100-foot-wide power line corridor would be located within the study area.

In order for the COE to determine whether practicable alternatives have been taken, NorthernStar is required to avoid impacts on wetlands to the maximum extent possible. NorthernStar must also demonstrate that it has taken appropriate and practicable steps to minimize wetland impacts in compliance with the COE's section 404(b)(1) guidelines that restrict discharges of dredged or fill material where a less environmentally damaging alternative exists. When unavoidable wetland impacts are proposed, the COE and ODSL would require that all practicable actions be taken to mitigate those impacts. This is consistent with the CEQ's Regulations for Implementing the Procedural Provisions of the NEPA (40 CFR 1508.20), which defines mitigation to include the following criteria:

- avoiding the impact altogether by not taking a certain action or parts of an action;
- minimizing impacts by limiting the degree or magnitude of the action and its implementation;

- rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
- compensating for the impact by replacing or providing substitute resources or environments.

For any large construction project, there is the potential for spills or leaks of fuels or hazardous materials from storage containers, equipment working in or near wetlands, and fuel transfers to adversely affect wetlands. NorthernStar would minimize the potential for spills by implementing its terminal ESC Plan. Specifically, NorthernStar would limit the refueling of equipment within 100 feet of wetlands, inspect all equipment and vehicles for leaks before entering wetlands, and wash all equipment and vehicles to remove any residual petroleum material before construction within wetlands.

Along the Columbia River shoreline, NorthernStar would implement its *Terminal Site Conceptual Revegetation Plan* that identifies specific revegetation practices within four vegetative zones (i.e., emergent zone, riparian low-shrub zone, riparian shrub zone, and upland herbaceous zone). Shoreline revegetation would include using potted plants, emergent plugs, and broadcast seed mixes to establish native herbaceous and woody species within these zones. The width of the zones would be variable, depending on the distance between the berm and the shoreline. The emergent zone would be located just below the MHHW line where daily tidal inundation occurs and would be planted with low-growing emergent vegetation with mature heights not exceeding 3 feet. The riparian low-shrub zone is located where the berm is nearest the shoreline, near the southern edge of the property. The area between the MHHW line and the toe of the berm would be planted with typical low-growing riparian shrub species, including Columbia River willow and red-osier dogwood, with mature heights of about 10 feet and 16 feet, respectively. The riparian shrub zone would be installed from the MHHW line upslope to approximately 2 feet above the MHHW line. Species planted would consist of typical forested riparian trees and shrubs with mature heights 16 feet and greater. The upland herbaceous zone would be located between the riparian zone and the toe of the berm and would vary in width depending on the distance from the berm to the shoreline. This zone would consist of low-growing native herbaceous species, including lupine species and native grass species with mature heights less than 5 feet. Additional information on the *Terminal Site Conceptual Revegetation Plan* as it relates to upland vegetative communities is included in section 4.4.2.2.

Compensatory Mitigation

NorthernStar has made a commitment that the proposed project would provide an overall significant net benefit to the environment of the lower Columbia River ecosystem. As described in its Compensatory Mitigation Plan, NorthernStar would approach wetland mitigation first through impact avoidance, then minimization, and finally through compensation (i.e., protection, restoration, creation, and enhancement).

Following temporary wetland impacts resulting from construction of the proposed project facilities, habitat and ecosystem function would be restored in place. Permanent impacts on wetlands would be mitigated by restoring habitat with similar ecological function. Mitigation would occur in areas substantially larger than that lost to permanent impacts, and would be restored to a higher level of ecosystem function.

Construction of the proposed LNG terminal would result in permanent and temporary wetland impacts. Temporary impacts within the proposed LNG terminal site would include shoreline impacts

resulting from the construction of the 5-foot containment berm that would suround the perimeter of the facility. Shoreline restoration would occur following construction of the berm and would be maintained until the revegetation areas meet performance standards. Vegetation would be planted during its dormant period to avoid mortality due to heat stress or drought.

Following construction of the LNG terminal, permanent impacts on wetlands would be mitigated through the implementation of NorthernStar's Compensatory Mitigation Plan. The Svensen Island Mitigation Sites would be the primary wetland mitigation sites in Oregon and are located about 14 miles downstream of the proposed Bradwood Landing LNG terminal in Clatsop County, Oregon (see figure 2.1.5-1). In addition, the Hunt Creek Mitigation Site would include preservation of wetland habitats adjacent to the LNG terminal site. This mitigation site is summarized below and discussed in detail in section 4.5.2.1.

The Svensen Island Mitigation Sites must succeed on several levels in order to offset resource impacts resulting from construction of the proposed LNG terminal. Generally, success would be determined by the applicant's ability to establish estuarine wetland conditions that would result in the capacity and opportunity to provide wetland functions at or greater than the capacity that would be lost at the impact site. The successful mitigation sites would restore, create, and/or enhance aquatic and terrestrial habitat; promote native species richness; and preserve existing high quality wetland areas. Factors that could limit the success of the mitigation sites include inaccurate water budget modeling, inaccurate grading elevations, barriers to fish passage, inaccurate plant species selections for the relevant hydrologic regimes, poor water quality, failure to obtain conservation easements or deed restrictions, failed plantings, and/or competition with non-native invasive plant species. A biologist would be present during construction of the mitigation sites to ensure that the sites are built without impacting adjacent fish habitat, to monitor grading activities, and to advise on construction procedures in order to ensure that the sites are constructed to plan. All seed mixes would be certified weed free.

In order to provide mitigation that is recognized as robust relative to the typical regulatory requirements, NorthernStar is proposing preservation and maintenance of an additional wetland area, the Hunt Creek Mitigation Site (see section 4.5.2.1 for a description of this site). This area would qualify as "Conservation in lieu" sites under Oregon DSL's CWM requirements because the site supports substantial populations of federally listed salmonids. Under the CWM program, there is no established ratio of conservation area relative to impact area.

The FERC received numerous comments stating that the mitigation proposed by NorthernStar does not adequately compensate for wetland impacts associated with the project. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. Because NorthernStar's Compensatory Mitigation Plan has not been finalized, we recommended in section 2.1.5 that NorthernStar continue to consult with the COE, NMFS, FWS, ODFW, ODSL, WDE, and other appropriate agencies to finalize its Compensatory Mitigation Plan.

4.4.1.3 Pipeline Facilities

Wetlands within the pipeline project area were delineated in accordance with the 1987 COE Wetland Delineation Manual (Environmental Laboratory, 1987), Oregon State Wetland Delineation Report Guidance (ODSL, 2000), and the Washington State Wetlands Identification and Delineation Manual (WDE, 1997). Between March and June 2006, URS conducted field surveys, where access was allowed, along a 200-foot-wide survey corridor centered over the proposed pipeline to identify wetlands in the project area. In areas where access was not granted, field personnel relied on NWI maps, county soil surveys, and digital topographic maps with a stream overlay to identify wetlands.

Common wetland vegetation identified during the field surveys of the proposed pipeline facilities is presented in table 4.4.1-4.

TABLE 4.4.1-4

Common Wetland Species Identified in Delineations Within the Bradwood Landing Pipeline Area

Common Name	Scientific Name	Common Name	Scientific Name
Emergent Wetlands			
Colonial bentgrass	*Agrostis capillaries*	Perennial ryegrass	*Lolium perenne*
Ladyfern	*Athyrium filix-femina*	Bird's-foot trefoil	*Lotus corniculatus*
Slough sedge	*Carex obnupta*	Water primrose	*Ludwigia palustris*
Coontail	*Ceratophyllum demersum*	Field mint	*Mentha arvensis*
Ovate spike-rush	*Eleocharis ovata*	Reed canary-grass	*Phalaris arundinacea*
Giant horsetail	*Equisetum arvense*	Kentucky bluegrass	*Poa pratensis*
Tall fescue	*Festuca arundinacea*	Water smartweed	*Polygonum amphibium*
Common velvetgrass	*Holcus lanatus*	Waterpepper	*Polygonum hydropiperoides*
Marsh pennywort	*Hydrocotyl ranunculoides*	Pondweed	*Potamogeton natens*
Jewel weed	*Impatiens noli-tangere*	Clasping-leaved pondweed	*Potamogeton richardsonii*
Common rush	*Juncus effuses*	Creeping buttercup	*Ranunculus repens*
Common duckweed	*Lemna minor*	White clover	*Trifolium repens*
Scrub-Shrub Wetlands			
Common rush	*Juncus effuses*	Black cottonwood	*Populus balsamifera*
Dagger-leaf rush	*Juncus ensifolius*	Cattail	*Typha* spp.
Bird's-foot trefoil	*Lotus corniculatus*	Red huckleberry	*Vaccinium parvifolium*
Forested Wetlands			
Vine maple	*Acer circinatum*	Jewel weed	*Impatiens noli-tangere*
Bigleaf maple	*Acer macrophyllum*	Common rush	*Juncus effuses*
Colonial bentgrass	*Agrostis capillaries*	Water parsely	*Oenanthe sarmentosa*
Red alder	*Alnus rubra*	Reed canary-grass	*Phalaris arundinacea*
Ladyfern	*Athyrium filix-femina*	Black cottonwood	*Populus balsamifera*
Slough sedge	*Carex obnupta*	Himalayan blackberry	*Rubus discolor*
Red-osier dogwood	*Cornus stolonifera*	Salmonberry	*Rubus spectabilis*
Scouring-rush	*Equisetum hyemale*	Sitka willow	*Salix sitchensis*
Tall fescue	*Festuca arundinacea*	Rose spiraea	*Spiraea douglasii*
Oregon ash	*Fraxinus latifolia*	Skunk cabbage	*Symplocarpus foetidus*
Common velvetgrass	*Holcus lanatus*	Youth-on-age	*Tolmiea menziesii*

Impacts and Mitigation

A detailed list of wetlands affected by the proposed pipeline facilities is provided in table 4.4.1-5. Table 4.4.1-6 summarizes the impacts associated with the construction and operation of the proposed pipeline facilities on wetlands. Construction of the pipeline facilities would temporarily affect approximately 97.9 acres of wetlands including about 5.0 acres of forested wetlands, 0.4 acre of scrub-shrub wetlands, 49.2 acres of emergent wetlands, and 43.3 acres of area that include multiple wetland types. Operation of the pipeline facilities would permanently affect approximately 14.7 acres of wetlands. Emergent and scrub-shrub wetlands would be allowed to revert to preconstruction conditions following construction. Therefore, operational impacts would consist of the permanent conversion of forested wetlands to other wetland types.

TABLE 4.4.1-5

Wetlands Affected by Construction and Operation of the Proposed Bradwood Landing Pipeline

County, State/MP	Wetland ID	Cowardin Classification [a]	Crossing Length (feet)	Construction Impact (acres) [b]	Operational Impact (acres) [c]
Clatsop County, Oregon					
3.8	B0511	PFO/PSS/PEM	25	<0.1	<0.1
3.8	C0511	PFO/PSS/PEM	143	0.3	0.1
3.9	A0510	PFO/PSS/PEM	30	0.1	<0.1
3.9	A0511	PFO/PSS/PEM	--	<0.1	--
4.5	A0508	PFO/PSS/PEM	517	1.1	0.4
4.8	A0505	PSS	25	<0.1	--
4.9	C0505	PEM	41	0.1	--
5.4	B0608	PFO	9	<0.1	<0.1
5.7	A0608	PFO/PEM/PSS	2,890	6.7	2.0
Clatsop County Totals			3,680	8.3	2.5
Columbia County, Oregon					
6.5	AA0515	PFO/PEM	5,061	11.7	3.5
7.3	AA0509	PEM	2,535	7.0	--
8.0	AA0508	PFO/PEM	4,700	11.8	3.2
8.7	EST-1 [d]	PEM	866	2.0	--
8.9	BB0512	PEM	547	1.5	--
9.0	AA0512	PEM	42	<0.1	--
9.2	EST-2 [d]	PEM	2,256	6.1	--
9.6	BB0511	PEM	2,093	5.6	--
9.9	AA0511	PEM	320	0.7	--
10.2	EST-3 [d]	PEM	2,139	5.8	--
10.6	AA0519	PEM	277	0.8	--
10.8	BB0519	PEM	1,085	2.8	--
10.9	CC0519	PEM	611	0.8	--
11.0	DD0519	PEM	--	0.7	--
11.1	EE0519	PEM	712	1.0	--
11.3	BB0615	PEM	1,315	1.8	--
11.5	AA0615	PFO/PEM	1,257	1.6	0.9
11.9	EST-4 [d]	PEM/PFO	2,514	5.6	1.7
12.3	C0606	PFO	1,787	3.1	1.2
12.7	AA0605	PEM	430	1.1	--
12.7	EST-5 [d]	PEM	366	1.1	--
12.9	A0606	PEM	442	0.9	--
13.0	B0606	PEM	260	0.3	--
13.1	EST-6 [d]	PEM	374	0.9	--
13.5	EST-8 [d]	PFO	80	0.1	0.1
14.8	AA0620	PEM/PSS	187	0.2	--
14.8	BB0620	PEM/PSS	--	<0.1	--
16.4	CC0622	PEM	212	0.2	--
16.6	BB0622	PEM	771	0.9	--
18.0	AA0523	PEM	1,534	2.7	--
18.2	BB0523	PEM	449	1.0	--
18.6	CC0523	PFO/PSS/PEM	1,460	4.0	1.0
19.0	DD0523	PFO/PSS/PEM	--	<0.1	--
Columbia County Totals			36,682	83.8	11.6

TABLE 4.4.1-5 (cont'd)

Wetlands Affected by Construction and Operation of the Proposed Bradwood Landing Pipeline

County, State/MP	Wetland ID	Cowardin Classification [a]	Crossing Length (feet)	Construction Impact (acres) [b]	Operational Impact (acres) [c]
Cowlitz County, Washington					
21.4	EST-3 [d]	PFO	145	0.3	0.1
23.2	EST-5 [d]	PFO	128	0.2	0.1
23.6	AA0427	PFO	99	<0.1	0.1
24.7	B0414	PFO/PEM	129	0.2	0.1
25.9	D0413	PEM	3	<0.1	--
26.0	C0413	PFO	62	0.1	<0.1
26.1	B0413	PSS	--	<0.1	--
26.2	A0413	PEM	--	<0.1	--
26.6	A0428	PFO	--	<0.1	--
26.7	EST-6 [d]	PFO	402	0.6	0.3
27.5	B0425	PFO	59	0.1	<0.1
27.7	A0425	PFO	--	<0.1	--
27.8	AA0424	PEM	844	2.1	--
28.0	A0424	PEM	238	0.1	--
28.0	EST-7 [d]	PEM	--	0.1	--
30.1	A0510	PFO	29	<0.1	<0.1
30.1	B0510	PFO	--	<0.1	--
30.1	D2-0510	PSS	--	<0.1	--
30.1	E0510	PSS	--	<0.1	--
30.2	B0524	PEM	15	<0.1	--
30.4	C0524	PFO	5	0.1	<0.1
30.4	G0511	PFO	30	<0.1	<0.1
30.4	I0511	PFO	33	<0.1	<0.1
30.7	E0511	PFO	15	<0.1	<0.1
30.7	F0511	PFO	--	<0.1	--
30.8	B0511	PSS	12	<0.1	--
30.8	C0511	PEM	--	<0.1	--
31.3	A0511	PEM	--	<0.1	--
31.5	EST-8 [d]	PFO	48	0.1	<0.1
31.7	EST-9 [d]	PFO	5	<0.1	<0.1
32.4	A0426	PFO	123	0.1	0.1
33.6	C0505	PFO	20	<0.1	<0.1
33.9	A0505	PFO	30	<0.1	<0.1
34.0	C0504	PEM	153	0.2	--
34.2	A0504	PEM	279	0.6	--
34.8	A0517	PEM	60	0.1	--
35.4	DD0426	PEM	289	0.2	--
36.0	CC0426	PSS	27	<0.1	--
36.2	AA0426	PSS	27	0.1	--
36.2	BB0426	PSS	219	0.3	--
	Cowlitz County Totals		3,528	5.9	0.6
Pipeline Project Totals			43,890	97.9	14.7

TABLE 4.4.1-5 (cont'd)

Wetlands Affected by Construction and Operation of the Proposed Bradwood Landing Pipeline

County, State/MP	Wetland ID	Cowardin Classification [a]	Crossing Length (feet)	Construction Impact (acres) [b]	Operational Impact (acres) [c]

Note: The totals shown in this table may not equal the sum of addends due to rounding.

[a] Cowardin Classification System:
PFO = Palustrine forested
PEM = Palustrine emergent
PSS = Palustrine scrub-shrub

[b] Construction impacts for the pipeline are based on an 85- to 100-foot-wide right-of-way and additional temporary workspaces.

[c] Operational impacts are based on the crossing length of the pipeline in all wetlands containing forested wetland areas and a 30-foot-wide permanent right-of-way. This includes a 10-foot-wide strip (centered over the pipeline) that would be permanently maintained as herbaceous wetland during operation of the project. In addition, trees within 15 feet of the pipeline greater than 15 feet in height may be selectively cut and removed from the permanent right-of-way.

[d] Due to limited access, these wetlands were identified based on NWI maps, county soil surveys, and digital topographic maps with a stream overlay.

TABLE 4.4.1-6

Summary of Wetlands Affected by Construction and Operation of the Proposed Bradwood Landing Pipeline

County	Forested Wetland		Scrub-Shrub Wetland		Emergent Wetland		Multiple Wetland Types	
	Const. (acres) [a]	Oper. (acres) [b]	Const. (acres) [a]	Oper. (acres) [c]	Const. (acres) [a]	Oper. (acres) [c]	Const. (acres) [a]	Oper. (acres) [b]
Clatsop, Oregon	<0.1	<0.1	<0.1	--	0.1	--	8.2	2.5
Columbia, Oregon	3.3	1.3	--	--	45.7	--	34.8	10.3
Cowlitz, Washington	1.7	0.5	0.4	--	3.5	--	0.3	0.1
Total	5.0	1.8	0.4	--	49.2	--	43.3	12.9

[a] Construction impacts for the pipeline are based on an 85- to 100-foot-wide right-of-way and additional temporary workspaces.

[b] Operational impacts are based on the crossing length of the pipeline in all wetlands containing forested wetland areas and a 30-foot-wide maintained right-of-way. This includes a 10-foot-wide strip (centered over the pipeline) that would be permanently maintained as herbaceous wetland during operation of the project. In addition, trees within 15 feet of the pipeline greater than 15 feet in height may be selectively cut and removed from the permanent right-of-way.

[c] Operational impacts on scrub-shrub and emergent wetlands would be avoided because herbaceous and scrub-shrub wetland vegetation in the pipeline right-of-way is generally not mowed or otherwise maintained.

Although our Procedures require that additional temporary workspaces be located at least 50 feet from waterbodies and wetland boundaries, NorthernStar identified 22 locations where additional temporary workspace is proposed to be located entirely or partially within wetlands or within 50 feet of a wetland. The wetland impacts resulting from these workspaces are included in the acreages presented in table 4.4.1-5.

None of the aboveground facilities associated with the proposed pipeline would be located in wetlands. Similarly, the pipe storage and contractor yard in Oregon would not be located in wetlands. However, the pipe and contractor yard in Washington at Longview has a drainage ditch adjacent to the southwestern side of the yard and another ditch runs through the southwestern corner of the property. The yard is an existing industrial site. However, NorthernStar has not filed either wetland delineations for the site or a statement that impacts on the wetlands depicted on figure 2.3.3-2 would be avoided. Therefore, **we recommend that:**

- **<u>Prior to activities</u> within the pipe storage and contractor yard in Washington, wetlands potentially affected by activities within the yard should be fenced. Construction activities should not occur within 50 feet of any wetland without prior review and written approval by the Director of OEP.**

NorthernStar would use existing access roads which would not require modification or improvement and would, therefore, not represent any additional impacts on wetlands.

NorthernStar would cross 21 wetlands along the proposed pipeline route using the HDD method. Clearing within areas crossed using the HDD method would be limited to hand trimming associated with the temporary deployment of HDD guidance (telemetry) cables (see section 4.3.2.4). If a frac-out were to occur, NorthernStar would implement its *HDD Contingency Plan,* which describes procedures and measures to be taken in the event of a frac-out. NorthernStar would station the necessary equipment and supplies to respond to a frac-out upon discovery of loss of drilling fluid at each HDD site. At the time of a frac-out, NorthernStar would stop drilling immediately, contain drilling fluids, and notify appropriate agencies. Appropriate resource experts (e.g., fisheries biologists and wetland scientists) would be on site

to monitor resources and effects of the release. To avoid wetland impacts at these locations during pipeline operation, NorthernStar would not maintain the right-of-way between the HDD entrance and exit locations. However, some of the additional temporary workspaces needed for HDD entry and exit points and pipe stringing could result in temporary impacts on wetlands.

The push-pull construction method is generally used in large wetland areas with suitable hydrology and topography (i.e., flooded or saturated soils and minimal local relief). In push-pull construction, the equipment required to place the pipeline in the trench is generally positioned at either end of the wetland crossing, and the pipeline is "floated" into position using a system of floats and rollers. Push-pull construction generally requires a narrower right-of-way and minimizes the operation of construction equipment within wetlands. As such, this method offers environmental advantages over conventional wetland construction approaches. Because of the potential environmental advantages of the push-pull construction method, this method should be used where sufficient water is present in the trench and other site conditions allow. NorthernStar would utilize the push-pull method where appropriate site-specific conditions are present at the time of construction. However, wetland conditions may preclude the use of the push-pull method.

As discussed in section 4.4.1.2, the impacts of project-related construction and operation activities on wetlands would vary depending on the timing of construction, construction techniques used, the sensitivity of the resources disturbed, and the length of time required for wetlands to be restored. The primary impact of pipeline construction and right-of-way maintenance activities on wetlands would be the temporary and permanent alteration of wetland vegetation. These effects would be greatest during and immediately following construction. In general, wetland impacts would be minimized by avoidance, mitigation of impacts, and compensation in accordance with federal, state, and local regulations. Typical pipeline construction methods when in wetlands are described in section 2.4.2.2. NorthernStar would mitigate construction-related impacts by implementing its *Waterbody and Wetland Construction and Mitigation Procedures Plan*, pipeline ESC Plan and SWPPP, and our Procedures. In addition, NorthernStar would comply with the COE's section 404 and ODSL's and WDE's section 401 permit conditions. As discussed in section 4.4.1.2, NorthernStar is required to avoid impacts on wetlands to the maximum extent possible and must demonstrate that it has taken appropriate and practicable steps to minimize wetland impacts in compliance with the COE's section 404(b)(1) guidelines that restrict discharges of dredged or fill material where a less environmentally damaging alternative exists. This is consistent with the CEQ's Regulations for Implementing the Procedural Provisions of the NEPA (40 CFR 1508.20), as further described in section 4.4.1.2. All necessary federal, state, and local permits described in table 1.3-1 would be obtained prior to the commencement of construction activities.

For any large construction project, there is the potential for spills or leaks of fuels or other hazardous materials from storage containers, equipment working in or near wetlands, and fuel transfers. The introduction of fuels or other hazardous materials as a result of spills or leaking equipment could also adversely affect these wetlands. NorthernStar would minimize the potential for spills by implementing its pipeline ESC Plan, SWPPP, and *Waterbody and Wetland Construction and Mitigation Procedures Plan* as well as our Procedures. Specifically, NorthernStar would limit the refueling of equipment within 100 feet of wetlands, inspect all equipment and vehicles for leaks before entering wetlands, and wash all equipment and vehicles to remove any residual petroleum material before construction within wetlands.

Wetlands temporarily affected by installation of the pipeline would be restored immediately following construction by grading sites back to their original contours with the topsoil replaced above the subsoil. Surface and sub-surface hydrology characteristics, including impermeable soil layers, within the trench would be identified and restored using native on-site material, imported clay, or bentonite during backfilling. To facilitate the restoration of perennial native vegetation in unsaturated wetlands, most vegetation would be replaced by seeding with conservation grasses, legumes, native herbaceous species,

or other standard erosion control/cover species, where required. Saturated wetlands would typically be re-vegetated by salvaging and maintaining appropriate specimens prior to construction for transplanting back into the wetland after construction is complete. The specimens would be maintained at the edge of the construction corridor or in a nearby staging area and kept viable by shading, watering, and mulching during pipeline construction. Upon restoring grade over the new pipeline, the salvaged wetland vegetation would be replanted in appropriate locations. If rare or unusual species are observed within the construction corridor, these would be salvaged and transplanted to restore the natural biodiversity of the impacted wetlands.

Generally, wetland communities would eventually transition back into a community with functionality similar to that of the wetland before construction. The herbaceous vegetation in emergent wetlands would regenerate quickly (typically within 1 to 3 years). Following revegetation, there would be little permanent impact on emergent wetland vegetation in the maintained right-of-way because these areas naturally consist of and would remain as an open and herbaceous community. Herbaceous wetland vegetation in the pipeline right-of-way is not generally mowed or otherwise maintained, although the FERC staff's Procedures allow annual maintenance of a 10-foot-wide strip centered over the pipeline.

Scrub-shrub wetlands could take several years to reach functionality similar to preconstruction conditions, depending on the age and complexity of the system. Forested wetlands would be replanted with in-kind wetland tree specimens (post-construction species composition would be similar to pre-construction composition), with the exception of the portion of the right-of-way within 5 feet of the pipeline (10 feet total), thereby minimizing the extent of disturbance. However, trees planted between 5 and 15 feet from the pipeline would be limited to a maximum height of 15 feet to allow for aerial inspection of the pipeline. NorthernStar's proposed tree planting exceeds the revegetation requirements of the FERC staff's Procedures. The corridor centered on the pipeline would be planted with a native grass seed mix and maintained in an herbaceous state to facilitate maintenance and inspection. Nearly complete canopy coverage over the pipeline would be expected to develop in most areas within approximately 20 years.

FERC Staff's Procedures

To avoid or minimize impacts on wetlands, NorthernStar would implement measures outlined in our Procedures during the construction and operation of the proposed LNG terminal and pipeline facilities. Our Procedures include, but are not limited to, the following requirements:

- Construction equipment operating within the right-of-way would be limited to that equipment necessary for clearing, excavation, pipe installation, backfilling, and restoration activities. All nonessential equipment would use upland access roads to the maximum extent practicable.

- Equipment operating within saturated wetlands would be low-ground-weight equipment or would operate from prefabricated construction mats.

- Temporary erosion and sedimentation control measures would be installed immediately after the initial disturbance of wetland soils and would be inspected and maintained regularly until final stabilization.

- Sedimentation controls would be installed across the construction right-of-way within wetlands to contain trench spoil, as needed.

- Grading and pulling of tree stumps would be limited to the area directly over the trenchline unless additional grading or stump removal is required for worker safety.

- In unsaturated wetlands, the uppermost 12 inches of topsoil along the pipeline trench would be segregated from the underlying subsoil.

- The appropriate land management or state agency should be consulted to develop a project-specific wetland restoration plan. The restoration plan should include measures for re-establishing herbaceous and/or woody species, controlling the invasion and spread of undesirable exotic species, and monitoring the success of revegetation and weed control efforts.

NorthernStar has stated that monitoring of wetlands would be conducted for a minimum of 3 years post-construction to ensure the success of wetland revegetation, if revegetation is not successful after 3 years, a remedial revegetation plan would be developed and implemented. However, comments were received on the draft EIS stating that the proposed duration of wetland monitoring is not adequate to ensure the success of revegetation along the right-of-way. Therefore, to ensure compliance with our Procedures, we have recommended in section 4.3.2.4 that NorthernStar continue to consult with the COE, NMFS, FWS, and appropriate federal and state agencies to finalize its *Waterbody and Wetland Construction and Mitigation Procedures Plan*, including procedures for monitoring the success of the revegetation.

Requested Modifications to the FERC's Staff's Procedures

NorthernStar's ESC Plans, SWPPP, and *Waterbody and Wetland Construction and Mitigation Procedures Plan* integrate the FERC staff's Procedures, with certain exceptions. The intent of the FERC staff's Procedures is to assist applicants by identifying baseline mitigation measures for minimizing the extent and duration of disturbances to soils, wetlands, and waterbodies associated with projects under the FERC's jurisdiction throughout the country. Included below is a description of NorthernStar's proposal to modify certain baseline mitigation measures included in our Procedures.

Construction Right-of-way Width in Wetlands

Item VI.A.3 of our Procedures requires that the construction right-of-way width in wetlands be limited to 75 feet. NorthernStar proposes to use an 85-foot-wide construction right-of-way within all wetlands where the crossing length is less than 100 feet and a 100-foot construction right-of-way where the crossing length is greater than 100 feet. NorthernStar's justification for the wider right-of-way is based on the following site-specific conditions:

- A minimum of 4 inches of concrete coating would be required to maintain negative buoyancy of the 36-inch-diameter pipe in wetlands. When combined with the natural weight of the steel pipe, this poses a challenge even for large side booms (Caterpillar 589s), which would require matting in wetland areas to achieve adequate load bearing capacity.

- Ditch depth would be a minimum of 7 to 7.5 feet to accommodate the pipeline dimensions, including the concrete coating, and minimum soil cover requirements.

- The soils in the project area would naturally slump to a 1:2 or flatter slope, resulting in excessive ditch widths. Once excavated, the soils would have a fluid consistency, resulting in the need for additional workspace to contain the spoil piles.

- Except in saturated wetlands, topsoil would be segregated and stored separately, as required by the Procedures. At least 2 feet of separation between the segregated topsoil and the trench spoil would be required to prevent intermingling.

- The volume of the excavated spoil material is expected to swell 30 percent upon excavation.

- To prevent sloughing of the excavated material back into the trench, excavated materials would be placed at least 4 feet from the edge of the trench, pipe would be strung no closer than 4 feet from the trench, and equipment operation would not occur within 6 feet of the excavated trench for safety.

- Excavated materials would be placed a minimum of 2 feet inside the sediment barriers, which in turn would be placed a minimum of 1 foot inside the construction right-of-way, in an effort to prevent any off right-of-way disturbance.

Based on the information provided by NorthernStar, the proposed 85-foot and 100-foot-wide right-of-way is necessary and justified to allow for safe and efficient construction of the pipeline in wetlands.

Additional Temporary Workspaces within 50 Feet of Wetland Boundaries

Item VI.B.1.a of our Procedures requires that all additional temporary workspaces such as staging areas and additional spoil storage areas be located at least 50 feet from wetland boundaries except where the adjacent upland consists of cropland. However, we have identified 5 additional temporary workspaces that would be within 50 feet of wetland boundaries and 17 additional temporary workspaces that are proposed to be located entirely or partially within wetlands.

Consistent with our Procedures, additional temporary workspaces should be located at least 50 feet outside of wetland boundaries where topographic conditions permit. However, we recognize that certain site-specific conditions may require placing additional temporary workspaces within wetlands or within 50 feet of a wetland boundary. We have reviewed the locations where additional temporary workspaces have been sited in or within 50 feet of a wetland, and our conclusions are provided in table 4.4.1-7. During the comment period on the draft EIS, NorthernStar provided additional information on the temporary workspaces within 50 feet of wetlands that the FERC staff previously did not find acceptable. In review of that new information, the FERC staff found that for all but three remaining locations, NorthernStar had justified why it should be allowed to place the temporary extra workspace within 50 feet of a wetland. However, based on the revised locations provided by NorthernStar in its December 21, 2007 submittal, in three cases the FERC staff was not satisfied, and therefore **we recommend that:**

- **<u>During construction</u>, NorthernStar should implement the following measures at the three temporary extra workspaces listed below and in table 4.4.1-7 that would be within 50 feet of wetlands.**

  a. B0505 – Wetland should be fenced and avoided regardless of the presence of saturated conditions during construction activities.

  b. EST-3 – The pull string section for the Abernathy Creek HDD should avoid this wetland and the waterbody located within the wetland boundaries.

  c. AA0424 – The extra workspace should be relocated and centered on the upland area approximately 250 feet west of the current location.

TABLE 4.4.1-7

NorthernStar's Request to Locate Additional Temporary Workspaces Within 50 feet of a Wetland

MP	Wetland ID	Rationale for Additional Temporary Workspace	Conclusion and Approval Status
Additional Temporary Workspace within 50 feet of Wetlands			
3.8	B0511	HDD pipe pull string laydown	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
4.8	B0505	HDD entry pit – Westport Slough	FERC staff recommends additional revisions.
4.9	C0505	HDD entry pit – Westport Slough	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
19.0	DD0523	HDD exit pit – Columbia River	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
36.2	AA0426	Meter Station – End of route	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
Additional Temporary Workspace Located within Wetlands			
5.4	B0608	HDD exit pit – Westport Slough	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
5.5	A0608	HDD pipe pull string laydown – Westport Slough	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
8.4	AA0508	HDD entry pit – Kelli Slough and Woodson Road	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
8.7	EST-1	HDD exit pit and pipe pull string laydown – Kelli Slough and Woodson Road	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
8.9	BB0512	HDD pipe pull string laydown – Kelli Slough and Woodson Road	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
9.9	AA0511	HDD entry pit – Midland Canal	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
10.2	EST-3	HDD exit pit and pipe pull string laydown – Midland Canal	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
13.1	EST-6	HDD entry pit – Clatskanie River	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
18.1	AA0523	HDD pipe string laydown – Columbia River	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
18.1	BB0523	HDD pipe string laydown – Columbia River	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
18.8	CC0523	HDD pipe string laydown – Columbia River	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
18.8	CC0523	Entry Pit – Road bore	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
21.4	EST-3	HDD pipe pull string laydown	FERC staff recommends additional revisions.
28.0	AA0424	Coal Creek Road and Coal Creek crossing	FERC staff recommends additional revisions.
34.2	A0504	HDD entry pit – Cowlitz River and Highway 411	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
34.8	A0517	HDD pipe pull string laydown and HDD exit pit – Interstate 5	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.
35.4	DD0426	HDD entry pit – Interstate 5	Given site-specific construction constraints, the location of this workspace is acceptable to the FERC staff.

Compensatory Mitigation

NorthernStar has made a commitment that the proposed project would provide an overall significant net benefit to the environment of the lower Columbia River ecosystem. As described in its Compensatory Mitigation Plan, NorthernStar would approach wetland mitigation first through impact avoidance, then minimization, and finally through compensation (i.e., protection, restoration, creation, and enhancement).

Following construction of the proposed pipeline, habitat and ecosystem function would be restored in place. Permanent impacts on wetlands would be mitigated by preserving or restoring habitat in the general project area with similar ecological function. Mitigation would occur in areas substantially larger than those lost to permanent impacts, and would be restored to a higher level of ecosystem function. Due to the separate regulatory jurisdictions, wetland impacts would be mitigated separately in Oregon and Washington.

As described in section 4.4.1.2, within Oregon, the Svensen Island Mitigation Sites would be the primary wetland mitigation sites, although the Hunt Creek Mitigation Site would be preserved and also contains wetland habitats. NorthernStar has identified the Delameter Creek Mitigation Site as the primary mitigation site for wetland impacts in Washington.

The FERC received numerous comments stating that the mitigation proposed by NorthernStar does not adequately compensate for wetland impacts associated with the project. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. Because NorthernStar's Compensatory Mitigation Plan has not been finalized, we have recommended that NorthernStar continue to consult with the COE, NMFS, FWS, ODFW, ODSL, WDE, and other appropriate agencies to finalize its Compensatory Mitigation Plan.

4.4.2 Upland Vegetation

The Bradwood Landing Project would be located in the northwestern portion of Oregon and the southwestern portion of Washington. This area falls within portions of three ecoregions, including the Coast Range, Puget Lowland Forest, and Cascades ecoregions (Thorson et al., 2003). The climate in these regions is marine influenced and abundant precipitation occurs during the fall, winter, and spring months. Historically, Sitka spruce (*Picea sitchensis*) and coastal redwood (*Sequoia sempervirens*) forests dominated coastal areas, while a mosaic of western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), and seral Douglas-fir (*Pseudotsuga menziesii*) were found in inland areas. Today, Douglas-fir plantations are prevalent on the intensively logged and managed landscape (Thorson et al., 2003). Within these ecoregions, 10 distinct upland vegetative communities have been identified that occur within the project area. These upland communities include the following: coniferous forest, deciduous forest, mixed forest, early seral forest, riparian forest, scrub-shrub, riparian scrub-shrub, agricultural and rangeland, dredged materials and bare ground, and developed areas.

Coniferous forest is comprised primarily of mid-successional (typical) conifer-dominated forest with trees aged between 20 and 80 years that have been planted for commercial timber, and to a lesser extent, late-successional (high-quality) remnant native coniferous forest with mature trees aged greater than 80 years. These forests are comprised of dense, even-aged stands of Douglas-fir, with a few occurrences of other species, including red alder *(Alnus rubra)* and western hemlock. Commercial timberland is present throughout both Oregon and Washington along the lower Columbia River, including the Zones of Concern.

Deciduous forest is comprised of mature cottonwoods (*Populus* spp.), willows (*Salix* spp.), red-osier dogwood, young red alder, and bigleaf maple *(Acer macrophyllum)*. Understory species include salmonberry (*Rubus spectabilis)*, swordfern (*Polystichum munitum*), vine maple *(Acer circinatum)*, beaked hazelnut (*Corylus cornuta*), youth-on-age *(Tomiea menziesii)*, and the invasive Himalayan blackberry.

Mixed forests are comprised of both deciduous and coniferous trees, but the dominant species are usually deciduous. Typical species include big-leaf maple, red alder, Douglas-fir, and western red cedar

in the canopy layer with shrubs such as vine maple, beaked hazelnut, and salal (*Gaultheria shallon*) in the understory.

Early seral forest is characterized by clearcut areas that have begun to regenerate with a mixture of native Douglas-fir and red alder seedlings and saplings with a sometimes dense growth of nonnative, weedy species such as Himalayan blackberry. With age, this habitat develops into even-aged stands of Douglas-fir.

Dominant species found within riparian forest communities in the project area include cottonwood, red alder, and big-leaf maple. Typical understory species include vine maple, salmonberry, elderberry (*Sambucus* spp.), swordfern, ladyfern *(Athyrium filix-femina)*, oxalis (*Oxalis* spp.), stinging nettle (*Urtica dioica*), and skunk cabbage (*Lysichiton americanum*).

Scrub-shrub communities are often the result of logging or fire and may be composed of native shrubs such as red huckleberry *(Vaccinium parvifolium)* and elderberry, with non-natives like Himalayan blackberry and Scotch broom (*Cytisus scoparius*) often being the dominant species.

Riparian scrub-shrub communities are comprised of cottonwood, Sitka spruce, red-osier dogwood, Sitka willow, and rose spiraea. Other common species include bulrush (*Scirpus* spp.), slough sedge *(Carex obnupta)*, skunk cabbage, and cattail (*Typha* spp.).

Agricultural land, including pastures, orchards, and poplar plantations, are low-quality intensively managed areas that occur primarily as open pastures, fallow fields, and commercial poplar plantations. Because they lack vegetative diversity and structural complexity, they generally provide habitat for few species other than those that are edge-adapted.

Dredged spoils and bare ground are noted for their nearly complete lack of vegetation and exposed soils. Shallower areas of dredged sands may support limited vegetation, including nonnative Scotch broom and other weedy species.

Developed areas include buildings, roads, utility corridors, and other developed sites. These areas are usually devoid of vegetation and food resources and lack structural complexity.

4.4.2.1 Waterway for LNG Marine Traffic

Existing Upland Vegetation

The waterway for LNG marine traffic would be located within the Coast Range ecoregion. This ecoregion consists of highly productive, rain-drenched coniferous forests that cover the low mountains of the Coast Range. Timber lands in the area have generally been logged at least once, along with disturbance associated with agricultural and rural residential development. There are limited riparian conservation areas, and what vegetated riparian areas remain are dominated by hardwoods rather than more complex conifer forests, especially the once common “spruce swamp” or old-growth Sitka spruce-dominated wetlands.

Upland vegetative communities along the waterway and within the Zones of Concern include coniferous, deciduous, mixed, and early seral forests; upland and riparian scrub-shrub; agricultural; dredged spoils and bare ground; and developed areas. Typical species composition within these vegetative communities is described in section 4.4.2.

The WDFW has identified and mapped 18 Priority Habitats, which are defined as habitats that exhibit one or more of the following attributes: comparatively high fish and wildlife density or species diversity; important fish and wildlife breeding habitat, seasonal ranges, or movement corridors; limited availability; high vulnerability to habitat alteration; and/or unique or dependent species. Based on WDFW definitions, Priority Habitats include the Columbia River itself as well as estuarine areas between the mouth of the Columbia River and the LNG terminal. Maps detailing sensitive environmental features and habitats along the LNG carrier transit route are depicted in Appendix C.

General Impacts and Mitigation

The addition of 125 LNG carriers per year on the Columbia River would represent a 7 percent increase in commercial ship traffic and 25 percent increase in deep-draft vessel traffic. The wakes produced by an LNG carrier are only slightly larger than those of the large vessels currently using the Columbia River. However, as described in section 4.5.1.1, additional analysis of the potential for increased shoreline erosion due to LNG carrier wakes will be included in the revised BA and EFH Assessment. To minimize the potential for increased shoreline erosion due to LNG carrier transit, we recommended that NorthernStar coordinate with the NMFS to determine appropriate LNG carrier speed, or other applicable measures, to avoid or minimize shoreline erosion.

In the event of a collision or allision of sufficient magnitude to rupture an LNG cargo tank, it is likely that sparks or flames would ignite the flammable vapors at the spill site. In the unlikely event that ignition did not occur, an LNG spill would rapidly vaporize on water and form a potentially flammable cloud. If the flammable vapor cloud encountered an ignition source, the cloud would burn back to the spill site, rather than outward towards shoreline habitats. In the unlikely event of an LNG spill on water, ignition of the LNG vapors could contribute to a forest fire in areas where the Columbia River navigation channel is adjacent to forested areas (e.g., between Altoona and Skamokawa). Given the relatively high precipitation in the region, large forest fires in the area are infrequent, but they can be severe when they do occur. The intensity and extent of a potential forest fire would be highly dependent on a number of variables including available fuel (e.g., woody material), moisture and temperature, fuel composition, wind, and topography. However, as discussed in section 4.11.5, the risk of a release of LNG due to an accident or intentional breach during transit of the LNG carriers is very small and can be managed with safety and security measures described in the WSR (Appendix G). Therefore, the potential impacts on upland vegetative communities would be less than significant.

4.4.2.2 LNG Terminal

Existing Upland Vegetation

Table 4.4.2-1 lists the upland vegetative communities present within the proposed LNG terminal site as well as along of the proposed pipeline route. Based on categories described in the ODFW's HMP, essential deciduous forest, riparian forest, and riparian scrub-shrub habitats occur within the proposed LNG terminal site. Deciduous forests occur along the southern portion of the LNG terminal site as a narrow band between a large dredged material placement area and a patch of palustrine scrub-shrub wetland. Riparian forest occurs in two isolated patches along the Columbia River on the eastern edge of the site, and riparian scrub-shrub communities are limited to the areas adjacent to Hunt Creek.

TABLE 4.4.2-1

Acres of Upland Vegetative Communities Affected by the Bradwood Landing Project

	LNG Terminal Facilities [a, b]		Pipeline Facilities [c, d]		Total	
Vegetative Community	Construction	Operation	Construction	Operation	Construction	Operation
Coniferous forest	8.6	2.4	76.2	22.9	84.8	25.3
Deciduous forest	7.8	3.5	32.1	9.6	39.9	13.1
Mixed forest	0.0	0.0	52.2	15.7	52.2	15.7
Early seral forest	9.1	1.6	16.3	4.9	29.9	6.5
Riparian forest	0.7	0.5	2.9	0.9	3.6	1.4
Scrub-shrub	12.8	2.1	6.9	3.0	19.7	5.1
Riparian scrub-shrub	<0.1	<0.1	0.0	0.0	<0.1	<0.1
Agricultural and rangeland	0.0	0.0	98.6	41.6	98.6	41.6
Dredged materials and bare ground	21.3	19.3	0.6	0.4	21.9	19.7
Developed areas	4.6	3.5	42.7	8.5	47.8	12.0
Total	64.9	32.9	328.5	107.5	398.4	140.4

Note: The totals shown in this table may not equal the sum of addends due to rounding.

[a] LNG terminal facilities include the Hunt Creek Bridge replacement, reroute of the railroad, and power line.

[b] Since the issuance of the draft EIS, modifications have been proposed to Clifton and Bradwood Roads and the construction worker parking area. Information quantifying these impacts on vegetative communities has not been provided.

[c] Acres impacted by construction based on the typical width of the temporary right-of-way being 100 feet and the typical permanent right-of-way width of 50 feet, except when crossing forested communities and most wetlands and streams as described in sections 4.4.2.3, 4.4.1.3, and 4.3.2.4, respectively.

[d] Estimated impacts on vegetative communities affected by construction and operation of the proposed pipeline do not include areas that would be crossed using the HDD method or existing access roads, as impacts on these areas would be avoided.

Impacts and Mitigation

Construction of the proposed LNG terminal facilities would affect about 64.9 acres of upland vegetation (see table 4.4.2-1). Specifically, this includes about 47.1 acres of upland vegetation for the LNG terminal and about 17.8 acres for the power line. The upland vegetative communities present on the LNG terminal site are categorized as deciduous and riparian forest, scrub-shrub, riparian scrub-shrub, dredged materials, and developed areas. Also present at the LNG terminal site are about 14.8 acres of wetlands and 63.5 acres of open water, which are discussed in sections 4.4.1.2 and 4.3.2.3, respectively.

LNG Terminal

As described above, 47.1 acres of upland vegetation would be impacted during construction of the LNG terminal. Following construction, 27.9 acres of uplands would be permanently converted to industrial use for operation of the LNG terminal. Currently, this area includes about 19.3 acres of dredged materials, 3.5 acres of developed areas, 2.5 acres of deciduous forest, 2.1 acres of scrub-shrub, 0.5 acre of riparian forest, and less than 0.1 acre of riparian scrub-shrub communities. As discussed above, the dredged material and developed areas include only limited vegetation; therefore, impacts would not be considered significant. Impacts on deciduous forest and scrub-shrub communities would not be significant on a regional scale because areas with similar vegetation characteristics are found on surrounding lands.

The greatest potential impacts on upland vegetation resulting from construction and operation of the LNG terminal would be on riparian forest communities due to their high productivity, species diversity, and contribution to both aquatic and upland ecosystem function (Knutson and Naef, 1997).

Based on concerns raised by the NMFS in its May 11, 2007 letter to the FERC, biologists from NorthernStar and URS surveyed the LNG terminal site in June 2007 to assess the number of cottonwood trees that would be removed within the riparian zone, which is the area within 300 feet of the Columbia River shoreline and adjacent Hunt Creek estuary up to the existing railroad alignment. Cottonwood trees over 20 feet in height were counted within seven discreet patches at the LNG terminal site. All trees less than 20 feet in height were not assessed because they are considered to be riparian scrub-shrub vegetation. Approximately 650 cottonwood trees were counted within the riparian zone. Of these, about 380 trees would be removed during construction of the LNG terminal. The remaining 270 trees would be preserved. Other tree species (i.e., Sitka spruce, red alder, Oregon ash, and bigleaf maple) occur within riparian forested areas at the LNG terminal site; however, they are not abundant (about 65 trees). The majority of the trees to be removed are located along the Hunt Creek estuary, along the northern edge of the proposed construction site boundary. Based on current design plans, NorthernStar proposes to preserve most trees along the Columbia River shoreline. However, trees that occur within 25 feet of the proposed fenceline would be removed for security reasons or topped below 25 feet and left with roots intact in order to provide habitat value (e.g., snags, perches).

The remaining 19.2 acres of uplands, which include 10.6 acres of scrub-shrub communities, 3.5 acres of early seral forest, 2.0 acres of dredged materials, 1.8 acres of deciduous forests, 1.1 acres of developed areas, and 0.2 acre of riparian forest areas would be restored after construction is completed. Restoration at the proposed LNG terminal site would be in accordance with NorthernStar's *Terminal Site Conceptual Revegetation Plan.*[11] In addition, NorthernStar would implement additional measures along the shorelines of the Columbia River and Hunt Creek as well as along the railroad right-of-way, as discussed below.

Along the Columbia River shoreline, NorthernStar would implement its *Terminal Site Conceptual Revegetation Plan* that identifies specific revegetation practices within four vegetative zones (i.e., emergent zone, riparian low-shrub zone, riparian shrub zone, and upland herbaceous zone). Shoreline revegetation would include using potted plants, emergent plugs, and broadcast seed mixes to establish native herbaceous and woody species within these zones. The width of the zones would be variable, depending on the distance between the berm and the shoreline. The emergent zone would be located just below the MHHW line where daily tidal inundation occurs and would be planted with low-growing emergent vegetation with mature heights not exceeding 3 feet. The riparian low-shrub zone is located where the berm is nearest the shoreline, near the southern edge of the property. The area between the MHHW line and the toe of the berm would be planted with typical low-growing riparian shrub species, including Columbia River willow and red-osier dogwood, with mature heights of about 10 feet and 16 feet, respectively. The riparian shrub zone would be installed from the MHHW line upslope to approximately 2 feet above the MHHW line. Species planted would consist of typical forested riparian trees and shrubs with mature heights 16 feet and greater. The upland herbaceous zone would be located between the riparian zone and the toe of the berm and would vary in width depending on the distance from the berm to the shoreline. This zone would consist of low-growing native herbaceous species, including lupine species and native grass species with mature heights less than 5 feet.

As described above, federal safety standards require that no trees taller than 25 feet be located within 25 feet of the security fence (located atop the perimeter berm). Therefore, along the northern portion of the shoreline, shrub and tree species with mature heights of less than 15 to 20 feet would be planted (or maintained where possible in areas that would not be cleared) within 25 feet of the security

[11] NorthernStar included its *Terminal Site Conceptual Revegetation Plan* as part of its JPA. NorthernStar filed its JPA with the FERC on November 22, 2006, and filed revisions to the JPA on April 5, 2007. This document is available for viewing by the public on the FERC's Internet web page at www.ferc.gov, through the eLibrary link, selecting "General Search," entering the docket number minus the last three digits (i.e., CP06-365), and putting in the proper date range.

fence. Along the southern portion of the shoreline, where the berm would be closest to the Columbia River, low-growing riparian shrub species would be installed within 25 feet of the security fence.

Adjacent to Hunt Creek, a riparian buffer at least 30 feet wide, as measured from the MHW mark, would be allowed to permanently revegetate in order to retain riparian function. NorthernStar would replace cleared trees at a 5:1 ratio within the LNG terminal site, resulting in about 1,895 trees being planted following construction. The majority of the replacement trees (e.g., cottonwood, Sitka spruce, red alder, Pacific willow, and other native species) would be installed within a 100-foot buffer along the northern edge of the proposed construction boundary. This area would serve as a forested buffer from the terminal site to the adjacent Hunt Creek estuary. The area is currently vegetated with a narrow band of cottonwood trees (part of which is proposed for removal) as well as scrub-shrub and emergent wetland vegetation. Installation of trees within this buffer would provide a visual screen from the terminal site to the adjacent Hunt Creek estuary and would provide habitat for fish and wildlife species.

Following construction, NorthernStar's railroad right-of-way revegetation plan would result in the installation of native vegetation within the realigned railroad right-of-way. The right-of-way would consist of a 100-foot corridor centered on the tracks. A 30- to 40-foot wide strip, centered on the tracks, would be left unvegetated to allow for visibility. The portion of the right-of-way on the north side of the tracks would consist of a concrete facility berm and would not be revegetated. Along the southern side of the tracks, vegetation would be installed in a 30- to 35-foot-wide planting zone which would extend the length of the proposed rail alignment. NorthernStar's railroad right-of-way revegetation plan consists of two vegetative zones. The width of the zones would be variable, depending on the distance from the railroad tracks to Hunt Creek. The majority of the planting zone would be vegetated with low-growing herbaceous species in order to maximize visibility and minimize fire fuel. Low-growing herbaceous species, including lupine species and native grass species, would have a mature height less than 5 feet. Where the railroad right-of-way approaches Hunt Creek, near the center of the rail realignment, upland shrubs would be installed. Upland shrubs would have a mature height of 10 feet and greater. NorthernStar intends to salvage and temporarily replant appropriate native plant species (along with native topsoil) prior to construction for site restoration and landscaping purposes after construction. NorthernStar does not anticipate that vegetative management would be required in the 30- to 35-foot area along the southern portion of the railroad right-of-way.

Maintenance throughout the LNG terminal site would consist of monitoring, removal of tree saplings within 25 feet of the security fence, and noxious weed removal. Monitoring of the site would consist of a walk-through assessment that would be scheduled to occur annually but may be conducted at any time. Additional maintenance and monitoring would be done to ensure survival and to verify that success criteria are met in areas planted for site restoration and compensatory mitigation. NorthernStar's Compensatory Mitigation Plan contains additional details regarding success criteria within mitigation sites.

As described above, NorthernStar would plant shrub and tree species with mature heights of less than 15 to 20 feet within 25 feet of the security fence; therefore, maintenance clearing in revegetated areas is not anticipated. However, in areas not cleared during construction, new tree saplings taller than 25 feet may occur within 25 feet of the security fence. These trees would be flagged for removal and would be topped, rather than grubbed, to allow for development of snags.

With the exception of areas within 25 feet of the security fence, riparian areas outside of the berm would be allowed to permanently revegetate in order to retain riparian function. Areas in need of noxious or invasive species removal would be flagged or marked. Noxious or invasive species would be removed in order to ensure that success criteria of installed native plant communities are met. Populations of noxious weeds and invasive non-native vegetation determined to significantly affect the installed

vegetation would be removed by hand, ensuring that native vegetation is not disturbed. The most effective method for managing some invasive species is manual removal of the entire plant, including its root mass. Removal would occur as soon as possible, before the invasive species goes to seed or develops a substantial root mass, which could increase the effort necessary to remove the plants. NorthernStar has committed to bagging invasive species in plastic and disposing them off site at a permitted landfill. Noxious weeds and other invasive plant species are discussed in detail in section 4.4.2.3.

Since the issuance of the draft EIS, NorthernStar has proposed modifications to Bradwood and Clifton Roads and has revised the proposed location for a construction worker parking lot. NorthernStar has not submitted information to the FERC regarding vegetation or other resource impacts at these locations. Therefore we recommended in section 4.2.2.1 that NorthernStar quantify and file impacts on vegetative communities associated with the modifications to Bradwood and Clifton Roads as well as the new proposed construction worker parking lot prior to construction.

Electric Power Line

Additional impacts on vegetation would occur as a result of construction of the electric power line. Clearing within the 100-foot-wide right-of-way would impact about 17.8 acres of vegetation. Included in this would be 8.6 acres of coniferous forest, 5.6 acres of early seral forest, 3.5 acres of deciduous forest, and 0.1 acre of scrub-shrub. Following construction, the affected area would be replanted with native trees and shrubs and allowed to revegetate. A 15-foot-wide area adjacent to either side of the transmission line would be maintained by PacifiCorp in a grassland/herbaceous cover type, which would result in the permanent conversion of 5.0 acres of forested land (2.4 acres of coniferous forest, 1.6 acres of early seral forest, and 1.0 acre of deciduous forest) to a grassland/herbaceous cover type. As part of their scheduled maintenance, PacifiCorp would also remove trees from within the 100-foot-wide permanent right-of-way that are dead, dying, diseased, deformed, or unstable and that have a high probability of falling.

4.4.2.3 Pipeline Facilities

Existing Upland Vegetation

Table 4.4.2-1 lists the upland vegetative communities present along the proposed pipeline route. Dominant and understory species composition within each of these communities is provided in section 4.4.2. Agriculture and coniferous forests are the most common vegetative communities along the proposed pipeline route, comprising 98.6 acres and 76.2 acres of land affected, respectively. Agricultural vegetative communities occur throughout the areas crossed by the proposed pipeline route and are often characterized by regular landscape patterns and straight borders due to ownership boundaries and multiple crops within a region. This community is diverse and includes several cover types ranging from low-stature annual grasses and row crops less than 3 feet tall at maturity to mature tree farms greater than 60 feet in height. Structural diversity within each cover type (crop) is low. Depending upon management intensity or cultivation method, agricultural communities may vary substantially in structure on an annual basis. Herbaceous agricultural fields and pastures are found scattered along the proposed pipeline route and are closely associated with roads, residential developments, and sometimes industrial developments. Deciduous cottonwood/poplar (*Populus* spp.) farms and coniferous Douglas-fir tree farms are also found along the pipeline route, usually in less-developed areas.

Coniferous forests also occur throughout the proposed pipeline route. The majority of coniferous forests are comprised primarily of trees between 20 and 80 years old that have been planted for commercial timber. However, a narrow band of old-growth coniferous forest occurs parallel to the

Columbia River within the far western portion of the pipeline route near the LNG terminal. These stands are characterized by mature Douglas-fir, with lesser amounts of mature western hemlock and western red cedar. The canopy is fairly open in places due to the presence of large snags as well as a steep basalt bluff that separates the forest from the Columbia River below. Dominant or co-dominant understory species in coniferous forest typically include hemlock and cedar saplings, vine maple, salal, dwarf Oregon grape (*Mahonia nervosa*), elderberry, swordfern, and the invasive Himalayan blackberry. Other forbs and ferns that frequently dominate the understory are bracken fern (*Pteridium aquilinum*), ladyfern, youth-on-age, and stinging nettle.

General Impacts and Mitigation

Pipeline Right-of-way

The primary impact from the pipeline and associated aboveground facilities on vegetative communities would be the cutting, clearing, and/or removal of existing vegetation within the construction work area. The degree of impact would depend on the type and amount of vegetation affected, the rate at which the vegetation would regenerate after construction, and the frequency of vegetation maintenance conducted during operation of the project. The swath of vegetation that would be disturbed during construction would be either 100 or 120 feet wide in upland areas, depending on whether topsoil segregation is required, with the exception of areas crossed using the HDD method. Absent unforeseen events such as inadvertent returns of drilling mud (see section 4.3.2.4), the only potential disturbance in areas crossed using the HDD method would be minor trimming of vegetation using hand tools directly over the pipeline. This minor clearing is required to facilitate the temporary deployment of HDD guidance (telemetry) cables along the ground during construction and to perform a leakage survey after installation and commissioning.

Secondary effects associated with disturbances to upland vegetation could include increased soil erosion (see section 4.2.3.2), increased potential for the introduction and establishment of invasive weedy species (see *Noxious Weeds and Other Invasive Plant Species* below), and a local reduction in available wildlife habitat (see section 4.5.3.3).

To reduce impacts on vegetation within the construction and permanent rights-of-way and improve revegetation potential, NorthernStar would implement its pipeline ESC Plan in Oregon and SWPPP in Washington as well as our Procedures. Following construction, all work areas would be restored, seeded with conservation grasses, legumes, native plant species, or other standard erosion control/cover species, where required, and allowed to naturally revegetate to preconstruction conditions, with the exception of upland forested communities which would be replanted in-kind with trees. The permanent right-of-way would generally be maintained in an herbaceous state following construction. NorthernStar would monitor the success of revegetation efforts and employ reseeding, fertilizing, and other measures until herbaceous vegetative cover and density are similar to the adjacent areas not disturbed by construction. If there are excessive noxious weeds after the first or second growing season, an agronomist would determine the need for additional restoration measures that NorthernStar would implement, as necessary.

NorthernStar's proposed construction right-of-way, temporary extra work areas, and access roads associated with the pipeline would disturb a total of about 328.5 acres of upland vegetation. As described above, NorthernStar would avoid impacts on about 178 acres of upland vegetation by using the HDD method to install the pipeline underneath old-growth coniferous forest and some roads. As described in table 4.4.2-1, the most common vegetative communities occurring along the proposed route are agricultural (98.6 acres), coniferous forest (76.2 acres), and mixed forest (52.2 acres), which account for nearly 70 percent of the vegetation that would be cleared or affected by construction. The next most

common cover types that would be affected are developed areas (42.7 acres) and deciduous forest (32.1 acres).

Agricultural communities would typically regenerate quickly after cleanup and reseeding of the right-of-way. Cultivated areas are regularly disturbed, generally receive ample water through irrigation if necessary, and would quickly reestablish on the right-of-way following replanting by the landowners; however, a small portion of the agricultural cover type (about 4.2 acres) also includes perennial crops associated with orchards, vineyards, tree plantations, and plant nurseries. Impacts on these perennial crops would be long term because of the time needed to establish the crops and, in some cases (i.e., orchards and tree plantations), the impacts would be permanent if the crop is restricted from being grown over the permanent easement. Vegetation would be replanted within the temporary construction right-of-way immediately after construction as part of site-specific plans and agreements with landowners, except large trees and shrubs, which, due to availability, may not be replaceable with specimens of comparable size. Additional information about impacts on and potential mitigation measures for residential areas, including landscaping, is presented in section 4.7.3.3.

Longer-term impacts would occur on upland scrub-shrub communities because these areas would be reseeded only with conservation grasses, legumes, native herbaceous species, or other standard erosion control/cover species, where required, and the shrub species that would recolonize the right-of-way from adjacent areas would require several years to reestablish their woody canopy. Permanent impacts would occur on the scrub-shrub community that is currently present within the permanent easement because the species would not be allowed to regenerate the woody canopy present before construction due to periodic right-of-way maintenance activities. Maintenance of the entire right-of-way would occur no more than once every 3 years. However, to facilitate maintenance and inspection, NorthernStar may clear a 10-foot-wide corridor centered on the pipeline annually.

Similar to scrub-shrub communities, impacts on forested communities (i.e., coniferous, deciduous, mixed, early seral, and riparian forests) would be considered long term because of the time required to restore the woody vegetation to its preconstruction condition. Impacts associated with construction and operation would be greatest on these cover types due to the change in structure and environment caused by the removal of the large tree canopy over the width of the construction right-of-way. The clearing of trees from the construction right-of-way could also affect the remaining trees along the edge of the right-of-way. Trees located on the edge of the right-of-way may be subject to mechanical damage to trunks and branches and root impacts from soil disturbance and compaction, all of which may result in the decreased health and viability of the remaining edge trees. Edge trees that were located within a dense stand of trees before construction may lack stability following removal of adjacent supporting trees, which may result in increased tree failures.

During construction, woody vegetation that has been cleared from the construction workspace would remain within the right-of-way until restoration commences. Woody vegetation would generally be ground in a tub grinder and spread onto the right-of-way as mulch. In areas where timber would be harvested, the trees would be cut and stacked for commercial sale. The logs would be hauled to market and the proceeds of the sale collected by the property owner. NorthernStar has made an agreement with the WDFW regarding the use of certain trees cut down during pipeline construction in Washington. Based on a protocol provided by the WDFW, certain trees would be hauled to a storage area to be utilized as the start of a LWD bank for the State of Washington. Other trees would be used to meet mitigation requirements. No trees, slash, or woody vegetation would be burned during construction of this project.

In upland forested areas, permanent impacts would be greatest over the maintained portion of the right-of-way, totaling about 54 acres. Upland forested communities would be replanted in-kind with trees, with the exception of the portion of the right-of-way within 15 feet of the pipeline (30 feet total),

thereby minimizing the extent of disturbance. NorthernStar's proposed tree planting exceeds the revegetation requirements of the FERC staff's Plan and Procedures. The 30-foot-wide corridor centered on the pipeline would be planted with a native grass seed mix and maintained in an herbaceous state to facilitate maintenance and inspection. As described above for upland scrub-shrub communities, annual clearing for maintenance of the pipeline in forested communities would be limited to the 10-foot corridor centered on the pipeline. Nearly complete canopy coverage over the pipeline would be expected to develop in most areas within approximately 20 years.

Adjacent to waterbodies, a riparian strip at least 25 feet wide, as measured from the waterbody's MHW mark, would be allowed to permanently revegetate with native plant species across the entire right-of-way. As described above, trees greater than 15 feet tall, or deep-rooted shrubs that could damage the pipeline's protective coating, obscure periodic surveillance, or interfere with potential repairs, would not be allowed to grow within 15 feet (30 feet total) of the pipeline.

Vegetation Communities of Special Concern or Value

As described above, the WDFW has identified and mapped 18 Priority Habitats. Vegetation communities of special concern were not specifically identified in Oregon. However, NorthernStar would mitigate for impacts on habitats of varying quality by complying with ODFW's HMP (see section 4.5.2.4).

About 1.8 acres of riparian Priority Habitat would be affected by construction of the Bradwood Landing pipeline in Washington. Of this, about 0.9 acre would be permanently maintained in an herbaceous state. Similar to other forested cover types, impacts on riparian forest would be considered long term because of the time required to restore the habitat to its preconstruction condition. To reduce impacts on riparian vegetation within the construction and permanent rights-of-way, NorthernStar would implement the measures included in its pipeline ESC Plan and SWPPP, as well as utilize the HDD or bore methods at up to 23 waterbody crossings (see section 4.3.2.4). NorthernStar would reduce the size of waterbody crossing staging areas and place these staging areas at least 50 feet from the water's edge whenever topographic conditions permit. Additionally, NorthernStar would allow a riparian buffer at least 25 feet wide, as measured from the waterbody's MHHW mark, to permanently revegetate with native woody plant species across the entire right-of-way; however trees greater than 15 feet tall, or deep-rooted shrubs that could damage the pipeline's protective coating, obscure periodic surveillance, or interfere with potential repairs, would not be allowed to grow within 15 feet (30 feet total) of the pipeline.

Noxious Weeds and Other Invasive Plant Species

Noxious weeds and other invasive plant species are non-native, undesirable native, or introduced species that are able to exclude and out-compete desirable native species, and thereby decrease overall species diversity. Noxious weeds often invade and persist in areas after the vegetation and ground have been disturbed and can hinder restoration.

The Oregon Department of Agriculture has developed the Noxious Weed Control Program. A part of the program's goals are to rate and classify weeds at the state level; to prevent the establishment and spread of noxious weeds; and to encourage and implement the control, containment, or eradication of infestations of designated weed species. The Noxious Weed Control Program places weeds on either "A" or "B" lists in order to prioritize and implement noxious weed control projects. "A" designated weeds either occur in the state in small enough infestations to make eradication or containment possible or are not known to occur, but their presence in neighboring states make future occurrence in Oregon seem imminent. The Oregon Department of Agriculture recommends eradication or intensive control when and where these weeds are found. "B" designated weeds are regionally abundant but may have limited

distribution in some counties. The Oregon Department of Agriculture recommends limited to intensive control at the state, county, or regional level as determined on a case-by-case basis. In addition, the Oregon Department of Agriculture annually develops a target list of weed species that will be the focus for prevention and control by the Noxious Weed Control Program, sanctioned by the Oregon State Weed Board. These weeds are "T" designated and are species selected from either the "A" or "B" lists.

Similarly, Washington has noxious weed laws that require counties and/or local weed districts to develop and oversee local weed management programs to control the spread of noxious weeds according to state laws. The Washington State Noxious Weed Control Board determines which plants are placed on the Washington State Noxious Weed List. Noxious weeds in Washington are placed into one of three categories. Class A weeds are non-native species with a limited distribution in the state and require eradication by state law. Class B weeds are species established in some regions of Washington but are of limited distribution or not present in other regions of the state, and treatment requirements vary between the different regions. Class C weeds are species already widely established in Washington or are of special interest to the state's agricultural industry. Control of Class C weeds may be required if desired by the county.

Biologists conducting field surveys for NorthernStar identified several species of noxious weeds occurring within the project area, including Scotch broom, Himalayan blackberry, reed canary-grass, and purple loosestrife. NorthernStar would consult with the Oregon and Washington Departments of Agriculture and other appropriate agencies to determine the location of other noxious weeds and whether soil-borne plant diseases of significance to agricultural productivity have been identified in the project area. To prevent and mitigate for the distribution of noxious weeds during construction and control noxious weeds that develop after construction, NorthernStar has agreed to implement the following measures, as described in its *Noxious Weeds and Soil-borne Plant Disease Control Plan*:[12]

- Contractors would be required to thoroughly clean each unit of construction equipment with high-pressure washing before the initial move of those units of construction equipment to the general construction site.

- Reasonable efforts would be made to obtain straw bales for erosion control and straw for mulch that are free of noxious and nuisance weed contamination.

- Where additional soil is necessary to restore the original soil contours as a result of the removal of excess rock from the trench backfill, imported soil would be used. NorthernStar would make reasonable efforts to obtain imported soil that is free of noxious weeds.

- When available, Oregon or Washington certified seed or equivalent would be used for revegetation.

- NorthernStar would monitor the revegetation of non-cultivated areas the first and second year after construction. Non-cultivated areas where seedling establishment has failed would be reseeded during the next appropriate seeding period. The revegetation of the construction area would be considered successful when, based on visual observation, the density or cover of well established, herbaceous, non-nuisance vegetation in the construction area is similar to the density or cover of herbaceous vegetation in adjacent

[12] NorthernStar included its *Noxious Weeds and Soil-borne Plant Disease Control Plan* as part of its JPA. NorthernStar filed its JPA with the FERC on November 22, 2006, and filed revisions to the JPA on April 5, 2007. This document is available for viewing by the public on the FERC's Internet web page at www.ferc.gov, through the eLibrary link, selecting "General Search," entering the docket number minus the last three digits (i.e., CP06-365), and putting in the proper date range.

areas not disturbed by construction. If the herbaceous vegetative cover or density in the construction area is not similar to that in adjacent areas not disturbed by construction, or if there are excessive noxious weeds after the first or second growing season, an agronomist would determine the need for additional restoration measures. NorthernStar would implement additional restoration or mitigation measures, as necessary.

On permanent right-of-way areas where NorthernStar has control of the surface use of the land such as aboveground valve sites and metering stations, weed control would be conducted in a manner that would prevent the spread of weeds to adjacent lands used for agriculture. Herbicide application on such areas would be conducted by an applicator licensed by the State of Oregon or Washington in accordance with our Procedures. Generally, herbicides would only be applied in the space directly over the pipeline and would target only the woody species, leaving the grasses intact to provide stability to the soils, and are applied during the dry part of the growing season when leaves are fully emerged. Herbicide application and other vegetation control near streams would be performed with hand tools. In accordance with our Procedures, herbicides would not be applied within 100 feet of any waterbody, including waterbodies containing federally listed species, designated critical habitat, or EFH.

The FERC received numerous comments relating to the adequacy of NorthernStar's *Noxious Weeds and Soil-borne Plant Disease Control Plan.* In its December 19, 2007 letter, the EPA stated that weed control methods proposed by NorthernStar should be identified. In its December 21, 2007 letter, the U.S. Department of the Interior recommended that all construction equipment be power-washed at a self-contained site before being transported to and/or from the construction right-of-way. Commentors also recommended that clean straw bales and fill be required for erosion control and that Oregon or Washington certified seed or equivalent be required for all revegetation. In addition, the NMFS has requested that specific information on the methods proposed and timing of noxious weed control be submitted as part of the revised BA and EFH Assessment. Therefore, **we recommend that:**

- **NorthernStar should continue to consult with the COE, FWS, NMFS, Oregon and Washington Departments of Agriculture, and other appropriate resource agencies to revise its *Noxious Weeds and Soil-borne Plant Disease Control Plan*. NorthernStar should file the final *Noxious Weeds and Soil-borne Disease Control Plan* along with agency comments on the plan with the Secretary <u>within 30 days</u> after the issuance of the final EIS.**

4.5 WILDLIFE AND AQUATIC RESOURCES

4.5.1 Waterway for LNG Marine Traffic

4.5.1.1 Aquatic Resources

The Columbia River is a highly productive biological environment that is influenced by a variety of complex physical processes. The major short-term processes affecting the area include tides and, secondly, local winds and currents. River flow also has a major seasonal impact, the extent of which depends on the volume of water from snow melt.

Existing Aquatic Resources

Marine Fish

The Columbia River, the estuary, and the offshore waters of the Pacific Ocean provide habitat for a variety of anadromous and resident fish species. Anadromous fish are present in the river throughout the year as adults migrating upstream to spawn, as juveniles rearing in the river and its tributaries, and as juveniles migrating downstream to the ocean. Anadromous salmonids occurring within or near the proposed project area include: Chinook, coho, sockeye, and chum salmon; steelhead; and coastal cutthroat trout. Of these, 13 ESU/DPSs are federally listed and are discussed in sections 4.6.1.1 and 4.6.2. In addition, EFH has been designated for Chinook and coho salmon along the waterway as discussed in section 4.5.1.2. Other anadromous and marine species include green and white sturgeon, eulachon, shad, striped bass, starry flounder, three spine sticklebacks, pea mouth, and Pacific and river lampreys.

Marine fish are present both in the Pacific Ocean and in the estuary of the Columbia River. Estuaries are protected nearshore areas such as bays, sounds, inlets, and river mouths, influenced by both ocean and freshwater. Because of tidal cycles and freshwater runoff, salinity varies within estuaries and results in great diversity, offering freshwater, brackish, and marine habitats within close proximity. Estuaries tend to be shallow, protected, nutrient rich, and are biologically productive, providing important habitat for marine organisms. As discussed in detail in section 4.5.1.2., EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity and has been designated within the Zones of Concern for more than 90 species of groundfish, 5 species of coastal pelagic species, 2 species of salmon, and 13 highly migratory species.

Larval and juvenile marine fish comprise a significant portion of the offshore planktonic communities. Smelt, tomcod, right-eye flounder, and anchovy are commonly found in the offshore communities during the winter and spring. Marine species that enter the estuary are generally confined to the deeper channels where salinity is high. Some species, in particular juveniles of these species, are more tolerant of lower salinity and can be found farther upriver and in the shallower areas associated with the bays. Bays are generally more productive than channel areas and provide feeding and rearing habitat for many marine species. Demersal fish (living near the bottom) are attracted to the bays for this reason. However, demersal fish can also be attracted to channel areas during seasonal periods with abundant benthic and epibenthic species. Pelagic fish (living in surface water to middle depths) are most likely to be found in areas rich in plankton. Fish most often found in the deeper channels of the estuary are white sturgeon, Pacific herring, shad, and surf smelt. Some marine species, such as Pacific herring, use the estuary as a spawning area (COE, 1999).

The estuary also serves as a nursery and rearing area for some species of marine fish, including Pacific tomcod, surfperch, rockfish, sanddabs, smelt, and starry flounder. These species are generally confined to the lower estuary where salinity is higher. However, English sole and Pacific staghorn

sculpin are somewhat tolerant of freshwater and occur as far upriver as Tongue Point. Similarly, starry flounder are known to occur as far upriver as Portland.

The lower Columbia River population of white sturgeon is the largest in the species range, due primarily to access to marine areas, abundant food resources, and consistently favorable hydrologic conditions during the spawning period (DeVore et al., 1995). White sturgeon occur throughout the lower estuary and river during all life history stages. Spawning occurs primarily in the deeper areas just below Bonneville Dam, though spawning is also known to occur in deepwater areas of the lower river. Spawning lasts for 38 to 48 days from late April or early May through June or July. Growth is rapid during the first summer, with young-of-the-year reaching a length of 7 inches by the end of September. Young-of-the-year and juvenile sturgeon are usually found in water deeper than 36 feet (McCabe and Tracy, 1994).

Freshwater Fish

Resident freshwater fish within the lower Columbia River include both coldwater (trout) and warmwater (bass, crappie, and bluegill) species. Fies (1971) conducted gill net surveys within the sloughs of the lower Columbia River to assess the stock of warmwater game fishes. The data from his study indicates that there are at least 16 non-salmonid species commonly occurring within the slough and lower floodplain reaches of streams within the subbasin. Five of these 16 species are native fish and the others are exotic or introduced species.

Several of the exotic fishes are predators of small fish and pose a threat to migrating juvenile salmonids. Northern pikeminnows (a native fish of the Columbia River), white crappie, black crappie, and largemouth bass are all predators and found within the sloughs and floodplain habitats of the Lower Columbia River Subbasin (Fies, 1971).

Fies (1971) found yellow bullhead to be abundant. Other exotic fish may compete with native fish for habitat or food, reducing growth rates of native fish and potentially decreasing survival. A few representative non-ESA listed species, known to occupy the basins and waterbodies containing federally listed salmonids in the project area are discussed in *Commercial and Recreational Fisheries*.

Marine Mammals

Thirty-one species of marine mammals have been recorded within the Northeastern Pacific Ocean, including 7 species of baleen whales; 17 species of toothed whales, dolphins, and porpoises; 5 species of pinnipeds (seals and sea lions); and sea otters (Carretta et al., 2006). Large numbers of Steller sea lions, California sea lions, and Pacific harbor seals can be found utilizing haulout sites along the lower Columbia River. Maps depicting the locations of haulout sites used by Steller sea lions and seals are included in Appendix C. Steller sea lions are federally and state-listed and are discussed in sections 4.6.1.1 and 4.6.2. Eight species of federally and state-listed whales potentially occur off the coasts of Oregon and Washington and are discussed in sections 4.6.1.1 and 4.6.1.2. The remaining marine mammals are protected under the MMPA and are discussed in detail in sections 4.6.1.3, 4.6.2.1, and 4.6.2.2.

Sea Turtles

Four species of sea turtles have been documented off the coasts of Oregon and Washington. These include the green, olive ridley, leatherback, and loggerhead sea turtles. Sea turtles occurring off the coasts of Oregon and Washington are protected under the ESA and are discussed in sections 4.6.1.1 and 4.6.2.1.

Commercial and Recreational Fisheries

The Columbia River, estuary, and Pacific Ocean support a number of valuable commercial fisheries. Major fisheries include Dungeness crab, salmon, steelhead, white and green sturgeon, eulachon, and bottom fish. However, fishing for salmon and bottom fish has declined in the last several years because of declining stocks of these species. As a result, there has been a shift to other fisheries including crab, tuna, and halibut. Recreational fisheries occur throughout the river for salmon, steelhead, sturgeon, and a variety of warmwater game fish.

Commercial salmon fishing is done by gill net in the lower river and occurs in stages: from mid-February to early March and sometimes in May (Chinook salmon), late June (sockeye salmon), June through August (Chinook salmon), and from mid-September to mid-November (Chinook and coho salmon). Commercial fishing for steelhead is done exclusively under treaty rights by Native Americans.

Commercial sturgeon fishing was originally a by-product of the salmon gill net fishery, but has become a major fishery in its own right due to the decline of the salmon fishery. Commercial fishing for sturgeon is done by gill net in the lower Columbia River. The lower Columbia River commercial white sturgeon harvest for 2005 was 8,152 fish (ODFW and WDFW, 2005). Most of the harvest occurs in the fall, although fishing also occurs in the winter, spring, and summer months. Some sturgeon are also caught during the terminal fishery for salmon in Youngs Bay (Norman and King, 1997).

Eulachon fished commercially are used for bait in recreational sturgeon fisheries, but they are also fished commercially and recreationally as food. Mainstem river fishing is done primarily by gill net and to a lesser extent by otter trawl. Fishing in the tributaries is done with dip nets as regulated by the States of Oregon and Washington. Total eulachon landings for the mainstem Columbia River for 2006 were estimated at 13,221 pounds, significantly higher than 2005, which had the lowest annual landings on record (208 pounds) (WDFW, 2006b). Eulachon are currently a candidate for listing in Washington and are discussed further in sections 4.6.1.3 and 4.6.2.

Terminal fisheries for salmon occur in Youngs Bay and Deep River (tributary to Grays Bay) and at several locations in Cathlamet Bay in the lower river. Terminal fisheries involve rearing juvenile salmon in pens and then releasing them to the ocean. When the fish return to the pen area, fishing is allowed in the immediate area to target only returning individuals. This type of fishery was developed to provide fishing opportunities without impacting wild runs.

Recreational fishing for eulachon, sturgeon, and salmon also occurs in the lower Columbia River. Recreational fishing (or dipping) for eulachon occurs in the tributaries using a dip net. Eulachon are used both as food and as sturgeon bait. Recreational harvest records are not kept but can be as high as the commercial landings during periods of high eulachon abundance. A large sturgeon fishery occurs in the estuary in the summer when sturgeon feed on bait fish that move into the estuary. Recreational fisheries for salmon also occur in the ocean and estuary, although this fishery has declined in recent years due to declining stocks. In addition, a fishery for rock and bottom fish occurs off some jetties and piers.

Fisheries of Special Concern

Fisheries resources of special concern occurring along the LNG marine transit route include: 1) fisheries protected by tribal treaty rights; 2) federally designated EFH for coho and Chinook salmon, coastal pelagic species, groundfish, and highly migratory species; 3) species listed federally as threatened, endangered, or candidates under the ESA and their designated or proposed critical habitat; and 4) species listed as threatened or endangered by the States of Oregon or Washington. Potential impacts on tribal fisheries as a result of the proposed project are discussed in section 4.8.2.4. Potential impacts on EFH

along the marine vessel route are discussed in section 4.5.1.2. Potential impacts on listed salmonids and their critical habitat, as well as state-listed threatened and endangered species, are discussed in section 4.6.2.1.

Impacts on Aquatic Resources

LNG marine traffic during operation of the Bradwood Landing Project has the potential to impact aquatic species through fish strandings, increased shoreline erosion, introduction of exotic species, vessel strikes, and releases of LNG. Much of the impact discussion included below applies to fish protected under the ESA, which are described in detail in section 4.6.1.1 and 4.6.2.1, and to EFH designated under the MSA, which is discussed further in section 4.5.1.2. In addition, marine mammals and sea turtles occurring along the waterway for LNG marine traffic are protected under the ESA and/or the MMPA and are described in sections 4.6.1.1 and 4.6.1.3.

Fish Strandings

A series of studies conducted on the lower Columbia River suggest that under certain conditions, deep-draft vessels can produce wakes that strand juvenile fish (Bauersfeld, 1977; Hinton and Emmett, 1994; Ackerman, 2002; Pearson et al., 2006; Entrix, 2008). Stranding can occur when fish become caught in a vessel's wake. The fish are then deposited on shore by the wave generated by the vessel wake. Stranding typically results in mortality unless another wave carries the fish back into the water. The most recent and comprehensive study on wake strandings on the lower Columbia River prepared by Pearson et al. (2006) suggests that the specific mechanisms of strandings are still not completely understood. It appears that no single factor controls fish strandings. Rather, a series of interlinked factors act together to produce stranding during a ship passage. These factors include:

- River-surface elevation – low tides are generally more likely to result in strandings than high tides.

- Beach slope – low-gradient beaches are generally more likely stranding locations than high-gradient ones.

- Wake characteristics – ship wakes that result in both the greatest drawn-down and run-up on the beach are generally most likely to result in strandings. Wake characteristics are influenced by a number of dynamics including vessel size and hull form ("short and fat" vessels have a greater displacement effect and generate larger wakes than "long and thin" vessels); vessel draught (the smaller the under-keel clearance, the larger the wakes; thus, loaded vessels are more likely to result in strandings than unloaded vessels); vessel speed (fast moving vessels generate larger wakes than slow vessels); the distance between the passing vessel and the beach (strandings are generally more likely at beaches close to the shipping channel than more distant beaches). Fish strandings were observed as a result of four types of vessel passages including: oil tankers, container ships, car carriers, and bulk carriers (in order of the vessels observed to cause the highest to lowest stranding frequency).

- Various biological factors – for example, the larger number of sub-yearling salmon that are present near the shoreline, the more fish that are likely to be stranded; salmon that are larger and relatively strong swimmers are generally less prone to stranding.

All of these factors can vary simultaneously, making it difficult to predict the location and to what degree strandings may occur. It is important to note that not all ship wakes strand fish. The Pearson

et al. (2006) study examined the statistical probability of strandings associated with deep-draft vessels transiting the lower Columbia River as part of the review of the Columbia River Channel Improvement Project. Pearson et al. (2006) specifically chose beaches along the lower Columbia River based on the following characteristics:

- all sites are known to have previously had juvenile salmon stranding (Bauersfeld, 1977);
- all sites have a gently sloping beach (previous work indicated that these beaches are prone to fish strandings);
- all beaches are exposed to ship wakes from the navigation channel; and
- all sites have evidence of fairly stable beach morphology.

The study looked at 126 vessel passages in three locations (County Line Park at CRM 51, Barlow Point at CRM 62, and Sauvie Island at CRM 97).

The three sites chosen for the Pearson et al. (2006) study are located upstream of Bradwood and the portion of the river LNG carriers would transit to the proposed LNG terminal. Reported strandings are greater upriver of the proposed LNG terminal compared to down river. Stranding events occurred in 46 of the 126 vessel passages observed. Of the fish that were stranded, the smaller fish of a cohort group tended to strand at a greater rate than larger fish from the same cohort group (Ackerman, 2002; Pearson et al., 2006). There is only one record of wake stranding (on Tenasillahe Island at about CRM 37) in the portion of the river downstream of the proposed LNG terminal site. There appear to be important differences in the lowermost 38 miles of the Columbia River compared with the portions of the river above the proposed LNG terminal site. The lower part of the river is broader and distances from the navigation channel to beaches are generally greater than in the upriver segment. The sampled densities of juvenile salmon are lower in the lower Columbia River shallows. Further, the effects of tides, currents, and winds may be more variable in the lower Columbia River.

Recognizing the limitations of the Pearson et al. (2006) stranding model for estimating stranding at sites other than the three beaches where the model was calibrated, Entrix (2008) developed a process model to identify regionally significant risk factors for stranding. Entrix (2008) then used bathymetric, aerial photographic, and other data sources to determine which beaches have the necessary risk factors.

Six risk factors for wake stranding were identified by the Entrix (2008) study:

- A confined channel – The type of long-period waves that have been observed to strand fish do not develop in unconfined channels.
- Distance from sailing line – Stranding has previously been encountered along the lower Columbia River on beaches up to 853 feet from the edge of the ship channel.
- Shielding features – Stranding is not observed on beaches that lack a "line of sight" to the navigational channel, so such beaches are presumably not at risk for stranding. Stranding risk is assumed to be low if a "line of sight" exists, but an intervening sand bar or the flows of a major tributary stream would disrupt the passage of a ship wake.
- Beach slope – Stranding is most often observed on beaches that have a very low slope. Stranding risk was assessed as high on beaches with a slope less than 2.5 percent, moderate on beaches with a 2.5 to 5 percent slope, low on beaches with a 5 to 10 percent slope, and minimal on beaches with a steeper slope.

- Presence of a berm – A berm is a break in bottom slope such that a shallow-water shelf exists offshore of the beach. Ship wakes propagate very effectively where there is a berm in water less than 18 feet deep, so much so that the presence of a berm is nearly a prerequisite for stranding to occur. Stranding risk increases as the berm becomes shallower; a high risk exists for berms less than 6 feet deep (CRD), a moderate risk exists for berms 6 to 12 feet deep, and a low risk exists for berms 12 to 18 feet deep.

- Fine-scale beach features – Certain beach features, such as riprap or vegetation, affect stranding risk. Aerial photography was reviewed to identify the occurrence of such features.

LNG carriers transiting the lower Columbia River over the operation life of the LNG terminal are likely to result in the stranding of some sub-yearling fish. Based on reasonably available information, we are not able to predict the level of fish strandings that would be directly associated with the Bradwood Landing Project. The quantitative results on the level of fish strandings from the stranding studies conducted to date cannot be extrapolated to other areas on the Columbia River because of the study designs and the varying forces that affect the important variables from one location to another. The FERC staff continues to study this issue in consultation with the NMFS, ODFW, and WDFW. The process model developed by Entrix (2008) will be expanded upon by conducting field analysis to groundtruth berms associated with beaches designated as high risk or greater. Additionally, a model will be developed to generate estimates of the number of fish expected to be impacted by LNG carrier activities. The new model will build from the Entrix (2008) process model described above by incorporating potential stranding risk, LNG carrier frequency and timing, juvenile salmonid run timing, and juvenile salmonid densities. These additional analyses regarding wake stranding effects on fish will be included in the revised BA and EFH Assessment.

Shoreline Erosion and Prop Wash

Prop wash from LNG carriers associated with the project, as well as ship wakes breaking on shore could cause increased erosion along the shoreline and resuspend the eroded material within the water column. Increased erosion and suspended sediment levels can adversely affect fish eggs and fish survival, benthic community diversity and health, and spawning habitat. At high concentrations, suspended sediments can affect oxygen exchange over the gills, resulting in weakened individuals or mortality.

Numerous comments were received on the draft EIS regarding the potential impacts on aquatic resources due to increased erosion and suspended sediment levels within the Columbia River. As described in section 4.1.2.3, LNG carrier wakes and tug propeller wash could impact shorelines along the route and contribute to erosion at a number of locations where the channel is narrow relative to vessel size, vessel speed remains high, shorelines are in close proximity to the sailing line, and banks already have suffered erosion from similar causes. Additional analysis of the potential impacts on salmonids from increased shoreline erosion due to LNG carrier wakes will be included in the revised BA and EFH Assessment. To minimize the potential for impacts on aquatic resources due to LNG carrier transit, **we recommend that:**

- **NorthernStar should coordinate with the NMFS to determine appropriate LNG carrier speed, or other applicable measures, to avoid or minimize impacts on juvenile fish from wake stranding and shoreline erosion due to LNG carrier transit along the waterway. Results of modeling and coordination, including any specific measures to be implemented, should be filed with the Secretary, <u>within 30 days</u> after issuance of the final EIS.**

Introduction of Exotic Species

LNG carriers in transit to and from the LNG terminal could import exotic species on their hulls and exterior equipment. The LNG carriers would come from the other side of the Pacific Ocean on a voyage taking approximately 3 weeks. Operators of commercial vessels have a significant economic interest in maintaining underwater body hull platings in a clean condition. Fouling of bottom platings would result in increased fuel costs for voyages and could also reduce the vessel's maximum transit speed. To prevent fouling and the associated economic costs, operators aggressively and conscientiously apply hull plating preservation and maintenance programs. Furthermore, failure to preserve and maintain hull plating not only raises short-term operation costs but also sets the stage for increased long-term hull maintenance costs. There is a particular sensitivity to this engineering and economic reality regarding commercial vessels operating at the higher end of the sailing rates schedule, as is the case for LNG carriers.

In addition to the antifouling program measures, fluid dynamics plays a practical role as a barrier to the introduction of invasive species in the manner described. The amount of water that passes over the hull and through the seachest is a massively large volume. The velocity of the seawater, abrasive by nature, along the hull would be expected to "waterblast" off anything that is not affixed to the hull (e.g., a barnacle). Normal ballast exchange requires only three changes of water through the ballast tanks to purge out any loading port organisms before arrival at the unloading port. These exchanges are done at sea and the exchanges occur at relatively low velocity. By contrast, the hull and seachest would have the equivalent of untold multiples of seawater exchange such that an organism on the hull or in the seachest would be flushed off with much more velocity and volume of water than the accepted international ballast exchange procedure.

The Coast Guard has developed responses to exotic/invasive organisms associated with foreign vessels. The Coast Guard Office of Operating and Environmental Standards developed *Mandatory Practices for All Vessels with Ballast Tanks on All Waters of the United States*. The mandatory practices include requirements to rinse anchors and anchor chains during retrieval to remove organisms and sediments at their place of origin and remove fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state, and federal regulations.

In addition, ships must have onboard and adhere to a Ballast Water Management Plan and must maintain a Ballast Water Record Book to record the intake and discharge of ballast water (IMO, 2004). As part of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, the IMO may institute more stringent requirements for the control of invasive organisms in ballast water, provided the convention is ratified by at least 30 member states (only 8 have currently ratified it). Under the 2004 convention, all ships with ballast water capacity more than 5,000 m^3 (which would include all LNG carriers) would be required to follow Ballast Water Exchange and/or Performance Standards, which include testing to demonstrate that potentially harmful organisms either are not present or are present in very small quantities. On September 2006, a federal district court ruled that by September 30, 2008, the EPA needs to take specific action to ensure that shipping companies comply with the intent of the CWA and restrict the discharge of ballast water into United States waters (Buck, 2006). While EPA has not developed specific actions, operation of the proposed project would be required to comply with any future EPA discharge requirements.

Based on above descriptions of hull plating surface treatments, the fluid dynamics along the LNG carrier's underwater body, and mandatory practices required by the Coast Guard and IMO, LNG carriers would not likely introduce exotic or invasive species into the lower Columbia River system.

Vessel Strikes

The addition of 125 vessel trips per year on the Columbia River and off the coasts of Oregon and Washington has the potential to result in collisions between LNG carriers and sea turtles and/or marine mammals. Although sea turtles and whales would not likely occur in the immediate vicinity of the LNG terminal, they could be affected by vessels transiting from areas located throughout the Pacific Basin. The potential for vessel strikes to affect sea turtles and/or marine mammals is discussed in detail in section 4.6.2.1. The potential also exists for vessel strikes to pinnipeds, as further discussed in section 4.6.2.1.

Release of LNG or Fuel

The potential exists for an LNG spill and associated fire during transit of the LNG carriers to the LNG terminal that could affect aquatic species occurring in the immediate vicinity of the spill. As described in section 4.11.5.3, the released LNG would vaporize rapidly upon contact with the air and water. Because LNG is not soluble in water and the LNG would completely vaporize shortly after being spilled, there would be no liquid left that could mix and/or contaminate the water. However, the greatest threat to aquatic species from an LNG spill would be thermal stress from the rapid change in water temperature due to contact with the cryogenic liquid (before the LNG vaporizes) or the fire associated with the ignited vapors. Any aquatic species in the immediate vicinity of the LNG or the fire would probably experience a sudden thermal shock that would be lethal. Aquatic species in the general area of a spill would most likely detect the temperature change and avoid the area. With implementation of the mitigation measures described in the Coast Guard's WSR (Appendix G), an LNG release would be highly unlikely, and therefore, the potential impacts on aquatic resources would be less than significant.

Fuel (e.g., diesel) used for vessel propulsion or auxiliary/emergency generators could potentially spill or leak. However, fuel on each ship is protected by the vessel's double hull. Furthermore, each LNG carrier would maintain a SOPEP which would contain measures to be implemented in the event of a petroleum release (see section 4.3.2.2).

4.5.1.2 Essential Fish Habitat

The MSA (Public Law 94-265 as amended through October 11, 1996) was established, along with other goals, to promote the protection of EFH in the review of projects conducted under federal permits, licenses, or other authorities that affect or have the potential to affect such habitat. EFH is defined in the MSA as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.

Federal agencies that authorize, fund, or undertake activities that may adversely impact EFH must consult with the NMFS. Although absolute criteria have not been established for conducting EFH consultations, the NMFS recommends consolidated EFH consultations with interagency coordination procedures required by other statutes, such as NEPA, the Fish and Wildlife Coordination Act, the ESA, and the Federal Power Act in order to reduce duplication and improve efficiency (50 CFR 600.920(e)). Generally, the EFH consultation process includes the following steps:

1) Notification – The action agency should clearly state the process being used for EFH consultations (e.g., incorporating EFH consultation into an EIS, section 10 permit).

2) EFH Assessment – The action agency should prepare an EFH Assessment that includes both identification of affected EFH and an assessment of impacts. Specifically, the EFH should include:

- a description of the proposed action;
- an analysis of the effects (including cumulative effects) of the proposed action on EFH, the managed fish species, and major prey species;
- the federal agency's views regarding the effects of the action on EFH; and
- proposed mitigation, if applicable.

3) EFH Conservation Recommendations – After reviewing the EFH Assessment, the NMFS should provide recommendations to the action agency regarding measures that can be taken by that agency to conserve EFH.

4) Agency Response – Within 30 days of receiving the recommendations, the action agency must respond to the NMFS. The action agency may notify the NMFS that a full response to the conservation recommendations will be provided by a specified completion date agreeable to all parties. The response must include a description of measures proposed by the agency to avoid, mitigate, or offset the impact of the activity on EFH.

We consolidated EFH consultations for the Bradwood Landing Project with the consultations required under the ESA. As such, we have prepared a BA and EFH Assessment for the Bradwood Landing Project and submitted it to the FWS and NMFS with a request to initiate the formal consultation process. The BA and EFH Assessment details the environmental baseline for EFH, federally listed species, and critical habitat; direct, indirect, interdependent and interrelated, and cumulative effects; proposed conservation measures; and determinations of effect. Based on comments from the FWS and NMFS, the FERC staff is currently revising the BA and EFH Assessment; upon completion, the BA and EFH Assessment will be resubmitted to the agencies with a request to initiate consultation.

Identification of Essential Fish Habitat along the Waterway for LNG Marine Traffic

EFH potentially affected by the proposed project was identified through written communication with the NMFS Portland Office (NMFS, 2006a). LNG carriers would transit from the proposed LNG terminal along the mainstem Columbia River to the mouth of the Columbia River and out to the edge of the EEZ. EFH in the Zones of Concern is shown on figure 4.5.1-1 and includes habitat for more than 90 species of groundfish, 5 species of coastal pelagic species, 2 species of salmon, and 13 highly migratory species.

Groundfish EFH

Based on the current *Fishery Management Plan* (FMP) for groundfish at the time of this writing, the overall extent of groundfish EFH for all fishery management unit species is identified as: 1) all waters and substrate within waters less than or equal to about 11,500 feet in relation to MHHW, or the upriver extent of saltwater intrusion (near Harrington Point at CRM 23); 2) seamounts in depths greater than about 11,500 feet as mapped in the EFH Assessment; and 3) areas designated as habitat areas of particular concern that are not already identified by the above criteria (PFMC, 2006a). However, the PFMC notes that these EFH designations are precautionary because they are based on the currently known maximum depth distribution of all life stages of groundfish (PFMC, 2006a).

The Pacific Coast groundfish FMP manages more than 90 species over a large and ecologically diverse area. Of these, spiny dogfish, big skate, Pacific herring, Pacific hake, black rockfish, kelp greenling, lingcod, cabezon, Pacific sanddab, butter sole, English sole, starry flounder, and sand sole are known to occur within the Columbia River estuary.

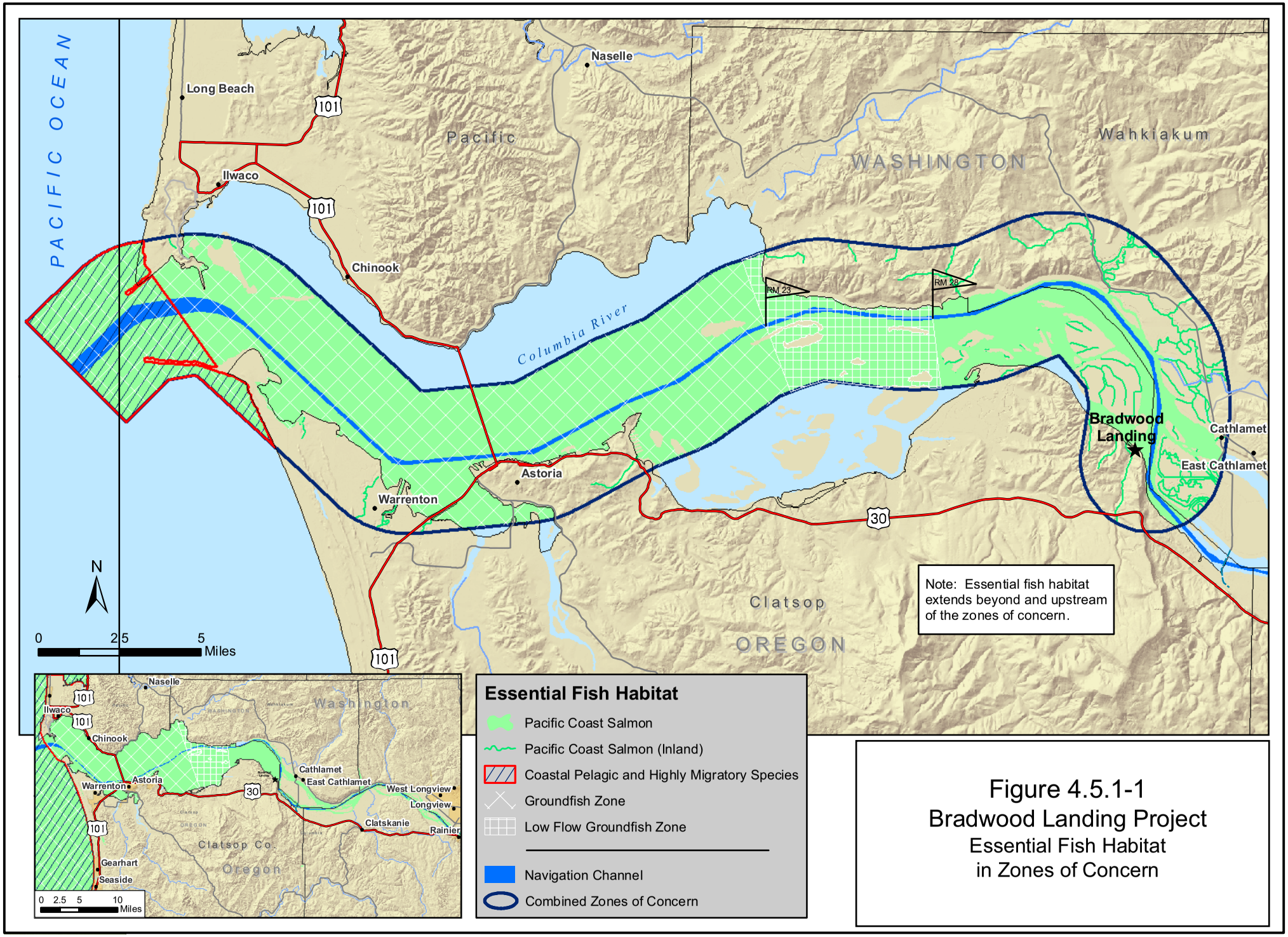


Figure 4.5.1-1
Bradwood Landing Project
Essential Fish Habitat
in Zones of Concern

Coastal Pelagic Species EFH

The EFH for coastal pelagics is defined by the species' temperature and geographic range during all life stages in the past, present, and where they could occur in the future. In addition to all marine and estuarine waters off the Pacific Coast to the limits of the EEZ, EFH for coastal pelagic species also includes portions of the water column where sea surface temperatures range between 50 °F (near the United States/Mexico maritime boundary) and 79 °F (seasonally and annually variable) (PFMC, 2006b).

The coastal pelagic species FMP includes five species: Northern anchovy, Pacific sardine, Pacific (chub) mackerel, jack mackerel, and market squid. Of these, two species (market squid and Pacific sardine) are known to occur in estuaries (PFMC, 1998).

Pacific Coast Salmon EFH

Pacific coast salmon EFH includes those waters and substrate necessary for salmon production needed to support a long-term sustainable salmon fishery and salmon contributions to a healthy ecosystem. In addition to all marine and estuarine waters off the Pacific coast to the limits of the EEZ, EFH for the Pacific coast salmon fishery includes all streams, lakes, ponds, wetlands, and other currently viable waterbodies and most habitat historically accessible to salmon. Excluded are some areas upstream of certain impassable man-made barriers (e.g., dams as identified by the PFMC in Appendix A of *Amendment 14 to the Pacific Coast Salmon Plan*), and longstanding, naturally impassable barriers (e.g., natural waterfalls in existence for several hundred years) (PFMC, 2000).

Based on available life history information, freshwater EFH for Pacific coast salmon consists of four major components:

- spawning and incubation habitats;
- juvenile rearing habitat;
- juvenile migration corridors; and
- adult migration corridors and holding habitat (Roni et al., 1999).

Important features of habitat for spawning, rearing, and migration include:

- substrate composition;
- water quality (i.e., dissolved oxygen, nutrients, temperature);
- water quantity, depth, and velocity;
- channel gradient and stability;
- food availability;
- cover and habitat complexity (e.g., LWD, pools, channel complexity, aquatic vegetation);
- space (habitat area);
- access and passage; and
- floodplain and habitat complexity.

Highly Migratory Species EFH

The EFH for highly migratory species is defined by the species' temperature and geographic range during all life stages in the past, present, and where they could occur in the future. In addition to all marine and estuarine waters off the Pacific coast to the limits of the EEZ, EFH has been designated for individual species due to their highly variable life histories. In general, species are found in temperate

waters with varying distributions and abundance based on oceanic environmental conditions including water temperature, current patterns, and the availability of prey (PFMC, 2003).

The highly migratory species FMP includes five species of tuna (north Pacific albacore, yellowfin, bigeye, skipjack, and northern bluefin), five species of shark (common thresher, pelagic thresher, bigeye thresher, shortfin mako, and blue), two billfish/swordfish (striped marlin and Pacific swordfish), and dorado (also known as dolphinfish and mahi-mahi). Five additional species (great white shark, megamouth shark, basking shark, Pacific halibut, and Pacific salmon) are included in the highly migratory species FMP for monitoring. Highly migratory species are pelagic and generally occur in the open ocean. Although they may spend part of their life cycle in nearshore waters, these species are not associated with estuaries (PFMC, 2003; PFMC, 2007).

Impacts on EFH

The PFMC (2000) identified potential sources of impacts on salmon EFH from non-fishing related activities. These include habitat modification or loss by actions that involve dredging, placement of fill, bank stabilization, removal of shoreline vegetation, waterway crossings for pipelines and conduits, removal of riparian vegetation, channel realignment, and the construction of docks and piers. In addition, construction adjacent to EFH could increase run-off of sediment, excess nutrients, chemicals, and petroleum products, all of which can adversely affect EFH (PFMC, 2006b). Potential adverse impacts on groundfish, coastal pelagic species, salmon, and highly migratory species are listed in table 4.5.1-1 and are discussed below.

TABLE 4.5.1-1

Potential Impacts on EFH Due to LNG Marine Traffic

EFH	Description of EFH	Project Action with Potential Impacts on EFH	Determination of Effect
Coastal Pelagic Species	All marine and estuarine waters from the coast to the limits of the EEZ and above the thermocline where sea surface temperatures range between 50 °F and 79 °F.	Accidental spill or leak of hazardous materials.	Minimal adverse effect or less than substantial adverse effect on EFH (see section 4.5.1.1 for a discussion of mitigation measures).
Groundfish	Aquatic habitat from the extent of saltwater intrusion in river mouths to the boundary of the EEZ.	Accidental spill or leak of hazardous materials.	Minimal adverse effect or less than substantial adverse effect on groundfish EFH (see section 4.5.1.1 for a discussion of mitigation measures).
Pacific Coast Salmon	All streams, lakes, ponds, wetlands, and other waterbodies currently and historically accessible to salmon.	Accidental spill or leak of hazardous materials.	Substantial adverse effect on Pacific Coast salmon EFH (see section 4.5.1.1 for a discussion of mitigation measures).
Highly Migratory Species	All marine waters from the coast to the limits of the EEZ.	Accidental spill or leak of hazardous materials.	Minimal adverse effect or less than substantial adverse effect on EFH (see section 4.5.1.1 for a discussion of mitigation measures).

Source: Pacific Fishery Management Council, 2006b.

Aspects of LNG marine traffic with the potential to adversely affect designated EFH along the LNG carrier transit route would be limited to accidental spills or leaks of hazardous materials. A discussion of measures that would be implemented to avoid or minimize impacts on aquatic resources (which includes EFH) due to an accidental spill or leak of hazardous materials is presented in section 4.5.1.1. As noted previously, the FERC staff is currently revising its BA and EFH Assessment for the Bradwood Landing Project, which will be resubmitted to the NMFS with a request to initiate formal

consultation in compliance with section 7 of the ESA and the MSA. The FERC will respond to any EFH Conservation Recommendations issued by the NMFS through the EFH/ESA consultation process.[13]

4.5.1.3 Terrestrial Wildlife

As described in section 4.4.2, nine upland vegetative communities occur within the Zones of Concern along the waterway. These communities provide nesting, cover, dispersal, and/or foraging habitat for a variety of wildlife. Open water and wetland habitats also provide these functions for wildlife species. Potential impacts on these habitats are described and quantified in sections 4.3.2.2 and 4.4.1.1, respectively.

Wildlife species that commonly occur in the communities along the waterway are described in table 4.5.1-2. The most prevalent upland habitats within the Zones of Concern along the waterway are forest (i.e., coniferous, deciduous, mixed, early seral, and riparian forests) and wetlands (i.e., estuarine intertidal and submerged and palustrine emergent, scrub-shrub, forested, and multiple wetland types). Forest habitats provide the greatest vertical structure and support diverse faunal assemblages. Wetland habitats support diverse floral species and provide foraging and dispersal habitat for a wide variety of wildlife species. A portion of the forest and wetland habitats would also be considered riparian habitat. Similar to the other forest habitats, riparian forest provides significant vertical structure, and generally supports the most diverse faunal assemblages of the affected habitats.

General Impacts on Terrestrial Wildlife

Potential impacts from LNG carrier transit along the waterway on terrestrial wildlife species and their habitats would generally be limited to increased shoreline erosion resulting from LNG marine traffic along the Columbia River and an accidental or intentional release of LNG during transit of the LNG carriers. As discussed in detail in section 4.1.2.3, the proposed project would increase deep-draft vessel traffic by about 25 percent. The LNG carriers would be larger than most of the deep-draft ships currently using the Columbia River; although larger ships are expected to transit the Columbia River once the Columbia River Channel Improvement Project is completed. Because the blockage ratio of the LNG carriers would be greater than that of most deep-draft ships currently traveling the Columbia River, the LNG carriers could produce slightly larger waves than most of the current ships operating at the same speed. LNG carriers would travel at speeds between 8 and 12 knots while on the Columbia River. The degree to which current ship traffic affects shorelines along the waterway is difficult to quantify due to the various other factors which contribute to shoreline erosion and accretion processes. A detailed analysis of the potential for increased shoreline erosion due to LNG carrier wakes will be included in the revised BA and EFH Assessment. However, we have also recommended in section 4.1.2.3 that NorthernStar coordinate with the NMFS to determine appropriate restrictions on LNG carrier speed, or other applicable measures, to avoid or minimize shoreline erosion due to LNG carrier transit along the waterway.

[13] Records of communications between the FERC and NMFS related to the consultation process for this project are available through http://www.ferc.gov/docs-filing/elibrary.asp.

TABLE 4.5.1-2

Wildlife Species Occurring within the Vegetative Communities along the Waterway and in the Vicinity of the Bradwood Landing LNG Terminal

Vegetative Communities	Typical Wildlife Found within the Vegetative Communities
Forest [a]	**Amphibians:** northwestern salamander, western red-backed salamander, roughskinned newt, western toad, Pacific treefrog, red-legged frog, bullfrog [d]. **Reptiles:** rubber boa, common garter snake, northwestern garter snake. **Mammals**: beaver, big brown bat, black bear, black-tailed deer, bobcat, bushy-tailed woodrat, California myotis, Columbian white-tailed deer, cougar, coyote, deer mouse, Douglas squirrel, elk, forest deer mouse, hoary bat, little brown myotis, long-eared myotis, long-legged myotis, mink, mountain beaver, porcupine, raccoon, red fox, Roosevelt elk, silver-haired bat, striped skunk, Townsend's chipmunk, vagrant shrew, western gray squirrel, Yuma myotis. **Birds:** American robin, bald eagle, barred owl, belted kingfisher, blue grouse, black-capped chickadee, dark-eyed junco, downy woodpecker, great blue heron, great-horned owl, hairy woodpecker, northern flicker, olive-sided flycatcher, osprey, peregrine falcon, red-breasted nuthatch, red-tailed hawk, ruby-crowned kinglet, ruffed grouse, rufous hummingbird, song sparrow, spotted towhee, Steller's jay, Swainson's thrush, varied thrush, willow flycatcher, winter wren, and yellow-rumped warbler.
Scrub-Shrub [b]	**Amphibians**: Pacific treefrog, red-legged frog, bullfrog [d]. **Reptiles:** rubber boa, northwestern garter snake, common garter snake. **Mammals**: beaver, big brown bat, black-tailed deer, California myotis, Columbian white-tailed deer, coyote, deer mouse, hoary bat, little brown myotis, long-eared myotis, long-legged myotis, mink, nutria [d], raccoon, red fox, Townsend's vole, Yuma myotis. **Birds:** American kestrel, American robin, Bewick's wren, dark-eyed junco, great blue heron, marsh wren, song sparrow, red-winged blackbird, red-tailed hawk, rufous hummingbird, white-crowned sparrow, wood duck.
Wetlands [c]	**Amphibians:** northwestern salamander, western toad, Pacific tree frog, red-legged frog, bullfrog [d], Oregon spotted frog. **Reptiles:** western painted turtle, northwestern pond turtle, common garter snake. **Mammals**: beaver, big brown bat, black bear, California myotis, coyote, hoary bat, little brown myotis, long-eared myotis, long-legged myotis, mink, muskrat, northern river otter, nutria [d], raccoon, striped skunk, silver-haired bat, Townsend's big-eared bat, vagrant shrew, Yuma myotis. **Birds:** American coot, belted kingfisher, Bewick's wren, black-bellied plover, black-capped chickadee, Canada goose, cinnamon teal, cliff swallow, common snipe, dunlin, great blue heron, greater yellowlegs, mallard, marsh wren, northern harrier, northern pintail, northern shoveler, peregrine falcon, pied-billed grebe, purple finch, red-winged blackbird, short-billed dowitchers, song sparrow, sora, tree swallow, violet-green swallow, Virginia rail, western sandpiper.
Streams and Ponds	**Amphibians:** long-toed salamander, northwestern salamander, Pacific giant salamander, western toad, Pacific tree frog, red-legged frog, bullfrog [d], Oregon spotted frog, tailed frog. **Reptiles:** western painted turtle, northwestern pond turtle, common garter snake, rubber boa. **Mammals**: beaver, big brown bat, black bear, California myotis, coyote, hoary bat, little brown myotis, long-eared myotis, mink, muskrat, nutria [d], raccoon, silver-haired bat, Townsend's big-eared bat, Yuma myotis. **Birds:** Bewick's wren, black swift, black-capped chickadee, black-throated gray warbler, common yellowthroat, olive-sided flycatcher, peregrine falcon, rufous hummingbird, song sparrow, spotted towhee, yellow warbler, American dipper, band-tailed pigeon, barn swallow, belted kingfisher, Bullock's oriole, common merganser, great blue heron, green heron, hooded merganser, mallard, mourning dove, red-eyed vireo, ruffed grouse, spotted sandpiper, warbling vireo, willow/alder flycatcher, Wilson's warbler, wood duck, yellow-breasted chat.
Nearshore	**Mammals**: beaver, big brown bat, black bear, California myotis, Pacific harbor seal, hoary bat, little brown myotis, long-eared myotis, long-legged myotis, mink, muskrat, northern river otter, nutria [d], raccoon, silver-haired bat, Steller sea lion, Townsend's big-eared bat, Yuma myotis. **Birds:** American dipper, bald eagle, bufflehead, California gull, Canada goose, Caspian tern, common goldeneye, cormorants, great blue heron, greater scaup, lesser scaup, mallard, northern rough-winged swallow, osprey, peregrine falcon, purple martin, red-winged blackbird, ring-billed gull, rock dove [d], western grebe.
Dredged Materials and Bare Ground	**Reptiles:** common garter snake, northwestern garter snake. **Mammals:** black-tailed deer, deer mouse, raccoon. **Birds:** American Crow, house sparrow [d], killdeer, mourning dove, rock dove [d], song sparrow, spotted towhee**.**

[a] Forested communities include coniferous, deciduous, mixed, early seral, and riparian forests.

[b] Scrub-shrub communities include both upland scrub-shrub and riparian scrub-shrub.

[c] Wetland communities include estuarine intertidal and submerged as well as palustrine emergent, scrub-shrub, forested, and multiple wetland types.

[d] Non-native species or invasive species occurring along the waterway or at the LNG terminal site.

In the unlikely event of a collision or allision of sufficient magnitude to rupture an LNG cargo tank, it is likely that sparks or flames would ignite the flammable vapors at the spill site. If that ignition did not occur, an LNG spill would rapidly vaporize on water and form a potentially flammable cloud. If the flammable vapor cloud encountered an ignition source, the cloud would burn back to the spill site, rather than outward towards shoreline habitats. However, it is possible that ignition of the LNG vapors could contribute to a forest fire in areas where the Columbia River navigation channel is adjacent to forested areas (e.g., between Altoona and Skamokawa). Given the relatively high precipitation in the region, large forest fires in the area are infrequent but they can be severe when they do occur. The intensity and extent of a potential forest fire would be highly dependent on a number of variables including available fuel (e.g., woody material), moisture and temperature, fuel composition, wind, and topography. With implementation of the mitigation measures described in the Coast Guard's WSR (Appendix G), an LNG release would be highly unlikely, and therefore, the potential impacts on terrestrial wildlife would be less than significant.

Unique or Sensitive Wildlife Habitats

Julia Butler Hansen National Wildlife Refuge

The JBHNWR is located between CRMs 33.5 and 39 and includes the Hunting Islands and Price Island in Washington as well as Tenasillahe Island, portions of Crims Island, Wallace Island, and several mainland parcels in Oregon. It contains approximately 6,100 acres of pasture, forested tidal swamp, brushy woodlots, marshes and sloughs along the Columbia River, including nearly 4,800 acres of diked floodplain and undiked islands. As described in section 4.6.1.1, the JBHNWR supports three subpopulations of Columbian white-tailed deer, which are federally listed as endangered under the ESA. During transit along the waterway, LNG carriers within the navigation channel would be adjacent to JBHNWR refuge lands between CRM 33.5 and the proposed LNG terminal. Although potential impacts on the JBHNWR resulting from LNG marine traffic associated with the proposed project would be limited to increased shoreline erosion and an accidental or intentional release of LNG during transit of the LNG carriers, these impacts could negatively influence management and recovery activities within the JBHNWR as discussed below.

As discussed above and in section 4.1.2.3, the proposed project would increase deep-draft vessel traffic by about 25 percent. The degree to which current ship traffic affects shorelines along the waterway is difficult to quantify due to the various other factors which contribute to shoreline erosion and accretion processes. Therefore, it is difficult to determine what additional impacts on the shorelines of the JBHNWR would occur as a result of increased LNG marine traffic. However, we have recommended in section 4.1.2.3 that NorthernStar coordinate with the NMFS to determine appropriate restrictions on LNG carrier speed, or other applicable measures, to avoid or minimize shoreline erosion due to LNG carrier transit along the waterway. In addition, NorthernStar prepared a *Shoreline Monitoring Plan*, which is described in section 4.1.3.3 that includes measures to reduce erosion of downstream banks should such erosion increase as a result of the project. The FERC staff continues to study this issue and additional analysis regarding shoreline erosion will be included in the revised BA and EFH Assessment.

Potential impacts on the JBHNWR from a release of LNG and associated fire include habitat modification as well as injury or mortality of species occurring within the JBHNWR. In its December 21, 2007 letter on the draft EIS, the U.S. Department of the Interior stated that Tenasillahe Island and the Mainland Refuge Unit would be especially vulnerable to adverse effects associated with the release of LNG and associated fire. In the event of a collision or allision of sufficient magnitude to rupture an LNG cargo tank, it is likely that sparks or flames would ignite the flammable vapors at the spill site. In the unlikely event that ignition did not occur, an LNG spill would rapidly vaporize on water and form a potentially flammable vapor cloud. If the flammable vapor cloud encountered an ignition source, the

LNG vapors could contribute to a forest fire within the JBHNWR. Given the relatively high precipitation in the region, large forest fires in the area are infrequent but they can be severe when they do occur. The intensity and extent of a potential forest fire and the resulting damage to the JBHNWR would be highly dependent on a number of variables including the extent of the LNG spill, available fuel (e.g., woody material), moisture and temperature, fuel composition, wind, and topography. Approximately 5,000 acres of the JBHNWR are within the Zones of Concern, a portion of which could be affected if an accidental or intentional breach of an LNG carrier were to occur during transit. However, as discussed in section 4.11.5.3, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G). Potential impacts on the Columbian white-tailed deer as a result of an LNG release are discussed in section 4.6.1.4.

Lewis and Clark National Wildlife Refuge

The LCNWR is located between CRMs 18.5 and 35 and includes 35,000 acres of islands, bars, mud flats, and tidal marshes in the Columbia River estuary. The eastern boundary of the refuge is located immediately west of the JBHNWR on Welch Island. The refuge is the largest marsh in western Oregon and was established to preserve wetland habitats in the lower Columbia River estuary and serve as a wintering area for migratory waterfowl and shorebirds. The LCNWR provides resting habitat for peak populations of 1,000 tundra swans, 5,000 Canada geese, and 50,000 ducks in February and March before the northward migration. Between 30 and 35 active bald eagle nests occur within the refuge. In addition, estuarine waters within the refuge provide foraging habitat for juvenile salmonids before entering the Pacific Ocean. Other fish species using the estuary include shad, smelt, perch, starry flounder, bass, catfish, and Pacific lamprey. Pacific harbor seals use sandbars and mud flats as resting sites at low tides, while seals and California sea lions feed on fish in the estuary. Beaver, raccoon, weasel, mink, muskrat, and river otter also live on the islands. Potential impacts on the LCNWR resulting from LNG marine traffic associated with the proposed project would be limited to increased shoreline erosion and an accidental or intentional release of LNG during transit of the LNG carriers. The potential for increased shoreline erosion at the LCNWR would be similar to that described above for the JBHNWR.

The islands composing the LCNWR occupy approximately 21,800 acres within the Zones of Concern, a portion of which could be affected if an accidental or intentional breach of an LNG carrier were to occur during transit. Potential impacts on the LCNWR from a release of LNG and associated fire would be similar to those described above for the JBHNWR and include habitat modification as well as injury or mortality of species occurring within the LCNWR. The intensity and extent of a potential forest fire and the resulting damage to the LCNWR would be highly dependent on a number of variables including the extent of the LNG spill, available fuel (e.g., woody material), moisture and temperature, fuel composition, wind, and topography. Similarly, injury and mortality to species would also be dependent on the time of year that the incident occurred as well as the mobility of the species.

Fort Stevens State Park

Fort Stevens State Park comprises approximately 4,300 acres and is located west of Warrenton, Oregon. According to the *Oregon Estuary Plan Book* (ODLCD, 2007), this state park contains some significant wildlife habitat. Two islands north of Fort Stevens State Park within the Columbia River also contain significant habitat. Potential impacts on Fort Stevens State Park resulting from the proposed project would be similar to those described above for the JBHNWR and LCNWR.

Mitigation Measures

As part of its Compensatory Mitigation Plan, NorthernStar would restore areas along the shoreline of the lower Columbia River at Svensen Island and preserve habitat at the mouth of Hunt Creek. However, the existing version of the Compensatory Mitigation Plan does not include a discussion of potential impacts on habitat due to LNG carrier traffic. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. To ensure that the proposed mitigation adequately compensates for project-related impacts, including impacts on downstream habitats from shoreline erosion, we recommended that NorthernStar continue to consult with the appropriate natural resource agencies to finalize its Compensatory Mitigation Plan. The final Compensatory Mitigation Plan would be filed along with agency comments and applicable approvals with the Secretary prior to construction of the project.

4.5.2 LNG Terminal

4.5.2.1 Aquatic Resources

The Bradwood Landing LNG terminal, which would be located at CRM 38, is upstream of the extent of saltwater intrusion (near Grassy Island at CRM 30) and is near the upriver estuarine boundary at CRM 38 (downstream edge of Puget Island) (Fox et al., 1984). The Columbia River near the LNG terminal site provides habitat for a variety of anadromous and resident fish species and is discussed below. A detailed discussion of aquatic species that have designated EFH in the vicinity of the LNG terminal or are listed as endangered or threatened is included in sections 4.5.2.2 and 4.6.1.1, respectively.

Existing Aquatic Resources

Marine Fish

Because the LNG terminal would be located near the upriver estuarine boundary of the Columbia River, with the exception of the starry flounder, marine species are not likely to occur at the proposed site. The starry flounder has been known to swim greater than 75 miles up major rivers but does not follow any migratory trend (NMFS, 2006e). All life stages (eggs, larvae, juveniles, and adults) of the starry flounder are present in estuaries; however, only juveniles and adults occur in freshwater. The starry flounder is discussed in detail in section 4.5.2.2.

The Columbia River near the LNG terminal site provides habitat for both anadromous and resident fish species. These species are described under the waterway for LNG marine traffic in section 4.5.1.1.

Freshwater Fish

Resident freshwater fish within the project area include both coldwater (trout) and warmwater (bass, crappie, and bluegill) species. These species are described in section 4.5.1.1.

Marine Mammals

Steller sea lions, California sea lions, and Pacific harbor seals use haulout sites along the lower Columbia River and may occur in the vicinity of the proposed LNG terminal (Appendix C). These species and other marine mammals are protected by the Marine Mammal Protection Act of 1972 and are described further in section 4.6.1.3. In addition to protection under the Marine Mammal Protection Act, Steller sea lions are federally and state-listed and are described in section 4.6.1.1.

Commercial and Recreational Fisheries

Commercial and recreational fisheries of the lower Columbia River are described in section 4.5.1.1.

Fisheries of Special Concern

Fisheries resources of special concern occurring in the vicinity of the LNG terminal include: 1) federally designated EFH for coho and Chinook salmon, as well as starry flounder; 2) species listed federally as threatened, endangered, or candidates for listing under the ESA and their designated or proposed critical habitat; and 3) species listed as threatened or endangered by the State of Oregon. Potential impacts on EFH at the LNG terminal are discussed in section 4.5.2.2. Potential impacts on federally and state-listed species and their critical habitat are discussed in section 4.6.2.2.

Impacts on Aquatic Resources

General project activities associated with the proposed LNG terminal that could potentially impact aquatic resources include in-water construction activities, habitat modification, water appropriations, artificial lighting, accidental spills or leaks of hazardous materials, and operation of the LNG terminal. Much of the impact discussion included below applies to fish protected under the ESA, which are described in detail in sections 4.6.1.1 and 4.6.2.2, and to EFH designated under the MSA, which is discussed further in section 4.5.2.2. As described above, Steller sea lions occurring within the vicinity of the proposed LNG terminal are protected under the ESA and the Marine Mammal Protection Act and are discussed in detail in sections 4.6.1.1 and 4.6.2.2.

<u>In-Water Construction Activities</u>

Fish, marine mammals, and other aquatic resources could be impacted by in-water construction activities including dredging, development of the river shoreline, pile driving, and filling of the log pond at the LNG terminal site. Direct impacts of in-water construction activities on aquatic resources would include the displacement of aquatic resources within the affected area and direct mortality of some individuals. During construction activities, mobile species, such as fish and marine mammals, would be expected to leave the vicinity of the project area. Animals displaced by construction activities may relocate into similar habitats nearby; however, the lack of adequate territorial space could force some animals into suboptimal habitats. The influx and increased density of animals in some undisturbed areas caused by these dislocations could increase inter- and intra-species competition and also reduce the reproductive success of animals that are not displaced by construction. The loss of these individuals could result in a decrease in the food stock available for predators of these species.

Comments were received on the draft EIS regarding impacts on shallow water habitat due to construction of the LNG terminal facilities. As described in section 4.4.1.1, shallow water habitat is defined as being between elevations slightly above MLLW and 6 feet below MLLW. Medium depth water is between 6 and 18 feet below MLLW, while deep water is defined as 18 feet and deeper (LCFRB, 2004). However, shallow water habitat as it relates to fish habitat generally refers to waters less than 20 feet deep. Therefore, the discussion of shallow water habitat that follows includes the shallow and medium depth water as defined by the LCFRB. Based on the description of the maneuvering area and berth in section 2.1.3, in-water construction activities impacting shallow water habitat would be limited to the driving of piles associated with the berth, which would occupy less than 0.1 acre of habitat. It is important to note that the ship berth and maneuvering area would be located approximately 300 feet from the shore. Therefore, direct impacts on shallow water habitat as a result of dredging are not anticipated.

The degree of impacts on aquatic resources associated with construction activities would depend on the timing of in-water construction. Construction during periods of sensitive fish activity (i.e., spawning, juvenile rearing, and migration) can have a greater impact on fish than construction during other periods. To minimize impacts on fish in the Columbia River, NorthernStar would limit dredging and other in-water activities to the November 1 through February 28 in-water work window recommended by the NMFS (NMFS, 2005a). Similarly, in-water activities at Hunt Creek would be limited to the July 1 through September 15 in-water work window recommended by the ODFW (ODFW, 2000).

Dredging

The water column and substrate in the vicinity of the proposed LNG terminal provides habitat for spawning, breeding, feeding, growth, migration, and shelter to numerous species of fish. Additionally, prey species occur within the water column and sediments within the ship berth and maneuvering area.

As discussed in section 2.4.1.2, NorthernStar proposes to dredge the LNG carrier berth and maneuvering area using a hydraulic cutterhead dredge with a 30-inch discharge pipe and a 4,950 horsepower pump. Dredging equipment would operate 24 hours per day, 7 days per week, pending any restrictions specified in the permits necessary for these activities. The exact time needed for dredging would depend on a number of variables that cannot be predicted, such as weather and river conditions; however, NorthernStar estimates that the dredging would be accomplished in about 48 to 72 days. Construction of the berth would require the removal of 700,000 cubic yards of sediments, increasing the water depth from an average of -33 feet CRD to -42 feet CRD with a 1-foot overdredge allowance. Dredging activities have the potential to impact aquatic resources through habitat alteration, temporary increases in suspended sediment and turbidity levels, removal of benthic organisms, resuspension of contaminated sediments, entrainment, increased noise, and alterations to sediment transport and deposition.

Habitat Alteration. Dredging of the berth and maneuvering area would result in permanent modification of aquatic habitats. Removing sediment from the river bottom, increasing the water depth an average of approximately 9 feet, and constructing over-water structures could potentially affect use of the project area by aquatic species. The removal of sediment from the river bottom is discussed in section 4.2.2.2. Increasing the water depth an average of approximately 9 feet could potentially result in reduced use of the area by juvenile fish. However, NorthernStar would mitigate for reduced habitat quality at the berth and maneuvering area through restoration and/or preservation of several times as much area of high quality habitat at the Svensen Island and Hunt Creek Mitigation Sites (see *Mitigation Measures*, below). Impacts on aquatic species from construction of over-water structures is discussed below (see *Habitat Modification, Over-water Structures*).

Increased Suspended Sediment and Turbidity Levels. Both anadromous and resident fish populations could be impacted by increased concentrations of suspended sediments as a result of dredging activities. This increase, known as a sediment plume, may delay or divert migratory passage and, in some instances, could cause total avoidance of an area by fish. Increased sedimentation can also adversely affect fish eggs and juvenile fish survival, benthic community diversity and health, foraging success, and suitability of spawning habitat. Suspended particles and sediment can result in increased turbidity, reducing in-water visibility that can affect the ability of sight-feeders to locate prey. In sufficient quantities, increased turbidity levels can affect oxygen exchange over the gills in aquatic species, resulting in weakened individuals or mortality. Additionally, sediments in the water column can be redeposited on downstream substrates, which could bury aquatic macroinvertebrates (an important food source for many species of fish). These potential effects could be exacerbated if the fish are in generally poor condition and under stress by other factors (i.e., increased water temperature).

The size and duration of the sediment plume is highly dependent upon the grain size of the material being dredged. As described in section 4.2.2.2, SWCA conducted a sediment analysis of the material which would be dredged as part of the proposed project. Within the dredge footprint, the substrate is almost exclusively sand, with very low silt and clay components (SWCA, 2006). Sand settles rapidly in the water column. In addition, WEST (2006) conducted hydraulic and sediment transport analyses using a combination of the RMA2 hydrodynamic model and the SED2D-WES sediment transport model (WEST, 2006). Based on its modeling, WEST concluded that the maximum sediment concentration would occur within 10 feet of the cutterhead. WEST's hydrodynamic modeling predicts project-related suspended sediment loads would be a maximum of 1 mg/L at the dredge site and diminish to 0.1mg/L before reaching Tenasillahe Island. By comparison, background measurements of TSS during the field program were on the order of 10 mg/L. Therefore, even assuming a considerable level of uncertainty in any of the model parameters, the impacts of the dredging operation would be very small and confined to an area immediately surrounding the proposed facility. The combined background and project-related suspended sediment concentrations are well below the lethal level for fish (WEST, 2006; Newcombe and MacDonald, 1991).

Background levels of turbidity in the Columbia River range from 3 to 8 NTUs. As discussed in section 4.3.2.3, WEST concluded that turbidity plumes from cutterhead dredging similar to the proposed dredging at Bradwood would return to within 1 NTU of background levels within 1 minute after suspension (WEST, 2006). Servizi and Martens (1992) found that 37 NTUs is the threshold for avoidance by juvenile coho and steelhead. Although the WEST report does not provide the maximum turbidity levels expected during dredging activities, the predicted suspended solid concentrations provided above indicate that turbidity levels from dredging activities would be well below the 37 NTU threshold. Therefore, impacts on aquatic species from increased turbidity levels would not be significant.

Removal of Benthic Organisms. Dredging may adversely affect prey species at the LNG terminal site by directly removing or burying immobile invertebrates. Species of aquatic organisms that exist on or within the bottom sediments include the sand shrimp (*Crangon* spp.), daphnia (*Daphnia* spp.), and copepods. These are all important prey organisms for the fish species present in the estuary (Bottom and Jones, 1990). Recolonization varies considerably with geographic location, sediment composition and types of organisms inhabiting the area (Kennish, 1997). Rates of recovery range from several months to as much as 2 to 3 years based on substrate type and currents in the affected area (NMFS, 2003).

Resuspension of Contaminated Sediments. SWCA (2006; 2007) conducted sediment sampling and analysis to determine the presence of contaminants within the proposed dredged materials and leave surface. As discussed in section 4.2.2.2, no elevated contaminant concentrations were detected. Comments were received on the draft EIS related to the potential for bioaccumulation of contaminants to occur due to dredging activities. The long-term bioaccumulative effects of pollutants on aquatic resources resulting from construction and operation of the proposed project cannot be characterized with the best available science. Bioaccumulative effects can result from a variety of physical, chemical, and biological processes. However, the concentration of contaminant levels reported in section 4.2.2.2 of the EIS does not indicate a likely significant biological effect.

Entrainment. Some fish may be susceptible to entrainment during dredging operations. Entrainment occurs when small fish (such as juvenile salmonids), eggs, and larvae are drawn through the screens of water intakes and cannot escape. Adult fish of medium to large species (such as salmonids) have sufficient swimming ability to avoid entrainment by dredging if they are present in the vicinity of dredges. NorthernStar would minimize fish entrainment during dredging activities by keeping the cutterhead within 3 feet of the river bottom and conducting dredging activities during specified in-water work window when the densities of fish in the project area is lowest.

Increased Noise. Dredging activities associated with construction and operation of the project would generate underwater sound pressure levels that could elicit responses in some fish, marine mammals, and other aquatic organisms (Richardson et al., 1995). Unfortunately, relatively little is known about the effects from exposure to underwater sound on most aquatic organisms, particularly fish (Hastings and Popper, 2005). Even in cases where data are available, most experts recommend extreme caution in attempting to extrapolate between species (Hastings and Popper, 2005). The intensity of the sound pressure levels from dredging activities can be quite variable. However, sound pressure levels are generally in the range of 112 to 160 decibels (dB) (re: 1 microPascal (μPa)), intensities that may influence organism behaviors or perceptions, but are unlikely to cause physiological damage (Richardson et al., 1995; Hanson et al., 2003). As described in section 4.6.2.2, it is possible that marine mammals could be adversely impacted by dredging activities. NorthernStar proposes to implement protective measures including the establishment of Safety, Buffer, and Impact Zones to protect the Steller sea lion during construction activities at the LNG terminal. To provide similar protections to other pinnipeds potentially occurring in the project area, we have recommended that NorthernStar expand the protective measures that would be used to avoid or minimize impacts on Steller sea lions during construction of the LNG terminal (i.e., Safety, Buffer, and Impact Zones) to include all pinnipeds (see section 4.6.2.2).

Alterations to Sediment Transport and Deposition. In addition to impacts on aquatic resources during dredging activities, dredging the berth and maneuvering area would result in long-term impacts on sediment transport and deposition. As discussed in section 4.2.2.2, modeling conducted by WEST analyzed potential impacts on sediment transport and deposition at low flow (125,000 cfs), normal flow (210,000 cfs), high flow (545,000 cfs), and extremely high flow conditions (864,000 cfs). Based on the WEST model, the proposed project would cause a reduction in stream flow through the Clifton Channel, resulting in a reduction of the water surface profile, shear stresses, and flow velocities through the channel. As a result of this, deposition may occur during high flows along the Clifton Channel. However, the results do not show significant changes to the overall bed conditions in the Clifton Channel for the range of flows modeled. Although the results of the WEST model did not indicate that significant changes to Clifton Channel would be anticipated, the small changes in the hydraulic characteristics associated with the proposed project could result in changes to existing fish habitats within other portions of the lower Columbia River.

As described in section 4.2.2.2, numerous comments were received on the draft EIS regarding the adequacy of the WEST modeling. As it relates to potential impacts on aquatic resources, the model does not address long-term alterations to sediment transport and deposition within Clifton Channel and/or the lower Columbia River, which could alter biological function and value for aquatic resources. Impacts on aquatic resources (including salmonids) attributed to changes in sediment transport and deposition may occur as a result of the proposed project. Additional analysis of potential impacts on salmonids from alterations to sediment transport and deposition will be included in the revised BA and EFH Assessment.

The biological impacts on aquatic resources from these changes would depend upon their location. For the fish in the Clifton Channel, there would be little impact. Fish in the main channel during flood flows would be affected by the increased size of the sediment plume from Puget Island. However, during high flows it is unlikely that fish would be present within the main channel. Salmonids and other fish tend to seek sheltered, off-channel locations during high flows. Although detailed data on fish distribution in the area during flood events is not available, the literature supports the idea that fish would avoid the main channel during periods of high flow in favor of Clifton Channel.

Development of the River Shoreline

Development of the river shoreline and has the potential to cause siltation at the water's edge and temporarily increase suspended sediment and turbidity levels in the water column that would affect

downstream habitat, fish health, and feeding behavior in the affected area (see *Dredging*). NorthernStar would implement BMPs from its terminal ESC Plan during construction of the LNG terminal, which would minimize impacts on aquatic resources by controlling erosion along the shoreline and lessen sediment movement.

Pile Driving

Tubular steel piles would be installed as part of the construction of the marine terminal (i.e., for breasting/mooring dolphins and unloading platforms/trestles) over a period of approximately 4 months. The actual number of days when pile driving would occur during this 4-month period depends on a number of variables such a weather and river conditions; however, NorthernStar estimates that about 60 days of pile driving would be required. Those days could be spread throughout the 4-month period. Studies have shown that the sound waves from pile driving may be intense enough to result in injury or trauma to fish, sea turtles, and other animals with gas-filled cavities, such as swim bladders, lungs, sinuses, and hearing structures (Hastings and Popper, 2005; Abbott and Bing-Sawyer, 2002).

Although the effects of pile driving are poorly studied and there appears to be substantial variation in a species' response to sound, intense sound pressure waves can change fish behavior or injure/kill fish through rupturing swim bladders or causing internal hemorrhaging (Hastings and Popper, 2005). The degree to which an individual fish exposed to sound waves would be affected is dependent upon variables such as the peak sound pressure level and frequency as well as the species, size, and condition of a fish (e.g., small fish appear to be more susceptible to injury by intense sound waves than are larger fish of the same species). The presence of predators can also influence how a fish might be affected by pile driving (e.g., fish stunned by pile-driving activities may be more susceptible to predators). In any case, forms of impact on marine organisms that could result from underwater sound levels include:

- Behavioral – interruption of normal behaviors (e.g., feeding, breeding, and/or nursing) and displacement;
- Perceptual – masking biologically important sounds (e.g., communication, predator/prey recognition); and
- Physiological – damage to body tissue.

In discussing the impacts of sound on aquatic resources it is important to note the difference in sound intensity in air versus water. Sound intensity in air uses a standard of 20 microPascals (μPa), while sound intensity measured in water uses a standard level of 1 μPa. There is a difference of 26 dB when converting air to water sound pressure levels. Therefore, if pile driving emits 201 dB in air, the underwater sound would be 227 dB re: 1 μPa. The NMFS' current noise thresholds for fish are a peak pressure of 180 dB re: 1 μPa for physical harm and an impulse pressure, or root mean square (rms), of 150 dB_{rms} re: 1 μPa for behavioral disruption (NMFS, 2007a).

The intensity of the sound pressure levels produced during pile driving depends on a variety of factors including, but not limited to, the type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer. Driving hollow steel piles with impact hammers can produce sharp spikes of sound that are intense enough to injure fish. For example, driving 96-inch-diameter steel piles using an impact hammer has been shown to generate peak sound pressure levels of up to 227 dB re: 1 μPa at 16 feet (Hastings and Popper, 2005). Close to piles, the impulse pressure is typically about 10 to 15 dB lower than the peak pressure. This level, however, is dependent not only on the pile and hammer characteristics, but also on the geometry

and boundaries of the surrounding underwater environment (Hastings and Popper, 2005). In some cases, fish may be startled by the first few strikes of an impact hammer. However, this response can wane and the fish may remain in the area (NMFS, 2001). As such, the potential effect on fish from impact hammers could be magnified because fish would not only be exposed to intense sound waves but may not avoid pile-driving activities, which would prolong their exposure to the potentially harmful sounds and increase their risk of injury or death. In a review of studies documenting fish kills associated with pile driving, the NMFS reported that all have occurred during use of an impact hammer on hollow steel piles (Hanson et al., 2003). On the other hand, the rapid repetitions of vibratory hammers produce relatively low intensity sound waves. Evidence also suggests that fish consistently display an avoidance response to sound from a vibratory hammer, even after repeated exposure (Dolat, 1997; Knudsen et al., 1997).

In addition to fish, Steller sea lions, California sea lions, and Pacific harbor seals may occur in the vicinity of the LNG terminal. Steller sea lions are described in detail in section 4.6.1.1. California sea lions occur along the lower Columbia River during the winter and spring using navigation buoys, jetties, and log booms (Jeffries et al., 2000). In addition, Pacific harbor seals occupy haulout sites on intertidal mudflats and sand bars along the northeast side of Welsh Island and the east end of Puget Island (Jeffries et al., 2000). In the event that a Steller sea lion or other marine mammal happens to be transiting the area during pile driving activities, it would be expected to avoid the immediate area in response to a higher level of human activity and noise associated with construction.

To minimize impacts on aquatic species as a result of pile driving, NorthernStar proposes to implement the following measures:

- observe in-water work windows – NorthernStar indicated that pile driving would only occur during the in-water work window established by the ODFW and the NMFS (November 1 through February 28) in order to minimize the number of fish exposed to high underwater noise levels.

- install 48-inch, 54-inch, 84-inch, and 96-inch diameter steel piles – NorthernStar proposes to install larger than normal steel pilings to minimize the number of piles and allow all piles to be installed vertically so that each pile can be driven with a caisson filled with bubbles to do the maximum possible to minimize acoustic impacts on aquatic resources (see reduction of peak sound pressure levels). Additional details regarding the number, length, and size of the piles as well as water depth is provided in table 2.1.3-1.

- utilize vibratory pile driving as conditions allow – NorthernStar would use vibratory pile driving equipment to install piles for the LNG carrier dock and mooring dolphins to the maximum extent possible before impact hammers would be used. Vibratory drivers tend to produce lower noise and vibration levels for most applications than impact pile drivers.

- reduction of peak sound pressure levels – NorthernStar would use two alternative measures to reduce peak in-water sound pressure levels:

    - Air bubble curtains have been used in a variety of pile driving applications to reduce underwater noise levels. NorthernStar would use a bubble curtain system that is contained within a caisson surrounding the driven piling. An attempt would be made to remove the water between the caisson and the pile to maximize the noise attenuation. If the water could not be removed, performance standards would be established which would specify a rate and distribution of bubbles. Prior to pile driving, the bubbler apparatus would be tested in similar water depths without the caisson to allow visual inspection of the bubble distribution by

divers and video cameras. If the bubbles are not uniform from bottom to surface, additional distribution rings may be added. For each pile installation, the bubble curtain would be activated before the initial vibratory pile driver stage to verify the performance of the bubble curtain. When properly deployed and operated, unconstrained bubble curtains can provide from 15 to 30+ dB of sound level reduction, even in currents on the order of 2 miles per hour (Hardyniec and Skeen, 2005; Jones, 2003). A noise reduction value of 25 dB for air bubble curtains is estimated.

- NorthernStar would also use a pile cap between the hammer and the pile during impact pile driving to further reduce underwater noise levels if monitoring indicates the bubble cushion within the caisson is not achieving the desired sound pressure reduction. The potential noise reduction provided by pile caps is not well documented in technical literature. However, Laughlin (2006) measured sound levels resulting from driving a 12-inch-diameter standard steel pile using bubble curtains and different pile cap materials. The results of the study indicated that using wood as a pile cap may provide a noise reduction value of 11 to 26 dB; however, wood compressed easily or caught on fire and therefore does not warrant regular use. Conbest™ (a canvas based laminate used in conjunction with a special Aluminum alloy) provided a noise reduction value of 7 to 8 dB, nylon provided a noise reduction value of 4 to 5 dB, and Micarta provided a noise reduction value of 1 to 5 dB.

The NMFS has raised concerns regarding the use of wood blocks during impact pile driving because of the potential for fire when used on large piles. Based on these concerns, NorthernStar has agreed to either eliminate the use of wood blocks, use wood blocks only during pile proofing, or to use a different material for a pile cap.

With the implementation of the above measures (25 dB of noise reduction from the caisson/air curtain and 5 dB of noise reduction from the cap) underwater sound pressure levels would not exceed 190 dB re: 1 μPa farther than about 33 feet from the pile and would not exceed 155 dB re: 1 μPa farther than approximately 7,053 feet from the pile when using the following equation:

$$Lr = Ls - 15 \log (D1/D2)$$

Where: Lr is received noise level in dB re: 1 μPa;
Ls is the noise source at a specified distance;
D1 is the radial distance; and
D2 is the source level distance.

This formula generally provides for a spreading loss of 4.5 dB per doubling of distance. Cylindrical spreading occurs when sound energy spreads outward in a cylindrical fashion bounded by the bottom sediment and water surface (i.e., shallow water), resulting in a spreading loss of 3 dB per doubling distance. Spherical spreading occurs when the when the source encounters little to no refraction or reflection from boundaries (i.e., deep water), resulting in a 6 dB reduction per doubling of distance. Because all pile driving would occur in a depth of 40 feet or less, the practical spreading loss of 4.5 dB per doubling of distance is appropriate.

As previously discussed, in-water monitoring would be completed to document that the appropriate noise attenuation procedures are being used to attenuate the pile driving noise and minimize

the distance to the NMFS' current noise thresholds for fish of 180 dB re: 1 μPa peak pressure for physical harm and 150 dB_{rms} re: 1 μPa impulse pressure for behavioral disruption (NMFS, 2007a).

The NMFS raised concerns in its May 11, 2007 letter to the FERC regarding the method of noise monitoring proposed by NorthernStar and the efficacy of bubble curtains during pile driving activities. NorthernStar proposes to use a qualified underwater acoustic monitor to record sound pressure levels once pile driving has begun. As described above, bubble curtains would be used to attenuate noise from pile driving activities and minimize potential impacts on aquatic resources. If bubble curtains did not function properly or were found to be ineffective, adverse impacts on sensitive aquatic resources could occur. Thus, **we recommend that:**

- **NorthernStar should consult with the appropriate federal and state agencies to develop a revised Bubble Curtain Contingency Plan that establishes a performance standard to assess whether or not bubble curtains are adequately working. The plan should describe specific noise attenuation methods to be implemented if monitoring indicates poor noise attenuation performance. The plan, including agency comments on the plan, should be filed with the Secretary for the review and written approval of the Director of OEP <u>prior to beginning offshore pile driving activities</u> at the LNG terminal.**

As described in section 4.6.2.2, it is possible that marine mammals could be adversely impacted by pile driving. NorthernStar proposes to implement protective measures including the establishment of Safety, Buffer, and Impact Zones to protect the Steller sea lion during construction activities at the LNG terminal. To provide similar protections to other pinnipeds potentially occurring in the project area, we have recommended that NorthernStar expand the protective measures that would be used to avoid or minimize impacts on Steller sea lions during construction of the LNG terminal (e.g., Safety, Buffer, and Impact Zones) to include all pinnipeds (see section 4.6.2.2).

Log Pond Filling

Filling the log pond at the LNG terminal site would result in a permanent loss of suitable off-channel refugia and rearing habitat that is used by various species of fish. The log pond potentially provides at least seasonal refugia during high flow for both rearing salmonids as well as resident and anadromous estuarine species. The primary salmonids expected to occur in the log pond include Chinook and coho salmon; however, the pond serves as designated critical habitat for 12 federally listed endangered or threatened salmonid ESU/DPSs. Based on constraints of site construction, filling the log pond is unavoidable. The pond would be filled entirely by material dredged from the ship berth and maneuvering area. As discussed in the *Fish Salvage Plan*, before and during filling of the log pond, NorthernStar would capture and remove fish using a trap, seine, electrofishing, or other methods to minimize risk of injury to fish. As soon as possible after having been identified, counted by age class to the extent practicable, and recorded, fish would be released into a safe release site within Hunt Creek just downstream of the entrance to the log pond outlet. To minimize re-entry of individuals into the log pond during collection efforts, **we recommend that:**

- **<u>During fish collection efforts</u> at the former mill log pond at the LNG terminal, NorthernStar should place nets at the outlet of the log pond that only allow emigration from the pond (e.g., winged fyke net without collection chamber attached or two disconnected block nets oriented outward from the pond).**

All fish capture work would be performed or supervised by qualified fisheries biologists and would operate under the NMFS's and ODFW's fish salvage guidelines. In addition, all work would be

performed under an ODFW/NMFS scientific collection permit and resource agency personnel would be invited to participate in or oversee the operations. Although all fish capture work would occur during the recommended in-water work window for the Columbia River, direct handling may adversely impact individual fish. NorthernStar would mitigate for impacts on fish and the permanent loss of habitat from filling the log pond by developing high quality replacement habitat in consultation with the NMFS and ODFW.

Habitat Modification

Fish, marine mammals, and other aquatic resources could be impacted indirectly by activities that alter terrestrial and riparian habitat including construction of the LNG terminal, the Hunt Creek Bridge replacement, realignment of the railroad tracks, and construction of the power line. In addition, during operation of the LNG terminal, over-water structures would result in habitat modification for aquatic resources. A discussion of potential impacts on aquatic resources as a result of these activities is provided below.

LNG Terminal

Fish and other aquatic resources could be impacted indirectly by activities that alter terrestrial and riparian habitats at the LNG terminal site during construction. The clearing of vegetation and grading activities during construction could increase water temperatures as well as erosion and suspended sediment levels in the Columbia River and Hunt Creek.

Vegetative clearing at the LNG terminal would remove about 14.8 acres of wetlands and 43.5 acres of upland scrub-shrub and forested habitats, which would expose the land to increased sunlight and result in indirect increases in water temperatures as water flows over the warmer land surface and eventually reaches the Columbia River or Hunt Creek (Beschta and Taylor, 1988). As described in section 4.3.2.1, the Columbia River is currently out of compliance for water temperature (ODEQ, 2007; WDE, 2006b). The effects of water temperature on the life stages of salmonids have been extensively reviewed by McCullough (1999). Maximum water temperatures ranging from 71.6 °F to 75.2 °F limit the distribution of many salmonids. For example, the optimum temperature for growth for the spring Chinook salmon is 60.1 °F; higher temperatures during summer could reduce growth and lead to increased mortality rates (McCullough, 1999). In some cases, higher temperatures and increased light can lead to increased production of in-stream microorganisms, algae, fungi, and macroinvertebrates, thereby boosting food availability for salmonids and in turn increasing salmonid production. Warmer stream temperatures may also accelerate fry emergence and extend the growing season, thereby enhancing fish growth. However, these potential positive effects generally occur in the summer and are often offset by fish losses because of reduced protective cover from LWD (Murphy et al., 1986; Hicks et al., 1991). Elevated water temperatures may also favor production of fish species that can out-compete salmonids in some situations (Bisson et al., 1992).

Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. NorthernStar would minimize potential impacts on waterbodies during construction by implementing the procedures in its pipeline ESC Plan for Oregon and SWPPP for Washington. To avoid impacts on water quality during operation of the LNG terminal, riparian areas outside of the berm would be allowed to permanently revegetate. As described in section 4.4.2.2, a riparian buffer at least 30 feet wide, as measured from the MHW mark, would be allowed to permanently revegetate adjacent to Hunt Creek. NorthernStar would replace cleared trees at a 5:1 ratio within the LNG terminal site, resulting in about 1,895 trees being planted following construction. The majority of the replacement trees (e.g., cottonwood, Sitka spruce, red alder, Pacific willow, and other native species) would be installed within a 100-foot buffer along the northern edge of the proposed construction

boundary. This area would serve as a forested buffer from the terminal site to the adjacent Hunt Creek estuary. NorthernStar has developed a monitoring plan and performance standards to measure successful revegetation of the site. If necessary, NorthernStar would take steps to control and remove noxious and invasive species in accordance with our Procedures. Noxious weeds and other invasive plant species are discussed in detail in section 4.4.2.3.

Power Line Construction

Construction of the power line could potentially impact aquatic resources in the vicinity of the LNG terminal. The nine streams crossed by the 1.5-mile-long power line are relatively narrow and steep, and are not believed to provide habitat for fish. The clearing and grading of vegetation during construction could increase erosion along streambanks and turbidity levels in the waterbodies. Because the downstream distances between the waterbodies crossed by the power line and Hunt Creek are over 0.5 mile, impacts on fish would not be anticipated. The overland distance between these waterbodies and the Columbia River ranges between 0.1 mile and 0.3 mile; however, the relief of the area is such that sediment movement into the Columbia River would not be anticipated. The power line would be owned and operated by PacifiCorp. Proposed measures to avoid impacts on aquatic resources would include revegetation, implementation of BMPs, and other measures specified in permits obtained by PacifiCorp.

Access Roads and Hunt Creek Bridge Replacement

The modifications to access roads and the replacement of Hunt Creek Bridge could potentially impact salmonids in lower Hunt Creek through increased siltation and turbidity caused by the introduction of sediments into the stream. Construction methods are summarized in section 2.4.1.1 and activities potentially impacting water quality are discussed in detail in section 4.3.2.3. Potential impacts on aquatic resources due to the road modifications and bridge replacement include the following:

- direct impacts on fish during salvage activities due to handling and electrofishing, if required at the bridge site;
- displacement of fish during demolition and construction; and
- increased turbidity and suspended sediment levels during pile removal and abutment construction;
- accidental spills or leaks of toxic materials (e.g., uncured concrete, demolition debris, equipment lubricants or fuel) during demolition and construction.

To minimize potential impacts on fish during salvage activities, if required, all salvage activities would occur within the in-water work window and would be performed or supervised by qualified fisheries biologists and would operate under the NMFS's and ODFW's fish salvage guidelines. In addition, all work would be performed under an ODFW/NMFS scientific collection permit and resource agency personnel would be invited to participate or oversee the operations.

Potential impacts on aquatic resources due to displacement during construction activities are described in section 4.5.2.1. The potential for increased turbidity and suspended sediment levels as well as accidental spills or leaks associated with road modifications and bridge replacement would be minimized through implementation of NorthernStar's terminal ESC Plan and the bridge demolition and construction BMPs described in section 4.3.2.3.

Railroad Realignment

As described in section 2.4.1.1, NorthernStar would remove a 4,200-foot-long portion of the existing PWRR line and construct a new segment outside the boundary of the proposed LNG terminal. The realigned railroad tracks would be constructed parallel to Hunt Creek for approximately 2,000 feet. After realignment of the railroad tracks, the creek and the edge of the railroad right-of-way would be between 50 and 400 feet apart for most of the 2,000 feet; however, for about 50 feet, the edge of the railroad right-of-way and Hunt Creek would be less than 50 feet apart. NorthernStar expects that a minimum 30-foot undeveloped buffer between the railroad right-of-way and the creek could be maintained in this area. Realignment of the railroad tracks could potentially impact salmonids and other aquatic resources in lower Hunt Creek through increased siltation and turbidity caused by the introduction of sediments into the stream. However, to avoid or minimize impacts on aquatic resources within Hunt Creek resulting from realignment of the railroad tracks, NorthernStar would restore the natural upland vegetative community by installing native vegetation within the railroad right-of-way as described in section 4.4.2.2 and by implementing its terminal ESC Plan.

Over-water Structures

As described in section 2.3, over-water structures associated with the marine berth would occupy approximately 1.0 acre over the Columbia River. Of this, structures would be located over approximately 0.5 acre of shallow water habitat. These structures have the potential to impact aquatic resources through changes in species behavior and the associated increased vulnerability of sensitive species to predation. In addition, the marine berth could indirectly impact aquatic resources through alterations to water quality, including changes in light, temperature, and nutrient levels directly beneath the docks.

An assessment of over 60 studies by Simenstad et al. (1999) found evidence that juvenile salmon react to shadows and other artifacts in the shoreline environment created by over-water structures. While changes in light from over-water structures have been shown to affect migration behavior in juvenile salmon, quantitative information on the significance of these behavioral responses is not available (Simenstad et al., 1999; Carrasquero, 2001).

Because juvenile salmonids (especially Chinook salmon) tend to migrate through shallow-water habitats along shorelines, over-water structures can impact migration through and use of potential habitat. Simenstad et al. (1999) found that juvenile salmon use both natural refuge and shaded areas as refuge, but they generally migrate along the edges of these areas, rather than entering them. However, in response to predators, they will seek refuge within shaded areas. Juvenile salmon have been observed to become "confused" upon encountering over-water structures due to the conflict between their preference to migrate through nearshore habitats and their avoidance of shaded areas. This confusion results in behavioral changes including splitting into smaller schools and seeking alternate pathways, which can ultimately cause a delay in migration (Simenstad, et al., 1999).

Recognized predators of juvenile salmonids in the lower Columbia River include bass, shad, lampreys, northern pikeminnow, and birds. Although numerous studies and anecdotal information from sport fisherman have suggested that docks and piers attract fish, studies have not been conducted to determine whether over-water structures actually increase the concentration of predatory fish, birds, or marine mammals (Simenstad et al., 1999; Carrasquero, 2001).

Changes in water quality within the shaded area created by the marine berth could reduce habitat quality for aquatic resources by altering the rate of photosynthesis, plant distribution, and indirectly by altering prey species composition and survival (Thom et al., 1997; Olson et al., 1996; Thom and Shreffler, 1996). NorthernStar would mitigate for reduced habitat quality at the berth and maneuvering area

through restoration of several times as much area of high quality habitat at the Svensen Island and Hunt Creek Mitigation Sites (see *Mitigation Measures*, below).

Water Appropriation and Discharge

During construction and operation of the proposed LNG terminal, NorthernStar would appropriate water from the Columbia River for multiple uses. Table 4.3.1-1 describes the proposed water appropriations and discharges associated with the proposed project. Potential impacts associated with water appropriation include entrainment and impingement of fish and reduced downstream flows. Potential impacts on aquatic resources due to discharges would be limited to changes in water quality.

Entrainment and Impingement

NorthernStar proposes to obtain water from the Columbia River through the terminal's permanent surface water intake for hydrostatic testing of the LNG storage tanks and pipeline, soil compaction and ground improvements, fire suppression system testing, and personal/sanitary use (see figure 2.1.3-3). NorthernStar would acquire the necessary permits from the ODWR before withdrawing water, including specific approvals from applicable resource agencies. Impacts on fish associated with surface water withdrawal would be minimized by using modern fish screening technology, which has been used within much of the Columbia River since the 1970s.

All intakes at the proposed LNG terminal that withdraw water from the Columbia River would be screened to minimize the likelihood of entrainment and impingement of juvenile fish in accordance with the ODFW and NFMS regulations and fish design criteria. The screen designs proposed by NorthernStar have been reviewed and approved by the NMFS. The fish screen criteria proposed for the temporary water intake is based on the NMFS, Juvenile Fish Screen Criteria and addendum as well as the Fish Screening Criteria for Anadromous Salmon (NMFS, 1995a; 1996; 1997). All the criteria specify the approach velocity and screen mesh opening sizes and considers both the presence and absence of fry-sized salmonids.

There are two locations proposed for water intake. The first location is the temporary surface water intake and pump that would be used to supply water for vibroflotation activities. A diesel-powered pump would divert water from the Columbia River at a maximum rate of 100 gpm (0.36 cfs). The temporary water intake would be located approximately 100 feet offshore, at a depth of 2 feet or more, meeting NMFS criteria. It would be equipped with a passive fish screen that complies with the ODFW regulations and NMFS fish screen design criteria. The fish screen would be designed to exclude salmonid fry; per the criteria, the screen mesh openings would not exceed 3/32 inch (2.38 mm) for a woven wire or perforated plate screen, or 0.0689 inch (1.75 mm) for a profile wire screen, with a minimum 27 percent open area. The screen would be mounted parallel with flow in the river and aligned with the adjacent bankline. The maximum approach velocity at the screen would be 0.2 ft/s. The proposed system meets the criteria for using a passive screen, including oversizing the screen to eliminate debris impingement (the effective screen area of NorthernStar's proposed M-L130 Pump-Rite model is nearly five times the required effective screen size). If debris is collected on the screen itself, debris would be physically removed by construction staff over the 3- to 4-month time frame the intake would be in use.

The second water withdrawal location would be the LNG terminal's permanent surface water intake and firewater pumping station, which would be used during construction to supply water for the hydrostatic testing of the LNG storage tanks. Construction of the LNG terminal would be scheduled so that the permanent water intake and pumping station would be online early enough in the construction period for use as a temporary water withdrawal location for hydrostatic testing of the LNG tanks. The firewater pumps would be mounted on the dock several feet below the mean low water elevation. The pumping station would be equipped with two 400 horsepower pumps, an electric primary pump, and a

diesel backup pump. The pumps would not operate simultaneously. The maximum rate of discharge of either pump would be 4,400 gpm (9.8 cfs) (GSI, 2006b).

The second water withdrawal location (permanent water intake), would be equipped with active (self-cleaning) fish screens that comply with the ODFW regulations and NMFS fish screen design criteria. The fish screen would be designed to exclude salmonid fry; per the criteria, the screen mesh openings would not exceed 3/32 inch (2.38 mm) for a woven wire or perforated plate screen, or 0.0689 inch (1.75 mm) for a profile wire screen, with a minimum 27 percent open area. The intake would be mounted parallel with flow in the river and aligned with the adjacent bankline. The current intake design assumes a maximum approach velocity at the screen of 0.33 ft/s. The proposed intake system would use an active, self-cleaning air backwash system (called Hydroburst) to clean debris and scour growth from the screens. The frequency with which the air backwash is used would depend on the debris load in the water column and the growth rate of algae and other sessile organisms.

In its May 11, 2007 letter to the FERC, the NMFS stated that flows need to be mapped post-construction to verify that screen velocities are acceptable. To ensure that screen velocities would comply with ODFW and NMFS fish screen criteria, **we recommend that:**

- **NorthernStar should conduct <u>post-installation</u> water flow mapping through all intake screens at the LNG terminal, and develop and implement a monitoring program to assess the effects of impingement and entrainment from use of the screened water supply system on juvenile salmonids during terminal operations. The monitoring program and water flow mapping plans should be developed in consultation with the NMFS and ODFW and, as appropriate, incorporate adaptive management strategies to identify and mitigate any adverse effects specifically associated with the project. The final monitoring program and water flow mapping results, as well as any agency comments, should be filed with the Secretary for the review and written approval of the Director of OEP <u>prior to operation of the screens</u>. In addition, NorthernStar should provide <u>annual reports</u> to both the FERC and NMFS regarding the efficacy of the screened water intake system, which would identify any problems and address how such problems would be rectified.**

In addition, water would be appropriated by LNG carriers during unloading as ballast and to cool the engines generating power for the offloading pumps and other onboard systems (see section 2.1.1.5). To minimize entrainment and impingement of juvenile fish during ballast and cooling water intake, NorthernStar would construct a system capable of delivering filtered water to the LNG carrier. NorthernStar would offer contract incentives to the LNG suppliers to retrofit LNG carriers to connect with the wharf filtered water supply so that all water withdrawn from the Columbia River would be done via screened intakes constructed by NorthernStar at the LNG terminal. Water supplied to the carriers via this intake system would be first used to cool the engines and then used to fill the ballast tanks to minimize the total intake and avoid discharging warm water into the Columbia River. In rare instances when ballast tanks fill before the need for shore-based cooling water is over, the ballast water would be circulated through the engines for cooling after the shore-based water supply is turned off and until the ship is ready to leave the wharf. NorthernStar would design the filtered water system to minimize entrainment and impingement of juvenile fish.

To ensure that impacts associated with entrainment and impingement are minimized, we recommended in the draft EIS that NorthernStar prepare a plan to ensure that only LNG carriers that have been retrofitted to use the screened water supply system at the berth are allowed to unload cargo at the Bradwood Landing LNG terminal. As discussed in section 4.3.2.3, NorthernStar has stated that due to changes in market conditions since issuance of the draft EIS, LNG carriers may arrive at the terminal without the necessary retrofitting in place to allow the use of the screened water supply system. The

FERC received numerous comments on the draft EIS related to potential impacts on aquatic resources in the event that the screened water intake system is not functional or would not be used for a period of time. We conducted a preliminary analysis of the number of out-migrating juvenile salmonids that would be entrained by LNG carriers at the wharf without the use of the filtered water supply system and NMFS-approved screens. The preliminary analysis, discussed below, indicates that a substantial number of migrating juvenile salmonids could be entrained, particularly during peak out-migrating periods (i.e., March through August).

Our preliminary analysis included: 1) a determination of the area near the intake which would be subject to velocities likely to result in impingement or entrainment of juvenile salmonids, and consideration of how that area relates to the terminal and LNG carrier's water intake locations; 2) an investigation of the widely varying migration behaviors of juvenile salmonids by species, which result in an array of spatial and temporal distributions; 3) an estimation of the number of juvenile salmonids out-migrating by species and season; and 4) a breakdown of the frequency with which LNG carriers would be expected to operate their intakes. We assumed that fish with swimming speeds greater than the intake velocity can avoid impingement. Swimming speed is estimated to be about 0.5 body length per second (Durbin et al., 1981). Thus, a fish 7-inches-long or larger would be able to avoid impingement or entrainment. However, smaller sized juveniles and non-motile larvae and eggs may not be able to avoid the intake, and thus are more susceptible to entrainment. Entrained organisms would be subjected to physical stress and pressure changes as a result of abrasion or contact with screens and pump impellers. Physical damage has not been well documented, but is assumed to injure entrained ichthyoplankton (Cada, 1990; Mayhew et al., 2000) and other water column organisms. Pressure changes, such as a sudden decrease in ambient pressure of 40 percent or more of the acclimation pressure, might burst swim bladders, thus resulting in the mortality of fish larvae that have developed swim bladders (Cada, 1990).

The preliminary analysis provided a rough estimate of the potential impacts on juvenile fish associated with cooling and ballast water intakes, and the estimates generated to this point require further refinement prior to incorporation into the FERC's revised BA and EFH Assessment. Future analysis may consider a variety of other factors that could widely influence the final values, including: 1) fish behaviors such as avoidance or attraction, diurnal peaks in migration; 2) fish movements lateral to stream flow; 3) migration patterns around Puget Island; 4) an account of all watersheds contributing juvenile salmonids that migrate past the wharf; 5) ESU and DPS specific migratory quantities and characteristics; and 6) velocities occurring near the LNG carrier intakes for different designs of LNG carriers.

NorthernStar has stated that it would continue to offer incentive-based contractual agreements for carriers to accommodate the screened water supply system, but it could not guarantee 100 percent use of the proposed system. Instead, NorthernStar proposes to develop a performance standard for the temperature of all cooling water discharges at the wharf and a performance standard for entrainment of juvenile fish at the wharf. Both performance standards would have a monitoring component. To date, we have not been provided any information on these potential performance standards. To ensure impacts to water quality are minimized, we are recommending in section 4.3.2.3 that NorthernStar develop performance standards for water temperature impacts and biocide use associated with LNG carrier water intakes and discharges. However, a performance standard for entrainment and impingement impacts could not appropriately mitigate the routine removal of 20 to 50 million gallons of unscreened water per LNG carrier visit at the Bradwood Landing terminal.

We compared NorthernStar's potential entrainment and impingement impacts to baseline conditions to analyze the potential for significant cumulative impacts. We estimated that roughly 1,800 commercial ships dock at various lower Columbia River ports annually. We note that no screening of water intakes to protect aquatic resources is currently conducted for any ships docked at Columbia River ports. About 50 percent of the commercial marine traffic on the Columbia River stops at Portland,

Oregon, 18 percent at Vancouver, Washington, and 10 percent at Longview, Washington (Merchant Exchange of Portland, 2007 Annual Report). Considering the ballast requirements of the various sized ships calling on those ports (e.g., container types, oil tankers, bulk carriers) and assuming that each commercial marine vessel is taking on ballast water, the combined withdrawal could reach 10.4 billion gallons of ballast water per year. We also considered the subset of larger container and oil tankers which are most comparable in size to the typical LNG carrier, which make up about 16 percent of the marine traffic on the lower Columbia River. We estimated that these carriers withdraw up to a total of 3.2 billion gallons for ballast per year. In comparison, the typical LNG carriers berthed at the Bradwood Landing terminal would intake approximately 3.1 billion gallons of ballast water per year. Therefore, in comparison to baseline conditions, we estimate that the Bradwood Landing Project could result in a roughly 30 percent increase in total ballast water withdrawals compared to current commercial shipping on the Columbia River, and would nearly double current ballast water withdrawals by large container ships and tankers. We were unable to find any relevant data for the amount of water that commercial ships currently operating in the Columbia River take on for engine cooling water, for comparative purposes.

We conclude that impacts on sensitive aquatic resources would not be adequately mitigated to a less than significant level without a screening mechanism that minimizes entrainment and impingement of sensitive species of juvenile fish. To ensure that impacts on sensitive aquatic resources from LNG carrier water appropriations and discharges at the LNG terminal would be appropriately mitigated, **we recommend that:**

- **<u>Within 30 days</u> after the issuance of the final EIS, NorthernStar should:**

  a. prepare a plan that outlines how NorthernStar would ensure only LNG carriers that are retrofitted to use the proposed screened water supply system at the wharf are allowed to unload cargo at the Bradwood Landing terminal. The plan should include a method of certifying to the FERC, in advance of a LNG carrier's initial call to the Bradwood Landing terminal, that the LNG carrier has been retrofitted to utilize NorthernStar's screened water intake system; or

  b. develop a plan for delivering screened engine cooling and ballast water to LNG carriers at the Bradwood Landing terminal that does not require carrier retrofitting.

  The proposed screened water supply system design plan should include monitoring, reporting, and adaptive management strategies to assure the system's efficacy at minimizing entrainment and impingement of sensitive species of juvenile fish.

The screened water system design and performance measures would be vetted during the formal consultation process and continuing consultations with the NMFS, ODFW, and other appropriate resource agencies. **We recommend that:**

- **<u>Prior to initial site preparation</u> at the LNG terminal, NorthernStar should file the final screened water system design plans and performance standards, along with NMFS comments on the plans and standards, with the Secretary for review and written approval by the Director of OEP.**

Reduced Downstream Flows

River flows are crucial to the migration of anadromous fish on their journey from spawning areas to the ocean. Historically, the Columbia River provided higher flow during the spring and fall, which coincided with juvenile salmon migration periods. The increased flow helped juvenile salmon migrate downstream and out into the ocean. Over time, the addition of dams, impoundments, and water diversions along the Columbia River has lead to a more constant flow pattern throughout the entire year by limiting the high and low flows below the dams.

The USGS maintains a gauging station at Beaver Army Terminal, located at CRM 53.8. Data obtained from this station is available for the period between 1992 and 2003. During this period, the average annual mean streamflow was 233,575 cfs, with a high of 329,700 cfs in 1997, and a low of 145,200 cfs in 2001 (USGS, 2006). Water withdrawals associated with construction and operation of the LNG terminal would be a fraction of these rates (i.e., less than 80 cfs). Although reduced downstream flows as a result of the proposed project are expected, the reduction would not be significant.

Changes in Water Quality Associated with Discharge

Following hydrostatic testing of the LNG storage tanks, water would be discharged at about 5,000 gpm to the Columbia River at the LNG terminal site. This discharge has the potential to impact aquatic species due to localized erosion and temporary changes in the chemical characteristics of water near the outfall. Construction impacts associated with increased erosion and suspended sediment levels would be minimized by discharging water through a temporary outfall located about 300 feet offshore that would be diffused or armored to avoid localized erosion. Changes in the chemical characteristics in the vicinity of the outfall could occur if chlorinated water is discharged to the Columbia River. Water appropriated for hydrostatic testing of the LNG storage tanks would be tested for bacteria before use. If bacteria levels are high enough to cause corrosion in the tanks, the water would be chlorinated before testing. To prevent chlorinated water from entering the Columbia River, all hydrostatic test water would be sampled and analyzed before discharge and dechlorinated as necessary.

Water appropriated for hydrostatic testing of the pipeline would be discharged to an upland area near the pipeline crossing of the Columbia River using appropriate filtering techniques. The water would be discharged at an approximate rate of 1,000 gpm and would not be chemically treated. All discharges would be in compliance with NorthernStar's ODEQ water discharge permit and would not be expected to impact fish.

During operation of the facility, water appropriated for testing of the fire suppression system would be discharged to the Columbia River via elevated fire monitors at the end of the dock. We do not anticipate any scour as a result of this testing because the elevated fire monitors would be located over 300 feet from the shoreline and would discharge in an area with an approximate water depth of 42 feet. Fire suppression test water would not come in contact with any source of contamination onsite prior to discharge.

While LNG carriers are docked at the LNG terminal wharf, they may discharge cooling water if they are not modified to discharge cooling water into the ballast tanks. As discussed in section 4.3.2.3, engine cooling water discharged to the Columbia River could initially be 19.4 °F higher than ambient water temperatures (ranging between 42 °F and 68 °F in Astoria, Oregon). Maximum water temperatures ranging from 71.6 °F to 75.2 °F limit the distribution of many salmonids. Potential impacts on aquatic resources due to temperature increases are discussed further above (see *Habitat Modification, LNG Terminal*). In addition, cooling water for the LNG carriers may be injected with a low dose of biocide (expected to be sodium hypochlorite) to prevent the growth of marine organisms. Discharge of the

residual chlorine concentration is not expected to affect aquatic resources outside of the mixing zone because of the relatively low concentration of sodium hypochlorite that may be present in the discharge, and mixing upon discharge would occur rapidly due to the volume of water in Columbia River and mixing by the tides and currents. However, due to the presence of federally listed species at the LNG terminal site, we have recommended in section 4.3.2.3 (see *Entrainment and Impingement*) that NorthernStar conduct additional modeling and develop mandatory performance standards for water temperature and biocide use at the LNG carrier wharf. The performance standards and resulting impacts on federally listed species and EFH at the LNG terminal wharf would be further analyzed in our revised BA and EFH Assessment.

LNG Terminal Lighting

Construction

The Bradwood Landing Project would necessitate the installation of temporary lighting to facilitate construction activities during evening hours as well as permanent lighting to meet operational safety and security requirements. The response of fish to artificial lights can be quite variable depending on a number of factors. Specific responses by fish to light seem dependent on the intensity of the light as well as the species and age-class of the fish (Hoar et al., 1957). Schools of juvenile chum salmon show a marked preference for light while juvenile sockeye retreat to darker areas. Juvenile coho are indifferent to light of moderately high intensities but become inactive in light of very low intensities. While the responses of fish to light are sometimes based on innate behaviors, in other cases, these responses may be based on the presence of prey items. For example, artificial lighting is documented to decrease the daily vertical migration of zooplankton that come to the surface to feed on algae under the cover of darkness.

To avoid and minimize lighting effects during construction, lights would be shielded and directed as needed to illuminate the work areas and meet safety requirements, but to avoid extending off site unnecessarily. Safety, security, and maintenance of the construction schedule would be the primary considerations for construction lighting. Due to the very dynamic nature of large-scale construction and limitations on dictating equipment to contractors, NorthernStar has not defined specific lighting plans for construction. However, it has stated that lights would be unlikely to shine directly at the water for any longer than brief moments during construction.

Operation

Based on NorthernStar's *Lighting Plan for the Bradwood Landing LNG Terminal* (Lighting Plan), lighting sources at the LNG terminal would be designed to provide a minimum of 22 Lux of light intensity on all illuminated areas from sunset to sunrise.[14] Minimum light intensities were determined by NorthernStar in accordance with the state-of-practice industry standards as specified in ANSI/IESNA RP-07-01. General lighting of outdoor open areas, roads and access ways, and the berth would be provided by pulse-start metal halide lights, high pressure sodium lamps, or compact fluorescent lamps in fixtures that use multiple lamps. The fixtures would be mounted on masts or off structural supports. All lighting fittings would be supplied with integral control gear. Before mitigation, metal halide lights would contribute more to the total light levels than high pressure sodium lamps or compact fluorescent lamps. However, because metal halides can be shielded with hoods and shields, stray light could be significantly reduced. Operational lighting impacts on aquatic species would be similar to construction lighting impacts described above, but would occur year-round for the life of the project.

[14] NorthernStar submitted its Lighting Plan for the Bradwood Landing Terminal as part of its response to the NMFS' May 11, 2007 request for additional information to the FERC on July 6, 2007. This document is available for viewing by the public on the FERC's Internet web page at www.ferc.gov, through the eLibrary link, selecting "General Search," entering the docket number minus the last three digits (i.e., CP06-365), and putting in the proper date range.

To minimize the potential impact on salmonids and other aquatic species from operational lighting, NorthernStar's Lighting Plan includes the use of directed lighting, diffusers, lenses, and shields where appropriate to reduce glare and light pollution. For example, tilted lights (e.g., bracket and stanchion mounted lights) would be directed toward the center of the facility to minimize stray light. In addition, hoods would be specified where possible for lights on the facility exterior (except for navigation aids and security lights) in order to focus light where needed for operational purposes, while minimizing stray light.

To address concerns raised by the NMFS, NorthernStar is conducting additional analysis of the impacts of terminal lighting on salmonids as part of the consultation process. Due to the presence of high-quality habitats and both federally and state-listed species in the vicinity of the LNG terminal, additional measures are necessary to minimize impacts from terminal lighting on wildlife and aquatic resources. Therefore, **we recommend that:**

- **NorthernStar should continue to consult with the NMFS, FWS, ODFW, and other appropriate agencies regarding revisions to its Lighting Plan. NorthernStar should file its final Lighting Plan along with agency comments with the Secretary for review and written approval by the Director of OEP, <u>prior to operation</u> of the LNG terminal.**

<u>Blasting</u>

Blasting may occur during construction of the LNG terminal at the quarry near the southwest corner of the site approximately 800 feet from the Columbia River. The location of the quarry is shown on figure 2.3.2-1. Potential impacts on aquatic resources from blasting at the LNG terminal would be similar to those described as a result of pile driving and include changes in behavior, decreased perception, and damage to body tissue. Published blasting data (Leonard Charles and Associates, 2005) recorded blasting noise similar to what would be expected at the Bradwood Landing site as 118 dB at a distance of 550 feet from the blast site. Using logarithmic spreading, the sound pressure level would attenuate to 100 dB at a distance of 4,370 feet from the source, or to 115 dB 800 feet northeast of the quarry at the Columbia River. Therefore, we estimate the area experiencing 100 dB blast overpressure would encompass the Columbia River. Special blasting techniques, such as charge weight control, blast pattern design, use of stemming material, depth of the charge, and cover material are typically used to control the blasting noise.

As previously discussed, the estimated noise in air at the shore of the Columbia River from blasting at the quarry would be 115 dB. As described above (see *In-water Construction, Pile Driving*), the equivalent underwater noise would be 141 dB re: 1 µPa. Blasting generally emits low frequency sound waves lasting 300 to 1,000 milliseconds (Aggregate Industries, 2005). Although this would generally not be considered impulse noise, the corresponding impulse pressure values would be expected to be less than 141 dB_{rms}. Therefore we do not anticipate that the noise thresholds for pinnipeds and salmonids (160dB_{rms} and 150 dB_{rms}, respectively) would be exceeded as a result of the blasting at the LNG terminal site.

Seal bombs, which have historically been used to prevent pinnipeds from feeding around fishing gear, create explosions in the range of 220 dB re 1 µPa (peak) (Richardson et al., 1995). The estimated maximum underwater noise exposure to pinnipeds from blasting at the Bradwood quarry would be less than such explosions. Although pinnipeds moving through the area would detect the blast noise and may avoid the area, after continued exposure to the blasting, the avoidance would be expected to wane (Richardson et al., 1995). Blasting at the quarry is not expected to result in adverse impacts on either pinnipeds or salmonids in the Columbia River and Clifton Channel. No underwater blasting is planned for this site.

Accidental Spills or Leaks of Hazardous Materials

For any large construction project, there is the potential for spills or leaks of fuels or hazardous materials from storage containers, equipment working in or near streams, and fuel transfers. Any spill of fuel or hazardous liquid that reaches a waterbody would be detrimental to water quality. The chemicals released during spills could have acute, direct effects on fish, or could have indirect effects such as altered behavior, changes in physiological processes, or changes in food sources. Fish could also be killed if a large volume of fuel or hazardous liquid is spilled into a waterbody. Ingestion of large numbers of contaminated fish could affect primary and secondary fish predators in the food chain.

To minimize the potential for spills, NorthernStar prepared a terminal ESC Plan that includes spill prevention and response procedures. NorthernStar's implementation of this plan would minimize the potential for and the impacts of any spill near surface waters. Specific measures in this plan include prohibiting liquid transfer, vehicle and equipment washing, and refueling within 100 feet of waterbodies and specific steps to be followed to control, contain, and clean up any spill that occurs.

LNG Terminal Operations

Additional terminal operations activities that could potentially impact fish and fish habitat include stormwater runoff, maintenance dredging, the routine discharge of condensate water from the SCVs, and increased noise.

Stormwater Runoff

About 40 percent (16 acres) of the LNG terminal site would be comprised of impervious surface (roadway, rooftop, enclosed structures, and LNG facilities). The remainder of the site would either be landscaping or a loosely packed gravel surface overlying dredged materials. As described in NorthernStar's *Stormwater Management Plan for Removal/Fill Permit Applications* (see section 4.3.1.3), soils at the site have high infiltration rates (at least 14 inches per hour), which would result in rain infiltrating directly into the ground except during major storms. Stormwater runoff that does not infiltrate directly into the ground would be routed to two drainage basins within the LNG terminal site. Rain falling on roofs and paved areas would also be conveyed to the drainage basins that would have capacity to hold runoff from at least a 100-year storm event. NorthernStar expects that all stormwater would be managed on site via infiltration. Therefore, adverse impacts on aquatic resources resulting from stormwater runoff are not anticipated.

Maintenance Dredging

As described in section 2.7.2, NorthernStar expects to dredge about 80,000 cubic yards of material from the ship berth and maneuvering area approximately every 2 to 4 years. NorthernStar proposes to place material from maintenance dredging at the Wahkiakum County Sand Pit site. A specific model has not been run to determine the anticipated turbidity levels resulting from placement of dredged materials at the Wahkiakum County Sand Pit site. However, as described in section 4.3.2.3, given the large grain size of the sediments, the materials are expected to rapidly settle out of the water and water quality impacts would be similar to that at the LNG terminal site during dredging operations. Maintenance dredging impacts on aquatic species would be similar to the dredging of the ship berth and maneuvering area, but would occur intermittently during the operation of the LNG terminal. Based on the recolonization rates described above (see *Dredging, Removal of Benthic Organisms*), the frequency of maintenance dredging may result in permanent alterations in the benthic community within the berth and maneuvering area.

Routine Discharge of Condensate Water from the SCVs

Water is produced as a by-product in the LNG vaporization process proposed by NorthernStar. As discussed in section 4.3.2.3, the SCVs would generate up to 160 gpm of condensate water during operation of the LNG terminal. NorthernStar proposes to discharge the SCV water to the Columbia River under an NPDES permit. Fish could be affected by this discharge due to temporary changes in water quality including increased acidity, increased temperature, and increased dissolved solids.

The pH of the water bath in an SCV is typically maintained at 5.6 standard units and the temperature of the bath is maintained between 55 °F and 65 °F. Before discharge, the pH of the SCV discharge water would be increased in a neutralization tank. An allowable discharge pH would be established during the NPDES permit review process, thereby mitigating potential impacts on aquatic resources.

The average water temperature in the Columbia River measured in Astoria between December 2005 and 2006 was 54.4 °F, ranging between 42 °F and 68 °F, depending on the season (NOAA National Oceanographic Data Center, 2006). The SCV discharge water would be 68 °F, which is generally warmer than the ambient water temperatures but would not exceed the temperature standard of 68 °F for fish rearing and migration (ODEQ, 2003). Plumes of warmer water can directly impact fish that come into contact with the water. Biological processes for coldwater fish tend to speed up and sensory processes slow down as water temperatures increase; immune systems may become compromised, and warmer waters may have reduced levels of dissolved oxygen, among other effects (Bjornn and Reiser, 1991). Warmwater plumes may also cause avoidance, requiring fish to move to other locations and exposing them to predation and additional consumption of their energy resources (NMFS, 2005a). Studies have found that adult survival rates in Columbia River salmonids are correlated with smolt weight at ocean migration. Since smolt weight is a function of energy used versus energy consumed, the less energy needed to survive, the more is available to build fat and energy reserves (Fresh et al., 2004). As described in detail in section 4.3.2.3, given the volume of SCV discharge in relation to the volume of flow in the river, we anticipate that water temperatures near the outfall would rapidly return to ambient conditions, thereby limiting the potential to adversely impact aquatic species

The total dissolved solids content of condensate would be about 10 times the concentration in the river (there is a guideline standard of 500 mg/L). Because the SCV water would be discharged using an outfall/diffuser system mounted below the water level near the eastern end of the dock to take advantage of better water circulation in the mainstem of the Columbia River, it is expected that the discharge would not have a measurable effect on the total dissolved solids content outside a mixing zone that extends about 10 feet from the diffuser. Through proper management of SCV water discharges, potential impacts on aquatic resources due to increased dissolved solids would be minimal.

Operational Acoustic Effects

Maintenance dredging activities and LNG carrier and tug operations along the LNG carrier transit route and at the LNG terminal would generate underwater sounds pressure levels that could elicit responses in marine organisms. The intensity of the sound pressure levels from vessel traffic and dredging activities can be quite variable. However, sound pressure levels are generally in the range of 112 to 160 dB (re: 1 μPa), intensities that may influence organism behaviors or perceptions but are not great enough to cause physiological damage (Richardson et al., 1995; NMFS, 2005a).

Operational acoustic impacts would depend upon the specific schedule, duration, and type of vessel traffic and the timing and extent of maintenance dredging. Generally, these impacts would be

behavioral and perceptual, and not physiological in nature as fish would tend to avoid the area during periods of high noise output.

Mitigation Measures

Project design, construction, and operation plans have been modified to avoid or minimize impacts on aquatic resources. These efforts would be ongoing during construction in order to capitalize on avoidance and minimization opportunities that cannot be predicted. However, both direct and indirect impacts on aquatic resources would result from construction and operation of the proposed project.

Following construction of the LNG terminal, habitat and ecosystem function would be restored in place. Permanent impacts on aquatic resources would be mitigated by restoring habitat with similar ecological function in areas substantially larger than that lost to permanent impacts. However, although compensatory mitigation actions would restore habitat and have long-term benefits to wetlands, estuarine ecosystems, and habitat for salmonids in general, there would be short-term adverse effects and longer term adverse effects on some non-target species. In terms of overall ecosystem health, these trade-offs are considered appropriate and valuable enough to more than balance the cost of the adverse effects.

NorthernStar identified a number of sites in the general project area that would be set aside and/or developed as compensatory mitigation. Mitigation for impacts on aquatic resources at the Svensen Island and Hunt Creek Mitigation Sites are summarized below. In addition, the Peterson Point Mitigation Site would include restoration of riparian habitats, thereby providing additional benefits to aquatic resources. This mitigation site is discussed in section 4.5.2.3. NorthernStar has also developed an SEI that would be implemented throughout the life of the project. The SEI is described in detail in section 4.6.2.2.

The FERC received numerous comments stating that the mitigation proposed by NorthernStar does not adequately compensate for impacts on aquatic resources associated with the project. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. To ensure that the mitigation proposed for the Bradwood Landing Project adequately compensates for project-related impacts, we have recommended that NorthernStar continue to consult with the appropriate natural resource agencies to finalize its Compensatory Mitigation Plan. The final Compensatory Mitigation Plan should be filed along with agency comments and applicable approvals with the Secretary prior to construction of the project.

Svensen Island Mitigation Sites

As discussed in section 4.4.1.2, the Svensen Island Mitigation Sites would be the primary wetland mitigation sites in Oregon and are located about 14 miles downstream of the proposed Bradwood Landing LNG terminal in Clatsop County, Oregon (see figure 2.1.5-1). For over 100 years, Svensen Island has been protected and separated from the Columbia River by a surrounding dike (an 1868 map shows the dike). The area inside the dike has been agricultural land since the dikes were constructed. Two cross dikes divide the island into three distinct areas. NorthernStar proposes to provide mitigation at two of the three areas, lower Svensen Island and middle Svensen Island. Existing conditions and a list of mitigation measures that would be implemented at these two areas are discussed in the following sections.

Lower Svensen Island

The westernmost section of the island (lower Svensen Island, which includes more than half of the island acreage) was flooded when the dike breached at the northwestern tip of the island in December 2003. Since then, twice daily high tides flood about 170 acres inside the dike, and tidal marsh has reestablished itself. A high percentage of the flooded area is now occupied by a diverse array of marsh species, mostly native, and is a fish and wildlife haven. Since the location is upriver of the area of

saltwater intrusion into the river, the marsh is a freshwater marsh. In addition to the main channel now bisecting the site, many smaller remnant channels exist. New channels stemming from the main channel also appear to be forming. At low tide, the eastern portion of the site is saturated, but only certain areas maintain standing water. A culvert in the northeastern part of the site prevents water from draining properly, and may strand fish at low tide.

Tidal marshes are the most productive fish habitats of the lower Columbia River estuary. Marsh vegetation, such as that found within the lower Svensen Island area, may produce an average annual standing crop of 5 tons per hectare. The resulting plant detritus can sustain a large and diverse population of invertebrates. Some of these small crustaceans and aquatic insects are an important food source for juvenile salmon. The tidal marsh includes dendritic channels that provide excellent fish habitat. Large numbers of juvenile Chinook and chum salmon are present within tidal channels of the marsh, and other species, such as starry flounder, likely use these areas as well. Chinook fry may rear in the marsh for up to a month. During that time, Chinook fry would nearly double in size and quadruple their weight as they feed on the abundant invertebrates. The protected and turbid water of the lower Svensen Island marsh also offers a certain amount of protection against predators. At present, fish have access to the site through the channel at the northwestern breach location and at the culvert that lost its tidegate. The site serves as a protected area for salmon rearing and may serve as a refuge from storm flows.

Wildlife observed at the site includes numerous shorebirds and waterfowl, in addition to raptors. Also, there have been recent reports of hundreds of red-legged frogs and thousands of Pacific chorus frogs during the spring and early summer. This provides some indication that common predators, such as bass and bullfrogs, are not prevalent within the lower Svensen Island area.

To mitigate for impacts on aquatic resources and wetlands due to the proposed project, NorthernStar has proposed to preserve lower Svensen Island and would also implement the following restoration activities:

- control invasive weeds;
- add anchored LWD at tidal channels as fish habitat features;
- further restore fish accessibility by removing two remaining tidegates from existing culverts;
- further restore fish habitat value by removing several (up to eight) remaining culverts on former farm roads that block fish escape with receding tides;
- further restore wetland and riparian habitat by removing remaining buildings and facilities so that plants can grow (possibly adding soil); and
- remove remaining fuel tanks that might pose a risk to aquatic organisms.

Middle Svensen Island

Middle Svensen Island includes both uplands and wetlands dominated by a mix of pasture grasses and invasive herbaceous species with shrubs (such as Himalayan blackberry and red elderberry) along some of the ditch spoil piles and the dikes. Because middle Svensen Island is generally isolated from the river and lower Svensen Island, it currently provides no habitat for fish. The area has seasonally saturated wetlands that have no surface water interconnection with the Columbia River except through tidegates on drainage ditches that preclude fish passage.

To mitigate for impacts on aquatic resources and wetlands due to the proposed project, NorthernStar has proposed implementing the following mitigation measures at middle Svensen Island:

- remove three tidegates on the south side of the island;
- breach the northern dike near the cross-dike between middle and lower Svensen Island (the above actions would flood about 65 acres at normal high tide);
- provide a large culvert connection through the cross-dike to facilitate wetland vegetation seed transport from lower to middle Svensen Island to speed wetland establishment;
- fill or reconfigure existing drainage ditches;
- excavate new low-tide channels;
- place some excavated material along selected dike areas to facilitate growth of shrubs and trees to be planted;
- add anchored LWD at tidal channels as fish habitat features; and
- control invasive weeds.

NorthernStar has an exclusive option to purchase a majority of Svensen Island. The habitat values would be maintained under a stewardship agreement with a land trust, which would be funded by NorthernStar.

Hunt Creek Mitigation Site

The Hunt Creek Mitigation Site is located adjacent to the proposed LNG terminal (see figure 2.1.5-1). The portion of Hunt Creek adjacent to the LNG terminal is designated EFH and provides spawning and rearing habitat for the Lower Columbia River coho salmon ESU. In addition, the confluence of Hunt Creek with Clifton Channel is designated critical habitat and provides rearing habitat for the same ESU/DPSs as the log pond that would be filled at the LNG terminal (see section 4.6.2.2). The Hunt Creek Mitigation Site would be a preservation area. The only active management proposed is the control of invasive weeds (e.g., purple loosestrife) to prevent a reduction of wetland and habitat functions.

The primary goal of the Hunt Creek Mitigation Site would be to assure protection and preservation of the tidal wetlands and stream habitat associated with the portion of Hunt Creek that would be located within the property owned by NorthernStar by placing a conservation easement on the title. Preservation of the Hunt Creek Mitigation Site would provide ongoing benefits to salmonids and other aquatic resources within the Columbia River estuary.

Monitoring and Adaptive Management

NorthernStar has committed to monitor fisheries at the Svensen Island Mitigation Sites semiannually for the first five years of the project. Following this period, monitoring would be conducted annually throughout the life of the project. Monitoring would include surveying and recording of the quality and extent of fisheries habitat present; taking depth measurements at various locations during both low and high tides to capture the extent of tidal function; observing fish directly to define patterns of access and utilization of the mitigation sites; and determining function of LWD. Due to proposed

activities at the Hunt Creek Mitigation Site being limited to noxious weed control, monitoring is not currently proposed.

The Svensen Island Mitigation Sites are considered new mitigation sites. Therefore, adaptive management would be needed. A number of corrections in management may be required to keep the mitigation site accessible to fish, grow appropriate vegetation, and maintain a properly functioning hydrologic regime. Working from the monitoring reports, management would be adjusted to ensure that mitigation objectives would be met despite obstacles that may occur.

4.5.2.2 Essential Fish Habitat

EFH is described in detail in section 4.5.1.2. Construction and operation of the proposed LNG terminal has the potential to impact one species of groundfish (starry flounder) and two species of Pacific coast salmon (Chinook and coho). These species are discussed below.

Of the 90 species managed by the groundfish FMP, only the starry flounder has been documented in freshwater habitat, such as at the proposed LNG terminal site. As described in section 4.5.1.2, starry flounder have been documented as residents in the lower Columbia River (Bottom and Jones, 1990). All life stages of the starry flounder are present in estuaries; however, only juveniles and adults occur in freshwater. Juvenile starry flounder prefer habitat with sandy to muddy substrates and adults prefer habitat with sandy to coarse substrates. Both of these substrate types occur at the proposed LNG terminal site, thus making it potential habitat for starry flounder. EFH for eggs, parr, smolt, and adult Chinook and coho salmon occur at the proposed LNG terminal site.

General project activities potentially impacting EFH include dredging of the berth and maneuvering area, filling of the log pond, shoreline development, pile driving, water withdrawals and discharges, railroad realignment, Hunt Creek Bridge replacement, and accidental spills or leaks of hazardous materials.

Potential impacts on aquatic resources (which include EFH) from construction of the proposed LNG terminal and maintenance dredging of the ship berth and maneuvering area are discussed in detail in section 4.5.2.1. As shown in table 4.5.2-1, dredging of the ship berth and maneuvering area, removal of riparian vegetation, shoreline development, pile driving, and water withdrawals and discharges would result in a substantial adverse effect on EFH for eggs, parr, smolt, and adult Chinook and coho salmon as well as juvenile and adult starry flounder. In addition, filling of the log pond and wetlands at the LNG terminal site, realignment of the railroad, and replacement of the Hunt Creek Bridge would result in substantial adverse impacts on Pacific coast salmon EFH. Construction adjacent to EFH could also result in increased stormwater runoff and/or an inadvertent spill of hazardous materials, either of which could result in substantial adverse effects on EFH. Construction and maintenance of the power line would result in impacts on the waterbodies crossed by the power line, which are unnamed tributaries to Hunt Creek. However, these tributaries are located upstream of Hunt Creek falls; therefore, because there is no fish passage above the falls and the tributaries are at least 5,700 feet from Hunt Creek falls and at least 2,500 feet from the Columbia River, impacts on EFH would not be expected to occur. A detailed discussion of measures that would be implemented to avoid or minimize impacts on aquatic resources (which include EFH) is presented in section 4.5.2.1.

TABLE 4.5.2-1

Potential Impacts on EFH Due to the Bradwood Landing LNG Terminal

EFH	Description of EFH	Project Action with Potential Impacts on EFH	Determination of Effect
Groundfish	Aquatic habitat from the extent of saltwater intrusion in river mouths to the boundary of the EEZ.	Accidental spill or leak of hazardous materials. Dredging of the berth and maneuvering area. Removal of riparian vegetation. Shoreline development. Pile driving. Water withdrawals and discharges.	Substantial adverse effect on starry flounder EFH (see section 4.5.2.1 for a discussion of mitigation measures).
Pacific Coast Salmon	All streams, lakes, ponds, wetlands, and other waterbodies currently and historically accessible to salmon.	Accidental spill or leak of hazardous materials. Dredging of the berth and maneuvering area. Removal of riparian vegetation. Shoreline development. Pile driving. Water withdrawals and discharges. Filling of the log pond. Railroad realignment. Hunt Creek Bridge replacement.	Substantial adverse effect on Pacific Coast salmon EFH (see section 4.5.2.1 for a discussion of mitigation measures).

Source: Pacific Fishery Management Council, 2006b.

4.5.2.3 Terrestrial Wildlife

As described in section 4.4.2.2, the Bradwood Landing LNG terminal site comprises eight distinct upland vegetation cover types. These vegetative communities provide nesting, cover, and/or foraging habitat for a variety of wildlife. Open water and wetland habitats also provide these functions for wildlife species. Potential impacts on these habitats are described and quantified in sections 4.3.2.3 and 4.4.1.2, respectively. The wildlife habitats that would be impacted by the proposed LNG terminal are shown in table 4.5.2-2.

TABLE 4.5.2-2

Acreages of Wildlife Habitats Impacted by the Bradwood Landing LNG Terminal

	LNG Terminal [a]	
Habitat	Construction	Operation
Coniferous forest	8.6	8.6
Deciduous forest	7.8	6.0
Early seral forest	8.6	5.6
Riparian forest	0.7	0.5
Scrub-shrub	12.8	2.2
Riparian scrub-shrub	<0.1	<0.1
Palustrine emergent wetland	5.7	5.7
Palustrine scrub-shrub wetland	3.4	2.7
Multiple wetland types	5.6	4.5
Open water	63.5	59.0
Dredged materials/bare ground	21.3	19.3
Developed and roads	5.1	2.0
Total	143.2	116.1

Note: The totals shown in this table may not equal the sum of addends due to rounding

[a] The LNG terminal includes terminal facilities, Hunt Creek Bridge replacement, and power line.

[b] Since the issuance of the draft EIS, modifications have been proposed to Clifton and Bradwood Roads and the construction worker parking area. Information quantifying these impacts on wildlife habitats has not been provided.

Table 4.5.1-2 identifies some of the wildlife species that are common to these habitats. The most prevalent habitats are open water, forest (i.e., coniferous, deciduous, mixed, early seral, and riparian forests), and wetlands (i.e., palustrine emergent, scrub-shrub, and multiple wetland types). Open water habitats account for approximately 44.3 percent of the wildlife habitat affected. Impacts on wildlife occurring in open water habitats are discussed in section 4.5.2.1. As described in section 4.5.1.3, forest habitats provide the greatest vertical structure and support diverse faunal assemblages. Wetland habitats support diverse floral species and provide foraging and dispersal habitat for a wide variety of wildlife species. These habitats account for about 17.9 and 10.2 percent, respectively, of the wildlife habitat that would be affected by construction of the proposed LNG terminal. A portion of the forest and wetland habitats would also be considered riparian habitat. Similar to the other forest habitats, riparian forest provides significant vertical structure, and generally supports the most diverse faunal assemblages of the affected habitats. The least prominent habitats that would be affected are, in descending order of prevalence, dredged materials and bare ground (14.8 percent), upland scrub-shrub (8.9 percent), developed (3.6 percent), and riparian scrub-shrub (less than 0.1 percent).

General Impacts on Terrestrial Wildlife

The impact of the project on terrestrial wildlife species and their habitats would vary depending on the requirements of each species and the existing habitat present within the project area. Construction of the proposed LNG terminal would affect 143.2 acres of wildlife habitat, and would permanently convert approximately 32.1 acres of land to industrial use. Direct impacts of construction on wildlife would include the displacement of wildlife within the project area and direct mortality of some individuals. Potential impacts on terrestrial wildlife from construction and operation of the proposed LNG terminal are discussed below.

During construction activities, mobile wildlife, such as birds and larger mammals, would be expected to leave the vicinity of the project area. Noise associated with construction could also disrupt bird courting or nesting and breeding of other wildlife in the vicinity of the proposed project. Impacts on migratory birds and proposed minimization measures are described in section 4.6.2.2. Animals displaced by construction activities may relocate into similar habitats nearby; however, the lack of adequate territorial space could force some animals into suboptimal habitats. The influx and increased density of animals in some undisturbed areas caused by these dislocations could increase inter- and intra-specific competition and also reduce the reproductive success of animals that are not displaced by construction. The loss of these individuals could result in a decrease in the food stock available for predators of these species. Additionally, some smaller, less mobile wildlife, such as small mammals and burrowing species (e.g., mice, voles, weasels, and beaver), amphibians, and reptiles, could be crushed by construction equipment or trapped in trenches. However, these effects would cease after construction and wildlife would return to the newly disturbed areas and adjacent, undisturbed habitats after restoration is completed.

As discussed in table 4.5.2-2, about 25.7 acres of upland forested habitat would be affected by construction of the LNG terminal and associated power line. Forested habitats affected by the LNG terminal would include 8.6 acres of coniferous forest, 7.8 acres of deciduous forest, 8.6 acres of early seral forest, and 0.7 acres of riparian forest. The greatest impact would be on sensitive species such as the olive-sided flycatcher, bald eagle, and other species associated with remnant mature coniferous forests that might have used this habitat for nesting or other activities (see section 4.6.2.2). The loss of some trees in this already small patch of habitat would decrease the proportion of habitat that is insulated from the edge, thus making the habitat less attractive to some species.

The scrub-shrub habitat (12.8 acres) impacts would be shorter term than the impacts on forest lands, but regeneration of these areas could still take up to 3 years. Although the structural component of

scrub-shrub habitats would recover slowly, successful restoration of non-woody vegetation may improve the value of forage for some wildlife within a relatively short time.

A total of about 0.7 and 14.8 acres of riparian forest and wetland habitats, respectively, would be affected by construction of the LNG terminal. These areas are important habitats for a number of resident wildlife species. Disturbance to these habitats would be minimized through implementation of NorthernStar's terminal ESC Plan.

Substrate disturbance associated with dredging and LNG carrier transit, especially in nearshore areas of the Columbia River, may temporarily reduce the availability of prey for many bird species. However, impacts would be temporary, as use of these habitats would resume upon the completion of construction.

Impacts on wildlife and their habitats from construction and operation of the LNG terminal would be mitigated for in accordance with recommendations from the FWS, ODFW, and WDFW as described in NorthernStar's preliminary Compensatory Mitigation Plan, which is being developed in coordination with the FWS and the ODFW. Potential impacts on wildlife due to terminal lighting, terminal fencing, and the electric power line are discussed below.

Terminal Lighting

As discussed in section 4.5.2.1, construction of the LNG terminal would require the installation of temporary lighting to facilitate some construction activities and permanent operational lighting. Glare from terminal lighting can affect foraging, reproduction, communication, and other critical wildlife behaviors. In some cases, these behavioral changes can lead to alterations in population or community dynamics (e.g., changes to inter-specific competition and/or predation).

One of the most pervasive effects of night lighting is on behaviors controlling orientation (Wada et al., 1987; Witherington, 1997; and Evans and Ogden, 1996). Sometimes, artificial lighting may disorient organisms used to navigating in dark environments. For example, songbirds can confuse lights on buildings and communication towers for stars that provide navigational cues during migration. This disorientation can lead to birds striking buildings and towers or colliding with one another, especially under overcast or foggy weather conditions (Evans and Ogden, 1996; Evans and Rosenberg, 1999). Conversely, increased illumination may extend diurnal or crepuscular behaviors into the nighttime by improving an animal's ability to orient itself (Longcore and Rich, 2004). This can be beneficial to some individual animals by allowing them to extend the length of activities such as foraging or mating.

Behavioral changes associated with increased lighting can affect activity levels, foraging behavior, habitat use, and mating (Wolfe and Summerlin, 1989; Yurk and Trites, 2000; Bird et al., 2004). In a study conducted by Buchanan (1993), the ability of frogs to detect and consume prey was significantly reduced under increased lighting. Many frogs exhibit a narrow range of environmental illumination in which they are active; within this range, frogs exhibit certain behaviors (such as calling, breeding, and foraging) only at very specific light levels. Bird et al., (2004) found that mice used fewer patches of food and ate less in areas with artificial lighting, indicating that the perceived risk of predation increases with increased lighting (Lima and Dill, 1990). Alternatively, certain species of bats are attracted to and congregate around lit areas, presumably to feed on insects also attracted by the light (Blake et al., 1994; Rydell and Baagøe, 1996). Although outdoor lighting has been shown to affect flight, navigation, vision, migration, dispersal, oviposition, mating, feeding and has lead to increased predation in some moth species, many moth species appear unaffected by outdoor lighting (Frank, 1988). Large mammals, such as mountain lions, strongly avoid lit areas, which can alter their movement patterns and potentially increase habitat fragmentation (Longcore and Rich, 2004).

Artificial lighting could positively and negatively affect wildlife in the vicinity of the proposed LNG terminal. The specific impacts of artificial lighting on individual organisms, populations, or communities are difficult to predict. To minimize the positive and negative impacts of lighting on wildlife, the FWS has developed the *Service Interim Guidelines for Recommendations on Communications Tower Siting, Construction, Operation, and Decommissioning*. These guidelines, which NorthernStar has agreed to implement, can be applied to facilities other than communication towers and include recommendations to reduce the number and intensity of security lights to the minimum required and to use down-shielding lights. To avoid and minimize construction lighting effects during construction, lights would be shielded and directed as needed to illuminate the work areas and meet safety requirements, but to avoid extending off-site unnecessarily. Researchers speculate that in rural locations, down-shielding would have an even greater effect than in urban areas because there is less illumination from other lit structures (Reed et al., 1985). While potential project impacts from artificial lighting cannot be completely eliminated, implementation of the FWS's guidelines related to facility lighting would minimize the potential for terminal lighting to adversely affect wildlife in the project area.

Due to the presence of high-quality habitats that are frequently used by shorebirds, waterfowl, and other waterbirds migrating along the Pacific Flyway and the potential presence of sensitive wildlife species, additional measures are necessary to minimize impacts from terminal lighting on wildlife in the vicinity of the proposed project. Therefore, we have recommended in section 4.5.2.1 that NorthernStar continue to consult with the NMFS, FWS, ODFW, and other applicable agencies to finalize its Lighting Plan.

Terminal Fencing

Comments were received during the scoping process regarding the potential impacts of fencing on wildlife movement patterns. For security purposes, fencing would be constructed around the LNG terminal. The fencing that would surround the proposed LNG terminal would be 8-foot-high woven wire and topped with barbed wire, which would potentially change wildlife movement patterns. At this height, the fence would effectively preclude most if not all wildlife from jumping over the fence (Montana State University, Extension Service, 2000), thus minimizing or eliminating the risk of wildlife being trapped within the LNG terminal site. Measures to minimize impacts from fencing would include establishment and maintenance of passage for mammals and other terrestrial wildlife around the perimeter of the fenced LNG terminal. This would be accomplished by maintaining a natural grade and native vegetative community along the shoreline between the berm and the MLLW elevation as described in section 4.4.2.2. In addition, the majority of the fenced area (71.7 percent) would be graveled and developed for industrial use, and thus would not provide suitable habitat for foraging, breeding, dispersal, or other wildlife movements. Therefore, wildlife in the area would be expected to use other, more suitable areas of habitat for dispersal or other movements. As such, significant impacts on wildlife as a result of the installation of terminal fencing are not anticipated.

Power Line

Construction of the power line would temporarily impact about 17.7 acres of forested habitats. Following construction, 12.7 acres of forest habitats would be replanted with native trees and shrubs and allowed to revegetate. In general, temporary impacts on terrestrial wildlife due to construction of the power line would be similar to those described above for construction of the LNG terminal; however, impacts would be considered longer-term because of the time required to restore forest habitat to its preconstruction condition. The remaining 0.1 acre of habitat temporarily impacted by the power line would be upland scrub-shrub. Restoration of woody vegetation associated with upland scrub-shrub habitat would be complete within 3 to 5 years.

Impacts on wildlife from operation of the power line would be limited to disturbance during maintenance activities and potential electrocution of nesting birds. Maintenance activities would include mechanical and chemical control of about 5.0 acres of forested habitats within the power line right-of-way and maintenance of access roads, towers, and the transmission lines. These activities would be conducted by PacifiCorp and would be of limited duration, but would happen infrequently over the life of the power line. Activities would be conducted only as needed to prevent vegetation from interfering with operation and maintenance of the power line. For the most part, the affected vegetative communities would be early seral forest, which is often dominated by shrubby vegetation within the right-of-way (see section 4.4.2.2). However, some clearing and topping/limbing of coniferous forest could be required to accommodate the supporting towers.

Specific vegetation maintenance procedures that PacifiCorp would apply to maintenance of the power line include:

- mowing would be limited to 15 feet on either side of distribution primary wires and within power line rights-of-way;
- frequency of vegetative control using mechanical and chemical means would be determined based on need and annual inspections and would not occur on a predetermined basis;
- wetlands would be worked by hand in accordance with all applicable federal, state, and local laws and regulations;
- tree removal conditions are site- and tree-specific. However, tree clearing would generally be limited to within 15 feet of distribution conductors and within the 100-foot power line right-of-way. Removal of trees that are dead, dying, diseased, deformed, or unstable and that have a high probability of falling would be emphasized;
- trees would not be felled into streams in a way that could obstruct or impair the flow of water, unless instructed otherwise by the responsible governing agency. Machine work would not be performed within 50 feet of a live stream. Water pollution would be prevented and soil or debris would not be placed in streams. Equipment would use existing or designated stream crossings. State fish and wildlife agencies would be contacted if tree removal in and around streams could cause erosion or if resulting exposure could increase water temperature. Federal and state laws and regulations would be followed concerning stream protection; and
- pre-maintenance surveys would be conducted to protect migratory birds by marking active nests if the line must be worked during nesting season.

Comments were raised during the scoping process regarding the potential for the power line to electrocute migratory birds and nesting raptors during operation of the proposed project. To minimize impacts on birds, PacifiCorp has included specific elements in the power line and tower design for use in raptor areas. Additional discussion of potential impacts on migratory birds is included in section 4.6.2.2.

Unique or Sensitive Wildlife Habitats

Julia Butler Hansen National Wildlife Refuge

The proposed LNG terminal site is near the JBHNWR, which is located on the far shore of the Columbia River in Washington and across Clifton Channel on Tenasillahe Island. The proposed ship berth and unloading facilities would be less than 2,000 feet from the closest point of the refuge – the southeast corner of Tenasillahe Island. The area historically has been used for the placement of dredged materials. As described above, the JBHNWR contains over 5,600 acres of pasture, forested tidal swamp, woodlots, marshes, and sloughs along the Columbia River in both Washington and Oregon and supports a population of Columbian white-tailed deer federally listed as endangered under the ESA. The presence of potentially suitable Columbian white-tailed deer habitat within the LNG terminal site, as well as the site's proximity to the refuge suggests that this species may utilize the area. Potential impacts on the Columbian white-tailed deer and its habitat are discussed in section 4.6.2.2. Impacts on wildlife at the JBHNWR as a result of construction and operation of the proposed LNG terminal would be limited to increased noise and terminal lighting. Impacts on wildlife as a result of terminal lighting are discussed above.

Increased noise would occur as a result of both construction and operation of the LNG terminal. As discussed in section 4.10.2.2, NorthernStar selected five (N1 - N5) noise measurement and analysis sites in the vicinity of the proposed LNG terminal (see figure 4.10.2-1). Although none of these sites were within the JBHNWR, N2 and N3 (both located on Puget Island) are a similar distance from the proposed terminal site as the southeastern corner of Tenasillahe Island within the JBHNWR across the Clifton Channel. Generally, the background noise levels at these locations are relatively low (46 to 48 A-weighted scale (dBA) L_{dn}). During dredging activities, noise levels are expected to average between 68 and 73 dBA L_{dn} at N2 and N3; during non-dredging construction activities at N2 and N3, noise levels would average between 50 and 53 dBA L_{dn}. During operation of the LNG terminal, the analysis showed an average increase of 4 dBA L_{dn} at N2 and N3. Noise levels attributed to construction and operation of the LNG facility drop off quickly to ambient levels at distances farther than N3 (farther than 1 mile from the LNG site). These data suggest that during construction and operation of the Bradwood Landing Project, noise levels at the southeastern corner of Tenasillahe Island would be higher than existing conditions. In fact, conditions may be noisy enough to disturb and/or displace some wildlife species found on the southeastern corner of Tenasillahe Island, particularly during dredging operations. However, this portion of the JBHNWR is dominated by sands deposited during dredging of the Columbia River navigation channel, and is an area that provides limited value as wildlife habitat. As such, we anticipate only relatively minor impacts on wildlife inhabiting the JBHNWR.

During the draft EIS comment period, comments were received regarding potential impacts on sensitive wildlife sites and sensitive species from blasting activities. NorthernStar would develop a Blasting Management Plan that would contain measures for noise mitigation. Due to the presence of both sensitive wildlife sites and high quality habitat for the Columbian white-tailed deer and other sensitive species in the vicinity of the LNG terminal, we recommend that:

- **NorthernStar should consult with the NMFS, FWS, ODFW, and other appropriate agencies in developing its Blasting Management Plan relative to the proposed noise mitigation measures. NorthernStar should file its Blasting Management Plan along with agency comments on the plan with the Secretary for review and written approval by the Director of OEP, prior to blasting activities.**

Oregon Major Big Game Habitat

The proposed LNG terminal site would be located within major big game habitat as mapped by Clatsop County. Elk and deer tracks were observed near the proposed terminal site during a site visit, and black bear have been observed at the site by previous property owners. The *Clatsop County Comprehensive Plan* (Clatsop County, 1996) includes development standards for ODFW-identified big game areas. To minimize disturbance to wildlife, NorthernStar would establish signage along roads and instruct project personnel to reduce vehicle speeds along roads where big game and Columbian white-tailed deer occur to avoid vehicle-animal collisions. Project personnel would also be instructed not to approach big game (either adults or young) at any time. Section 4.6.2.2 includes additional discussion of the Columbian white-tailed deer.

Active Osprey Nest

The proposed LNG terminal site currently supports an active osprey nest on an existing piling along the Columbia River shoreline near the southeast end of the LNG terminal site. Ospreys are common birds of prey that are frequently present near rivers and other waterbodies that provide sufficient quantities of aquatic prey. This species is common along the Columbia River and often builds nests on artificial nest platforms provided by the utility companies. These nest sites are frequently located in close proximity to roadways and other disturbed sites.

The osprey nest would be affected by increased noise and visual disturbance coming from the construction area, which could lead to nest abandonment and failed reproduction. Therefore, NorthernStar has consulted with biologists from the FWS and ODFW to identify appropriate measures to avoid or minimize disturbance to nesting osprey and avoid a "taking" under the Migratory Bird Treaty Act. Per ODFW recommendations, osprey nest relocation would be conducted outside of the critical nesting period (early September through late February). This relocation would occur when no osprey courtship behavior is observed at the site and when the nest is not being actively used (i.e., outside of the breeding season).

Osprey typically exhibit a high degree of nest fidelity and are likely to attempt to rebuild at the existing location unless a superior site is provided nearby. As such, the relocated structure would be of comparable or better quality and meet the following conditions:

- the new nest platform would be in an exposed location that is as high or higher than the original nest site and surrounding structures (including power lines);
- the new location would be located as close as possible to the existing nest, but no closer than 0.25 mile from activities associated with construction and operation of the LNG terminal;
- the new location would be no closer than 600 feet to an existing osprey, bald eagle, or peregrine falcon nest;
- if using a transmission pole, a predator guard (sheet metal) would be installed at the base of the pole;
- an elevated perch (minimum of 3 feet above the nest platform) would be included in the platform design to attract the osprey pair to the new nest site;

- the platform and structure would be mounted securely and capable of supporting a nest that may weigh 100 to 200 pounds; and

- the old nest would be kept intact (if possible) and relocated onto the new platform; however, if the nest cannot be kept intact, portions of the old nest would be used to construct the new nest.

If the piling for the original nest were to be left intact, it would be modified to discourage ospreys from rebuilding a nest at the same site. This would likely be accomplished by installing a triangular perch guard to prevent osprey from landing and rebuilding the replaced nest.

Mitigation Measures

Project design, construction, and operation plans have been modified to avoid or minimize impacts on terrestrial wildlife. These efforts would be ongoing during construction in order to capitalize on avoidance and minimization opportunities that cannot be predicted. However, both direct and indirect impacts on wildlife would result from construction and operation of the proposed LNG terminal. Mitigation measures discussed in this section are specifically for impacts on upland habitats. Mitigation measures proposed by NorthernStar for wetland and aquatic habitats would also benefit terrestrial wildlife, and are discussed in sections 4.4.1.2 and 4.5.2.1, respectively, and in NorthernStar's Compensatory Mitigation Plan.

The FERC received numerous comments stating that the mitigation proposed by NorthernStar does not adequately compensate for impacts associated with the project. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. To ensure that the mitigation proposed for the Bradwood Landing Project adequately compensates for project-related impacts, we have recommended that NorthernStar continue to consult with the appropriate natural resource agencies to finalize its Compensatory Mitigation Plan. The final Compensatory Mitigation Plan should be filed along with agency comments and applicable approvals with the Secretary prior to construction of the project.

The primary proposed mitigation site for impacts on wildlife habitat is at Peterson Point, which is located 6 miles west of Clatskanie, Oregon. The Peterson Point Mitigation Site currently provides habitat for a variety of wildlife species including Columbian white-tailed deer, beaver, bald eagle, northern harrier, red-tailed hawk, numerous species of waterfowl and songbirds, and a variety of reptiles and amphibians, including tree frogs. About 40 to 100 Columbian white-tailed deer from the Oregon lowlands subpopulation occasionally use the site. Additionally, there are two bald eagle nests within a 2-mile radius of the site; one is located about 1.0 mile north of the mitigation site on a slough bordering Whites Island and the other is located about 1.8 miles from the site on Whites Island. No other federally endangered or threatened species have been documented at the Peterson Point Mitigation Site.

NorthernStar proposes to restore about 114 acres of native forest and about 31 acres of riparian habitat. As described in section 4.5.3.3, the current owner has been working with Ducks Unlimited to enhance wildlife habitat values through a combination of activities including blocking drainage ditches, installing flow control structures, and clearing hybrid poplars. The result is a mosaic of hybrid poplar stands, emergent wetlands and pasture/grassland habitats. The proposed mitigation parcels are in strategic locations throughout the site and include 114 acres of hybrid poplars on relatively higher ground that is drier than many of the other areas at the site due, in part, to flow control structures and pump stations, which regulate the water levels in the sloughs and ditches. In addition, the mitigation site contains 31 acres along the Columbia River and Westport Slough that are currently providing high-quality riparian habitat. Mitigation at this site would include a combination of preservation and enhancement by planting understory and riparian vegetation (for Columbian white-tailed deer), controlling noxious weeds,

installing artificial nest structures (for purple martins, osprey, wood ducks, and bats), and installing brush piles to provide refugia for small mammals, herptofauna, and ground-nesting birds. The parcels restored on the Peterson Point Mitigation Site would be protected in perpetuity from development by accomplishing deed restrictions, memorandums of understanding, and control by a third party.

The primary goal of the Peterson Point Mitigation Site would be to enhance and protect potentially suitable habitat for the Columbian white-tailed deer (see section 4.6.2.2). However, by restoring 145 acres of forested habitat, a net benefit would be provided to a wide variety of terrestrial wildlife species by increasing the availability of potential habitat for breeding, foraging, and dispersal. NorthernStar proposes to conduct annual monitoring of the Peterson Point Mitigation Site for 5 years. Monitoring reports, which would be submitted to the ODFW and FWS, would include a detailed summary of conditions of each of the parcels. In addition to submitting monitoring results, recommendations would be made for maintenance of non-native weedy species and/or corrective actions necessary to meet the performance standards.

NorthernStar has also developed an SEI, which would be implemented throughout the life of the project. Although the primary goal of the SEI would be to ensure the recovery of salmon and the lower Columbia River ecosystem, the projects would also benefit terrestrial species. The SEI is described in detail in section 4.6.2.2.

4.5.2.4 Oregon Department of Fish and Wildlife - Habitat Mitigation Policy

The ODFW developed a HMP (OAR 635-415-0010) to further fish and wildlife management policies "through application of consistent goals and standards to mitigate impacts on fish and wildlife habitat caused by land and water development actions" (ODFW, 2006a). The policy includes a description of six qualitative habitat categories, which are based on relative importance to fish and wildlife. The rule establishes mitigation goals and corresponding implementation standards for each habitat category. These categories with their mitigation goals and implementation standards are summarized below.

- Habitat Category 1 is irreplaceable, essential habitat for a fish or wildlife species, population, or a unique assemblage of species and is limited on either a physiographic province or site-specific basis, depending on the individual species, population, or unique assemblage. The mitigation goal for Category 1 habitat is no loss of either habitat quantity or quality. The implementation standard recommends or requires avoidance of impacts through alternatives to the proposed development action; or no authorization of the proposed development action if impacts cannot be avoided.

- Habitat Category 2 is essential habitat for a fish or wildlife species, population, or unique assemblage of species and is limited either on a physiographic province or site-specific basis depending on the individual species, population, or unique assemblage. The mitigation goal, if impacts are unavoidable, is no net loss of either habitat quantity or quality and to provide a net benefit of habitat quantity or quality. The implementation standard recommends or requires avoidance of impacts through alternatives to the proposed development action; or mitigation of impacts, if unavoidable, through reliable in-kind, in-proximity habitat mitigation to achieve no net loss of either pre-development habitat quantity or quality. In addition, a net benefit of habitat quantity or quality must be provided. If this cannot be achieved, the ODFW shall recommend against or shall not authorize the proposed development action.

- Habitat Category 3 is essential habitat for fish and wildlife, or important habitat for fish and wildlife that is limited either on a physiographic province or site-specific basis, depending on the individual species or population. The mitigation goal is no net loss of either habitat quantity or quality. The implementation standard recommends or requires avoidance of impacts through alternatives to the proposed development action; or mitigation of impacts, if unavoidable, through reliable in-kind, in-proximity habitat mitigation to achieve no net loss in either pre-development habitat quantity or quality. If this cannot be achieved, ODFW shall recommend against or shall not authorize the proposed development action.

- Habitat Category 4 is important habitat for fish and wildlife species. The mitigation goal is no net loss in either existing habitat quantity or quality. The implementation standard recommends or requires avoidance of impacts through alternatives to the proposed development action; or mitigation of impacts, if unavoidable, through reliable in-kind or out-of-kind, in-proximity or off-proximity habitat mitigation to achieve no net loss in either pre-development habitat quantity or quality. If this cannot be achieved, ODFW shall recommend against or shall not authorize the proposed development action.

- Habitat Category 5 is habitat for fish and wildlife having high potential to become either essential or important habitat. The mitigation goal, if impacts are unavoidable, is to provide a net benefit in habitat quantity or quality. The implementation standard recommends or requires avoidance of impacts through alternatives to the proposed development action; or mitigation of impacts, if unavoidable, through actions that contribute to essential or important habitat. If this cannot be achieved, ODFW shall recommend against or shall not authorize the proposed development action.

- Habitat Category 6 is habitat that has low potential to become essential or important habitat for fish and wildlife. The mitigation goal is to minimize impacts. The implementation standard recommends or requires actions that minimize direct habitat loss and avoid impacts on off-site habitat.

NorthernStar's Compensatory Mitigation Plan identified a number of sites in the general project area that would be set aside and/or developed as compensatory mitigation. Specifically, these sites would compensate for temporary or permanent impacts on wetlands, wildlife habitats, and salmonid habitats that could not otherwise be mitigated. The compensatory mitigation sites were identified only after all other forms of impact mitigation (i.e., avoidance, minimization, rectification, and reduction) were considered and, when appropriate, implemented. In developing these sites, it is NorthernStar's intent to provide an overall net benefit to the environment of the lower Columbia River ecosystem. However, because NorthernStar's Compensatory Mitigation Plan has not been finalized, we recommended in section 4.4.1.1, that NorthernStar continue to consult with the COE, ODSL, WDE, other applicable agencies, and appropriate Native American tribes to finalize its Compensatory Mitigation Plan. Based on NorthernStar's proposed compensatory mitigation and our recommendation to continue to consult with appropriate agencies regarding compensatory mitigation, we anticipate that the goals and standards of ODFW's HMP would be met.

4.5.3 Pipeline Facilities

4.5.3.1 Aquatic Resources

Existing Aquatic Resources

Anadromous and freshwater fish occurring in the lower Columbia River and its tributaries are described in section 4.5.1.1.

Commercial and Recreational Fisheries

Commercial and recreational fisheries of the lower Columbia River and its tributaries are described in section 4.5.1.1.

Impacts on Aquatic Resources

General project activities potentially impacting aquatic resources include in-water construction activities, terrestrial/riparian habitat modification, water appropriations, accidental spills or leaks of hazardous materials, and periodic maintenance of the pipeline. Much of the impact discussion included below applies to the fish protected under the ESA, which are described in detail in sections 4.6.1.1 and 4.6.2.3, and to EFH designated under the MSA, which is discussed further in section 4.5.2.3.

In-Water Construction Activities

Fish and other aquatic resources could be impacted by in-water construction activities associated with pipeline construction. The degree of impacts on fish associated with construction activities would depend on the timing of in-water construction. Construction during periods of sensitive fish activity (i.e., spawning, juvenile rearing, and migration) can have a greater impact on fish than construction during other periods. To minimize impacts on fish, pipeline construction within waterbodies would occur during in-water work windows designated by the ODFW and WDFW.

The proposed pipeline would impact 94 waterbodies, of which 52 are intermittent and 42 are perennial. Of these, up to 23 would be crossed using the HDD or conventional bore methods, which would avoid in-water construction activities. The remaining waterbodies would be crossed using a dry open-cut method (see table 4.3.2-4). Waterbody crossing methods are described in detail in sections 2.4.2.2 and 4.3.2.4).

In-stream construction across waterbodies would directly affect aquatic resources. In addition, construction across waterbodies would remove vegetation and habitat, thereby potentially increasing the sedimentation and turbidity of the water, streambank erosion, and water temperature. Construction-related impacts on aquatic resources could also result from an inadvertent release of drilling mud during HDDs. A discussion of potential impacts on aquatic resources is provided below. The degree of impact would depend on the proposed crossing method, the existing conditions at each crossing location, the mitigation measures employed, and the timing of construction.

Dry waterbody crossing methods (i.e., diverted dry open-cut, flume, dam and pump) could interfere with essential life processes. In-stream construction could also delay or prevent migrating fish from reaching upstream spawning areas or could delay downstream movement of juveniles. Equipment moving through a stream and the trenching of a waterbody could physically damage fish, fish eggs, and other aquatic organisms, including fish prey and forage species. In-stream structures for support of equipment bridges over streams may similarly impact fish and other aquatic organisms. The HDD and

conventional bore methods avoid in-stream construction and generally minimize impacts on aquatic resources.

The majority of the waterbodies affected by the Bradwood Landing Project would be crossed using the dam and pump or flume method if water is flowing in the waterbody at the time of construction. In-stream activities associated with placing the flume pipe and constructing the sandbag dams would be expected to displace most fish either upstream or downstream from the dams. Flumes and dams would be completely installed and functioning before any in-stream disturbance. All flume and dam and pump crossings would be completed as a single effort to minimize the duration of in-stream disturbance.

Inadvertent Release of Drilling Mud

NorthernStar proposes to install the pipeline across all 12 waterbodies containing federally listed salmonids or their designated critical habitat (see table 4.3.2-6) using the HDD or conventional bore method. The HDD and bore methods eliminate the need to excavate a trench through the stream or river channel, and would minimize or eliminate sedimentation and turbidity associated with the more common open-cut methods of pipeline construction. NorthernStar has agreed to follow our Procedures, which require submittal of a plan prior to construction that contains site-specific diagrams showing the location of mud pits, pipe staging areas, and all areas to be disturbed or cleared for construction.

Although the HDD method would minimize or avoid in-stream impacts on aquatic resources because it eliminates the need for in-stream excavation, it does not completely eliminate the possibility of impacts due to the possibility of an inadvertent release of drilling mud or fluid (also referred to as a frac-out) into the waterbody. Drilling mud primarily consists of water mixed with bentonite, which is a naturally occurring clay material. The only other possible additives would be non-toxic solid materials (e.g., sawdust, nut shells, bentonite pellets, or other commercially available non-toxic products) that could be needed to plug an inadvertent release. Bentonite, by itself, is essentially non-toxic (Breteler et al., 1985; Hartman and Martin, 1984; Sprague and Logan, 1979). However, bentonite, as with any fine particulate material, can interfere with oxygen exchange by the gills of aquatic organisms (EPA, 1986). The degree of interference generally increases with water temperature (Horkel and Pearson, 1976). Impacts would be localized and would normally be limited to individual fish in the immediate vicinity of the frac-out. The majority of highly mobile aquatic organisms, such as fish, would be able to avoid or move away from the affected area. Other less mobile or immobile organisms, such as fish eggs, mussels, and other macroinvertebrates, would incur direct mortality.

Comments were received on the draft EIS relating to potential impacts on spawning habitat due to a frac-out during pipeline construction. As stated above, if fish eggs are present in the vicinity of a frac-out, direct mortality could occur. However, at the time of a frac-out, NorthernStar would stop drilling immediately and notify appropriate agencies. A vacuum truck or pump(s), with a sufficient hose, would then be used to remove the bentonite, working from downstream to upstream, to allow maximum visibility. Hand tools may be used to scarify the sediments and ensure removal to the maximum extent practicable, thus minimizing impacts on spawning habitat.

As discussed in section 4.3.2.4, the highest potential for a frac-out typically occurs at the beginning or the end of the HDD borehole where the separation between the borehole and ground surface is the least. NorthernStar has designed the proposed HDD crossings so that areas at greatest risk of a potential inadvertent release are in upland areas away from the water's edge. HDD entry and exit pits would be located a minimum of 75 feet from sensitive waterbodies (Appendix B), which would minimize the potential for an inadvertent release into a waterbody, thereby minimizing the likelihood of impacts on aquatic resources. NorthernStar's *HDD Contingency Plan* describes how the drilling operations would be conducted and monitored to minimize the potential for inadvertent drilling mud releases. The plan also

includes procedures and measures to be taken during an inadvertent release of drilling mud. NorthernStar would station the necessary equipment and supplies to respond to an inadvertent release of drilling mud upon discovery of loss of drilling fluid. At the time of a release of drilling mud, NorthernStar would stop drilling immediately, contain drilling fluids, and notify appropriate agencies. Appropriate resource experts, such as fisheries biologists and wetland scientists would be brought onsite to monitor resources and effects of the release.

Suspended Sediments and Turbidity

Increased suspended sediment and turbidity levels, due to in-water trenching and backfilling, would pose the greatest potential for impacts on aquatic species due to construction of the proposed pipeline. The extent of the impact would be dependent on sediment loads, water velocity, and sediment particle size at the time of construction. Potential impacts of clearing the pipeline right-of-way would be analogous to, but on a much smaller scale than, timber harvest and associated road construction, which have been found to increase the frequency and magnitude of soil destabilization, erosion, and eventually stream sedimentation (Everest et al., 1987; Swanson et al., 1987). As discussed above, sedimentation can adversely affect fish eggs and fish survival, benthic community diversity and health, and spawning habitat. Suspended particles and sediment can result in turbidity in sufficient quantities to affect oxygen exchange over the gills in aquatic species, resulting in weakened individuals or mortality. Additionally, sediment stirred into the water column can be redeposited on downstream substrates, which could bury aquatic macroinvertebrates (an important food source for salmonids). However, studies indicate that impacts on streams and rivers from typical pipeline construction would be temporary, and that no long-term effects on water temperature, pH, dissolved oxygen, benthic invertebrate populations, or fish populations would occur (Vinkour and Shubert, 1987; Blais and Simpson, 1997). To reduce sedimentation and erosion, NorthernStar would perform turbidity monitoring in accordance with state permits, implement its pipeline ESC Plan for Oregon, and its SWPPP for Washington. NorthernStar would compensate for impacts on surface waters and aquatic resources that could not be avoided by setting aside or developing a number of mitigation sites, which are described in its Compensatory Mitigation Plan.

Vegetation and Habitat Removal

Aquatic resources could be affected through the removal of vegetation and habitat at the waterbody crossing sites. Potential impacts include increased water temperature, decreased LWD and the associated reduction in habitat, and increased mass failures adjacent to waterbodies. These impacts are discussed below.

Clearing the right-of-way would remove shading vegetation from uplands and riparian areas, exposing the land and water to increased sunlight, resulting in both direct increases in water temperatures and indirect increases as water flows over the warmer land surface and eventually reaches the waterbody (Beschta and Taylor, 1988). The effects of water temperature on the life stages of salmonids have been extensively reviewed and are described in section 4.5.2.1. To mitigate these potential impacts, NorthernStar would allow a corridor at least 25 feet wide, as measured from the OHWM, to permanently revegetate with native plant species across the entire construction right-of-way following construction. However, to facilitate access for periodic pipeline corrosion/leak surveys, a corridor centered on the pipeline and up to 10 feet wide may be maintained in an herbaceous state. NorthernStar's use of the HDD construction method to cross waterbodies would also limit impacts on riparian habitats. The only potential disturbance in riparian areas crossed using the HDD method would be minor trimming of vegetation using hand tools directly over the pipeline. This minor clearing is required to facilitate the temporary deployment of HDD guidance (telemetry) cables along the ground during construction and to perform a leakage survey after installation and commissioning.

In addition to potential temperature impacts, one of the most significant potential effects of forest clearing on fisheries is the reduction of LWD in streams and on land (Harmon et al., 1986; Sedell et al., 1988). Large logs provide in-stream channel structures (i.e., pools and riffles), which are critical to salmon spawning and rearing. As the size of individual logs or accumulations of logs increases, the size and stability of pools that are created also increase (Beschta, 1983). Riparian forests that undergo harvesting of large trees take on secondary-growth characteristics and contribute lower quantities of woody debris than unmanaged, old-growth forests (Bisson et al., 1987). However, sufficiently wide, carefully managed riparian buffers that retain a full complement of ages, sizes, and species of native trees and vegetation can ensure adequate recruitment of LWD to streams (Bisson et al., 1987; Murphy and Koski, 1989; Morman, 1993).

NorthernStar is consulting with the FWS, NMFS, and state agencies regarding potential mitigation for replacement of in-stream habitat. These preliminary discussions indicate that mitigation could include the placement of LWD within the waterbodies following construction to mitigate for loss of habitat from in-stream construction. The use of LWD as a mitigation measure for impacts associated with in-stream construction has been documented as an effective means of creating in-stream habitat heterogeneity, reducing streambank erosion, reducing sediment mobilization, and enhancing local fish abundance (Scarborough and Robertson, 2002; Bethel and Neal, 2003). Because short-term loss of riparian vegetation within construction work areas may affect water temperatures by removing shade sources, placement of LWD on the streambanks and in the streams can provide shade and increase bank stability while vegetation is maturing following construction. Additionally, placement of LWD in streams or on streambanks can supply habitat for forage species and enhance the salmonid rearing potential of an area. Due to the importance of numerous fish species in waterbodies along the proposed route, we have recommended in section 4.3.2.4 that NorthernStar continue to consult with the COE, NMFS, FWS, and appropriate federal and state agencies to finalize its *Waterbody and Wetland Construction and Mitigation Procedures Plan*, including a description of the specific methods of in-water habitat mitigation to be conducted.

Forest clearing and construction have also been found to increase the frequency and amount of sediment production through mass failures which are a major contributor of sediment to streams, particularly in steep landscapes (Swanson et al., 1987). Mass failures adjacent to streams and resulting debris flows carve stream banks, thereby resulting in significant patches of bare ground. These areas favor revegetation by fast-growing species such as red alder rather than a diverse plant community which is normally characteristic of riparian habitats (Knutson and Naef, 1997). Debris flows also move LWD to floodplain areas or to concentrated locations, reducing the distribution of this habitat throughout the stream (Swanson et al., 1987). Although the potential for mass failures cannot be completely eliminated, since this is also a natural phenomenon, NorthernStar would ensure equipment stability and worker safety by avoiding the placement of HDD or bore entry and exit pits in areas where steep slopes are present because they require significant extra workspace as compared to open-cut methods. Clearing this extra workspace on already unstable sideslopes would increase the likelihood of mass failures and landslides. NorthernStar would also implement its pipeline ESC Plan for Oregon and its SWPPP for Washington to reduce the potential for mass failures. In addition, we have also recommended that NorthernStar conduct additional field mapping and subsurface investigations as needed to develop a Final Pipeline Design Geotechnical Report.

Streambank Erosion

The clearing and grading of vegetation during construction could increase erosion along streambanks and turbidity levels in the waterbodies. Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. The degree of impact on aquatic

organisms would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size. To minimize these impacts, NorthernStar would use temporary equipment bridges, mats, and pads to support equipment that must cross the waterbody or work in saturated soils adjacent to the waterbody. In accordance with our Procedures and where topography allows, NorthernStar would attempt to preserve a minimum of 10 feet of vegetation along the waterbody banks during clearing and grading and locate temporary extra workspaces back from the edge of perennial and intermittent waterbodies where feasible to minimize the disturbance of riparian vegetation. As discussed in section 4.4.2.3, NorthernStar would allow a corridor at least 25 feet wide, as measured from the OHWM, to permanently revegetate with native plant species across the entire construction right-of-way following construction. At waterbodies that would be crossed via the HDD method, the only anticipated streambank disturbance would be minor trimming of vegetation using hand tools directly over the pipeline. NorthernStar would also install sediment barriers, such as silt fence and straw/hay bales, adjacent to waterbodies until the right-of-way revegetation is complete.

Introduction of Exotic Species

Comments were received on the draft EIS stating that invasive mussels may occur within waterbodies crossed by the proposed project. Although NorthernStar has developed a *Noxious Weeds and Soil-borne Plant Disease Control Plan* for upland vegetation, a similar plan has not been developed to prevent the introduction of invasive species into waterbodies impacted by pipeline construction. Therefore, we have recommended in section 4.3.2.4 that NorthernStar continue to consult with the COE, NMFS, FWS, and appropriate federal and state agencies to finalize its *Waterbody and Wetland Construction and Mitigation Procedures Plan*, including measures to prevent the spread of invasive species due to construction activities within waterbodies.

Terrestrial/Riparian Habitat Modification

Fish and other aquatic resources could be impacted indirectly by activities that alter terrestrial and riparian habitat including upland pipeline construction. The clearing and grading of vegetation during construction could increase erosion along streambanks and turbidity levels in the waterbodies. Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. The degree of impact on aquatic organisms due to erosion would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size. Potential impacts due to vegetation clearing are discussed above (see *Vegetation and Habitat Removal*). NorthernStar would minimize potential impacts on wildlife during construction by implementing the procedures in its pipeline ESC Plan for Oregon and SWPPP for Washington. To avoid impacts on aquatic habitat during operation of the project, NorthernStar would allow a riparian strip at least 25 feet wide, as measured from the waterbody's MHW mark, to permanently revegetate with native plant species across the entire construction right-of-way. Within the riparian strip, trees greater than 15 feet tall, or deep-rooted shrubs that could damage the pipeline's protective coating, obscure periodic surveillance, or interfere with potential repairs, would not be allowed to grow within 15 feet (30 feet total) of the pipeline (see section 4.4.2.3).

Water Appropriation

As discussed in section 4.3.2.4, NorthernStar would appropriate water from the Columbia River for hydrostatic testing of the proposed pipeline. As described in section 4.5.2.1, NorthernStar would obtain the necessary permits from state agencies before withdrawing water and use modern fish screening technology on surface water intakes. The volume of water withdrawn for hydrostatic testing of the pipeline would not measurably reduce downstream flows. Water appropriated for hydrostatic testing of

the pipeline would be discharged to an upland area near the pipeline crossing of the Columbia River using appropriate filtering techniques. The water would be discharged at an approximate rate of 1,000 gpm and would not be chemically treated. All discharges would be in compliance with NorthernStar's ODEQ water discharge permit and would not be expected to impact fish.

Accidental Spills or Leaks of Hazardous Materials

For any large construction project, there is the potential for spills or leaks of fuels or hazardous materials from storage containers, equipment working in or near streams, and fuel transfers. Any spill of fuel or hazardous liquid that reaches a waterbody would be detrimental to water quality. The chemicals released during spills could have acute, direct effects on fish, or could have indirect effects such as altered behavior, changes in physiological processes, or changes in food sources. Fish could also be killed if a large volume of fuel or hazardous liquid is spilled into a waterbody. Ingestion of large numbers of contaminated fish could affect primary and secondary fish predators in the food chain.

To minimize the potential for spills, NorthernStar prepared a pipeline ESC Plan and a SWPPP that include spill prevention and response procedures. NorthernStar's implementation of these plans would minimize the potential for and the impact of any spill near surface waters. Specific measures in these plans include prohibiting liquid transfer, vehicle and equipment washing, and refueling within 100 feet of waterbodies and specific steps to be followed to control, contain, and clean up any spill that occurs. NorthernStar's implementation of these plans would minimize the potential for and the impact of any spill near surface water during construction of the pipeline.

Crossing of Unstable Slopes

Most of the unstable slopes near sensitive waterbodies would be crossed by the HDD construction method. There are no other locations where the pipeline would cross an unstable slope within 200 feet upslope of a waterbody. Further information regarding unstable slopes and mitigation measures is provided in section 4.1.4.3.

Mitigation Measures

Project design, construction, and operation plans have been modified to avoid or minimize impacts on aquatic resources. These efforts would be ongoing during construction in order to capitalize on avoidance and minimization opportunities that cannot be predicted. However, both direct and indirect impacts on aquatic resources would result from construction and operation of the proposed pipeline. NorthernStar has committed to provide an overall net benefit to the environment of the lower Columbia River ecosystem.

Following construction of the pipeline, habitat and ecosystem function would be restored in place. Permanent impacts on aquatic resources would be mitigated by restoring habitat with similar ecological function. Mitigation would occur in areas substantially larger than that lost to permanent impacts, and would be restored to a higher level of ecosystem function. However, although compensatory mitigation actions would restore habitat and have long-term benefits to wetlands, estuarine ecosystems, and habitat for salmonids in general, there would be short-term adverse effects and longer term adverse effects on some non-target species. In terms of overall ecosystem health, these trade-offs are considered appropriate and valuable enough to more than balance the cost of the adverse effects.

As described in sections 4.5.2.2 and 4.5.2.3, NorthernStar identified a number of sites in the general project area that would be set aside and/or developed as compensatory mitigation in Oregon. In addition to these sites in Oregon, the Delameter Creek Mitigation Site would include restoration of

riparian habitats in Washington, thereby providing additional benefits to aquatic resources. This mitigation site is discussed in section 4.4.1.3.

The FERC received numerous comments stating that the mitigation proposed by NorthernStar does not adequately compensate for impacts associated with the project. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. To ensure that the mitigation proposed for the Bradwood Landing Project adequately compensates for project-related impacts, we have recommended that NorthernStar continue to consult with the appropriate natural resource agencies to finalize its Compensatory Mitigation Plan. The final Compensatory Mitigation Plan should be filed along with agency comments and applicable approvals with the Secretary prior to construction of the project.

4.5.3.2 Essential Fish Habitat

EFH is described in detail in section 4.5.1.2. Table 4.5.3-1 provides a list of the waterbodies impacted by the proposed route that provide EFH for salmonid species. For the purposes of this analysis, all fish-bearing streams that would be crossed by the proposed pipeline route are assumed to provide EFH for Chinook or coho salmon. Within the nine waterbodies designated as EFH for Chinook and/or coho salmon that would be crossed using the open-cut method, in-water work would affect a total of 0.4 acre of EFH would be temporary affected. As described in section 4.3.2.4, all waterbody crossings that involve open trenching would be constructed during established in-water work windows. To reduce impacts on EFH, NorthernStar would implement its *Waterbody and Wetland Construction and Mitigation Procedures Pla*n, pipeline ESC in Oregon, and SWPPP in Washington as well as our Procedures.

In freshwater, EFH for Chinook and coho salmon include habitats for spawning, rearing, and migration corridors (PFMC, 2003). Components of the proposed pipeline with the potential to adversely affect designated EFH include removal of terrestrial and riparian vegetation, in-water pipeline construction, accidental spills and leaks of hazardous materials, and water appropriation for hydrostatic testing. Construction adjacent to EFH could also result in increased stormwater runoff and/or an inadvertent spill of hazardous materials, either of which could result in substantial adverse effects on EFH. Potential impacts on aquatic resources (which include EFH) from pipeline construction as well as measures that would be implemented to avoid or minimize impacts on aquatic resources is presented in section 4.5.3.1.

The determinations of effect on EFH resulting from the proposed Bradwood Landing pipeline are described in table 4.5.3-2. The FERC will respond to any EFH Conservation Recommendations issued by the NMFS through the EFH/ESA consultation process. Official written correspondence between FERC and the NMFS for the Bradwood Landing Project is part of the public record for this proceeding and is available through the FERC's internet web page (at www.ferc.gov) by clicking on the elibrary link.

4.5.3.3 Terrestrial Wildlife

As described in section 4.4.2.3, the Bradwood Landing pipeline would cross nine distinct upland vegetation cover types. Each of these vegetative communities provides nesting, cover, and/or foraging habitat for a variety of wildlife. Open water and wetlands habitats also provide these functions for wildlife species. Potential impacts on these habitat types are described and quantified in sections 4.3.2.4 and 4.4.1.3, respectively. Wildlife habitats crossed by the pipeline are shown in table 4.5.3-3.

TABLE 4.5.3-1

Fishbearing Waterbodies Impacted by the Bradwood Landing Pipeline

Waterbody	MP	Type/Flow Conditions	Proposed Crossing Method
Oregon [a]			
Tributary 1 to Driscoll Slough	4.1	Perennial	HDD
Driscoll Slough	4.2	Perennial	HDD
Tributary to Westport Slough	5.0	Intermittent	HDD
Westport Slough	5.2	Perennial	HDD
Westport Slough/ Midland Canal	10.0	Perennial	HDD
Clatskanie River	13.2	Perennial	HDD
Larson Slough	15.0	Perennial	Dam and Pump
McLean Slough 1	16.8	Intermittent	Dam and Pump
McLean Slough 2	17.7	Intermittent	N/A [b]
Columbia River	19.0	Perennial	HDD
Washington [c]			
Columbia River	19.6	Perennial	HDD
Cameron Creek	20.6	Perennial	HDD
Abernathy Creek	21.1	Perennial	HDD
Germany Creek	22.4	Perennial	HDD
Fall Creek	23.2	Perennial	Dam and Pump or Flume
Harmony Creek	24.7	Perennial	Bore
Brock Creek	26.0	Perennial	Dam and Pump or Flume
Tributary 5 to Coal Creek	27.5	Perennial	Bore
Tributary 1 to Coal Creek	27.7	Intermittent	N/A [b]
Coal Creek	28.0	Perennial	HDD
Tributary 1 to Clark Creek	30.3	Intermittent	Dam and Pump
Clark Creek	30.4	Perennial	Dam and Pump or Flume
Tributary 2 to Clark Creek	30.7	Intermittent	Dam and Pump
Cowlitz River	34.3	Perennial	HDD
Ostrander Creek	36.2	Perennial	Bore

[a] NMFS, Northwest Fisheries Science Center, 2005
[b] Not crossed by proposed centerline. No crossing method proposed.
[c] Washington Department of Natural Resources, 2007.

TABLE 4.5.3-2

Potential Impacts on EFH Due to the Bradwood Landing Pipeline

EFH	Description of EFH	Project Action with Potential Impacts on EFH	Determination of Effect
Pacific Coast Salmon	All streams, lakes, ponds, wetlands, and other waterbodies currently and historically accessible to salmon.	Accidental spill or leak of hazardous materials. Pipeline construction at waterbody crossings. Water withdrawals. Accidental spills or leaks of hazardous materials.	Substantial adverse effect on Pacific Coast salmon EFH (see section 4.5.3.1 for a discussion of mitigation measures).

Source: Pacific Fishery Management Council, 2006.

TABLE 4.5.3-3

Acreages of Wildlife Habitats Impacted by the Bradwood Landing Pipeline Facilities

Habitat	Pipeline [a]	
	Construction	Operation
Coniferous forest	76.2	22.9
Deciduous forest	32.1	9.6
Mixed forest	52.5	15.7
Early seral forest	16.3	4.9
Riparian forest	2.9	0.9
Scrub-shrub	6.9	3.0
Palustrine emergent wetland	49.2	0.0
Palustrine scrub-shrub wetland	0.4	0.0
Palustrine forested wetland	5.0	1.8
Multiple wetland types	43.3	12.9
Open water	10.9	3.8
Agricultural	98.6	41.6
Dredged materials/bare ground	0.6	0.4
Developed and roads	42.7	8.5
Total	437.6	126.0

[a] Pipeline facilities includes the construction or permanent right-of-way, extra work spaces, and associated aboveground facilities.

Table 4.5.3-4 identifies some of the wildlife species that are common to these habitats. The most prevalent habitats are forest (i.e., evergreen, deciduous, mixed, early seral, and riparian forests) and wetlands (i.e., palustrine emergent, scrub-shrub, forested, and multiple wetland types). Forest habitats provide the greatest vertical structure and support diverse faunal assemblages. Wetland habitats support diverse floral species and provide foraging and dispersal habitat for a wide variety of wildlife species. These habitats account for about 41.1 and 22.4 percent, respectively, of the wildlife habitat that would be affected by construction of the proposed project. A portion of the forest and wetland habitats would also be considered riparian habitat. Similar to the other forest habitats, riparian forest provides significant vertical structure, and generally supports the most diverse faunal assemblages of the affected habitats. Agricultural and developed lands account for approximately 22.5 and 9.8 percent, respectively, of the wildlife habitat affected. Although agricultural habitats support several cover types, they often have low diversity within each cover type. The least prominent habitats that would be affected are, in descending order of prevalence, open water habitats (2.5 percent), upland scrub-shrub (1.6 percent) and dredged materials and bare ground (<1.0 percent).

General Impacts on Terrestrial Wildlife

Construction of the proposed pipeline would affect 437.6 acres of wildlife habitat and would convert approximately 159.1 acres of land to permanent right-of-way, which would be maintained in an herbaceous state. The impacts of construction and operation of the proposed pipeline on terrestrial wildlife and wildlife habitats would vary depending upon the timing of construction and types of construction techniques used, as well as on the requirements of each species and the habitat present where various project components would be constructed. Direct impacts of construction on wildlife would include the displacement of wildlife within the project area and direct mortality of some individuals. In general, impacts on terrestrial wildlife due to construction of the pipeline and proposed mitigation measures would be similar to those described above for construction of the LNG terminal.

TABLE 4.5.3-4

Wildlife Species Occurring within the Vegetative Communities in the Bradwood Landing Pipeline Area

Vegetative Communities	Typical Wildlife Found within the Vegetative Communities
Forest [a]	**Amphibians:** northwestern salamander, western red-backed salamander, roughskinned newt, western toad, Pacific treefrog, red-legged frog, bullfrog [d]. **Reptiles:** rubber boa, common garter snake, northwestern garter snake. **Mammals**: beaver, big brown bat, black bear, black-tailed deer, bobcat, bushy-tailed woodrat, California myotis, Columbian white-tailed deer, cougar, coyote, deer mouse, Douglas squirrel, elk, forest deer mouse, hoary bat, little brown myotis, long-eared myotis, long-legged myotis, mink, mountain beaver, porcupine, raccoon, red fox, silver-haired bat, striped skunk, Townsend's chipmunk, vagrant shrew, western gray squirrel, Yuma myotis. **Birds:** American robin, bald eagle, barred owl, belted kingfisher, blue grouse, black-capped chickadee, dark-eyed junco, downy woodpecker, great blue heron, great-horned owl, hairy woodpecker, northern flicker, olive-sided flycatcher, osprey, peregrine falcon, red-breasted nuthatch, red-tailed hawk, ruby-crowned kinglet, ruffed grouse, rufous hummingbird, song sparrow, spotted towhee, Steller's jay, Swainson's thrush, willow flycatcher, winter wren, and yellow-rumped warbler.
Scrub-Shrub [b]	**Amphibians**: Pacific treefrog, red-legged frog, bullfrog [d]. **Reptiles:** rubber boa, northwestern garter snake, common garter snake. **Mammals**: beaver, big brown bat, black-tailed deer, California myotis, Columbian white-tailed deer, coyote, deer mouse, hoary bat, little brown myotis, long-eared myotis, long-legged myotis, mink, nutria [d], raccoon, red fox, Townsend's vole, Yuma myotis. **Birds:** American kestrel, American robin, Bewick's wren, dark-eyed junco, great blue heron, marsh wren, song sparrow, red-winged blackbird, red-tailed hawk, rufous hummingbird, white-crowned sparrow, wood duck.
Wetlands [c]	**Amphibians:** northwestern salamander, western toad, Pacific tree frog, red-legged frog, bullfrog [d], Oregon spotted frog. **Reptiles:** western painted turtle, northwestern pond turtle, common garter snake. **Mammals**: beaver, big brown bat, black bear, California myotis, coyote, hoary bat, little brown myotis, long-eared myotis, long-legged myotis, mink, muskrat, northern river otter, nutria [d], raccoon, striped skunk, silver-haired bat, Townsend's big-eared bat, vagrant shrew, Yuma myotis. **Birds:** American coot, belted kingfisher, Bewick's wren, black-bellied plover, black-capped chickadee, Canada goose, cinnamon teal, cliff swallow, common snipe, dunlin, great blue heron, greater yellowlegs, mallard, marsh wren, northern harrier, northern pintail, northern shoveler, peregrine falcon, pied-billed grebe, purple finch, red-winged blackbird, short-billed dowitchers song sparrow, sora, tree swallow, violet-green swallow, Virginia rail, western sandpiper.
Streams and Ponds	**Amphibians:** long-toed salamander, northwestern salamander, Pacific giant salamander, western toad, Pacific tree frog, red-legged frog, bullfrog [d], Oregon spotted frog, tailed frog. **Reptiles:** western painted turtle, northwestern pond turtle, common garter snake, rubber boa. **Mammals**: beaver, big brown bat, black bear, California myotis, coyote, hoary bat, little brown myotis, long-eared myotis, mink, muskrat, nutria [d], raccoon, silver-haired bat, Townsend's big-eared bat, Yuma myotis. **Birds:** American dipper, band-tailed pigeon, barn swallow, belted kingfisher, Bewick's wren, black swift, black-capped chickadee, black-throated gray warbler, Bullock's oriole, common merganser, common yellowthroat, great blue heron, green heron, hooded merganser, mallard, mourning dove, olive-sided flycatcher, peregrine falcon, red-eyed vireo, ruffed grouse, rufous hummingbird, song sparrow, spotted sandpiper, spotted towhee, warbling vireo, willow/alder flycatcher, Wilson's warbler, wood duck, yellow-breasted chat, yellow warbler.
Nearshore	**Mammals**: beaver, big brown bat, black bear, California myotis, Pacific harbor seal, hoary bat, little brown myotis, long-eared myotis, long-legged myotis, mink, muskrat, northern river otter, nutria [d], raccoon, silver-haired bat, Steller sea lion, Townsend's big-eared bat, Yuma myotis. **Birds:** American dipper, bald eagle, bufflehead, California gull, Canada goose, Caspian tern, common goldeneye, cormorants, great blue heron, greater scaup, lesser scaup, mallard, northern rough-winged swallow, osprey, peregrine falcon, purple martin, red-winged blackbird, ring-billed gull, rock dove [d], western grebe.
Agricultural	**Mammals**: beaver, big brown bat, black-tailed deer, black rat, California myotis, coast mole, coyote, creeping vole, deer mouse, fox squirrel, hoary bat, house mouse, little brown myotis, long-eared myotis, long-legged myotis, long-tailed vole, muskrat, shrew-mole, silver-haired bat, snowshoe hare, striped skunk, Townsend's big-eared bat, Townsend's mole, Townsend's vole, Trowbridge's shrew, vagrant shrew, Yuma myotis. **Birds:** American bittern, American crow, Canada goose, common yellowthroat, barn swallow, Brewer's blackbird, common snipe, house finch, house sparrow [d], killdeer, mourning dove, northern harrier, red-tailed hawk, ring-necked pheasant, rock dove [d], Savannah sparrow, song sparrow, spotted towhee, western meadowlark.
Dredged Materials and Bare Ground	**Reptiles:** common garter snake, northwestern garter snake. **Mammals:** black-tailed deer, deer mouse, raccoon. **Birds:** American Crow, killdeer, mourning dove, rock dove [d], song sparrow, spotted towhee**.**

[a] Forested communities include coniferous, deciduous, mixed, early seral, and riparian forests.

[b] Scrub-shrub communities include both upland scrub-shrub and riparian scrub-shrub.

[c] Wetland communities include palustrine emergent, palustrine scrub-shrub, palustrine forested, and multiple wetland types.

[d] Non-native species or invasive species occurring in the vicinity of the pipeline.

As described in detail in NorthernStar's pipeline ESC Plan, the entire construction right-of-way would be allowed to revegetate; however, large brush and trees would be periodically removed near the pipeline. Trees greater than 15 feet tall, or deep-rooted shrubs that could damage the pipeline's protective coating, obscure periodic surveillance, or interfere with potential repairs, would not be allowed to grow within 15 feet (30 feet total) of the pipeline. A 10-foot-wide area centered over the pipeline may be cleared annually, which would result in the conversion of forested communities to a grassland/herbaceous cover type.

Because much of the area affected by pipeline construction would be allowed to revert to the preconstruction habitat type, impacts on wildlife species would generally be short term. However, long-term impacts on terrestrial wildlife would occur in forested areas due to the time required to restore the forested habitat to its preconstruction condition. As discussed in section 4.4.2.2, about 176.8 acres of upland forested habitat would be affected by construction of pipeline facilities. Forested habitats affected by pipeline construction would include 76.2 acres of coniferous forest, 52.2 acres of mixed forest, 32.1 acres of deciduous forest, and 16.3 acres of early seral forest. Upland forested communities would be replanted in-kind with trees, with the exception of the portion of the right-of-way within 15 feet of the pipeline (30 feet total), resulting in permanent impacts on about 54 acres of upland forested communities.

Clearing of forested habitats associated with pipeline construction and maintenance would increase the amount of edge habitat in the area. Forest fragmentation can have negative effects on forest dwelling species, causing individuals to crowd into remaining patches of habitat. This can lead to increased competition for nesting habitat, breeding habitat, and food resources (Piatt et al, 2006). It also allows fringe forest species to move into the area, which can lead to competition for resources and can increase levels of predation and nest parasitism (Cornell Lab of Ornithology, 2003). Consequently, some studies have shown a positive correlation between nest success rates and greater distances from the forest edge (Piatt et al, 2006). However, due to the similar and ample habitat in the vicinity of the project, the conversion of 54 acres of forested habitats to herbaceous/grassland habitats would not be expected to have an adverse impact on wildlife populations.

Temporary impacts on scrub-shrub habitat due to construction (6.9 acres) of the pipeline would be more short term than the impacts on forest lands, but regeneration of these areas could still take up to 3 years. Although the structural component of scrub-shrub habitats would recover slowly, successful restoration of non-woody vegetation may improve the value of forage for some wildlife within a relatively short time.

A total of about 2.9 and 97.9 acres of riparian forest and wetland habitats, respectively, would be affected by construction of the pipeline facilities. These areas are important habitats for a number of resident wildlife species. Disturbance to these habitats would be minimized through implementation of NorthernStar's pipeline ESC Plan in Oregon and SWPPP in Washington and would be mitigated in accordance with recommendations from the FWS, NMFS, ODFW, and WDFW as described in NorthernStar's Compensatory Mitigation Plan. We have also recommended that NorthernStar consult with the appropriate federal and state resource agencies to develop a project specific Wetland Restoration Plan that would include measures to re-establish herbaceous and/or woody species, control exotic species, and monitor the success of wetland revegetation and weed control efforts. Additional discussion of wetland impacts and mitigation can be found in section 4.4.1.3.

Following construction and restoration, NorthernStar would monitor the revegetation of the right-of-way in non-cultivated areas during the first and second year after construction, and until revegetation is considered successful. Non-cultivated areas where seedling establishment has failed would be reseeded during the next appropriate seeding period. The revegetation of the construction area would be considered successful when, based on visual observation, the density or cover of well established,

herbaceous, non-nuisance vegetation in the construction area is similar to the density or cover of herbaceous vegetation in adjacent areas not disturbed by construction. If the herbaceous vegetative cover or density in the construction area is not similar to the herbaceous vegetative cover or density in adjacent areas not disturbed by construction, or if there are excessive noxious weeds after the first or second growing season, an agronomist would determine the need for additional restoration measures. NorthernStar would implement additional restoration or mitigation measures, as necessary. Additionally, NorthernStar has developed a *Noxious Weeds and Soil-borne Plant Disease Control Plan* to prevent the introduction and proliferation of noxious weeds during and after construction.

Unique or Sensitive Wildlife Habitats

Oregon Major Big Game Habitat

MPs 0.0 through 1.0 of the proposed pipeline route would be located within major big game habitat as mapped by Clatsop County. In addition, the proposed pipeline route between MPs 1.0 and 6.2 is mapped as peripheral big game range. Elk and deer tracks were observed near the proposed terminal site during a site visit, and black bear have been observed at the site by previous property owners. The *Clatsop County Comprehensive Plan* (Clatsop County, 1996) includes development standards for ODFW-identified big game areas. To minimize disturbance to wildlife, NorthernStar would establish signage along roads and instruct project personnel to reduce vehicle speeds along roads where big game, including Columbian white-tailed deer, occur to prevent vehicle-animal collisions. Project personnel would also be instructed not to approach big game (either adults or young) at any time. Sections 4.6.1.1 and 4.6.2 include additional discussion of the Columbian white-tailed deer.

Ducks Unlimited Waterfowl Management Area

From approximate MPs 6.0 to 8.1, the proposed pipeline would cross the Karamanos property, portions of which are managed by Ducks Unlimited as a waterfowl management area. NorthernStar has initiated consultation with the landowner and the Ducks Unlimited land manager regarding the proposed project (Karamanos, 2005; Lobdel, 2005). According to the landowner, Ducks Unlimited is funding the establishment of more wetland habitat with ponds over a 35-year period in the western and eastern portions of the property. To minimize impacts on waterfowl, NorthernStar would schedule construction activities between March and September, the period when waterfowl would be least likely to inhabit the property. In addition, because the Karamanos property is proposed for use as a mitigation site (the Peterson Point Mitigation Site), it is unlikely that the project would result in adverse impacts on the portion of the property managed by Ducks Unlimited (see section 4.5.2.3).

Westside Riparian-Wetlands

Approximately 1.8 acres of riparian forest habitat would be affected by the portion of the proposed pipeline in Washington. By definition, this vegetation community is a WDFW Priority Habitat. Approximately 85 percent of Washington's terrestrial vertebrate species use riparian habitat for essential life activities and the density of wildlife in riparian areas is comparatively high (Knutson and Naef, 1997). Forested riparian habitat has an abundance of snags that are critical to cavity-nesting birds and mammals and to many insectivorous birds. Downed logs are common within this habitat and provide cover and resting habitat for amphibians, reptiles, and small mammals. In addition, the relatively mild microclimate of riparian areas offers relief from hot, dry summers and cold, snowy winters which is especially important to species such as Columbian white-tailed deer and elk (Knutson and Naef, 1997). Riparian habitats form natural corridors that are important travel routes between foraging areas, breeding areas, and seasonal ranges, and provide protected dispersal routes for young (Knutson and Naef, 1997).

Based on the WDFW Priority Habitat classification, riparian habitats within the project area are also considered critical areas by Cowlitz County (as defined in Chapter 19.15 of the CCC) and warrant protection. Proposed mitigation for impacts on riparian forest is included in NorthernStar's Compensatory Mitigation Plan.

Mitigation Measures

As described in detail in section 4.5.2.3, the Peterson Point Mitigation Site would be the primary mitigation site for impacts on terrestrial wildlife in Oregon. The restoration of forested habitat at the Delameter Creek Mitigation Site would provide a net benefit to wildlife in the vicinity of the proposed project in Washington. However, as described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. To ensure that the mitigation proposed for the Bradwood Landing Project adequately compensates for project-related impacts, we have recommended that NorthernStar continue to consult with the appropriate natural resource agencies to finalize its Compensatory Mitigation Plan. The final Compensatory Mitigation Plan would be filed along with agency comments and applicable approvals with the Secretary prior to construction of the project.

4.6 THREATENED, ENDANGERED, AND OTHER SPECIAL STATUS SPECIES

Federal agencies are required by section 7 of the ESA (19 USC § 1536(c)), as amended, to ensure that any actions authorized, funded, or carried out by the agency do not jeopardize the continued existence of a federally listed endangered or threatened species, or result in the destruction or adverse modification of the designated critical habitat of a federally listed species. The action agencies (i.e., the FERC, COE, and Coast Guard) are required to consult with the FWS and/or NMFS to determine whether federally listed endangered or threatened species or designated critical habitat are found in the vicinity of the proposed project, and to determine the proposed action's potential effects on those species or critical habitats. For actions involving major construction activities with the potential to affect listed species or designated critical habitat, the federal agency must prepare a BA for those species that may be affected. The action agency must submit its BA to the FWS and/or NMFS and, if it is determined that the action would likely adversely affect a listed species, the federal agency must submit a request for formal consultation to comply with section 7 of the ESA. In response, the FWS and/or NMFS would issue a BO as to whether or not the federal action would likely jeopardize the continued existence of a listed species, or result in the destruction or adverse modification of designated critical habitat.

As the lead federal agency in conducting the NEPA analysis, FERC is also analyzing project-related activities authorized by the Coast Guard and the COE that could potentially affect federally listed endangered and threatened species. In compliance with section 7 of the ESA and the MSA, the FERC staff prepared a BA and EFH Assessment for the Bradwood Landing Project and submitted it to the FWS and NMFS in March 2007. Based on comments from the FWS and NMFS, the FERC staff is currently revising the BA and EFH Assessment and will resubmit the BA and EFH Assessment to the services with a request to initiate consultation. The BA and EFH Assessment details the environmental baseline for federally listed species, designated critical habitat, and EFH; direct, indirect, interdependent and interrelated, and cumulative effects; proposed conservation measures; and determinations of effect. A general summary of the information included in the BA and EFH Assessment is included in this EIS.

In addition to the federal ESA, the State of Oregon has endangered species provisions that protect native vertebrates and plants on state lands (ORS sections 496.172 to .192; 498.026; 564.100 to .135) and requires consideration of the impacts of forest practices on threatened and endangered species (ORS section 527.610). The State of Washington also has an endangered species law that covers animals (Wa. Rev. Code Ann. sections 77.08.010, 77.12.020, 77.16.040, 77.16.120, 77.21.010). Most species that are listed by these states as either threatened or endangered are also listed as federally threatened or endangered. Other special status species include those protected by the Migratory Bird Treaty Act and the MMPA.

For purposes of this environmental analysis, special status species of plants and animals include:

- species that are listed by the federal government as endangered or threatened, or are candidates for listing;
- species listed by Oregon and Washington as endangered, threatened, or candidates for listing;
- species listed under the MMPA;
- species listed under the Migratory Bird Treaty Act; and
- species identified by federal or state agencies as rare or sensitive with the potential to occur in the vicinity of the proposed project.

To assess potential impacts on special status species and designated critical habitat, the FERC staff (assisted by NorthernStar, as our non-federal representative) informally consulted with the FWS, NMFS, ODFW, WDFW, Oregon Natural Heritage Information Center (ORNHIC), and WDNR Natural Heritage Program (WNHP).

Table 4.6.1-1 identifies the special status species potentially occurring in the project area and describes the portion of the project area where the species may occur. The current status of species is discussed in section 4.6.1. Potential impacts on special status species and their designated critical habitat is discussed in section 4.6.2.

4.6.1 Current Status of Species

4.6.1.1 Federally Listed Threatened and Endangered Species

Fish

Informal consultation with the FWS and NMFS identified 13 federally listed threatened or endangered anadromous salmonid ESUs or DPSs, as well as the North American green sturgeon, as potentially occurring in the project area (see table 4.6.1-1). ESUs and DPSs are distinct populations of a species of fish or wildlife that interbreed when mature (Waples, 1991). Designated critical habitat for 12 of these ESU/DPSs is also present in the project area. Critical habitat has not been designated for the Lower Columbia River Coho salmon ESU or the Southern DPS of the North American green sturgeon.

Primary Constituent Elements (PCE), included in the critical habitat designation (70 Federal Register 52630 – 52858), essential to support one or more life stages of the ESU or DPS (sites for spawning, rearing, migration, and foraging) include:

- freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development;
- freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;
- freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- estuarine areas free of obstruction and water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
- nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

TABLE 4.6.1-1

Federally Listed Species Potentially Occurring in the Vicinity of the Bradwood Landing Project

Species	Federal Status	State Status		Portion of the Project Area Where Species May Occur
		Oregon	Washington	
Fish				
Chinook Salmon *Oncorhynchus tshawytscha*				
• Lower Columbia River ESU	Threatened [a]	NL	Candidate	LNG carrier route LNG terminal Pipeline facilities
• Upper Columbia River Spring-run ESU	Endangered [a]	NL	Candidate	LNG carrier route LNG terminal Pipeline facilities
• Upper Willamette River ESU	Threatened [a]	NL	NL	LNG carrier route LNG terminal Pipeline facilities
• Snake River Spring/Summer-run ESU	Threatened [a]	Threatened	Candidate	LNG carrier route LNG terminal Pipeline facilities
• Snake River Fall-run ESU	Threatened [a]	Threatened	Candidate	LNG carrier route LNG terminal Pipeline facilities
Chum Salmon *O. keta*				
• Columbia River ESU	Threatened [a]	NL	Candidate	LNG carrier route LNG terminal Pipeline facilities
Coho Salmon *O. kisutch*				
• Lower Columbia River ESU	Threatened	Endangered	NL	LNG carrier route LNG terminal Pipeline facilities
Sockeye Salmon *O. nerka*				
• Snake River ESU	Endangered [a]	NL	Candidate	LNG carrier route LNG terminal Pipeline facilities
Steelhead *O. mykiss*				
• Lower Columbia River DPS	Threatened [a]	NL	Candidate	LNG carrier route LNG terminal Pipeline facilities
• Middle Columbia River DPS	Threatened [a]	NL	Candidate	LNG carrier route LNG terminal Pipeline facilities
• Upper Columbia River DPS	Threatened [a]	NL	Candidate	LNG carrier route LNG terminal Pipeline facilities
• Upper Willamette River DPS	Threatened [a]	NL	NL	LNG carrier route LNG terminal Pipeline facilities
• Snake River Basin DPS	Threatened [a]	NL	Candidate	LNG carrier route LNG terminal Pipeline facilities
Bull Trout *Salvelinus confluentus*				
• Columbia River DPS	Threatened [b]	NL	Candidate	NA

TABLE 4.6.1-1 (cont'd)

Federally Listed Species Potentially Occurring in the Vicinity of the Bradwood Landing Project

Species	Federal Status	State Status		Portion of the Project Area Where Species May Occur
		Oregon	Washington	
North American Green Sturgeon *Acipenser medirostris*				
• Southern DPS	Threatened	NL	NL	LNG carrier route LNG terminal
Reptiles and Amphibians				
Green Sea Turtle *Chelonia mydas*	Endangered	Endangered	Threatened	LNG carrier route
Leatherback Sea Turtle *Dermochelys coriacea*	Endangered	Endangered	Endangered	LNG carrier route
Loggerhead Sea Turtle *Caretta caretta*	Threatened	Threatened	Threatened	LNG carrier route
Olive Ridley Sea Turtle *Lepidochelys olivacea*	Endangered	Endangered	NL	LNG carrier route
Mammals				
Blue Whale *Balaenoptera musculus*	Endangered	Endangered	Endangered	LNG carrier route
Fin Whale *Balaenoptera physalus*	Endangered	Endangered	Endangered	LNG carrier route
Humpback Whale *Megaptera novaeangliae*	Endangered	Endangered	Endangered	LNG carrier route
North Pacific Right Whale *Eubalaena japonica*	Endangered [c]	Endangered	NL	LNG carrier route
Sei Whale *Balaenoptera borealis*	Endangered	Endangered	Endangered	LNG carrier route
Killer Whale *Orcinus orca*				
• Southern Resident DPS	Endangered	NL	Endangered	LNG carrier route
Sperm Whale *Physeter macrocephalus*	Endangered	Endangered	Endangered	LNG carrier route
Steller Sea Lion *Eumetopias jubatus*				
• Eastern DPS	Threatened	NL	Threatened	LNG carrier route LNG terminal
Columbian White-tailed Deer *Odocoileus virginianus leucurus*				
• Lower Columbia River DPS	Endangered	NL	Endangered	LNG carrier route LNG terminal Pipeline facilities
Birds				
Brown Pelican *Pelecanus occidenatlis*	Endangered [d]	Endangered	Endangered	LNG carrier route
Marbled Murrelet *Brachyramphus marmoratus*	Threatened	Threatened	Threatened	LNG carrier route LNG terminal Pipeline facilities
Northern Spotted Owl *Strix occidentalis caurina*	Threatened	Threatened	Endangered	LNG carrier route LNG terminal Pipeline facilities
Short-tailed Albatross *Phoebastria albatrus*	Endangered	Endangered	Candidate	LNG carrier route
Streaked Horned Lark *Eremophila alpestris strigata*	Candidate	NL	Candidate	LNG carrier route LNG terminal

TABLE 4.6.1-1 (cont'd)

Federally Listed Species Potentially Occurring in the Vicinity of the Bradwood Landing Project

Species	Federal Status	State Status		Portion of the Project Area Where Species May Occur
		Oregon	Washington	
Western Snowy Plover *Charadrius alexandrinus nivosus*				
• Pacific Coast DPS	Threatened [e]	Threatened	Endangered	LNG carrier route LNG terminal
Invertebrates				
Oregon Silverspot Butterfly *Speyeria zerene hippolyta*	Threatened	NL	Endangered	LNG carrier route
Plants				
Kincaid's Lupine *Lupinus sulphureus kincaidii*	Threatened	Threatened	Endangered	LNG carrier route LNG terminal Pipeline facilities
Nelson's Checker-mallow *Sidalcea nelsoniana*	Threatened	Threatened	Endangered	LNG carrier route LNG terminal
Water Howellia *Howellia aquatilis*	Threatened	NL	Threatened	LNG terminal Pipeline facilities

[a] Denotes critical habitat for this species has been designated within the proposed project area.

[b] Although the bull trout is federally listed as threatened, the NMFS has stated that it does not occur in the proposed project area (NMFS, 2006c); therefore, it is not included in the discussion of special status species.

[c] Endangered status for the North Pacific right whale was proposed December 27, 2006 (71 FR 77694-77704).

[d] The FWS proposed to remove the brown pelican from the list of endangered and threatened species due to recovery on February 20, 2008 (73 FR 9408-9433).

[e] Critical habitat for the Pacific Coast DPS of the western snowy plover was proposed on March 22, 2004 (69 FR 75608-75656).

NA Not applicable

NL Not listed

Sources: NMFS, 2006c; FWS, 2006a, 2006b, 2006c; ODFW, 2007; ORNHIC, 2006; WDFW, 2006a; WNHP, 2007.

Detailed descriptions of designated critical habitat for the salmonid ESU/DPSs potentially affected by the project are provided in the BA and EFH Assessment for the Bradwood Landing Project. Sections 4.6.2.1, 4.6.2.2, and 4.6.2.3 provide summaries of designated critical habitat along the waterway for LNG traffic, at the LNG terminal, and along the pipeline route, respectively.

Each of the ESU/DPSs can be divided into ocean-type salmonids and stream-type salmonids. Ocean-type salmonid ESUs in the project area include one chum ESU and three Chinook ESUs (Lower Columbia River, Snake River Fall, and Upper Willamette River). Ocean-type subyearlings, known as fry, commonly spend weeks to months in rearing habitats before undergoing a physiological transition called smolting. Smolting develops the additional strength, energy, and reserve capacity required to adapt to and survive the physical and biological challenges of the ocean environment. Ocean-type smolts migrate downstream to and through the estuary as subyearlings, generally leaving the spawning and rearing area when they have reached a size of 3 to 4 inches. Because they undergo migration at a smaller size, ocean-type salmonids tend to form schools, presumably to reduce predation (Pitcher, 1986).

Stream-type salmonid ESU/DPSs in the project area include five steelhead DPSs (Upper Willamette River, Upper Columbia River, Middle Columbia River, Lower Columbia River, and Snake River Basin), two Chinook ESUs (Upper Columbia River Spring and Lower Snake River Spring/Summer), one sockeye ESU, and one coho ESU. Stream-type salmonids usually remain in the area from which they hatched for 1 year or more and migrate to the ocean as relatively large smolts (generally 4 to 12 inches). Duration and location of rearing varies by salmonid species; for example, steelhead may remain in freshwater for several years before migrating to the ocean, and sockeye rear in lakes rather than streams. As is the case with ocean-type salmonids, stream-type salmonid smolts undergo a physiological alteration in the spring that prepares them for migration and saltwater adaptation. Although the timing of migration varies by species, smolts tend to be spring migrants that pass quickly through the project area from early April to September, remaining in the area between a few days and weeks.

The larger size of the stream-type smolts allows them to occupy a wider range of habitats. Stream-type smolts are commonly found farther from shore with a deeper distribution than ocean-type migrants. Johnsen and Sims (1973) compared beach seine and purse seine catches of Chinook from fresh and brackish water sites in the lower Columbia River. The majority of Chinook collected from the shorelines by beach seine were in the range of 2.0 to 3.0 inches, while the majority of Chinook collected from deeper water by purse seine were in the range of 3.5 to 6.0 inches. These larger fish collected from offshore locations are the smolt-size juveniles characteristic of stream-type salmon.

The following sections discuss the life histories and existing conditions for salmonids identified by the FWS and NMFS as potentially occurring in the vicinity of the proposed project.

Chinook Salmon

Populations of Chinook, called "runs," are grouped by the time they return to the rivers to begin their final spawning journey; spring, summer, fall, and winter. Although Chinook salmon can be found entering spawning rivers throughout the year, the majority return from April to December. Spawning and rearing times are dependent on the timing of the individual runs. Because of their large mature body size (approximately 30 pounds and 36 inches in length) (NOAA, 2007), Chinook salmon tend to use deeper water and larger gravel size to spawn than other salmonids. The female digs the nest, or redd, about 1 foot deep in areas with moderate to high velocity water. Most spawning and rearing activity takes place in the main stream channels immediately above the saltwater limit or hundreds of miles upstream. Depending on size, a female Chinook will produce 2,000 to 14,000 eggs, with an average of 5,000 eggs per female. Adults die soon after spawning.

Young Chinook salmon emerge from their redds in 3 to 5 months. Research shows that low dissolved oxygen levels and/or low water temperatures increase the length of time the eggs take to develop. The juvenile salmon grow and feed as they migrate downstream toward the ocean, stopping to rear in coastal estuaries for periods lasting up to 5 months before completing their migration to the open ocean. Most Chinook salmon smolts from the Pacific Northwest enter the ocean during their first year of life. Chinook salmon return to spawn in as little as 1 year, or may remain in the ocean for up to 9 years before returning to spawn. Chinook salmon are opportunistic and carnivorous feeders throughout their life, primarily feeding on insects, crustaceans, invertebrates, and other fish.

From April through November, sub-yearling ocean-type juvenile Chinook salmon inhabit the estuaries and intertidal areas of the Pacific Coast. These estuarine areas with fresh and saltwater wetlands and aquatic/riparian vegetation provide habitats that are crucial to juvenile Chinook salmon survival (Myers et al., 1998). Water quality within these areas is also crucial to their survival. Increases in siltation, changes in water temperature, and loss of riparian vegetation all have negative impacts on water quality (StreamNet, 2006). Finally, LWD provides deep, slow flowing pools and off-channel alcoves, creating cover from predators, protection from the sun, and feeding areas for juvenile Chinook.

Lower Columbia River Chinook

Both spring- and fall-run Chinook salmon comprise the ESU, but the majority are fall-run. Evidence from coded wire tag recoveries indicate that since 1960 the majority of the returning fall Chinook salmon on the Oregon side of the lower Columbia River are strays from Big Creek hatchery as well as Rogue River fall-run Chinook salmon released into Big Creek and the Youngs Bay area (Biological Review Team, 1997; Kostow, 1995). A significant portion of the naturally spawning Chinook salmon in Skamokawa Creek and Elochoman River are hatchery strays (WDFW, 2003). Long-term population trends for the Clatskanie River are positive, with an annual increase of 1 to 5 percent (Biological Review Team, 1997). However, trends for most of the other tributaries in the lower Columbia River are negative. The draft 2005 ODFW Oregon Native Fish Status Report indicates that naturally produced Lower Columbia River fall- and spring-run Chinook salmon in Oregon are currently at risk for extinction (ODFW, 2005).

Kostow (1995) designated three streams of the Lower Columbia-Clatskanie subbasin as containing habitat for spawning of fall Chinook: Hunt Creek, Plympton Creek, and the Clatskanie River. Hunt Creek is located adjacent to the LNG terminal site and is a tributary to the Columbia River. Plympton Creek is a tributary to the Westport Slough, which is crossed by the proposed pipeline. Clatskanie River is a tributary to the Columbia River, which is crossed by the proposed pipeline and is hydrologically connected to Westport Slough.

Eight to 10 historic populations in this ESU have become extirpated, most of them spring-run populations. Some natural production still occurs within the lower Columbia River in about 20 populations; however, only one population exceeds 1,000 spawners. High hatchery production continues to pose genetic and ecological risks to natural populations and masks their performance. Although the Clatskanie River population is an exception, most populations in this ESU have not substantially increased in recent years (Biological Review Team, 2003).

Upper Columbia River Spring-run Chinook

Upper Columbia River spring-run Chinook salmon populations exhibit an ocean-type life history (Taylor, 1990; Chapman et al., 1991; Chapman et al., 1994; Matthews and Waples, 1991; Waknitz et al., 1995). Spawning takes place in large, low-elevation streams (Schreck et al., 1986). Ocean-type fry west of the Cascade Crest emerge in April and May, and the majority rear from 1 to 4 months in freshwater

prior to emigrating to the ocean (Mullan, 1987; Olsen et al., 1992; Hymer et al., 1992; WDFW and Western Washington Treaty Indian Tribes, 1993; Chapman et al., 1994; Marshall et al., 1995). However, a small proportion of summer- and fall-run fish remain in freshwater until their second spring and emigrate as yearlings (Chapman et al., 1994; Waknitz et al., 1995). The proportion of yearling out-migrants varies from year to year, perhaps because of environmental fluctuations.

Upper Willamette River Chinook

Willamette Falls limits access of this ESU to the upper reaches of the Willamette River. High flows in the spring provide a window when returning salmon can ascend the falls, while low flows in autumn prevent fish from ascending the falls (Howell et al., 1985). Three major populations exist in the river above Willamette Falls, including the McKenzie River and the North and South Forks of the Santiam River (Kostow, 1995). Adult spring Chinook salmon enter the Columbia River in March and April, but they do not ascend Willamette Falls until May or June. Spawning generally begins in late August and continues into early October, peaking in September (Mattson, 1948; Nicholas, 1995; Willis et al., 1995). Approximately one-third of the habitat available to this run has been made inaccessible by the construction of dams, and the natural production areas for this ESU are limited.

Snake River Spring/Summer-run Chinook

The Snake River contains five principal subbasins that produce spring- and/or summer-run Chinook salmon (Columbia Basin Fish and Wildlife Authority, 1990). Three of the five principal sub-basins (Clearwater, Grand Ronde, and Salmon Rivers) are large, complex systems composed of several smaller tributaries, which are further composed of many small streams. In contrast, the other two principal subbasins (Tucannon and Imnaha Rivers) are small systems in which the majority of salmon production occurs within the main rivers themselves. In addition to the five principal subbasins, three small streams provide small spawning and rearing areas (Columbia Basin Fish and Wildlife Authority, 1990). Snake River spring- and/or summer-run Chinook salmon have historically spawned in virtually all accessible and suitable habitat in the Snake River upstream from its confluence with the Columbia River (Evermann, 1896; Fulton, 1968).

Adult spring-run Chinook salmon enter the Columbia River and migrate upstream past Bonneville Dam (CRM 146) from March through May; summer-run Chinook salmon migrate during June and July. Snake River spring- and summer-run Chinook salmon tend to use small, higher elevation streams (headwaters). Snake River spring- and summer-run Chinook salmon exhibit a stream-type life history, and migrate swiftly to the ocean as yearling smolts (Schreck et al., 1986).

This ESU saw a large increase in returning salmon in many populations in 2001. However, recent abundance in this ESU is still short of the levels proposed in the recovery plan for Snake River salmon (NMFS, 1995b). The high level of both production/mitigation and supplementation hatcheries in this ESU leads to ongoing risks to natural populations and makes it difficult to assess trends in natural productivity and growth rate (Biological Review Team, 2003).

Snake River Fall-run Chinook

Adult Snake River fall-run Chinook salmon enter the Columbia River in July and August and reach the mouth of the Snake River between the middle of August and October. Spawning occurs in the mainstem and in the lower reaches of large tributaries in October and November. Based on what is known of Upper Columbia River fall-run Chinook salmon, juveniles in the Snake River presumably emerge from the gravel in March and April, and downstream migration usually begins within several weeks of emergence (Chapman et al., 1991). An overall average of 41 percent of the wild fish and 51

percent of the hatchery fish rear in mainstem Snake and Columbia River reservoirs, migrating out as yearling reservoir-type smolts the following year, with the remainder out-migrating as ocean-type sub-yearlings (Connor et al., 2005).

Fall-run Chinook salmon were widely distributed throughout the Snake River and many of its tributaries, from its confluence with the Columbia River upstream to Shoshone Falls, Idaho (Columbia Basin Interagency Committee, 1957; Haas, 1965; Fulton, 1968; Van Hyning, 1968; Lavier, 1976). The construction of 12 dams on the mainstem Snake River substantially reduced the distribution and abundance of the Snake River Fall-run Chinook salmon ESU (Irving and Bjornn, 1981). Fish passage facilities proved unsuccessful at several projects, and spawning habitats, particularly areas most frequently used by fall-run Chinook salmon, were eliminated with the formation of reservoirs.

Chum Salmon

Chum salmon spend more of their life history in marine waters than other Pacific salmonids. Chum salmon usually spawn in coastal areas, and juveniles out-migrate to the estuary almost immediately after emerging from the gravel that covers their redds (Salo, 1991). As discussed previously, this ocean-type migratory behavior contrasts with the stream-type behavior of some other species of salmonids. This means survival and growth in juvenile chum salmon depends less on freshwater conditions than on favorable estuarine conditions.

Mature chum salmon are fall-run fish and return to the lower reaches of coastal streams to spawn. Chum salmon usually migrate only a short distance upstream, to a point just upstream from the tidewater limit. Unlike other salmon, chum are not strong jumpers, so they are often found distributed downstream from significant barriers in spawning streams. The female lays about 2,000 to 4,000 eggs in a redd and will guard her nest until her death a short time later, about 11 to 15 days after entering freshwater. Chum salmon eggs hatch between December and February and the juvenile chum salmon emerge from the gravel in 1 to 2 months, depending on stream temperature. They quickly migrate downstream to the estuary, feeding on insect larvae in the stream during their journey. Chum salmon juveniles are common in estuaries from January through July (StreamNet, 2006).

Very little research has been done on the Columbia River runs of chum salmon and there is not much known about the status of this species. Historically, chum salmon spawned in the lower reaches of several streams within the lower Columbia-Clatskanie subbasin.

Observations of chum salmon fry are often more difficult to make than are observations of juveniles of other salmonids because chum salmon out-migrants: 1) are smaller than out-migrants of other salmonids; 2) migrate at night; 3) usually have less distance to migrate before reaching saltwater than do other species; and 4) do not school as tightly as some other salmonids. Downstream migration may take only a few hours or days in rivers where spawning sites are close to the mouth of the river or it may take several months.

Kostow (1995) cited a dramatic decline in run sizes within the Columbia River, noting that the 1992 commercial harvest landed about 700 fish, whereas harvest prior to the 1940s ranged from 100,000 to 600,000 fish annually. Most of the production of chum salmon within the lower Columbia River is from streams on the Washington side of the river and the mainstem Columbia River below Bonneville Dam (CRM 146) (Ehlke and Keller, 2003). Chum salmon have been reported in October in the Washougal, Lewis, Kalama, and Cowlitz Rivers in Washington and the Sandy River in Oregon (Salo, 1991). However, the NMFS does not recognize any naturally spawning populations of chum salmon in Oregon (Johnson et al., 1997). Since 1995, there have been no recreational or directed commercial harvests of chum salmon within the Columbia River (Johnson et al., 1997).

Coho Salmon

Coho generally spawn in the tributaries and headwater streams of large rivers, preferably in areas with low water velocity and small-sized gravel. The female digs from one to four redds and generally spawns with different males in each redd, producing 1,000 to 5,000 eggs. Coho die soon after spawning. The eggs hatch in about 1 month and juveniles emerge from the gravel in about 2 to 5 weeks. Juvenile coho usually remain in freshwater for 1 year, moving in and out of side-channels, sloughs, beaver ponds, and tributary streams, seeking food and shelter from the high winter currents (Weitkamp et al., 1995). Although they may begin their migration downstream from April through August, most migrate downstream approximately 1 year after emerging from the gravel (Weitkamp et al., 1995). Coho salmon generally spend 2 days to 1 month in the estuary, feeding and adapting to saltwater before entering the open ocean. Coho generally spend 2 years in the ocean, returning to natal streams to spawn in their third year of life. A small percentage of the coho, usually less than 5 percent of the population, will return early after only 1 year in the ocean and are known as "jack salmon" (Weitkamp et al., 1995).

The coho salmon is a carnivorous and opportunistic feeder throughout its life, feeding primarily on insects, invertebrates, and crustaceans when young, and on other fish and squid when in the open ocean. Like other salmonids, including Chinook, juvenile coho require LWD to provide deep, slow flowing pools that create cover from predators, protection from the sun, and feeding areas.

Spawning of adult coho is largely dependent on streamflows, with most of the population in the lower Columbia River spawning when there is an increase in or maximal streamflow. Generally, adult Lower Columbia River coho salmon can be found migrating to their natal streams between June and February and spawning from September through March (Weitkamp et al., 1995; Good et al., 2005; WDFW, 2003; Wade, 2000, 2002).

Coho salmon from the Lower Columbia River ESU are mostly hatchery produced individuals. Only within the Clackamas and Sandy Rivers of the Columbia River ESU are natural populations known to be found (Good et al., 2005). The 2001 Biological Review Team review of the coho ESU in the lower Columbia River indicated that the vast majority, over 90 percent, of the historical populations appear to be either extirpated or nearly so.

Sockeye Salmon

The sockeye salmon is an anadromous fish with a stream-type life history that spawns and rears in freshwater lakes and streams. The life history of sockeye is variable throughout the Pacific Northwest, depending largely on the region of origin and local stream conditions. Migration into freshwater to spawn commonly occurs between June and August, with spawning taking place August through December. Most sockeye migrate great distances up freshwater streams, through lakes, and into tributary streams, although some sockeye do spawn in the shores of freshwater lakes (Gustafson et al., 1997).

Sockeye salmon are native to the Snake River and historically were abundant in several lake systems in Idaho and Oregon (Gustafson et al., 1997). In this century, a variety of factors have led to the demise of all Snake River sockeye salmon except those returning to Redfish Lake in the Stanley Basin of Idaho. Adults migrate upstream to Redfish Lake between July and September. Juveniles migrate downstream from Redfish Lake during April and May (Dolat, 1997).

Snake River sockeye salmon are unique in that they are the longest migrating sockeye salmon population in the world, traveling up to 900 miles to the high elevation lakes where they spawn. Since becoming listed as an endangered species in 1991, hatchery programs have begun to assist recovery efforts for the population (Good et al., 2005).

Steelhead

Steelhead are listed on a DPS basis, which is analogous to the salmonid ESU designations. Steelhead is the name commonly applied to the anadromous form of the biological species *Oncorhynchus mykiss*. The anadromous form of steelhead is under the jurisdiction of NMFS, while the resident freshwater forms, usually called rainbow or redband trout, are under the jurisdiction of the FWS. Steelhead exhibit one of the most complex suites of life history traits of any species of Pacific salmonid. Unlike other salmonids, steelhead can spawn more than once (iteroparous), whereas all other salmonids discussed spawn once then die (semelparous). The anadromous steelhead may spend up to 7 years in freshwater before smoltification and up to 3 years in saltwater before returning to spawn. Spawning migrations occur throughout the year, with seasonal peaks of activity. In a given river basin, there may be one or more peaks in migration activity. Large rivers, such as the Columbia River, may have migrating adult steelhead at all times of the year.

Steelhead can be divided into two basic reproductive ecotypes based on the state of sexual maturity at the time of river entry and duration of spawning migration (Burgner et al., 1992). The stream-maturing type enters freshwater in a sexually immature condition between May and October and requires several months to mature and spawn. The ocean-maturing type enters freshwater as a mature adult between November and April and spawns shortly thereafter. Steelhead found in the Columbia River are almost exclusively stream-maturing and generally spawn farther upstream than ocean-maturing steelhead.

Lower Columbia River Steelhead

This DPS occupies streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington (inclusive), and the Willamette and Hood Rivers, Oregon (inclusive). Excluded are steelhead populations in the upper Willamette River Basin above Willamette Falls, Oregon and the Little and Big White Salmon Rivers, Washington. This DPS comprises both winter- and summer-run steelhead. Genetic data show distinction between steelhead of this DPS and adjacent regions, with a particularly strong difference between coastal and inland steelhead in the vicinity of the Cascade Crest (Busby et al., 1996). The majority of stocks within this DPS, for which data is available, have been declining in the recent past, but some have been increasing strongly (Busby et al., 1996; Good et al., 2005).

Middle Columbia River Steelhead

Almost all steelhead populations within this DPS are summer-run fish, with two winter-run exceptions in the Klickitat River and Fifteenmile Creek watersheds. A balance between 1- and 2-year-old smolt out-migrants characterizes most of the populations within this DPS. Adults spend between 1 and 2 years in the ocean before returning to spawn.

Production within the Middle Columbia River steelhead DPS has declined due, in part, to losing spawning habitat because of low flows. Loss of riparian habitat and in-stream structure are also threats to the Middle Columbia River steelhead. Blockages have prevented access to sizable steelhead production areas in the Deschutes and White Salmon Rivers. While there are hatchery facilities located within the drainages of the DPS, there are also stocks within the DPS that have had little or no supplementation from hatcheries.

Upper Columbia River Steelhead

All of the steelhead in this DPS are summer-run fish. Upper Columbia River steelhead return to the Columbia River in the later summer and early fall; most migrate relatively quickly up the mainstem of the river to their natal tributaries. A portion of the returning run over-winters in the mainstem reservoirs,

passing over the upper dams in April and May of the following year. Spawning occurs in the late spring of the calendar year following entry into the river. Upper Columbia River steelhead smolt out-migrants are predominantly 2- and 3-year-old juveniles. Most adult steelhead return after 1 or 2 years at sea, starting the cycle again (Busby et al., 1996).

Current abundance of the Upper Columbia River steelhead, both natural and hatchery produced, have increased in recent years. The average return through Priest Rapids Dam from 1997 through 2001 was 12,900 fish, while the average for the previous 5 years (1992 through 1996) was 7,800 fish. Most returns to the upper Columbia River are hatchery origin fish. Wild fish estimated during this period averaged 2,200 fish, more than double the average from the previous 5-year average of 1,040 fish.

Upper Willamette River Steelhead

This DPS occupies the Willamette River and its tributaries upstream from Willamette Falls. The native steelhead of this basin are late-migrating winter steelhead, entering fresh water primarily in March and April (Busby et al., 1996). This unusual run timing appears to be an adaptation for ascending Willamette Falls, which functions as an isolating mechanism for upper Willamette River steelhead. Early migrating winter steelhead and summer steelhead have been introduced to the upper Willamette River basin and, since naturally spawned steelhead are defined as part of the DPS, some populations (particularly early spawning fish in Coast Range subbasins) may represent introduced stocks. On average, native winter steelhead within this DPS have been declining since 1971 and have exhibited large fluctuations in abundance (ODFW, 2005).

Snake River Basin Steelhead

The Snake River Basin steelhead DPS is comprised of a diversity of steelhead populations with more similar genetic make-up to each other than to those steelhead that spawn outside of the Snake River basin. The Snake River Basin steelhead DPS spawn at high elevations (up to 6,500 feet) and migrate up to 900 miles to their spawning locations. Within this DPS, all steelhead are summer-run fish, but they are divided into two ecotypes, commonly referred to as either A-run or B-run. A-run fish are defined as passing Bonneville Dam before August 25 and B-run fish pass Bonneville Dam after August 25 (Busby et al., 1996). Adult A-run steelhead enter freshwater from June through August and are smaller than B-run fish, which enter freshwater from late August through October. Most of the steelhead populations in the Columbia River basin east of the Cascade Range are A-run fish. B-run steelhead are thought to be produced only in the Clearwater, Middle Fork Salmon, and South Fork Salmon Rivers (Busby et al., 1996). Much of the Snake River Basin steelhead DPS is currently composed of hatchery fish.

North American Green Sturgeon

The Southern DPS of North American green sturgeon is federally listed as threatened. Based on spawning locations, two DPS have been designated for this species: the Southern DPS and the Northern DPS. The Northern DPS spawn in the Rogue, Klamath, Trinity, and Eel Rivers in Oregon and California, and the Southern DPS only spawn in the Sacramento River, California.

Green sturgeon are anadromous and occur along the west coast of the United States and Canada (Erickson and Hightower, 2007). They are the most marine of all sturgeon species (Adams et al., 2006). Migration behaviors and distinctions between non-spawning locations for each DPS are unclear. Both the Northern and Southern DPS have been identified by genetic analysis in the Columbia River and associated estuaries in Oregon/Washington. In the Columbia River system, sturgeon concentrate in the estuaries during summer months. They have been known to travel upriver as far as the Bonneville Dam, but do not spawn in the river (Israel et al., 2004). Green sturgeon abundance is relatively high in the

Columbia River estuary system compared to other estuaries on the west coast of the United States (NOAA, 2006G).

Juveniles spend 1 to 3 years in freshwater before migrating to near coastal habitats between late summer and early winter (Israel et al., 2004; Erickson and Hightower, 2007; Adams et al., 2006). Mature adults (13 to 20 years old) return to natal rivers during the summer every 3 to 5 years, where they broadcast spawn their eggs over the surface of river cobbles (Israel et al., 2004; Adams et al., 2006). Green sturgeon feed on benthic invertebrates and tend to be nocturnal (Israel et al., 2004). When at sea, sturgeon are found over shallow continental shelf areas (less than 300 feet deep) and are often concentrated in specific areas off the coasts of Oregon and Washington (Erickson and Hightower, 2007).

Sea Turtles

Four species of sea turtles have been documented off the coasts of Oregon and Washington and are federally listed as threatened or endangered under the ESA. These include the green, olive ridley, leatherback, and loggerhead sea turtles. Sea turtles nesting on beaches in the United States are under the jurisdiction of the FWS; sea turtles occurring in U.S. waters are under the jurisdiction of the NMFS. None of the listed sea turtles are known to nest along the Pacific Coast of the United States (NMFS and FWS, 1998a; 1998b; 1998c; 1998d).

All four species of sea turtles potentially affected by the project are highly migratory. Eastern Pacific populations of sea turtles generally spend the winter months in breeding grounds off of southern Mexico and Central America, and although sea turtles have been reported during the summer months as far north as Alaska, occurrences are more common in southern California and northern Mexico (NMFS and FWS, 1998a, 1998b, 1998c, and 1998d).

Although sea turtles are generally considered a warm temperate marine reptile; green, olive ridley, leatherback, and loggerhead sea turtles have been recorded off the coasts of Oregon and Washington in the last 10 years (Green et al., 1992). Green et al. (1992) conducted a study to assess the presence and abundance of federally listed species off the Pacific Coast of the United States. This study collected both aerial and shipboard marine fauna data along the Washington and Oregon coasts between 1989 and 1990. During this time, 16 sea turtles were observed; all sightings were leatherback sea turtles and all occurred between June and September, when water temperatures are warmest. Most (62.5 percent) of these sightings occurred over the continental slope waters, with the remainder found over the continental shelf.

The diets of sea turtles vary greatly. Green sea turtles are known to be generally herbivorous; the foraging habits of olive ridley sea turtles are largely unknown, although crustaceans are believed to be a major part of their diet; loggerhead sea turtles primarily forage on benthic invertebrates; and leatherback sea turtles forage on cnidarians and tunicates (NMFS and FWS, 1998a, 1998b, 1998c, and 1998d).

Whales

Seven species of whales potentially occur off the coasts of Oregon and Washington that are federally listed as endangered under the ESA (these species are also protected under the MMPA). These include the blue, fin, humpback, North Pacific right, sei, Southern Resident killer, and sperm whales. Whales tend to feed during the summer in the northern latitudes and migrate to the tropical southern latitudes in the winter for breeding. Some whales do not migrate as far north as the rest of the population; therefore, whales can be encountered throughout the year off the coasts of Oregon and Washington.

As depicted in figure 4.6.1-1, marine mammal aerial and shipboard surveys have been conducted in the waters off of Oregon and Washington to determine marine species distribution, abundance, and habitat use patterns. In addition, opportunistic sighting data compiled by the NMFS National Marine Mammal Laboratory's Platform of Opportunity Program (POP) was also used to assess whale distribution. The POP database has been collecting opportunistic data since 1958. Based on the distribution data from both the POP database and the Green et al. 1992 study, beyond the base of the continental slope, marine mammal sightings become increasingly rare compared to sightings along either the slope or shelf. The sperm and sei whales, which are known to have a more oceanic (deeper depth) distribution than other whale species, are exceptions to this pattern.

The blue whale, a baleen whale, is the largest animal ever known to have lived on Earth. Blue whales are found in all oceans worldwide. Blue whales in the Pacific Coast region are part of the Eastern North Pacific Stock, which contains an estimated1,186 whales (Caretta et al., 2007). Blue whales spend about one-half their time outside the EEZ (Caretta et al., 2007). Blue whales forage in portions of the LNG carrier transit route off of California, British Columbia, and/or the Gulf of Alaska. In addition, blue whales occur throughout the EEZ between June and November prior to migrating south. Unpublished satellite data shows blue whales migrating north/south offshore of the Columbia River mouth, although the distance from the mouth was not known at the writing of this EIS (Calambokidis, 2006).

The fin whale is a baleen whale with populations centered in the temperate zones of both the northern and southern hemispheres. Fin whales found off the Pacific Coast are part of the California/Washington/Oregon Stock. Ship surveys conducted off the Pacific Coast estimated the population to be 3,454 whales (Caretta et al., 2007). Acoustic signals from fin whales are detected year-round off the coasts of northern California, Oregon, and Washington, with peak numbers occurring in the summer and fall (NMFS, 1998). Recent observations show aggregations of fin whales off the coast of Oregon during the summer months (Caretta et al., 2007). Although it has been determined that fin whales are migratory, the pattern of migration is apparently complex, and not well-understood. For example, fin whales occur year-round in some areas (such as the Pacific Coast), but the density of individuals in an area changes seasonally (NMFS, 1998). Although their distribution and migratory patterns are not well understood, 78 percent of the 27 fin whale sightings recorded by Green et al. (1992) and all 9 sightings recorded in the POP database occurred over the slope.

The humpback, one of the large baleen whales, occurs in all oceans of the world, although it is less common in Arctic regions. The Eastern North Pacific Stock resides along the Pacific Coast in the summer and fall months and spends the winter and spring in coastal Central America and Mexico (Caretta et al., 2007). Caretta et al. (2007) provided a best estimate of abundance for the population of humpbacks in California, Oregon, and Washington coastal waters of approximately 1,396 whales. The humpback whales of the Pacific Coast have generally increased in abundance since the taking of humpback whales was prohibited in 1966. Humpback whales occur throughout the EEZ between May and November, with the higher concentrations occurring near abrupt changes in bathymetric relief. Humpback whales congregate near the shelf edge, especially near Heceta Bank in Oregon and submarine canyons in Washington (Green et al., 1992). Of the 68 humpback whale sightings recorded during the Green et al. (1992) study, 41 percent occurred over the shelf, 57 percent occurred over the slope, and 2 percent occurred offshore. The POP database recorded 22 sightings; of these, 29 percent occurred over the shelf, 52 percent occurred over the slope, and 19 percent occurred offshore.

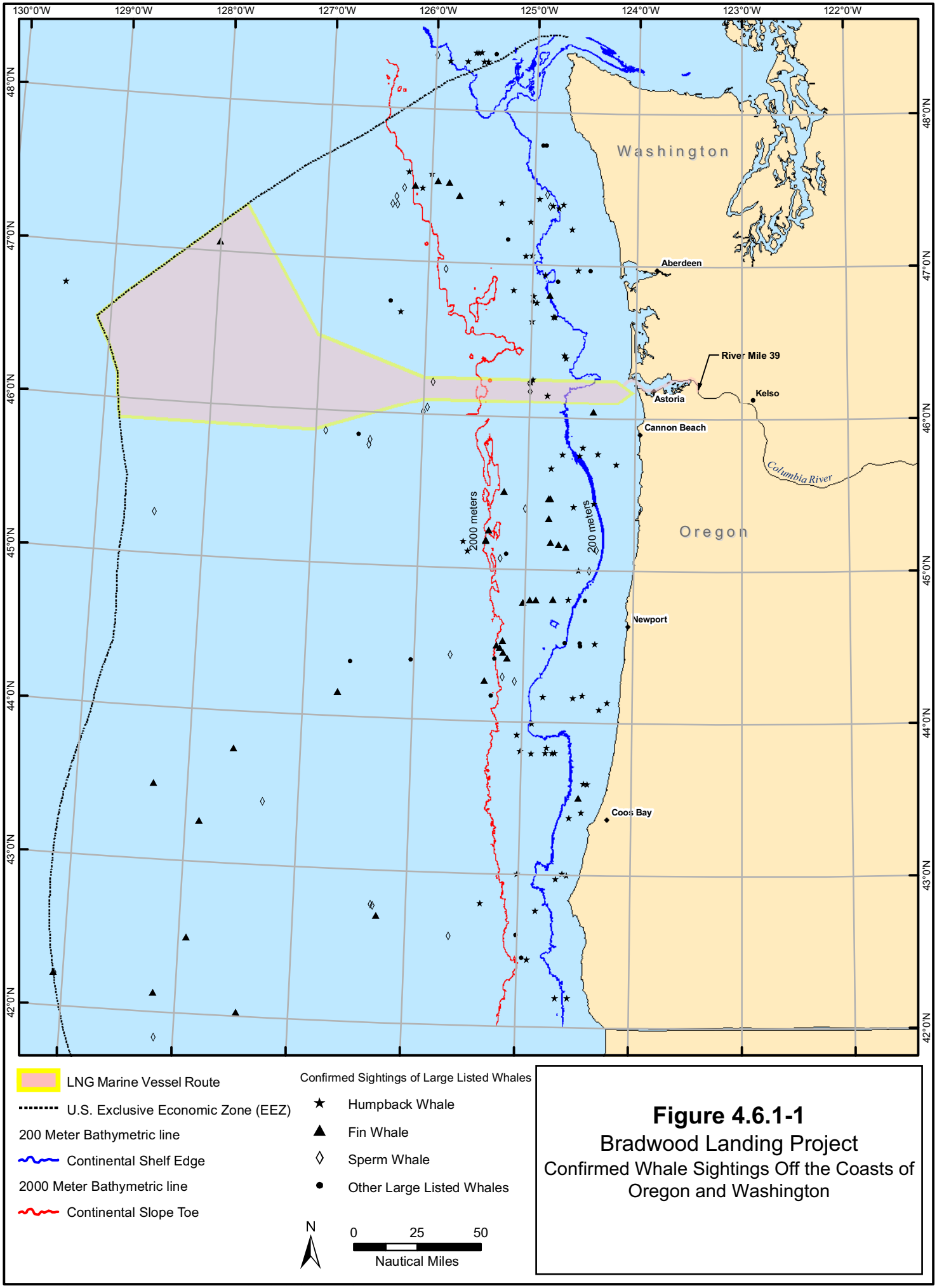


Figure 4.6.1-1
Bradwood Landing Project
Confirmed Whale Sightings Off the Coasts of Oregon and Washington

The North Pacific right whale historically ranged across the entire North Pacific Ocean. The current status of this species is unknown but is thought to number only in the tens of animals. Between 1900 and 1994, only 29 verifiable sightings occurred along the Pacific Coast and Hawaii (Caretta, et al., 1995). Recent sightings of the North Pacific right whale have occurred in the Bering Sea and Northern Gulf of Alaska near Kodiak Island. North Pacific right whales are known to occur in the southeast Bering Sea and the northern Gulf of Alaska. The right whales that have been found here have been predominantly males, but at least one female has been identified by genetic analysis of a biopsy sample (LeDuc, 2004). Little else is known about the North Pacific right whale's current state, including whether the whales known to occur in the Bering Sea are all that remain of the entire population, or if they are just one portion of the eastern population, with the rest of the population occurring elsewhere during summer months. Additionally, little, if anything, is known about the route that North Pacific right whales take on their migration south.

The sei whale is a baleen whale with a similar life history, appearance, and distribution as the fin whale. Sei whales occurring off the Pacific Coast are part of the Eastern North Pacific Stock. Generally occurring in offshore waters, sei whales do not appear to be associated with coastal features, which partially accounts for the low frequency of observations in the shelf waters of Oregon and Washington (NMFS, 1998; Caretta et al., 2005). The sei whale abundance estimate for California, Oregon, and Washington waters out to 300 nautical miles is approximately43 whales (Caretta et al., 2007). Migration of the Eastern North Pacific Stock is between coastal waters of the Pacific Coast and Vancouver Island (Rice, 1977). Sei whales have been recorded within the EEZ during the summer months. The POP database includes four sightings of sei whales since 1958. Of these, one sighting occurred in shelf waters, one occurred along the slope, and two occurred offshore. However, shipboard surveys between 1991 and 2001 did not record any sightings of the sei whale within the EEZ (Caretta et al., 2005; Green et al., 1992).

The Southern Resident killer whale, a toothed whale, occurs in all oceans and seas of the world, although it prefers the colder waters of both hemispheres. The greatest abundances of killer whales occur within 500 miles of the continents (Mitchell, 1975). Killer whales inhabiting the inland and coastal waters of Oregon and Washington are part of the Eastern North Pacific Southern Resident Stock. This stock is comprised of three pods, one occurs in inland waters, and the other two spend more time offshore (Ford et al., 2000). However, most sightings of these resident whales occur during the summer months in inland waters of Washington and southern British Columbia. This stock has been intensely studied and contained an estimated 88 whales as of November 2007 (Center for Whale Research, 2008). The Southern Resident killer whale DPS occurs mainly within the inland waters of Washington. However, during the winter of 2005 and 2006, Southern Resident killer whales were documented daily at the mouth of the Columbia River (Calambokidis, 2006).

The sperm whale, a toothed whale, is found throughout the northern Pacific Ocean, and has been seen in every season except winter off the coasts of Oregon and Washington (Green et al., 1992). Sperm whales found off the coasts of Oregon and Washington are part of the California-Oregon-Washington Stock, which contains about 2,265 individuals (Caretta et al., 2007). Sperm whale abundance appears to have been rather variable off the coast of California between 1979/1980 and 1996, but does not show any obvious trends. Large populations of sperm whales are known to occur both west and south of the California-Oregon-Washington stock; however, there is no evidence of sperm whale movements into this region from either the west or south (NMFS 2006f). Sperm whales are known to occur in both the open offshore portions of the EEZ and along the slope. Of the 36 recorded during the Green et al. (1992) study, 11 percent occurred over the slope and 89 percent occurred offshore. The POP database had 10 sightings and, of those, 7 occurred over the slope and 3 occurred offshore.

Steller Sea Lion

The Steller sea lion is federally listed as endangered under the ESA, is listed as threatened by the State of Washington, and is protected under the MMPA. The largest of the eared seals, which includes sea lions and fur seals, the Steller sea lion occurs along the rim of the northern Pacific Ocean (NMFS, 1992). Steller sea lions occurring near the project area are part of the Eastern DPS, which extends from southeastern Alaska to northern California. In 2002, the total population of the Eastern DPS was estimated to be 47,885 (Pitcher, ADFG, NMFS unpublished data). The numbers of Steller sea lions in Oregon and Washington have increased in recent years, with Oregon counts increasing at an average rate of 3.7 percent per year since 1977, and Washington counts increasing an average of 9.2 percent per year since the early 1990s (LCFRB, 2004).

Steller sea lions occur throughout the year in Oregon and Washington. Although not known to migrate, Steller sea lions disperse widely outside of the breeding season. Recent tagging efforts have shown that Steller sea lions move between the mouth of the Columbia River and the Bonneville Dam at CRM 146, foraging for food (Stansell et al., 2007). Rookeries occur in a wide variety of areas, but most locations have specific favorable characteristics, including slightly sloped topography, protection from the wind, and isolation from humans and other mammalian predators. Rookeries are occupied from late May through early July, with females arriving about 3 days before the pup is born (NMFS, 1992). Females generally exhibit site fidelity, and rookery locations change little from year to year (NMFS, 1992). No breeding territories (or rookeries) are located in Washington, but five Steller sea lion rookeries occur in Oregon, including Rogue Reef, Sea Lion Caves, Three Arch Rocks, and both Long Brown Rock and Seal Rock at Orford Reef. The nearest rookery to the proposed project is at Three Arch Rocks, which is about 60 miles south of the mouth of the Columbia River.

Haulout sites are locations used by breeding, non-breeding, and subadult sea lions during the non-breeding season, and are generally associated with jetties, offshore rocks and islands, logbooms, marina docks, and navigation buoys (NMFS, 1992; LCFRB, 2004). Similar to rookeries, sea lions show a high degree of site fidelity to haulouts. The nearest haulout site to the proposed project is the South Jetty near the mouth of the Columbia River, which is used by hundreds of sea lions every year (LCFRB, 2004). Use of the South Jetty is lowest in the spring and summer, when adults return to rookeries for pupping and breeding, and increases in fall and winter when animals move to haulouts and forage on salmonids and eulachon. The only other haulout site used by Steller sea lions in the vicinity of the lower Columbia River is the Large Navigation Buoy, which is located about 6 miles into the Pacific Ocean (Jeffries et al., 2000). Recent surveys by the WDFW documented 1,000 Steller sea lions near the mouth of the Columbia River (WDFW, 2007).

Columbian White-tailed Deer

The Columbian white-tailed deer, listed as endangered both federally and in Washington, is the westernmost subspecies of the white-tailed deer. Currently, there are two Columbian white-tailed deer DPSs, one is located in Douglas County, Oregon, and the other is located along the lower Columbia River in Oregon and Washington (Brown, 2003; Smith et al., 2003). Current population estimates for subpopulations of the Columbian white-tailed deer along the lower Columbia River are provided in table 4.6.1-2. Population density is estimated at about 25 to 75 deer per square mile (Clark, 2006).

TABLE 4.6.1-2

Population Estimates for the Columbian White-tailed Deer along the Lower Columbia River

Location	2005 Population
Julia Butler Hansen National Wildlife Refuge	
Washington Mainland	100
Tenasillahe Island	100
Wallace Island	25
Crims Island	25
Puget Island	125
Westport Bottomlands	120
Clatskanie Lowlands	25
Fisher Island and Willow Grove	25
Lord Island and Diblee Flats	20

Source: Clark, 2006.

The majority of deer within the Columbia River population are included in one of four subpopulations (Washington mainland, Tenasillahe Island, Puget Island, and the Oregon lowlands). Each subpopulation is geographically separated by major channels of the Columbia River (WDFW, 2004). Both the Washington mainland and Tenasillahe Island subpopulations occur within the JBHNWR, which was established in 1972 (and was then called the Columbian White-tailed Deer National Wildlife Refuge) to protect over 5,600 acres of shoreline and island habitat for the preservation of the Columbian white-tailed deer (WDFW, 2004). These subpopulations are both currently considered secure and viable. The Oregon lowlands subpopulation is located near the community of Westport and reportedly further upstream in the Clatskanie lowlands (FWS, 1983; Clark, 2006). There are also plans to establish another subpopulation on Crims Island, and another subpopulation is being planned on a group of islands including Fisher, Hump, Lord, and Walker islands (FWS, 2005a). This group of islands is located approximately 1 mile upstream of the Crims Island subpopulation and the two subpopulations are expected to merge in the future (FWS, 2005a).

Columbian white-tailed deer typically inhabit forested areas located along waterways and generally select areas that offer both food and cover (Davison, 1979; Verts and Carraway, 1998). Sitka spruce with a grass understory is used most frequently; however, in summer, Columbian white-tailed deer preferentially inhabit mixed forests of western red cedar, red alder, and Sitka spruce with a grassy understory (Suring and Vohs, 1979). Pastures are generally avoided, presumably due to limited cover (Verts and Carraway, 1998). In a study conducted by Smith (1987), density of deer was greatest in areas where woodland cover was greater than 50 percent. Foraging habitat used by Columbian white-tailed deer is generally located within 820 feet of forest cover, and varies greatly with season. Typical forage includes evergreen blackberry, Pacific ninebark, red-osier dogwood, salal, juniper, western red cedar, foxtail, orchard grass, tall fescue, mannagrass, yarrow, red clover, and buttercup (Dublin, 1980). However, Dublin (1980) found that between 25 percent and 50 percent of the diet was comprised of woody browse species between September and February.

Fawning begins at the beginning of June and ends in mid- to late-July (ODOT, 2006; Watson and Schirato, 1990). Peak fawning occurs in mid- to late-June (FWS, 2003). Habitats used for fawning include fields of tall grasses and other habitats that provide thermal and hiding cover and are located away from other deer (Clark, 2006). After birth, the doe goes about her usual activities, returning several times a day to nurse the newborn fawns (Clark, 2006). The young fawns will generally rest or hide during the day in the same location where they were born or may be moved one or more times by the mother (Clark,

2006). Fawns typically are weaned after 10 weeks, although some may continue nursing into autumn (Verts and Carraway, 1998).

Brown Pelican

On February 20, 2008, the FWS proposed to remove the brown pelican from the list of endangered and threatened species due to recovery (73 Federal Register 9408–9433). The brown pelican is currently listed federally and by the states of Oregon and Washington as endangered. The brown pelican occurs along the Pacific Coast between California and Chile (FWS, 2006f). Habitat of the brown pelican is mainly coastal; they are rarely seen inland or far out at sea (FWS, 2006g). Pelicans nest in colonies that are usually located on coastal islands, on the ground, or in small bushes and trees (Palmer, 1962). Nests are composed primarily of grasses, reeds, sticks, and straw and are situated to avoid mammalian predators. This species is not known to breed in Oregon; however, the mouth of the Columbia River supports one of the largest non-breeding communal roosts in the United States. In 2002, as many as 11,000 brown pelicans roosted on East Sand Island at the mouth of the Columbia River between late spring and early fall (FWS, 2008). Brown pelicans roosting in this area feed mostly in shallow portions of the estuary but may sometimes occur up to 40 miles from shore. Their diet consists of various fishes, especially sardines (*Sardinops* spp.), mullet (*Mugil* spp.), and anchovies (*Engraulis* spp.) (FWS, 2005b).

Marbled Murrelet

The marbled murrelet is listed federally and by the states of Oregon and Washington as threatened. Marbled murrelets breed along the Pacific Coast of the United States between Alaska and central California. In the Pacific Northwest, marbled murrelets nest solitarily on mossy platforms on large branches in mature conifer forests within 20 to 50 miles of the coast (Lank et al., 2003; FWS, 1997). Nest stands utilized by marbled murrelets typically have multiple canopy layers, moderate to high canopy closure, and are composed of Douglas-fir, Sitka spruce, and western hemlock. Marbled murrelets nest high in large trees (minimum of 30 inches diameter at breast height) with large, moss-covered branches that serve as nest platforms (Burger, 2002; Nelson and Wilson, 2002). Forests with trees older than 150 years are thought to provide the best structures for suitable nesting habitat, but they also will also use younger stands of trees for nesting (Nelson and Wilson, 2002; Hamer and Nelson, 1995; FWS, 1997; FWS, 2004). Marbled murrelets forage in nearshore marine habitats, generally in waters less than 260 feet deep, on a variety of small fish and invertebrates (FWS, 1996a).

Northern Spotted Owl

The northern spotted owl is listed as threatened federally and in Oregon, and as endangered in Washington. The northern spotted owl is a forest bird that inhabits old-growth coniferous and mixed conifer-hardwood forests from British Columbia through northern California. Suitable habitats for spotted owls provide elements necessary for nesting, roosting, foraging, and dispersal. Characteristics of nesting and roosting habitat in western Oregon and Washington generally include forests dominated by Douglas-fir and western hemlock with large (more than 30 inches diameter at breast height) overstory trees. Canopies exhibit a moderate to high canopy closure (60 to 80 percent), and are multi-layered with multiple tree species (FWS, 1992a). In addition, trees with various structural deformities (cavities, broken tops, mistletoe infections) and large snags are also characteristics of northern spotted owl habitat, as well as accumulated fallen trees and debris on the forest floor (FWS, 1992a). Most nest and roost sites are within forest stands with trees that are often older than 200 years, but spotted owls also utilize mature forests 100 to 200 years old. Foraging and dispersal habitats may be in younger, more open and fragmented forests than those associated with nesting and roosting (FWS, 1992a).

Short-tailed Albatross

The short-tailed albatross is listed as endangered both federally and by the State of Oregon. Short-tailed albatross are oceanic birds that occur throughout most of the North Pacific Ocean and are often found close to the Pacific Coast of the United States (FWS, 2006h). The short-tailed albatross generally breeds in the South Pacific, where it nests on the ground on small oceanic islands, favoring volcanic ash slopes with sparse vegetation and formerly level open areas adjacent to tall clumps of the grass *Miscanthus sinensis* (NatureServe, 2006). Most of the world's breeding short-tailed albatross nest on Torishima Island in the Tsubamezaki colony from late October through early November. There are no breeding populations of short-tailed albatross in the United States, but attempted nesting has been regularly observed on Midway Atoll in the northwestern Hawaiian Islands (FWS, 2006h). Short-tailed albatross forage at sea, but specific geographic and seasonal distribution patterns within the marine range are not well understood. The short-tailed albatross forages at the water surface on squid, fish, eggs of flying fish, shrimp, and other crustaceans (FWS, 2006h). Short-tailed albatross are also known to follow ships and forage on scraps and other refuse (NatureServe, 2006).

Streaked Horned Lark

The streaked horned lark is a candidate for listing federally and in the State of Washington. The streaked horned lark is a rare subspecies of the horned lark that breeds and winters in Oregon and Washington. Historically, many streaked horned larks bred and over-wintered in Oregon (Gabrielson and Jewett, 1940); however, the Washington population was largely migratory (Bowles, 1900; Rogers, 1999; 2000). Currently, flocks tend to arrive in the later half of February, and most leave by mid- to late-August (Bowles, 1900; Rogers, 1999; 2000). Surveys conducted in the winter of 2003 – 2004 and 2004 – 2005 indicate that, as suggested by Rogers (2000), most streaked horned larks winter along the lower Columbia River and in western Oregon (Pearson and Hopey, 2005; Pearson et al., 2005). In 2005, Pearson and Hopey found that there are two peaks in clutch initiation: the first taking place in April through early May or late May through early June, and the second taking place in late June through early July as a result of nesting failure in the first clutch.

This species is associated with bare ground or sparsely vegetated habitats. Along the lower Columbia River, streaked horned larks nest between late March and June in sparsely vegetated, expanses of sand adjacent to the river, or in areas dominated by grasses and forbs with few or no trees or shrubs (Pearson and Hopey, 2005). Streaked horned lark nests are built in shallow depressions in the open or near grassy clumps (FWS, 2006i). Foraging for weed seeds and insects occurs in sparsely vegetated dunes, beaches, and dredge spoils, as well as intertidal areas (FWS, 2006i; Pearson and Hopey, personal observation).

Western Snowy Plover

The western snowy plover is federally listed as threatened within 50 miles of the Pacific Coast. In addition, the western snowy plover is listed in the State of Oregon as threatened and by the State of Washington as endangered. The Pacific Coast population of western snowy plovers occurs from southern Washington to southern Baja California, Mexico (FWS, 2006j). This species nests beside or near tidal waters on barren to sparsely vegetated sand beaches, dry salt flats in lagoons, dredge spoils deposited on beach or dune habitat, levees and flats at salt-evaporation ponds, and river bars (FWS, 2006j). Plovers lay their eggs in shallow depressions in sandy or salty areas with sparse vegetation between early March and late September (FWS, 2006k). Western snowy plovers forage primarily on invertebrates in the wet sand and among surf-cast kelp within the intertidal zone; in dry, sandy areas above the high tide; on salt pans; on spoil sites; and along the edges of salt marshes, salt ponds, and lagoons (FWS, 2006k).

Eight main nesting areas currently occur along Oregon's coast (FWS, 2006l). The northernmost of these sites is near the central coastal community of Florence, which is about 155 miles south of the mouth of the Columbia River. This species historically occurred within the coastal areas of the lower Columbia River, but plovers have not been documented in this area since 1985 (69 Federal Register 75617). In addition, there is no evidence that indicates the western snowy plover occurs or has occurred upstream of the mouth of the Columbia River (Pacific Coast Joint Venture, 1994).

Oregon Silverspot Butterfly

The Oregon silverspot butterfly is listed as threatened federally and as endangered by the State of Washington. The range of the Oregon silverspot butterfly is restricted to coastal areas of California, Oregon, and Washington, where it occurs in three types of grassland habitat, including coastal salt spray meadows, stabilized dunes, and mountain meadows (Washington State Department of Transportation (WDOT), 2006; FWS, 2005c). The Oregon silverspot butterfly requires the early blue violet (*Violet adunca*) as a host plant to complete its development. Females oviposit their eggs near the violet in late August and early September (FWS, 2006m). As an adult, the Oregon silverspot generally moves out of the meadows and into the fringes of conifers or brush where there is shelter for more efficient heat conservation and nectaring flights. Where such sheltered conditions exist, the adults will use various nectar sources, including California aster (*Aster chilensis*), yarrow (*Achillea millefolium*), Indian thistle (*Cirsium edule*), false dandelion (*Hypochaeris radieata*), and tansy ragwort (*Senecio jacobaea*) (FWS, 2006m).

Kincaid's Lupine

Kincaid's lupine is listed as threatened federally and by the states of Oregon and Washington. Kincaid's lupine is the primary host plant for the federally endangered Fender's blue butterfly; the plant is used by Fender's blue butterfly for egg-laying and as a larval food source (FWS, 2005b).

Kincaid's lupine is a low-growing plant that is unable to survive prolonged periods of shade. Loss of prairie habitat has made the ecosystem supporting Kincaid's lupine one of the most endangered in the United States (Noss et al., 1995). The few remnant patches of prairie habitat in Oregon and Washington are threatened to varying degrees by the spread of invasive grasses and shrubs as well as by the succession of prairie to forest (FWS, 2005a). This species is found mainly in the Willamette Valley and south into Douglas County, Oregon, where it occupies both wet and upland prairie habitats and open oak savannas (WDNR and BLM, 1997; FWS, 2005b).

Nelson's Checker-mallow

Nelson's checker-mallow is listed as threatened federally and by the State of Oregon, and is listed as endangered in Washington. There are two Nelson's checker-mallow DPSs (northern Coast Range and Willamette Valley). The Willamette Valley DPS also includes two outlying populations occurring in Cowlitz and Lewis Counties, Washington (FWS, 1998).

The Willamette Valley DPS of Nelson's checker-mallow usually occupies open habitat such as ditches, margins of streams, roadsides, fence rows, drainage swales, native prairie remnants, and fallow fields (FWS, 1998). Most known sites have been densely colonized by invasive weeds, especially introduced forage grasses. Throughout its range, Nelson's checker-mallow habitat is threatened by reduction in native prairie and grassland habitat caused by fire suppression; the associated invasion of woody species; and because of residential, agricultural, and commercial development in otherwise suitable habitat (WDNR and BLM, 1997; FWS, 1998). The Willamette Valley population is considered extremely imperiled and at high risk of extirpation due to agricultural and urban development,

competition with invasive species, seed predation by weevils, small population sizes, and genetic isolation and lack of variation (FWS, 1998).

Water Howellia

Water howellia is listed as threatened both federally and by the state of Washington. Water howellia is an aquatic plant restricted to seasonally flooded, freshwater wetlands. These wetlands are generally small (less than 2.5 acres) and shallow (less than 3 feet deep) (FWS, 1996b). Water howellia require late summer/fall drying of the wetland for seed germination, and spring submergence for growth and subsequent blooming (FWS, 1996b). In western Washington, water howellia inhabit wetlands bordered by Oregon ash and trembling aspen and are generally located adjacent to forests dominated by Douglas-fir and Oregon white oak. Shrubs and emergent vegetation often occurring near water howellia include red-osier dogwood, snowberry, hardhack, water parsnip, bur-reed, inflated sedge, lesser spearwort, and water buttercup (FWS, 1996b; WDNR and BLM, 1997).

4.6.1.2 State Listed Threatened and Endangered Species

NorthernStar consulted with the ODFW, ORNHIC, WDFW, and WNHP to identify state-listed endangered and threatened species with the potential to occur within the proposed project area. Many state listed endangered or threatened species are also federally listed; these species were discussed previously in section 4.6.1.1. Life history information for the remaining state listed threatened or endangered species are discussed below.

Bald Eagle

The bald eagle is listed as threatened by the states of Oregon and Washington. Although the bald eagle was previously listed as threatened under the ESA, the FWS announced on June 28, 2007 that the bald eagle has recovered and would be removed from the list of threatened and endangered species effective August 8, 2007. However, the bald eagle is still federally protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Under both laws, the disturbance of eagles, their nests, and eggs is prohibited. On June 5, 2007, the FWS issued the Bald Eagle Management Guidelines, which clarified its regulations regarding implementation of the Bald and Golden Eagle Protection Act.

In the Pacific Northwest, bald eagles typically nest in multi-layered, uneven-aged, coniferous stands that are located within 1 mile of large bodies of water (Anthony et al., 1982). Trees are preferably large and stoutly limbed, with snags, broken tops, or rocks that provide easy access to foraging areas. Bald eagles often construct several nests within a territory and alternate between them from year to year; however, overall fidelity to a territory near a reliable food source is high (Stinson et al., 2001).

In Oregon and Washington, bald eagles may begin nest repairs in December, but courtship and pair bonding generally occur during January and February (Stinson et al., 2001). Adults begin incubating eggs by mid to late March, and young hatch near the end of April. Juveniles typically fledge during July but may remain in the nest vicinity through the end of summer (Garrett et al., 1993). Bald eagles inhabiting the Columbia River estuary forage primarily on tidal flats. Although bald eagles on the Columbia River feed primarily on fish; waterfowl, mammals, and marine invertebrates also can make up about 10 percent of this species' diet (Watson et al., 1991; Garrett et al., 1993).

Adult bald eagles in Oregon and Washington remain in their territories until early fall, when they migrate to British Columbia or southeastern Alaska for about 6 weeks to forage on early salmon runs. Fledglings and juvenile eagles also migrate north during this time, but will remain in British Columbia or

Alaska for several months before returning. During this time, southern migrants will occupy rivers in Oregon and Washington for several weeks before continuing north on their migration.

Bald eagles may roost communally in the winter, with three or more eagles perching for consecutive nights in the same trees (Watson and Rodrick, 2001). Communal roosts tend to be located near a rich food resource (i.e., runs of anadromous fish, high concentrations of waterfowl) and in forest stands that are uneven-aged and have at least a remnant of the old-growth forest component (FWS, 1986). Roosts tend to have more favorable microclimates and protection from inclement weather than surrounding areas and thereby facilitate energy conservation. Areas free of disturbance also are an important feature of bald eagle wintering habitat (FWS, 1986).

The greatest threats to nesting and wintering eagle populations are activities that permanently alter bald eagle habitat (e.g., removal of nest, roost, and perch trees, removal of buffers) and human activities that temporarily disturb eagles to the point of reproductive failure or reduced vigor (Watson and Rodrick, 2001). Human activities near nest sites during the breeding season can disturb eagles, leading to abandonment and reduced reproductive success. Disturbances to feeding eagles, particularly during the winter months, can cause the birds to expend more energy, which increases their susceptibility to disease and poor health (Stalmaster, 1987).

Western Pond Turtle

The western pond turtle is listed as endangered in the State of Washington and is classified as sensitive-critical in the State of Oregon. The current range of the western pond turtle extends from Puget Sound in Washington, south to Baja California (Hays et al., 1999). This species of turtle is highly aquatic and occurs in streams, ponds, lakes, and permanent and seasonal wetlands during most of the year. Although western pond turtles spend most of their lives in water, they require terrestrial habitats for nesting. In addition, pond turtles often over-winter on land and may spend portions of the warmest months in aestivation (an inactive state to avoid drought conditions) (Hays et al., 1999). Pond turtles are generally wary, initiating escape behavior when a perceived threat is 330 feet or more distant; however, they may be seen basking on emergent or floating vegetation, logs, rocks, and occasionally mud or sand banks (Hays et al., 1999). Western pond turtles generally nest within 330 feet of water, but may occasionally nest up to 1,300 feet from the nearest waterbody. The western pond turtle is an omnivore and a scavenger, foraging primarily on insects, including the larvae of caddisflies, dragonflies, and nymphs (PacificBio, 2006).

Gray Whale

The eastern North Pacific stock of gray whale was the target of intense whaling between the 1850s and early 1900s, but has increased to about 26,600 individuals as of 1999, largely due to protection from commercial whaling. The eastern North Pacific gray whale represents one of the ESA's success stories. The gray whale was listed as endangered throughout its range on June 2, 1970, and was officially considered recovered and delisted on June 16, 1994. The gray whale is still listed as endangered in the State of Oregon.

Gray whales make the longest migration of any whale, traveling 4,600 to 6,200 miles semi-annually between their summer feeding grounds and winter breeding grounds. Gray whales generally travel within 2 miles of the shoreline over most of their migration route, unless crossing mouths of rivers and straits (Dohl et al., 1983; Braham, 1984). Most of the Eastern North Pacific stock spends the summer feeding in the northern Bering and Chukchi Seas. However, gray whales have been reported feeding in the summer in waters off of Southeast Alaska, British Columbia, Washington, Oregon, and California. Each fall, the whales generally begin their migration between November and December south along the

coast of North America from Alaska to Baja California, Mexico. The eastern North Pacific stock winters mainly along the west coast of Baja California, using certain shallow, nearly landlocked lagoons and bays. The northbound migration generally begins in mid-February and continues through May, with cows and newborn calves migrating northward primarily between March and June along the west coast of the United States.

Subsistence hunters in Alaska and Russia have traditionally harvested whales from the eastern North Pacific stock; between 1996 and 2000, an average of 97 whales per year were taken. The nearshore migration route used by gray whales makes ship strikes another potential source of mortality; between 1996 and 2000, six serious injuries or mortalities of gray whales caused by ship strikes were documented. Gray whales entangled in fishing gear have reportedly been found swimming, floating, or stranded along the Pacific Coast of the United States and British Columbia, and during the 5-year period from 1996 to 2000, an estimated five to six gray whales died per year as a result of interactions with commercial fishing gear. Gray whales are also subjected to the effects of coastal development, pollution, military activities, exploration and development of oil and gas resources, and the whale watching industry.

In 1999 and 2000, a large number of gray whale strandings (273 in 1999 and 355 in 2000) occurred along the west coast of North America between Baja California, Mexico and the Bering Sea. This was compared to an average of 38 gray whale strandings per year for the previous 4 years and only 21 strandings in 2001. While the direct cause is unknown, a variety of anthropomorphic events (e.g., chemical contamination, fishery interactions and ship strikes) are hypothesized to have played a role. Other projected theories include starvation, natural toxins, and disease.

Western Wahoo

Western wahoo is listed as threatened in the State of Washington and grows in shaded, moist draws and ravines west of the Cascades (WNHP, 2007). Western wahoo generally prefers forested areas, but is sometimes found in grassy areas with some trees. Commonly associated species include Oregon white oak (*Quercus garryana*), Douglas-fir, snowberry (*Symphoricarpos albus*), Pacific blackberry (*Rubus ursinus*), western hemlock (*Tsuga heterophylla*), swordfern, and Sitka spruce. This species is generally found on fine sandy loam, silty loam, and silty clay loam soils, and it flowers from May to June (WNHP, 2003).

4.6.1.3 Other Special Status Species

Sensitive Species

In addition to the species listed under the ESA or by the States of Oregon and Washington, seven species that are candidates for listing as endangered or threatened or species of special concern have been identified by state agencies as having the potential to occur in the vicinity of the proposed project. In addition, the NMFS and ODFW expressed concerns regarding several sensitive species, including the coastal cutthroat trout, red -legged frog, tailed frog, western painted turtle, American peregrine falcon, and olive-sided flycatcher. The life histories of these sensitive species are discussed below.

<u>Coastal Cutthroat Trout</u>

The coastal cutthroat trout is currently listed in Oregon as a critically sensitive species. Habitat requirements vary depending on the life history traits of individual populations. Unlike other anadromous salmonids, sea-run forms of coastal cutthroat trout do not over-winter in the ocean and rarely make extended migrations across large bodies of water (64 Federal Register 16397). Migrations are normally within 6 miles of land, but have been detected up to 30 miles offshore (Giger, 1972; Sumner, 1972; Jones,

1976; Pearcy, 1997; Johnston, 1982). Coastal cutthroat trout may migrate to sea in late spring/early summer at 2 to 3 years of age, and return to freshwater in late autumn/early winter; however, some migrate entirely within a freshwater environment (British Columbia Ministry of Environment, Environmental Stewardship Division, 2007; FWS, 2007a). In the Pacific Northwest, coastal cutthroat trout spawn in tributaries of small watersheds and in small tributaries of larger watersheds between summer and winter. Young cutthroat trout emerge from the gravel between March and June, depending on location and timing of spawning, with a peak in April (Trotter, 1997).

In particular, anadromous coastal cutthroat trout of Oregon typically spawn in the lower Columbia River tributaries that are free of barriers to upstream movement, and later migrate to estuarine or marine water to feed (Johnson et al., 1999). Studies done on anadromous cutthroat trout in the lower Columbia River streams have shown over a 90 percent decline in both wild and hatchery fish in the last decade (ODFW, 1997). Potential factors believed to be contributing to this decline include: genetics, fisheries, reduction in nearshore productivity, and reduction of stream and estuary habitat (ODFW, 1997).

Eulachon

Eulachon (Columbia River smelt) are a candidate for listing in the State of Washington. From December to April, eulachon migrate from the ocean to upriver spawning areas in the mainstem Columbia and Cowlitz Rivers and occasionally into the Lewis, Kalama, and Sandy Rivers. Like salmonids, both male and female adults die after spawning. Eulachon are broadcast spawners and females release from 20,000 to 60,000 eggs. The eggs are sticky and settle to the bottom where they incubate for 30 to 40 days before hatching. Larval eulachon are about 0.15 inch in size and drift with the bottom currents as they develop, ultimately entering the ocean.

Eulachon are primarily fished commercially for use as bait for both the commercial and recreational sturgeon fisheries, but they are also fished as food. Mainstem fishing is done primarily by gill net and, to a lesser extent, by otter trawl. Fishing in the tributaries is done with dip nets as regulated by the States of Oregon and Washington. Total eulachon landings for the mainstem Columbia River for 2006 were estimated at 13,221 pounds, significantly higher than 2005, which had the lowest annual landings on record (208 pounds) (WDFW, 2006b). The highly variable or possibly cyclical run size makes trends in abundance hard to interpret; however, recent ocean conditions are probably the most important factor controlling eulachon abundance, and even riverine conditions (e.g., water temperature) play a major role in determining the species' spawning distribution and abundance (NMFS, 1999).

Lampreys

The lampreys (family Petromyzonidae, stone suckers) belong to a group of fish known as Agnatha, the most primitive of all living vertebrates. Two species of lamprey are designated as sensitive species and are native to the Columbia River basin: the Pacific lamprey (*Lampetra tridentata*), and river lamprey (*L. ayresi*). The river lamprey is currently a candidate for listing as endangered or threatened in the State of Washington and the Pacific lamprey is listed vulnerable within Oregon (ODFW, 2007; WDFW, 2007). The Pacific and river lamprey are both anadromous species. On January 23, 2003, a petition was filed by 11 conservation groups to list these two species as endangered or threatened under the ESA.

Life history information is sparse for these species. Larval lampreys are referred to as ammocoetes. They spend up to 6 years burrowed in the sediment, feeding on diatoms and detritus where they transform into a juvenile stage called macropthalmia. At this stage the lampreys are silver in color, develop teeth and a sucker-like disc, and form true eyes. Physiological transformations occur that initiate migratory behaviors and enable them to tolerate sea water (Fish Passage Center, 2007). After a 2-month

transformation into adults, Pacific and river lamprey migrate into the ocean where they spend 2 to 3 years parasitizing fishes and mammals (PSMFC, 1997). Pacific lampreys enter saltwater between late winter and early spring, while river lampreys enter saltwater between May and July. Lampreys return to freshwater rivers to spawn in the spring, where they lay up to 100,000 eggs in a nest built in gravel or sandy sediments. The adults die after spawning (PSMFC, 1997; ODFW, 2002).

The freshwater habitat requirements of lamprey are similar to anadromous salmonids and include mid-gradient tributaries for spawning. Juveniles burrow into soft mud substrates and remain there for up to 6 years. Adults then move to marine environments for 2 to 3 years before returning to tributaries to spawn (Bayer and Seelye, 1999).

Columbia Torrent (seep) Salamander

The Columbia torrent (seep) salamander is a candidate for listing in the State of Washington and is listed as critical on Oregon's State Sensitive Species List. The Columbia torrent salamander lives in coastal coniferous forests at the edges of clear, cold, fast-flowing streams with rock or gravel bottoms in southwestern Washington and northern Oregon (Burke Museum of Natural History and Culture, 2006; NatureServe, 2006). They can be abundant under gravel at stream edges and in the spray zones of waterfalls. During rainy seasons, they are occasionally found on land away from streams (Burke Museum of Natural History and Culture, 2006). Breeding occurs in spring and early summer, with eggs being laid under gravel in shaded streams (NatureServe, 2006). The Columbia torrent salamander forages on aquatic and semi-aquatic invertebrates, including beetles, stoneflies, snails, flies, and amphipods. (Nussbaum et al., 1983).

Northern Red-legged Frog

The northern red-legged frog is listed as sensitive-undetermined within the Coast Range Ecosystem by the State of Oregon and occurs from southwest British Columbia to Mendocino County in northern California. This species is most common in humid forests, woodlands, grasslands, and streamsides with plant cover (California Herps, 2006). Adult frogs require riparian vegetation near deep, still, or slow-moving ponds or intermittent streams. Riparian habitats provide shelter, escape from predators, and shade to maintain cool water temperatures (Animal Diversity Web, 2007).

Reproduction in northern red-legged frogs occurs from late November to early April, ensuring water temperatures between about 43 °F and 45 °F. Breeding habitat is in permanent water sources such as lakes, ponds, reservoirs, slow streams, marshes, bogs, and swamps; however, non-breeding frogs can be highly terrestrial and are sometimes found in damp areas far from water (California Herps, 2006). The female lays egg masses ranging from 500 to 1,100 eggs in perennial waterbodies that contain extensive vegetation consisting of cattails and tules or bulrushes (Hickman and Roberts, 1995; Davidson, 1996; Jennings and Hayes, 1985). Eggs attach at a minimum depth of 18 inches and at least 2 to 3 feet from the water's edge and hatch within 6 to 14 days (Jennings et al., 1993; Davidson, 1996). As they grow, the froglets move from shallow water to knee-deep water to hide from larger predators (Jennings and Hayes, 1985; Hickman and Roberts, 1995). Males can probably reproduce after 3 years of age while females reproduce after 4 years (Jennings and Hayes, 1985). Life spans of the Northern red-legged frogs range from 12 to 15 years (Cowan, 1941).

Tailed Frog

Tailed frogs are listed as vulnerable on Oregon's State Sensitive Species List and occur in shallow, cold, clear, shaded streams typically found in permanent forests. These streams possess a bed containing rocks that adults can hide under and flat, protruding, moss-free stones that tadpoles can cling

onto with their adhesive organ (Hallock and McAllister, 2005; Getubig, 2006). Adults tend to be highly aquatic, though they have been seen to venture onto land during the night when the humidity and moisture content of the forest is high (Getubig, 2006).

Western Painted Turtle

The western painted turtle is listed as critical on Oregon's State Sensitive Species List and occurs in slow-moving shallow streams, rivers, and lakes. This species prefers soft substrates with abundant vegetation and half-submerged logs for basking (Conant and Collins, 1998). Western painted turtles forage on aquatic vegetation, insects, crayfish, and small mollusks (Conant and Collins, 1998).

Townsend's Big-eared Bat

The Townsend's big-eared bat is currently a candidate for listing as threatened or endangered in the State of Washington and is listed as critical on Oregon's State Sensitive Species List. Townsend's big-eared bat has been documented in nearly every county in Washington and is common throughout most of Oregon (WDFW, 2005). Most habitats occurring in the counties affected by the project are suitable for feeding by Townsend's big-eared bats; however, the distribution of suitable roosts influences the actual locations where they are able to feed. A variety of different roost types are required by Townsend's big-eared bats, including day, nursery, night, and winter roosts. Day roosts are used for resting and hiding during the active season and may include old buildings, silos, concrete bunkers, barns, caves, and mines (WDFW, 2005). Nursery roosts occur in similar structures as well as actively used buildings and large "rooms" in concrete dams (WDFW, 2005). Unlike day and nursery roosts, Townsend's big-eared bats use night roosts for very short periods as stopover hiding and resting places between feeding bouts, but little is known about the use of night roosts. During winter, roosts may be used for weeks to months at a time and may include caves, lava tubes, mines, and other structures. Unlike many species of bats, bridges are not considered valuable roosts for Townsend's big-eared bats (WDFW, 2005). Mating takes place between November and February, with females giving birth to a single young in late May or early June (Schmidly, 1991; Nagorsen and Brigham, 1993). Townsend's big-eared bats forage nocturnally, emerging from roosts later than many bat species to forage primarily on moths; however, they will feed on a variety of other arthropods when available (WDFW, 2005; Nagorsen and Brigham, 1993).

American Peregrine Falcon

Although the American peregrine falcon was previously listed as endangered by the State of Oregon, on April 13, 2007, the ODFW delisted the American peregrine falcon from the Oregon Threatened and Endangered Species List. American peregrine falcons occur from non-Arctic portions of Alaska and Canada south to Baja California, Central Arizona, and Mexico. This species winters chiefly in its breeding range, except that the more northern birds move south (FWS, 2006n). The American peregrine falcon nests in cliffs that tend to dominate the surrounding landscape; however, they also utilize cut riverbanks, trees, and manmade structures, including tall towers and the ledges of tall buildings (FWS, 2006n). Nests typically are situated on ledges of vertical rocky cliffs, commonly with a sheltering overhang (Palmer, 1988; Campbell et al., 1990). The diet of American peregrine falcons includes small- to medium-sized avian species, such as blue jays, flickers, meadowlarks, pigeons, starlings, shorebirds, and waterfowl (FWS, 2006n).

Lewis' Woodpecker

Lewis' woodpecker is currently a candidate for listing in the State of Washington. Although this species historically occurred throughout southwestern Washington, its distribution is currently limited to

areas east of the Cascades and is not known to occur within the project area. Lewis' woodpecker is closely associated with old-growth ponderosa pine and mature riparian cottonwood forests throughout the west (NatureServe, 2006). Suitable habitat for Lewis' woodpecker typically includes forests with an open canopy and shrubby understory, snags available for nest sites, hawking perches, and insect fauna (Bock, 1970). Breeding populations of this species are locally distributed, often occurring in colonies and in burned forests (Jewett et al., 1953; Raphael and White, 1984; Block and Brennan, 1987; and Tobalske, 1997). Lewis' woodpecker is an opportunistic feeder whose diet varies seasonally. During the spring and summer, Lewis' woodpecker primarily forages on insects including ants, bees and wasps, beetles, grasshoppers, and true bugs (Tobalske, 1997). Fruits and berries are the most frequently eaten foods in late summer and fall, and winter food sources include acorns, commercial nuts, and corn (WDFW, 2002).

Northern Goshawk

The northern goshawk is currently a candidate for listing in the State of Washington and is listed as critical on Oregon's State Sensitive Species List. The northern goshawk is widely distributed across North America and generally inhabits coniferous and mixed forests, preferring mature forests with a combination of old, tall trees with intermediate canopy coverage and small open areas within the forest for foraging during their nesting season (Pajerski, 2005; Johnsgard, 1990; Squires and Reynolds, 1997). In the western United States, this species generally nests in mature forests dominated by ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), Douglas-fir, cedar, spruce, willow, and aspen (*Populus tremuloides*) (NatureServe, 2006). Typically, the nest is located near the trunk of a medium to large tree and near openings in the forest such as roads, swamps, and meadows (Pajerski, 2005). Northern goshawks breed between early April and mid-June. Mating northern goshawks begin to prepare their nests as much as 2 months before egg-laying. Northern goshawks forage on a wide variety of vertebrates and, occasionally, insects (NatureServe, 2006).

Olive-sided Flycatcher

The olive-sided flycatcher is listed as vulnerable on Oregon's State Sensitive Species List. The olive-sided flycatcher has a widespread distribution and occurs in coniferous forests, usually at mid- to high-elevations (Cornell Lab of Ornithology, 2006). Olive-sided flycatchers are most often associated with forest openings, forest edges near natural openings (e.g., meadows, bogs, canyons, rivers), human-made openings (e.g., harvest units), or open to semi-open forest stands. The olive-sided flycatcher has been recorded on both of the Breeding Bird Surveys conducted near the project area (Sauer et al., 2005).

Purple Martin

The purple martin is currently a candidate for listing in the State of Washington and is listed as critical on Oregon's State Sensitive Species List. Purple martins occur within much of the eastern United States during the summer months. In the western states, this species occurs in scattered locations along the Pacific Coast, and in the deserts and mountains of the southwest into Mexico (Cornell Lab of Ornithology, 2006). Purple martins arrive along the Pacific Coast between April and June and return to South America between August and mid-October (NatureServe, 2006). A study conducted in 1998 to determine the distribution, abundance, and nest site characteristics of purple martins in Oregon found that they were locally common along the Columbia River, in some coastal estuaries, and at the Fern Ridge Reservoir (Hovarth, 1999). Habitat chosen for nesting sites varied substantially and included open water, grassy fields, recent clearcuts, and burns with brush and young trees. However, characteristics common to nesting sites included a distance of more than 18 feet to large live trees and the presence of an unoccupied cavity (Hovarth, 1999). Purple martins forage on a variety of invertebrates, including ants, wasps, beetles, grasshoppers, and dragonflies (NatureServe, 2006).

Marine Mammals

The MMPA established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates, with certain exceptions, the "take" of marine mammals on the high seas by persons, vessels, or other conveyances subject to the jurisdiction of the United States. Thirty-one species of marine mammals have been recorded off the coasts of Oregon and Washington, including 6 species of baleen whales; 19 species of toothed whales, beaked whales, dolphins, and porpoises; 5 species of pinnipeds (seals and sea lions); and the sea otter (Caretta et al., 2007; Angliss and Outlaw, 2008). Of these, five species of baleen whales, two species of toothed whales, and one pinniped are either state- or federally listed and are discussed in sections 4.6.1.1 and 4.6.1.2.

Off the coasts of Oregon and Washington, 11 whales (minke, short-finned pilot, Baird's beaked, Cuvier's beaked, pygmy sperm, dwarf sperm whales, and 6 species of mesoplodont beaked whales), 4 dolphins (Pacific white-sided, Risso's, short-beaked common, and northern right whale dolphins), and 2 porpoises (harbor and Dall's porpoises) are all known to occur (Caretta et al., 2007; Angliss and Outlaw, 2008). However, the occurrence of these species would generally be limited to marine portions of the waterway.

In addition, California sea lions, Pacific harbor seals, Northern elephant seals, Northern fur seals, and sea otters occur off the coasts of Washington and/or Oregon. Although Northern fur seals and Northern elephant seals are occasionally present in this area, they do not occur in great numbers or for very long (NMFS, 2007b). The extent of Northern fur seals, and Northern elephant seals, presence in nearshore marine areas adjacent to the Columbia River is unknown (NMFS, 2008b). Similarly, the occurrence of the sea otter is limited to waters off the coast of Washington from Destruction Island (near the Hoh River) north to Neah Bay (FWS, 1995). Alternatively, large numbers of California sea lions and Pacific harbor seals can be found utilizing haulout (or resting) sites along the lower Columbia River (locations shown on maps in Appendix C). These species are described below.

<u>California Sea Lions</u>

California sea lions are found from southern Mexico to southeast Alaska. The United States stock is defined geographically for management purposes and is described as being comprised of animals that breed in the waters of the U.S. The current population estimate for the United States stock of California sea lions is 238,000 (Carretta et al., 2007) and has now reached carrying capacity.

California sea lions generally occur in the lower Columbia River during much of the year, except between mid-June and August when most animals return to breeding rookeries in southern California. However, peak numbers occur during the migration periods in May and September (Scordino, 2006). Recent surveys conducted by the WDFW documented 1,500 California sea lions near the mouth of the Columbia River in 2006 (WDFW, 2007; Jeffries, 2008). Females are rarely observed north of the California-Oregon border; therefore, California sea lions in the Pacific Northwest are sub-adult or adult males (NMFS, 2008b).

The breeding range of California sea lions in the United States is centered on the California Channel Islands but pupping has been reported farther north on the Farallon Islands and at Año Nuevo, California (Keith et al., 1984). Mature males (over 8 years) defend breeding territories on rookeries between May and August. Females return to the rookeries to give birth and most pups are born in June. Males breed with females that come into estrus in their territory. Most males are unsuccessful at establishing breeding territory on the rookeries due to heavy competition between dominant animals and retreat to the sea or to nearby "bachelor" beaches to await breeding opportunities (Heath, 2002)

California sea lions feed on a variety of fish and cephalopods (squid, octopus) based upon season, location, and prey availability. In Oregon coastal rivers, California sea lions are known to eat salmonids and lamprey along with other non-salmonid fish (Roffe and Mate, 1984). Based on analysis of intestinal samples, the California sea lion diet in the Columbia River estuary includes smelt, salmonids, rockfish, lamprey, and herring (Brown et al., 1995).

Pacific Harbor Seals

Pacific harbor seals inhabit coastal and estuarine waters and shoreline areas from Baja California to western Alaska. The Oregon/Washington Coastal stock of harbor seal is one of three management stocks for this species along the Pacific coast of the continental United States. The range of the Oregon/Washington stock, defined geographically for management purposes, extends from the California/Oregon border north to the Strait of Juan de Fuca at Cape Flattery, Washington.

Pacific harbor seals are present throughout the year at the mouth of the Columbia River. Several stocks of Pacific harbor seals occur in waters along the Pacific Coast. The Oregon/Washington coastal stock is estimated to contain about 25,000 animals (NMFS, 2007b).

Numerous harbor seal haulout sites are found on the intertidal mudflats and sandbars in the lower Columbia River estuary including nursery areas in Cathlamet Bay near Astoria (Jeffries et al. 2000; NMFS, 2008b). Harbor seals generally are non-migratory but local movements are associated with factors such as tides, weather, season, prey availability, and reproduction (Scheffer and Slipp, 1944; Bigg, 1969, 1981). Along the coasts of Oregon and Washington females give birth to pups at haulout sites between April and mid-July (Huber et al., 2001). Females breed within weeks of giving birth and breeding activity takes place in the water (NMFS, 2008c).

Although harbor seals are present year-round in the Columbia River estuary, they do exhibit seasonal movements and their numbers within the Columbia River upstream of the South Jetty increase from January to April and then decrease from May through August as the harbor seals move to adjacent bays (e.g., Netarts Bay, Tillamook Bay, Willapa Bay, and Grays Harbor) during the pupping season (Jeffries, 2008). During a typical day in May, approximately 3,000 Pacific harbor seals can be observed resting on haulout sites in the Columbia River estuary (NMFS, 2008b), but very few, if any, may be upstream of the South Jetty area.

The diet of harbor seals in the lower Columbia River is seasonally variable and diverse. In the winter, smelt are predominant; at other times of year, the diet includes anchovy, Pacific herring, salmonids, staghorn sculpin, starry flounder, and lamprey (Riemer and Brown, 1997). Harbor seals forage at varying distances from their haulouts depending on the frequency and quantity of prey encountered. The foraging home-range for harbor seals is unstudied in the Columbia River estuary. However, several studies have taken place in other areas of the Pacific (e.g., Alaska and California). For example, despite occasional long-distance movements in excess of 124 miles, harbor seals in both the Pacific and Atlantic Oceans rarely forage more than 31 miles from haul-out sites (Lowry et al., 2001). However, harbor seals in San Francisco Bay were found to have a foraging home range of only 3 miles from their primary haulout (Grigg et al., 2001).

Migratory Bird Treaty Act

The Columbia River estuary is one of the most important sites on the Pacific Flyway for migratory birds, with more than 300 species occurring in the area throughout the year (Lower Columbia River Estuary Partnership, 2007a). Peak counts in the estuary during migration have been almost 150,000 birds (Lower Columbia River Estuary Partnership, 1999). The Migratory Bird Treaty Act implements

various treaties and conventions for the protection of migratory birds. Under this act, taking, killing, or possessing migratory birds (including any part, nest, or egg) is unlawful.

4.6.2 Impacts and Mitigation

4.6.2.1 Waterway for LNG Marine Traffic

Federally Listed Species

Fish

Lower Columbia River Chinook Salmon ESU

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult, smolt, and juvenile life stages of the Lower Columbia River Chinook salmon ESU. The marine portion of the waterway provides habitat for adult salmon throughout the year. Within the lower Columbia River, migrating spring- and fall-run adults occur between March and June and August and October, respectively. Spring-run out-migrating smolts occur during their second spring/summer, and fall-run out-migrating smolts occur primarily as sub-yearlings from April through June (NMFS, 2005c). In addition, juvenile Chinook salmon rear throughout the year in nearshore habitat of the Columbia River mainstem, lower Columbia River islands, and the accessible low gradient reaches of Columbia River floodplain sloughs.

Critical Habitat – The Lower Columbia River Chinook salmon ESU has designated critical habitat (rearing and migratory corridor PCEs) within the lower Columbia River mainstem. Chinook salmon migrate through the Columbia River estuary en route to their spawning grounds upstream. In addition, critical habitat for rearing has been designated within nearshore habitats of the Columbia River mainstem, Columbia River islands, and the accessible low gradient reaches of Columbia River floodplain sloughs (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation.

Upper Columbia River Spring-run Chinook Salmon ESU

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult and smolt life stages of the Upper Columbia River Spring-run Chinook salmon ESU. The marine portion of the waterway provides habitat for adult salmon throughout the year. Within the lower Columbia River, spawning adults migrate upstream to their spawning grounds between March and June and smolts out-migrate between May and June (NMFS, 2005c). In addition, juveniles spend approximately 1 year rearing in freshwater before passing through the lower Columbia River between May and June (NMFS, 2005c). The Upper Columbia River Spring-run Chinook salmon ESU does not have spawning or rearing habitat along the waterway.

Critical Habitat – The Columbia River is designated as critical habitat (rearing and migratory corridor PCEs) for the Upper Columbia River Spring-run Chinook salmon ESU. However, as described above, no rearing occurs along the portion of the lower Columbia River affected by LNG carrier transit (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation.

Upper Willamette River Chinook Salmon ESU

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult, smolt, and juvenile life stages of the Upper Willamette River Chinook salmon ESU. The marine portion of the waterway provides habitat for adult salmon throughout the year. Within the lower Columbia River, spawning adults migrate upstream to their spawning grounds primarily between April and May, with a peak in mid-May, but have also been known to occur as early as February (NMFS, 2005c). According to the NMFS (2005c), out-migration has been found to occur in recently emerged juveniles in the winter through early spring, in sub-yearlings in the fall through early winter, and as yearlings in the late winter through spring. In addition, juvenile Upper Willamette River Chinook salmon rear throughout the year in nearshore habitat of the Columbia River mainstem, lower Columbia River islands, and the accessible low gradient reaches of Columbia River floodplain sloughs.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Upper Willamette River Chinook salmon ESU (70 Federal Register 52630 – 52858). The lateral extent of critical habitat for each designated stream reach is defined as the width of the stream channel as defined by its bankfull elevation.

Snake River Spring/Summer-run Chinook Salmon ESU

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult and smolt life stages of the Snake River Spring/Summer-run Chinook salmon ESU. The marine portion of the waterway provides habitat for adult salmon throughout the year. Within the lower Columbia River, spawning adults migrate upstream to their spawning grounds between January and May (COE, 1973). Out-migrating smolts pass through the lower Columbia River during their second spring/summer (Bell Fisheries Handbook, 1973). The Snake River Spring/Summer-run Chinook salmon ESU does not have spawning or rearing habitat along the waterway.

Critical Habitat – The Columbia River is designated critical habitat (migratory corridor PCE) for the Snake River Spring/Summer-run Chinook salmon ESU (58 Federal Register 68543 – 68554). Adjacent riparian zones are included in the designation, defined as those areas within 300 feet of the normal line of highwater of a stream channel.

Snake River Fall-run Chinook Salmon ESU

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult, smolt, and juvenile life stages of the Snake River Fall-run Chinook salmon ESU. The marine portion of the waterway provides habitat for adult salmon throughout the year. Within the lower Columbia River, spawning adults migrate upstream to their spawning grounds between August and December and out-migrating sub-yearling smolts pass through the lower Columbia River between April and June (Bell Fisheries Handbook, 1973). In addition, juveniles spend up to 1 year rearing in nearshore habitat of the Columbia River mainstem, lower Columbia River islands, and the accessible low gradient reaches of Columbia River floodplain sloughs (Bell Fisheries Handbook, 1973).

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Snake River Fall-run Chinook salmon ESU (58 Federal Register 68543 – 68554). Adjacent riparian zones are included in the designation, defined as those areas within 300 feet of the normal line of highwater of a stream channel.

Columbia River Chum Salmon ESU

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for all life stages of the Columbia River chum salmon ESU. The marine portion of the waterway provides habitat for adult salmon throughout the year. Within the lower Columbia River, migrating adults and spawning occur between mid-October and December (Ehlke and Keller, 2003; NMFS, 2005c). Out-migrating smolts are present between March and May, with a peak in mid-March/early April (NMFS, 2005c). Juvenile chum salmon generally migrate directly to estuaries upon hatching; however, occasionally juveniles rear in the waters of the lower Columbia River and its tributaries between December and May (NMFS, 2005c).

Critical Habitat – The Columbia River is designated as critical habitat (rearing, migratory corridor, and spawning PCEs) for the Columbia River chum salmon ESU (70 Federal Register 52630 – 52858). As described above, adult chum salmon migrate through and spawn in the lower Columbia River. In addition, critical habitat for juvenile rearing has been designated within nearshore habitats of the Columbia River mainstem. The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation.

Lower Columbia River Coho Salmon ESU

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult, smolt, and juvenile life stages of the Lower Columbia River Coho Salmon ESU. The marine portion of the waterway provides habitat for adult salmon throughout the year. Within the lower Columbia River, adults migrate upstream to their spawning grounds between late August and early February, peaking in October; sub-yearling smolts out-migrate through the lower Columbia River between March and July; and juveniles rear throughout the year in nearshore habitat of the Columbia River mainstem, lower Columbia River islands, and the accessible low gradient reaches of Columbia River floodplain sloughs.

Critical Habitat – Critical habitat has not been designated for the Lower Columbia River coho salmon ESU.

Snake River Sockeye Salmon ESU

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult and smolt life stages of the Snake River sockeye salmon ESU. The marine portion of the waterway provides habitat for adult salmon throughout the year. Within the lower Columbia River, spawning adults are known to migrate upstream in two different runs to their spawning grounds. The first occurs as an early run between late July and early August, and the second occurs as a late run from September to October (Bell Fisheries Handbook, 1973). Out-migrating yearling smolts pass through the lower Columbia River between April and June (Bell Fisheries Handbook, 1973). The Snake River sockeye salmon ESU does not have spawning or rearing habitat along the waterway.

Critical Habitat – The Columbia River is designated critical habitat (migratory corridor PCE) for the Snake River sockeye salmon ESU (58 Federal Register 68543 – 68554). Critical habitat includes the adjacent riparian zone defined as those areas within 300 feet of the normal line of high water of a stream channel.

Lower Columbia River Steelhead DPS

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult, smolt, and juvenile life stages of the Lower Columbia River steelhead DPS. The marine portion of the waterway provides habitat for adult steelhead throughout the year. The lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity. Out-migrating smolts pass through the lower Columbia River between March and June with peaks in April or May (NMFS, 2005c). In addition, juveniles rear throughout the year in nearshore habitat of the Columbia River mainstem, lower Columbia River islands, and the accessible low gradient reaches of Columbia River floodplain sloughs.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Lower Columbia River steelhead DPS (70 Federal Register 52630 – 52858). The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Middle Columbia River Steelhead DPS

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult and smolt life stages of the Middle Columbia River steelhead DPS. The marine portion of the waterway provides habitat for adult steelhead throughout the year. The lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity. Out-migrating smolts pass through the lower Columbia River between March and June (NMFS, 2005c). The Middle Columbia River steelhead DPS does not have spawning or rearing habitat along the waterway.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Middle Columbia River steelhead DPS (70 Federal Register 52630 – 52858). The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Upper Columbia River Steelhead DPS

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult and smolt life stages of the Upper Columbia River steelhead DPS. The marine portion of the waterway provides habitat for adult steelhead throughout the year. The lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity. Out-migrating smolts pass through the lower Columbia River between March and June (Bell Fisheries Handbook, 1973). The Upper Columbia River steelhead DPS does not have spawning or rearing habitat along the waterway.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Upper Columbia River steelhead DPS (70 Federal Register 52630 – 52858). The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Upper Willamette River Steelhead DPS

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult and smolt life stages of the Upper Willamette River steelhead DPS. The marine portion of the waterway provides habitat for adult steelhead throughout the year. The lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity. Out-migrating smolts

pass through the lower Columbia River between March and July (Bell Fisheries Handbook, 1973). The Upper Willamette River steelhead DPS does not have spawning or rearing habitat along the waterway.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Upper Willamette River steelhead DPS (70 Federal Register 52630 – 52858). However, as described above, no rearing occurs along the portion of the lower Columbia River affected by LNG carrier transit. The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Snake River Basin Steelhead DPS

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for adult and smolt life stages of the Snake River Basin steelhead DPS. The marine portion of the waterway provides habitat for adult steelhead throughout the year. The lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity. Out-migrating smolts pass through the lower Columbia River between March and June (Bell Fisheries Handbook, 1973). The Snake River Basin steelhead DPS does not have spawning or rearing habitat along the waterway.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Snake River Basin steelhead DPS (70 Federal Register 52630 – 52858). However, as described above, no rearing occurs along the portion of the lower Columbia River affected by LNG carrier transit. The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

North American Green Sturgeon

Occurrence along the Waterway – The waterway for LNG marine traffic provides habitat for the adult life stage of North American green sturgeon. Green sturgeon occur within the marine portion of the waterway and in the lower reaches of the Columbia River (NOAA, 2006G; Israel et al, 2004). Within the lower Columbia River, sturgeon concentrate during the late summer and early fall (Adams et al, 2006).

Critical Habitat – Critical habitat has not been designated for the North American green sturgeon.

Impacts and Mitigation

During operation of the Bradwood Landing Project, LNG marine traffic could potentially affect federally listed fish species and/or their designated critical habitat through various activities including:

- fish strandings;
- shoreline erosion;
- ship engine cooling water appropriations and discharges;
- accidental spill or leak of hazardous materials; and
- accidental or intentional breach of an LNG carrier.

Potential impacts and mitigation from each of these factors are summarized in table 4.6.2-1. Potential impacts on aquatic resources (including salmonids and sturgeon) from LNG marine traffic are discussed in section 4.5.1.1. As noted previously, the FERC staff is currently revising its BA and EFH Assessment for the Bradwood Landing Project, which will be resubmitted to the NMFS with a request to initiate formal consultation in compliance with section 7 of the ESA and the MSA. The FERC would not allow construction of the project to proceed until after we have concluded formal consultation with the NMFS and FWS.

TABLE 4.6.2-1

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
LNG Marine Traffic					
Fish strandings [b]	Salmonids and sturgeon - Mortality of sub-yearlings.	Existing deep-draft vessel traffic on the lower Columbia River.	125 LNG carriers per year.	Avoid	• The speed of LNG carriers on the Columbia River would be limited by the tethered tug to speeds below which most wake stranding occurs.
				Minimize	• LNG carriers would only traverse the lower 38 miles of the Columbia River where very little wake stranding has been documented. • We have recommended in section 4.5.1.1 that NorthernStar coordinate with the NMFS to determine appropriate LNG carrier speed, or other applicable measures, to avoid or minimize wake stranding impacts.
Shoreline erosion [b]	Salmonids and sturgeon - Resuspension of material in water column.	Shoreline erosion along the Columbia River is caused by river currents, wind waves, and ship wakes. Ship wakes breaking on shore can cause erosion along the shoreline and resuspend the eroded material with the water column.	125 LNG carriers per year would contribute ship wakes similar to other deep draft vessels on the lower Columbia River.	Minimize	• The speed of LNG carriers on the Columbia River would be limited by the tethered tug, thus reducing the potential for shoreline erosion. • We have recommended in section 4.5.1.1 that NorthernStar coordinate with the NMFS to determine appropriate LNG carrier speed, or other applicable measures, to avoid or minimize shoreline erosion impacts. • We have recommended in section 4.1.3.3 that NorthernStar prepare a *Shoreline Monitoring Plan* for the west end of Puget Island.
Ship ballast and cooling water appropriations and discharges [b]	Salmonids and sturgeon - Entrainment, introduction and spread of exotic species, changes in water temperature. Discharge of warm water that has been treated with biocide.	NA	125 LNG carriers per year would appropriate and discharge water for engine cooling and as ballast.	Minimize	• NorthernStar changed its original project design to provide screened water to ships at dock for cooling engines and filling ballast tanks, thus minimizing entrainment impacts on juvenile salmonids. NorthernStar would offer contract incentives for ships to retrofit in order to utilize the system.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
					• While docked, LNG carriers that are retrofitted would recirculate ballast water through the engines for cooling after the shore-based water supply is turned off and until the ship is ready to leave the wharf to avoid additional water intake and discharging heated water within the LNG wharf and maneuvering area. • We have recommended in section 4.3.2.3 that NorthernStar develop performance standards for water temperature impacts and biocide use associated with LNG carrier water intakes and discharges. • We have recommended in section 4.5.2.1 that NorthernStar conduct post-installation water flow mapping through all intake screens at the LNG terminal, and develop and implement a monitoring program to assess the effects of impingement and entrainment from use of the screened water supply system on juvenile salmonids during terminal operations. • We have recommended in section 4.5.2.1 that NorthernStar either require LNG carriers to be retrofitted or develop an alternative system meeting the same standard that does not require vessel retrofitting. • LNG carrier operators would follow industry standard hull plating surface treatments and mandatory ballast management practices required by the Coast Guard and IMO to minimize possible introduction or spread of exotic species.
Transiting of LNG marine vessels	Sea turtles, whales, and Steller sea lion - Increased noise levels, vessel strikes.	Existing vessel traffic.	125 LNG carriers per year.	Avoid	• LNG carriers push a considerable bow wave when underway on the open ocean, which would likely push sea turtles away from the vessel.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
				Minimize	• NorthernStar would minimize impacts on whales by contractually requiring that the LNG carriers travel in a defined area that would narrow to 10 nautical miles in width between 126 degrees to the marshalling area off the mouth of the Columbia River. • We have recommended in section 4.6.2.1 that NorthernStar coordinate with the NMFS to determine appropriate LNG carrier speed and seasonal restrictions, or other applicable measures to avoid or minimize impacts on whales.
Accidental spill or leak of hazardous materials	Salmonids, sturgeon, sea turtles, whales, and Steller sea lion - Direct impacts, changes in food sources, water contamination.	Existing vessel traffic.	125 LNG carriers per year.	Avoid	• All LNG carriers are constructed with double hulls, which increases the structural integrity of the hull system and provides protection for the cargo tanks in case of an accident.
				Minimize	• Each LNG carrier would maintain a SOPEP, which would contain measures to be implemented in the event of a spill or release. • The presence of vessels involved in spill control and clean-up would discourage aquatic species from approaching the area.
Accidental or intentional breach of an LNG carrier	Salmonids, sturgeon, sea turtles, whales, Steller sea lion, Columbian white-tailed deer, brown pelican, marbled murrelet, northern spotted owl, streaked horned lark, western snowy plover, Kincaid's lupine, and Nelson's checker-mallow - Mortality.	Existing vessel traffic.	125 LNG carriers per year.	Minimize	• The risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed with appropriate safety and security measures.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
In-water Construction Activities					
Dredging of the berth and maneuvering area; dredge material placement [b]	Salmonids and sturgeon - Alteration of habitat, increased suspended sediment and turbidity levels, removal of benthic organisms, resuspension of contaminated sediments, entrainment of eggs and juvenile salmonids, increased noise, and altered sediment transport and deposition rates. Steller sea lion - Displacement.	Nearshore habitat with water depths ranging from 21 to 42 feet. Designated as critical habitat for 12 species of salmonids. The Wahkiakum County Sand Pit site is similar in function to the LNG terminal site, but has been affected by previous and ongoing dredged material placement.	46 acres of habitat would be dredged to a depth of 42 feet CRD, making the area deeper and more uniform.	Avoid Minimize	• Site location was chosen where no shallow water habitat would be dredged. • Site location was chosen where only water deeper than 21 feet would be dredged. • Dredging during the NMFS recommended in-water work window would minimize impacts on salmonids. • NorthernStar would use BMPs to minimize sedimentation impacts from dredging, resulting in only minor, non-lethal effects. • We have recommended in section 4.2.2.2 that NorthernStar prepare a plan to monitor the side slopes of the maneuvering are after dredging; the plan shall include slope protection measures, should such mitigation be necessary. • We have recommended in section 4.10.2.2 that NorthernStar file a finalized dredging noise mitigation plan that would identify all measures to be implemented during dredging to reduce noise levels.
Development of the river shoreline	Salmonids and sturgeon - Increased suspended sediment and turbidity levels.	The site was used as a rough saw mill until 1962. The site has most recently been used as a dredged material disposal site by the COE.	Site would be raised to 25 feet NAVD 88 and surrounded by a 5-foot perimeter berm.	Minimize	• NorthernStar would implement their terminal ESC Plan to minimize impacts on water quality. • Following construction, shoreline would be replanted with native vegetative communities and monitored annually for 5 years.
Pile driving	Salmonids, sturgeon, Steller sea lions, Columbian white-tailed deer, and streaked horned larks - Increased sound pressure levels and noise.	NA	NA	Minimize	• Pile driving would occur during the NMFS recommended in-water work window, minimizing impacts on salmonids. • NorthernStar revised the project design to use larger than normal piles to minimize the number of piles required. • Piles would be installed vertically, which allows the use of bubble curtains (caissons full of bubbles) to minimize sound pressure levels during pile driving.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
					• We have recommended in section 4.5.2.1 that NorthernStar continue to consult with the appropriate federal and state agencies to develop a revised Bubble Curtain Contingency Plan that establishes a performance standard to assess whether or not bubble curtains are adequately working. The plan would describe specific noise attenuation methods to be implemented if monitoring indicates poor noise attenuation performance. • NorthernStar would use a pile cap between the hammer and the pile during impact pile driving to further reduce underwater noise levels if monitoring indicates the bubble cushion within the caisson is not achieving the desired sound pressure reduction. • NorthernStar would use vibratory pile drivers as conditions allow to lower sound pressure levels during pile driving. • NorthernStar would monitor for Steller sea lions within the established Safety Zone and not start pile driving until any Steller sea lions have moved outside the Safety and Buffer Zones.
Filling log pond	Salmonids and sturgeon - Loss of rearing habitat.	Off-channel refugia and rearing habitat. Designated as critical habitat for 12 species of salmonids.	Log pond would be filled during construction of the LNG terminal.	Avoid	• NorthernStar selected a previously developed industrial location to avoid impacts on less disturbed sites.
				Minimize	• NorthernStar would implement its *Fish Salvage Plan* to capture, record, and release as many salmonids as possible. • We have recommended in section 4.5.2.1 that during fish collection efforts, NorthernStar place nets at the outlet of the log pond that only allow emigration from the pond.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
Placement of wharf and piles in nearshore portion of the Columbia River	Salmonids and sturgeon - Loss of rearing and migratory habitat; behavioral changes, increased predation, alterations to water quality.	Nearshore habitat, depths ranging from 20 to 40 feet. Designated as critical habitat for 12 species of salmonids.	Pilings would occupy about 0.4 acre of nearshore habitat. Current would go around pilings, changing microhabitats locally. Unloading platform would occupy a total area of about 0.5 acre; shading associated with the platform could alter the microhabitat within this area.	Minimize	• The number of pilings would be minimized by using larger diameter piles.
HDD stream crossings	Salmonids and sturgeon - Loss of drilling mud to river (frac-out) and related water quality impacts.	Undisturbed stream-bottom habitats.	NA	Avoid	• The HDD method is the preferred method for avoiding impacts on listed species.
				Minimize	• NorthernStar would implement its *HDD Contingency Plan* to minimize potential impacts from a frac-out, if one were to occur.
Open-cut stream crossings	Salmonids and sturgeon - Increased suspended sediment and turbidity levels, vegetation removal, increased water temperature, decreased LWD and the associated reduction in habitat, mass failures, streambank erosion, and physical damage.	Undisturbed stream-bottom habitats.	Flume or dam and pump methods would minimize suspended sediment and turbidity levels.	Avoid	• NorthernStar would use the HDD or bore method to cross all 12 waterbodies known to contain listed salmonids.
				Minimize	• NorthernStar would implement our Procedures and its pipeline ESC Plan in Oregon and SWPPP in Washington to minimize potential impacts. • NorthernStar would allow a riparian buffer at least 25 feet wide to permanently revegetate with native woody plant species across the entire right-of-way after construction is completed.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
					• We have recommended in section 4.3.2.4 that NorthernStar continue to consult with the COE, NMFS, FWS, and appropriate federal agencies to finalize its *Waterbody and Wetland Construction and Mitigation Procedures Plan*.
Habitat Modification					
Conversion of existing habitats to industrial use at the LNG terminal site	Columbian white-tailed deer - Habitat loss.	The LNG terminal site has patches of potentially suitable foraging, resting, and fawning habitat for the Columbian white-tailed deer.	Potentially suitable habitat for the Columbian white-tailed deer would be limited to riparian vegetation along the shoreline of the Columbia River; however, fencing around the facility and the infrastructure would preclude use of the site.	Avoid	• NorthernStar selected a former industrial site to avoid preferred or more pristine habitats. • We have recommended in section 4.6.2.3 that pipeline construction activities shall not occur in potential habitat during the fawning season (between June 1 and July 15).
				Minimize	• The LNG terminal site has been minimized and is smaller than existing LNG terminals.
Power line construction	Salmonids and sturgeon - Change in water temperature, loss of LWD, sediment runoff. Columbian white-tailed deer - Habitat modification.	Forested habitat that is predominately commercially managed stands of Douglas-fir.	About 17.8 acres of forested habitat would be cleared for construction of the proposed power line. Of this, 5.0 acres would be maintained in a grassland/ herbaceous cover type.	Avoid	• During early project planning, NorthernStar rerouted the proposed power line to avoid impacts on old-growth forest.
				Minimize	• PacifiCorp would implement BMPs to minimize erosion.
Hunt Creek Bridge Replacement	Salmonids and sturgeon - Erosion, displacement, acoustic shock and noise, increased suspended sediment and turbidity levels.	Existing bridge across Hunt Creek.	New pre-cast concrete bridge.	Avoid	• The proposed bridge would be located 2.4 feet above the 100-year floodplain and the concrete abutments would be installed above the MHHW and from the adjacent uplands to avoid impacts on Hunt Creek. • Existing wooden piles would remain in place; only the piers and piles that interfere with the new bridge would be cut.
				Minimize	• NorthernStar would implement its terminal ESC Plan to minimize potential impacts on Hunt Creek. • Bridge demolition and construction would occur during the ODFW recommended in-water work window for Hunt Creek.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
					• Project design would minimize sedimentation by allowing water to drain toward vegetated areas before entering Hunt Creek. • Banks disturbed by construction would be revegetated with native vegetation that is typical of the area and a riparian buffer at least 30 feet wide would be allowed to permanently revegetate. • We have recommended in section 4.3.2.3 that NorthernStar conduct water quality monitoring at points both 100 feet downstream and 100 feet upstream from the bridge during demolition or construction activities.
Railroad realignment	Salmonids and sturgeon - Erosion, displacement, acoustic shock and noise, increased suspended sediment and turbidity levels.	Existing PWRR railroad.	Removal and realignment of a 4,200-foot-long portion of the existing PWRR line.	Minimize	• NorthernStar would implement its terminal ESC Plan to minimize potential impacts on Hunt Creek. • Project design would minimize sedimentation by allowing water to drain toward vegetated areas before entering Hunt Creek. • Water quality monitoring would be conducted during the construction periods most likely to result in increased suspended sediments and turbidity. • Banks disturbed by construction would be revegetated with native vegetation that is typical of the area and a riparian buffer at least 30 feet wide would be allowed to permanently revegetate. • NorthernStar would construct a 2-foot-high berm of earth covered with native grass between the Hunt Creek oxbow and the railroad tracks. The berm would extend for 100 feet centered on the apex of the oxbow. • NorthernStar would use concrete railroad ties in place of treated railroad ties within 100 feet of Hunt Creek.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
Upland pipeline construction	Salmonids and sturgeon - Increased erosion resulting in increased suspended sediment and turbidity levels. Columbian white-tailed deer - Habitat modification, disruption of fawning. Kincaid's lupine, Nelson's checker-mallow - Removal.	Various.	Construction right-of-way would be replanted and allowed to fully revegetate.	Avoid	• Vegetative clearing during construction would be scheduled outside of the Columbian white-tailed deer fawning season.
				Minimize	• NorthernStar would implement our Procedures and its pipeline ESC Plan in Oregon and SWPPP in Washington to minimize potential impacts on water quality. • NorthernStar would allow a riparian buffer at least 25 feet wide to permanently revegetate with native woody plant species across the entire right-of-way after construction is completed. • We have recommended in section 4.4.2.3 that NorthernStar revise its *Noxious Weeds and Soil-borne Plant Disease Control Plan*. • We have recommended in section 4.6.2.2 that NorthernStar conduct additional botanical surveys before construction of the proposed pipeline.
Miscellaneous Construction Activities					
Water appropriation and discharge	Salmonids and sturgeon - Entrainment, impingement, reduced downstream flows, changes in water quality.	NA	Withdrawal of up to 84 million gallons of water from the Columbia River.	Minimize	• NorthernStar would install screens on all water intakes using NMFS and ODFW fish-screen criteria. • We have recommended in section 4.5.2.1 that NorthernStar conduct post-installation water flow mapping through all intake screens at the LNG terminal, and develop and implement a monitoring program to assess the effects of impingement and entrainment from use of the screened water supply system on juvenile salmonids.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
Construction lighting of the LNG terminal site.	Salmonids and sturgeon, and Columbian white-tailed deer - Avoidance, predator attraction.	NA	Lighted construction area.	Minimize	• We have recommended in section 4.5.2.1 that NorthernStar continue to consult with the FWS, NMFS and ODFW to finalize its *Terminal Lighting Plan* for construction and operation of the LNG terminal.
Blasting	Salmonids, sturgeon, and Steller sea lions – Changes in behavior, decreased perception, and damage to body tissue.	NA	Blasting at the quarry could generate noise levels of 115 dB.	Avoid	• The estimated maximum noise exposure to salmonids and pinnipeds from blasting at the Bradwood quarry (115 dB) would be less than the noise thresholds for pinnipeds and salmonids (160dB$_{rms}$ and 150 dB$_{rms}$). Therefore, adverse impacts on federally listed species as a result of blasting at the LNG terminal site are not expected.
				Minimize	• We have included a recommendation that NorthernStar consult with the NMFS, FWS, ODFW, and other appropriate agencies when developing its Blasting Management Plan.
Accidental spills or leaks of hazardous materials	Salmonids and sturgeon - Water quality, direct and indirect effects on organisms.	NA	NA	Avoid	• NorthernStar would prohibit liquid transfer as well as refueling of vehicles and equipment within 100 feet of waterbodies.
				Minimize	• NorthernStar would implement our Procedures and its ESC Plans in Oregon and SWPPP in Washington to minimize the likelihood of an accidental spill or leak of hazardous materials occurring.
Collisions with vehicle or railway traffic	Columbian white-tailed deer - Increased likelihood of collisions between vehicles or trains and deer.	Current use of Clifton Road is estimated at about 50 vehicle trips per day. Railway is not currently in use.	Up to 1,500 vehicle trips per day would occur along Clifton and Bradwood roads during construction of the proposed project. Railway use is expected to be infrequent.	Minimize	• NorthernStar would post speed limit and deer warning signs on all roads. • NorthernStar would implement a training and awareness program for all personnel accessing the LNG terminal site. • NorthernStar would make information available to train operators about the risk of collision and importance of protecting the Columbian white-tailed deer. • NorthernStar would bus construction workers to the terminal site from a temporary parking lot southeast of the Taylorville interchange at Highway 30.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
					• We have recommended that NorthernStar develop a traffic management plan to reduce traffic impacts.
LNG Terminal Operation					
Stormwater runoff	Salmonids and sturgeon - Increased suspended sediment and turbidity levels.	The proposed LNG site currently consists of highly permeable soils (typical drainage is greater than 14 inches per hour).	About 6 acres at the proposed LNG terminal site would be impervious surface. The remainder would be either landscaping or loosely packed gravel overlying dredged materials. Modifications to Bradwood and Clifton Roads as well as the Hunt Creek Bridge replacement would increase the total impervious surface.	Avoid	• Drainage basins described in NorthernStar's *Stormwater Management Plan* would contain stormwater runoff generated by a 100-year storm event. • Curb extensions would discharge stormwater into small rock flow spreader structures before flowing through vegetation. • NorthernStar would construct a bioswale on the west side of the bridge to increase this distance between the new bridge and Hunt Creek and provide storage necessary to promote infiltration. • NorthernStar would install additional culverts and drainage ditches would be installed to improve stormwater drainage from Clifton Road.
Accidental spills or leaks of hazardous materials	Salmonids and sturgeon - Water quality, direct and indirect effects on organisms.	NA	NA	Avoid	• Perimeter berm would contain any potential spills or leaks of hazardous materials at the LNG terminal.
Maintenance dredging [b]	Salmonids and sturgeon - Alteration of habitat, increased suspended sediment and turbidity levels, removal of benthic organisms, resuspension of contaminated sediments, entrainment of eggs and juvenile salmonids, increased noise, and alteration sediment transport and deposition rates. Steller sea lions - Displacement.	LNG carrier berth and maneuvering area would have developed benthic invertebrate communities due to influx from areas immediately upriver. Proposed dredge disposal site is similar in function to the LNG terminal site, but has been affected by previous and ongoing dredged material disposal.	Dredging would result in a depth of -42 feet CRD within the LNG carrier berth and maneuvering area.	Avoid	• Loss of sediment for downstream habitat would be partially avoided by placing dredged material back into the river system.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
				Minimize	• Dredging during the NMFS recommended in-water work window would minimize impacts on salmonids. • NorthernStar would use BMPs to minimize sedimentation impacts from dredging, resulting in only minor, non-lethal effects.
Routine discharge of condensate water from the SCVs	Salmonids and sturgeon - Increased acidity, temperature, and dissolved solids in water in the vicinity of the LNG terminal.	NA	Discharge of 160 gpm of water to the Columbia River.	Avoid	• NorthernStar would neutralize SCV discharge water as required under its NPDES permit prior to discharge to the Columbia River.
				Minimize	• NorthernStar would discharge SCV water using an outfall/diffuser system mounted below the water level. Measurable increases of dissolved solids would be contained within a 10-foot mixing zone.
Routine discharge of condensate water from the fire suppression system	Salmonids and sturgeon - Increased water temperature.	NA	Discharge of 260,000 gallons of water per week to the Columbia River.	Avoid	• Water used for fire suppression system testing would be returned to the Columbia River essentially unchanged.
Operation of noise-producing equipment	Salmonids, sturgeon, Columbian white-tailed deer, and streaked horned larks - Increased sound pressure levels and noise.	Existing noise levels at the nearest noise sensitive areas range from about 44 to 48 L_{dn} (dBA).	Noise levels at the nearest noise sensitive areas would range from about 40 to 50 L_{dn} (dBA).	Minimize	• To minimize noise generated during operation of the LNG terminal, NorthernStar would incorporate noise barriers or enclosures to block sound transmission from operating equipment; valves with "low-noise" trims, acoustical insulation for aboveground piping, and selection of equipment types with the least noise emissions. • We have recommended in section 4.10.2.2 that NorthernStar make all reasonable efforts to ensure its predicted noise levels from the LNG terminal are not exceeded at noise sensitive areas.

TABLE 4.6.2-1 (cont'd)

Summary of Potential Impacts and Mitigation Measures for Federally Listed Species Associated with the Bradwood Landing Project

Action	Species - Potential Impact	Baseline Condition	Proposed Condition	Resolution [a]	Description
Lighting of the ship berth and unloading facilities	Salmonids, sturgeon, and Columbian white-tailed deer - Avoidance of the area, predator attraction.	NA	Lighted LNG import terminal.	Minimize	• NorthernStar's final LNG terminal lighting design would include light reduction techniques (e.g., directed lighting, timers, motion sensors) to avoid unnecessary lighting. • We have recommended in section 4.5.2.1 that NorthernStar continue to consult with the FWS, NMFS and ODFW to finalize its *Terminal Lighting Plan* for construction and operation of the LNG terminal.
Pipeline Operation					
Vegetative clearing for maintenance of the right-of-way	Salmonids and sturgeon - Change in water temperature, loss of LWD, sediment runoff. Columbian white-tailed deer - Habitat modification, disruption of fawning.	Variable	Maintenance of 50-foot-wide right-of-way in uplands.	Avoid Minimize	• Vegetative clearing would be conducted outside of the Columbian white-tailed deer fawning season. • NorthernStar would implement our Procedures and its pipeline ESC Plan in Oregon and SWPPP in Washington to minimize potential impacts on water quality. • NorthernStar would allow a riparian buffer adjacent to waterbodies at least 25 feet wide to permanently revegetate with native woody plant species across the entire right-of-way after construction is completed. • NorthernStar would minimize the disturbance to upland forested communities by replanting the right-of-way in-kind with trees, with the exception of a 30-foot strip centered along the pipeline, which would be maintained as an herbaceous community. • We have recommended in section 4.3.2.4 that NorthernStar continue to consult with the COE, NMFS, FWS, and appropriate federal agencies to finalize its *Waterbody and Wetland Construction and Mitigation Procedures Plan*.

[a] Unavoidable impacts would be resolved through implementation of NorthernStar's final Compensatory Mitigation Plan.

[b] Potential impacts on federally listed species due to wake stranding, shoreline erosion, entrainment and impingement, and habitat modification due to dredging continues to be studied and will be discussed in additional detail in the revised BA and EFH Assessment.

Sea Turtles

Occurrence along the Waterway

As discussed in section 4.6.1.1, although sea turtles are generally considered a warm temperate marine reptile, green, olive ridley, leatherback, and loggerhead sea turtles have been recorded off the coasts of Oregon and Washington in the last 10 years (Green et al., 1992). Most (62.5 percent) of these sightings occurred over the continental slope waters, with the remainder found over the continental shelf. Sea turtles would not likely occur within the lower Columbia River; however, they may occur in marine portions of the LNG carrier route.

Critical Habitat

Designated critical habitat for the sea turtles does not occur within the Zones of Concern associated with LNG carrier transit. Critical habitat has been designated for the green sea turtle in waters off of Puerto Rico and for the leatherback sea turtle in waters near the U.S. Virgin Islands (63 Federal Register 46693 – 46701 and 44 Federal Register 17711 – 17712, respectively). Critical habitat has not been designated for olive ridley or loggerhead sea turtles.

Impacts and Mitigation

As discussed in section 2.1, construction and operation of the Bradwood Landing Project would result in the addition of 125 vessel trips per year on the Columbia River and off the coasts of Oregon and Washington. Potential impacts on sea turtles as a result of increased vessel traffic include increases in underwater noise generated by engines, vessel-sea turtle strikes, and possible spills or leaks of hazardous materials.

Engine-noise produced by LNG carriers would result in temporary increases in underwater noise levels near the transiting ships. However, because sea turtles are mobile, it is anticipated that they would avoid areas with high noise levels during operation of the proposed project. Sea turtles could also be vulnerable to vessel strikes as a result of the proposed project. Vulnerability to collision with an LNG carrier would be greatest while sea turtles feed, swim, and rest near the surface of the water. In areas of intense ship traffic, sea turtles can experience propeller or collision injuries; however, most of these injuries are caused by small, fast moving vessels (NMFS, 2004b). In contrast, LNG carriers push a considerable bow wave when underway on the open ocean because of their design and large displacement tonnage. This wave pushes water, flotsam, and other small objects (such as sea turtles) away from the vessel. Therefore, sea turtles are not likely to be struck by LNG carriers as a result of the project.

If a sea turtle were to encounter a spill, leak, or accidental release of fuels, lubricants, or other hazardous substance from an LNG carrier, a turtle would be at risk due to impacts on respiratory system, skin, blood chemistry, and salt gland function (NMFS, 2004b). Sea turtles are susceptible to the effects of spills either by direct encounter or ingestion of contaminated prey. Fuel (e.g., diesel) used for vessel propulsion or auxiliary/emergency generators could potentially spill or leak. However, fuel on each ship is protected by the vessel's double hull. Furthermore, each LNG carrier would maintain a SOPEP which would contain measures to be implemented in the event of a petroleum release (see section 4.3.2.2). In addition, the presence of the vessels involved in spill control and clean-up would discourage sea turtles from approaching spill areas.

The potential exists for an LNG spill and associated fire during transit of the LNG carriers to the LNG terminal that could affect sea turtles present at the ocean surface at the time of the spill. As described in section 4.11.5.3, the released LNG would vaporize rapidly upon contact with the air and

water. Because LNG is not soluble in water and the LNG would completely vaporize shortly after being spilled, there would be no liquid left that could mix and/or contaminate the water. However, the greatest threat to sea turtles from an LNG spill would be thermal stress from coming into contact with the cryogenic liquid (before the LNG vaporizes) or the fire associated with the ignited vapors. Any sea turtles in the immediate vicinity of the LNG or the fire would probably experience a sudden thermal shock that would be lethal. Sea turtles in the general area of a spill would most likely detect the temperature change and avoid the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Whales

Occurrence along the Waterway

Seven species of whales potentially occur off the coasts of Oregon and Washington, including the blue, fin, humpback, North Pacific right, sei, Southern Resident killer, and sperm whales. Whales tend to feed during the summer in the northern latitudes and migrate to the tropical southern latitudes in the winter for breeding. Some whales do not migrate as far north as the rest of the population; therefore, whales can be encountered throughout the year off the coasts of Oregon and Washington.

Critical Habitat

Critical habitat has not been designated for any of the species potentially occurring along the LNG carrier route. However, designated critical habitat for the Southern Resident killer whale DPS has been designated in three specific areas: the Summer Core Area in Haro Strait and waters around the San Juan Islands; Puget Sound; and the Strait of Juan de Fuca (71 Federal Register 69054 – 69070).

Impacts and Mitigation

Construction of the Bradwood Landing Project would not result in impacts on whales. However, operation of the project would result in increased vessel traffic as LNG carriers move through the EEZ to and from the proposed LNG import terminal on the Columbia River. The Columbia River currently supports between 1,800 and 2,000 vessel trips per year. The project would increase vessel traffic into the Columbia River by an additional 125 roundtrip vessel trips, annually. The increase of 125 vessels trips per year from the Bradwood Landing Project represents a 7 percent increase over the current volume. Potential impacts on whales resulting from increased vessel traffic could include: increases in underwater noise generated by engines, vessel-whale strikes, and spills or leaks of hazardous materials.

Noise – Operation of the Bradwood Landing Project has the potential to impact whales due to periodic increases in both underwater and surface noise. This noise would be generated by ship engines as they transit to and from their port of origin (LNG export facility), through the EEZ, to and from the proposed LNG import terminal on the Columbia River.

Noise in the aquatic environment is defined as sound from an array of sources that does not convey biologically significant information. The marine environment contains many natural and anthropogenic sources of noise. Natural noise includes surf, wind, earthquakes, and biological activity. Anthropogenic sources include noise generated to locate submerged objects, measure environmental features, and conduct industrial activities. Noise can be neutral background acoustical clutter, or can impede acoustic communication or other biological functions (NMFS, 2005b).

Cargo ships are the largest component of commercial vessel traffic and also generate higher levels of low frequency noise than other vessels. Over the last few decades, vessel operation statistics indicate steady growth in vessel traffic with an increase in both the number of vessels and in the tonnage of goods shipped (Mazzuca, 2001). Along the Pacific Coast, the bulk of commercial vessel traffic is concentrated through a few major ports, including Los Angeles, Long Beach, Oakland, Seattle, and Tacoma. Noise from shipping is concentrated into the regions adjacent to these ports and their approaches (Hildebrand, 2004). For example, between 1950 and 2000, the overall increase in low-frequency noise was 16 dB (Mazzuca, 2001). During this period, the number of ships worldwide tripled (from about 30,000 to 87,000) and the gross tonnage increased by a factor of 6.5 (from about 85 to 550 million gross tons) (NRC, 2003; Hildebrand, 2004).

LNG carriers are in the category of cargo and tanker vessels, which are increasing in numbers world wide. Cargo vessels are known to emit high levels of low frequency sound (6.8 to 7.7 hertz (Hz) at 181 to 190 dB, re: 1 μPa) capable of traveling long distances (Richardson et al., 1995). Noise generated by LNG carriers is generally omni-directional, emitting from all sides of the vessel. Noise levels are greater on the sides of the vessel and weaker on the front and rear of the ship. The omni-directional, moving sound source may be the reason that whales do not always avoid oncoming ships and are thus struck and either injured or killed.

Whales tend to either react strongly or not at all to the noise generated by oncoming ships. These reactions often occur in response to changes in engine and propeller speed. Baleen whales generally avoid approaching vessels and exhibit a greater tendency to avoid vessels moving at higher speeds. In order to avoid an approaching vessel, baleen whales may move to an area more than 1 mile from their original location.

Vessel-whale Strikes –Whales are seasonally present predominantly where the continental shelf and the continental slope occur (Green et al., 1991). Green et al. (2001) also found that whales are not randomly distributed off the Oregon and Washington coasts: humpback whales tend to travel north and south over the continental slope and outer continental shelf during summer; sperm whales have a wider distribution, but are generally found outside the continental slope; and fin whales are primarily found over the continental slope. In addition, some species tend to concentrate in certain areas off the Oregon and Washington coasts. Numerous surveys have been conducted in the waters off of Oregon and Washington to determine whale species distribution, abundance, and habitat use patterns. In addition, data compiled by the NMFS National Marine Mammal Laboratory's POP database was used to assess whale distribution. Based on the distribution data from both the POP database and available survey data, at any point beyond the base of the continental slope, whale sightings become increasingly rare and not as likely as a sighting along either the slope or shelf. The exception to this would be sperm and sei whales, which are known to have a more oceanic (deeper depth) distribution than other whale species. Therefore, collisions between LNG carriers and whales are less likely in the open ocean over the abyssal plain or ocean floor than they are along the continental shelf and slope. Figure 4.6.1-1 shows the confirmed whale sitings off the coasts of Oregon and Washington in relation to the continental slope and shelf.

The ship strike database indicates that large and fast moving vessels (greater than 12 knots) are most typically associated with whale strikes. Some species of whales have been found to exhibit behaviors that increase their susceptibility to collision when approached by vessels. These behaviors include startle responses, more erratic surface movements, reduced surface time, fewer blows per surfacing, shorter intervals between successive blows, and increased frequency of dives without raised flukes (Whitehead et al., 1990; Cawthorn, 1992; Gordon et al., 1992).

When in the open ocean, LNG carriers are expected to travel at approximately 20 knots. Vessels in the open ocean are not subject to any speed restrictions and generally transit along the Great Circle

Route, which is about 300 miles offshore. This open ocean area is considered outside of the project area and within the range of existing conditions because the LNG carriers would be present with all other commercial vessels in the open ocean, regardless of its specific port. However, on approach to ports, vessel traffic is concentrated over the continental shelf and slope, which is also where many whale species congregate off the coasts of Oregon and Washington, especially during the summer months.

Within the Columbia River navigation channel (CRM -3 to CRM 100) and in the marine waters approaching the entrance/exit of the navigation channel (at least out to CRM -8) the Columbia River Bar and River Pilots would determine the ship speed. The decision about proper LNG carrier speed is founded on prudent seamanship and sound marine practice and is targeted toward safe navigation and maneuvering of the vessel. The appropriate speed for given circumstances is highly dependent on the navigation channel characteristics, weather conditions, tide, type of ship, existing vessel traffic and any other maneuvering constraints. LNG carrier speeds would accordingly vary depending on current conditions, but would be limited to approximately 12 knots. This limitation is due to the escort tugboat on stern tether during transit. At present, there is no known speed restriction to reduce vessel collisions with marine mammals within the Columbia River shipping channel. However, given the nature of the entrance to the Columbia River, LNG carriers would be operating at controlled speeds such that large whales and other marine mammals should have sufficient time to avoid the carrier in this location.

Based on information provided by the NMFS, 11 vessel strikes were either reported in the region or detected by necropsy by the Northwest Marine Mammal Stranding Network between January 2002 and January 2008 (NMFS, 2007a; 2008). Strikes were observed in every month except March, April, and December; therefore, we cannot predict whether a vessel strike would be more likely during certain times of the year. Of the reported whale-vessel strikes, fin whales were encountered most frequently (six strikes), and blue, sei, humpback, sperm, and gray whales each had one strike. Jensen and Silber (2003) note that many strikes likely go undetected or unreported as they may occur in remote areas or struck whales may drift out to sea. Thus, the actual number of whale strikes is undoubtedly much greater than reported (Jensen and Silber, 2003). Using the ship trip database for the area between the Strait of Juan de Fuca and Humboldt Bay, approximately 7,931 vessel trips (including LNG carriers) occurred along the coastline in 2002 (Pacific States/British Columbia Oil Spill Task Force, 2002). Because there is no vessel traffic data for any prior or subsequent years, NorthernStar used the number of transits in 2002 as representative of the volume of traffic in this area. This resulted in a total of about 47,586 vessel trips in this region over the same time period that resulted in 11 recorded whale strikes. Based on the available information presented above, statistically, every 7,931 vessel trips would result in a reported fin whale strike and every 47,586 vessel trips would result in a reported blue, sei, humpback, sperm, and gray whale strike. However, as noted above, the number of ship trips per whale strike is likely lower than current information suggests.

The Bradwood Landing Project would result in about 125 LNG carriers calling on the LNG terminal per year, which would result in about 250 vessel trips (to and from the terminal) per year. Based on the number of vessel trips calling on the LNG terminal annually and an estimated operating life 40 years for the LNG terminal (see section 2.9), approximately 10,000 vessel trips would occur during operation of the Bradwood Landing Project. Therefore, our analysis indicates that statistically, LNG carriers associated with the Bradwood Landing Project would strike 1.25 fin whales. The likelihood of an LNG carrier striking a blue, sei, or humpback whale would be about 20 percent.

Based on comments made by the NMFS in its May 11, 2007 letter to the FERC, NorthernStar submitted an analysis of the potential for a vessel-whale strike to occur due to operation of the Bradwood Landing Project. The information provided by NorthernStar states that the statistical likelihood of a vessel-whale strike during operation of the project (40 years) would be less than one whale. However,

based on the assumptions used in NorthernStar's analysis and on feedback received from the NMFS, we feel that the FERC staff's analysis more accurately represents the likelihood of a vessel strike.

NorthernStar would minimize impacts on whales by contractually requiring that the LNG carriers travel in a defined area that would narrow to 10 nautical miles in width between 126 degrees (west of the toe of the continental slope) to the marshalling area off the mouth of the Columbia River (see figure 4.6.1-1). Traveling at an angle that is perpendicular to the continental slope and shelf would minimize the transit through areas where whales would be most likely to occur. This route would avoid known feeding concentration areas and National Marine Sanctuaries. However, because the project would be statistically likely to strike a fin whale, additional measures are necessary to minimize potential impacts on whales. Therefore, **we recommend that:**

- **NorthernStar should coordinate with the NMFS to determine appropriate LNG carrier speed and seasonal restrictions, or other restrictions to be implemented, to avoid or minimize impacts on whales. Results of the coordination, including a discussion of restrictions to be implemented, should be filed with the Secretary, <u>prior to commencing operation</u> of the LNG terminal.**

As noted previously, the FERC staff is currently revising its BA and EFH Assessment for the Bradwood Landing Project, which will be resubmitted to the NMFS with a request to initiate formal consultation in compliance with section 7 of the ESA. The FERC would not allow construction of the project to proceed until we have completed formal consultation.

<u>Spills or Leaks of Hazardous Materials</u> – Spills, leaks, or accidental releases of fuels, lubricants, or other hazardous substances could potentially occur during operation of the proposed project. A spill, leak, or accidental release of hazardous materials to offshore waters could impact whales directly or indirectly through changes in food sources or contamination of the water. However, as discussed above under sea turtles, each vessel would maintain a SOPEP.

The potential exists for an LNG spill and associated fire during transit of the LNG carriers to the LNG terminal that could affect whales present in the area at the time of the spill. As stated in section 4.11.5.3, the released LNG would vaporize rapidly upon contact with the air and water. Because LNG is not soluble in water and the LNG would completely vaporize shortly after being spilled, there would be no liquid left that could mix with and/or contaminate the water. The greatest threat to whales from an LNG spill would be thermal stress from coming into contact with the cryogenic liquid (before the LNG vaporizes) or the fire associated with the ignited vapors. Any whales that came into direct contact with the LNG or the fire would probably experience a sudden thermal shock that could be lethal. Whales in the general area of a spill would most likely detect the temperature change and avoid the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

<u>Steller Sea Lion</u>

Occurrence along the Waterway

Two pinniped haulouts occur along the waterway for LNG marine traffic, the South Jetty and the docks at the Astoria East Mooring Basin. The South Jetty is located near the mouth of the Columbia River and is used by hundreds of Steller sea lions every year (LCFRB, 2004). Steller sea lions have also been documented hauling out at the Astoria East Mooring Basin (Brown, 2008). Use of the haulouts is lowest in the spring and summer (during the breeding season) and increases in fall and winter when animals move to haulouts and forage on salmonids and eulachon. Recent surveys by the WDFW

documented 1,500 Steller sea lions near the mouth of the Columbia River (WDFW, 2007; Jeffries, 2008). The nearest rookery is Three Arch Rocks, which is located about 60 miles south of the mouth of the Columbia River.

Critical Habitat

Designated critical habitat for the Steller sea lion does not occur within the Zones of Concern associated with LNG carrier transit. The nearest occurrence of designated critical habitat for the Steller sea lion is at Orford Reef near Port Orford, approximately 280 miles south of the Columbia River mouth (58 Federal Register 45269 – 45285).

Impacts and Mitigation

During operation of the Bradwood Landing Project, Steller sea lions could be impacted by increased LNG marine traffic and accidental spills or leaks of hazardous materials along the LNG carrier route. To date, the various impacts on Steller sea lions from human disturbance have not been studied. Close approach by humans and boats has been shown to cause sea lions at haulouts to go into the water (NMFS, 1992). Repeated disturbance by humans could result in abandonment of the South Jetty haulout site (Kenyon, 1962). However, due to the Steller sea lions' tolerance of current large vessel traffic along the Columbia River, it is expected that an increase of about 7 percent in large vessel traffic during operation of the proposed project would not significantly increase disturbance to Steller sea lions. Similarly, the wakes from LNG carriers moving to and from the proposed LNG import terminal would not significantly increase wave heights and the potential to disturb sea lions at the South Jetty haulout site. Collisions with Steller sea lions would not be expected from the LNG marine traffic because Steller sea lions are highly maneuverable and fast swimmers and they are accustomed to ship traffic in this area. There are no known reports of collisions between Steller sea lions and vessels.

Spills, leaks, or accidental releases of fuels, lubricants, or other hazardous substances could potentially occur during operation of the proposed project. A spill, leak, or accidental release of hazardous materials could result in mortality to the Steller sea lion. However, as indicated above under the discussion of sea turtles, each vessel would maintain a SOPEP.

The potential exists for an LNG spill and associated fire during transit of the LNG carriers to the LNG terminal that could affect Steller sea lions present in the area at the time of the spill. The greatest threat to Steller sea lions occurring adjacent to the shipping route from an LNG spill would be thermal stress from coming into contact with the cryogenic liquid (before the LNG vaporizes) or the fire associated with the ignited vapors. This could be particularly damaging if the LNG spill were near the South Jetty or the Large Navigation Buoy during the fall or winter months when use of these sites as haulouts by Steller sea lions is greatest. Any sea lions that came into direct contact with the LNG or the fire would probably experience a sudden thermal shock that could be lethal. Sea lions in the general area of a spill would most likely detect the temperature change and avoid the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Columbian White-tailed Deer

Occurrence along the Waterway

Columbian white-tailed deer typically inhabit forested areas located along waterways and generally select areas that offer both food and cover (Davison, 1979; Verts and Carraway, 1998). Based

on current distribution, Columbian white-tailed deer would only occur between CRM 33 and the LNG terminal.

Critical Habitat

Critical habitat has not been designated for the Columbian white-tailed deer.

Impacts and Mitigation

During operation of the proposed project, impacts on Columbian white-tailed deer from LNG marine traffic would be limited to an accidental or intentional breach of an LNG carrier. Potential impacts on Columbian white-tailed deer from a release of LNG and associated fire include habitat modification, injury, or mortality. In the event of a collision or allision of sufficient magnitude to rupture an LNG cargo tank, it is likely that sparks or flames would ignite the flammable vapors at the spill site. In the unlikely event that ignition did not occur, an LNG spill would rapidly vaporize on water and form a potentially flammable cloud. If the flammable vapor cloud encountered an ignition source, the cloud would burn back to the spill site, rather than outward towards shoreline habitats. In the unlikely event of an LNG spill on water, ignition of the LNG vapors could contribute to a forest fire in areas where the ship route is adjacent to forested habitat. The intensity and extent of a potential forest fire and the resulting damage to Columbian white-tailed deer and its habitat would be highly dependent on a number of variables including the extent of the LNG spill, available fuel (e.g., woody material), moisture and temperature, fuel composition, wind, and topography. Nearly 11,000 acres of essential habitat (both privately owned and part of the JBHNWR) are found within the Zones of Concern, a portion of which could be affected if an accidental or intentional breach of an LNG carrier were to occur during transit. Due to the deer's limited routes of egress from islands along the LNG transit route (e.g., Tenasillahe, Crims, and Wallace Islands), it is possible that a catastrophic event involving an LNG carrier could result in adverse impacts on a subpopulation of Columbian white-tailed deer. However, as discussed in section 4.11.5.3, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Brown Pelican

Occurrence along the Waterway

The brown pelican primarily occurs in coastal habitats; they are rarely seen inland or far out at sea (FWS, 2006g). Therefore, brown pelicans occurring along the waterway would be concentrated in the area near the mouth of the Columbia River during the late spring, summer, and early fall months (FWS, 2008).

Critical Habitat

Critical habitat has not been designated for the brown pelican.

Impacts and Mitigation

During operation of the proposed project, impacts on brown pelicans from LNG marine traffic would be limited to an accidental or intentional breach of an LNG carrier. If a brown pelican were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the pelican would likely be injured, killed, or displaced from the area. The potential exists for an LNG spill and associated fire during transit of the LNG carriers to the LNG terminal that could affect brown pelicans present in the area at the time of the spill. The greatest threat to brown pelicans occurring along the waterway from an

LNG spill would be thermal stress from coming into contact with the cryogenic liquid (before the LNG vaporizes) or the fire associated with the ignited vapors. This could be particularly damaging if the LNG spill were near East Sand Island between late spring and early fall when brown pelicans concentrations are highest. Any pelicans that came into direct contact with the LNG or the fire would probably experience a sudden thermal shock that could be lethal. Brown pelicans in the general area of a spill would most likely detect the temperature change and avoid the area. However, as discussed in section 4.11.5.3, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Marbled Murrelet

Occurrence along the Waterway

Marbled murrelets may occur in old-growth forest and nearshore habitats along the LNG carrier route throughout the year. In addition, about 176 acres of designated critical habitat for the marbled murrelet occur within the Zones of Concern.

Critical Habitat

Designated critical habitat for the marbled murrelet does not occur within the Zones of Concern associated with LNG carrier transit. The closest critical habitat unit to the LNG carrier route is OR-01-a, which is about 2.5 miles southeast of the LNG terminal site near Wauna, in Clatsop County, Oregon (61 Federal Register 26255 – 26320).

Impacts and Mitigation

During operation of the proposed project, impacts on marbled murrelets from LNG marine traffic would be limited to an accidental or intentional breach of an LNG carrier. Potential impacts on the marbled murrelet and its designated critical habitat from a release of LNG and associated fire include habitat modification, injury, or mortality. In the unlikely event of an LNG spill on water, ignition of the LNG vapors could contribute to a forest fire in areas where the ship route is adjacent to marbled murrelet habitat. This could be particularly damaging if a spill were to occur during the marbled murrelet nesting season. Given the relatively high precipitation in the region, large forest fires in the area are infrequent but they can be severe when they do occur. The intensity and extent of a potential forest fire and the resulting damage to marbled murrelet habitat would be highly dependent on a number of variables including the extent of the LNG spill, available fuel (e.g., woody material), moisture and temperature, fuel composition, wind, and topography. However, as discussed in section 4.11.5.3, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Northern Spotted Owl

Occurrence along the Waterway

Northern spotted owl may occur in old-growth coniferous and mixed conifer-hardwood forests along the LNG carrier route throughout the year.

Critical Habitat

Designated critical habitat for the northern spotted owl does not occur within the Zones of Concern associated with LNG carrier transit. The closest critical habitat unit to the LNG carrier route is

WA-39 (57 Federal Register 1796 – 1838), which is located about 24.4 miles east of the pipeline interconnect with the Williams Northwest pipeline system in eastern Cowlitz County (FWS, 1992b).

Impacts and Mitigation

During operation of the proposed project, impacts on northern spotted owls from LNG marine traffic would be limited to an accidental or intentional breach of an LNG carrier. If a northern spotted owl were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the risk and impacts would be similar to those described above for the marbled murrelet.

Short-tailed Albatross

Occurrence along the Waterway

Because the short-tailed albatross is a pelagic species, this species may occur in waters off the coasts of Oregon and Washington.

Critical Habitat

Critical habitat has not been designated for the short-tailed albatross.

Impacts and Mitigation

During operation of the proposed project, impacts on short-tailed albatross from LNG carrier traffic would be limited to an accidental or intentional breach of an LNG carrier. If a short-tailed albatross were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the albatross would likely be injured, killed, or displaced from the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Streaked Horned Lark

Occurrence along the Waterway

Streaked horned lark breeding and wintering areas occur along the waterway for LNG marine traffic on five dredge spoil islands along the lower Columbia River, including Rice Island, Miller Sands, Pillar Rock Island, West Wallace Island, and an unnamed island located just upstream of Tenasillahe Island (Pearson and Altman, 2005). Although some streaked horned larks are migratory, these sites may be occupied throughout the year.

Critical Habitat

Critical habitat has not been designated for the streaked horned lark.

Impacts and Mitigation

During operation of the proposed project, impacts on streaked horned larks from LNG carrier traffic would be limited to possible increased shoreline erosion and an accidental or intentional breach of an LNG carrier. If a streaked horned lark were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the lark would likely be injured, killed, or displaced from the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is

extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Western Snowy Plover

Occurrence along the Waterway

The western snowy plover historically occurred within the coastal areas of the lower Columbia River; however, plovers have not been documented along the lower Columbia River since 1985 (69 Federal Register 75617). In addition, there is no evidence that indicates the western snowy plover occurs or has occurred upstream of the mouth of the Columbia River (Pacific Coast Joint Venture, 1994).

Critical Habitat

Designated critical habitat for the western snowy plover does not occur within the Zones of Concern associated with LNG carrier transit. The nearest designated critical habitat unit to the waterway for LNG marine traffic is WA-4, which is located about 40 miles northwest of the LNG terminal in Pacific County, Washington (64 Federal Register 68507 – 68544).

Impacts and Mitigation

During operation of the proposed project, impacts on western snowy plovers from LNG carrier traffic would be limited to an accidental or intentional breach of an LNG carrier. If a western snowy plover were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the plover would likely be injured, killed, or displaced from the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Oregon Silverspot Butterfly

Occurrence along the Waterway

Within the counties located adjacent to the LNG carrier route, the Oregon silverspot butterfly is only known to occur within the coastal dune habitat in Clatsop County, Oregon. While potential habitat may be present, Oregon silverspot butterflies are not known to occur along the LNG carrier route.

Critical Habitat

Designated critical habitat for the Oregon silverspot butterfly does not occur within the Zones of Concern associated with LNG carrier transit. The nearest designated critical habitat unit to the waterway for LNG marine traffic is located about 175 miles south of the LNG terminal in Lane County, Oregon (45 Federal Register 44935 – 44939).

Impacts and Mitigation

During operation of the proposed project, impacts on Oregon silverspot butterflies from LNG carrier traffic would be limited to an accidental or intentional breach of an LNG carrier. If an Oregon silverspot butterfly were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the butterfly would likely be injured, killed, or displaced from the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Kincaid's Lupine

Occurrence along the Waterway

While potential habitat may be present, no Kincaid's lupine plants are known to occur within the Zones of Concern along the waterway for LNG marine transit.

Critical Habitat

Critical habitat has not been designated for Kincaid's lupine. However, critical habitat was proposed for this species in 2005 (70 Federal Register 66491 – 66599). The nearest proposed critical habitat unit for this species is located in Lewis County, Washington, which is approximately 30 miles northeast of the proposed LNG terminal site.

Impacts and Mitigation

During operation of the proposed project, impacts on Kincaid's lupine from LNG carrier traffic would be limited to an accidental or intentional breach of an LNG carrier. In the unlikely event that an accidental or intentional breach of an LNG carrier resulted in a forest fire, the resulting damage to Kincaid's lupine and its habitat would be highly dependent on a number of variables including the extent of the LNG spill, available fuel (e.g., woody material), moisture and temperature, fuel composition, wind, and topography. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Nelson's Checker-mallow

Occurrence along the Waterway

While potential habitat may be present, no Nelson's checker-mallow plants are known to occur within the Zones of Concern along the waterway for LNG marine transit.

Critical Habitat

Critical habitat has not been designated for Nelson's checker-mallow.

Impacts and Mitigation

During operation of the proposed project, impacts on Nelson's checker-mallow from LNG carrier traffic would be limited to an accidental or intentional breach of an LNG carrier. The risks and impacts associated with an accidental or intentional breach of an LNG carrier on Nelson's checker-mallow would be similar to those described for Kincaid's lupine.

State Listed Threatened and Endangered Species

NorthernStar consulted with the ODFW, ORNHIC, WDFW, and WNHP to identify state listed endangered and threatened species with the potential to occur within the proposed project area. Many state listed endangered or threatened species are also federally listed; these species were discussed above (see *Waterway for LNG Marine Traffic, Federally Listed Species*). The remaining state listed threatened or endangered species are discussed below.

Gray Whale

Gray whales occur off the coasts of Oregon and Washington during their northern migration between March and June and their southern migration, beginning in November and December. Potential impacts on gray whales as a result of LNG carrier traffic associated with the Bradwood Landing Project are discussed above (see *Whales*).

Bald Eagle

Bald eagle nesting, foraging, and wintering areas occur along the waterway for LNG marine traffic in the form of mature riparian forested and upland forested habitats. Bald eagles occur along the lower Columbia River throughout the year. During operation of the proposed project, impacts on bald eagles from LNG marine traffic would be limited to an accidental or intentional breach of an LNG carrier. Potential impacts on bald eagles from a release of LNG and associated fire include habitat modification, injury, or mortality. In the unlikely event of an LNG spill on water, ignition of the LNG vapors could contribute to a forest fire in areas where the ship route is adjacent to bald eagle habitat. This could be particularly damaging if a spill were to occur during the bald eagle nesting season. Given the relatively high precipitation in the region, large forest fires in the area are infrequent but they can be severe when they do occur. The intensity and extent of a potential forest fire and the resulting damage to bald eagle habitat would be highly dependent on a number of variables including the extent of the LNG spill, available fuel (e.g., woody material), moisture and temperature, fuel composition, wind, and topography. However, as discussed in section 4.11.5.3, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Other Special Status Species

Sensitive Species

In addition to the species listed under the ESA or by the States of Oregon and Washington, five species that are candidates for listing as endangered or threatened or species of special concern have been identified by state agencies as having the potential to occur in the vicinity of the proposed project. The ODFW also expressed concerns regarding several other sensitive species, including the coastal cutthroat trout, red-legged frog, tailed frog, western painted turtle, American peregrine falcon, and olive-sided flycatcher. These sensitive species are discussed below.

Coastal Cutthroat Trout

During operation of the Bradwood Landing Project, potential impacts on coastal cutthroat trout from LNG marine traffic would be similar to those associated with aquatic species (Section 4.5.1.1).

Eulachon

During operation of the Bradwood Landing Project, potential impacts on eulachon from LNG marine traffic would be similar to those associated with aquatic species (Section 4.5.1.1).

Lampreys

During operation of the Bradwood Landing Project, potential impacts on lampreys from LNG marine traffic would be similar to those associated with aquatic species (see section 4.5.1.1).

Red-legged Frog

If a red-legged frog were to be within the Zones of Concern in the event of an accidental or intentional breach, the frog would likely be injured, killed, or displaced from the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Tailed Frog

If a tailed frog were to be within the Zones of Concern in the event of an accidental or intentional breach, the frog would likely be injured, killed, or displaced from the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

Western Painted Turtle

If a western painted turtle were to be within the Zones of Concern in the event of an accidental or intentional breach, the turtle would likely be injured, killed, or displaced from the area. However, the risk of an accidental or intentional release of LNG during transit of the LNG carriers is extremely low and can be managed by implementing the recommendations in the Coast Guard's WSR (Appendix G).

American Peregrine Falcon

American peregrine falcons may occur in cliffs, riverbanks, and trees and on the ledges of vertical structures within the Zones of Concern throughout the year (FWS, 2006n). If an American peregrine falcon were in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the risks and impacts would be similar to those described above for the bald eagle.

Northern Goshawk

If a northern goshawk were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the risks and impacts would be similar to those described above for the bald eagle.

Olive-sided Flycatcher

If an olive-sided flycatcher were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the risks and impacts would be similar to those described above for the bald eagle.

Purple Martin

If a purple martin were to be in the vicinity of an LNG carrier in the event of an accidental or intentional breach, the risks and impacts would be similar to those described above for the bald eagle.

Marine Mammals

As described in section 4.6.1.1, thirty-one species of marine mammals have been recorded off the coasts of Oregon and Washington, including 6 species of baleen whales; 19 species of toothed whales, beaked whales, dolphins, and porpoises; 5 species of pinnipeds (seals and sea lions); and the sea otter (Caretta et al., 2007; Angliss and Outlaw, 2008). Of these, five species of baleen whales, two species of

toothed whales, and one pinniped are either state- or federally listed and are discussed in sections 4.6.1.1 and 4.6.1.2.

The 22 remaining species include 11 whales, 4 dolphins, 4 pinnipeds, 2 porpoises, and the sea otter. As described in section 4.6.1.3, occurrence of whales, dolphins, and porpoises would be limited to marine portions of the waterway. Northern fur seals and Northern elephant seals are occasionally present along the waterway, but not in great numbers or for very long (NMFS, 2008b). In contrast, Pacific harbor seals and California sea lions frequent the lower Columbia River and adjacent nearshore marine areas along the LNG carrier route.

Potential impacts on marine mammals as a result of LNG marine traffic would be limited to spills or leaks of hazardous materials, disturbance due to increased noise and ship traffic levels, and vessel strikes. Impacts on other marine mammals due to spills or leaks of hazardous materials would be similar to those described for the Steller sea lion.

To date, the various impacts on Pacific harbor seals, California sea lions, northern fur seals, and elephant seals from human disturbance have not been studied extensively. Close approach by humans and boats has been shown to cause sea lions and Pacific harbor seals at haulouts to go into the water (NMFS, 1992; Matthews, 2000). Repeated disturbance by humans could result in abandonment of the South Jetty of the Columbia River haulout site (Kenyon, 1962). However, due to marine mammals tolerance of current large vessel traffic along the Columbia River, it is expected that an increase of about 7 percent in commercial vessel traffic during operation of the proposed project would not significantly increase disturbance to Steller sea lions. In recent years, there are no known reports of collisions between vessels and either Pacific harbor seals or northern fur seals; however, boat collisions have resulted in the deaths of three California sea lions and two elephant seals (Caretta et al., 2007).

Within the marine portion of the waterway, increased vessel traffic could increase the risk of minimal long-term intermittent impacts on dolphins, porpoises, and whales. Vessels could collide with marine mammals regardless of vessel size and type. However, the most vulnerable cetaceans include slow-moving species or species that spend extended periods of time at the surface. In contrast, dolphins often change their behavior in response to vessels, approaching vessels to ride the wake, extending interbreath intervals, decreasing inter-animal distance, changing headings, or increase swimming speed. Dolphins might be struck by vessels due to inattentiveness, age or health, or voluminous vessel traffic (MMS, 2002). NorthernStar has stated that it will apply for an Incidental Harassment Authorization pursuant to MMPA section 101(a)(5)(D); therefore, potential impacts would be addressed as part of NorthernStar's consultation with NMFS.

Migratory Bird Treaty Act

During operation of the proposed project, an accidental or intentional breach of an LNG carrier while in transit could affect migratory birds and their habitats. Because the Columbia River estuary is one of the most important sites on the Pacific Flyway for migratory birds, the risks and impacts on migratory birds as a result of an accidental or intentional breach of an LNG carrier would be similar to those described above for the brown pelican, which is concentrated within portions of the lower Columbia River during parts of the year.

4.6.2.2 LNG Terminal

Federally Listed Species

Fish

Lower Columbia River Chinook Salmon ESU

Occurrence at the LNG Terminal – The Lower Columbia River Chinook salmon ESU may occur in the following areas associated with the proposed LNG terminal: the Columbia River, Hunt Creek, and the log pond. The Columbia River at the proposed LNG terminal site provides habitat for migrating spring- and fall-run adults from March and June and August and October, respectively (NMFS, 2005c). Spring-run out-migrating smolts occur during their second spring/summer, and fall-run out-migrating smolts occur as sub-yearlings from April through June (NMFS, 2005c; ODFW, 2005; Wade, 2000, 2002). In addition, juvenile Chinook salmon rear throughout the year in nearshore habitat of the Columbia River mainstem.

Hunt Creek, which is adjacent to the LNG terminal site, is one of three streams of the lower Columbia-Clatskanie subbasin that have been designated as containing habitat for spawning of fall Chinook salmon (Kostow, 1995). In addition, juvenile Chinook salmon rear in Hunt Creek throughout the year. The log pond potentially provides at least seasonal refugia during high flow for juvenile Chinook salmon.

Juvenile salmon entering the Columbia River upstream of Bradwood Landing are subject to a flow split upstream of Puget Island between the Columbia River shipping channel (Oregon side of Puget Island) and Cathlamet Channel (Washington side of Puget Island). Juvenile fish migrating along the Oregon side of Puget Island would pass near the proposed LNG terminal at Bradwood Landing. While the out-migrating patterns of juvenile salmonids are relatively well understood, the distribution of out-migrants as they pass Puget Island, and therefore the proposed terminal location, are less so. The majority of flow through the area is associated with the navigation channel which is along the Oregon side of Puget Island. Therefore, at a minimum, the channel oriented species such as yearling Chinook, sockeye, steelhead and Coho would likely be exposed to potential impacts at the terminal. Schreck et al. (2005) determined that smolt-sized Chinook salmon predominately occur in the main shipping channel. Additionally, Carlson et al. (2001) observed a greater percentage of fish along the channel margin on the Oregon side of the channel than the Washington side, both above and below the flow split at Puget Island. Similarly, based on sampling efforts documented by Dawley et al. (1986), fewer sub-yearling Chinook salmon appear to migrate along the Washington shore of the Columbia River just upstream of Puget Island than along the Oregon shore.

The percentage of fish that would be exposed to impacts associated with construction and operation of the LNG terminal is not clear; however, it appears that a higher percentage of out-migrating juvenile salmonids would occur on the Oregon side of Puget Island and therefore be exposed to impacts associated with LNG terminal construction (e.g., dredging) and operation (e.g., ballast and ship engine cooling water intake) activities. As described in section 4.5.2.1, additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – The lower Columbia River is designated as critical habitat (rearing, migratory corridor, and spawning PCEs) for the Lower Columbia River Chinook salmon ESU. As described above, salmon migrate through the Columbia River estuary and past the LNG terminal site en route to their spawning grounds upstream. In addition, critical habitat for juvenile rearing has been designated within nearshore habitats of the Columbia River mainstem and Hunt Creek (70 Federal Register 52630 – 52858).

The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal would affect 63 acres of designated critical habitat for the Lower Columbia River Chinook salmon ESU, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – The Bradwood Landing LNG terminal would affect salmonids and/or their designated critical habitat through various activities including:

- in-water construction activities such as:
  - dredging;
  - development of the river shoreline;
  - pile driving; and
  - log pond filling;
- terrestrial/riparian habitat modification such as:
  - bridge construction and railroad realignment; and
  - power line construction;
- water appropriation activities such as:
  - ship ballast and engine cooling water;
  - hydrostatic testing; and
  - fire suppression system testing;
- LNG terminal lighting;
- accidental spills and leaks of hazardous materials; and
- LNG terminal operations activities such as:
  - maintenance dredging;
  - routine discharge of condensate water from the SCVs; and
  - operational acoustic effects.

Potential impacts and mitigation from each of these factors are summarized in table 4.6.2-1 and described in detail in section 4.5.2.1. NorthernStar's proposed mitigation measures are summarized below (see *Compensatory Mitigation*).

Construction of the proposed LNG terminal would affect 68.5 acres of designated critical habitat for the Lower Columbia River Chinook salmon ESU. Of these, 5.0 acres would be permanently impacted by filling the log pond at the LNG terminal site. The remaining 63.5 acres within the ship berth and maneuvering area would be permanently modified by the addition of piles and other over-water structures as well as dredging.

Upper Columbia River Spring-run Chinook Salmon ESU

Occurrence at the LNG Terminal – Occurrence of the Upper Columbia River Spring-run Chinook salmon ESU at the LNG terminal site would be limited to seasonal migrations within the lower Columbia River and occasional use of Hunt Creek during summer months by juveniles. The life stages present and seasonal occurrence of the Upper Columbia River Spring-run Chinook Salmon ESU along the lower Columbia River are described in section 4.6.2.1. As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – The Columbia River is designated as critical habitat (rearing and migratory corridor PCEs) for the Upper Columbia River Spring-run Chinook salmon ESU (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal

would affect 63 acres of designated critical habitat for the Upper Columbia River Chinook salmon ESU, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Migration of Upper Columbia River Spring-run Chinook salmon past the project site and occasional use of Hunt Creek by juveniles would occur outside of the in-water work window, thus excluding them from being present during pile driving, dredging, or other in-water construction activities that may cause an avoidance reaction or result in adverse affects. Impacts on designated critical habitat for the Upper Columbia River Spring-run Chinook salmon ESU would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

Upper Willamette River Chinook Salmon ESU

Occurrence at the LNG Terminal – The Upper Willamette River Chinook salmon ESU may occur in the following areas associated with the proposed LNG terminal: the Columbia River, Hunt Creek, and the log pond. The Columbia River at the proposed LNG terminal site provides habitat for migrating adults primarily between April and May, with a peak in mid-May, and for juvenile rearing throughout the year (ODFW, 2005; Kostow, 1995; NMFS, 2005c). According to the NMFS (2005c), out-migration has been found to occur in recently emerged juveniles during the winter through early spring, in sub-yearlings during the fall through early winter, and as yearlings in the late winter through spring. Hunt Creek provides rearing habitat for juvenile Chinook salmon throughout the year. The log pond potentially provides at least seasonal refugia during high flow for juvenile Chinook salmon. As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – The Columbia River is designated as critical habitat (rearing and migratory corridor PCEs) for the Upper Willamette River Chinook salmon ESU. As described above, salmon migrate through the lower Columbia River and past the LNG terminal site en route to their spawning grounds upstream. In addition, critical habitat for juvenile rearing has been designated within nearshore habitats of the Columbia River mainstem and Hunt Creek (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal would affect 63 acres of designated critical habitat for the Upper Willamette River Chinook salmon ESU, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Impacts on designated critical habitat for the Upper Willamette River Chinook salmon ESU would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

Snake River Spring/Summer-run Chinook Salmon ESU

Occurrence at the LNG Terminal – Occurrence of the Snake River Spring/Summer-run Chinook salmon ESU at the LNG terminal site would be limited to seasonal migrations within the lower Columbia River and occasional use of Hunt Creek during summer months by juveniles. The life stages present and seasonal occurrence of the Snake River Spring/Summer-run Chinook salmon ESU along the lower Columbia River are described in section 4.6.2.1. As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – The Columbia River is designated critical habitat (migratory corridor PCE) for the Snake River Spring/Summer-run Chinook salmon ESU (58 Federal Register 68543 – 68554). Adjacent riparian zones are included in the designation, defined as those areas within 300 feet of the normal line of high water of a stream channel. Based on this designation, the proposed LNG terminal would affect 79 acres of designated critical habitat for the Snake River Spring/Summer-run Chinook salmon ESU, including 58 acres within the Columbia River, 5 acres within the log pond, and 16 acres along the shoreline of the Columbia River.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Migration of Snake River Spring/Summer-run Chinook salmon past the project site and occasional use of Hunt Creek by juveniles would occur outside of the in-water work window, thus excluding them from being present during pile driving, dredging, or other in-water construction that may cause an avoidance reaction or result in adverse affects. This species does not rear in the nearshore areas and would not be affected by those activities.

As described above, the Columbia River and adjacent riparian zone, defined as those areas within 300 feet of the normal line of high water of a stream channel, are designated critical habitat. Based on this designation, construction of the proposed LNG terminal would affect 84.5 acres of designated critical habitat for the Snake River Spring/Summer-run Chinook salmon ESU. Of these, 5 acres would be permanently impacted by filling the log pond at the LNG terminal site, and 63.5 acres within the ship berth and maneuvering area would be permanently modified by the addition of piles and other over-water structures as well as dredging. The remaining 16 acres would occur along the shoreline of the Columbia River at the proposed LNG terminal site. Although NorthernStar has committed to restoration of a portion of this area (see section 4.4.2.2), permanent conversions of designated critical habitat along the shoreline of the Columbia River are anticipated. NorthernStar's proposed mitigation measures are summarized below (see *Compensatory Mitigation*).

Snake River Fall-run Chinook Salmon ESU

Occurrence at the LNG Terminal – The Snake River Fall-run Chinook salmon ESU may occur in the following areas associated with the proposed LNG terminal: the Columbia River, Hunt Creek, and the log pond. The Columbia River at the proposed LNG terminal site provides habitat for migrating adults between August and December, out-migrating smolts between April and June, and for juvenile rearing throughout the year (Myers et al., 1998; Good et al., 2005; Bell Fisheries Handbook, 1973). Hunt Creek provides rearing habitat for juvenile Chinook salmon throughout the year. The log pond potentially provides at least seasonal refugia during high flow for juvenile Chinook salmon. As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated as critical habitat (rearing and migratory corridor PCEs) for the Snake River Fall-run Chinook salmon ESU. In addition, critical habitat for juvenile rearing has been designated within nearshore habitats of the Columbia River mainstem and Hunt Creek (70 Federal Register 52630 – 52858). Adjacent riparian zones are included in the designation, defined as those areas within 300 feet of the normal line of high water of a stream channel. Based on this designation, the proposed LNG terminal would affect 79 acres of designated critical habitat for the Snake River Fall-run Chinook salmon ESU, including 58 acres within the Columbia River, 5 acres within the log pond, and 16 acres along the shoreline of the Columbia River.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon*

ESU). Impacts on designated critical habitat for the Snake River Fall-run Chinook salmon ESU would be similar to those described above for the Snake River Spring/Summer-run Chinook salmon ESU.

Columbia River Chum Salmon ESU

Occurrence at the LNG Terminal – The Columbia River chum salmon ESU has migration corridors and both spawning and rearing habitats within the Columbia River at the proposed LNG terminal site and occasional use of Hunt Creek during summer months by juveniles. The life stages present and seasonal occurrence of the Columbia River chum salmon ESU along the lower Columbia River are described in section 4.6.2.1. As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated as critical habitat (rearing, migratory corridor, and spawning PCEs) for the Columbia River chum salmon ESU (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal would affect 63 acres of designated critical habitat for the Columbia River chum salmon ESU, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Impacts on designated critical habitat for the Columbia River chum salmon ESU would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

Lower Columbia River Coho Salmon ESU

Occurrence at the LNG Terminal – The Lower Columbia River coho salmon ESU may occur in the following areas associated with the proposed LNG terminal: the Columbia River, Hunt Creek, and the log pond. The Columbia River at the proposed LNG terminal site provides habitat for migrating adults between late August and February, peaking in October; out-migrating smolts between March and July; and for juvenile rearing throughout the year (ODFW, 2005; Good et al., 2005; Wade, 2000, 2002; Bell Fisheries Handbook, 1973). Hunt Creek provides rearing habitat for juvenile coho salmon throughout the year. The log pond potentially provides at least seasonal refugia during high flow for juvenile coho salmon. As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – Critical habitat has not been designated for the Lower Columbia River coho salmon ESU.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Although critical habitat has not been designated for the Lower Columbia River coho salmon ESU, impacts on the Lower Columbia River coho salmon ESU would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

Snake River Sockeye Salmon ESU

Occurrence at the LNG Terminal – Occurrence of the Snake River sockeye salmon ESU at the LNG terminal site would be limited to seasonal migrations within the lower Columbia River (Gustafson et al., 1997; Good et al., 2005). The life stages present and seasonal occurrence of the Snake River

sockeye salmon ESU along the lower Columbia River are described in section 4.6.2.1. As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated critical habitat (migratory corridor PCE) for the Snake River sockeye salmon ESU (58 Federal Register 68543 – 68554). Critical habitat includes the adjacent riparian zone defined as those areas within 300 feet of the normal line of high water of a stream channel. The proposed LNG terminal would affect 79 acres of designated critical habitat for the Snake River sockeye salmon ESU, including 58 acres within the Columbia River, 5 acres within the log pond, and 16 acres along the shoreline of the Columbia River.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Migration of Snake River sockeye salmon and occasional use of Hunt Creek by juveniles would occur outside of the in-water work window, thus excluding them from being present during pile driving, dredging, or other in-water construction that may cause an avoidance reaction or result in adverse affects. This species does not rear in the nearshore areas of the lower Columbia River and would not be affected by those activities. Impacts on designated critical habitat for the Snake River sockeye salmon ESU would be similar to those described above for the Snake River Spring/Summer-run Chinook salmon ESU.

Lower Columbia River Steelhead DPS

Occurrence at the LNG Terminal – The Lower Columbia River steelhead DPS may occur in the following areas associated with the proposed LNG terminal: the Columbia River, Hunt Creek, and the log pond. As described in section 4.6.2.1, the Columbia River at the proposed LNG terminal site provides habitat for migrating adults throughout the year, with seasonal peaks in activity; out-migrating smolts occur from March to June with a peak in April or May; and rearing juveniles throughout the year (Good et al., 2005; NMFS, 2005c). Hunt Creek and the log pond potentially provide at least seasonal refugia for juvenile steelhead. As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated as critical habitat (rearing and migratory corridor PCEs) for the Lower Columbia River steelhead DPS (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal would affect 63 acres of designated critical habitat for the Lower Columbia River steelhead DPS, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Impacts on designated critical habitat for the Lower Columbia River steelhead DPS would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

Middle Columbia River Steelhead DPS

Occurrence at the LNG Terminal – Occurrence of the Middle Columbia River steelhead DPS at the LNG terminal site would be limited to migration within the lower Columbia River and occasional use of Hunt Creek during summer months by juveniles. As described in section 4.6.2.1, the Columbia River at the proposed LNG terminal site provides habitat for migrating adults throughout the year, with seasonal peaks in activity, and out-migrating smolts occur during March to June (NMFS, 2005c). As described

above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Middle Columbia River steelhead DPS (70 Federal Register 52630 – 52858). However, this DPS is not known to rear within the Columbia River at the proposed LNG terminal site. The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal would affect 63 acres of designated critical habitat for the Middle Columbia River steelhead DPS, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Impacts on designated critical habitat for the Middle Columbia River steelhead DPS would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

Upper Columbia River Steelhead DPS

Occurrence at the LNG Terminal – Occurrence of the Upper Columbia River steelhead DPS at the LNG terminal site would be limited to migration within the lower Columbia River and occasional use of Hunt Creek during summer months by juveniles. As described in section 4.6.2.1, the Columbia River at the proposed LNG terminal site provides habitat for migrating adults throughout the year, with seasonal peaks in activity, and out-migrating smolts March and June (Bell Fisheries Handbook, 1973). As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Upper Columbia River steelhead DPS (70 Federal Register 52630 – 52858). However, this DPS is not known to rear within the Columbia River at the proposed LNG terminal site. The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal would affect 63 acres of designated critical habitat for the Upper Columbia River steelhead DPS, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Impacts on designated critical habitat for the Upper Columbia River steelhead DPS would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

Upper Willamette River Steelhead DPS

Occurrence at the LNG Terminal – Occurrence of the Upper Willamette River steelhead DPS at the LNG terminal site would be limited to migration within the lower Columbia River and occasional use of Hunt Creek during summer months by juveniles. As described in section 4.6.2.1, the Columbia River at the proposed LNG terminal site provides habitat for migrating adults throughout the year, with seasonal peaks in activity, and out-migrating smolts between March and July (Bell Fisheries Handbook, 1973). As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Upper Willamette River steelhead DPS (70 Federal Register 52630 – 52858).

However, this DPS is not known to rear within the Columbia River at the proposed LNG terminal site. The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal would affect 63 acres of designated critical habitat for the Upper Willamette River steelhead DPS, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Impacts on designated critical habitat for the Upper Willamette River steelhead DPS would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

Snake River Basin Steelhead DPS

Occurrence at the LNG Terminal – Occurrence of the Snake River Basin steelhead DPS at the LNG terminal site would be limited to migration within the lower Columbia River and occasional use of Hunt Creek during summer months by juveniles. As described in section 4.6.2.1, the Columbia River at the proposed LNG terminal site provides habitat for migrating adults throughout the year, with seasonal peaks in activity, and out-migrating smolts pass through the lower Columbia River between March and June (Bell Fisheries Handbook, 1973). As described above (see *Lower Columbia River Chinook Salmon ESU*), additional analysis of salmonid occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Snake River Basin steelhead DPS (70 Federal Register 52630 – 52858). However, this DPS is not known to rear within the Columbia River at the proposed LNG terminal site. The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation. The proposed LNG terminal would affect 63 acres of designated critical habitat for the Snake River Basin steelhead DPS, including 58 acres within the Columbia River and 5 acres within the log pond.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on salmonids are described above (see *Lower Columbia River Chinook Salmon ESU*). Impacts on designated critical habitat for the Snake River Basin steelhead DPS would be similar to those described above for the Lower Columbia River Chinook Salmon ESU.

North American Green Sturgeon

Occurrence at the LNG Terminal – As described in section 4.6.1.1, the North American green sturgeon is the most marine-oriented of sturgeons occurring in North America. They are known to concentrate in the Columbia River estuary during the late summer and fall months. As described in section 4.5.2.1, additional analysis of fish occurrence at the LNG terminal site will be included in the revised BA and EFH Assessment.

Critical Habitat – Critical habitat has not been designated for the North American green sturgeon.

Impacts and Mitigation – Potential impacts from construction and operation of the Bradwood Landing LNG terminal on the North American green sturgeon would be similar to those described above for Lower Columbia River Chinook Salmon ESU.

Compensatory Mitigation

As summarized in table 4.6.2-1, project design, construction, and operation plans have been modified to avoid or minimize impacts on salmonid ESU/DPSs and their designated critical habitat. These efforts would be ongoing during construction in order to capitalize on avoidance and minimization opportunities that cannot be predicted. However, both direct and indirect impacts on salmonids would result from construction and operation of the proposed project. NorthernStar has committed to provide an overall net benefit to the environment of the lower Columbia River ecosystem.

Following construction of the LNG terminal, habitat and ecosystem function would be restored in place. Permanent impacts on aquatic resources would be mitigated by restoring habitat with similar ecological function. The FERC received numerous comments stating that the mitigation proposed by NorthernStar does not adequately compensate for impacts on aquatic resources associated with the project. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. To ensure that the mitigation proposed for the Bradwood Landing Project adequately compensates for project-related impacts, we have recommended that NorthernStar continue to consult with the appropriate natural resource agencies to finalize its Compensatory Mitigation Plan. The final Compensatory Mitigation Plan will be filed along with agency comments and applicable approvals with the Secretary prior to construction of the project.

Salmon Enhancement Initiative

As part of the Bradwood Landing Project, NorthernStar proposes to implement an SEI to contribute to the recovery of salmon and the lower Columbia River ecosystem. NorthernStar proposed the SEI as a voluntary action that would be above and beyond the mitigation measures used to avoid, minimize, rectify, reduce, and/or compensate for environmental impacts that are required by the regulations. However, various permit requirements would ensure its implementation if the project is authorized. NorthernStar's SEI would potentially contribute significantly to the conservation and recovery of salmonids (and other species) protected under the ESA.

The SEI would entail providing funding for salmon preservation, enhancement, and restoration projects on the lower Columbia River that would likely total more than $50 million over the life of the Bradwood Landing Project. Of these monies, $7 million would be available for an Early Action Plan to be implemented during the period between the start of project construction and the start of project operation. The remainder of the monies would be available for long-term measures that would be funded through yearly installments of $1.3 million beginning after the project becomes operational. The National Fish and Wildlife Foundation's (NFWF) Western Partnership Office in Portland, Oregon would serve as the fiscal agent for SEI funds.

NorthernStar would work with the LCFRB to develop the SEI. The SEI would include initial and ongoing outreach to, and consultation with, watershed and estuary restoration groups, tribes, agencies, and other entities involved in preservation, restoration, and other salmon and ecological enhancement efforts on the lower Columbia River. The LCFRB would lead and facilitate this outreach and consultation process to:

- design and develop SEI processes and procedures, including the criteria for project selection, processes for allocating funds, and means of evaluating performance;
- establish a Steering Committee to help develop the Early Action Plan;

- authorize the allocation of SEI funding upon approval of funding allocation plans by the Steering Committee; and

- evaluate the ecological and salmon benefits of SEI proposals and actions with the goal of measuring progress and adaptively improving performance of the SEI to ensure the highest value and resource benefit for SEI investments.

The LCFRB would convene, administer, and chair the Steering Committee. Those invited to participate on the Steering Committee would include, but not be limited to, representatives of the LCFRB, other regional watershed and estuary restoration groups, NMFS, FWS, ODFW, WDFW, and tribes.

Allocation of SEI funds would be guided by project selection criteria, the application of best available science and plans, and a collaborative process facilitated by the LCFRB. This process is designed to serve the SEI, but it could also demonstrate the concept of using best available science and plans, and a collaborative process, to optimize the investment of other funds (e.g., mitigation and environmental fines, judgments, and settlements) for better efficiency and ecological effectiveness.

The LCFRB and the Steering Committee would prepare and submit to NorthernStar and the NFWF an annual implementation plan and budget that identifies recommended actions and projected funding allocations for the upcoming year. Funds would be released after the Steering Committee's plan and budget have been approved by the NFWF. The LCFRB and the Steering Committee would prepare and make available to the public an annual progress report that describes the activities of the SEI, including funding allocations and project summaries that describe the status and ecological outcomes of individual projects.

Project Selection Criteria. The following selection criteria regarding geographic scope, focal species, biological criteria, and other considerations would guide selection of specific SEI salmon and ecosystem preservation, restoration, and enhancement projects for both the Early Action Plan and long-term funding program.

SEI projects would be located within the lower Columbia River watershed, which includes the Columbia River estuary, mainstem area, and associated Oregon and Washington tributaries. Although the Steering Committee would have final authority to determine the geographical extent of the scope of the SEI, the lower Columbia River has been defined as that portion of the river below Bonneville Dam to the mouth.

The primary purpose of SEI projects would be the recovery of ESA-listed salmon and steelhead stocks as well as the general ecological enhancement of the lower Columbia River ecosystem. However, SEI projects would also benefit other aquatic and terrestrial listed and non-listed species such as the Pacific and river lampreys, bull trout, smelt, bald eagle, and Columbian white-tailed deer.

Projects would be designed to accomplish one or more of the following functions:

- protect existing functional habitats and the processes that sustain them;
- strive for no further degradation of habitat or supporting processes;
- re-connect isolated habitat;
- restore watershed and estuarine processes (ecosystem function);
- restore habitat structure, including developing LWD banks for restoration materials;
- create new habitat where previous habitat is not recoverable; and/or
- reduce mortality of ESA-listed fish species and improve abundance.

Other considerations in project design would include:

- leverage, and be combined with, other monies to maximize benefits;
- seize time-limited opportunities;
- support research that addresses critical uncertainties and informs restoration decision-making, as well as programs that improve the ability to monitor, evaluate, and enhance the performance of restoration efforts;
- support efforts to use watershed and salmon recovery science and plans to inform and improve regulatory processes and decision-making (e.g., mitigation) for net resource benefit; and
- address specific recovery needs identified for lower Columbia salmonids in the following plans:
    - the (Washington) *Lower Columbia River Salmon Recovery and Fish & Wildlife Plan* (LCFRB, 2004), adopted by the NMFS as the *Interim Regional Recovery Plan of the Washington Management Unit for the Lower Columbia River* on February 3, 2006;
    - future revisions, enhancements, and additions to the above plans and supporting documents, including the final *Lower Columbia River Salmon Recovery and Fish & Wildlife Plan* (Oregon and Washington) when completed and adopted by the NMFS;
    - the *Northwest Power and Conservation Council Fish and Wildlife Program Subbasin Plan for the Lower Columbia Mainstem and Estuary* (Northwest Power and Conservation Council, 2004); and
    - the *Lower Columbia River Estuary Program Comprehensive Conservation and Management Plan* (Lower Columbia River Estuary Partnership, 1999).

Early Action Plan. The SEI would include an Early Action Plan to be implemented between the period after the start of construction and prior to operation of the LNG terminal. NorthernStar's initial $7 million commitment would be payable, through the NFWF, for projects, programs, and administrative expenses contained in the Early Action Plan upon its approval by the Steering Committee. The Early Action Plan would be designed to:

- employ the project selection criteria, emphasizing use of best available science and plans to develop a prioritized list of high-value, short-term measures (projects, programs, and other efforts) to support recovery of salmon and the lower Columbia River ecosystem;
- outline a 3-year implementation work plan to fully utilize the SEI's initial funding with a schedule for short-term measures and administrative costs on a year-by-year basis;
- execute the Early Action Plan year by year, evaluating performance, new information and opportunities, and the need to adaptively revise the plan with the benefit of this evaluation;
- allocate the funds for projects in both Oregon and Washington; and

- address a potentially wide range of projects and initiatives that may include focused research that informs restoration and recovery decision-making (such as fish mortality issues and strategies), an LWD bank, and control of invasive species, as well as habitat preservation and restoration.

Although the Steering Committee would need to evaluate individual project proposals under the Early Action Plan, the following examples are the kinds of projects and programs that could be funded through the SEI:

- establishment of an LWD bank program to support habitat restoration projects on the lower Columbia River. This would include development of the program plan and procedures and establishment of the infrastructure necessary for implementation;

- implementation of high priority estuarine restoration and enhancement projects identified in the *Columbia River Estuary Recovery Plan Module* (NMFS, 2006d). Project priorities would focus on the following: restoration of riparian habitat, modification of in-water structures to improve estuarine processes and reduce predation effects, and breaching or lowering of dikes/levees to restore access to off-channel habitats;

- implementation of key restoration and enhancement projects on the lower 12 miles of the Grays River, based upon high priority needs and locations identified in the *Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan*. Projects would complement ongoing restoration efforts and would focus on key habitat parameters for chum, Chinook, winter steelhead, and coho;

- acquisition of and restoration of portions of Svensen Island not dedicated to compensatory mitigation (upper Svensen Island);

- implementation projects identified by Oregon Watershed Councils that address restoration needs identified by initial limiting factors analysis performed by the ODFW as part of its Recovery Plan process;

- implementation of one or more comprehensive restoration projects on Mill, Abernathy, and Germany Creeks, focusing on in-stream habitat complexity and diversity. The project(s) would implement a primary restoration component of the Intensively Monitored Watershed program and would be designed to test the effectiveness and biological response of habitat restoration actions; and

- support development and implementation of innovative mitigation strategies and programs, including mitigation banks, that further the purpose and intent of the SEI and maximize net resource benefits and integrate processes associated with mitigation actions.

Long-Term Annual Funding. After the LNG terminal begins operation, NorthernStar would fund its SEI through an annual contribution of $1.3 million for as long as the LNG terminal operates, approximately 30 to 40 years (see section 2.9). Long-term funding for the SEI would be paid to the NFWF or its successor in a lump sum of $1.3 million annually upon approval by the Steering Committee of an annual funding allocation package. The long-term funding would also be used to develop and implement annual funding allocation packages employing the criteria described above (which emphasize use of best available science and plans) to develop a prioritized list of high-value projects, programs, and other efforts to support recovery of salmon and the lower Columbia River ecosystem. If, in the judgment

of the chair/convener of the Steering Committee, broad agreement on a funding allocation package may not be achieved, funding decisions may be deferred to the next cycle.

Projects covered under the long-term funding program would be similar in nature to projects covered under the Early Action Plan, but may, at the discretion of the Steering Committee, put relatively greater emphasis on adaptive management and restoration project maintenance, support for monitoring, and mortality reduction measures. In fact, it is likely that the list of example projects listed under the Early Action Plan is longer than initial funding could support. Therefore, projects on that list not funded under the Early Action Plan would be immediate candidates for funding under the long-term funding program.

Another category of beneficial actions likely to attract funding from the long-term funding component of the SEI is the ongoing maintenance and further incremental adaptive management of projects either funded by the Early Action Plan or by others. In many cases, some low level of ongoing funding may be critical to achieving original goals for the project or for attaining newly recognized opportunities. These funds are often difficult to get through other funding mechanisms because they must compete for funding with projects that appear to have higher increments of value. The lack of funding or the timing of funding opportunities may allow problems to persist and benefits to languish or disappear. The Steering Committee could be given the flexibility to allocate meaningful funding to ongoing needs so that a reasonable level of funding is available, as needed, to meet these priorities.

Evaluation of Enhancement Efforts. The LCFRB and Steering Committee would evaluate and, where feasible, quantify both proposed SEI actions for their potential benefit to focal species and the lower Columbia River ecosystem as well as the performance of SEI actions after they have been implemented. The monitoring, modeling, research, analysis, and adaptive management associated with evaluation should be considered priority measures by the Steering Committee and could be included in funding allocation packages.

Steller Sea Lion

Occurrence at the LNG Terminal

As described in section 4.6.1.1, although Steller sea lions generally occur downstream of Tongue Point (CRM 19), recent tagging efforts have shown that Steller sea lions move between the mouth of the Columbia River and the Bonneville Dam, foraging for food from mid-December through February, and as late as May (Stansell et al., 2007). In 2002, no Steller sea lions were observed at the Bonneville Dam; however, since that time, documented occurrences of Steller sea lions have increased. As described in table 4.6.2-2, during the 2007 hazing observation period (January 1 through May), nine individual Steller sea lions were documented. As of March 16, observers have documented 42 individual Steller sea lions hauled out at Phoca Rock (10 miles downstream of Bonneville Dam) in 2008, thus representing just over a four-fold increase from the number of individuals counted in 2007 (Stansell, 2008). Steller sea lions present at the Bonneville Dam and Phoca Rock would transit past the LNG terminal at least twice (once on the way up to the dam, and once to return to the ocean). Biologists visiting the proposed LNG terminal site on March 13, 2006 observed a single sea lion foraging in the Columbia River, but it is not known if this individual was a Steller sea lion or the more common California sea lion. The sea lion was eating and "playing" with a large silver fish in the area between the proposed LNG terminal and the upstream end of Tenasillahe Island.

TABLE 4.6.2-2

Numbers of Pinnipeds Observed at Bonneville Dam by Year

	2002	2003	2004	2005	2006	2007	2008
Maximum number of pinnipeds	31	111	105	85	85	80	Not yet complete
Maximum number of California sea lions	30	106	101	80	72	69	Not yet complete
Maximum number of Steller sea lions	0	3	2	4	10	9	42 [b]
Maximum number of Pacific harbor seals	1	2	2	1	3	2	Not yet complete
Date of first California sea lion observation [a]	March 20	March 14	February 22	February 20	February 9	January 8 November 8	November 8
Date of last California sea lion observation [a]	May 17	May 27	May 26	June 10	June 5	May 26	Still observing
Date of first Steller sea lion observation [a]	--	March 23	April 17	December 6	December 10	November 6	November 6
Date of first Pacific harbor seal observation [a]	unknown	unknown	unknown	December 12	December 12	January 18 August 28	August 28

[a] The dedicated study period occurs between January and May, and possibly into June. All sightings outside this time frame are incidental observations by dam personnel.

[b] Sightings in 2008 accurate through March 16, 2008.

Source Stansell, 2008

It is unknown if individual Steller sea lions stay at the dam from November though mid-May, or if they transit back to the ocean during these months, as they are neither branded nor satellite-tagged (Jeffries, 2008). It is speculated that Steller sea lions are not moving up and down the river like the satellite tagged California sea lions, because they return to the dam the day following hazing activities; however, it is difficult to be certain which animals are present (Jeffries, 2008; Stansell, 2008; Brown, 2008). In addition, the general patterns are neither consistent nor constant, and there is variability with each individual animal (Brown, 2008).

If individuals do transit back and forth between the ocean and the dam, they would pass by the LNG terminal location during the in-water construction period when pile driving and dredging activities would occur. Potential disturbance from noise impacts would not be expected to be significant because the Steller sea lions are hazed along with the California sea lions in the ongoing effort to protect threatened and endangered salmon as they arrive at and pass the dam (Jeffries, 2008). Hazing, which involves both underwater and air noise deterrents, begins at different times, depending on several factors (Jeffries, 2008). In 2007, hazing began in late February and ended in late May (Stansell et al., 2007). Some animals start to leave the dam area when they hear the sound of the vessel engines (Jeffries, 2008).

It is important to note that Steller sea lions that move upriver as far as Bonneville Dam endure daily (or multiple days per week) hazing events that change their behavior and yet they continue to return to the area to feed. There are no known sturgeon concentration areas in the Columbia River near the terminal that would provide the same feeding opportunity as the situation at the dam. Therefore, it is likely that pinnipeds, and specifically California sea lions and Steller sea lions, occurring in the vicinity of the LNG terminal site would be in transit to the dam or back down to the ocean and would not be expected to linger near the LNG terminal.

Critical Habitat

As described in section 4.6.2.1, the nearest occurrence of designated critical habitat for the Steller sea lion is at Orford Reef, approximately 280 miles south of the Columbia River mouth (58 Federal Register 45269 – 45285).

Impacts and Mitigation

Since Steller sea lions are expected to move through the area near the LNG terminal site, it is possible that underwater sound pressure levels during construction activities at the LNG terminal could adversely impact any sea lions occurring in the area. In addition, construction and operation of the LNG terminal could result in accidental spills or leaks of hazardous materials or result in use of the LNG terminal site as a haulout by Steller sea lions.

Noise – Noise from dredging, general construction, and pile driving activities would be generated at the proposed LNG terminal site. Although dredges are major sources of underwater noise in the Columbia River, Steller sea lions show a high degree of site fidelity to the haulout located at the South Jetty of the Columbia River despite the COE conducting regular maintenance dredging of the navigation channel. Therefore, dredging activities would not be expected to affect the Steller sea lion.

The portion of the river near Bradwood is subject to frequent vessel traffic from tugs, barges, and large container ships headed upstream to other ports of call (e.g., Longview, Kalama, Portland). In an opportunistic recording of a tug pushing a barge in the Snohomish River, Washington, the broadband level reached a maximum value of 146 dB in a 1-second period and a sustained average of 137 dB over a period of 50 seconds at 40 meters (131 feet) (Burgess et al., 2005). Furthermore, Steller sea lions transiting past the LNG terminal site are often enroute to the Bonneville Dam to feed, where background levels may be much higher there as a result of the dam operations. Once pinnipeds (including Steller sea lions) arrive at the dam in winter through May, hazing operations take place almost daily; that level of underwater and air noise harassment does not discourage these animals from returning to the site the same day or the next day (Stansell, 2008; Gearin, 2008; Jeffries, 2008).

As described in section 4.5.2.1, pile driving activities would occur between the hours of 7:00 AM and 10:00 PM for about 60 days spread over the NMFS-recommended in-water work window (between November 1 and February 28). Using an impact hammer to drive 96-inch-diameter steel piles may generate underwater sound pressure levels up to 227 dB (re: 1 μPa) at 16 feet. Close to piles, the RMS is typically about 10 to 15 dB lower than the peak. However, this level is dependent not only on the pile and hammer characteristics, but also on the geometry and boundaries of the surrounding underwater environment (Hastings and Popper, 2005). This is above the threshold for injury to Steller sea lions (190 dB_{rms}) and the threshold for disturbance (160 dB_{rms}). To minimize potential impacts on Steller sea lions due to increased noise during construction and pile driving activities, NorthernStar would establish a construction safety zone, buffer zone, and a noise impact zone around pile driving and construction activities at the LNG terminal site.

Based on a 4.5 dB practical spreading loss, the distance to the 160 dB_{rms} re: 1 μPa isopleth would be 3,281 feet. The use of bubble curtains, dewatered cofferdams, and special noise-reducing pile caps would assist with minimizing the distance to the 160 dB_{rms} (re: 1 μPa) isopleth. As discussed in section 4.5.2.1, in-water monitoring would be completed to document the effectiveness of the pile driving noise mitigation and to determine if additional noise mitigation measures are needed to reduce the distance to the 160 dB_{rms} (re: 1 μPa) isopleth.

Safety Zone – A Safety Zone would initially be established within a 500-foot radius around pile driving activities. Once pile driving begins, a qualified underwater acoustic monitor would record sound pressure levels to determine the 190 dB_{rms} isopleth (a continuous line on a map connecting equal points). That would become the new Safety Zone boundary. No pile driving would be initiated until a qualified marine mammal monitor surveys the Safety Zone. If the monitor sights a Steller sea lion in the Safety Zone, pile driving start-up would be delayed until the monitor determines, through sighting or by waiting approximately 15 minutes, that the animal or animals have likely moved beyond the Safety Zone. Once pile driving begins on an individual pile, however, that segment would be completed without cessation notwithstanding any pinniped presence in the Safety Zone, since continuous sound is considered more protective than stopping and starting, which might allow pinnipeds to return to the area where they would be subject to additional start-up sounds.

Because of the potential that pile driving may be carried out if pinnipeds are present in the Safety Zone (i.e., the animals may be exposed to sound pressures in excess of 160 dB), NorthernStar has stated that it will apply for an Incidental Harassment Authorization pursuant to MMPA section 101(a)(5)(D). The NMFS and NorthernStar suggested that the level of detail required for the issuance of an Incidental Harassment Authorization be included in this final EIS. NorthernStar submitted additional information to the FERC relating to potential impacts on marine mammals on April 17, 2007. However, this information was not submitted at a date that allowed sufficient time for independent verification by the FERC staff prior to inclusion in this document.

The NMFS may elect to use relevant portions of the final EIS in order to facilitate the application and permitting process. In some instances, the NMFS may require additional mitigation and monitoring measures to ensure that the taking would result in the least practicable adverse impact on affected marine mammal species or stocks. These could include measures considered but eliminated in this final EIS or as yet undeveloped measures. The public will have an opportunity to provide information to the NMFS through the MMPA process during the comment period following the NMFS's Notice of Receipt of the application for an Incidental Harassment Authorization or request for the implementation of regulations governing incidental taking (i.e., Letter of Authorization). In addition, the public will also have an opportunity to provide information following publication of the proposed rule. Any mitigation measures not considered in the final EIS but required through the MMPA process may require evaluation by NMFS in accordance with the NEPA.

The exact sequence of pile driving cannot be known until a contractor is hired and develops a construction sequence. The sound monitoring to establish the 190 dB_{rms} isopleth or 200 dB instantaneous peak sound pressure level would either be done with the largest pilings at the beginning, and the protective zones established at that point and used for all the pilings (most protective approach), or if the pilings have to be driven from the shore out, progressing from smaller to larger and shallower to deeper water, then monitoring and establishment of the protective zones would be done for each size of piling.

Buffer Zone – In addition to the Safety Zone described above, NorthernStar proposes to establish a Buffer Zone for Steller sea lions. The Buffer Zone would be established by monitoring once pile driving begins. It would be established at the 160 dB_{rms} isopleth. No pile driving would be initiated until a qualified marine mammal monitor surveys the Buffer Area. If the qualified marine mammal monitor observes a Steller sea lion in the Buffer Area on a line of movement toward the Safety Zone, pile driving would be delayed until the monitor determines, through sighting or by waiting approximately 15 minutes, that the Steller sea lion is on a line of movement that will take it away from the Safety Zone. Once pile driving begins on an individual pile, however, that segment would be completed without cessation notwithstanding any Steller sea lion presence in the Buffer Zone, since continuous sound is considered more protective than stopping and starting, which might allow Steller sea lions to return to the area where they would be subject to additional start-up sounds.

Other In-water and On-shore Equipment Noise Impact Zone – Construction activities not related to pile driving would also be expected to generate noise that could disturb pinnipeds in the unlikely event they are in the vicinity of LNG terminal construction activities. Therefore, NorthernStar proposes to establish a 50-foot radius Impact Zone around ongoing construction activities (the Impact Zone would include any areas of the Columbia River within a 50-foot radius of construction). Each day before non-pile driving construction begins, a qualified marine mammal monitor would search the Impact Zone for Steller sea lions. If a Steller sea lion is sighted within the Impact Zone, construction within the Impact Zone would be delayed until the monitor determines that no Steller sea lion is present within the Impact Zone.

Accidental Spill or Leaks of Hazardous Materials – Spills, leaks, or accidental releases of fuels, lubricants, or other hazardous substances could potentially occur during construction or operation of the proposed LNG terminal. A spill, leak, or accidental release of hazardous materials could result in mortality to the Steller sea lion. NorthernStar would minimize potential impacts associated with spills or leaks of hazardous materials during construction by implementing the spill prevention and response procedures in its terminal ESC Plan (see section 4.3.2.3). As discussed in section 4.3.2.3, a 5-foot-high perimeter berm would surround the portion of the LNG terminal containing the LNG storage tanks and vaporization units. The berm would provide containment in the unlikely event of a tank rupture; thus minimizing impacts on Steller sea lions.

Use of the LNG Terminal Site as a Haulout – Steller sea lions have been documented using various manmade objects as haulouts (e.g., navigation buoys, jetties, and docks). However, Steller sea lion haulout sites do not occur along the Columbia River upriver from the South Jetty. Following construction, the proposed LNG terminal site would be well above the water surface, leaving only vertical pilings in the water. The primary shoreline modification would be the construction of the perimeter berm above the high water mark, which would have a steeper slope than the existing shoreline. Therefore, Steller sea lions would not be expected to use the LNG terminal as a haulout site during operation of the proposed project.

Columbian White-tailed Deer

Occurrence at the LNG Terminal

The ORNHIC provided two database records of the Columbian white-tailed deer in the vicinity of the proposed LNG terminal site, about 0.5 mile southeast along the Bradwood cliffs and about 0.8 mile northwest on Tenasillahe Island. Columbian white-tailed deer are also known to occur on Puget Island, which is across the Columbia River (about 0.4 to 0.5 mile to the east) from the proposed LNG terminal.

Critical Habitat

Critical habitat has not been designated for the Columbian white-tailed deer.

Impacts and Mitigation

Potential impacts on Columbian white-tailed deer from construction and operation of the proposed LNG terminal include habitat modification; increased noise and disturbances; and collisions with vehicle or railway traffic. These impacts are discussed below.

Habitat Modification – About 59 acres of potentially suitable habitat for the Columbian white-tailed deer would be temporarily or permanently impacted by the LNG terminal facilities. The LNG terminal facility would be surrounded by an 8-foot-high fence, and thus would permanently exclude

Columbian white-tailed deer. Potentially suitable habitat for Columbian white-tailed deer at the LNG terminal site and its associated facilities includes forest (coniferous, deciduous, riparian, and early seral forests as well as forested wetlands), scrub shrub (upland scrub-shrub and palustrine scrub-shrub wetland), and palustrine emergent wetlands. These habitats are discussed below.

Construction and operation of the LNG terminal facilities would temporarily or permanently impact about 33.5 acres of forested habitats (22.9 acres temporary removal and 10.6 acres permanent removal). About 8.6 acres of this impact would be on commercially managed coniferous forest that could be harvested within 5-15 years and 5.6 acres are seral coniferous forests that are likely to be harvested in 20-40 years. Due to the location of these habitats in the hills above the LNG terminal site where the power line would be located, these habitats provide only marginally suitable habitat for Columbian white-tailed deer. The remaining 19.3 acres (12.7 acres temporary removal and 6.6 acres permanent removal) impacted by construction and operation provides potentially suitable foraging, resting, and fawning habitat for Columbian white-tailed deer. Following construction, the 22.9 acres of temporarily impacted forest habitats would be replanted in-kind with native trees as described in NorthernStar's terminal ESC Plan. However, as described in section 4.4.2.2, impacts on forested communities would be considered long-term because of the time required to restore the woody vegetation to its preconstruction condition. NorthernStar has developed a monitoring plan and performance standards to measure successful revegetation of the site. If necessary, NorthernStar would take steps to control and remove noxious and invasive species.

In addition, construction and operation of the LNG terminal facilities would impact about 19.0 acres of scrub-shrub habitats (12.3 acres temporary removal and 6.7 acres permanent removal). Of these, 10.7 acres of temporarily affected habitats are upland communities dominated by non-native Scotch broom. The remaining 8.3 acres provide potentially suitable foraging, fawning, and resting habitat for Columbian white-tailed deer. Similar to forested areas, restoration would follow the terminal ESC Plan. Due to the time required to restore the woody vegetation to its preconstruction condition, restoration is expected to be complete within 3 to 5 years.

About 11.3 acres of palustrine emergent wetland habitat (1.1 acres temporary removal and 10.2 acres permanent removal) would be impacted by construction and operation of the LNG terminal facilities. Loss of these wetland habitats could displace deer that forage and seek cover in these areas. However, it is unknown if this species uses these habitats at the proposed LNG terminal site and additional potentially suitable habitat occurs about 1,500 feet downstream of the proposed LNG terminal site. As discussed in section 4.4.1.2, restoration of wetland areas would be in accordance with NorthernStar's terminal ESC Plan. These areas would be expected to recover fully within 1 to 3 years.

The LNG terminal site would occupy a narrow strip of bottomland habitat that separates the Columbia River from forested hills that may provide a migratory corridor for Columbian white-tailed deer moving between the Wauna-Westport area, Tenasillahe Island, and/or Brownsmead. In addition, Columbian white-tailed deer moving between Tenasillahe and Puget Islands may use this corridor. Although movements between subpopulations may be infrequent, they are important for maintaining gene flow between the subpopulations. Because each subpopulation of Columbian white-tailed deer is small (less than 200 individuals), the risk of inbreeding depression within any subpopulation occurs unless there is occasional genetic exchange between members of other subpopulations. Both construction and operation of the LNG terminal could block or interfere with movement of Columbian white-tailed deer between these subpopulations.

Increased Noise and Disturbances – Increased noise and physical disturbances associated with construction and operation of the proposed LNG terminal could adversely affect Columbian white-tailed deer by disruption of foraging and resting behaviors and temporary displacement in response to

construction disturbance if this species is present during construction. As described in section 4.10.2.2, NorthernStar conducted noise attenuation modeling to predict noise levels that would be generated by construction and operation of the LNG terminal. Results of this modeling found that the average increase in ambient noise during construction would range from 5 to 24 dBA (depending on the use of selective noise mitigation measures). During operation, noise levels are estimated to increase by 5 dBA over ambient conditions. This impact would be long-term in duration, but with time, any Columbian white-tailed deer using the area would likely become habituated to the changed environment.

Collisions with Vehicle or Railway Traffic – As discussed in section 4.8.2.7, construction workers traveling to and from the proposed LNG terminal could generate up to 1,500 vehicle trips per day. During operation, the LNG terminal would generate an average of 125 daily trips, or 75 daily trips over baseline conditions. Although Columbian white-tailed deer have not been confirmed to use either Clifton or Bradwood Roads, some level of use is assumed in the lowlands that surround the LNG terminal. Elevated traffic levels would increase the likelihood of collisions between Columbian white-tailed deer and vehicles transiting to or from the LNG terminal. This impact would be greatly reduced by posting speed limit and deer warning signs on all roads. To further reduce potential impacts on deer, NorthernStar would implement a training and awareness program for all personnel constructing or accessing the LNG terminal. This program would teach personnel about the natural history and endangerment factors for the Columbian white-tailed deer, the reasons for protecting this species, and the responsibilities of personnel in preventing impacts on this species. In addition, construction workers would be bussed from a temporary parking lot located southeast of the Taylorville interchange at Highway 30, thereby reducing traffic along Clifton and Bradwood Roads.

The existing railway, which is currently in service but not in use, may be used to transport construction materials to the LNG terminal site. Rail service would likely be infrequent and the risk of collision would be low due to the expectedly low frequency of traffic on the railway and the short-term use of the line (during construction). Once construction has been completed, exposure would be eliminated. Potential for collisions would be greatly reduced by requiring that train operators sound the horn on approach to alert Columbian white-tailed deer that may be present. In addition, NorthernStar would make information available to train operators about the risk of collision and the importance of protecting Columbian white-tailed deer.

Marbled Murrelet

Occurrence at the LNG Terminal

The Priority Habitats and Species (PHS) and ORNHIC have no records of the marbled murrelet within 2 miles of the proposed LNG terminal (ORNHIC, 2004 and 2006). Forests in the vicinity of the proposed LNG terminal are relatively young and generally lack characteristics that contribute to nesting, foraging, and roosting habitats for marbled murrelets. However, marginally suitable late-successional habitat for this species is located within a narrow fringe of mature conifers on the bluffs just upstream of the LNG terminal.

Critical Habitat

The closest critical habitat unit to the proposed LNG terminal is OR-01-a, which is about 2.5 miles southeast of the LNG terminal site near Wauna, in Clatsop County, Oregon (61 Federal Register 26255 – 26320).

Impacts and Mitigation

In its April 20, 2007 letter to the FERC, the FWS commented that suitable nesting habitat for the marbled murrelet may occur in several locations within the project area. Furthermore, the FWS recommended that, unless there are documented reasons to conclude that nesting is not occurring, NorthernStar should conduct surveys to determine the nesting status of marbled murrelets in the project area. In response to this letter, NorthernStar has stated that it will conduct field investigations to confirm that potentially suitable habitat occurs in the project area. If suitable habitat is identified, NorthernStar would either conduct surveys to determine presence of marbled murrelets or would simply assume presence of marbled murrelets in the project area.

If present, marbled murrelets could potentially be affected by construction and operation of the proposed LNG terminal if nest trees and surrounding habitat were to be removed, or if construction were to occur in the vicinity of an active nest. Indirect impacts could include short-term avoidance of foraging habitat and increased visual and auditory disturbance due to construction activities. In addition, increased noise and other physical disturbances associated with operation of the LNG terminal could temporarily cause marbled murrelets to avoid the area. As noted previously, the FERC staff is currently revising its BA and EFH Assessment for the Bradwood Landing Project, which will be resubmitted to the FWS with a request to initiate formal consultation in compliance with section 7 of the ESA. Additional analysis of the potential for occurrence of and potential impacts on marbled murrelets in the vicinity of the LNG terminal site will be included in the revised BA and EFH Assessment. The FERC would not allow construction of the project to proceed until after we have completed formal consultation.

Northern Spotted Owl

Occurrence at the LNG Terminal

A search of the ORNHIC and PHS databases found no northern spotted owl nest site records within a 2-mile search radius of the proposed LNG terminal. The nearest known active spotted owl nest is located between 3 and 4 miles south of the LNG terminal in the Clatsop State Forest (ORNHIC, 2006). Forests in the vicinity of the proposed LNG terminal site are relatively young and generally lack characteristics that contribute to nesting, foraging, and roosting habitats for spotted owls. Marginally suitable late-successional habitat for this species is limited to a narrow fringe of mature conifers that occurs on the bluffs just upstream of the LNG terminal.

Critical Habitat

The closest critical habitat unit to the proposed LNG terminal is WA-39 (57 Federal Register 1796 – 1838), which is located over 50 miles east of the LNG terminal in eastern Cowlitz County (FWS, 1992b).

Impacts and Mitigation

Because there are no known occurrences of northern spotted owls in the vicinity of the LNG terminal, only marginally suitable habitat occurs within the areas affected by the LNG terminal facilities, and the distance to the nearest critical habitat unit (50 miles east), it is unlikely that northern spotted owls would be affected by construction or operation of the LNG terminal.

Streaked Horned Lark

Occurrence at the LNG Terminal

As described in section 4.6.1.1, streaked horned larks are known to occupy breeding sites on five dredge spoil islands along the lower Columbia River. The nearest breeding site occurs on an unnamed island located just upstream of Tenasillahe Island about 1 mile north of the proposed LNG terminal site (Pearson and Altman, 2005). In addition, dredge spoil areas associated with the LNG terminal and the Wahkiakum County Sand Pit site on Puget Island provide potentially suitable nesting habitat for the streaked horned lark. Although some streaked horned larks are migratory, potential habitat may be occupied throughout the year.

Critical Habitat

Critical habitat has not been designated for the streaked horned lark.

Impacts and Mitigation

The greatest potential for activities associated with construction and operation of the LNG terminal to adversely impact this species would be during the nesting season. Project activities at the LNG terminal site would begin before the nesting season and would occur between November and February at the Wahkiakum County Sand Pit site. Because streaked horned larks would not be likely to initiate nesting within an active construction site, impacts on nesting activities would not be anticipated.

Western Snowy Plover

Occurrence at the LNG Terminal

A search of the ORNHIC and PHS databases found no western snowy plover nest site records within a 2-mile search radius of the proposed LNG terminal. Although potential nesting habitat for the western snowy plover exists on dredge spoil areas at the LNG terminal, the nearest known nesting location is over 150 miles south of the LNG terminal site.

Critical Habitat

The nearest critical habitat unit to the proposed LNG terminal is WA-4, which is located about 40 miles northwest in Pacific County, Washington (64 Federal Register 68507 – 68544).

Impacts and Mitigation

Given the lack of observations of this species in the vicinity, it is unlikely that the western snowy plover would be affected by construction or operation of the LNG terminal.

Kincaid's Lupine

Occurrence at the LNG Terminal

The ORNHIC has no record of Kincaid's lupine within a 2-mile radius of the proposed LNG terminal. Although potentially suitable habitat for Kincaid's lupine is present at the LNG terminal site within the grassy openings that are interspersed in upland scrub-shrub habitat, a botanical survey conducted by NorthernStar in June 2006 did not identify Kincaid's lupine in areas that would be disturbed by project activities. However, the FWS raised concerns regarding terrestrial habitat survey methods in

their April 20, 2007 letter to the FERC requesting additional information for the BA and EFH Assessment. To confirm that listed endangered or threatened plants do not occur in the project area and would not likely be adversely affected by project activities, **we recommend that:**

- **<u>Prior to construction</u> of the LNG terminal and pipeline facilities, NorthernStar should conduct additional botanical surveys, where necessary, for federally listed endangered and threatened plants in the appropriate habitats within the project area during the appropriate survey period. <u>Before the initiation</u> of surveys, NorthernStar should consult with the FWS for appropriate survey methods and periods for each species. If project facilities are not constructed <u>within 1 year</u> from the date of issuance of authorizations, NorthernStar should consult with the appropriate offices of the FWS to update the species list and to determine if additional surveys are required. The survey reports and any FWS comments on the survey and its conclusions should be filed with the Secretary. The survey reports should include the following information:**

  a. name(s) and qualifications of the person(s) conducting the survey;

  b. method(s) used to conduct the survey;

  c. date(s) of the survey;

  d. area surveyed (include the mileposts surveyed); and

  e. proposed mitigation measures that would substantially minimize or avoid potential impacts on listed endangered or threatened plants found in the project area.

  NorthernStar must receive written approval from the Director of OEP <u>before implementing any mitigation measures</u>.

Critical Habitat

Critical habitat has not been designated for Kincaid's lupine. However, critical habitat was proposed for this species in 2005 (70 Federal Register 66491 – 66599). The nearest proposed critical habitat unit for this species is located in Lewis County, Washington, which is approximately 30 miles northeast of the proposed LNG terminal site.

Impacts and Mitigation

Because there are no known occurrences of Kincaid's lupine in the vicinity of the LNG terminal and the nearest proposed critical habitat unit for Kincaid's lupine is located approximately 30 miles northeast of the LNG terminal, with the implementation of our recommendation to complete any necessary follow-up surveys, it is unlikely that Kincaid's lupine would be affected by construction or operation of the LNG terminal.

Water Howellia

Occurrence at the LNG Terminal

The ORNHIC has no record of water howellia within a 2-mile radius of the proposed LNG terminal. Although potentially suitable habitat for water howellia is present at the LNG terminal site, water howellia was not identified during a botanical survey conducted by NorthernStar in June 2006 in areas that would be disturbed by project activities. However, the FWS raised concerns regarding terrestrial habitat survey methods in their April 20, 2007 letter to the FERC requesting additional information for the BA and EFH Assessment. Therefore, we have recommended that NorthernStar conduct additional botanical surveys for federally listed endangered and threatened plants in the appropriate habitats within the project area during the appropriate survey period (see *Kincaid's lupine*).

Critical Habitat

Critical habitat has not been designated for water howellia.

Impacts and Mitigation

Because there are no known occurrences of water howellia in the vicinity of the LNG terminal, and with the implementation of our recommendation to complete any necessary follow-up surveys, it is unlikely that water howellia would be affected by construction or operation of the LNG terminal.

State Listed Threatened and Endangered Species

NorthernStar consulted with the ODFW, ORNHIC, WDFW, and WNHP to identify state listed endangered and threatened species with the potential to occur at the LNG terminal. Many state listed endangered or threatened species are also federally listed and were previously described. The remaining species (bald eagle) is discussed below.

Bald Eagle

During field visits to the proposed LNG terminal site, eagles were observed flying over the area near the proposed LNG terminal site; however no bald eagle nests occur within 0.5 mile of the proposed LNG terminal. The WDFW has also mapped bald eagle communal winter roost sites, which may be found along the Columbia River in the vicinity of the proposed LNG terminal and are most likely to be occupied from November through March.

Breeding bald eagles could potentially be affected by construction and operation of the proposed LNG terminal if nest trees and surrounding habitat are removed, or if construction were to occur in the vicinity of an active nest or communal roost. Indirect impacts on bald eagles could include short-term displacement of aquatic prey populations due to in-water activities, increased visual and auditory construction disturbance, and potentially increased suspended sediment and turbidity levels. Displacement of aquatic prey could indirectly affect bald eagles that may utilize these species as a portion of their diet. In addition, increased noise and other physical disturbances associated with operation of the LNG terminal could temporarily cause bald eagles to avoid the area.

To minimize impacts on bald eagles before and during construction and operation of the LNG terminal, NorthernStar has agreed to implement the following measures:

- Review the most recent Isaacs and Anthony annual bald eagle nesting survey database for current nest locations. This document is generally available each December; however, current nesting season activity can usually be obtained by contacting Frank Isaacs directly. Direct contact would be made to access data before each construction season to update new nest locations.

- Minimize construction, operation, and maintenance activities within 0.5 mile of any nest (or 0.25 mile if any nest is within line-of-sight of the project), or to non-breeding season (October 31 to December 31).

- Avoid removal of potentially suitable bald eagle nest or roost trees (e.g., mature deciduous or coniferous trees that offer an unobstructed view of the surrounding area).

- Restore large areas of estuarine habitat suitable for salmonid rearing, and other measures that would increase fish production and ecosystem health in the lower Columbia River area.

To minimize impacts on bald eagles before and during construction of the project, **we recommend that:**

- **NorthernStar should conduct a survey for bald eagles, where necessary, <u>prior to construction</u> of the LNG terminal and pipeline facilities. <u>Before the initiation</u> of surveys, NorthernStar should consult with the FWS, ODFW, and WDFW for appropriate survey methods and periods for the surveys. The survey reports and any agency comments on the survey and its conclusions should be filed with the Secretary. The survey reports should include the following information:**

  a. name(s) and qualifications of the person(s) conducting the survey;

  b. method(s) used to conduct the survey;

  c. date(s) of the survey;

  d. area surveyed (include the mileposts surveyed); and

  e. proposed mitigation measures that would substantially minimize or avoid potential impacts on bald eagles found in the project area.

  NorthernStar must receive written approval from the Director of OEP <u>before implementing</u> any mitigation measures.

Other Special Status Species

<u>Sensitive Species</u>

In addition to the species listed under the ESA or by the States of Oregon and Washington, five species that are candidates for listing as endangered or threatened or species of special concern have been identified by the agencies as having the potential to occur in the vicinity of the proposed LNG terminal. The ODFW also expressed concerns regarding several other sensitive species, including the coastal cutthroat trout, red-legged frog, American peregrine falcon, and olive-sided flycatcher. The NMFS requested analysis of the North American green sturgeon. These sensitive species are discussed below.

Coastal Cutthroat Trout

Potential spawning habitat for coastal cutthroat trout exists in the portion of Hunt Creek below the falls. In addition, the mouth of Hunt Creek and main channel of the Columbia River likely provide habitat for coastal cutthroat trout. Potential impacts resulting from construction and operation of the proposed LNG terminal on coastal cutthroat trout would be similar to those discussed previously concerning federally listed salmonids. As discussed in section 4.5.2.1, NorthernStar would implement various mitigation measures to avoid, minimize, rectify, reduce, and/or compensate for impacts on salmonids; these measures would also benefit coastal cutthroat trout.

Eulachon

The WDFW expressed concern about potential impacts on eulachon spawning in the mainstem Columbia River and out-migration of smelt larvae as a result of construction and operation of the proposed LNG terminal. Potential impacts on eulachon would be similar to those discussed previously concerning federally listed salmonids. Research by the WDFW and ODFW has lead to recommendations that dredging and disposal of dredged material be prohibited in the Columbia River between CRM 35 and CRM 75 from March through June, which is the key spawning and post spawning periods for eulachon. The established ODFW in-water work window for the Columbia River (November 1 through February 28) implements these recommendations. A discussion of additional measures to avoid, minimize, rectify, reduce, and/or compensate for impacts on aquatic resources is included in section 4.5.2.1.

Lampreys

Based on general requirements for spawning habitat, potential spawning habitat for the Pacific lamprey exists below the falls on Hunt Creek. In addition, estuarine and fluvial environments at the mouth of Hunt Creek and within the main channel of the Columbia River may provide bottom habitat for juvenile lampreys. The mainstem Columbia River also serves as a migratory route for adults moving to or returning from the sea. Potential impacts resulting from construction and operation of the proposed LNG terminal on lampreys would be similar to those discussed previously concerning federally listed salmonids. As discussed in section 4.5.2.1, NorthernStar would implement various mitigation measures to avoid, minimize, rectify, reduce, and/or compensate impacts on salmonids; these measures would also benefit river and Pacific lampreys.

North American Green Sturgeon

Potential impacts resulting from construction and operation of the proposed LNG terminal on North American green sturgeon would be similar to those discussed previously concerning federally listed salmonids. As discussed in section 4.5.2.1, NorthernStar would implement various mitigation measures to avoid, minimize, rectify, reduce, and/or compensate for impacts on salmonids; these measures would also benefit North American green sturgeon.

Red-legged Frog

There is potential for the red-legged frog to occur in wetlands and waterbodies in the vicinity of the proposed LNG terminal. Potential impacts on aquatic species as a result of construction and operation of the proposed LNG terminal are discussed in section 4.5.2.1. Due to the presence of hundreds of red-legged frogs on lower Svensen Island, preservation of existing habitat and restoration of additional habitat on lower and middle Svensen Island would mitigate for any impacts on potential red-legged frog habitat lost at the LNG terminal site.

American Peregrine Falcon

Suitable habitat for the American peregrine falcon is located immediately east of the LNG terminal on basalt cliffs that border the western bank of the Columbia River. American peregrine falcons have been observed during site visits flying over the bluffs located immediately south of the LNG terminal. The ORNHIC database has one record of an active nest from this area, which is about 0.8 mile east of the LNG terminal. Given the distance and the location of the potential nesting habitat, it is unlikely that the American peregrine falcon would be adversely impacted by construction or operation of the LNG terminal.

Northern Goshawk

Forests in the vicinity of the proposed LNG terminal site are relatively young and generally lack characteristics that contribute to nesting, foraging, and roosting habitats for northern goshawks. Marginally suitable late-successional habitat for this species is limited to a narrow fringe of mature conifers that occurs on the bluffs just upstream of the LNG terminal. The ORNHIC database does not have any records of this species occurring within 5 miles of the LNG terminal site. Significant impacts on northern goshawks from construction and operation of the proposed LNG terminal would not be anticipated.

Olive-sided Flycatcher

The olive-sided flycatcher has been recorded on both of the Breeding Bird Surveys conducted near the LNG terminal site (Sauer et al., 2005). Construction and operation of the LNG terminal could potentially affect the olive-sided flycatcher due to clearing of forested habitats. Potential impacts and proposed mitigation for clearing of forested habitat are discussed in section 4.4.2.2. Migratory birds are discussed below (see *Migratory Bird Treaty Act*).

Purple Martin

A study conducted in 1998 to determine distribution, abundance, and nest site characteristics of purple martins in Oregon found that martins were locally common along the Columbia River, in some coastal estuaries, and at the Fern Ridge Reservoir (Hovarth, 1999). Purple martins have been documented on nearby river islands, and they were observed flying over the proposed LNG terminal site during a site visit in early August 2005 (ORNHIC, 2006). Potentially suitable nesting habitat for this species is present within the project area in the form of abandoned pilings. However, construction activities at the LNG terminal site would begin during the recommended in-water window (November 1 – February 28), which concludes before purple martins return to the west coast from their wintering grounds in South America. Therefore, disturbance to purple martins nesting at the LNG terminal site would not occur. To mitigate for the permanent loss of potential nesting habitat, NorthernStar proposes to install purple martin gourds at the Peterson Point and Middle Svensen Island Mitigation Sites.

<u>Marine Mammals</u>

As described above, both California sea lions and Pacific harbor seals are expected to occur within the Columbia River near the LNG terminal site regularly. California sea lions occur in the lower Columbia River between September and mid-June, but do not have any haulout sites in the vicinity of the proposed LNG terminal. California sea lions would travel through the project area enroute to foraging areas at Bonneville Dam and Willamette Falls where salmon congregate at these restriction points. As part of dedicated hazing efforts to discourage pinnipeds from foraging on salmon at the dam, observers have documented between 30 California sea lions at the dam (in 2002) to as many as 106 individuals (in 2003).

In contrast, harbor seals have six haulouts within 10 miles of the proposed LNG terminal site and would be expected to occur near the LNG terminal on a more regular basis during the in-water work window. Harbor seals arrive at Bonneville Dam as early as August 28 (in 2007); therefore, occurrence within the Columbia River upstream of the South Jetty could occur as early as August. However, larger numbers of harbor seals would be expected during their seasonal movements into the Columbia River between January and April (Jeffries, 2008).

Jeffries et al. (2000) documented pinniped haulouts along the lower Columbia River, including six haulout sites within 10 river miles of the proposed terminal site. These sites are predominantly or solely used by Pacific harbor seals. At the time of the survey, approximately 1,800 harbor seals were counted at these six haulout sites. Because specific foraging areas for each of the haulouts within 10 miles of the terminal are not known to exist, it is expected that harbor seals using these haulouts would likely forage near the LNG terminal site.

As described above (see *Steller Sea Lion*), it is possible that pinnipeds could be adversely impacted by dredging and pile-driving activities at the LNG terminal. NorthernStar proposes to implement protective measures including the establishment of safety, buffer, and impact zones to protect the Steller sea lion during construction activities at the LNG terminal (see *Steller Sea Lion*). To provide similar protections to other pinnipeds potentially occurring in the vicinity of the LNG terminal, **we recommend that:**

- **NorthernStar should expand the protective measures that would be used to avoid or minimize impacts on Steller sea lions <u>during construction</u> of the LNG terminal (e.g., safety, buffer, and noise impact zones) to include all pinnipeds.**

In addition, because of the potential that pile driving may be carried out if pinnipeds are present in the Safety Zone (i.e., the animals may be exposed to sound pressures in excess of 160 dB), NorthernStar has stated that it intends to obtain an Incidental Harassment Authorization, in consultation with the NMFS before beginning pile driving activities

<u>Migratory Bird Treaty Act</u>

As described in section 4.5.2.3, habitat modification, increased noise levels, terminal lighting, and vegetative clearing associated with construction and operation of the proposed LNG terminal could adversely affect migratory birds occurring in the vicinity of the LNG terminal. Although the LNG terminal would be located within a portion of the Columbia River estuary that provides important stop-over habitat for migrating birds, it is anticipated that adequate habitat is located in the vicinity of the LNG terminal to accommodate birds displaced by habitat modification and increased noise levels. In addition, restoration and preservation at the proposed mitigation sites would also provide new or enhanced areas of bird habitat.

Potential impacts on wildlife (including migratory birds) due to terminal lighting are discussed in sections 4.5.2.1 and 4.5.2.3. Due to the presence of high-quality habitats that are frequently used by shorebirds, waterfowl, and other waterbirds migrating along the Pacific Flyway, additional measures are necessary to minimize impacts from terminal lighting on migratory birds in the vicinity of the proposed project. Therefore, we have recommended in section 4.5.2.1 that NorthernStar continue to consult with the NMFS, FWS, ODFW, and other applicable agencies to finalize its Lighting Plan.

To minimize impacts on migratory birds from vegetative clearing, NorthernStar has stated that it would avoid clearing during peak nesting season and would clear for vegetation maintenance only between mid-July and October. However, due to the importance of the area for migratory birds,

additional measures are necessary to minimize impacts on nesting birds due to construction of the LNG terminal. Therefore, **we recommend that:**

- **NorthernStar should consult with the FWS and other appropriate agencies to develop a Migratory Bird Nest Avoidance Plan to minimize impacts on migratory birds during the peak nesting season. NorthernStar should file its Migratory Bird Nest Avoidance Plan along with agency comments with the Secretary <u>prior to the commencement</u> of clearing activities at the LNG terminal and along the pipeline.**

4.6.2.3 Pipeline Facilities

Federally Listed Species

<u>Salmonids</u>

Lower Columbia River Chinook Salmon ESU

<u>Occurrence along the Pipeline Route</u> – Lower Columbia River Chinook salmon ESU occur in the following waterbodies crossed by the proposed pipeline route: Westport Slough, Clatskanie River, Columbia River, Cameron Creek, Abernathy Creek, Germany Creek, Cowlitz River, and Ostrander Creek (ODFW, 2005; Wade, 2000, 2002). These waterbodies provide habitat for migrating spring- and fall-run adults from March to June and August to October, respectively (NMFS, 2005c). Spring-run salmon out-migrate as yearlings during the spring and summer. In contrast, fall-run salmon out-migrate as sub-yearlings from April through June (NMFS, 2005c). Juvenile rearing for both spring- and fall-run populations occurs within these waterbodies throughout the year (ODFW, 2005; Wade, 2000, 2002).

<u>Critical Habitat</u> – Within the waterbodies crossed by the proposed pipeline route, the Lower Columbia River Chinook salmon ESU has designated critical habitat (migratory corridor PCE) within the lower Columbia River mainstem. As described in section 4.6.2.1, adult salmon from this ESU migrate through the lower Columbia River en route to their spawning grounds in upstream and smolts out-migrate through the lower Columbia River. In addition, critical habitat (spawning PCE) has been designated at the proposed crossings of the Columbia River, Abernathy Creek, Germany Creek, and Ostrander Creek. Finally, critical habitat (rearing PCE) has been designated within nearshore habitats of the Columbia River mainstem, Columbia River islands, and the accessible low gradient reaches of Columbia River floodplain sloughs, Hunt Creek, Westport Slough, Clatskanie River, Cameron Creek, Abernathy Creek, Germany Creek, Cowlitz River, and Ostrander Creek (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation.

Upper Columbia River Spring-run Chinook Salmon ESU

<u>Occurrence along the Pipeline Route</u> – Occurrence of the Upper Columbia River Spring-run Chinook salmon ESU within waterbodies crossed by the proposed pipeline route would be limited to seasonal migrations within the lower Columbia River. The life stages present and seasonal occurrence of the Upper Columbia River Spring-run Chinook Salmon ESU along the lower Columbia River are described in section 4.6.2.1.

<u>Critical Habitat</u> – As described in section 4.6.2.1, the Columbia River is designated as critical habitat (rearing and migratory corridor PCEs) for the Upper Columbia River Spring-run Chinook salmon ESU (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation.

Upper Willamette River Chinook Salmon ESU

Occurrence along the Pipeline Route – Upper Willamette River Chinook salmon occur in the following waterbodies crossed by the proposed pipeline route: Westport Slough; Columbia River; and the tidal reaches of the Clatskanie River, Abernathy Creek, Germany Creek, and Cowlitz River (ODFW, 2005; Kostow, 1995). The Columbia River provides habitat for migrating adults between April and May, with a peak in mid-May, (NMFS, 2005c). According to the Biological Review Team (2005), out-migration has been found to occur in recently emerged juveniles during the winter through early spring, in sub-yearlings during the fall through early winter, and as yearlings in the late winter through spring (NMFS, 2005c). In addition, juvenile sub-yearling Chinook salmon from the Upper Willamette River Chinook salmon ESU rear over-winter in nearshore habitats, of the Columbia River mainstem, Westport Slough, and the tidal reaches of the Clatskanie River, Abernathy Creek, Germany Creek, and the Cowlitz River, after juveniles emerge between February and June (NMFS, 2005c).

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated as critical habitat (rearing and migratory corridor PCEs) for the Upper Willamette River Chinook salmon ESU (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation.

Snake River Spring/Summer-run Chinook Salmon ESU

Occurrence along the Pipeline Route – Occurrence of the Snake River Spring/Summer-run Chinook salmon ESU within waterbodies crossed by the proposed pipeline route would be limited to seasonal migrations within the lower Columbia River. The life stages present and seasonal occurrence of the Snake River Spring/Summer-run Chinook salmon ESU along the lower Columbia River are described in section 4.6.2.1.

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated critical habitat (migratory corridor PCE) for the Snake River Spring/Summer-run Chinook salmon ESU (58 Federal Register 68543 – 68554). Adjacent riparian zones are included in the designation, defined as those areas within 300 feet of the normal line of high water of a stream channel.

Snake River Fall-run Chinook Salmon ESU

Occurrence along the Pipeline Route – Snake River Fall-run Chinook salmon occur in the following waterbodies crossed by the proposed pipeline route: Westport Slough; Columbia River; and the tidal reaches of the Clatskanie River, Abernathy Creek, Germany Creek, and Cowlitz River (ODFW, 2005; Kostow, 1995). As described in section 4.6.2.1, the Columbia River provides habitat for migrating adults between August and December and for out-migrating smolts between April and June (Bell Fisheries Handbook, 1973). In addition, juvenile sub-yearling Chinook salmon from the Snake River Fall-run Chinook salmon ESU rear in nearshore habitats of the Columbia River mainstem, Westport Slough, and the tidal reaches of the Clatskanie River, Abernathy Creek, Germany Creek, and the Cowlitz River for up to 1 year before out-migrating (Bell Fisheries Handbook, 1973).

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated as critical habitat (rearing and migratory corridor PCEs) for the Snake River Fall-run Chinook salmon ESU. Adjacent riparian zones are included in the designation, defined as those areas within 300 feet of the normal line of high water of a stream channel.

Columbia River Chum Salmon ESU

Occurrence along the Pipeline Route – Columbia River chum salmon occur in the following waterbodies crossed by the proposed pipeline route: Westport Slough; Columbia River; and the tidal reaches of the Clatskanie River, Abernathy Creek, Germany Creek, and the Cowlitz River (Ehlke and Keller, 2002). Chum salmon populations in tributaries crossed by the proposed pipeline route in Oregon are extirpated and the few fish observed in these tributaries are strays from runs returning to Washington tributaries of the lower Columbia River (ODFW, 2005). The Columbia River, Abernathy Creek, Germany Creek, and the Cowlitz River provide habitat for migrating and spawning adults between mid-October and December and for out-migrating smolts between March and May, with a peak from mid-April through early May (NMFS, 2005c). In addition, out-migrating smolts from Washington tributaries of the lower Columbia River and spawning areas in the Columbia River upstream of the project area rear in nearshore habitat of the Columbia River mainstem and the tidal reaches of the Clatskanie River, Abernathy Creek, Germany Creek, and the Cowlitz River between December and May (Bell Fisheries Handbook, 1973).

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated as critical habitat (rearing, migratory corridor, and spawning PCEs) for the Columbia River chum salmon ESU (70 Federal Register 52630 – 52858). In addition, critical habitat (rearing and migratory corridor PCEs) has been designated at the proposed crossings of Abernathy Creek, Germany Creek, and the Cowlitz River (70 Federal Register 52630 – 52858). The designation defines the lateral extent of critical habitat for each designated stream reach as the width of the stream channel as defined by its bankfull elevation.

Lower Columbia River Coho Salmon ESU

Occurrence along the Pipeline Route – The Columbia River coho salmon ESU may occur in the following waterbodies crossed by the proposed pipeline route: Westport Slough, Clatskanie River, Columbia River, Cameron Creek, Abernathy Creek, Germany Creek, Tributary 5 to Coal Creek, Coal Creek, Cowlitz River, Ostrander Creek, and Ostrander Creek Tributary 1 (ODFW, 2005; Good et al., 2005; Wade, 2000, 2002). Within the waterbodies listed above, adult migration occurs between June and February, smolt out-migration occurs between April and August, and juvenile rearing occurs throughout the year (ODFW, 2005; Good et al., 2005; Wade, 2000, 2002).

Critical Habitat – Critical habitat has not been designated for the Lower Columbia River coho salmon ESU.

Snake River Sockeye Salmon ESU

Occurrence along the Pipeline Route – Occurrence of the Snake River sockeye salmon ESU within waterbodies crossed by the proposed pipeline route would be limited to seasonal migrations within the lower Columbia River. The life stages present and seasonal occurrence of the Snake River sockeye salmon ESU along the lower Columbia River are described in section 4.6.2.1.

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated critical habitat (migratory corridor PCE) for the Snake River sockeye salmon ESU (58 Federal Register 68543 – 68554). Critical habitat includes the adjacent riparian zone defined as those areas within 300 feet of the normal line of high water of a stream channel; therefore, the log pond at the LNG terminal is included in the critical habitat designation.

Lower Columbia River Steelhead DPS

Occurrence along the Pipeline Route – The Lower Columbia River steelhead DPS may occur in the following waterbodies crossed by the proposed pipeline route: the Columbia River, the Cowlitz River, Ostrander Creek, and Tributary 1 to Ostrander Creek (Wade, 2000, 2002). Due to the variability in the lifecycle of steelhead, adult migration within the waterbodies listed above occurs throughout the year, with seasonal peaks in activity; smolts out-migrate between March and June, with a peak in April or May; and juvenile rearing occurs throughout the year (Wade, 2000, 2002; NMFS, 2005c).

Critical Habitat – Within the waterbodies crossed by the proposed pipeline route, critical habitat (rearing and migratory corridor PCEs) has been designated for the Lower Columbia River steelhead DPS in the Columbia River, the Cowlitz River, and Ostrander Creek (70 Federal Register 52630 – 52858). The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Middle Columbia River Steelhead DPS

Occurrence along the Pipeline Route – Occurrence of the Middle Columbia River steelhead DPS within waterbodies crossed by the proposed pipeline would be limited to migration within the lower Columbia River. As described in section 4.6.2.1, the lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity, and out-migrating smolts between March and June (NMFS, 2005c).

Critical Habitat – As described in section 4.6.2.1, the Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Middle Columbia River steelhead DPS (70 Federal Register 52630 – 52858). The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Upper Columbia River Steelhead DPS

Occurrence along the Pipeline Route – Occurrence of the Upper Columbia River steelhead DPS within waterbodies crossed by the proposed pipeline route would be limited to migration within the lower Columbia River. As described in section 4.6.2.1, the lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity, and out-migrating smolts between March and June (Bell Fisheries Handbook, 1973).

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Upper Columbia River steelhead DPS (70 Federal Register 52630 – 52858). The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Upper Willamette River Steelhead DPS

Occurrence along the Pipeline Route – Occurrence of the Upper Willamette River steelhead DPS within waterbodies crossed by the proposed pipeline route would be limited to migration within the lower Columbia River. As described in section 4.6.2.1, the lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity, and out-migrating smolts between March and July (Bell Fisheries Handbook, 1973).

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Upper Willamette River steelhead DPS (70 Federal Register 52630 – 52858). The

lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Snake River Basin Steelhead DPS

Occurrence along the Pipeline Route – Occurrence of the Snake River Basin steelhead DPS within the waterbodies crossed by the proposed pipeline route would be limited to migration within the lower Columbia River. As described in section 4.6.2.1, the lower Columbia River provides habitat for migrating adults throughout the year, with seasonal peaks in activity, and out-migrating smolts between March and June (Bell Fisheries Handbook, 1973).

Critical Habitat – The Columbia River is designated critical habitat (rearing and migratory corridor PCEs) for the Snake River Basin steelhead DPS (70 Federal Register 52630 – 52858). The lateral extent of critical habitat for each designated stream reach is the width of the stream channel as defined by its bankfull elevation.

Impacts and Mitigation

The pipeline facilities associated with the Bradwood Landing Project would affect federally listed salmonids and sturgeon and/or their designated critical habitat through various activities including:

- in-water pipeline construction;
- terrestrial/riparian habitat modification associated with construction;
- accidental spills and leaks of hazardous materials; and
- maintenance vegetation clearing.

Potential impacts and mitigation from each of these factors are summarized in table 4.6.2-1 and discussed in detail in section 4.5.3.1. The FERC received numerous comments stating that the mitigation proposed by NorthernStar does not adequately compensate for impacts on aquatic resources associated with the project. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. To ensure that the mitigation proposed for the Bradwood Landing Project adequately compensates for project-related impacts, we have recommended that NorthernStar continue to consult with the appropriate natural resource agencies to finalize its Compensatory Mitigation Plan. The final Compensatory Mitigation Plan would be filed along with agency comments and applicable approvals with the Secretary prior to construction of the project.

Columbian White-tailed Deer

Occurrence along the Pipeline Route

During the investigation for this project, biologists observed Columbian white-tailed deer from the Oregon lowlands subpopulation along the proposed pipeline route at commercial poplar plantations between Westport Slough and the Clatskanie River. Within the known range of the Oregon lowlands subpopulation, the proposed pipeline would cross lands designated by the FWS as Essential Habitat for the Columbian white-tailed deer between MPs 5.3 and 7.1. Essential Habitat is also located within 0.5 mile of the pipeline between MP 10.5 and MP 13.7 (FWS and the Columbian White-tailed Deer Recovery Team, 1983).

Critical Habitat

Critical habitat has not been designated for the Columbian white-tailed deer.

Impacts and Mitigation

Potential impacts on Columbian white-tailed deer from construction and operation of the proposed pipeline include habitat modification and increased noise and disturbances. These impacts are discussed below.

Habitat Modification – About 178.5 acres of potentially suitable habitat for the Columbian white-tailed deer would be temporarily impacted by construction of the pipeline facilities within areas known to support Columbian white-tailed deer. In general, impacts on Columbian white-tailed deer habitat would occur between MPs 4 and 19 of the proposed route. Potentially suitable habitats for Columbian white-tailed deer along the proposed pipeline route are categorized as forest (coniferous, deciduous, mixed, riparian, and early seral forests as well as forested wetlands), scrub shrub (upland scrub-shrub and palustrine scrub-shrub wetland), and herbaceous (pastures, open fields, commercial poplar plantations and palustrine emergent wetlands). These habitats are discussed below.

Within areas known to support Columbian white-tailed deer, construction and operation of the proposed pipeline would impact about 31.6 acres of forested habitats (24.0 acres temporary removal and 7.6 acres permanent removal). Of this, 21.3 acres (14.9 acres temporary removal and 6.4 acres permanent removal) consist of commercially managed coniferous forest, which would likely be harvested within 5 to 15 years. Due to the location of these habitats in the hills above the LNG terminal site, these habitats provide only marginally suitable habitat for Columbian white-tailed deer, which prefer lowland habitats.

In addition, about 32.0 acres (22.4 acres temporary removal and 9.6 acres permanent removal) of designated essential habitat would be affected due to removal of forested vegetation within construction right-of-way and extra work areas. Most of the essential habitat within the proposed pipeline route consists of young hybrid poplar plantations (classified as palustrine emergent wetlands), with lesser amounts of pastures/open fields, riparian forest, and emergent wetlands. Columbian white-tailed deer have been observed using commercial poplar plantations where it occurs along the proposed pipeline route between the communities of Westport and Port Westward.

Removal of forested habitats could temporarily reduce cover and forage opportunities for Columbian white-tailed deer or lead to displacement into adjacent habitats. As described in section 4.4.2.3, upland forested habitats would be replanted in-kind with trees, with the exception of the portion of the right-of-way within 15 feet of the pipeline (30 feet total), and forested wetlands would be replanted in-kind with trees, with the exception of the portion of the right-of-way within 5 feet of the pipeline (10 feet total), thereby minimizing the extent of disturbance. NorthernStar's proposed tree planting exceeds the revegetation requirements of the FERC staff's Plan and Procedures. The corridor centered on the pipeline would be planted with a native grass seed mix and maintained in an herbaceous state to facilitate maintenance and inspection. Nearly complete canopy coverage over the pipeline would be expected to develop in most areas within approximately 20 years. The resulting corridor of herbaceous corridor could provide potential foraging or movement habitat for Columbian white-tailed deer.

About 9.6 acres of scrub-shrub habitats (all temporary) within areas known to support Columbian white-tailed deer would be impacted by construction and operation of the proposed pipeline. These habitats may provide suitable fawning, resting, and foraging habitat. As described above, the recovery time for impacts on scrub-shrub habitats would be significantly less than that required in forested habitats. With the exception of the herbaceous corridor centered on the pipeline, scrub-shrub habitats would be expected to recover to preconstruction conditions within 3 to 5 years.

In addition, 137.4 acres of herbaceous habitats (99.6 acres temporary removal and 37.8 acres permanent removal) would be affected by construction of the proposed pipeline within areas known to

support Columbian white-tailed deer. Due to the early successional stage of these habitats, they would be expected to recover very quickly from construction-related disturbance. Fields cleared early in the growing season may recover by the end of the growing season; whereas, fields cleared later in the growing season would be expected to recover the following spring.

During construction of the pipeline, Columbian white-tailed deer may avoid or abandon areas within about 1,000 feet of active work sites (U.S. Department of the Interior, 2007). During the first 2 to 4 weeks of life, fawns rely entirely on remaining motionless to avoid predators. Therefore, if construction activities were to occur during this period, fawns would be vulnerable to being crushed by construction vehicles. Furthermore, fawns need to nurse between five and six times per day. Because Columbian white-tailed deer would be expected to avoid or abandon areas within 1,000 feet of construction activities, fawns hidden near construction areas would not likely be nursed for the entire length of time each day that activities occurred, which could negatively impact their survival. To minimize disturbances to Columbian white-tailed deer, NorthernStar has stated that ground disturbing activities in suitable Columbian white-tailed deer habitat would be scheduled outside of the fawning season where possible. However, because fawns are highly vulnerable during the fawning season, the U.S. Department of the Interior recommended that no construction activities of any kind occur between MPs 4 and 19 during the fawning season. In order to provide the protection requested by the U.S. Department of the Interior, **we recommend that:**

- **Pipeline construction activities should not occur within potential habitat for Columbian white-tailed deer (MPs 4 to 19) between June 1 and July 15.**

Maintenance vegetation clearing along the pipeline route would be conducted between August 1 and April 15, thus avoiding the fawning season.

NorthernStar would compensate for habitat impacts through enhancing and protecting suitable habitats at the Peterson Point Mitigation Site, an area used extensively by the Oregon lowlands subpopulation of Columbian white-tailed deer. The FERC received numerous comments stating that the mitigation proposed by NorthernStar does not adequately compensate for impacts associated with the project. As described in section 2.1.5, NorthernStar is currently revising its Compensatory Mitigation Plan. To ensure that the mitigation proposed for the Bradwood Landing Project adequately compensates for project-related impacts, we have recommended that NorthernStar continue to consult with the appropriate natural resource agencies to finalize its Compensatory Mitigation Plan. The final Compensatory Mitigation Plan would be filed along with agency comments and applicable approvals with the Secretary prior to construction of the project.

Increased Noise and Disturbances – Increased noise and physical disturbances associated with construction and operation of the proposed pipeline and associated facilities could adversely affect Columbian white-tailed deer by disruption of foraging and resting behaviors, and temporary displacement in response to construction disturbance if this species is present during construction. Pipeline maintenance would result in periodic increases in noise and other physical disturbances; however, NorthernStar would schedule ground disturbing activities in suitable Columbian white-tailed deer habitat outside of the fawning season where possible.

Marbled Murrelet

Occurrence along the Pipeline Route

The PHS and ORNHIC have no records of the marbled murrelet within 2 miles of the proposed pipeline route (ORNHIC, 2004 and 2006). Forests in the vicinity of the proposed pipeline are relatively

young and generally lack characteristics that contribute to nesting habitats, foraging, and roosting areas for marbled murrelets.

Critical Habitat

Within the counties crossed by the Bradwood Landing pipeline, critical habitat units for the marbled murrelet have been designated within Clatsop County, Oregon and Cowlitz County, Washington. The closest critical habitat unit to the Bradwood Landing pipeline is in Clatsop County about 0.4 mile southwest of MP 2.5 (FWS, 1996a).

Impacts and Mitigation

As described in section 4.6.2.2, in its April 20, 2007 letter to the FERC, the FWS commented that suitable nesting habitat for the marbled murrelet may occur in several locations within the project area. A total of 21.6 acres of potentially suitable habitat for marbled murrelets occurs within areas impacted by the proposed pipeline. Of this, 12.5 acres would be permanently converted to herbaceous habitat. Specifically, approximately 3.3 acres of category 2 coniferous forest (based on the State of Oregon's HMP) would be permanently impacted by the proposed pipeline in Oregon. In addition, construction and operation of the proposed pipeline in Washington would impact about 12.2 acres of high quality coniferous forest habitats (6.1 acres would be permanent), 5.8 acres of high quality mixed forest habitats (2.9 acres would be permanent), and 0.3 acre of high quality riparian forest habitats (0.2 acre would be permanent).

Within areas of potentially suitable habitat, the FWS recommended that unless there are documented reasons to conclude that nesting is not occurring, NorthernStar should conduct surveys to determine the nesting status of marbled murrelets in the project area. In response to this letter, NorthernStar has stated that it will conduct field investigations to confirm that potentially suitable habitat occurs in the project area. If suitable habitat is identified, NorthernStar would either conduct surveys to determine presence of marbled murrelets or would simply assume presence in the project area.

If present, marbled murrelets could potentially be affected by construction of the proposed pipeline if nest trees and surrounding habitat were to be removed, or if construction were to occur in the vicinity of an active nest. Indirect impacts could include short-term avoidance of foraging habitat and increased visual and auditory disturbance due to construction activities. As noted previously, the FERC staff is currently revising its BA and EFH Assessment for the Bradwood Landing Project, which will be resubmitted to the FWS with a request to initiate formal consultation in compliance with section 7 of the ESA. Additional analysis of the potential for occurrence of and potential impacts on marbled murrelets in the vicinity of pipeline facilities will be included in the revised BA and EFH Assessment. The FERC would not allow construction of the project to proceed until after we have completed formal consultation.

Northern Spotted Owl

Occurrence along the Pipeline Route

A search of the ORNHIC and PHS databases found no northern spotted owl nest site records within a 2-mile search radius of the proposed project area. The nearest known active spotted owl nest is located between 3 and 4 miles south of the LNG terminal in the Clatsop State Forest (ORNHIC, 2006). Forests in the vicinity of the proposed pipeline route are relatively young and generally lack characteristics that contribute to nesting habitats, foraging, and roosting areas for spotted owls.

Critical Habitat

Within the counties crossed by the Bradwood Landing pipeline, critical habitat for the northern spotted owl has been designated in Cowlitz County, Washington. The closest critical habitat unit to the proposed pipeline route is WA-39 (FWS, 1992b), located about 24.4 miles east of the pipeline interconnect with the Williams Northwest pipeline system in eastern Cowlitz County (FWS, 1992b).

Impacts and Mitigation

Because there are no known occurrences of northern spotted owls in the vicinity of the proposed pipeline route, and the distance to the nearest critical habitat unit is over 20 miles, it is unlikely that northern spotted owls would be affected by construction or operation of the proposed pipeline.

Kincaid's Lupine

Occurrence along the Pipeline Route

The ORNHIC has no record of Kincaid's lupine within a 2-mile radius of the proposed pipeline route and there is little habitat that is potentially suitable for this species in the project area. Additionally, a botanical survey of the project area conducted by biologists contracted by NorthernStar did not identify Kincaid's lupine in the project area. Because the FWS raised concerns regarding terrestrial habitat survey methods in their April 20, 2007 letter to the FERC and the botanical survey report prepared for this project did not clearly confirm that all areas of potential habitat were surveyed during appropriate survey periods, we have recommended NorthernStar complete additional consultations with the FWS and conduct additional surveys, as necessary (see section 4.6.2.2).

Critical Habitat

Critical habitat has not been designated for Kincaid's lupine. However, critical habitat was proposed for this species in 2005 (70 Federal Register 66491 – 66599). The nearest proposed critical habitat unit for this species is located in Lewis County, Washington, which is over 20 miles north of MP 22.

Impacts and Mitigation

Because there are no known occurrences of Kincaid's lupine in the vicinity of the pipeline route and the nearest proposed critical habitat unit for Kincaid's lupine is located over 20 miles north of MP 22, with the implementation of our recommendation to complete any necessary follow-up surveys, it is unlikely that Kincaid's lupine would be affected by construction or operation of the proposed pipeline.

Nelson's Checker-mallow

Occurrence along the Pipeline Route

The ORNHIC has no record of Nelson's checker-mallow occurring within 2 miles of the project facilities. Additionally, a botanical survey of the project area conducted by NorthernStar in June 2006 did not identify Nelson's checker-mallow in the project area. However, Nelson's checker-mallow has been documented near Coal Creek Road in Cowlitz County. According to WNHP data, the Coal Creek site was first discovered in 1990 and contains two subpopulations: the northern subpopulation and the southern subpopulation. The northern subpopulation is located near the junction of Carlon Loop Road and Coal Creek Road and contains over 100 plants in a patchy distribution. The southern subpopulation

is located east of Carlon Loop Road and occupies an area approximately 10 feet by 15 feet in size. The northern subpopulation is located outside of the proposed pipeline alignment and is not likely to be impacted by construction of the proposed project. However, based on WNHP data, the southern subpopulation occurs within the proposed pipeline alignment near MP 28.0.

The southern subpopulation was not seen in a cursory look by the WNHP in 2006 (Arnett, 2006). In addition, another pipeline was installed in this location in 1992, after the last documented siting. However, based on concerns raised by the FWS, NorthernStar conducted additional surveys for Nelson's checker-mallow in June and July 2007. No Nelson's checker-mallow plants were observed at or around the pipeline crossing near Coal Creek (the historic southern subpopulation). The location of the historic southern population is now an actively grazed horse pasture, with a parcel to the south that undergoes regular herbicide spraying. However, at least 15 Nelson's checker-mallow plants were observed at the historic northern subpopulation, approximately 0.5 miles north of the pipeline right-of-way at MP 28.0.

Critical Habitat

Critical habitat has not been designated for Nelson's checker-mallow.

Impacts and Mitigation

As described above, the southern subpopulation of Nelson's checker-mallow was documented within the proposed project area near MP 28.0 in 1991, but not during surveys in 2007. Since this species has the ability to tolerate disturbances such as regular mowing and some ground disturbance, botanical surveys would be conducted prior to ground disturbing activities in the vicinity of the southern subpopulation. If the species is present, NorthernStar has stated that the area would be identified and protective fencing would be erected prior to construction and for the duration of all ground disturbing activities. If no rare plant species are found, no special precautions would be warranted. Furthermore, NorthernStar proposes to install the pipeline near the southern subpopulation of Nelson's checker-mallow using the HDD or conventional bore method. Therefore, impacts on the southern subpopulation of Nelson's checker-mallow due to construction of the proposed pipeline are not anticipated. Because the HDD method would be used to install the proposed pipeline, maintenance vegetative clearing would be avoided; therefore impacts on the southern subpopulation of Nelson's checker-mallow during operation of the pipeline are not anticipated.

Because there are no other known occurrences of Nelson's checker-mallow in the vicinity of the proposed pipeline, with the implementation of our recommendation to complete any necessary follow-up surveys, impacts on Nelson's checker-mallow due to construction or operation of the pipeline are not anticipated.

<u>Water Howellia</u>

Occurrence along the Pipeline Route

The FWS conducted extensive searches in Oregon but failed to locate water howellia; therefore, it is thought to be extirpated from the state (FWS, 1996b). Mincemoyer (2005) provided 18 records for populations of water howellia in western Washington. The ORNHIC and PHS databases had no record of water howellia within a 2-mile-radius search area of the proposed pipeline route. This species is not documented within the project area. Field surveys conducted in June 2006 determined that potential habitat for water howellia is located within the project area along the proposed pipeline route but did not identify any occurrences of water howellia in the project area. Because the FWS raised concerns regarding terrestrial habitat survey methods in their April 20, 2007 letter to the FERC and the botanical

survey report prepared for this project did not clearly confirm that all areas of potential habitat were surveyed during appropriate survey periods, we have recommended NorthernStar complete additional consultations with the FWS and conduct additional surveys, as necessary (see section 4.6.2.2).

Critical Habitat

Critical habitat has not been designated for water howellia.

Impacts and Mitigation

Because there are no known occurrences of water howellia in the vicinity of the pipeline route, with the implementation of our recommendation to complete any necessary follow-up surveys, it is unlikely that water howellia would be affected by construction or operation of the proposed pipeline.

State Listed Threatened and Endangered Species

NorthernStar consulted with the ODFW, ORNHIC, WDFW, and WNHP to identify state-listed endangered and threatened species with the potential to occur along the proposed pipeline route. Many state listed endangered or threatened species are also federally listed; these species were discussed previously (see *Pipeline Facilities, Federally Listed Species*). The remaining state listed threatened or endangered species are discussed below.

Western Pond Turtle

The western pond turtle has been extirpated from most of its former range in Washington, but two known populations remain in the Columbia River Gorge. Potentially suitable habitat for this species is found along the pipeline route where it crosses wetlands, sloughs, and other open water areas. However, little or no suitable upland nesting habitat is present as these areas are often densely vegetated. The ORNHIC had no records of occurrence for this species within 5 miles of the pipeline route in Oregon. With implementation of NorthernStar's SWPPP, the potential to impact the western pond turtle or its habitats would be minimal.

Bald Eagle

Bald eagle nesting, foraging, and wintering areas are known to occur within all counties affected by the proposed project in the form of mature riparian forested and upland forested habitats. Isaacs and Anthony (2005) identified five bald eagle nests within 0.5 mile of the proposed pipeline. The closest documented bald eagle nest site is approximately 0.4 mile from the proposed pipeline route near Abernathy Creek in Cowlitz County, Washington (Isaacs and Anthony, 2005). This nest site is located downstream of the Abernathy Creek crossing in heavy coniferous forest habitat. Other nest sites are located 0.5 mile from the proposed pipeline at Crims Island, Poysky Slough, Poysky Island, and Wallace Island in Columbia County, Oregon (Isaacs and Anthony, 2005). The Poysky Slough nest site is located in a stand of mature cottonwoods adjacent to a dike access road and a commercial poplar farm. The Poysky Island site was first documented in 2005 and successfully fledged two eaglets that year. During field visits to the proposed LNG terminal site and pipeline route, eagles were observed flying over the area near the proposed LNG terminal site as well as over Abernathy Creek. The WDFW has also mapped bald eagle communal winter roost sites. Such sites may be found along all of the major waterbodies crossed by the project and are most likely to be occupied from November through March.

Breeding bald eagles could potentially be affected by pipeline activities if nest trees and surrounding habitat are removed, or if construction were to occur in the vicinity of an active nest or

communal roost. The FWS (2007c) developed the *National Bald Eagle Management Guidelines* to help increase and maintain bald eagle populations by protecting important nesting and communal roosting habitat while allowing for flexibility in accommodating site-specific conditions. These guidelines call for preserving communal roost, nest, and important foraging sites; maintaining natural forested (or vegetative) buffers around nest trees; and avoiding certain activities during the nesting and roosting periods. When construction activities are within line-of-site of an active nest site, the FWS recommends maintaining a 660-foot buffer to minimize visual and auditory effects. Nests, nest trees, and habitat immediately surrounding the nest tree should not be removed at any time of the year.

Indirect impacts on bald eagles could include increased visual and auditory construction disturbance. Displacement of aquatic prey could indirectly affect bald eagles that may utilize these species as a portion of their diet. In addition, increased noise and other physical disturbances associated with construction and operation of the proposed pipeline, could temporarily cause bald eagles to avoid the area. Measures proposed by NorthernStar to minimize impacts on bald eagles before and during construction and operation of the project are discussed in section 4.6.2.2

Western Wahoo

During botanical surveys, a western wahoo population was found at the Abernathy Creek pipeline crossing in Cowlitz County, Washington (near MP 21.1). The pipeline would be installed using the HDD method at this waterbody, which would avoid disturbance of this species. Furthermore, NorthernStar would install a fence around the site to avoid any inadvertent impacts on the western wahoo plants during pipeline construction.

Other Special Status Species

Sensitive Species

In addition to the species listed under the ESA or by the States of Oregon and Washington, four species that are candidates for listing as endangered or threatened or species of special concern have been identified by state agencies as having the potential to occur in the vicinity of the proposed pipeline. The ODFW also expressed concerns regarding several other sensitive species, including the coastal cutthroat trout, red-legged frog, tailed frog, western painted turtle, American peregrine falcon, and olive-sided flycatcher. These sensitive species are discussed below.

Coastal Cutthroat Trout

Potential habitat for coastal cutthroat trout occurs along the proposed pipeline route in the main channel of the Columbia River. NorthernStar proposes to install the pipeline beneath the Columbia River using the HDD method. Therefore, any impacts on coastal cutthroat trout would be avoided unless a frac-out occurs or an HDD borehole is unsuccessful. As discussed in section 4.5.3.1, NorthernStar would implement various mitigation measures to avoid, minimize, rectify, reduce, and/or compensate impacts on salmonids; these measures would also benefit coastal cutthroat trout. Therefore, impacts on coastal cutthroat trout as a result of construction and operation of the proposed pipeline would not be significant.

Eulachon

The WDFW expressed concern about potential impacts on eulachon larvae as they migrate down the Columbia River to the Pacific Ocean. NorthernStar proposes to install the pipeline beneath the Columbia River using the HDD method. Therefore, any impacts on eulachon would be avoided unless a frac-out occurs or an HDD borehole is unsuccessful. As discussed in section 4.5.3.1, NorthernStar would

implement various mitigation measures to avoid, minimize, rectify, reduce, and/or compensate impacts on salmonids; these measures would also benefit eulachon. Therefore, impacts on eulachon as a result of construction and operation of the proposed pipeline would not be significant.

Lampreys

Potential bottom habitat for juvenile lamprey occurs within the main channel of the Columbia River. The mainstem Columbia River also serves as a migratory route for adults moving to or returning from the sea. NorthernStar proposes to install the pipeline beneath the Columbia River using the HDD method. Therefore, any impacts on lampreys would be avoided unless a frac-out occurs or an HDD borehole is unsuccessful. As discussed in section 4.5.3.1, NorthernStar would implement various mitigation measures to avoid, minimize, rectify, reduce, and/or compensate impacts on salmonids; these measures would also benefit lampreys. Therefore, significant impacts on lamprey as a result of construction and operation of the proposed pipeline are not anticipated.

Columbia Torrent (seep) Salamander

Potentially suitable habitat for this species is found at stream crossings along the proposed pipeline route. Project-related disturbances at many of the significant stream crossings would be avoided through the use of the HDD method (see section 4.3.2.4). With implementation of NorthernStar's ESC Plans and SWPPP, the potential to impact the Columbia torrent salamander or its habitats would be minimal.

Red-legged Frog

Potential habitat for the red-legged frog occurs in wetlands and waterbodies along the proposed pipeline route. Potential impacts and mitigation for waterbody crossings on aquatic species are discussed in section 4.5.3.1. Hundreds of led-legged frogs have been reported on lower Svensen Island. Restoration and preservation of lower Svensen Island would mitigate for any significant impacts on red-legged frogs or their habitats along the proposed pipeline route.

Tailed Frog

Potentially suitable habitat for tailed frogs exists within cold, shallow waterbodies crossed by the proposed pipeline route. Potential impacts and mitigation for waterbody crossings on aquatic species are discussed in section 4.5.3.1.

Western Painted Turtle

The western painted turtle could potentially occur along the proposed pipeline route in emergent wetlands and shallow waterbodies. Potential impacts and mitigation for waterbody crossings on aquatic species are discussed in section 4.5.3.1.

Townsend's Big-eared Bat

Potentially suitable foraging habitat for this species may occur along the pipeline route. However, preferred roosting habitat for the Townsend's big-eared bat does not occur in the project area. In addition, the ORNHIC had no record of this species within 5 miles of the pipeline route in Oregon. As part of its Mitigation Plan, NorthernStar proposes to enhance potential bat habitat by installing bat houses at the Peterson Point Mitigation Site. Therefore, we have determined that construction and operation of

the Bradwood Landing Project is not likely to result in significant impacts on the Townsend's big-eared bat.

American Peregrine Falcon

American peregrine falcons have been observed during site visits flying over potentially suitable habitat bordering the western bank of the Columbia River near MP 2.0. The ORNHIC database has one record of an active nest from this area, which is about 0.8 mile east of the pipeline origin at the LNG terminal. Given the distance and the location of the potential nesting habitat, it is not likely that the American peregrine falcon would be adversely impacted by construction or operation of the proposed pipeline.

Olive-sided Flycatcher

The olive-sided flycatcher has been recorded on both of the Breeding Bird Surveys conducted near the proposed pipeline route (Sauer et al., 2005). Construction and operation of the proposed pipeline could potentially affect the olive-sided flycatcher due to clearing of forested habitats. Potential impacts and proposed mitigation for clearing of forested habitat are discussed in section 4.4.2.3. Migratory birds are discussed below (see *Migratory Bird Treaty Act*).

Migratory Bird Treaty Act

During construction and operation of the proposed pipeline, habitat modification, increased noise and lighting, and vegetative clearing could adversely affect migratory birds occurring along the pipeline route. Potential impacts on terrestrial wildlife, including migratory birds, due to habitat modification as well as increased noise and lighting are discussed in section 4.5.2.3. In order to minimize potential impacts, NorthernStar has stated that vegetative clearing along the pipeline route would be conducted between August 1 and April 15, thus avoiding the peak nesting season. However, due to the importance of the area for migratory birds, additional measures are necessary to minimize impacts on nesting birds due construction and maintenance clearing along the pipeline route. Therefore, we recommended in section 4.6.2.2 that NorthernStar consult with the FWS and other appropriate agencies to develop a Migratory Bird Nest Avoidance Plan to minimize impacts on migratory birds during the peak nesting season.

4.6.3 Conclusions and Recommendations for Threatened, Endangered, and Other Special Status Species

As described above, informal consultations with the FWS and NMFS have identified 37 federally listed species as potentially occurring in the general vicinity of the Bradwood Landing Project. In addition, California sea lions and Pacific harbor seals transit past and utilize haulout sites upstream from the LNG terminal site. The Columbia River estuary is also one of the most important sites on the Pacific Flyway for migratory birds. Finally, although no longer listed under the ESA, the bald eagle is federally protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Under both laws, the disturbance of eagles, their nests, and eggs is prohibited.

A variety of measures have been proposed by NorthernStar that would avoid or minimize environmental impacts on threatened, endangered, and other special status species. These measures include:

- reducing the size of the LNG terminal footprint to avoid or minimize impacts on wetlands and Hunt Creek;

- routing the power line to avoid impacts on late-successional forest habitats;
- routing the pipeline to avoid or minimize impacts on sensitive environmental features and/or habitats;
- extensive use of the HDD or bore technique during construction of the pipeline to avoid or minimize disturbance of sensitive habitats, including waterbodies containing sensitive aquatic species or habitats;
- minimizing potential water quality impacts by using erosion control measures;
- restoring temporary construction work areas by implementing appropriate restoration and revegetation techniques;
- replanting forested habitats with in-kind tree specimens, with the exception of the portion of the right-of-way within 5 feet of the pipeline (10 feet total), thereby minimizing the extent of disturbance;
- controlling the spread of noxious and/or invasive plants;
- selecting larger than normal diameter pilings for the LNG carrier berth and unloading facilities;
- driving all piles vertically within a bubble-filled caisson to minimize acoustic impacts on aquatic species (thus minimizing the number of piles and the length of pile driving activities);
- providing screened water intakes at the LNG terminal to provide cooling and ballast water to the LNG carriers while unloading to minimize entrainment and impingement of juvenile fish; and
- minimizing the amount of water drawn from the Columbia River by filling LNG carrier ballast tanks with the same water used to cool the engines (thus also minimizing the discharge of warm water into the Columbia River).

Additionally, NorthernStar has proposed compensatory mitigation that provides new or enhanced areas of aquatic and wildlife habitats. Moreover, NorthernStar's voluntary implementation of its SEI has the potential to provide significant benefits to salmonids and the lower Columbia River ecosystem (see section 4.6.2.2). In addition to benefiting special status species, these measures would also benefit general wildlife, fisheries, and vegetation in the project area.

Beyond the mitigation proposed by NorthernStar, we have recommended that additional measures be implemented to further reduce potential impacts on protected species, including:

- continue to coordinate with the NMFS, FWS, ODFW, and/or other appropriate agencies regarding the following potential issues:
    - wake stranding of juvenile salmonids;
    - shoreline erosion;

- entrainment and impingement of juvenile salmonids;
- temperature impacts due to discharges at the LNG terminal wharf;
- LNG carrier speed, seasonal, or other restrictions to avoid or minimize impacts on whales;
- development of the final Compensatory Mitigation Plan;
- development of the final Waterbody and Wetland Construction and Mitigation Procedures Plan;
- development of a revised Bubble Curtain Contingency Plan;
- development of a revised Lighting Plan;
- agency consultation during development of a Blasting Management Plan; and
- development of a Migratory Bird Nest Avoidance Plan;

- place nets at the outlet of the log pond that only allow emigration from the pond;
- conduct post-installation water flow mapping through all intake screens at the LNG terminal, and develop and implement a monitoring program to assess the effects of impingement and entrainment from use of the screened water supply system on juvenile salmonids during terminal operations;
- conduct additional botanical surveys for federally listed endangered and threatened plants;
- conduct a survey for bald eagles prior to construction of LNG terminal and pipeline facilities;
- expand the protective measures that would be used to avoid or minimize impacts on Steller sea lions during construction of the LNG terminal to include all pinnipeds;
- avoid pipeline construction activities within potential habitat for Columbian white-tailed deer between June 1 and July 15.

Prior to and throughout construction, NorthernStar would train all personnel on procedures that should be followed to comply with proposed and required environmental mitigation measures.

We have determined that the proposed project may expose pinnipeds to sound pressures above the NMFS's threshold for injury and/or disturbance. Because of the potential impacts from pile driving activities on pinnipeds, NorthernStar has stated that it will apply for an Incidental Harassment Authorization pursuant to MMPA section 101(a)(5)(D).

The findings of effect for federally listed species included in table 4.6.3-1 are based on informal consultations with the FWS and NMFS, completed field surveys, and review of NorthernStar's proposed measures to avoid, minimize, or mitigate impacts on listed species. In compliance with section 7 of the ESA and the MSA, the FERC staff is currently revising its BA and EFH Assessment for the Bradwood Landing Project, which will be resubmitted to the NMFS and FWS with a request to initiate formal consultation.

TABLE 4.6.3-1

Federally Listed Endangered, Threatened, or Candidate Species Potentially Occurring in the Vicinity of the Bradwood Landing Project

Species	Determination of Effect	
	Species	Critical Habitat
FISH		
Chinook Salmon *Oncorhynchus tshawytscha*		
• Lower Columbia River ESU	LAA	LAA
• Upper Columbia River Spring-run ESU	LAA	LAA
• Upper Willamette River ESU	LAA	LAA
• Snake River Spring/Summer-run ESU	LAA	LAA
• Snake River Fall-run ESU	LAA	LAA
Chum Salmon *O. keta*		
• Columbia River ESU	LAA	LAA
Coho Salmon *O. kisutch*		
• Lower Columbia River ESU	LAA	NA
Sockeye Salmon *O. nerka*		
• Snake River ESU	LAA	LAA
Steelhead *O. mykiss*		
• Lower Columbia River DPS	LAA	LAA
• Middle Columbia River DPS	LAA	NLAA
• Upper Columbia River DPS	LAA	NLAA
• Upper Willamette River DPS	LAA	NLAA
• Snake River Basin DPS	LAA	NLAA
Bull Trout *Salvelinus confluentus*		
• Columbia River DPS	NE	NE
North American Green Sturgeon *Acipenser medirostris*		
• Southern DPS	LAA	NA
REPTILES AND AMPHIBIANS		
Green Sea Turtle *Chelonia mydas*	NLAA	NE
Leatherback Sea Turtle *Dermochelys coriacea*	NLAA	NE
Loggerhead Sea Turtle *Caretta caretta*	NLAA	NA
Olive Ridley Sea Turtle *Lepidochelys olivacea*	NLAA	NA
Oregon Spotted Frog *Rana pretiosa*	NE	NA
MAMMALS		
Blue Whale *Balaenoptera musculus*	NLAA	NA
Fin Whale *Balaenoptera physalus*	LAA	NA
Humpback Whale *Megaptera novaeangliae*	NLAA	NA
North Pacific Right Whale *Eubalaena japonica*	NLAA	NA

TABLE 4.6.3-1 (cont'd)

Federally Listed Endangered, Threatened, or Candidate Species Potentially Occurring in the Vicinity of the Bradwood Landing Project

	Determination of Effect	
Species	Species	Critical Habitat
Sei Whale *Balaenoptera borealis*	NLAA	NA
Killer Whale *Orcinus orca*		
• Southern Resident DPS	NLAA	NE
Sperm Whale *Physeter macrocephalus*	NLAA	NA
Steller Sea Lion *Eumetopias jubatus*		
• Eastern DPS	LAA	NE
Columbian White-tailed Deer *Odocoileus virginianus leucurus*		
• Columbia River DPS	LAA	NA
BIRDS		
Brown Pelican *Pelecanus occidenatlis*	NLAA	NA
Marbled Murrelet *Brachyramphus marmoratus*	LAA	NLAA
Northern Spotted Owl *Strix occidentalis caurina*	NLAA	NE
Short-tailed Albatross *Phoebastria albatrus*	NE	NA
Streaked Horned Lark *Eremophila alpestris strigata*	NLAA	NA
Western Snowy Plover *Charadrius alexandrinus nivosus*		
• Pacific Coast DPS	NE	NLAA
Yellow-billed Cuckoo *Coccyzus americanus*	NE	NA
INVERTEBRATES		
Oregon Silverspot Butterfly *Speyeria zerene hippolyta*	NE	NE
PLANTS		
Kincaid's Lupine *Lupinus sulphureus kincaidii*	NLAA	NE
Nelson's Checker-mallow *Sidalcea nelsoniana*	NLAA	NA
Water Howellia *Howellia aquatilis*	NLAA	NA

Based on information included in the revised BA and EFH Assessment developed during the formal consultation process by NorthernStar, the NMFS and FWS will prepare BOs as to whether or not the federal actions associated with this project would likely jeopardize the continued existence of a listed species, or result in the destruction or adverse modification of designated critical habitat; summarize the information on which the opinion is based; and discuss in detail the effects of the project on listed species or designated critical habitat. The BOs may recommend reasonable and prudent measures to be implemented to minimize impacts on specific individuals or habitat and reduce the level of take associated with project activities. In addition, the BOs would include the specific terms and conditions by which the reasonable and prudent measures are to be accomplished. As described above, the FERC would not allow construction of the project until after we have completed formal consultation with the NMFS and FWS. In compliance with the ESA, **we recommend that:**

- **NorthernStar should not begin construction activities at the LNG terminal and the pipeline <u>until</u>:**

  a. the staff completes formal consultation with the NMFS and FWS;

  b. NorthernStar completes consultation with the NMFS under section 101(a)(5)(D) of the MMPA; and

  c. NorthernStar has received written notification from the Director of OEP that construction or use of mitigation may begin.

4.7 LAND USE, RECREATION, AND VISUAL RESOURCES

4.7.1 Waterway for LNG Marine Traffic

4.7.1.1 Land Use

Land use along the shore of the waterway for LNG marine traffic consists primarily of forest. The lower Columbia River is mostly a rural region, with the exception of the urban areas of Cathlamet and Ilwaco in Washington, and Astoria and Warrenton in Oregon. Elsewhere along the shore of the waterway are scattered residences and commercial/industrial locations. On the northern shoreline of the Columbia River from the Long Beach peninsula eastward in Pacific County, Washington are the sparsely populated unincorporated communities of Chinook, McGowan, Megler, and Knappton, and in Wahkiakum County eastward to CRM 38 are Pigeon Bluff, Altoona, Dahlia, Pillar Rock, Brookfield, Rockland, Bayview, and Skamokawa. On the southern shore of the river in Clatsop County, Oregon between Astoria and Bradwood, are the small unincorporated communities of Burnside, Svensen, Knappa, Brownsmead, and Clifton.

During transit to the LNG terminal, the potential exists for an accidental or intentional breach of an LNG carrier resulting in a release of LNG. Being less dense than water, the LNG would float on the surface before vaporizing. As the LNG vaporizes, a vapor cloud may form that is initially heavier than air and may be dispersed by wind. An LNG vapor cloud cannot explode in the open atmosphere, but can burn if ignited. In the unlikely case of an LNG spill and associated pool fire, land uses and associated vegetation adjacent to the shipping route could be impacted. Effects on structures within Zone 1 would be most severe, while buildings within Zone 3 would be less impacted. However, with implementation of the mitigation measures described in the Coast Guard's WSR, an LNG release along the waterway would be highly unlikely and the potential impact on structures would be less than significant.

4.7.1.2 Existing Residences and Planned Developments

Existing Residences

The majority of land along the waterway within the Zones of Concern is rural, with the exception of the Warrenton/Astoria urban areas in Clatsop County, Oregon and the Cathlamet/Puget Island area of Wahkiakum County, Washington. There are about 1,799 housing units in the City of Warrenton, 4,858 housing units in the City of Astoria, and 278 housing units in the City of Cathlamet. There are other scattered residences in the sparsely populated unincorporated communities elsewhere along the waterway overlapped by the Zones of Concern. In Washington along the waterway, Pillar Rock, Rockland, and Bayview are within Zone 1; Altoona, Brookfield, and Skamokawa are within Zone 2; and Pigeon Bluff and Cathlamet are within Zone 3. In Oregon, Hammond and the waterfront areas of Warrenton and Astoria are within Zone 1; portions of Warrenton, and Astoria are in Zone 2; and part of Astoria and Clifton are overlapped by Zone 3. Population along the waterway is discussed in detail in section 4.8.1.1.

Visual impacts from LNG marine traffic passing by existing commercial and residential areas along the waterway would be short term, lasting only minutes within the viewshed. These communities already view thousands of ships traveling up and down the Columbia River.

Residential and commercial areas could be affected by an accidental or intentional breach of an LNG carrier resulting in a release of LNG during transit. In the unlikely event of an LNG release, the effects from a resulting fire would be fairly limited and the fire would be relatively short-lived. Structures within Zone 1 (e.g., along the Astoria waterfront) could be damaged in the event of a pool fire, while structures within Zone 3 would be less affected. However, with implementation of the mitigation measures described in the Coast Guard's WSR, the potential for an LNG release would be extremely unlikely and the potential impacts on residential and commercial areas would be less than significant.

Planned Developments

Based on conversations with the affected counties and communities, we identified future commercial and residential developments along the waterway to be used by LNG marine traffic for this project (see table 4.12-1). As of November 2006, several ongoing or proposed developments were noted on or near the waterfront of Astoria. Projects that were currently under construction included a restaurant, office, and retail development located at Pier 1; the Red Building renovation to accommodate small shops, banquet and conference facilities, and offices located east of Pier 1; a public park development located at 9th Street that also includes a possible expansion; the Millpond Development to accommodate housing units between 23rd and 29th Streets; and a 93-unit condominium development located East of Pier 39 that that also includes a potential expansion. Proposed projects included: a public square located east of Pier 1; a condominium and associated restaurant and retail developments at several locations including Columbia Street, Pier 11, 3rd Street, 7th Street, 14th Street, and 15th Street; a 20-townhouse development on 29th Street that was scheduled to begin construction in summer 2007; an unspecified proposed development located at East Mooring Basin; and a building renovation to accommodate restaurant, office, retail, and boat rental establishments located at Pier 39. Three projects were recently completed, including: the Cannery Pier Hotel located east of Pier 1; a building to accommodate office and residential properties located on 31st Street; and a new subdivision located east of Sewer Lagoon. In addition, the River Theater development to accommodate coffee, art, and theater retail located east of Pier 1 was pending a building permit (Cook, 2006; Johnson, 2006; Larson, 2006; McCoy, 2006).

The effects of LNG marine traffic on planned residential and commercial developments along the waterway would primarily be visual. Observers would only see an LNG carrier for a few minutes at any given location as it passes by. Large vessels in the Columbia River are already a common sight within the viewshed for the proposed residential and commercial developments (see section 4.8.1.7). With the implementation of the safety and security measures outlined in the Coast Guard's WSR, it is highly unlikely that there would be a release of LNG from a passing LNG carrier that would lead to a spill and related pool fire, therefore the project should not have any significant impacts on planned commercial or residential developments along the waterway.

4.7.1.3 Coastal Zone Management

Section 4.7.2.4 addresses coastal zone management review for the Bradwood Landing Project.

4.7.1.4 Recreation, Public Interest, and Special Use Areas

A number of recreational and public interest areas are located along the waterway to be used by LNG marine traffic for this project. Potentially sensitive special use areas within the Zones of Concern are shown on figure 4.7.1-1. The potential impacts of LNG marine traffic on recreational sites along the waterway and regional tourism is further discussed in section 4.8.1.8.

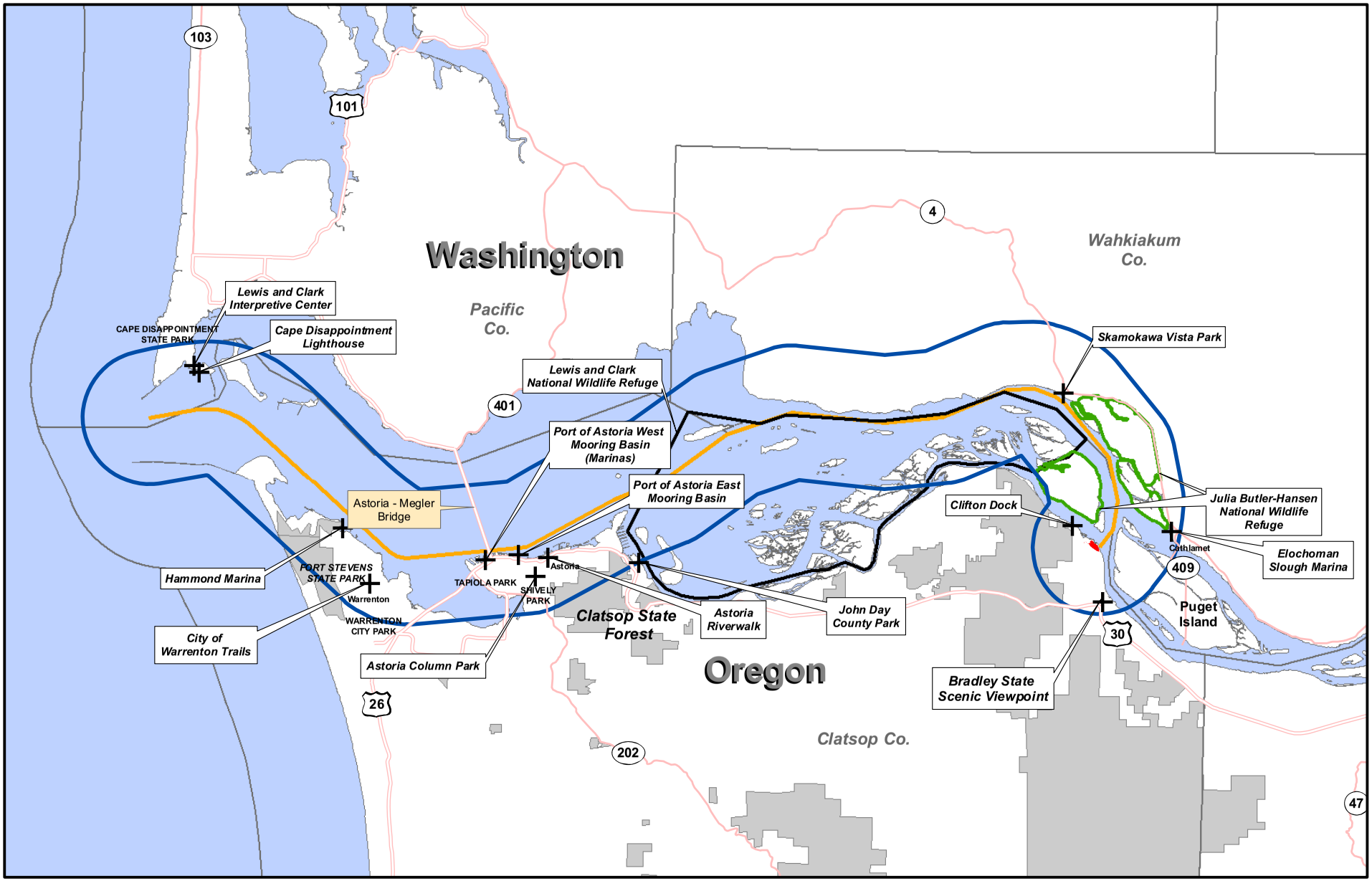


Figure 4.7.1-1
Bradwood Landing Project
Potential Sensitive Resources Along Waterway

Designated Recreation and Public Interest Areas

Lewis and Clark National Historic Trail

The Lewis and Clark National Historic Trail (LCNHT) was authorized by the National Trails System Act of 1978. The trail extends about 3,700 miles, crossing 11 states from Wood River, Illinois to the mouth of the Columbia River, tracing the journey of the Lewis and Clark expedition of 1804-1806. The LCNHT is administered by the National Park Service (NPS), but includes lands in federal, tribal, state, county, local, and private jurisdictions. There are 11 official interpretive centers along the LCNHT, and many other unofficial partnering centers operated by various entities. The NPS headquarters for the LCNHT is in Omaha, Nebraska. The purpose and mission of the LCNHT is to preserve remnants of the historic route of the 1804-1806 Corps of Discovery expedition, provide a comprehensive interpretation of the expedition and the trail, and allow for better public understanding and appreciation of our nation's cultural and natural heritage through opportunities at various locations for visitor enjoyment and use of trail resources (NPS, 2006). We discuss potential project-related impacts on the LCNHT in sections 4.8.1.8 and 4.9 of this EIS.

Lewis and Clark National Historic Park

The Lewis and Clark National Historic Park (LCNHP) is at the western terminus of the LCNHT. Under the umbrella of the NPS, the LCNHP in made up of 12 park sites along the Pacific Coast from Long Beach, Washington to Cannon Beach, Oregon. The LCNHP was created by Congress in 2004, expanding the Fort Clatsop National Memorial, originally established in 1958, by adding other sites at the mouth of the Columbia River related to the Lewis and Clark expedition. The purpose of the LCNHP is to preserve and interpret resources associated with the Corps of Discovery's 1805-1806 winter encampment near the Pacific Ocean at Fort Clatsop. The legislation directed the NPS to work with Oregon and Washington State Parks to promote visitor use and cooperative management (Applegate, et al., 2005). There are two state parks that form a portion of the LCNHP that would be overlapped by the Zones of Concern for LNG marine traffic along the waterway to the Bradwood Landing LNG terminal. These potentially affected elements include Fort Disappointment State Park, which contains the Lewis and Clark Interpretive Center and a memorial to Thomas Jefferson, in Washington, and Fort Stevens State Park in Oregon. The other elements of the LCNHP, including Fort Columbia State Park, Dismal Nitch, and Station Camp in Washington, and Ecola State Park, Sunset Beach State Recreation Area, Fort Clatsop, Fort to Sea Trail, Salt Works, and Netul Landing in Oregon are outside of the Zones of Concern and would not be affected by the project. Potential project related impacts on the LCNHP are discussed in sections 4.8.1.8 and 4.9 of this EIS.

Lower Columbia River Water Trail

The Lower Columbia River Water Trail stretches 146 miles in length from Bonneville Dam to the Pacific Ocean. The water trail is intended for use by people in non-motorized boats, to travel for daily or overnight excursions along the free-flowing portion of the lower Columbia River. There are multiple launches, landings, and campsites located along this segment of the river. The water trail is administered through the Lower Columbia River Water Trail Committee of the Lower Columbia River Estuary Partnership, a non-profit corporation, whose goals include protecting the ecosystem, improving habitat, reducing river pollution, and educating the public. The partnership is attempting to connect the public to the lower Columbia River by promoting the water trail as a valuable resource for recreation, education, and stewardship, and increase access to the river by improving launch and landing sites for non-motorized water craft. The partnership seeks to engage the interest of local counties, communities, businesses, and individuals to support its programs (Lower Columbia River Estuary Partnership, 2007b). The NPS has provided community assistance to this water trail under the Outdoor Recreation Act of 1963. These grants have enabled the Water Trail Committee to inventory more than 70 waypoints along the trial, and

develop an interactive web site to provide paddlers with trail information. The lower Columbia River is divided between the states of Washington and Oregon. The partnership owns no land or facilities along the trail. Instead, the water trail utilizes existing recreational facilities owned and operated by various city, county, or state government agencies. These are discussed further in section 4.8.

Cape Disappointment State Park

Cape Disappointment is a Washington State Park. It encompasses 1,882 acres on the Long Beach peninsula, between the Pacific Ocean and the Columbia River, in Pacific County, Washington. This park is one of the elements of the LCNHP and provides access to the Lower Columbia River Water Trail. Cape Disappointment State Park includes the historic location of Fort Canby, two historic lighthouses (North Head Lighthouse on the Pacific Coast and Cape Disappointment Lighthouse on the Columbia River), the Lewis and Clark Interpretive Center, Thomas Jefferson Memorial, Colbert House Museum, amphitheater, ball fields, boat ramp and dock, 20 picnic tables, campsites and cabins, and 7 miles of hiking trails. The southern portion of the park, including Fort Canby, the Cape Disappointment Lighthouse, and the Lewis and Clark Interpretive Center, is overlapped by Zone 3. Potential project-related impacts on historic elements of the park are discussed in section 4.9.

Fort Stevens State Park

Fort Stevens is an Oregon State Park and an element in the LCNHP. It covers about 3,700 acres at the mouth of the Columbia River, west of Hammond, Oregon, between the Pacific Ocean and Trestle Bay. It is named for the former federal military installation, originally commissioned in 1863, located within its boundaries, and the park includes the remains of gun batteries and the commander's station, and a military museum. Also part of the Fort Stevens State Park, are the remains of the ship wreck of the Peter Iredale, Coffenbury Lake and Swash Lake, wildlife viewing platforms, 9 miles of bike paths, and 5 miles of hiking trails, including the northern trailhead for the Oregon Coast Trail. With 530 campsites, Fort Stevens State Park is the largest public campground of any state park in Oregon. The northern portion of Fort Stevens State Park, including the military museum and Fort Stevens gun batteries, are overlapped by Zone 2.

Lewis and Clark National Wildlife Refuge

The LCNWR is a unit within the system of 547 wildlife refuges nationwide, first established in response to the federal conservation movement by President Theodore Roosevelt in 1903, and operated by the FWS. These refuges offer a network of protected habitats to benefit fish and wildlife, and offer outdoor experiences for the American public. The LCNWR, created in 1971, is meant to preserve wetland habitats along the lower Columbia River estuary and serve as a wintering area for migratory waterfowl and shorebirds. The refuge boundary encompasses 35,000 acres of tidelands and open water, including 8,313 acres of islands and sandbars between CRMs 18.5 and 35 in the Columbia River. It provides nesting areas for about 35 bald eagles, 1,000 tundra swans, 5,000 geese, and 30,000 ducks. The estuary within the LCNWR also offers habitat for fish, seals, otter, beaver, raccoon, weasel, mink, and muskrat. The LCNWR is administered out of the office for the JBHNWR in Cathlamet, has no developed recreational facilities, and the inlands within its boundaries can only be accessed by boat, with launches available at Skamokawa in Washington and John Day Point and Aldrich Point in Oregon. Portions of the LCNWR are overlapped by the Zones 1, 2, and 3.

Julia Butler Hansen National Wildlife Refuge

The JBHNWR was established in 1972 specifically to protect and manage the federally listed endangered Columbian white-tailed deer. The JBHNWR extends from approximate CRM 33.5 to CRM

39 along the Columbia River, and includes the Hunting Islands and Price Island in Washington, and Tenasillahe Island, Crims Island, Wallace Island, and several small parcels in the vicinity of Westport in Oregon. It contains approximately 6,100 acres of pastures, forested tidal swamps, marshes, sloughs, and open water. The JBHNWR provides habitat for fish, wintering birds, including bald eagles and osprey, a small herd of Roosevelt elk, and various other mammals, reptiles and amphibians (FWS, 2007b). The islands within the refuge can only be reached by boat. Public recreational facilities within the JBHNWR include its headquarters off of Steamboat Slough Road, and the mainland dike road, which is used for vehicle access, public fishing, and wildlife viewing opportunities. Portions of the JBHNWR are overlapped by Zones 1, 2, and 3.

Clatsop State Forest

The Clatsop State Forest, comprising some 518,000 acres, is the only public forest in Northwestern Oregon and is administered by the Astoria District of the Oregon Department of Forestry (ODF). According to the ODF (2001), the Clatsop State Forest is 98 percent Board of Forestry Lands. These lands were privately owned and logged between 1910 and 1940, and when Clatsop and Columbia Counties foreclosed due to landowners not paying their taxes, the counties deeded these cutover and unmanaged forest lands to the Board of Forestry to manage as a state forest. The remaining 2 percent of the Clatsop State Forest are Common School Fund Lands. The *Clatsop State Forest Astoria District Recreation Management Plan* outlines the implementation of recreation management in the state forest through objectives and actions, activity zoning, and the type of facilities the ODF will develop and manage. Recreational uses in the Clatsop State Forest occur along roads, rivers, and streams. Recreational activities include hunting, fishing, dispersed or campground camping, off-highway vehicle use, horseback riding, mountain biking, hiking, and scenic viewing (at viewpoints), and some interpretation. Portion of Clatsop State Forest are overlapped by Zone 3 just south and east of the City of Astoria, and to the west of Clifton.

Warrenton/Astoria Parks and Museums

The Warrenton Waterfront Trail and Carruthers Park are overlapped by Zone 2. Within Zone 3 at Warrenton is the Fishermen's Memorial and Lighthouse Park.

Parks in Astoria located within 1,600 meters south of the navigation channel (partly or wholly overlapped by the extent of Zone 2) include Astoria Column, Shively Park, Maritime Park, 4-H fair grounds, Tapiola Park, Warren Field, Fort Astoria, and Fred Lindstrom Memorial Park. The Yacht Club Park is overlapped by Zone 3. The 125-foot-high Astoria Column, dedicated in 1926, is located within a 780-acre wooded park located on Astoria's highest hill. Tapiola Park, established in 1941 by members of the Finnish Brotherhood, includes a skate park in a former swimming pool and an "educational superplayground." Shively Park was developed for Astoria's Centennial celebration in 1911 and designed by Arthur Peck. A small park at 15th and Exchange Streets contains a partial replica of Fort Astoria. Warren Field covers 8 acres. The City of Astoria also operates an Aquatic Center along Marine Drive within Zone 2.

Along the Columbia River waterfront in Astoria, besides the docks, are the Maritime Memorial Park, 6th Street Viewing Dock, 14th Street Riverpark, and the pedestrian/bike Columbia Riverwalk Trail. A restored 1914 trolley runs for 3 miles between Basin and 36th Streets. Portions of these facilities are overlapped by Zone 1. Near the waterfront, within Zone 2, is the 1926 Astoria Victory Monument and Doughboy Statue.

Also situated along Astoria's waterfront is the Columbia River Maritime Museum. Other museums in Astoria, within Zone 2, include the Flavel House in an 1885 Queen Anne Victorian at 8th and

Duane Streets, the Heritage Museum in the old 1904 City Hall building at 16th and Exchange Streets, and the Uppertown Firefighters and Children's Museum in the 1896 North Pacific Brewery building at 30th Street and Marine Drive. The Liberty Theater is in a 1925 Italian Renaissance style building at Commercial and 12th Streets (Astoria and Warrenton Chamber of Commerce, 2007; Astoria's Historic Resources and Heritage, 2006). Astoria's historic resources are addressed in section 4.9.

Skamokawa Vista Park

The 70-acre Skamokawa Vista Park, operated by Wahkiakum Port District No. 2, is located on the north shore of the Columbia River, at about CRM 32, near the mouth of the Skamokawa Creek. The park includes a campground with 34 sites for hookups, playground, game field, and basketball and tennis courts. Additional amenities include picnic tables, toilets, shower, beach, and facilities for small boat launch. It provides access to the Lower Columbia River Water Trail. Skamokawa Vista Park is within Zone 2.

Cathlamet Parks

Within the City of Cathlamet, which is partly overlapped by Zone 3, are two parks and a swimming pool operated by the Department of Parks and Recreation. Erickson Park consists of 10 acres on Columbia Street, acquired in 1947, that includes a covered shelter, and tennis and basketball courts, playground equipment, and nature paths. Strong Park covers about 2 acres on the Cathlamet waterfront and includes the Wahkiakum County Museum (Town of Cathlamet, 2007).

Schools, Libraries, and Hospitals

The Warrenton community library is located within Zone 2. However, all of the public schools in Warrenton appear to be outside of the Zones of Concern.

In Astoria, Captain Robert Gray Elementary School, John Jacob Astor Elementary School, Clatsop Community College, Clatsop Care Center, Columbia Memorial Hospital, Clatsop County Health and Human Services, and the public library are overlapped by Zone 2. Within Zone 3 are Astoria Middle School and Astoria High School. Local infrastructure and public services, including schools and hospitals, for the communities along the waterway used by LNG marine traffic are further discussed in section 4.8.1.6.

Military Installations

The Tongue Point Naval Air Station was established in 1940 on the east side of Astoria, Oregon. In 1964 the Coast Guard Astoria Air Station was located at the Tongue Point Naval Air Station. It was relocated to the Astoria Regional Airport southeast of Warrenton in 1966. However, the Coast Guard maintains an Aid to Navigation Team at Tongue Point and has docking facilities for cutters along the Astoria waterfront. The Coast Guard facility at Tongue Point is overlapped by Zone 2, while the Coast Guard Air Station is within Zone 3. The Coast Guard also operates a life boat station at Cape Disappointment in Ilwaco, Washington, and the mooring for that station is overlapped by Zone 3.

Impacts on Recreation and Public Interest Areas

The main impact on recreation and public interest areas as a result of LNG marine traffic in the waterway would be visual. Visual impacts associated with LNG marine traffic are discussed in section 4.7.1.5.

In the unlikely event of an LNG spill from a tanker in route along the waterway to the terminal, and an associated pool fire, there may be effects upon recreational facilities, parks, and other public interest areas. Those facilities within Zone 1 could sustain damages to structures, features, or vegetation. Facilities within Zone 3 would be less affected. However, with the implementation of the safety and security measures outlined in the Coast Guard's WSR, the chance of a spill would be extremely remote and the potential impacts on recreational facilities, parks, and other public interest areas would be less than significant.

General Recreation and Other River Users

The lower Columbia River is used for both commercial and recreational purposes. Portions of the discussion below are based upon the findings of the *River User Impact Analysis* relative to LNG marine traffic produced for NorthernStar (Kraley, 2006), and NorthernStar's preliminary WSA by ABSG Consulting, Inc.[15] The potential impact of LNG marine traffic in the waterway on commercial and recreational users of the lower Columbia River is further discussed in section 4.8.1.7, and recreation and tourism is also addressed in section 4.8.1.8.

Commercial Uses

Commercial activities along the lower Columbia River include: shipping, commercial fishing, charter boat services, cruises, ship piloting (both along the river and at the bar), tugboat operations and long-shoring, and miscellaneous shore-based activities in the Astoria area. These commercial activities and potential impacts of the Bradwood Landing Project on these activities are further discussed in section 4.8.1.7.

Recreational Uses

Recreational activities for the lower Columbia River and shoreline include: fishing, water-skiing, boating, sailing, kayaking, windsurfing, personal watercraft, sunbathing, sightseeing, wildlife viewing, hiking, camping, picnicking, and beach combing. The potential impact of LNG marine traffic in the waterway on recreation and tourism is further discussed in section 4.8.1.8.

Fishing

Recreational fishing occurs most frequently during the summer months (averaging about 300 private fishing boats in the waters of the Columbia River estuary per day between June and August). The largest fishery on the river, at Buoy 10 near the mouth of the Columbia, is fished during August and accounts for the highest level of recreational boat traffic during that time. According to the ODFW, in 2005 Washington and Oregon anglers combined took over 400,000 fishing trips along the almost 150-mile-long stretch of the lower Columbia River between Bonneville Dam and Buoy 10 (Watts and Takata, 2006).

Boating and Sailing

Recreational boaters, including sport fishers and sailers, can reach the lower Columbia River from upstream boat ramps and marinas, including locations in Kalama and Longview, Washington, and Rainier and Clatskanie, Oregon. Along the waterway to be used by LNG marine traffic in Washington,

[15] The *River User Impact Analysis* was attached as Appendix A to Resource Report 5 in NorthernStar's June 5, 2006 application. It is available for viewing on the FERC Internet website (http://www.ferc.gov). Using the "eLibrary" link, select "General Search" from the eLibrary menu and enter the docket number excluding the last three digits in the "Docket Number" field (i.e., CP06-365). Be sure to select an appropriate date range. ABSG Consulting Inc.'s, May 18, 2006, "Waterway Suitability Assessment, Bradwood Landing LNG Project, Columbia River," was submitted to the Coast Guard under its SSI regulations and is not available to the public.

there are boat launches at Cape Disappointment State Park, Chinook, Knappton, and Skamokawa, and moorings at marinas at Ilwaco and Cathlamet. In Clatsop County, Oregon, there are recreational boat ramps at John Day Park, Knappa, Aldrich Point, and Westport, and marinas in Hammond, Warrenton, and Astoria. Both power boats and sailboats can access the lower Columbia River from the boat launches and marinas mentioned above.

Accurate information on the boat traffic into or out of various launches along the lower Columbia River is unavailable, as most rely on the honor system with payment drop boxes based on donations. Therefore, it is not possible to estimate the current level of recreational boat traffic. However, a sense of recreational boating activity can be gauged from the operation of local marinas (see table 4.7.1-1).

TABLE 4.7.1-1

Marinas and Boat Launches in the Lower Columbia River

Marina or Boat Launch	County	State	Gross Revenue
Astoria East Mooring Basin	Clatsop	OR	$90,000
Hammond Marina	Clatsop	OR	$205,000
Warrenton Marina	Clatsop	OR	$315,000
Astoria West Mooring Basin	Clatsop	OR	$310,000
Rainier City Marina	Columbia	OR	$32,000
Kalama Marina	Cowlitz	WA	$328,000
Willow Grove Boat Launch	Cowlitz	WA	NA
Cape Disappointment State Park	Pacific	WA	$170,000
Port of Chinook	Pacific	WA	$400,000
Port of Ilwaco	Pacific	WA	$700,000
Elochoman Slough Marina	Wahkiakum	WA	$433,000

NA Not available.

The Hammond Marina, at about CRM 11, includes a four-boat launch ramp, 140 slips, and offers overnight moorage for both commercial and recreational vessels. Facilities include a fuel dock, restroom and showers, picnic area, camping area, and parking lot for 400 vehicles. Two Columbia River Pilot cutters operate out of this marina. The entrance to the Hammond Boat Basin is 1,410 feet from the navigation channel, within Zone 2.

The Warrenton Marina is located up the Skipanon River from the Columbia River navigation channel, but is still overlapped by Zone 3. The marina contains 370 slips, and its facilities include restrooms, showers, and a fish cleaning station (Astoria-Warrenton Chamber of Commerce, 2007). There are an additional 92 slips at the Skipanon Marina.

The Port of Astoria operates two marinas for recreational boaters, overlapped by Zone 1, with moorings for craft up to 100 feet long. The West Basin, located at about CRM 14, contains 335 slips. The East Basin, at about CRM 15.6, has 82 slips, and a public pier, and is home to some of Astoria's fishing fleet (Port of Astoria, 2007). There is also a transient dock at 17th Street.

Water-skiing, Jet-skiing, Windsurfing, and Kayaking

Other recreational uses of the lower Columbia River include water-skiing, personal watercraft such as jet-skis, windsurfing, kite surfing, kayaking and canoeing. Wake-boarding, tubing, and other, similar boat-pulled activities are included in our discussion of water-skiing. Water-skiing and the

aforementioned related activities typically occur upriver of CRM 38, where the water is calmer and other boat traffic is relatively sparse.

Windsurfing and kite surfing are relatively recent activities along the lower Columbia River. Most of this activity occurs upriver of CRM 38, with a favorite location being near Clatskanie, Oregon. The Columbia River off of Jones Beach (CRM 47) is known to be used by windsurfers and kite surfers. Windsurfers also use the Columbia River off of Chinook County Park in Pacific County, Washington (CRM 6). However, both Jones Beach and Chinook County Park are located outside of the Zones of Concerns for LNG marine traffic to the proposed Bradwood Landing LNG terminal. Little, if any, windsurfing occurs in the waterway that would be used by LNG marine traffic. Where these activities do take place is typically in shallow areas of the river, near shore, away from the navigation channel. Therefore, we do not expect the project to have any direct impacts on windsurfing or kite surfing activities.

Personal watercraft, such as jet-skis, can be rented in Warrenton, Oregon, and Longview, Washington. This activity can take place in shallower waters, outside of the navigation channel along the lower Columbia River.

Kayaking and canoeing typically occur near the shore and outside of the shipping channel. Kayak rentals are available at several points along the lower Columbia River, including in Warrenton, Oregon and Skamokawa, Cathlamet, and Longview, Washington.

Sunbathing, Beachcombing, Sightseeing, Wildlife Viewing, Hiking, Swimming, Camping, and Picnicking

Increased commercial ship traffic in the lower Columbia River resulting from this project should not have significant negative impacts on sunbathing, beachcombing, sightseeing, wildlife viewing, hiking, swimming, camping, and picnicking. The only developed recreational beach immediately adjacent to the waterway to be used by LNG marine traffic is at Skamokawa Vista Park, at CRM 32, in Wahkiakum County, Washington. Parks and other recreational and public interest areas are discussed above and in section 4.8.1.8. Potential visual impacts from LNG carrier traffic along the river on park and beach users are discussed in section 4.7.1.5. Elsewhere in this EIS are discussions of ship wakes and the potential for shoreline erosion.

Potential Impacts of LNG Marine Traffic in the Waterway on Other River Users

Recreational boaters, including power boat and sailboat users, have always needed to account for commercial ship traffic on the Lower Columbia River. Fishermen frequenting the area indicate that other ship traffic does not represent either a detriment to their fishing experience or to the location they decide to fish (Kraley, 2006). While currently almost 2,000 commercial ships use the lower Columbia River, the project would add about 125 LNG carriers per year to the existing marine traffic. One of the conditions of the Coast Guard's WSR is to impose a moving 500-yard safety and security zone around LNG carriers heading up river. Recreational boat operators may have to move out of that zone while an LNG carrier passes by. We believe this minor inconvenience would only last for a few minutes, as the LNG carriers would travel up river at speeds between 8 and 12 knots. The Coast Guard's WSR further addressed communication networks that would need to be implemented to make other river users aware of future LNG carrier deliveries.

Operators of personal watercraft, such as jet-skis, and kayakers, canoers, and windsurfers typically stay in shallow waters outside of the navigation channel. They may be affected by wakes from LNG carriers. However, large commercial ships that currently travel through the lower Columbia River

already create wakes of similar size to those that would be generated by LNG carriers, and jet-skiers, kayakers, and canoers should be familiar with how to deal with wakes from large ships.

In the unlikely event of an LNG spill and associated pool fire, recreational river users could potentially be affected, depending on the location and duration of the incident. However, with the safety and security measures outlined in the Coast Guard's WSR, the likelihood of such impacts would be extremely remote and the potential impact on recreation river users would be less than significant.

4.7.1.5 Visual Resources

People in Oregon and Washington along the waterway for LNG marine traffic would view LNG carriers on the Columbia River from the point the ships enter the river to the LNG terminal at CRM 38. The proposed LNG terminal is expected to receive approximately 125 LNG carriers per year, averaging 10 to 11 ships per month or one every 3 days. In addition, the Clatsop State Forest has designated Land Management Classifications along the Columbia River just west of the proposed LNG terminal that include the visual focused stewardship subclass. We believe that the visual impacts of LNG marine traffic would be short term, for it would typically take a vessel only a few minutes to pass through the viewshed, traveling at the average speed between 8 and 12 knots. LNG carriers would be generally consistent with large tankers that currently use the navigation channel heading to and from upriver ports. There are as many as 2,000 commercial vessels per year that travel up and down the Columbia River. Therefore, the addition of 125 LNG carriers per year would not be a significant increase in terms of visual impacts for observers along the waterway.

4.7.2 LNG Terminal

4.7.2.1 Land Use

The proposed LNG terminal would be on the southern shore of the Columbia River and southeastern end of the Clifton Channel in Clatsop County, Oregon. NorthernStar controls a 411-acre upland tract, with an option to purchase from the current landowner. Historically, this property was the site of several lumber mills that operated from about 1843 to 1852, 1910 to 1920, and 1930 to 1962, and the location of the town of Bradwood from about 1930 to 1985 (see section 4.9.1.2). Between about 1966 and 2003 the COE placed almost 900,000 cubic yards of material dredged during maintenance of the Columbia River navigation channel at Bradwood.

Construction of the LNG terminal would affect about 61 acres within the 411-acre upland tract controlled by NorthernStar, and about 40 acres would be needed for the permanent operation of the onshore facility structures (see table 4.7.2-1). The remainder of the upland tract to be acquired by NorthernStar would be left alone as a buffer area around the terminal; kept in its current land use as forest, shrub, or wetlands. NorthernStar intends to conserve and improve wetland habitat at the mouth of the Hunt Creek as part of its wetland and habitat mitigation plan. A 58-acre area of the Columbia River would be used for a turning basin and ship berth at the terminal. Within the 58-acre maneuvering area, 46 acres would be dredged from the river bottom that is owned by the state of Oregon (section 1.3 discusses the permits that NorthernStar would need to obtain before being allowed to dredge in the Columbia River). Additionally, a power line would be constructed to bring electricity to the LNG terminal, affecting 16.9 acres. The right-of-way for the power line would be on private land that would have to be acquired by PacificCorp.

TABLE 4.7.2-1

Land Uses Affected by the Construction and Operation of the Proposed LNG Terminal [a]

	Marine Industrial (acres)		Forest/Aquatic Natural (acres)		Aquatic Development (acres)		Forest (acres)		Aquatic Development/ Aquatic Conservation (acres)		Total (acres)	
Facility Component	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.
Ship Berth and Unloading Facilities	5.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	1.0
LNG Storage	20.5	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.5	14.5
Regasification	16.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	10.5
Bridge/Road/Railroad Easements	0.0	0.0	11.9	8.1	0.0	0.0	0.0	0.0	0.0	0.0	11.9	8.1
Water Storage and Treatment	6.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	4.5
Buildings	0.0	0.0	0.0	0.0	1.0	0.5	0.0	0.0	0.0	0.0	1.0	0.5
Buffer	0.0	0.0	6.0	1.0	0.0	0.0	0.9	0.9	0.0	0.0	6.9	1.9
Power Line Right-of-Way	0.0	0.0	0.0	0.0	0.0	0.0	16.9	16.9	0.0	0.0	16.9	16.9
Ship Berth and Maneuvering Area (includes 46-acre dredge area footprint)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.0	58.0	58.0	58.0
Total	48.5	30.5	17.9	9.1	1.0	0.5	17.8	17.8	58.0	58.0	143.2	115.9

[a] These were the land use zoning designations at the time NorthernStar filed its applications with the FERC in June 2006. However, in March 2008 Clatsop County changed the zoning for the proposed LNG terminal.

Con. Construction

Oper. Operation

The proposed 58-acre ship maneuvering area for the terminal in the Columbia River is currently open water. About 21 acres onshore that would be impacted by construction of the LNG terminal is currently dredged material piles. The onshore area impacted by construction of the LNG terminal is currently forested and scrub-shrub vegetation. Within the onshore area, wetlands characterized as emergent, scrub-shrub, and forested are also present (see table 4.4.1-2). Construction of the 1.5-mile-long powerline would affect forested land. Commercial/industrial lands affected by construction of the proposed LNG terminal would include Bradwood Road and the PWRR. Section 2.1.3 describes the various components of the LNG terminal.

Based on the *Clatsop County Comprehensive Plan*, at the time when NorthernStar filed its applications with the FERC, the land that may be affected by construction and operation of the LNG terminal was zoned as Marine Industrial, Forest, Aquatic Development, Aquatic Natural, and Aquatic Conservation. A DMD Overlay zone applies to a portion of the site. The DMD Overlay Zone is intended to designate sites for disposal of dredged materials. Additionally, an inactive licensed basalt quarry is presently located on the LNG terminal site. The quarry may be activated during construction but would be decommissioned before the LNG terminal is operational.

In response to NorthernStar's land use application to Clatsop County, the zoning for portions of the terminal have been changed. Additional information regarding land use zones at the proposed LNG terminal is provided below in section 4.7.2.2.

4.7.2.2 Consistency with Existing Land Use Plans, Policies, Designations, and Guidelines

State and local government entities in Oregon have established plans, policies, designations, and guidelines for land use development in the project area. At the time NorthernStar filed its applications with the FERC it appeared that the proposed project would not be wholly consistent with some of those plans. However, in March 2008, Clatsop County made a final decision to change the land use zoning at the proposed Bradwood Landing LNG terminal. Consistency of the Bradwood Landing Project with local and state zoning and land use planning goals ordinances, and regulations is discussed below and in section 4.7.3.2. Consistency with coastal zone management programs is discussed in section 4.7.2.4.

Land use in Oregon is required to be consistent with the Statewide Land Use Planning Goals. The goals are implemented in Clatsop County through its state-acknowledged Comprehensive Plan as established by Clatsop County Ordinance 80-14, the Land and Water Development and Use Ordinance (LWDUO). The land uses described in section 4.7.2.1 also equate to the zoning codes used by Clatsop County. These include Marine Industrial, Forest, Aquatic Development, Aquatic Natural, and Aquatic Conservation Two. According to the Comprehensive Plan, the following summarizes the purposes of each of the land use zoning codes affected by the project:

- Marine Industrial – to manage Columbia River Estuary shorelands in urban and urbanizable areas and shorelands in rural areas especially suited for water-dependent development and to reserve these shorelands for water-dependent industrial, commercial, and high-intensity recreational use. The provisions of the Marine Industrial zone are set forth in section 3.620 - 3.636 of the LWDUO.

- Forest 80 – to conserve forest lands by maintaining the county's forest land base; to protect the county's forest economy by making possible economically efficient forest practices that assure the continuous growth and harvest of forest tree species as the leading use of forest land consistent with sound management of soil, air, water, fish and wildlife resources, and scenic resources; and to provide for public and private recreational opportunities and agriculture. The provisions of the Forest 80 zone are set forth in section 3.550 - 3.558 of the LWDUO.

- Aquatic Natural – to assure the preservation and protection of significant fish and wildlife habitats, continued biological productivity of the Columbia River estuarine resources, and scientific research and educational opportunities. These areas are managed to preserve natural resources in recognition of dynamic, natural, geological, and evolutionary processes. This zoning code includes all tidal marshes, tidal flats, and seagrass, algae beds, and ecologically important subtidal areas, and is intended to preserve those natural aquatic resource systems existing relatively free of human influence. Provisions of the Aquatic Natural zone are set forth in section 3.802 - 3.812 of the LWDUO.

- Aquatic Development – to provide for navigation, and other identified needs for public, commercial, and industrial water-dependent uses, consistent with the level of development or alteration allowed by this zone and the need to minimize damage to the Columbia River estuarine ecosystem. Provisions of the Aquatic Development zone are found in section 3.740 - 3.756 of the LWDUO.

- Aquatic Conservation Two – to conserve designated areas of the Columbia River Estuary for long-term uses of renewable resources that do not require major alterations of the estuary, except for the purpose of restoration. These areas are managed for the protection and conservation of their natural resources and benefits, and include areas needed for

maintenance and enhancement of biological productivity, recreational resources, aesthetic values, aquaculture and open water portions of the estuary. Areas that are partially altered and adjacent to existing developments of low to moderate intensity that do not possess the resource characteristics of other aquatic areas are also included in this zone. The provisions of the Aquatic Conservation Two zone are set forth in section 3.780 - 3.792 of the LWDUO.

During project scoping, we received a letter from the Clatsop County Board of Commissioners that further outlined the county's land use regulations and ordinances that apply to the construction and operation of an LNG terminal at Bradwood (Clatsop County Board of Commissioners, 2005). While the letter was not intended to express any position or establish any findings by Clatsop County regarding NorthernStar's proposal, it did identify several apparent conflicts between the existing land use zoning and the action at the time NorthernStar filed its applications with the FERC. Some of the concerns expressed by Clatsop County during scoping are summarized below.

The main policies of Clatsop County's Comprehensive Plan that relate to the LNG terminal are found in the plan's "Goal 16 and 17 Element: Columbia River Estuary." The Goal 16 and 17 Element contains six major policy sections, labeled P15, P20, P21, P30, P40, and P50. Each of these sections contains a detailed set of related policies. For example, P20, "Columbia River Estuary Shoreland and Aquatic Regional Policies," consists of 20 policies dealing with topics such as diking, log storage, and fish and wildlife habitat in the Columbia River estuary. All of Bradwood's shoreline lies within the Columbia River estuary and hence is subject to Goal 16. Therefore, much of the Goal 16 and 17 Element of Clatsop County's plan is relevant to the Bradwood Landing Project. For example, the "use tables" for aquatic and shoreland areas specify categories of development that may be allowed on lands along the Columbia River, including the proposed LNG terminal site. The policies most directly applicable to the proposed development are:

- P20.3, "Deep-Water Navigation, Port and Industrial Development;"
- P20.5, "Dredging and Dredged Material Disposal;"
- P20.6, "Estuarine Construction;" and
- P30.21, "Bradwood."

P30.21 is a three-page subarea plan for the Bradwood area. Some of the key provisions most relevant to the Bradwood Landing Project are as follows:

> *The Bradwood Industrial site offers limited potential for small to medium water-dependent industrial development. There is deep water close to shore, some available vacant land and the proximity of the wildlife refuge…Future development which would require extensive filling (impacting aquatic areas in excess of 20 acres) along the Columbia River shoreline for the purpose of creating additional industrial land is not appropriate. In order to fully utilize the marine industrial shorelands, it would be appropriate to fill the old Bradwood mill pond. This pond covers an area of less than 10 acres. This fill activity would be subject to the state and federal permit process and the development of proper mitigation areas. An upland area along the entrance road into Bradwood has been identified as a potential mitigation site.*

On December 12, 2006, NorthernStar filed an application with Clatsop County to amend the combined Clatsop County Comprehensive Plan Map and Zoning Map to change areas that were zoned as Aquatic Development to Marine Industrial, and from Aquatic Conservation Two to Aquatic Development. In addition, the application sought an amendment to the Clatsop County Comprehensive Plan to allow dredging for the creation of the terminal turning basin and berth, and to delete language in the plan relating to small and medium scaled development. The Clatsop County Planning Commission

held hearings on NorthernStar's land use application in July 2007, and recommended approval of the applications subject to conditions following public deliberations in August 2007, with an adoption of findings on September 28, 2007. The Board of Commissioners held public hearings in October and November 2007, with a tentative decision to approve the application in December 2007. A final decision to adopt the zoning changes was made on March 20, 2008.

The Marine Industrial zone covers that portion of the Bradwood property formerly occupied by the Bradley-Woodard lumber mill. Much of this land has been raised above the elevation of the adjoining marsh and wetlands by deposition of dredged materials and by fill used to create berms for the railroad and haul road that cross the property. As discussed above, the zone is intended for intensive water-dependent industrial uses, subject to various standards and requirements regarding matters such as buffers, building height, and setback. Therefore, NorthernStar's activities proposed within the Marine Industrial zone are permitted or conditionally permitted uses within this zone.

In the middle of the portion of the Bradwood tract zoned as Marine Industrial is the former mill pond; now partly filled with silt. The county's land use maps show the above-water silted parts of the mill pond to be zoned Marine Industrial and the remaining underwater portion to be zoned Aquatic Development. All the mill pond and Aquatic Development-zoned waters are owned by the state and are not part of the privately owned Bradwood property. In its March 2008 decision, the Clatsop County Board of Commissioners changed the zoning of the 2.51-acre mill pond area from Aquatic Development to Marine Industrial.

Related to the Marine Industrial zone is the DMD Overlay Zone, which applies to the same part of the proposed LNG terminal site that is zoned Marine Industrial. The zone is intended to designate sites for disposal of dredged materials, for which the Bradwood property has already been used. Resulting dredged materials are evident as large sand dunes along the shore of the Columbia River on the eastern part of the site. The provisions of the DMD Overlay Zone are set forth in Clatsop County's LWDUO in section 4.160-4.172. The DMD Overlay Zone is intended to "protect important dredged material disposal sites from incompatible and preemptive uses that may limit their ultimate use for the deposition of dredged material." It thus prohibits many uses that would otherwise be allowed under the Marine Industrial zone as outlined in section 4.168 of the LWDUO and, therefore, the activities proposed by NorthernStar would not be permitted in this zone. The DMD Overlay Zone, however, does contain provisions for withdrawing the DMD designation under certain conditions.

A portion of the land required for the proposed LNG terminal was zoned Aquatic Natural. Generally, the Aquatic Natural designation was intended as a conservation zone for the protection of fish and wildlife habitats, and estuarine and aquatic resources. At the proposed LNG terminal, the Aquatic Natural zone covered a low-lying brushy area of disturbed wetlands bounded on the northwest by Hunt Creek, on the east by the railroad track that runs through Bradwood, and on the southwest by Clifton Road. Two smaller strips of Aquatic Natural-zoned land were also identified between the railroad and tidal marsh and between the berms that support the parallel road and railroad. Typically, intensive industrial activities would not be allowed in Aquatic Natural zoned lands. However, in its March 2008 decision, the Clatsop County Board of Commissioners re-zoned these areas, covering a total of 5.35 acres, to Marine Industrial.

A portion of the land for the proposed berth at the LNG terminal is zoned as Aquatic Development. The Aquatic Development zone applies to an aquatic strip or band of the estuary along the northeastern shore of Bradwood. These Aquatic Development-zoned areas are not part of the privately owned 411-acre Bradwood tract; they are owned by the state. Generally, the zone allows many of the intensive water-dependent industrial uses proposed by NorthernStar, such as "cargo loading and unloading facilities."

The portion of the Columbia River where NorthernStar proposes to create its turning basin/maneuvering area was formerly zoned as Aquatic Conservation Two. This area is owned by the State of Oregon, and NorthernStar would have to acquire permits from the COE, ODSL, and ODEQ, as discussed in sections 1.3 and 4.3.2.3, for the dredging of the turning basin. Generally, as mentioned above, the Aquatic Conservation Two zone is a conservation zone intended to protect estuarine resources. Typically, industrial activities would not be allowed within the Aquatic Conservation Two zone. However, in its March 2008 decision, the Clatsop County Board of Commissioners changed the zoning of the 46.4 acres where NorthernStar would dredge its turning basin to Aquatic Development, and changed the plan designation for this area from Conservation – Other Resources to Development.

The Forest 80 zone applies to lands that would be crossed by the nonjurisdictional power line, and portions of the access roads serving the LNG terminal. However, the access roads are currently cleared and are not actually forested. Generally, as discussed above, this zone is intended to conserve forest lands for growing and harvesting trees. However, roads, transmission lines, and gas pipelines would be allowed within the Forest 80 zone, subject to certain conditions and limitations. Therefore, NorthernStar's activities proposed within this zone appear to be permitted or conditionally permitted uses.

Part of the LNG terminal site contains a quarry, which is subject to a Quarry Mining Overlay. Uses permitted or conditionally permitted in the underlying zone, including "Sensitive Uses," are allowed in the quarry impact area subject to the underlying zone criteria and as otherwise authorized by the energy, social, economic and environmental analysis (section 4.4.20 of the LWDUO). The new use may not interfere with or cause an adverse impact on permitted mineral activity or prevent adjacent mineral activity from meeting applicable standards. The quarry site is under the control of NorthernStar. NorthernStar plans to possibly use material from the quarry during construction of the proposed project and then cease quarry operations during the life of the facility.

The March 20, 2008 final decision by the Clatsop County Board of Commissions to approve the land use applications for the proposed Bradwood Landing Project was based upon NorthernStar accepting a series of conditions, including:

- submittal of copies of state and federal permits required for project development;
- certain stipulations for bridge replacement;
- a specific time window for removing the two concrete batch plants;
- developing and submitting a shoreline monitoring plan prior to dredging;
- maintaining access to Clifton Channel;
- developing and submitting a dredge material disposal plan prior to dredging;
- preventing runoff from the dredge disposal site to adjacent wetlands and intertidal areas;
- revegetation of the dredge disposal area if there is a delay in constructing the facility;
- re-establishment of stream banks and associated vegetation following construction of the electric power lines;
- submitting a site plan demonstrating compliance with county site development standards;

- certain widening and vegetative clearing along Rulryville Road;
- certain signage along Taylorville Road;
- submitting construction drawings for the purposes of flood hazard review;
- not opposing re-zoning of a parcel near the facility as Aquatic Natural;
- only two tanks would be permitted as part of the land-use review process;
- submitting a suitable Mitigation Plan that meets the applicable county performance standards, and is consistent with approvals from other agencies;
- making Clifton and Bradwood Road improvements consistent with county requirements;
- developing a decommissioning plan that includes financial assurance for site restoration;
- implementing safety recommendations outlined in Clatsop County's Public Safety Assessment for the facility;
- securing permits related to constructing and operating the helicopter pad prior to constructing the LNG facility; and
- developing and submitting an erosion control plan consistent with county standards.

In a letter dated November 14, 2007, as part of the application review process noted above, NorthernStar committed to meeting the conditions specified by Clatsop County.

4.7.2.3 Existing Residences and Planned Developments

Existing Residences

Based on review of aerial photographs and site visits, no residences are present within 0.5 mile of the LNG terminal. Two abandoned, unoccupied structures are located within the parcel controlled by NorthernStar. These consist of an open-sided pole barn erected in about 1985 that is partly covered by dredged material and the concrete remains of what was formerly an office building for the Bradley-Woodard lumber mill. The closest residence to the proposed LNG terminal is about 0.6 mile to the northeast across the Columbia River on Puget Island. No hospitals, fire departments, law enforcement offices, churches, or schools are located within 1 mile of the LNG terminal.

There are 21 residences within a 0.6- to 1.0-mile radius around the LNG terminal; all are located on the western tip of Puget Island. NorthernStar identified 45 other residences between 1 and 2 miles away from the terminal, including 3 houses in Clifton. Additionally, about 15 commercial structures were identified between 1 and 2 miles from the proposed LNG terminal.

The closest communities to the proposed LNG terminal are Clifton and Knappa, in Clatsop County, Oregon, and Puget Island and Cathlamet in Wahkiakum County, Washington. Clifton is located about 1 mile west of Bradwood on the south shore of the Columbia River along the Clifton Channel. It was the site of a fish packing factory in the 1870s, but by the 1960s Clifton had lost its post office, and an observer in 2000 counted only about five dwellings there (Helwig, 2000). Knappa is a rural unincorporated community, with a school district and fire department, located more than 3 miles

southwest of Bradwood along Highway 30. Puget Island, situated in the middle of the Columbia River and extending west to east from CRM 38 to CRM 45, has a disbursed rural population of just under 800 people. The town of Cathlamet is the Wahkiakum County seat, first founded by fur traders in the 1840s, and incorporated in 1907. It has a population of about 560 people and is located more than 3 miles northeast of Bradwood, on the other side of the Columbia River. Section 4.8 discusses regional population, local community social services, and infrastructure for the area.

During construction and operation of the LNG terminal there could be impacts on nearby residential and commercial areas from increased traffic on local roads, dust, odors, and noise. There would also be visual impacts for people residing or passing through the viewshed that includes the terminal. In general, as the distance from the terminal increases, the severity of the impacts decreases. We believe that most of the impacts on nearby residential communities related to traffic, dust, and odors would be temporary and short term, and not significant.

The majority of project workers would commute on Highway 30, which could have traffic implications for the communities of Clatskanie to the east and Knappa to the west. In order to allow construction traffic to move to and from the site safely, and lessen the impact on nearby communities, NorthernStar would follow a traffic management plan.

It is possible that construction of the proposed LNG terminal could have temporary adverse impacts on air quality due to fugitive dust emissions. The amount of fugitive dust would depend on the composition and moisture content of soils disturbed during construction activities. Given the regional climate and the distance to nearby residential communities, it is unlikely that fugitive dust from project construction would have an adverse effect. However, NorthernStar would implement BMPs to ensure that dust does not cause a nuisance (see section 4.10.1.2).

Dredging activities can sometimes result in odors, primarily due to hydrogen sulfides released from decaying organic material (e.g., plants) that occur in the dredged sediments. Generally, the greatest potential for odors is shortly after the dredged materials are brought to the surface and when the material is still wet (particularly when temperatures are warm). The sediments to be dredged from the turning basin site do not contain a high percentage of organic material. Additionally, the issue of odors associated with dredged material has not been particularly problematic for other dredging operations on the Columbia River. Therefore, neither dredging nor sediment disposal associated with the Bradwood Landing Project is expected to cause, or contribute to, objectionable odors on nearby residential and commercial areas.

To minimize noise impact on nearby noise-sensitive areas (NSA), NorthernStar would consider incorporating such noise attenuation measures as:

- use of bubble curtains and wooden blocks during pile driving;
- noise barriers or enclosures to block sound transmission from operating equipment;
- use of noise attenuation devices (i.e., exhaust mufflers) on construction equipment to manufacturers' recommended specifications;
- restricting activities with the potential to cause an exceedance of regulatory limits to daylight hours (i.e., dusk to dawn), except dredging;
- working with the dredging contractor to ensure that the project complies with any noise regulations applicable to nighttime construction activities;

- valves with "low-noise" trims;
- acoustical insulation for aboveground piping; and
- selection of equipment types with the least noise emissions.

Additional information on measures NorthernStar would implement to reduce impacts associated with increased traffic, dust, and noise is presented in sections 4.8.2.7, 4.10.1.2, and 4.10.2.2, respectively. Visual impacts are discussed in more detail in section 4.7.2.7.

Planned Developments

We did not identify any future planned residential or commercial developments in close proximity to the proposed LNG terminal. Based on NorthernStar's conversations with Clatsop County, no permits for new developments near the site have been filed (Stoel Rives, 2005). Wahkiakum County's Public Works Department indicated that its current construction projects include countywide guardrails, Altoona Pillar Rock slide repair, Puget Island ferry ramp replacement, West Little Island paving, and Beaver Creek emergency repair. Planned developments identified in the area that may cumulatively or additively impact resources that would be affected by construction and operation of the Bradwood Landing Project are discussed in section 4.12.

4.7.2.4 Coastal Zone Management

In 1972, Congress passed the CZMA to "preserve, protect, develop, and where possible, to restore or enhance, the resources of the nation's coastal zone for this and succeeding generations" and to "encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone" (16 USC 1452, section 303 (1) and (2)).

Section 307 (c)(3)(A) of the CZMA states that "any applicant for a required federal license or permit to conduct an activity, in or outside the coastal zone, affecting any land or water use or natural resource of the coastal zone of that state shall provide a certification that the proposed activity complies with the enforceable policies of the state's approved program and that such activity would be conducted in a manner consistent with the program." In order to participate in the coastal zone management program, a state is required to prepare a program management plan for approval by the OCRM. Once the OCRM has approved a plan and its enforceable program policies, a state program gains "federal consistency" jurisdiction. This means that any federal action (e.g., a project requiring federally issued licenses or permits) that takes place within a state's coastal zone must be found to be consistent with state coastal policies before the federal action can take place.

The Bradwood Landing Project is subject to a federal Coastal Zone Consistency Review because it would: 1) involve activities within the coastal zone of Oregon; and 2) require several federal permits and approvals (see table 1.3-1). Oregon has an approved coastal zone management program administered by the ODLCD, per section 306(d)(5) of the CZMA and ORS196.435. A description of the state's program, the applicable project activities, and information provided by NorthernStar in its FERC section 7(c) application regarding consistency of the project with state policies is provided below.

According to the OCMP, the coastal zone of Oregon encompasses the:

area lying between the Washington and California borders on the north and south, bound on the west by the extent of the state's territorial sea jurisdiction (3 nautical miles offshore), and

extending east to the crest of the Coast Range except at: [a] the Columbia River where the coastal zone extends to the downstream end of Puget Island, [b] the Umpqua River where the coastal zone extends to Scottsburg, and [c] the Rogue River where the coastal zone extends to Agness.

The mission of the OCMP is "to provide the public with sustainable coastal natural resources" (OCMP, 2005). To accomplish this mission, the OCMP has combined various state statutes for managing the state's coastal lands and waters into a single, coordinated package. The package, administered by the ODLCD, has three basic parts:

1. *The 19 Statewide Planning Goals*. The 19 goals are Oregon's standards for comprehensive land use planning. The goals set requirements on how land use decisions are to be made by local governments and state agencies. The ODLCD is responsible for adopting and interpreting most of the 19 goals, sets overall rules for planning decisions, and oversees the statewide program.

2. *City and County Comprehensive Land Use Plans*. In Oregon, local governments share the job of land use planning with the state by preparing and adopting plans. Ordinances are then implemented to meet the statewide planning goals and are coordinated with relevant programs of Oregon state agencies. In effect, day-to-day land use decisions can be made by local governments in conformance with their state-approved plans.

3. *State Agencies and Natural Resource Laws*. Since the late 1960s, the Oregon Legislature has adopted numerous statutes in response to threats on coastal and statewide resources from uncontrolled development. These statutes include the Oregon Beach Bill, administered by the Oregon Parks and Recreation Department, and the Removal/Fill Law, administered by the ODSL. All state agencies must also follow certain requirements of the Statewide Planning Goals and must coordinate their land use actions with local government comprehensive land use plans. This helps ensure that all land use decisions by local governments and by state agencies are done more or less under the umbrella of the Statewide Planning Goals.

NorthernStar is coordinating with the COE and ODLCD regarding coastal zone management review as part of the COE section 404 permit application. Federal regulations require the federal consistency determination request to contain at least: 1) a detailed description of the proposed activity; 2) a discussion of anticipated coastal zone effects; and 3) an evaluation of the activity and effects in light of the enforceable policies of the approved OCMP.

NorthernStar submitted a draft consistency certification to the ODLCD on May 31, 2006. A formal certification with a request for a formal federal consistency review was submitted on December 8, 2006. In a January 5, 2007 letter to NorthernStar, the ODLCD stated that the certification did not include the necessary data and information required by 15 CFR 930.58(a) and that the agency's 6-month review period had not yet begun. Among the information requested and subsequently provided by NorthernStar was: copies of complete applications for federal, state, and local licenses, permits, and approvals; findings that clearly identify data and information from referenced documents together with a clear explanation of why this information leads to a conclusion that a standard is met; additional details on the rail line realignment; the effects and compliance with state and local requirements for the proposed soil disposal area, temporary parking area, power line, concrete plant, aggregate site use, barge operations, road improvements, bridge replacement, mitigation, and in-water dredge material disposal site use; and copies of referenced supporting documents.

NorthernStar submitted a revised consistency certification on October 23, 2007. On November 21, 2007, ODLCD determined that although NorthernStar's application did not include all necessary data, pursuant to 15 CFR 930.60(a)(2) its 6-month review period began with the submission of the revised consistency certification. However, on April 10, 2008, the ODLCD and NorthernStar executed a Stay Agreement that allowed for a 150-day continuation period, when NorthernStar could provide additional information to supplement its application with the ODLCD. According to the Stay Agreement, the ODLCD would make its consistency determination for this project on or before September 21, 2008. On May 9, 2008, ODLCD sent NorthernStar a data request to clarify information about the project.

If the Bradwood Landing Project is authorized by the Commission, NorthernStar would need to document that its project is consistent with the CZMA before the FERC would allow any construction activities to begin. Therefore, **we recommend that:**

- **<u>Prior to construction</u>, of the LNG terminal and pipeline, NorthernStar should file with the Secretary documentation of concurrence from the ODLCD that the project is consistent with the CZMA.**

4.7.2.5 Hazardous Waste Sites

Based on an August 2005 Phase I Environmental Site Assessment, there are no contaminated sites within 0.25 mile of the proposed LNG terminal site (AMEC, 2005). However, the Environmental Site Assessment did identify several RECs on the property. RECs are defined by the presence or likely presence of hazardous substances and petroleum products on a property under conditions that could indicate an existing release, a past release, or a material threat of a release into the ground, groundwater, or surface water. The following RECs were identified at the site:

- REC 1 – two gasoline USTs, of which one was located at a former town store and the other was located at the main mill office. Documentation of their removal or decommissioning was not found;

- REC 2 – an area of the former train/maintenance shop building located at the mill where trains and other equipment were maintained;

- REC 3 – suspect asbestos-containing cement board scattered along the south side of the PWRR tracks;

- REC 4 – solid waste disposal and burn areas located along Bradwood Road, between the northwestern end of town and the Hunt Creek Bridge; and

- REC 5 – the potential presence of PCBs and dioxins in dredged Columbia River sand deposited at the proposed site.

RECs 1 and 2 are buried under dredged material. Because excavations would not be a component of LNG terminal construction, NorthernStar does not anticipate the need to manage potentially contaminated materials associated with RECs 1 and 2.

Before construction, NorthernStar would inspect the area occupied by REC 3. Any suspected asbestos-containing material would be collected and disposed of appropriately and in accordance with applicable state and federal regulations.

Similar to RECs 1 and 2, REC 4 has no surface manifestation and is buried. The realigned railroad and the LNG terminal administrative building would overlap the footprint of REC 4. However, because excavation is not a component of railroad construction and the administrative building would be constructed on fill, it is not anticipated that management of potentially contaminated materials associated with REC 4 would be required.

REC 5 is described as the potential presence of PCBs and dioxins in dredged Columbia River sand deposited at the site. However, in a February 1, 2006 letter from the COE to NorthernStar, the COE stated "USACE dredged material placed at this site is not a potential source of contaminants based on historical information" (COE, 2006).

In summary, management of potentially contaminated materials during LNG terminal construction is not anticipated. However, we have recommended that NorthernStar prepare a *Plan for the Discovery and Management of Contaminated Soils and Groundwater* that would specify the procedures to be followed to identify, characterize, and properly manage potentially contaminated materials in the event they are encountered during construction of the project (see section 4.2.2.1).

4.7.2.6 Recreation, Public Interest, and Special Use Areas

The Bradwood Landing LNG terminal would not affect any national or state parks, Indian reservations, or wild and scenic rivers. The project would be located on private property that does not provide public access to the Columbia River.

There are several recreation and public interest areas located in the vicinity of the proposed LNG terminal. The Clatsop State Forest boundary is about 0.3 mile west of the terminal. Tenasillahe Island, which is part of the JBHNWR, is located about 0.7 mile northwest across Clifton Channel from the terminal. The Bradley State Scenic Viewpoint is located about 1.8 miles southeast of the terminal. The Elochoman Slough Marina at Cathlamet is more than 3 miles northeast of Bradwood. The closest developed public recreational beach is at Skamokawa Vista Park, about 4 miles northwest of the terminal, across the Columbia River in Wahkiakum County, Washington. We do not believe that the project would have any significant adverse effects on these recreational use areas, which are further discussed below.

Designated Recreation and Public Interest Areas

The nearest recreational and public interest areas to the proposed Bradwood Landing LNG terminal include:

- a portion of the LCNHT, which is congruent with the Columbia River and within the area to be affected by terminal construction and operation;
- a portion for the Lower Columbia River Water Trail that is adjacent to the terminal and its LNG carrier berth and within the area that would be dredged for the proposed turning basin/maneuvering area;
- Bradwood Cliffs and old growth forest, which is about 0.2 mile south;
- the Clatsop State Forest, which is about 0.3 mile west;
- the JBHNWR, which is about 0.7 mile north on Tenasillahe Island;
- county land, which is about 1 mile southwest; and
- the Bradley State Scenic Viewpoint, which is about 1.8 miles southeast.

Lewis and Clark National Historic Trail

The LCNHT follows the lower Columbia River adjacent to the proposed LNG terminal at Bradwood, where NorthernStar would dredge its turning basin. Project impacts on the LCNHT are addressed in section 4.9.

Lower Columbia River Water Trail

The Lower Columbia River Water Trail also follows the river past the proposed LNG terminal. The water trail is intended for use by non-motorized water craft mostly during daily excursions. The proposed LNG carrier turning basin/maneuvering area and terminal berth would overlap a portion of the water trail. The dredging for these facilities may temporarily impact users of the water trail during construction. The Zones of Concern along the waterway for LNG marine traffic would also overlap the water trail, and potential project-related impacts associated with LNG carrier transit to and from the terminal are discussed in section 4.7.1.4.

Bradwood Cliffs/Old Growth Forest

Within about 0.25-mile of the proposed LNG terminal are the "Bradwood Cliffs," which have been identified as a "Scenic and Natural Area" in the Clatsop County Northeast Community Plan. The plan describes the cliffs as follows: "The area consists of 40 acres of old growth Douglas fir forest standing on basalt ledge overlooking the Columbia River. This stand is highly natural and the old growth trees will continue to constitute a viable natural ecosystem if left alone. The steep rocky slopes could not tolerate logging." Additional details on existing upland forested communities are presented in section 4.4.2.2.

Construction and operation of the LNG terminal would not affect old growth forest or the Bradwood Cliffs, NorthernStar revised the power line route so as to avoid impacts on the old growth forest associated with the Bradwood Cliffs (see section 3.1.7).

Clatsop State Forest

Located about 0.3 mile west of the LNG terminal site in Oregon is the Clatsop State Forest. The *Clatsop State Forest Astoria District Recreation Management Plan* outlines the implementation of recreation management in the state forest through objectives and actions, activity zoning, and the type of facilities the ODF will develop and manage. Dispersed recreational activities occur on forest lands, including hunting, fishing, camping, off-highway vehicle use, horseback riding, mountain biking, hiking, and scenic viewing. The ODF's Forest Management Plan for Northwest Oregon has Land Management Classification designations that include areas of visual concern. There is a visual designation along the Columbia River on the Clatsop State Forest directly west of the proposed Bradwood Landing LNG terminal.

The only effect the proposed LNG terminal may have on visitors to the Clatsop State Forest would be visual impacts for viewers using the forest. Visual impacts are addressed in section 4.7.2.7.

Julia Butler Hansen National Wildlife Refuge

Located about 0.7 mile north of the LNG terminal site on Tenasillahe Island is the JBHNWR. The eastern end of Tenasillahe Island has been used to store materials dredged from the Columbia River during maintenance of the federal navigation channel. The JBHNWR was established to protect the endangered Columbian white-tailed deer. It contains several public use facilities. Of these, the closest to

the LNG terminal is the Tenasillahe Island dike, which is open to the public and provides visitors access to the periphery of the island for wildlife viewing opportunities. Tenasillahe Island can only be reached by boat.

During construction and operation of the proposed LNG terminal there could be potential impacts on the JBHNWR, including noise and light. These impacts are discussed elsewhere in this EIS. Visual impacts are addressed in section 4.7.2.7.

County Land

Located about 1.0 mile south-southwest of the LNG terminal site is land owned by Clatsop County. Due to the distance, construction and operation of the Bradwood Landing Project is not expected to have any direct or indirect impacts on this land.

Bradley State Scenic Viewpoint

The Bradley State Scenic Viewpoint, located about 1.8 miles southeast of the proposed LNG terminal, was donated as park land to the Oregon Highway Commission in 1922. It currently serves as a rest stop along Highway 30, accommodates picnicking, and provides a view of the Columbia River and Puget Island. The LNG terminal would not be visible from this spot. However, the proposed power line to the terminal may be visible. Section 4.7.2.7 discusses the visual impacts associated with the LNG terminal.

General Recreation and Special Uses

It is possible that dredging of the turning basin during construction of the proposed LNG terminal may interfere with recreational use of the Columbia River. Because the temporary mooring of the dredge barges would occupy a relatively large portion of the channel throughout dredging operations, this equipment might present an obstruction to navigation; however, dredging would only occur between November and January when river use is lowest. Therefore, impacts on recreational uses of the river during construction would be minor and short term. Operation of the LNG terminal would not significantly affect recreational uses of the river because none of the structures to be constructed as part of the ship berth would be located within the navigation channel. Potential effects on river users resulting from LNG marine traffic in the waterway to the terminal are addressed in section 4.7.1.4.

The primary impact of the proposed LNG terminal on recreational river users in the immediate vicinity would be visual. Visual impacts are discussed in section 4.7.2.7.

4.7.2.7 Visual Resources

The degree of visual impact that may result from a proposed project is typically determined by considering the general character of the existing landscape and the visually prominent features of the proposed facility. The site is bordered on the north and east by the Columbia River, and on the south and west by forest land. Southwest of the proposed site, cliffs between 225 and 235 feet high occur along the southern side of the Columbia River. Hunt Creek enters the site from the south, dropping down from the surrounding hills with a waterfall, and runs along the western side of the site before entering the Columbia River. Views from the site include the confluence of the Clifton Channel and Columbia River, and Tenasillahe and Puget Islands. The terrain in the area of the site is relatively flat along the river and slopes upward west and south of the river. The proposed Bradwood Landing LNG terminal site is not a unique or scenic resource designated by Clatsop County or the State of Oregon. The overall visual

character of the site area is of a previously used industrial site. The dominant visible landforms currently on the site are the piles of dredged materials.

Topography would screen the LNG terminal from view by potential onlookers from the south and west and those traveling along Highway 30. The proposed LNG terminal would be visible from the Columbia River, the western shore of Puget Island, and the JBHNWR (see figure 4.7.2-1). NorthernStar conducted a visual assessment for the proposed project.[16] The results of the visual assessment for the Bradwood Landing Project are summarized below.

Commercial and recreational users of the Columbia River would have an unobstructed view of the LNG terminal from the river, resulting in a high to moderate overall visual impact, depending on the viewer's location and the time of year. Similarly, residents along the western shore of Puget Island and visitors to the portion of the JBHNWR on Tenasillahe Island would also experience unobstructed views of the LNG terminal, resulting in a high to moderate overall visual impact (see figures 4.7.2-2 and 4.7.2-3). Due to distance, intervening islands, and vegetation, views of the LNG terminal site from the portion of the JBHNWR on the Washington side of the Columbia River and Cathlamet would be partially obstructed, resulting in a moderate to low overall visual impact (see figures 4.7.2-4 and 4.7.2-5). Recreational users of Skamokawa Vista Park would have an unobstructed to partially obstructed view of the LNG terminal, depending on their location (see figure 4.7.2-6). However, because the park is located about 4.3 miles north of the proposed site, the resulting potential visual impacts would be low.

The completed LNG terminal would include a variety of structures as described in section 2.1.3. A component of assessing the potential visual contrast of the LNG facilities is to compare the relative scale of the structures to surrounding landscape elements. In that regard, the LNG storage tanks would be the most significant contribution to visual effects simply because of their size. The tanks would be about 254 feet in diameter and about 135 feet high, and would be constructed at a base elevation of about 20 feet above NAVD. As a result, the anticipated elevation at the top of the tanks would be about 155 feet above NAVD. About 500 feet south of the LNG storage tanks are cliffs which rise about 225 to 235 feet in height, and forested hills behind them would be a backdrop reducing visual impacts from viewpoints along the Columbia River. Furthermore, NorthernStar proposes to paint the LNG storage tanks so that they would blend in with the forested hillside in the background. Additionally, a berm would be built around the site approximately 25 feet above the water level and trees would be planted at the shoreline to provide a natural barrier between the river and the LNG terminal.

The exteriors of the LNG terminal structures would be painted to reduce visual impacts. Local planners would be consulted for color tones and hues selection. Colors of building materials suitable for the facility purpose would be chosen to blend into the existing visual environment.

[16] The Visual Assessment for the Bradwood Landing LNG terminal was filed on June 5, 2006 as Appendix 8A of Resource Report 8, and is available to the public through the FERC's Internet website (http://www.ferc.gov). Using the "eLibrary" link, select "General Search" from the eLibrary menu and enter the docket number excluding the last three digits in the "Docket Number" field (i.e., CP06-365). Be sure to select an appropriate date range.

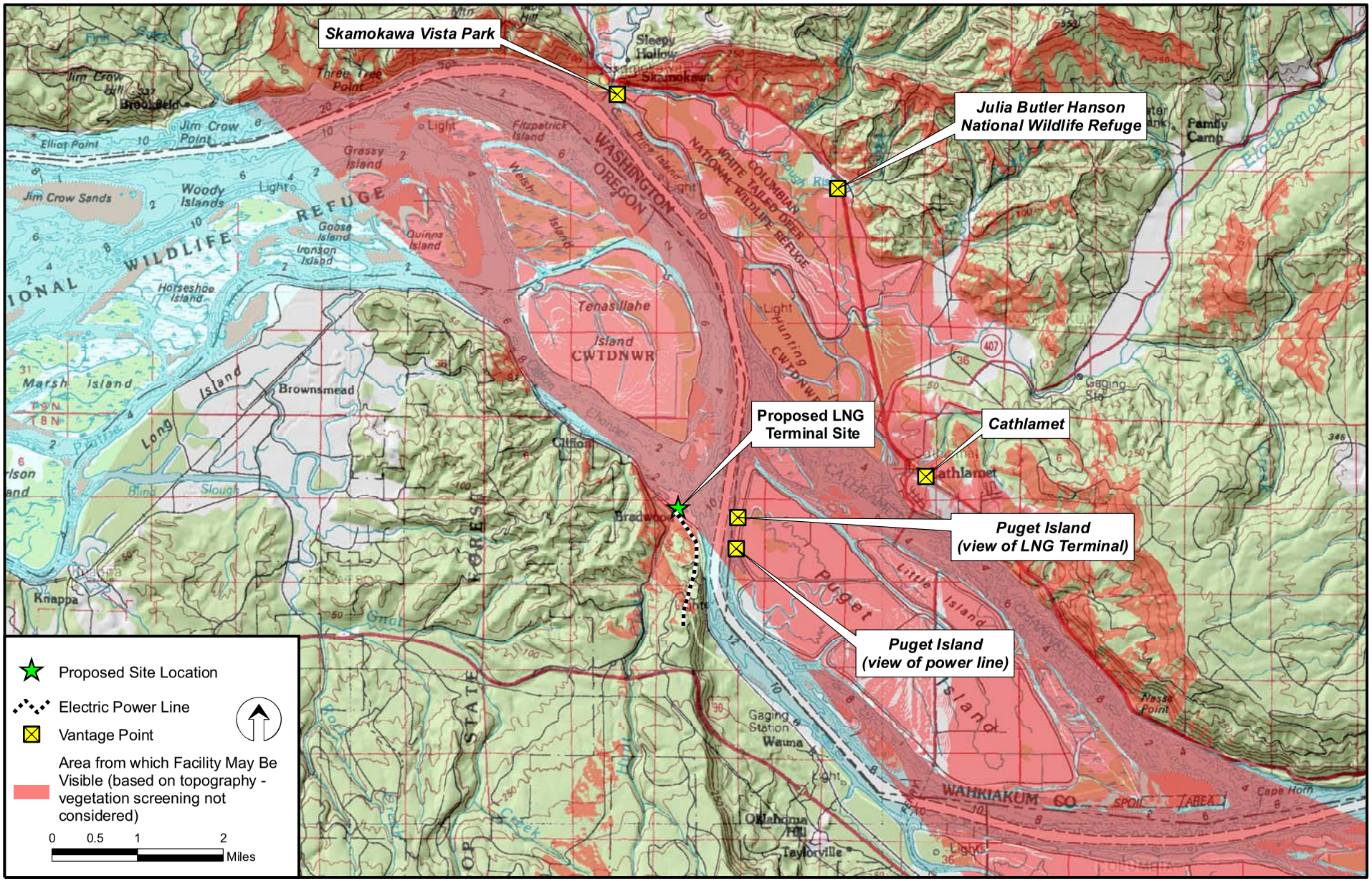


Figure 4.7.2-1
Bradwood Landing Project
Key Observation Points

Existing

Proposed

Figure 4.7.7-2
Bradwood Landing Project
View of the LNG Terminal Site without LNG Carrier from Puget Island

Existing

Proposed

Figure 4.7.2-3
Bradwood Landing Project
View of the LNG Terminal Site with LNG Carrier from Puget Island

Existing

Proposed

Figure 4.7.2-4
Bradwood Landing Project
View from the Northwestern Boundary of the JBHNWR in Washington

Existing

Proposed

Figure 4.7.2-5
Bradwood Landing Project
View of the LNG Terminal Site from Cathlamet

Existing

Proposed

Figure 4.7.2-6
Bradwood Landing Project
View of the LNG Terminal Site from Skamokawa Vista Park

The facility would require lighting at night for operational and personal safety and security reasons. For example, lighting would be needed for vessel navigation and for illuminating work areas after sunset. In addition, lights may be needed at the ship berth, construction staging areas, and parking lots. Exterior lighting at the LNG terminal site would be installed as necessary for general plant operations, worker and visitor safety, and security.[17] Lighting at the LNG terminal site is expected to be in accordance with OSHA requirements, with the recommendations of ANSI/IESNA Recommended Practice for Industrial Facilities, other applicable codes, and proper security practices.

NorthernStar filed its Lighting Plan in July 2007, which would minimize the number and/or intensity of facility lighting whenever possible through use of specific lighting intensities, light placement, and height. Down-shielding lights would also be used whenever possible to reduce off-site light scatter and illuminating of facility structures. At the current time there are no nighttime light sources at or in the immediate vicinity of the site. NorthernStar would minimize the impacts of nighttime lighting on surrounding areas through installation of appropriately focused lighting fixtures. Most of the lighting would be located in internal areas of the facility and would, therefore, not have a significant impact on surrounding areas. Overall, lighting impacts would be less than those from other developed areas along the river. Sections 4.5.2.1 and 4.5.2.3 include additional discussion of potential lighting impacts on wildlife.

Because the LNG terminal site is not served by public utilities, NorthernStar would need to supply electrical power to the facility via a 1.5-mile-long power line extension with a 100-foot right-of-way. The power line would interconnect with the existing BPA system and be constructed, owned, operated, and maintained by PacifiCorp. Five new standard pole H-frame towers, measuring 60- to 105-feet tall, would be set about 11 feet into the ground, leaving approximately 50 to 95 feet of power line pole exposed aboveground. Construction and operation of the power line would impact about 16.9 and 5.0 acres, respectively, of forest land, resulting in a permanent impact on visual resources. However, the power line would generally be located adjacent to the Columbia River in a relatively remote, rural area. The power line poles and exposed operational right-of-way would be noticeable primarily from users of the Columbia River and from a few distant vantage points, including the Bradley State Scenic Viewpoint. Figure 4.7.2-7 depicts a visual simulation of the power line from Puget Island. Two of the towers would be visible against the sky. Section 3.1.7 contains a discussion of the power line route alternatives analysis, in which visual impacts were considered.

4.7.3 Pipeline Facilities

4.7.3.1 Land Use

The Bradwood Landing Project would involve construction of one 36.3-mile-long, 30- to 36-inch-diameter pipeline that would connect the LNG terminal with the existing Williams Northwest pipeline north of Kelso, Washington. Additionally, other entities may construct three nonjurisdictional lateral pipelines. These include the 0.2-mile-long, 4-inch-diameter lateral pipeline to the Wauna Mill; the 1.4-mile-long, 24-inch-diameter lateral pipeline to the Northwest Natural pipeline servicing the Mist natural gas storage facility; and the 0.6-mile-long, 12-inch-diameter lateral pipeline to the PGE Beaver Power Plant. Table 4.7.3-1 summarizes the land uses crossed by the proposed pipeline and lateral routes.

[17] The Office of Pipeline Safety (OPS) within the DOT has statutory authority to regulate the safety and security of LNG plants under the Natural Gas Pipeline Safety Act of 1968 (P.L. 90-481). The OPS security regulations for LNG facilities are found in Title 49 CFR 193, Liquefied Natural Gas Facilities: Federal Safety Standards (Subpart J-Security). These regulations govern security procedures, protective enclosures, communications, monitoring, lighting, power sources, and warning signs. Title 49 CFR 193.2911 deals specifically with security lighting requirements.

Figure 4.7.2-7
Bradwood Landing Project
View of Proposed Power Line from Puget Island

TABLE 4.7.3-1

Land Uses Affected by the Construction and Operation Rights-of-way for the Proposed Pipeline and Laterals [a]

County, State/ Facility	Agricultural [b] (acres)		Forest [c] (acres)		Rangeland [d] (acres)		Open [e] (acres)		Commercial [f] (acres)		Residential (acres)		Water [g] (acres)		Total (acres)	
	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.
Clatsop County, Oregon																
Pipeline	0.0	0.0	51.5	25.1	10.2	5.8	5.3	2.5	7.3	3.8	0.0	0.0	1.8	0.9	76.1	38.1
Georgia-Pacific Lateral	0.0	0.0	0.1	<0.1	0.0	0.0	0.0	0.0	2.4	1.2	0.0	0.0	0.0	0.0	2.5	1.2
Columbia County, Oregon																
Pipeline	51.6	23.2	59.7	29.8	25.5	12.0	16.3	7.7	6.4	2.9	0.0	0.0	8.7	4.4	168.2	80.0
Northwest Natural Lateral	0.2	0.2	14.0	6.9	0.9	0.5	0.0	0.0	0.7	0.3	0.0	0.0	0.0	0.0	15.8	7.9
PGE Lateral	0.0	0.0	1.6	0.8	0.4	0.2	0.0	0.0	4.2	2.1	0.0	0.0	0.0	0.0	6.2	3.1
Cowlitz County, Washington																
Pipeline	22.8	10.0	161.6	81.2	14.5	7.4	0.2	0.1	2.4	1.1	1.0	0.4	4.5	2.3	207.0	102.5
Total	74.6	33.4	288.5	143.8	51.5	25.9	21.8	10.3	23.4	11.4	1.0	0.4	15.0	7.6	475.8	232.8

Note: The totals shown in this table may not equal the sum of addends due to rounding.

[a] Assumes an 85-, 100-, to 120-foot-wide construction right of way for the main pipeline, and a 100-foot-wide construction right-of-way for the lateral pipelines (see Appendix F). Assumes a 50-foot-wide operational right-of-way for the main pipeline and lateral pipelines.

[b] Agricultural land includes cropland, pastureland, orchards, groves, vineyards, nurseries, and other agricultural land.

[c] Forest land includes deciduous, evergreen, and mixed forests, and forested wetlands.

[d] Rangeland includes herbaceous, mixed, and shrub and brush rangeland.

[e] Open land includes transitional areas and non-forested wetlands.

[f] Commercial land includes industrial, mixed urban or built up land; strip mines, quarries, and gravel pits; and transportation and communications corridors.

[g] Water includes streams and canals.

Con. Construction

Oper. Operation

Of the 36.3 miles of the NorthernStar pipeline route, about 8.0 miles (22 percent) would be constructed adjacent to the existing KB pipeline. The remaining 78 percent of the pipeline route would be constructed on newly created right-of-way.

The predominant land use that would be crossed is forest, comprising about 50 percent of the pipeline route. Agricultural and rangeland are the next two most predominant land uses affected.

About 8.2 miles of the pipeline would cross forest land, 8.3 miles would cross wetlands, 6.7 miles would cross agricultural land, 4.8 miles would cross rangeland, 2.9 miles would cross commercial land, 0.2 mile would cross residential land, 3.0 miles would cross open land, and 2.2 miles would cross open water. Wetland and upland communities crossed by the proposed route are described in detail in section 4.4.1.3 and 4.4.2.3, respectively.

Land use impacts associated with the pipelines would include the disturbance of existing land uses within the construction right-of-way during construction and retention of a new permanent right-of-way for operation of the pipeline. NorthernStar proposes to use a 100-foot-wide construction right-of-way for the majority of the pipeline route. NorthernStar has also indicated that an additional 20 feet of construction right-of-way width may be needed for stockpiling topsoil wherever topsoil must be segregated from subsoil (e.g., in agricultural and residential lands). The 20 feet of additional width is based on the segregation of up to a 12-inch-thick layer of topsoil excavated only from directly over the pipe ditch and under the spoil pile (ditch plus spoil side).

In addition, in wetlands where the crossing length is 100 feet or less, NorthernStar would reduce the construction right-of-way to a width of 85 feet. The 85-foot limitation on the construction right-of-way width would not apply to wetlands in actively cultivated or rotated cropland. Appendix F provides a list by milepost of the locations where NorthernStar would use an 85-, 100-, or 120-foot-wide construction right-of-way.

Where the Bradwood Landing pipeline would be adjacent to the existing KB pipeline, the proposed temporary construction right-of-way would overlap onto the existing pipeline's permanent right-of-way. The overlap would be up to 10 feet on the spoil side of the pipe ditch, but no closer than 15 feet from the existing pipeline to keep construction equipment off the operating pipeline to prevent damage to the existing line.

Following construction, a 50-foot-wide permanent right-of-way would be maintained for operation and maintenance of the pipeline. The typical right-of-way cross sections that NorthernStar would use for the pipeline route are provided in Appendix D.

In addition to the construction right-of-way, NorthernStar would require temporary extra workspace outside the standard construction right-of-way at locations where additional excavation, soil placement requirements, or equipment management and staging would make it impracticable to carry out all construction operations within a 100-foot-wide corridor. These would include road and railroad crossings; wetland and waterbody crossings, areas with steep side slopes or severe terrain, areas requiring topsoil segregation, truck turnarounds, hydrostatic test water withdrawal pump locations, hydrostatic test water discharge locations, pipeline and utility crossovers, tie-ins to existing pipelines and laterals, HDD entry and exit points, staging and fabrication areas for HDD pull sections, and foreign pipeline crossings. Extra workspace may also be required where special construction techniques would be used. The size and configuration of each extra workspace is unique and dependent upon the existing conditions (e.g., available or accessible space, the presence of buildings and other structures, crossing angle, crossing depth, length of crossing, terrain, the presence of trees or sensitive habitat) at each work location. Table 4.7.3-2 lists by milepost the locations of and land uses affected by additional temporary workspaces required for pipeline construction. NorthernStar would access the construction right-of-way via existing public and private roads that intersect the right-of-way. Modifications or improvements to support the expected loads would not be required. Table 4.7.3-3 lists by milepost the roads identified by NorthernStar that would be used to access construction.

To support construction of the pipeline, NorthernStar proposes to use two pipe storage and contractor yards, one in Oregon (Yard A) and one in Washington (Yard B). Both pipe storage and contractor yards would be located on previously disturbed land. Yard A would be located within a fill site for dredged material located on the Wauna Mill property (at about MP 4.4) and would affect approximately 9.1 acres (see figure 2.3.3-1). Yard B would be located in a commercially zoned area off of Washington Way in Longview, Washington and would affect approximately 9.3 acres (see figure 2.3.3-2).

NorthernStar proposes to construct the following: 1) one pig launcher within the LNG terminal at MP 0.0, one launcher/receiver at MP 18.8, and one pig receiver at the pipeline terminus at MP 36.3; 2) a meter station at each of the following five locations: the LNG terminal (MP 0.0), the delivery point to the Wauna Mill (MP 3.7), the interconnection with the Northwest Natural intrastate pipeline to the Mist storage facility (MP 11.4), the delivery point to the PGE Beaver Power Plant at Port Westward (MP 18.9), and the terminus of the pipeline at the interconnection with Williams Northwest (MP 36.3); and 3) four MLVs at MPs 3.7, 18.8, 26.3, and 31.7. Table 4.7.3-4 summarizes by milepost the land use impacts at the proposed aboveground facilities.

TABLE 4.7.3-2

Additional Temporary Workspaces Required for Construction of the Bradwood Landing Pipeline

County, State/ MP	Type of Additional Temporary Workspace [a]	Area Affected (acres)	Land Use Type
Clatsop County, Oregon			
0.0	HDD entry	1.0	Rangeland
		0.7	Forest
1.3	HDD exit	1.4	Forest
1.4	Pipe laydown	<0.1	Forest
		1.3	Forest
1.4	Pipe laydown	1.4	Forest
3.3	HDD entry	0.1	Rangeland
		1.1	Forest
3.7	HDD exit	1.0	Commercial
		0.3	Rangeland
3.7	Pipe laydown	0.3	Rangeland
		0.8	Rangeland
		0.1	Commercial
4.0	HDD entry	1.2	Rangeland
4.3	HDD exit	1.1	Commercial
		<0.1	Forest
4.4	Pipe laydown	2.4	Commercial
4.8	HDD entry	1.1	Commercial
5.4	HDD exit	1.2	Forest
5.4	Pipe laydown	1.2	Forest
Columbia County, Oregon			
8.4	HDD entry	1.2	Agricultural
8.6	HDD exit	1.1	Agricultural
		0.1	Water
8.7	Pipe laydown	0.6	Agricultural
		<0.1	Water
		0.6	Open
9.9	HDD entry	0.8	Agricultural
		0.4	Open
10.1	HDD exit	1.2	Agricultural
10.2	Pipe laydown	1.3	Agricultural
		<0.1	Water
13.2	HDD entry	0.9	Rangeland
		0.1	Open
13.4	HDD exit	1.1	Rangeland
		0.1	Forest
13.5	Pipe laydown	1.1	Forest
18.1	Pipe laydown	1.0	Agricultural
		0.1	Water
		0.5	Commercial
		0.1	Rangeland
		3.8	Open
18.8	HDD for slick bore	0.1	Rangeland
18.8	HDD for slick bore	0.1	Commercial
19.0	HDD exit	1.2	Commercial

TABLE 4.7.3-2 (cont'd)

Additional Temporary Workspaces Required for Construction of the Bradwood Landing Pipeline

County, State/ MP	Type of Additional Temporary Workspace [a]	Area Affected (acres)	Land Use Type
Cowlitz County, Washington			
19.8 [b]	HDD entry	1.2	Forest
		0.2	Residential
20.1	Pipe laydown	0.8	Forest
		<0.1	Water
20.2	Pipe laydown	0.8	Forest
		<0.1	Water
20.3	HDD exit	1.2	Forest
20.8	HDD double entry	1.2	Forest
21.2	HDD exit	1.2	Forest
21.2	Pipe laydown	1.4	Forest
22.2	HDD entry	1.2	Forest
22.4	HDD exit	1.2	Agricultural
22.5	Pipe laydown	0.3	Agricultural
		0.9	Forest
28.0	For bluff area	0.1	Forest
		0.3	Residential
34.2 [b]	HDD entry	1.2	Agricultural
34.6	Pipe laydown	1.3	Agricultural
34.6	HDD exit	1.2	Agricultural
34.7	Pipe laydown	1.3	Agricultural
34.8	HDD exit	0.9	Agricultural
35.3	HDD entry	0.3	Residential
		0.8	Rangeland

[a] HDD entry and exit workspaces were included in the land use types affected by the pipeline right-of-way.

[b] The acreages of State of Washington, Department of State Lands are estimates. As part of the process of obtaining an easement from the WDNR, NorthernStar would be required to complete a survey, conducted by a Washington state licensed surveyor, of each waterbody that would be affected by the pipeline to determine the amount of state-owned aquatic land that would be affected.

TABLE 4.7.3-3

Access Roads Required for Construction of the Bradwood Landing Project

Access Road No.	Approximate MP [a]	Approx. Length (feet)	Approx. Width (feet)	Surface Type	Current Land Use
0	2.1 and 2.4	3,256	18	Dirt	Private Road
1	2.1 and 2.4	2,591	18	Dirt	Private Road
2	3.0	355	35	Paved	Private Road
3	3.6, 3.9, and 4.1	3,342	25	Dirt	Private Road
30	4.7	1,566	25	Dirt	Private Road
4	4.8	810	35	Dirt	Private Road
5	6.7	493	26	Dirt	Private Road
6	7.5	706	27	Dirt	Private Road
7	7.8	665	26	Dirt	Private Road
8	8.1	634	27	Dirt	Private Road
9	8.4	528	21	Dirt	Private Road
10	8.6	702	25	Paved	Private Road
33	8.9	1,185	23	Dirt	Private Road
11	10.3	495	22	Dirt	Private Road
13	12.6	780	20	Dirt	Private Road
14	13.4	552	14	Dirt	Private Road
35	19.0	272	28	Dirt	Private Road
16	19.8	2211	27	Dirt	Private Road
17	20.4	1,490	57	Dirt	Private Road
31	20.9	2,777	33	Dirt	Private Road
18	22.1	2,439	41	Paved	Private Road
19	22.5	853	25	Dirt	Private Road
20	22.9	2,565	39	Paved	Private Road
21	23.5	1,663	50	Dirt	Private Road
22	24.6 and 24.7	3,929	48	Dirt	Private Road
23	25.4	3,118	58	Dirt	Private Road
24	30.3	491	45	Dirt	Private Road
25	33.2	3,321	27	Dirt	Private Road
26	34.9	1,540	40	Dirt	Private Road
27	35.5	1,471	32	Dirt	Private Road
28	35.9	1,387	26	Dirt	Private Road
29	36.3	784	39	Dirt	Private Road

[a] Indicates where road intersects the construction right-of-way, which may occur at more than one location.

TABLE 4.7.3-4

Land Uses Affected by Construction and Operation of Aboveground Facilities

State, County/ Facility	MP	Construction Impacts (acres)	Operation Impacts (acres)	Land Use Type(s)
Clatsop County, Oregon				
Launcher and Meter Station – Bradwood Terminal	0.0 (In Terminal)	0.2 [a]	0.2 [a]	Commercial
MLV	3.7	0.5	0.1	Commercial
Meter Station – Georgia-Pacific Wauna Mill Interconnect	3.7	0.2	<0.1	Commercial
Columbia County, Oregon				
Meter Station – Northwest Natural Interconnect	11.4	0.9	0.1	Agricultural
MLV at Receiver/Launcher Facility	18.8	1.2	0.4	Commercial
Meter Station – PGE Beaver Power Plant Interconnect	18.9	0.4	<0.1	Commercial
Cowlitz County, Washington				
MLV	26.3	0.5	<0.1	Forest
MLV	31.7	0.5	<0.1	Agricultural, Forest
Receiver and Meter Station – Williams Northwest Pipeline Interconnect	36.3	0.6	0.4	Rangeland
Total Land Use for Aboveground Facilities		4.8	1.2	

[a] Land use impacts associated with the launcher and receiver are included with the LNG terminal acreage totals included table 4.7.2-1 and, therefore, are not included as part of the total land use affected by the aboveground facilities associated with the pipeline.

Construction of the pipeline facilities would disturb a total of about 553.0 acres of land, including the pipeline construction rights-of-way, temporary extra workspace, two pipe storage and contractor yards, and aboveground facilities. Of this total, 475.8 acres would be disturbed by the pipeline construction rights-of-way, 54.0 acres would be disturbed by temporary extra workspace, 18.4 acres would be disturbed by the pipe storage and contractor yards, and 4.8 acres would be disturbed by aboveground facilities. Table 4.7.3-5 summarizes the acres of each land use that would be affected by construction and operation of the proposed pipeline facilities.

Forest land would be the primary land use affected by construction of the pipeline facilities, totaling about 308.8 acres (56 percent). The remaining land uses that would be disturbed consist of 90.2 acres (16 percent) of agricultural land, 58.8 acres (11 percent) of rangeland, 51.6 acres (9 percent) of commercial land, 26.7 acres (5 percent) of open land, 15.1 acres (3 percent) of water, and 1.8 acres (less than 1 percent) of residential land.

Of the 553.0 acres of land affected by construction of the pipeline facilities, about 232.8 acres would be retained as permanent right-of-way for the pipelines and 1.2 acres would be retained for aboveground facilities. The land retained for the meter stations and MLVs would be fenced and off limits to any future development. The land that is retained as permanent right-of-way for the pipeline would be allowed to revert to former use with certain restrictions. Activities such as the construction of aboveground structures, including houses, house additions, garages, patios, pools, or any other object not easily removable, or the planting and cultivating of trees or orchards, would be prohibited within the permanent right-of-way. The permanent right-of-way would result in long-term impacts on about 143.9 acres of forest land and about 1.7 acres of orchards, groves, vineyards, or nurseries included with agricultural land. The remaining areas that are used for construction (e.g., rangeland, additional temporary workspace) would be allowed to revert to prior uses following construction with no restrictions.

TABLE 4.7.3-5

Acres of Land Affected by Construction and Operation of the Pipeline Facilities for the Bradwood Landing Project

	Agricultural		Forest		Rangeland		Open		Commercial		Residential		Water		Total	
Facility	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.	Con.	Oper.
Pipeline Rights-of-Way[a]	74.5	33.3	288.6	143.9	51.5	25.9	21.8	10.3	23.4	11.4	1.0	0.4	15.0	7.6	475.8	232.8
Additional temporary workspace	14.6	0.0	19.4	0.0	6.7	0.0	4.9	0.0	7.5	0.0	0.8	0.0	0.1	0.0	54.0	0.0
Pipe Storage/ Contractor Yards	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.4	0.0	0.0	0.0	0.0	0.0	18.4	0.0
Aboveground Facilities	1.1	0.1	0.8	0.1	0.6	0.4	0.0	0.0	2.3	0.6	0.0	0.0	0.0	0.0	4.8	1.2
Total	90.2	33.4	308.8	144.0	58.8	26.3	26.7	10.3	51.6	12.0	1.8	0.4	15.1	7.6	553.0	234.0

Note: The totals shown in this table may not equal the sum of addends due to rounding.
[a] Includes main pipeline and three lateral pipelines.
Con. Construction
Oper. Operation

One specialty crop would be affected by construction of the proposed pipeline, a Christmas tree farm. The Christmas tree farm is located in Cowlitz County, Washington and would be crossed between MPs 31.7 and 32.0. NorthernStar has stated that it would initiate discussions with the landowner(s) before construction to coordinate activities to occur at a time that would minimize impacts on the productivity of the tree farm, such as constructing after harvest periods. After construction activities are completed, NorthernStar would repair and/or restore all contours and grade to as near original conditions as possible.

Nearly 93 percent of the pipeline facilities would be located on privately owned lands with the exception of those portions of the pipeline within public road rights-of-way and state and local lands discussed in section 4.7.3.6. NorthernStar would need to acquire new easements or property to construct and operate the proposed facilities. The easement would convey both temporary (for construction) and permanent rights-of-way to NorthernStar and would give NorthernStar the right to construct, operate, and maintain the pipeline facilities. Typically, NorthernStar would negotiate a one-time payment for each easement. Some land management agencies (e.g., the WDNR) may request alternate easement payment schedules. An easement agreement between a company and a landowner typically specifies compensation for losses resulting from construction, including losses of non-renewable and other resources, damages to property during construction, and restrictions on existing uses that would not be permitted on the permanent right-of-way after construction.

If an easement cannot be negotiated with a landowner and the project has been certificated by the FERC, the company may use the right of eminent domain granted to it under section 7(h) of the NGA and the procedures set forth under the Federal Rules of Civic Procedure (Rule 71A) to obtain the right-of-way and extra workspace areas. The company would still be required to compensate the landowner for the right-of-way and damages incurred during construction. However, the level of compensation would be determined by a court according to state or federal law.

4.7.3.2 Consistency with Existing Land Use Plans, Policies, Designations, and Guidelines

Clatsop County, Oregon

The first 6.2 miles of the proposed Bradwood Landing sendout pipeline would be in Clatsop County, Oregon. As discussed in section 4.7.2.2, land use in Oregon must be consistent with the Statewide Land Use Planning Goals, which have been established in Clatsop County by its Comprehensive Plan. The proposed pipeline facilities in Clatsop County, Oregon would cross lands zoned as Marine Industrial, Forest 80, Heavy Industrial, Lake and Wetlands, Aquatic Development, Open Space, Parks, and Recreation, and Exclusive Farm Use. According to the Clatsop County's LWDUO, the pipeline facilities appear to be consistent with the base zoning as listed in table 4.7.3-6.

TABLE 4.7.3-6

Clatsop County Comprehensive Plan Land Use Zones Related to the Bradwood Landing Pipeline

Comprehensive Plan Zone	Use Description (LWDUO Section Reference)
Marine Industrial	Water-dependent industrial and port uses, including fuel dispensing facilities (section 3.624(10)).
	Utilities, maximum utilization of existing easements and rights-of-way shall be made (section 3.624(13)). [a]
	Public utility structures (section 3.626(1)). [a]
Forest 80	Physical alterations to the land auxiliary to forest practices including, but not limited to, those made for purposes of exploration, mining, commercial gravel extraction and processing, landfills, dams, reservoirs, road construction, and recreational facilities (section 3.553(2)).
	Utility facilities for the purpose of generating power subject to the standards in section 3.509. A power generation facility shall not preclude more than 10 acres from use as a commercial forest operation unless an exception is taken (section 3.555(11)). [a]
	New gas distribution lines with rights-of-way 50 feet or less in width subject to standards in section 3.509 (section 3.554(5)).
Heavy Industrial	Utilities with maximum utilization of existing easements and rights-of-way (section 3.404(5)). [a]
	Distribution services (section 3.405(2)).
Lake and Wetlands	Submerged pipeline (section 3.613 (4)).
Aquatic Development	Water-dependent use and pipelines (section 3.746(1)).
Open Space, Parks, and Recreation	Amended to include cable, sewerline, waterline, or other pipeline (section 3.584).
Exclusive Farm Zone	Utility facilities necessary for public service (section 3.564(4)).

[a] Utilities are defined in LWDUO section 1.030 as local sewer, water, gas, telephone, and power distribution lines necessary for local utility service. Included in this definition are uses needed to operate transmission and distribution lines such as pumping stations, repeater stations, and water storage tanks. Clatsop County ruled that the proposed Bradwood Landing pipeline does not qualify as a utility as defined in the LWDUO because it would not provide local service.

In March 2006, NorthernStar met with the Clatsop County Planning Director to obtain land use ordinance information and to discuss local land use regulations. NorthernStar reviewed the Geologic Hazards Overlay District (GHO), Flood Hazard Overlay District (FHO), and Shoreland Overlay District (SO) ordinances determined by the county as relevant to the proposed project. Clatsop County's GHO does not identify permitted uses but rather requires the applicant to obtain a geologic hazard permit and identifies requisite geotechnical report and construction requirements. Similarly, the FHO identifies standards applicable to construction in flood plains.

The SO is described in section 4.084 of the LWDUO as "areas described on official Clatsop County Zoning Maps. It does not include shoreland areas of the Columbia River Estuary designated Marine Industrial Shoreland, Conservation Shoreland, or Natural Shoreland." The SO also classifies

certain coastal shorelands as Category 1 or Category 2. Category 1 lands are described in the Estuarine and Coastal Shoreland Element of the Clatsop County Comprehensive Plan as:

8.1.1 significant, non-estuarine marshes;
8.1.2 riparian resources;
8.1.3 significant fish and wildlife habitat;
8.1.4 exceptional aesthetic resource; and
8.1.5 historical and archaeological sites.

Category 2 lands are shorelands that are not Category 1 lands and are not zoned Marine Industrial Conservation Shorelands or Natural Shorelands (section 4.086 of the LWDUO).

NorthernStar, in coordination with the county, reviewed the CREST's resource maps showing the SO boundary. One map depicted the project as within the SO boundary, while another did not. While it was unclear through NorthernStar's conversations with the county whether the project would be located within the SO zone, the Clatsop County segment of the pipeline does not appear to be subject to the SO restrictions because it would be located within areas zoned Marine Industrial, which are expressly exempted from the SO regulations.

Based on NorthernStar's review, the remainder of the pipeline in Clatsop County would not affect land described in the Estuarine and Coastal Shoreland Element of the Comprehensive Plan as Category 1 (i.e., significant non-estuarine marshes, riparian resources, significant fish and wildlife habitat, exceptional aesthetic resource, or historical and archaeological sites). However, the proposed route would affect wetlands and habitat areas. If any of the Clatsop County lands affected by the project are determined to be Category 1 lands, the pipeline use would not be allowed on those lands under the zoning ordinances (section 4.088 of the LWDUO). If no Category 1 lands are to be affected, the area would default to Category 2 lands but only if regulated by the SO overlay, which, as described above, does not apply because the area is zoned Marine Industrial.

In addition to the ordinances described above, part of the Bradwood Landing LNG terminal site in which a portion of the pipeline would be located is designated as a DMD Overlay Zone (see section 4.7.2.2). The DMD Overlay Zone ordinance does not allow uses that would preclude use of the site for disposal of dredged material. The installation of the pipeline would not preclude the use of the LNG terminal site for dredged material placement. In addition, installation and operation of the pipeline would not interfere with ongoing quarry operations or permitted quarry activity.

As previously mentioned in section 4.7.2.2, NorthernStar filed a land use application with Clatsop County in December 2006. On February 9, 2007, NorthernStar filed an application with Clatsop County to amend the Clatsop County Land Development and Water Use Ordinance to add "cable, sewerline, waterline, or other pipeline" as permitted uses in Open Space, Parks, and Recreation zones. The proposed amendments were accepted by the Clatsop County Board of Commissions in their March 20, 2008 decision regarding the Bradwood Landing Project, subject to some specific conditions, as discussed below.

Clatsop County found that the pipeline would be consistent with applicable provisions of its Flood Hazard Overlay Zone. The way in which the pipeline would be installed underground should not displace floodwater. However, one of the conditions of the Clatsop County's approval of NorthernStar's land use application was that the pipeline should be properly backfilled, and the right-of-way graded and restored, so as not to impede drainage or increase the risk of flooding.

Clatsop County indicated that no specialized standards exist in the LWDOU intended to address natural gas pipelines. However, it believes that there are standards for riparian protection outlined in section 4.237 of the County's Standards Document that would apply to this project, because the pipeline would be a development "affecting vegetation adjacent to and bordering Columbia River estuarine aquatic areas." Therefore, as part its conditional approval of NorthernStar's land use application, Clatsop County indicated that a riparian vegetation restoration plan should be prepared. Potential impacts on wetlands would be mitigated by HDDs at some locations along the pipeline route in Clatsop County, and implementation of the measures outlined in NorthernStar's *Waterbody and Wetland Construction and Mitigation Procedures Plan*.

Clatsop County found the pipeline crossing of Marine Industrial-zoned land, where it begins in the tract containing the LNG import terminal, to be allowed as a water-dependent activity. The pipeline crossing of about 2.6 miles of Forest 80-zoned land would be allowed by Clatsop County as a "new distribution line," conditioned on the restoration of the temporary construction right-of-way outside of the 50-foot-wide permanent operational pipeline easement. Clatsop County found the pipeline crossing of about 2.6 miles of Heavy Industrial-zoned land in the vicinity of the Wauna pulp mill to be a conditionally allowed use, provided that state and federal wildlife agencies are consulted regarding potential impacts and mitigation for the Columbian white-tailed deer. The pipeline would cross a short segment of land zoned as Lakes and Wetlands at Driscoll Slough. Because NorthernStar would use an HDD to avoid impacts on Driscoll Slough, Clatsop County considers this to be a permitted use within this zone as a submerged pipeline. The pipeline would also cross Westport Slough with an HDD, in an area zoned as Aquatic Development, and Clatsop County found this to be an allowed use. Near River Ranch, in the vicinity of MP 5.3, the pipeline would cross about 0.7 mile of land zoned as Open Space, Parks, and Recreation. As a result of its review of NorthernStar's request for amendment, Clatsop County revised its plan for Open Space, Parks and Recreation-zoned lands to allow for pipeline crossings. Lastly, Clatsop County found that the pipeline crossing of about 0.2 mile of land zoned for Exclusive Farm Use, designed as Rural Agricultural Land in the Comprehensive Plan, at about MP 6.0, would be an allowed use.

Columbia County, Oregon

The proposed Bradwood Landing sendout pipeline would cross lands within Columbia County, Oregon between MPs 6.2 and 18.9. In March 2006, NorthernStar met with Columbia County's Chief Planner to obtain land use ordinance information and to discuss local land use regulations. Similar to Clatsop County, the Statewide Land Use Planning Goals are implemented in Columbia County through its state-acknowledged Comprehensive Plan. The Comprehensive Plan is implemented through the Columbia County Zoning Ordinance and related land use implementing ordinances.

The proposed pipeline in Columbia County, Oregon would cross lands zoned as Primary Agriculture (PA-38) between MPs 6.2 to 12.5 and MPs 13.2 to 17.4; lands zoned as Resource Industrial - Planned Development (RIPD) between MPs 17.4 to 19.0; and lands zoned as Rural Residential - 5 Acre Minimum (RR-5) between MPs 12.5 to 13.2. The proposed pipeline crossing of PA-38 zoned lands is allowed as a conditional use because it is a facility necessary for public utility service (Zoning Ordinance Section 303.8). Conditional uses may be approved in the PA-38 zone when an applicant satisfies all the requirements for obtaining a conditional use permit.

The proposed pipeline crossing RIPD-zoned lands would be allowed as a conditional use because it constitutes the "distribution of services" under Columbia County Zoning Ordinance Section 683.1. A permit with conditions is typically approved by the County Planning Commission when an applicant demonstrates that its proposal would conform to the goals and policies of the Comprehensive Plan.

The proposed pipeline is not allowed as an outright or conditional use in the RR-5 zone. The county would usually have to rezone this segment of the pipeline route or amend its zoning ordinance to allow this use. However, in a letter to the FERC dated July 12, 2006, the Planning Director for Columbia County indicated that land use approvals are not required for the Bradwood Landing Project in Columbia County, because the county believes its local permitting process is preempted by the FERC's authority to site pipelines under the NGA. The county indicated that it would raise with the FERC any significant issues it may identify in the future regarding inconsistencies the project may have with its Comprehensive Plan and local land use implementing ordinances.

Cowlitz County, Washington

The proposed Bradwood Landing pipeline would cross lands within Cowlitz County, Washington between MPs 19.4 and 36.3. In March 2006, NorthernStar met with Cowlitz County's land use and environmental planning staff to discuss its proposed pipeline facilities, and applicable county plans, policies, designations, regulations, and guidelines.

The proposed pipeline segment in Cowlitz County would be located entirely within an "unclassified" (also referred to as "unzoned") area. The CCC section 18.10.270, states that the unclassified areas "are generally those expansive areas of Cowlitz County which have not had extensive urban development and probably would not have any degree of such development in the foreseeable future." CCC section 18.10.275 also states that "all uses which have not been declared a nuisance by statute, resolution, ordinance, or court of competent jurisdiction are permitted." Therefore, construction and operation of the proposed pipeline facilities appear to be a permitted use not subject to conditional use approval criteria. Unzoned or unclassified areas remain subject to county and state environmental regulations, including the Shoreline Management Act (RCW 90.58) and the county's Critical Areas Ordinance (CCC Chapter 19.15), which are discussed below.

Cowlitz County would consider issuing a general permit for the pipeline under its Gas and Oil Pipelines Ordinance and review of the project for compliance with the Cowlitz County Comprehensive Plan. The Cowlitz County Comprehensive Plan includes all of the county's formally adopted land use planning goals and policies. The plan generally references "utilities," including natural gas pipelines, within the economic development element and the land use element. Generally speaking, the Cowlitz County Comprehensive Plan policies encourage minimization of negative environmental impacts, including impacts on shorelines and adjacent land uses. The plan also encourages utilization of corridor areas for agricultural and small tree production; imposes guidelines to "establish common or jointly used corridors" and placement of utility lines "closer together;" encourages utility companies to "make arrangements, where practical, to use existing rights of way;" and requires control of noxious weeds. Based on NorthernStar's discussions with county staff, compliance with the Shoreline Management Act, would be considered concurrently with the project's SEPA review. County staff also indicated that through the general permit, the county typically seeks assurance that the pipeline is a safe facility. Permits under Cowlitz County's Floodplain Management and Forest Lands Conversion Ordinances could also be considered.

Cowlitz County's SMMP was adopted to implement state planning and regulatory requirements under the Shoreline Management Act. A shoreline substantial development permit and potentially a shoreline conditional use permit for portions of the pipeline proposed within 200 feet of the ordinary high water line of "shorelines of the state" may be reviewed under the SMMP. The Columbia River and six other streams along the proposed corridor are considered shorelines of the state. Further, NorthernStar's facilities would be located in the Conservancy, Urban, and Rural Districts of the shoreline. In these districts, utilities including gas pipelines are a permitted use, subject to requirements to minimize impacts on vegetation and the environment, and subject further to sufficient restoration measures (see section

4.3.2.4). In the event that all surface impacts on jurisdictional shorelines are avoided through HDD or conventional bore construction methods (with bore hole pads set back from the ordinary high water mark and associated wetlands by at least 200 feet), it appears that the proposed pipeline segment through Cowlitz County would be consistent with the substantial development and conditional use provisions of the SMMP.

Cowlitz County's Critical Areas Ordinance requires critical areas permits for disturbance of wetlands, critical aquifer recharge areas, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. Critical areas permits are administrative permits and generally control the development standards to minimize impacts on critical areas. NorthernStar would design its project to be consistent with the local Critical Areas Ordinance. The county staff appeared most concerned about the pipeline's potential impacts on streams and the crossing of geologically sensitive areas. Detailed information on geological hazards and streams crossed by the pipeline is presented in sections 4.1.4.3 and 4.3.2.4 of this EIS.

Cowlitz County is the SEPA lead agency and is responsible for coordinating the SEPA and the NEPA reviews. This EIS may be used to satisfy the SEPA if the requirements of WAC 197-11-610 and 197-11-630 are met. After the final EIS for the Bradwood Landing Project is issued by the FERC, Cowlitz County would adopt it if an independent review of the document confirms that it meets the county's environmental standards. As indicated in section 1.4, we met with Cowlitz County staff in December 2006 to discuss this EIS and compliance responsibilities under the SEPA.

4.7.3.3 Existing Residences and Planned Developments

Existing Residences

Table 4.7.3-7 lists by MP residences that NorthernStar identified to be within 50 feet of construction work areas for its proposed pipeline. No residences are located within 50 feet of the aboveground facilities associated with the proposed Bradwood Landing sendout pipeline. NorthernStar did not identify any residences immediately adjacent to the proposed pipeline in Clatsop County, Oregon, between MPs 0.0 and 6.2.

TABLE 4.7.3-7

Structures Located Within 50 Feet of the Pipeline Construction Work Areas [a, b]

County, State/ MP	Type of Structure	Distance from Pipeline Centerline (feet)	Distance from Construction Work Space (feet)
Columbia County, Oregon			
13.1	Residence	50	30
13.4	Barn and workshops	63	32
15.0	Residence	9	Within
17.7	Residence	50	25
Cowlitz County, Washington			
34.1	Barn	40	5
34.7	Shed	93	38

[a] Structures, buildings, or residences that would be avoided by the HDD method are not included in this table as impacts on these structures would be avoided.

[b] Based on review of aerial imagery.

Within Columbia County, Oregon, between MPs 6.2 and 18.9, NorthernStar identified three residences and one barn within 50 feet of its proposed pipeline construction right-of-way. NorthernStar

would avoid impacts on two residences located at about MP 17.5 by moving the pipeline to the opposite side of Hermo Road.

NorthernStar did not identify any residences within 50 feet of the proposed pipeline in Cowlitz County, Washington, between MPs 19.4 and 36.3. However, the pipeline construction right-of-way would be within 50 feet of a barn at about MP 34.1, and close to a maintenance shed for a nearby rock quarry at about MP 34.6. In addition, impacts on two residences at about MP 21.1 would be avoided by the use of an HDD under Germany Creek, while impacts on a residence at about MP 28.1 would be avoided by the use of an HDD under Coal Creek.

In residential areas, impacts associated with installation of an underground natural gas pipeline include disturbance during construction and encumbrance for future uses (e.g., the limitation on future permanent structures within the permanent right-of-way). In general, as the distance from the construction work area increases, the impacts on residences decrease.

Temporary construction impacts on residential areas could include inconvenience caused by construction related traffic; blocking of roads and driveways; noise and dust generated by construction equipment; ground disturbance of lawns; removal of trees, landscaped shrubs, or other vegetative screening between residences and/or adjacent rights-of-way; potential damage to existing septic systems or wells; and removal of aboveground structures, such as sheds or trailers, from within the right-of-way.

Potential impacts on wells and proposed mitigation measures are discussed in Section 4.3.1.4. On December 21, 2007, NorthernStar filed with the FERC a *Residential Construction Conceptual Mitigation Plan*.[18] This conceptual plan outlined the following general measures that NorthernStar would implement to minimize construction related impacts on residences and other structures located within 50 feet of the proposed pipeline construction right-of-way:

- install fencing on the edge of the construction right-of-way for 100 feet on each side of the residence;
- implement dust control plans;
- cleanup construction work areas daily;
- preserve landscaping and mature trees to the extent possible;
- restore lawns and landscaping immediately after backfilling the trench;
- weld, inspect, and coat pipe before excavation of the trench;
- excavate the trench only at the time when the pipe is ready to be lowered in;
- backfill immediately after the pipe is lowered into the trench;
- construct during daylight hours, according to the landowner's needs;
- discuss spoil management with the landowner;
- discuss removal of trees with the landowner;
- reach agreement with the landowner during easement negotiations about plantings in pasture; and
- discuss temporary relocation of the residents during construction.

[18] NorthernStar's Residential Construction Conceptual Mitigation Plan was filed on December 21, 2007, in response to recommend Environmental Condition 31 in our draft EIS. This document can be viewed by the public through the eLibrary link on the FERC internet webpage at www.ferc.gov. Put in Docket No. CP06-365, the date of the filing, and look up accession number 20071226-0098.

Our review of this conceptual plan found that it did not address the full range of potential impacts on residences close to the construction right-of-way. For example, some commentors on our draft EIS questioned how potential impacts on septic systems from pipeline construction activities would be mitigated.

NorthernStar recognized that it did not yet have access to some properties along the pipeline route, and so it could not develop detailed site-specific residential construction mitigation plans for all houses within 50 feet of the construction right-of-way. NorthernStar committed to filing a final formal site-specific residential construction mitigation plan, after the FERC issues an Order authorizing the project, but before construction of the pipeline would begin. Therefore, **we recommend that:**

- **<u>Before pipeline construction</u> begins, NorthernStar should file with the Secretary, for the review and written approval of the Director of OEP, a plan outlining measures that should be implemented to mitigate pipeline construction impacts on domestic water supply systems and septic systems. For all residences located within 50 feet of the pipeline construction work area, <u>during construction</u> of the pipeline, NorthernStar should:**

  a. not remove mature trees and landscaping within the edge of the construction work area, unless necessary for safe operation of construction equipment;

  b. immediately after backfilling the trench, restore all lawn areas and landscaping within the construction work area consistent with the requirements of the FERC staff's Plan;

  c. fence the edge of the construction work area adjacent to the residence for a distance of 100 feet on either side of the residence to ensure that construction equipment and materials, including the spoil pile, remain within the construction work area;

  d. try to maintain a minimum distance of 25 feet between the residence and the edge of the construction work area; and

  e. for any residence closer than 25 feet to the construction work area, file a site-specific plan with the Secretary for the review and written approval of the Director of OEP <u>before pipeline construction</u>. The plan should include:

    (1) a description of construction techniques to be used (such as reduced pipeline separation, centerline adjustment, use of stove-pipe or drag-section techniques, working over existing pipelines, pipeline crossover, bore, etc.), and include a dimensioned site plan that shows:

      i. the location of the residence in relation to the new pipeline and, where appropriate, the existing pipelines;
      ii. the edge of the construction work area;
      iii. the edge of the new permanent right-of-way; and
      iv. other nearby residences, structures, roads, or waterbodies.

(2) a description of how NorthernStar would ensure the trench is not excavated until the pipe is ready for installation and the trench is backfilled immediately after pipe installation; and

(3) evidence of landowner concurrence if the construction work area and fencing would be located within 10 feet of a residence.

To minimize additional impacts on traffic, NorthernStar would minimize trips to and from Bradwood, and would develop a traffic management plan (see section 4.8.2.7).

Planned Developments

We did not identify any future planned residential or commercial developments in close proximity to the proposed pipeline route in Clatsop County Oregon. In comments on our draft EIS, Cowlitz County, Washington, indicated that William and Marjorie Castle submitted a building permit application to the county for a proposed single family dwelling located adjacent to the Bradwood Landing pipeline route. Therefore, **we recommend that**:

- **<u>Prior to construction</u> of the pipeline, NorthernStar should study Cowlitz County records to determine all plans for future residential and commercial developments along the proposed pipeline route in Washington, and file the results of that study with the Secretary, for the review and written approval of the Director of OEP. The study should specifically include the Castle family house plans, and provide details about how NorthernStar would avoid or mitigate impacts on that future residence, including the distance (in feet) from the proposed house to the pipeline construction right-of-way.**

Columbia County has identified several development projects at the Port Westward Industrial Area, including a recently completed 400 MW gas-fired electric generation plant operated by PGE, an ethanol plant currently being installed by Cascade Grain Products, LLC, and a 536 MW power plant to be built in the near future by Summit Westward Energy, LLC. The county has invested about $16.5 million to make road and access improvements at the Port Westward Industrial Area, to be completed by the end of 2009, and it is concerned about potential impacts of the Bradwood Landing Project on those improvements.

Maps received from the Port of St. Helens and PGE also show that the proposed Bradwood Landing pipeline would cross a potential future outfall connection and a proposed Port of St. Helens industrial discharge line at approximate MPs 18.8 and 18.9, respectively, and be within 100 feet of an unidentified potential future facility between MPs 18.5 and 18.7. Further, the Oregon Economic and Community Development Department and Columbia County Regional Coordinator have identified road and water improvement projects in Port Westward and the proposed project vicinity that are either currently ongoing or proposed.

During planning of the proposed pipeline, landowners expressed concerns about impacts of the proposed route on agricultural land in the Port Westward area. Port of St. Helens staff expressed additional concerns (e.g., conflicts with existing infrastructure, existing industrial development, and planned development) regarding the original proposed pipeline route. In response, NorthernStar developed an alternative route variation between approximate MPs 13.5 and 18.2 that follows property boundaries and road alignments and would minimize impacts on active agricultural areas without significant additional construction impacts on natural resources (see section 3.1.8.2). This new pipeline

alignment, which increased the length of the pipeline by 1.6 miles, also would minimize potential conflicts with future development projects.

The currently proposed route for the Bradwood Landing pipeline, as illustrated in the maps attached in Appendix B to the draft EIS, shows it on the north side of Collins Road between about MPs 16 and 17, then being adjacent to the east side of Hermo Road from about MPs 17 to 18. In comments filed December 19, 2007 on our draft EIS, Columbia County indicated that it intends to expand Hermo Road on its east side, so there would be a potential conflict with the installation of the Bradwood Landing pipeline. Therefore, **we recommend that:**

- **<u>Prior to pipeline construction</u>, NorthernStar should document that it has consulted with the Port of St. Helens, the Columbia County Development Agency, and other appropriate agencies and representatives of Columbia County, to determine if its pipeline may have impacts on county improvements in the vicinity of the Port Westward Industrial Area, and file with the Secretary a plan to avoid or mitigate those impacts, for the review and written approval of the Director of OEP.**

4.7.3.4 Coastal Zone Management

Section 4.7.2.4 addresses coastal zone management review for the entire Bradwood Landing Project, including the pipeline facilities.

4.7.3.5 Hazardous Waste Sites

In February and April 2006, NorthernStar conducted a search of environmental records to identify locations of known or potential contamination within the project vicinity. The records reviewed included over 50 federal and state databases including the EPA's National Priorities List (NPL), CERCLIS, and Resource Conservation and Recovery Information System (RCRIS); the ODEQ's Environmental Cleanup Site Information System (ECSI), Oregon Solid Waste Facilities list, Underground Storage Tank database, and Spills Data; and the WDE's Confirmed & Suspected Contaminated Sites List (CSCSL), Hazardous Sites list, Underground Storage Tank database, and Aboveground Storage Tank list. Based on these records, 10 potentially contaminated sites were identified within 1,500 feet of the construction work areas. These sites are summarized in table 4.2.3-3. Based on the distance of these sites from the proposed project area and the fact that soil and groundwater contamination either has not been reported or has been cleaned up for each facility, NorthernStar does not expect to encounter contamination from these sites during pipeline construction.

While the majority of the sites identified are at such a distance that they would not affect construction, there is potential to encounter unknown aspects of the identified sites or new areas of contamination. Therefore, we have recommended that NorthernStar prepare a *Plan for the Discovery and Management of Contaminated Soils and Groundwater* that specifies the procedures to be followed to identify, characterize, and properly manage potentially contaminated materials (see section 4.2.2.1).

4.7.3.6 Recreation, Public Interest, and Special Use Areas

The Bradwood Landing pipeline would not affect any Indian reservations, or federally designated wild and scenic rivers. Several recreation and public interest areas are located near the proposed pipeline facilities.

Designated Recreation and Public Interest Areas

Special interest areas administered by federal, state, or local agencies that would be in the vicinity of or crossed by the proposed pipeline are listed in table 4.7.3-8.

TABLE 4.7.3-8

Special Interest Areas in the Vicinity of or Crossed by the Bradwood Landing Pipeline Route

Description	MP	Length of Crossing (miles)	Distance from Pipeline Centerline (feet)	Distance from Construction Workspace (feet)	Construction Impacts (acres)	Operational Impacts (acres)
Bradley State Scenic Viewpoint	1.7	NA	1,000	935	NA	NA
Ducks Unlimited Waterfowl Management Area	6.0	2.1	NA	NA	27.9	12.8
Jones Beach	9.0	NA	1,111	1,056	NA	NA
Port of Portland	9.3	0.2	NA	NA	2.4	1.0
Port of St. Helens	16.9	2.1	NA	NA	26.0	13.0
LCNHT and Lower Columbia River Water Trail	19.0	NA	0	0	NA	NA
JBHNWR	19.0	NA	2,000	1,935	NA	NA
State of Washington, Department of State Lands [a]	19.6 21.1 34.2	<0.1 <0.1 <0.1	NA NA NA	NA NA NA	0.3 0.4 0.2	0.1 0.2 0.1
City of Longview	28.5	NA	130	95	NA	NA

[a] The acreages of State of Washington, Department of State Lands are estimates. As part of the process of obtaining an easement from the WDNR, NorthernStar would be required to complete a survey, conducted by a Washington state licensed surveyor, of each waterbody that would be affected by the pipeline to determine the amount of state-owned aquatic land that would be affected.

NA Not applicable.

Bradley State Scenic Viewpoint

The Bradley State Scenic Viewpoint, a roadside park administered by the Oregon Parks and Recreation Department, is approximately 1,000 feet west of MP 1.7 of the proposed pipeline. No direct impacts on the Bradley State Scenic Viewpoint are anticipated as the pipeline route is not within the park's boundary. Indirect visual impacts are discussed in section 4.7.3.7.

Ducks Unlimited Waterfowl Management Area

Between approximate MPs 6.0 and 8.1, the proposed pipeline route would cross private property managed by Ducks Unlimited as a waterfowl management area. NorthernStar has consulted with the landowner and the Ducks Unlimited land manager regarding the proposed Bradwood Landing pipeline (Karamanos, 2005; Lobdel, 2005). According to the landowner, Ducks Unlimited is funding the establishment of more wetland habitat with ponds over a 35-year period. The Ducks Unlimited land manager indicated that there is a recorded agreement for the 275 acres on the western portion of the property with federal monies being spent over a period of 25 to 30 years. Ducks Unlimited is in the process of negotiating a conservation easement on an additional portion of the land with the owner for the same purposes. NorthernStar has stated it is consulting with the owner regarding the use of portions of the remaining property as the Peterson Point Mitigation Site (see section 4.5.2.2).

NorthernStar has stated that construction activities would be planned to occur from March to September at a time when waterfowl would least likely inhabit the property. Further, NorthernStar would continue to coordinate with the landowner and Ducks Unlimited before construction activities to identify and address their concerns.

Jones Beach

Jones Beach is on land owned by the ODSL on the southern shore of the Columbia River, between Wauna and Clatskanie, at about CRM 47. The beach has been created out of dredged sand piles, deposited by the COE during its maintenance of the navigation channel. It has no developed facilities, except for a parking lot. The beach is used for recreation by ORV drivers. The Lower Columbia River Water Trail can be accessed from Jones Beach. The river at this location is also used by windsurfers and kite surfers. The proposed pipeline would be about 0.2 mile from Jones Beach, and should have no impacts on the beach, its visitors, and river users in this area.

Julia Butler Hanson National Wildlife Refuge

The pipeline at MP 19 would be within about 2,000 feet east of the JBHNWR at Crims Island. NorthernStar would cross under the Columbia River using the HDD method in this area, thus avoiding any direct impacts on the refuge. Additional information on the JBHNWR is provided in sections 4.5.2.3 and 4.6.

Lewis and Clark National Historic Trail

The LCNHT follows the lower Columbia River. The Lewis and Clark expedition of 1805-1806 camped in the vicinity of the proposed pipeline, near Cape Horn on the Washington side of the river, near the mouth of the Clatskanie River in Oregon, and on either Walker or Dibblee Island. However, none of the Lewis and Clark campsites in the project area have been definitely relocated, or recorded as archaeological sites. The Bradwood Landing pipeline would cross the LCNHT along the Columbia River near MP 19. The pipeline would cross under the river at this location using an HDD. Potential project impacts on the LCNHT are discussed in section 4.9.

Lower Columbia River Water Trail

The proposed pipeline would cross the Columbia River using an HDD starting from the Oregon side at about MP 19. Therefore, the pipeline would have no impacts on the Lower Columbia River Water Trail.

Other Lands

The pipeline route would also cross state and local lands. These include the Port of Portland (MP 9.3), the Port of St. Helens (MP 16.9), and State of Washington lands (MPs 19.6, 21.1, and 34.2). Also, the City of Longview is located within 130 feet of the pipeline MP 28.5. Furthermore, the states own submerged lands crossed by the pipeline. For Washington, the amount of state-owned aquatic land that the pipeline would affect at the Columbia and Cowlitz Rivers would be determined at the time a survey of each waterbody is completed by a Washington state licensed surveyor. NorthernStar would be required to complete this survey as part of the process of obtaining an easement from the WDNR, which is generally one of the last steps in the permitting and licensing process. At this time, only estimates of acreage impacts can be provided, subject to change once the aforementioned surveys of both crossings are completed (Ellis, 2008). NorthernStar would obtain the appropriate authorizations to use or cross these

areas in accordance with applicable regulations. Impacts associated with the pipeline would be temporary and there would be no long-term or adverse impacts on these areas.

General Recreation and Special Uses

Much of the general recreation and special use of the area that would be affected by the proposed pipeline facilities is similar to that described for the LNG terminal. These uses include sightseeing, wildlife viewing, hiking, swimming, camping, and picnicking activities. The primary impact associated with construction of the project would be visual. Construction would alter visual aesthetics by removing existing vegetation and disturbing soils. Construction would also generate dust and noise, which could be a nuisance to recreational users. Construction could also interfere with or diminish the quality of the recreational experience by affecting wildlife movements or disturbing trails. In general, impacts on recreation and special interest areas would be temporary and would be limited to the period of active construction, which typically would last only several days to several weeks in any one area. NorthernStar would minimize construction-related impacts on these areas by installing its pipeline adjacent to existing rights-of-way to the extent possible, ensuring effective post-construction reclamation of the right-of-way to preconstruction conditions, and coordinating construction activities with land management agencies so that they occur outside of the primary recreation and special use periods (e.g., after harvest, during months when waterfowl are least likely to occupy an area).

The Clatskanie City Park is located about 2.5 miles south of the proposed pipeline (MP 13.4) and is the site of an annual bluegrass festival, which is held in August. In addition, the park has a swimming pool, sport playing field, an indoor skate park, playgrounds for younger children, horse arena, picnic tables, barbecue facility, restrooms, recreational vehicle (RV) hook-ups and facilities for camping, canoeing, paddle boating, and a boat ramp.

The Cities of Longview and Kelso, Washington are located about 4 miles south of the proposed pipeline. Recreational and tourist attractions within Longview include an 18-hole golf course, tennis courts, baseball fields, sturgeon fishing, year-round boating, Columbia Theatre for the Performing Arts, registered historical buildings, art exhibits, lecture series, summer community concerts, as well as an annual County Fair hosting the Thunder Mountain Pro Rodeo (Cowlitz County Washington State Tourism Department, 2007). Within Kelso, recreational and tourist attractions include the Mount St. Helens Volcano and Information Center; Cowlitz County Historical Museum, and the Three Rivers Golf Course, which is the only 18-hole golf course constructed on volcanic ash from Mount St. Helens. In September, Kelso celebrates its Scottish heritage with the annual Highlander Festival. Cowlitz County owns and operates a 60-acre beach park on the north side of the Columbia River at Willow Grove.

We believe that the proposed Bradwood Landing sendout pipeline would not have any significant direct impacts on general recreational use of the project area. Regional tourism should not be significantly affected because the pipeline would be installed underground and, therefore, after the right-of-way is properly restored following construction, the pipeline should not be visible to most distant visitors. The aboveground facilities associated with the proposed pipeline would be minor.

We received comments on the draft EIS regarding the potential for the permanent pipeline right-of-way to increase accessibility for ORV use, trespassing, and vandalism. Measures that NorthernStar could utilize to protect the right-of-way from unauthorized use may include placement of berms across the right-of-way; rock redistribution and strategic placement, without making it into a challenging obstacle course; or placement of woody material removed during construction across the right-of-way to both disguise the right-of-way and serve as "vertical mulch." Any such measures could be included in a landowners' easement negotiation process with NorthernStar.

4.7.3.7 Visual Resources

Visual resources along the pipeline route are a function of geology, climate, and historical processes and include topographic relief, vegetation, water, wildlife, land use, and human uses and development. The vegetation along the pipeline route consists mainly of medium-to large-diameter trees on mostly rolling terrain.

NorthernStar proposes to use up to a 120-foot-wide construction right-of-way. Some areas along the pipeline route would be widened for temporary extra workspaces. Visual impacts associated with the construction right-of-way and temporary extra workspaces would include the removal of existing vegetation and the exposure of bare soils, as well as earthwork and grading scars associated with heavy equipment tracks, trenching, and machinery and tool storage. Other visual effects could result from the removal of large individual trees that have intrinsic aesthetic value; the removal or alteration of vegetation that may currently provide a visual barrier from undesirable views; or landform changes that introduce contrasts in visual scale, spatial characteristics, form, line, color, or texture.

Visual impacts would be greatest where the pipeline route parallels or crosses roads and the pipeline right-of-way may be seen by passing motorists, on residents where vegetation used for visual screening of existing utility rights-of-way would be removed, and in forested areas. The duration of visual impacts would depend on the type of vegetation that is cleared or altered. The impact of vegetation clearing would be shortest in agricultural, range, and open lands, where the reestablishment of vegetation following construction would be relatively fast (generally less than 5 years).

The visual impacts would be greater in forest land, which would take many years to regenerate mature trees. The greatest potential visual impact would result from the removal of large specimen trees, which would take longer than other vegetation types to regenerate and would be prevented from reestablishing on the permanent right-of-way. The establishment of a new pipeline right-of-way through these forested areas would create a permanent visual impact. Although the temporary portion of the construction right-of-way would be allowed to revert to preconstruction conditions, the new permanent right-of-way would be maintained in an herbaceous state. NorthernStar's restoration plan calls for the planting of in-kind trees outside of a 30-foot-wide corridor centered on the pipeline within the cleared construction right-of-way that is presently forest. Also, in forested wetlands, the right-of-way would be replanted with in-kind wetland tree specimens, with the exception of the portion of the right-of-way within 5 feet of the pipeline (10 feet total), thereby minimizing the extent of disturbance. Nearly complete canopy coverage over the pipeline would be expected to develop in most forested upland and forested wetland areas within approximately 20 years. In general, visual contrasts in forested areas would be noticeable primarily from road crossings and the scattered rural residences. Several major roads would be crossed by the pipeline. Therefore, many motorists would be visually aware of pipeline construction and would notice permanent tree removal to accommodate the permanent right-of-way.

About 22 percent of the Bradwood Landing pipeline would be located adjacent to the existing KB pipeline right-of-way. Construction within or adjacent to existing rights-of-way typically reduces impacts on visual resources because it minimizes vegetation clearing. However, a degree of permanent clearing still must occur to properly maintain and operate a pipeline right-of-way. Vegetation would be cleared during construction of the Bradwood Landing pipeline and would result in both short-term and long-term impacts on visual resources depending on the type of vegetation that is removed. NorthernStar would maintain its permanent right-of-way in an herbaceous state.

Revegetation of the right-of-way is an important mitigation measure that would be used to reduce visual impacts of pipeline construction and operation. NorthernStar would monitor and measure

revegetation success in accordance with the FERC's guidelines for proper establishment of the desired species and weed control.

Construction of the pipeline would result in indirect visual impacts on the Bradley State Scenic Viewpoint, located approximately 1,000 feet west of MP 1.7. Between MPs 0.0 and 1.3, the pipeline would be installed using the HDD method to reduce impacts on the Bradwood Cliffs and associated forest. Since the proposed Bradwood Landing pipeline would be located at the base of the hill east of the Bradley State Wayside viewpoint, and would only occupy a 50-foot-wide permanent right-of-way once it is permanently restored, NorthernStar does not anticipate a major impact on the view. The proposed pipeline right-of-way through most of the forested area would not be seen from the Bradley State Scenic Viewpoint because the ridge blocks the view. Where the right-of-way is closer to the Wauna Mill, the right-of-way follows existing roads or cleared areas. A stretch of the right-of-way south of the paper mill is forested near the Wauna Mill's landfills. At the end of construction, the right-of-way would look similar to many of the access roads on the Wauna Mill property.

All affected permanent and temporary workspace visible from the Bradley State Scenic Viewpoint is zoned Forest 80. By definition, all Forest 80-zoned property is subject to harvest under the guidelines established by the Oregon Department of Forestry, including its jurisdiction over the harvesting of the trees involved with NorthernStar's pipeline right-of-way. Therefore, removal of forest land to accommodate the permanent right-of-way would not be inconsistent with tree removal allowed by state zoning.

Construction and operation of the new aboveground facilities associated with the Bradwood Landing pipeline would have a permanent impact on visual resources. However, none of these sites are located in areas identified as having any special or unique scenic characteristics or in areas with any designated protection for scenic values. The facilities would be located in industrial areas, or in rural areas with generally moderate to low scenic values that are not sensitive to visual resource changes due to a low number of potential viewers. However, construction and ground disturbances would be noticeable to viewers in the vicinity of these activities. Permanent structures would be relatively small and, as such, would remain subordinate to the visual landscape in which they would be located. Further, NorthernStar would paint the meter stations a non-reflective color that would blend with the surrounding landscape, the use of which would reduce the visual impacts associated with operation of the aboveground facilities.

4.8 SOCIOECONOMICS

The Bradwood Landing Project includes the construction and operation of an LNG import terminal in Clatsop County, Oregon and a 36.3-mile-long natural gas sendout pipeline that would cross through portions of Clatsop and Columbia Counties, Oregon and Cowlitz County, Washington. Therefore, most of the project-related socioeconomic impacts would occur within these counties. However, socioeconomic effects relating to construction of the project would also extend into the Portland-Vancouver-Beaverton, Oregon-Washington, Metropolitan Statistical Area (Portland MSA), where approximately 75 percent of the construction workforce for the LNG terminal and 86 percent of the construction workforce for the pipeline are expected to reside. Columbia County is one of seven counties included in the Portland MSA; therefore, overlap will occur when discussing potential socioeconomic impacts on these areas. Socioeconomic effects relating to LNG marine traffic during operation of the LNG terminal could also extend into Wahkiakum and Pacific Counties, Washington.

Several potential socioeconomic effects may result from construction and operation of the proposed Bradwood Landing Project. Many of these potential effects would occur during the construction phase and would result from the number of local and non-local construction workers who would work on the project; their income and local expenditures; and their impact on traffic flow, population, housing, and public services. Other potential impacts are related to operation of the project, such as LNG marine traffic along the lower Columbia River and its effects on other river users. Operation of the project would have impacts on the local economy, including increased property tax revenue, increased job opportunities and income, and ongoing local expenditures by NorthernStar.

The potential impacts of the project on land use and residences in the vicinity of the project are discussed in section 4.7. A discussion of the cumulative impacts of the Bradwood Landing Project when considered with other proposed or reasonably foreseeable future projects is included in section 4.12.

4.8.1 Waterway for LNG Marine Traffic

As described above, socioeconomic effects related to LNG marine traffic along the waterway would potentially impact Wahkiakum, Pacific, and Cowlitz Counties in Washington and Clatsop County in Oregon. Within these counties, the communities of Warrenton and Astoria, Oregon and Ilwaco, Cathlamet, and Puget Island, Washington have over 500 people residing there.

4.8.1.1 Population

Table 4.8.1-1 provides a summary of population statistics for the three counties and communities with populations over 500 along the waterway. With the exception of Ilwaco, at least a portion of each of the communities in this table would be within the Zones of Concern during LNG carrier transit up the Columbia River. The counties affected by the Bradwood Landing Project vary in their population totals and densities. Clatsop County, Oregon has a population density higher than the average for the State of Oregon. The highest population density occurring along the waterway is within the City of Astoria, with 1,597.6 persons per square mile. The lowest population density occurring along the waterway is within Wahkiakum County, with an average of 14.5 persons per square mile. However, during the tourist season, population in some communities can more than double (ODE, 2006).

TABLE 4.8.1-1

Existing Population in the Counties and Communities Along the Waterway for LNG Marine Traffic

State/County/Community	Population 1990	Population 2006	Percent Change	Population Density [a] 1990	Population Density [a] 2006 [b]
Oregon	2,842,321	3,700,758	30.2	29.6	38.6
Clatsop County	33,301	37,315	12.1	40.3	45.1
Astoria (CRM 14) [b c]	10,069	9,813	-2.6	1,766.5	1,597.6
Warrenton (CRM 10) [c]	2,681	4,096	52.8	160.5	332.2
Washington	4,866,692	6,395,798	31.4	73.1	96.1
Pacific County	18,882	21,735	15.1	19.4	22.3
Ilwaco (CRM 3) [c]	815	950	16.6	388.1	452.4
Wahkiakum County	3,327	4,026	21.0	12.6	15.2
Cathlamet (CRM 39) [c]	508	565	11.2	1,270.0	1,426.2
Puget Island (CRM 38) [c]	734	798	8.7	97.9	106.4

[a] Persons per square mile based on population and land area size: Oregon (95,997 square miles), Clatsop County (827 square miles), Astoria (5.7 square miles), Warrenton (16.7 square miles), Washington (66,544 square miles), Pacific County (975 square miles),Ilwaco (2.1 square miles), Wahkiakum County (264 square miles), Cathlamet (0.4 square mile), and Puget Island (7.5 square miles).

[b] Information from the U.S. Census Bureau includes the community of Navy Heights (population of 627 persons) as part of the City of Astoria.

[c] Census Bureau 2006 data not available. Data from U.S. Census Bureau, 2000 Census data.

Sources: U.S. Census Bureau, American Population, Housing Units, Area, and Density, 1990.
U.S. Census Bureau, State and County Quickfacts, 2006.

No changes to the local population distribution or number are expected to occur as a result of the proposed LNG marine traffic. However, the population within the Zones of Concern along the waterway could be affected due to an accidental or intentional breach of an LNG carrier resulting in a release of LNG during transit to the LNG terminal. The severity of impacts on populations in Zones 1-3 would depend on the location of the incident relative to the population, the scope of the incident, and whether the released LNG ignited or evaporated. Impacts from a pool fire would be most severe in Zone 1 and decreasing outward through Zones 2 and 3. However, with the implementation of the safety and security measures and conditions outlined in the Coast Guard's WSR (see Appendix G), an LNG release along the waterway would be highly unlikely and the potential impact on the area population would be less than significant.

4.8.1.2 Housing

Housing statistics for the counties and communities larger than 500 persons along the waterway, are presented in table 4.8.1-2. A total of 10,116 vacant housing units occur in the counties along the waterway. Within the communities considered, vacancy rates ranged from a low of 32 available units in Cathlamet, Washington to a high of 623 units in Astoria, Oregon.

At Astoria, there are five hotels or motels (Cannery Pier Hotel, Astoria Rivershore Motel, Lamplighter Motel, Holiday Inn Express, and the Dunes Motel), with a total of 253 rooms combined, overlapped by Zone 1. Within Zone 2 in Astoria are seven hotels or motels (Hotel Elliott, Hideaway Inn and Hostel, Best Western, Red Lion Inn, Comfort Suites, Fisherman Suites, and Paradise Home Stay), with a combined total of 333 rooms.

TABLE 4.8.1-2

Housing Characteristics in the Counties and Communities Along the Waterway for LNG Marine Traffic

State/County/MSA	Total Housing Units	Total Vacant Housing Units	Vacancy Rate (percent)	Median Gross Monthly Rent
Oregon	1,452,709	118,986	8.2	$620
Clatsop County	19,685	4,982	25.3	$543
Astoria [a]	4,858	623	12.8	$519
Warrenton	1,799	178	9.9	$561
Washington	2,451,075	179,677	7.3	$663
Pacific County	13,991	4,895	35.0	$483
Ilwaco	524	108	20.6	$565
Wahkiakum County	1,792	239	13.3	$519
Cathlamet	278	32	11.5	$395
Puget Island	404	72	17.8	$783

[a] Information from the U.S. Census Bureau includes the community of Navy Heights (population of 627 persons) as part of the City of Astoria.

Source: U.S. Census Bureau, 2000.

LNG marine traffic should not result in significant changes in demand for housing in the communities along the waterway. The lower Columbia River is already used by almost 2,000 commercial ships per year. Residential structures and hotels within the Zones of Concern along the waterway could be affected in the event of an accidental or intentional breach of an LNG carrier resulting in a release of LNG and an associated fire. As discussed further in section 4.11.5, if a pool fire occurred where the transit route is close to shore, structures within 2,200 feet of the center of a spill could be subject to a long-term loss of use. However, with the implementation of the safety and security measures and conditions outlined in the Coast Guard's WSR, an LNG release along the waterway would be highly unlikely and the potential impact on housing would be less than significant.

4.8.1.3 Property Values

In 2005, the total assessed value of real property in Pacific County, Washington was $1,633,127,590, while the total assessed value of real property in Wahkiakum County, Washington was $277,859,240 (Workforce Explorer, 2007). The total real market value of assessed property in Clatsop County, Oregon in the fiscal year 2005 to 2006 was $5,438,799 (Oregon Department of Revenue, 2007). In 2005, the estimated median value of a house in Warrenton was $147,200, in Astoria it was $153,500, and in Cathlamet it was $122,900 (City Data, 2007).

Currently, almost 2,000 commercial ships per year using the Columbia River navigation channel pass by the communities along the river shore in Pacific and Wahkiakum Counties, Washington, and Clatsop County, Oregon. If the proposed LNG terminal goes into operation, commercial river traffic would increase by about 7 percent (Parsons Brinckerhoff, 2005). We do not believe that this slight increase in commercial river traffic would have any negative impacts on property values in communities along the waterway. We are unaware of any studies that have been done relative to the effects on property values due to the potential hazards of LNG marine traffic, and none have been filed with the FERC. With implementation of the safety and security measures and conditions outlined in the Coast Guard's WSR, it is highly unlikely that there would be an incident involving an LNG carrier using the waterway that would affect adjacent property values.

4.8.1.4 Economy and Employment

Table 4.8.1-3 provides a summary of existing economic conditions in counties and communities along the waterway. According to the U.S. Census Bureau (2000), the top industries in the areas along the waterway include education, health, and social services. Reflecting the level of tourism in these communities, arts, entertainment, recreation, accommodation and food services, and retail trade comprise a large percentage of employment in Astoria and Warrenton, respectively. The top employer in two of the three affected counties is a forestry or wood products company, reflecting the continued importance of forestry in the region. According to the Clatsop County Community Profile, the county's top employers include the Georgia-Pacific pulp and paper mill, state and local governments, and the Coast Guard (Clatsop County, 2005). Pacific County's top private employer is Coast Seafoods (Pacific County Economic Development Council, 2007). In Wahkiakum County, Jerry DeBriae Logging Company, Wahkiakum County, and Wahkiakum County School District are the top employers (Lower Columbia Economic Development Council, 2005).

TABLE 4.8.1-3

Existing Economic Conditions in the Counties and Communities Along the Waterway for LNG Marine Traffic

State/County/ Community	Per Capita Income (2000)	Civilian Labor Force (2000)	Unemployment Rate (percent) (2006)	Top Industries by Employment (2000)
Oregon	$20,940	1,740,298	5.4	Education, Health and Social Services (19.3%) Manufacturing (14.4%)
Clatsop County	$19,515	17,656	5.0	Education, Health and Social Services (19.2%) Arts, Entertainment, Recreation, Accommodation, and Food Services (15.7%)
Astoria [a]	$18,759	4,796	6.9	Education, Health and Social Services (22.0%) Arts, Entertainment, Recreation, Accommodation, and Food Services (14.1%)
Warrenton	$16,874	1,933	3.7	Education, Health and Social Services (19.3%) Retail Trade (18.6%)
Washington	$22,973	2,979,824	5.0	Education, Health and Social Services (19.4%) Manufacturing (12.5%)
Pacific County	$17,322	8,663	6.6	Education, Health and Social Services (21.3%) Arts, Entertainment, Recreation, Accommodation, and Food Services (12.6%)
Ilwaco	$16,138	435	6.4	Education, Health and Social Services (23.3%) Arts, Entertainment, Recreation, Accommodation, and Food Services (12.3%)
Wahkiakum County	$19,063	1,691	6.5	Education, Health and Social Services (24.6%) Agriculture, Forestry, Fishing and Hunting, and Mining (14.6%)
Cathlamet	$18,588	216	9.7	Education, Health and Social Services (29.7%) Agriculture; Forestry; Fishing and Hunting; and Mining (11.3%) Public Administration (11.3%)
Puget Island	$22,444	374	8.0	Education, Health and Social Services (29.1%) Manufacturing (12.2%)

[a] Information from the U.S. Census Bureau includes the community of Navy Heights (population of 627 persons) as part of the City of Astoria.

Sources: U.S. Census Bureau, Profile of Selected Economic Characteristics, 2000.
U.S. Department of Labor, Bureau of Labor Statistics. Local Area Unemployment Statistics, 2006.

Within the counties and communities along the waterway, average per capita income was slightly lower than the averages for Oregon and Washington. In 2006, Warrenton and Clatsop County, Oregon had unemployment rates lower than the state average of 5.4 percent. The remaining counties and communities along the waterway had unemployment rates higher than state averages, ranging from 6.4 percent within Ilwaco, Washington to 9.7 percent within Cathlamet, Washington.

LNG marine traffic could have beneficial impacts on the economy of the counties along the waterway. NorthernStar would have to rent at least three tugboats, and pay their crews, to escort each LNG carrier. This is discussed in section 4.8.1.7. The economy in the area could be affected in the unlikely event of an accidental or intentional breach of an LNG carrier resulting in a release of LNG. If a pool fire occurred where the transit route is close to shore, businesses within 2,200 feet of the center of a spill could be subject to a long-term loss of use. However, because the hazard area surrounding an LNG cargo vessel is transient (moving with the vessel along its route), it is not possible to accurately quantify the economic impact of an incident. Also, given the precipitation in the region, any project-related fire would likely be of short duration and limited extent. Nevertheless, with the implementation of the safety and security measures and conditions outlined in the Coast Guard's WSR, an LNG release along the waterway would be highly unlikely and the potential impact on the economy and employment would be less than significant.

4.8.1.5 Tax Revenues

The tax revenues generated by the Bradwood Landing Project would be associated with construction and operation of the LNG terminal and pipeline facilities themselves, and not with the LNG carriers. Therefore, LNG marine traffic along the waterway would not affect tax revenues in the area.

4.8.1.6 Local Infrastructure and Public Services

Information on existing public services in the area of the waterway for LNG marine traffic is provided in table 4.8.1-4. Warrenton, Astoria, and Cathlamet are incorporated cities within the Zones of Concern along the waterway for LNG marine traffic. The other communities listed on table 4.8.1-4 are within approximately 30 miles of the waterway and provide public services to the region.

Warrenton, Oregon was incorporated in 1899. The city government includes an administrative office run by a City Manager, a finance department, planning department, fire and police departments, municipal court, and department of public works. The City of Astoria is the county seat for Clatsop County, Oregon. The Astoria city government is administered by a City Manager, and includes departments of finance, public works, fire, police, community developments, and parks and recreation. Astoria has a port authority that operates an airport and several marinas. Northwest Natural provides natural gas and Pacific Power provides electricity to Warrenton and Astoria.

The town of Cathlamet, Washington, which is the county seat for Wahkiakum County, was incorporated in 1907. The town government is directed by a Mayor and Council. Town employees include a treasurer, clerk, public works supervisor, attorney, and librarian. There is a Fire Department, Public Works Department, Planning Commission, and Library Board, and the town operates parks and recreational facilities. The town manages a water treatment plant and sewer system, but its main source of water comes from the Wahkiakum County Public Utilities District No. 1, which also provides electricity. Natural gas is not currently available in Cathlamet (Town of Cathlamet, 2007; Lower Columbia Economic Development Council, 2007).

TABLE 4.8.1-4

Existing Public Services in the Vicinity of the Bradwood Landing Project

Facility	Location	Details
Hospitals	Astoria	Columbia Memorial Hospital Level III Trauma Center with 49 beds
	Cathlamet	Wahkiakum Family Practice Clinic Outpatient Treatment
	Ilwaco	Ocean Beach Hospital 15 beds
	Longview	St. Johns Medical Center Level III Trauma Center with 193 beds
	Seaside	Providence Seaside 22 extended care beds, 34 acute care beds
	St. Helens	St. Helens Lab Outpatient Treatment
Ambulance Services	Astoria	Medix Ambulance
	Clatskanie	Clatskanie Ambulance
Fire Departments	Columbia	Columbia River Fire and Rescue 7 stations in Columbia County
	Cowlitz County	Cowlitz County Fire Protection District #2 Serving the Kelso/Longview area
	Cowlitz County	Cowlitz County Fire Protection District #6 Serving the Castle Rock area
	Astoria	Astoria Fire Department
	Astoria	Lewis and Clark Rural Fire Protection District (RFPD)
	Astoria	Olney Walluski Fire and Rescue
	Astoria	John Day-Fernhill RFPD
	Clatskanie	Clatskanie RFPD
	Gearhart	Gearhart RFPD
	Knappa	Knappa-Svensen Burnside RFPD
	Longview	Longview Fire Department
	Seaside	Seaside Fire and Rescue
	Warrenton	Warrenton Fire Department
	Westport	Westport Wauna Fire District
Law Enforcement	Clatsop County	Clatsop County Sheriff's Office 60 officers
	Columbia County	Columbia County Sheriff's Department 6 police officers
	Cowlitz County	Cowlitz County Sheriff's Office 48 commissioned deputies
	Wahkiakum County	Wahkiakum County Sheriff's Office 8 officers
	Astoria	City of Astoria Police Department
	Clatskanie	Clatskanie Police Department 5 police officers
	Columbia	Columbia City Police Department 7 police officers
	Castle Rock	Castle Rock Police Department
	Kelso	Kelso Police Department
	Longview	Longview Police Department
	Svensen	Svensen Sheriff Station
	St. Helens	St. Helens Police Department 18 police officers

Sources: Columbia Memorial Hospital, 2006; Providence Seaside Hospital, 2006; Legacy Health System, 2006; Peace Health, 2006; Orr, 2004; NorthernStar's communications, 2005.

There are structural elements of the local infrastructure within the communities along the waterway for LNG marine traffic that are overlapped by the Zones of Concern. At about CRM 5, Zone 3 overlaps with the Coast Guard Cape Disappointment Station mooring on the north shore of the Columbia River in Pacific County, Washington.

The former town of Hammond has been merged into the City of Warrenton, in Clatsop County, Oregon. The City of Warrenton covers 17 square miles, and is responsible for the southern shoreline of the Columbia River from Clatsop Spit (Buoy 14) east to Smith Point. At about CRM 11, the Hammond Boat Basin and the Youngs Bay Bridge along Highway 101 are within Zone 2. Within Zone 3 is the Warrenton police and fire departments, the Warrenton-Astoria Regional Airport, including the Coast Guard Air Station (about 3,700 meters south of the navigation channel), and the Warrenton Marina.

The City of Astoria, in Clatsop County, Oregon, is located between about CRMs 13 and 14. Within Zone 1 at Astoria is Pier 1, where cruise ships berth; Pier 2, serving the bulk of the local commercial fishing fleet, and recreational boating facilities at the West Basin and East Basin marinas and the 17th Street dock, operated by the Port of Astoria; the Astoria-Megler Bridge over the Columbia River along Highway 101; the Astoria police and fire departments and emergency information center; the Columbia River Maritime Museum; the riverfront trolley; and boat anchorages. Within Zone 2 at Astoria is Captain Robert Gray Elementary School, with 780 students (1,100 meters south of the navigation channel); John Jacob Astor Elementary School, with 298 students (1,200 meters south of the navigation channel); Clatsop Care Center; Columbia Memorial Hospital (1,200 meters south of the navigation channel); Clatsop County Health and Human Services; and the Coast Guard base at Tongue Point. Within Zone 3 at Astoria is Astoria Middle School, with 550 students (1,900 meters south of navigation channel) and Astoria High School, with 760 students (1,700 meters south of the navigation channel).

At about CRM 33, the Wahkiakum County Fire Protection District No. 2 in Skamokawa, Washington is overlapped by Zone 1. There is also a town center in Skamokawa.

In Cathlamet, Washington, at about CRM 39, the Wahkiakum County Fire Protection District No. 1, the town of Cathlamet fire department, and town hall are overlapped by Zone 3.

In review of NorthernStar's WSA, the Coast Guard identified resource gaps that exist in the ability of local emergency services, including police and fire departments, to respond to a potential incident involving an LNG carrier in the waterway. The Coast Guard has outlined conditions in its WSR that must be met in order to have the waterway found suitable for LNG marine traffic (see Appendix G). In addition, the ODE requested that the FERC require NorthernStar to fill emergency response gaps in Clatsop County. On March 24, 2008, NorthernStar filed its first draft ERP. In accordance with the EPAct, the ERP must offer a cost-sharing plan, and outline how NorthernStar would fill resource gaps and supplement the first-responder capabilities of the local jurisdictions. As discussed further in section 4.11.6, we will require NorthernStar to file a final ERP for review and approval by the Director of OEP prior to the beginning of project construction activities.

4.8.1.7 Transportation and River Traffic

The main road systems along the waterway include Washington State Route 4 running east-west parallel to the lower Columbia River on the north side in Washington, and Oregon State Route 30 running east-west on the south side of the river in Oregon. U.S. Highway 101 runs south-north between Warrenton, Oregon and Ilwaco, Washington, crossing the Columbia River from Astoria, Oregon to Point Ellice, Washington. The Zones of Concern overlap Highway 101, including the Youngs Bay Bridge at Warrenton, and the Astoria-Megler Bridge over the Columbia River at about CRM 13, and a portion of Washington State Route 4 near Cathlamet, and Oregon State Route 30 south of Bradwood and at Astoria.

In the unlikely event of an LNG carrier accident that results in a spill and associated pool fire, these roads may be affected. However, we believe that with the implementation of the conditions outlined in the Coast Guard's WSR, the likelihood for such impacts is extremely remote.

About 2,000 commercial ships per year use the Columbia River navigation channel to reach upriver ports. In 2007, 18 cruise ships docked at Astoria and 19 cruise ships are scheduled to call in 2008. Table 4.8.1-5 includes the totals of the various commercial vessel types that used the river in 2004, 2005, and 2006. In addition, several smaller river cruise vessels travel between Portland and Astoria that could be affected by passage of the LNG carriers associated with the proposed project. However, we expect that impacts on these smaller vessels would be similar to the impacts on other recreational river users as discussed in section 4.8.1.8.

TABLE 4.8.1-5

Density and Type of the Shipping Marine Traffic on the Columbia River

Vessel Type	2004	2005	2006	Total	Daily 3-Year Average
Container vessels	198	94	140	432	0.39
Tankers	163	137	188	488	0.45
Car carriers	247	267	344	858	0.78
Bulkers	780	795	733	2,308	2.11
General Cargo (includes log ships)	244	218	252	714	0.65
Others (includes barges, naval, etc.)	76	76	57	209	0.16
Ocean-going cruise Ships	20	24	26	70	0.06
Total	1,728	1,611	1,740	5,079	

In accordance with the Coast Guard's guidance in the NVIC-05-05, NorthernStar prepared a WSA to address potential impacts of its proposal on other waterway users. The Coast Guard validated the WSA, and issued a WSR in February 2007 (see Appendix G). The conditions outlined in the WSR are discussed in section 4.11.5.5. After the completion of the final EIS, the Coast Guard will complete its review and issue an LOR to address the suitability of the waterway for LNG marine traffic. A discussion of safety issues related to LNG marine traffic is included in section 4.11.5. Impacts on recreational activities on the Columbia River are discussed in section 4.7.1.4.

NorthernStar indicated that about 125 LNG carriers per year would travel along the navigation channel in the Columbia River to the LNG terminal at Bradwood. As discussed in section 2.1.1, the LNG carriers could range in capacity from 100,000 to 200,000 m^3, although the Coast Guard would limit the size of the LNG carriers to a maximum capacity of 148,000 m^3 until additional risk analyses addressing larger vessels have been completed (see section 4.11.5). Typically, LNG carriers would be up to 1,000 feet long, have drafts of about 40 feet deep, and travel at a speed of up to 12 knots in the waterway.

We do not believe that LNG carriers transiting in the waterway to and from the proposed Bradwood Landing terminal would be significant impediments to other river traffic. They would represent only a minor increase in current totals for commercial ship traffic. This is more fully discussed below. In addition to the potential impacts discussed below, an incident that results in an LNG spill from a carrier in the waterway would affect other commercial traffic in the lower Columbia River. However, with the implementation of the safety and security measures and conditions outlined by the Coast Guard in its WSR, we believe that an LNG release along the waterway would be highly unlikely and the potential impact on transportation and river traffic would be less than significant.

Shipping

Other ship traffic using the navigation channel of the Columbia River at the same time that an LNG carrier is transiting the waterway to the terminal may be affected by the conditions outlined in the Coast Guard's WSR. These conditions include:

- establishment of a 500-yard moving safety and security zone around the LNG carrier while it is underway or at anchor on the Columbia River and a 200-yard fixed security zone while the LNG carrier is moored at the LNG terminal; and

- one-way traffic when meeting an LNG carrier along certain portions of the waterway, such as at turns along the Columbia River.

The 200-yard fixed security zone while the LNG carrier is moored at the LNG terminal was designed to minimize impacts on other vessels while ensuring adequate protection of the LNG carrier (see figure 4.8.1-1). It should be noted that the Coast Guard's moving safety/security and moored vessel security zones would not be treated as absolute exclusion zones that would preclude all other vessel movements. Rather, other vessels may be allowed to transit through the moving safety/security and moored vessel security zones with the permission of the COTP. The expectation is that the COTP's Representative would work with the pilots and patrol assets to control traffic, and would routinely allow vessels to transit the safety/security zone based on a case-by-case assessment conducted on scene.

Although one-way traffic would be imposed along certain portions of the waterway during the LNG carrier transit, four passing zones along the transit route would allow two-way traffic. The passing zones are based on informal best practices currently used by deep-draft traffic. The meeting and overtaking of vessels is coordinated by river pilots using their VTIS system and bridge-to-bridge communication. Through careful traffic management, prearrangement of meeting locations, and an expanded vessel traffic information system, traffic delays are expected to be negligible, as the traffic patterns are designed to resemble those already in use by deep-draft traffic today. Overtaking an LNG carrier would be prohibited; however, due to the relative speed of an LNG carrier, and with vessel traffic planning, it is extremely unlikely this prohibition would result in any measurable delays.

A marginal increase in ship traffic could occasionally increase the wait time for ships in Astoria. If a large number of ships arrive at the mouth of the Columbia River in a short time period, some may need to wait for a pilot. A similar scenario plays out just upriver of Astoria when bar and river pilots replace one another.

NorthernStar filed an analysis of vessel arrival patterns at the mouth of the Columbia River, to determine the potential for navigational conflicts LNG carrier traffic may have with other commercial ships traversing the Columbia River bar. LNG carriers are expected to cross the bar within a 3-hour window prior to high tide. The study found that about half the time, arriving LNG carriers would encounter no other commercial vessels while crossing the bar during the 3-hour tidal window. The maximum number of other commercial vessels that may be encountered by an arriving LNG carrier at the mouth of the Columbia River would be four. Almost 80 percent of the time, there would be no delays for LNG carriers crossing the bar due to other traffic. However, 20 percent of the time the average delay at the bar for an LNG carrier due to other traffic would be about 26 minutes. In one case, an arriving LNG carrier would have to wait 2.23 hours to cross the bar because of a cruise ship departure.[19]

[19] Parsons Brinckerhoff, 30 May 2007, Columbia River Navigation Channel Analysis of Vessel Arrival Patterns, filed on March 24, 2008. This document is available for viewing by the public via the FERC's Internet webpage at www.ferc.gov through the eLibrary link. Go to Docket No. CP06-365, select an appropriate date range, and look up accession number 20080325-5012.

Proposed LNG Terminal Site
LNG Carrier
Security Zone

0 750 1,500 2,250 Feet

Figure 4.8.1-1
Bradwood Landing Project
Fixed Security Zone Around Unloading LNG Carrier

The worst case delay scenario is that another ship would be required to wait an entire tide cycle (12 hours or more). However, proactive scheduling and active communication between LNG carriers and other commercial ships could help to mitigate potential impacts. Further, because the river currently supports a high level of cargo shipping, it is anticipated that other vessels have extensive experience with ship traffic and would be adept at minimizing wait time. NorthernStar has filed a proposal for navigation protocols and priorities that would minimize delays to other commercial vessels on the lower Columbia River due to LNG carrier traffic.[20]

In the unlikely event of an LNG spill, the physical properties of LNG would limit any potential impacts. If spilled into water, the cryogenic liquid would vaporize rapidly upon contact with the warm air and water over a period of approximately 1 to 2.5 hours. If an LNG spill occurred along the transit route, ship traffic may be temporarily interrupted in the navigation channel; however, traffic in the navigation channel would quickly resume normal operations and any economic impact on the maritime industry would be minimal.

Commercial Fishing and Indian Treaty Fishing Rights

In recent years, commercial fishing for salmon and sturgeon (the primary commercial fish) along the Columbia River has been limited to a season lasting just a few days, occasionally even hours. These seasons are regulated according to forecasted fish populations with the goal of sustaining the fishery. There is a commercial fishing fleet based out of Astoria, Oregon and Ilwaco, Washington, in addition to others located along the lower Columbia River all the way up to Bonneville Dam. In part due to their proximity to Astoria and net-pen fisheries, commercial fishing activities on the lower river are concentrated on Young's Bay and the mouth of the Columbia. At certain times, there may be a peak of up to 200 commercial fishing boats on the lower Columbia River (Kraley, 2006). There are five Select Area Fisheries Evaluation net-pen rearing and fishing sites situated between CRM 10 and 35. In 2003, returning select area fishing generated $3,290,642.

Gill-netters on the lower Columbia River recognize, among themselves, certain "drift rights." These drift rights are held by members of associations that pool their efforts to clear particular fisheries or "drifts" of snags and debris. This membership gives the members of the drift exclusive rights to fish this area on the ebb tide. Although the drift rights are considered to be only a gentleman's agreement, a membership may be bought or sold, with the permission of the other members of the association. The drift rights allow each group of fisherman to fish in its respective area. The fish are not considered to be common property among the entire fleet; rather, they belong to the specific drift until they are either caught or move on. By contrast, in more mobile adaptations such as trolling, fish are considered common property until actually caught (Martin, 1994). However, as a matter of law, in neither Oregon nor Washington may individuals or associations obtain exclusive fishing rights in any portion of a navigable waterway, such as the Columbia River. In 1990, the Washington Supreme Court specifically rejected the claims of a gill-netter association to exclusive drift rights on the lower Columbia River, finding that "local custom and usage do not support legal recognition of drift rights." Although exclusive, location-specific drift rights are not authorized by commercial gill net licenses and do not have any legal recognition in Oregon or Washington, NorthernStar is negotiating with the claimants of such rights in areas immediately adjacent to the project site regarding potential mitigation.

LNG marine traffic in the waterway should not have significant adverse effects on commercial and gill net fishing. Commercial fishermen already take into consideration current large tanker traffic on the lower Columbia River. Project-related LNG carrier transit would increase commercial ship traffic in

[20] Parsons Brinckerhoff, 31 January 2007, Columbia River Navigation Channel Analysis of Navigation Protocols and Priorities, filed March 24, 2008. This document is available for viewing by the public via the FERC's Internet webpage at www.ferc.gov through the eLibrary link. Go to Docket No. CP06-365, select an appropriate date range, and look up accession number 20080325-5012.

the waterway by about 7 percent. It is expected that fishermen could encounter an LNG carrier on the river about once every 1.5 days. Fishing vessels may have to temporarily move out of the way to avoid the safety and security zones surrounding the LNG carriers during their transit upriver to the terminal. However, it is anticipated that such inconveniences would be short term, lasting only a few minutes while an LNG carrier passes at speeds between 8 to 12 knots.

Comments were received on the draft EIS regarding potential impacts of the project on Indian treaty fishing rights. Four Indian tribes exercise their treaty fishing rights for ceremonial, subsistence, and commercial purposes in the Columbia River above Bonneville Dam. No Indian treaty fishing sites have been identified along the waterway for LNG marine traffic. However, salmon migrating to and from sites above Bonneville Dam could be affected by the passage of LNG carriers during operation of the proposed project. As discussed in section 4.5.1.1, NorthernStar would avoid, minimize, reduce, rectify, and compensate for impacts on fishery resources during construction and operation of the project. Therefore, no significant adverse impacts on Indian treaty fishing rights are anticipated as a result of the proposed project.

Charter Boat Services

A charter fleet operates out of Ilwaco, Washington. Charter boat traffic in 2004 occurred primarily during the summer months and peaked during June with a daily average of 15 boats per day. Although the average daily traffic is sparse, this traffic is likely more concentrated during weekend periods. Because charter services extend beyond the mouth of the Columbia River into the open ocean, charters have extensive experience with ship traffic and are adept at minimizing its impact. For these reasons, and due to the relatively minor increase in overall ship traffic due to the project, LNG carriers would have minimal impact on charter services.

Ferry

A ferry runs between Westport, Oregon and Puget Island, Washington. The ferry is operated by Wahkiakum County and links Washington State Route 409 to Oregon Highway 30 (Wahkiakum County Commission, 2005). This ferry is located 5 miles upriver of Bradwood and would not be impacted by the Bradwood Landing Project.

Ship Piloting

The piloting grounds of the Columbia River are divided into the Columbia River Bar and the river proper. From entry into United States waters to a location in the channel off Tongue Point east of Astoria, LNG carriers would transit under the navigational control of a Columbia River Bar Pilot. LNG carriers would transit under Columbia River Pilot supervision from Tongue Point to the proposed LNG terminal. Arrival and docking operations would proceed under the supervision of the Columbia River Pilots with assistance tugs. Although NorthernStar would be responsible for payment of pilot fees, the true impact on pilotage from this project would take the form of lower tariffs for other shippers. NorthernStar would contribute approximately $1.6 million of the fixed costs associated with pilot service. Currently, this cost is being borne by all of the other ships that use the pilots. Therefore, because of the fees paid by NorthernStar, the resulting per ship pilotage fee paid by other users would be lowered significantly, which has the potential to increase the competitiveness of the region as a shipping destination.

Currently, both piloting grounds have unused capacity. Therefore, the 7 percent increase in ship traffic associated with the proposed project could be serviced with the existing number of pilots. Although pilots would experience increased deck-time and ships serviced per pilot, additional pilots

would not be needed (Kraley, 2006). The increased deck-time per pilot may result in increased wait time for ships in Astoria occasionally. This is due to the fact that there are different pilots for the Columbia River Bar and for the Columbia River, and the pilots change just upstream of Astoria.

In a letter to the FERC dated October 10, 2005, Captain Steve Brown, President of the Columbia River Pilots, expressed the opinion that the pilots could move the LNG carriers without incident. He noted that there is nothing uniquely difficult about LNG carriers from the standpoint of safe navigation, and the pilots routinely move vessels of similar size. The pilots suggested that the LNG transits occur mostly during daylight hours during the first months of operation of the terminal, and that two pilots be assigned to each LNG carrier, as is currently the practice for large tankers carrying petroleum products.

Tugboat Operations and Long-Shoring Activities

The Coast Guard's WSR requires that each LNG carrier be escorted by a minimum of two tugs; at least one of which must be a tractor tug. A third tug would be necessary for turning and mooring to the terminal berth. NorthernStar estimated it would pay about $1.4 million per year in tugboat rental fees, and the increased tugboat activities related to the Bradwood Landing Project would result in the hiring of approximately 40 additional employees to work on the LNG carrier escort tugboats.

4.8.1.8 Recreation and Tourism

The Zones of Concern along the waterway would overlap with state parks, local parks, national wildlife refuges, and marinas located along the shore of the Columbia River. Therefore, LNG marine traffic has the potential to affect recreational and tourist related activities. Some commentors on our draft EIS expressed concerns that the project could have negative impacts on tourism in the region. However, we could find no evidence to support that contention, and our analysis, provided in sections 4.8.1.4, 4.8.2.4, and 4.8.3.4, indicates that the project may have benefits for the local economy.

One of the main impacts on recreational users and tourists visiting parks and wildlife refuges along the lower Columbia River would be visual impacts associated with the passing of an LNG carrier in the waterway. As we discussed in section 4.7.1.5, visual impacts on recreational users and tourists should not be significant, as LNG carriers would normally transit in the waterway at speeds between 8 to 12 knots, and would only be visible to park and wildlife refuge visitors for a short period.

State and Local Parks

In Pacific County, Washington, Cape Disappointment State Park occupies about 1,882 acres on the Long Beach Peninsula between the Pacific Ocean and the Columbia River. In Clatsop County, Oregon, on the opposite side of the Columbia River at its mouth, is Fort Stevens State Park, covering about 3,700 acres.

In Warrenton, Oregon, the Zones of Concern along the waterway for LNG marine traffic would overlap the Waterfront Trial, Carruthers Park, and the Fisherman's Memorial and Lighthouse Park. In Astoria, Oregon, the Zones of Concern would overlap the Maritime Memorial Park, 6th Street Viewing Dock, 14th Street Riverpark, Riverwalk Trail, Victory Monument and Doughboy Statue, Astoria Column, Shively Park, the 4-H fairgrounds, Tapiola Park, Warren Field, Fred Lindstrom Memorial Park, and Yacht Club Park. In Wahkiakum County, Washington, the Zones of Concern would overlap Skamokawa Vista Park and Wahkiakum County Fairgrounds in Skamokawa, and Erickson Park and Strong Park in Cathlamet. State and local parks are described further in section 4.7.1.4. We believe that with the measures to be implemented by NorthernStar, and the conditions outlined in the Coast Guard's WSR, the likelihood for impacts on these parks is extremely remote.

National Parks, Trails, and Wildlife Refuges

The Zones of Concern along the waterway for LNG marine traffic would overlap two elements of the LCNHP (Cape Disappointment State Park and Fort Stevens State Park), the LCNHT, the Lower Columbia River Water Trail, and two national wildlife refuges, including the LCNWR and JBHNWR. We address potential impacts on the LCNHP and LCNHT in section 4.9, and further discuss the national wildlife refuges in section 4.7.1.4. We believe that with the safety and security measures and conditions outlined in the Coast Guard's WSR, there would be little possibility of a spill of LNG from a carrier in transit to the terminal, and that the potential for adverse impacts on national wildlife refuges within the Zones of Concern along the waterway is extremely remote.

Cruise Ships

During scoping, comments were received regarding potential project-related impacts on large, ocean-going cruise ships that use the navigation channel of the Columbia River to reach Astoria. The Port of Astoria has been visited by cruise ships since 1996, and has invested more than $10 million in improvements at Pier No. 1 to accommodate these vessels (Port of Astoria, 2006b). Eighteen cruises were scheduled to call on the Port during 2007 between April and November. Nineteen cruise ships are scheduled to make Astoria a port-of-call in 2008. The Coast Guard also recognized this issue, and its WSR contains the following conditions:

- when any cruise ship is moored at Astoria, LNG carriers would be restricted to transiting in good visibility (6 miles or more);
- any cruise ship at Astoria would require separate waterfront security when an LNG carrier is in transit in the vicinity; and
- a cruise ship and an LNG carrier would not be placed in a meeting situation.

We believe that with implementation of the conditions of the WSR, the potential for LNG marine traffic in the waterway to adversely affect cruise ships traveling to or docking at Astoria is extremely remote.

We received comments on the draft EIS regarding potential impacts on cruise ships that travel between Astoria and Portland. No large ocean-going cruise ships (i.e., the type of cruise ship referred to in the WSR) travel beyond the Port of Astoria to Portland. Several smaller river cruise vessels travel between Portland and Astoria that could be affected by passage of the LNG carriers associated with the proposed project. However, we expect that impacts on these smaller vessels would be similar to the impacts on other recreational river users as discussed below.

Recreational Fishing

The ODFW estimated that in 2005, anglers from Washington and Oregon combined to total more than 400,000 fishing trips along the lower Columbia River between Bonneville Dam and Buoy 10 (Watts and Takata, 2006). According to NorthernStar's *River User Impact Analysis*, about 46,000 recreational fishing boats go out on the Columbia River estuary between February and October, based on per-day use data from 2004.

We do not believe that the proposed project would have significant impacts on recreational fishing boats on the lower Columbia River. As discussed in sections 4.7.1.4 and 4.8.1.7, fishing boats are used to dealing with commercial ship traffic, and would merely move out of the way of LNG carriers

passing by in the waterway. Nor would the safety and security zones imposed by the Coast Guard around LNG carriers in the waterway or at dock at the terminal limit access to fishing grounds.

Non-Fishing Recreational River Users

Non-fishing recreational river users include power boaters, sailboaters, charter boat services, river cruise services, jet-skiers, water-skiers, windsurfers, kite surfers, kayakers, and canoers. Non-motorized water craft may be using the Lower Columbia River Water Trail for daily excursions. Recreational river users can access the lower Columbia River via boat ramps at Cape Disappointment State Park, Chinook County Park, Knappton, Oneida, Skamokawa Vista Park, East Sunny Sands, County Line Park, and Willow Grove Park in Washington, and at Youngs Bay Marine Park, Netul Landing, John Day Park, Knappa Docks, Aldrich Point, Westport, Jones Beach, Beaver Boat Ramp and Park, and Dibblee Point Beach in Oregon. There are marinas located in Ilwaco and Cathlamet, Washington; and at Hammond, Warrenton, and Astoria in Oregon. In addition, personal watercraft rentals are available in Warrenton, Oregon, and kayak rentals are available in Cathlamet and Skamokawa, Washington, and Warrenton, Oregon. Recreational river use is discussed in more detail in section 4.7.1.4.

The moving safety and security zone imposed by the Coast Guard around LNG carriers in transit up the waterway to the terminal may have temporary impacts on recreational river users. During the passage of the LNG carrier, other river users would have to briefly move to other portions of the Columbia River outside of the safety and security zone. Windsurfers, jet-skiers, kayakers, and canoers tend to use shallow waters near shore, and outside of the navigation channel. Some small recreational craft may be affected by wakes from LNG carriers. However, current recreational river users already have to contend with large commercial vessels and their wakes. Any inconveniences caused by the passage of an LNG carrier would be short term, since those vessels would travel at speeds between 8 and 12 knots.

4.8.1.9 Environmental Justice

Executive Order 12898 on Environmental Justice requires that each federal agency address disproportionately high and adverse health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. As part of the preparation of this EIS, the NEPA review process must provide opportunities for effective community participation and involve consultation with affected communities. If the proposed action would result in significant adverse effects to minority or low-income populations or Native American tribes, the NEPA analysis should address those impacts as part of the alternatives analysis and identify appropriate mitigation measures to address the effects.

Tables 4.8.1-6 and 4.8.1-7 describe the ethnic and racial composition and income distribution of the communities occurring within the Zones of Concern associated with LNG carriers. Navy Heights, a suburb of Astoria, is the only community with a significantly higher percentage of people below poverty within the Zones of Concern along the waterway for LNG marine traffic. There are no predominantly minority communities within the Zones of Concern along the waterway for LNG marine traffic and the population of Native Americans is less than 2 percent of the total population. About 93 percent of the population of Warrenton is white non-Hispanic. Approximately 14.2 percent live below federal standards defining poverty. About 91 percent of the population of Astoria is white non-Hispanic. About 16 percent live below the poverty line. A little more than 94 percent of the population of Cathlamet is white non-Hispanic. About 15 percent are considered impoverished. Clatsop County in 2006 had an unemployment rate of about 5.7 percent (Bureau of Economic Analysis (BEA), 2007). In Pacific County in 2005, about 2,300 people per month received either state or federal non-medical assistance. In Wahkiakum County in 2005, about 320 people per month received either state or federal non-medical assistance. Therefore, neither low-income nor minority groups would be disproportionately affected by LNG carrier transit.

TABLE 4.8.1-6

Demographics of Communities Along the Waterway for LNG Marine Vessel Traffic [a]

State/County/Community	Total Population (2000)	Percent White	Percent Black or African American	Percent American Indian & Alaska Native	Percent Asian	Percent Native Hawaiian & Other Pacific Islander	Percent Other Race	Percent Hispanic or Latino – Any Race	Percent Minority
Oregon	3,421,399	86.5	1.6	1.3	2.9	0.2	7.5	8.0	13.5
Clatsop County	35,630	93.1	0.5	1.0	1.2	0.1	4.1	4.5	6.9
Astoria	9,813	91.0	0.5	1.14	1.9	0.2	5.3	5.9	9.0
Clifton	33	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fort Stevens [b]	322	93.2	0.3	0.0	1.6	0.0	4.9	2.2	6.8
Hammond [b]	158	94.3	0.6	0.0	1.9	0.0	3.2	1.3	5.7
Navy Heights [c]	627	76.2	0.4	2.4	0.9	0.6	19.5	22.9	23.8
Warrenton	4,096	92.5	0.2	1.3	1.7	0.1	4.2	2.9	7.5
Washington	5,894,121	81.8	3.2	1.5	5.4	0.4	7.7	7.4	18.2
Pacific County	20,984	90.5	0.2	2.4	2.0	0.1	4.8	5.0	9.5
Wahkiakum County	3,824	93.4	0.3	1.6	0.5	0.1	4.1	2.6	6.6
Altoona	40	75.0	0.0	12.5	0	0	12.5	0.0	25
Brookfield/Dahlia [d]	33	69.7	0.0	15.2	0	0	15.1	0.0	30.3
Cathlamet	565	94.1	0.5	1.6	0.8	0.0	3.0	0.5	5.9
Puget Island	798	94.1	0.3	1.7	0.2	0.0	3.7	2.5	5.9
Skamokawa	178	97.2	0.0	1.7	0.6	0.0	0.0	0.6	2.2

[a] Populations considered potentially affected for the environmental justice analysis along the waterway for LNG marine vessel traffic include those communities within the Zones of Concern.

[b] Information from the U.S. Census Bureau includes the communities of Fort Stevens and Hammond as part of the City of Warrenton.

[c] Information from the U.S. Census Bureau includes the community of Navy Heights as part of the City of Astoria.

[d] The communities of Brookfield and Dahlia are contained within the same Block in Wahkiakum County (Block 1103, Block Group 1, Census Tract 9501.

Sources: U.S. Census Bureau, Census 2000

TABLE 4.8.1-7

Income Distribution of Communities Along the Waterway for LNG Marine Traffic

State/County/Community	Total Population (2000) [a]	Per Capita Income in Dollars (1999)	Median Household Income in Dollars (1999)	Percentage of Persons Below Poverty (1999)
Oregon	3,421,399	20,940	40,916	11.6
Clatsop County	35,630	19,515	36,301	13.2
Astoria	9,813	18,759	33,011	15.9
Clifton	33	14,549	28,438	14.4
Fort Stevens [b]	322	16,587	35,000	14.5
Hammond [b]	158	16,587	35,000	14.5
Navy Heights [c]	627	12,730	25,043	25.3
Warrenton	4,096	16,874	33,472	14.2
Washington	5,894,121	22,973	45,776	10.6
Pacific County	20,984	17,322	31,209	14.4
Wahkiakum County	3,824	19,063	39,444	8.1
Altoona	40	16,297	35,893	9.8
Brookfield/Dahlia [d]	33	16,297	35,893	9.8
Cathlamet	565	18,588	33,409	15.1
Puget Island	798	22,444	48,906	9.4
Skamokawa	178	18,233	36,250	7.0

[a] Populations considered potentially affected for the environmental justice analysis along the waterway for LNG marine vessel traffic include those communities within the Zones of Concern.

[b] Information from the U.S. Census Bureau includes the communities of Fort Stevens and Hammond as part of the City of Warrenton.

[c] Information from the U.S. Census Bureau includes the community of Navy Heights as part of the City of Astoria.

[d] The communities of Brookfield and Dahlia are contained within the same Block in Wahkiakum County (Block 1103, Block Group 1, Census Tract 9501).

Source: U.S. Census Bureau, Census 2000

4.8.2 LNG Terminal

4.8.2.1 Population

Population statistics for areas where socioeconomic effects would occur due to construction of the LNG terminal area are provided in table 4.8.2-1. These areas vary widely in their population totals and densities. Both Clatsop and Columbia Counties in Oregon have population densities higher than the average for the State of Oregon (44.0, 71.5, and 36.6 persons per square mile, respectively). The highest population density in the area occurs within the Portland MSA, which has a population density of 381.5 persons per square mile. The least densely populated county affected by the project is Wahkiakum County, with an average density of 14.2 persons per square mile. Populations in the four-county area range from 3,755 persons in Wahkiakum County to 96,189 persons in Cowlitz County (U.S. Census Bureau, 2004).

TABLE 4.8.2-1

Existing Population in the Areas Where Socioeconomic Effects Would Occur as a Result of Construction and Operation of the Bradwood Landing LNG Terminal and Natural Gas Sendout Pipeline

State/County/ MSA or Community	Population			Population Density [a]	
	1990	2006 [b]	Percent Change	1990	2006 [b]
Oregon	2,842,321	3,700,758	30.2	29.6	38.6
Clatsop County	33,301	37,315	12.1	40.3	45.1
Columbia County [c]	37,557	49,163	30.9	57.2	74.9
Portland MSA	1,477,895	2,063,277 [d]	39.6	294.0	410.4 [d]
Washington	4,866,692	6,395,798	31.4	73.1	96.1
Wahkiakum County	3,327	4,026	21.0	12.6	15.2
Cowlitz County	82,119	99,905	21.7	72.1	87.7
Puget Island	734	798 [d]	8.7	97.9	106.4 [d]

[a] Persons per square mile based on population and land area size: Oregon (95,996.79 square miles), Clatsop County (827.23 square miles), Columbia County (656.72 square miles), Portland MSA (5,027.66 square miles), Washington (66,544.06 square miles), Wahkiakum County (264.24 square miles), Cowlitz County (1,138.64 square miles) and Puget Island (7.5 square miles).

[b] Estimated.

[c] Included in population statistics for Portland MSA.

[d] Census Bureau 2006 data not available. Data from U.S. Census Bureau, 2000 Census data.

Sources: U.S. Census Bureau, 1990.
U.S. Census Bureau, 2006.

No appreciable changes to the local population distribution or number are expected to occur as a result of the proposed LNG terminal. The total population change would equal the total number of non-local construction workers, plus any family members accompanying them. NorthernStar anticipates that the majority of the labor force for construction of the LNG terminal would come from Clatsop, Columbia, Wahkiakum, or Cowlitz Counties (i.e., four-county area),[21] or from the Portland MSA (Columbia Pacific Building Trades Council, 2005). Ten or fewer specialty workers or managers may temporarily relocate to the area during construction of the proposed LNG terminal. Based on the average family size within the areas affected of 3.1 persons (U.S. Census Bureau, 2000), if 10 workers relocate to the study area, the population would increase by approximately 30 people. This potential population increase would be easily absorbed by the affected areas. NorthernStar has indicated that it is committed to hiring and training local residents during operation of the project. Based on commuting patterns at the nearby Wauna Mill (Georgia-Pacific, 2004), almost all of the permanent employees of the LNG terminal would likely reside within a radius of about 80 miles. Therefore, operation of the LNG terminal would not directly result in a noticeable population increase in the local community.

4.8.2.2 Housing

Housing statistics for the areas where socioeconomic effects would occur due to construction of the proposed LNG terminal are presented in table 4.8.2-2. Vacancy rates in the vicinity of the project range from 5.7 percent in the Portland MSA to 25.3 percent in Clatsop County. Temporary housing availability varies seasonally and ranges from bed and breakfasts to hotels and motels, and from studio apartments to four-bedroom homes. Based on information from local hotels, the tourist season in this region runs from June through September. During this season, vacancy rates average 15 percent. During the off-season, vacancy rates are approximately 45 percent (Astoria-Warrenton Area Chamber of Commerce, 2005). In addition, temporary housing is available in campgrounds and recreational vehicle (RV) parks, which provide over 2,000 individual sites in the four-county area.

[21] Pacific County is not expected to provide a source of workers for either construction or operation of the LNG terminal.

TABLE 4.8.2-2

Housing Characteristics in the Areas Where Socioeconomic Effects Would Occur as a Result of Construction and Operation of the Bradwood Landing LNG Terminal and Natural Gas Sendout Pipeline

State/County/MSA	Total Housing Units	Total Vacant Housing Units	Vacancy Rate (percent)	Median Gross Monthly Rent
Oregon	1,452,709	118,986	8.2	$620
Clatsop County	19,685	4,982	25.3	$543
Columbia County [a]	17,572	1,197	6.8	$581
Portland MSA	786,300	44,524	5.7	$672
Washington	2,451,075	179,677	7.3	$663
Wahkiakum County	1,792	239	13.3	$519
Cowlitz County	38,624	2,774	7.2	$518
Puget Island	404	72	17.8	$783

[a] Housing statistics from Columbia County are also included in the Portland MSA.

Source: U.S. Census Bureau, 2000.

Construction and operation of the LNG terminal are not expected to affect the availability of housing in the study area. As discussed in section 4.8.2.1, NorthernStar would employ local workers who would reside within commuting distance of the project. Approximately 75 percent of the construction workforce for the LNG terminal would commute daily from the Portland MSA. It is assumed that commuting workers would not require temporary housing. This use of local workers depends primarily on union agreements, the contractor hired for the project, and the methods the contractor uses to hire subcontractors (Columbia Pacific Building Trades Council, 2005). NorthernStar estimates no money would be spent on temporary housing for the commuting construction workers.

During construction of the proposed LNG terminal, 10 or fewer workers may be hired from outside the area. Based on the average family size of 3.1 persons described in section 4.8.2.1, we estimate that as many as 30 people may move into the area as a result of construction of the LNG terminal. This relatively small number of non-local people requiring housing would not adversely affect the regional housing market.

4.8.2.3 Property Values

Comments were received during scoping regarding the potential effect of the project on property values. Property values on Puget Island are among the highest in Wahkiakum County due to the waterfront access and views. Factual projections of future land values on Puget Island would not be possible until the LNG terminal is in place and property sales data begin to accumulate (Wahkiakum County Commission, 2005).

There are few empirical studies on the impact of industrial facilities on nearby property values. A 1993 study conducted by the Argonne National Laboratory examined the economic impacts of the presence of "noxious" facilities on local wages and property values. Eight types of facilities were studied: nuclear power plants; coal-, gas-, or oil-fired power plants; military chemical weapons sites; hazardous waste sites; refineries; chemical weapon storage sites; former chemical weapon storage sites that are now contaminated; and LNG storage plants. The study examined the effects of 262 facilities on standardized 1,000-square-mile areas across the United States. Eleven of these were LNG facilities. The results of the study concluded that the presence of five of the eight types of "noxious" facilities have a significantly negative effect on property values and a positive effect on wages. However, the study concluded that the presence of an LNG facility did not have a significant positive or negative effect on either wages or property values (Clark and Nieves, 1993).

A 2006 study examined local county assessment records for neighborhoods surrounding existing LNG "peak storage" facilities in Newport and Portland, Oregon. The study found that property values around the Newport LNG plant are not depressed, and within 0.5 mile of the facility are about 25 homes with above average market value. Around the Portland LNG plant are many other industrial or commercial properties, and new businesses continue to move into the area. The study concluded that there is no evidence to support the concern that the presence of an LNG storage facility would reduce nearby property values (ECONorthwest, 2006).

4.8.2.4 Economy and Employment

Existing economic conditions in the areas where socioeconomic effects would occur due to construction of the LNG terminal are provided in table 4.8.2-3. Within these areas, average per capita income was slightly lower than the averages for Oregon and Washington ($20,940 and $22,973, respectively). In contrast, the per capita income for the Portland MSA was $23,321, which was slightly higher than average for the State of Oregon. In 2004, the unemployment rates for counties within the study area were similar to or slightly higher than state averages, ranging from 5.0 percent within Clatsop County to 8.0 percent in Puget Island.

TABLE 4.8.2-3

Existing Economic Conditions in the Areas Where Socioeconomic Effects Would Occur as a Result of Construction and Operation of the Bradwood Landing LNG Terminal and Natural Gas Sendout Pipeline

State/County/MSA	Per Capita Income (2000)	Civilian Labor Force (2000)	Unemployment Rate (percent) (2006)	Top Industries by Employment (2000)
Oregon	$20,940	1,740,298	5.4	Education, Health and Social Services (19.3%) Manufacturing (14.4%)
Clatsop County	$19,515	17,656	5.0	Education, Health and Social Services (19.2%) Arts, Entertainment, Recreation, Accommodation, and Food Services (15.7%)
Columbia County	$20,078	21,379	5.8	Manufacturing (22.1%) Education, Health and Social Services (15.8%)
Portland MSA	$23,321	1,089,000 [a]	5.1	Education, Health and Social Services (21.7%) Trade, Transportation, and Utilities (20.2%)
Washington	$22,973	2,979,824	5.0	Education, Health and Social Services (19.4%) Manufacturing (12.5%)
Wahkiakum County	$19,063	1,691	6.5	Education, Health and Social Services (24.6%) Agriculture, Forestry, Fishing and Hunting, and Mining (14.6%)
Puget Island	$22,444	374	8.0	Education, Health and Social Services (29.1%) Manufacturing (12.2%)

[a] U.S. Department of Labor, Bureau of Labor Statistics, 2005.

Sources: U.S. Department of Agriculture, Economic Research Service, 2004.
U.S. Census Bureau, 2000.
U.S. Department of Labor, Bureau of Labor Statistics, 2006.

As discussed in section 4.8.2.1, most of the labor force for construction of the LNG terminal is expected to come from the four-county area or from the Portland MSA. NorthernStar anticipates that 10 or fewer specialty workers and managers may be hired from outside the study area for construction of the LNG terminal. Tables 4.8.2-4 and 4.8.2-5 list the estimated construction workforce for the LNG terminal and the counties of residence NorthernStar anticipates the workers to commute from, respectively.

TABLE 4.8.2-4

Estimated Construction Workforce for the LNG Terminal

Timeframe	Average Number of Workers per Month	Percent of Total Construction Workforce
Year 1	220	22.2%
Year 2	470	47.3%
Year 3	303	30.5%
Average Workforce	331	--
Peak Construction (months 20 - 26)	506	--

TABLE 4.8.2-5

Sources of Construction Workers for the LNG Terminal

Location	Average Number of Workers Commuting	Percent of Workers Commuting	Number of Workers Commuting During Peak Construction
Clatsop County	50	15	76
Portland MSA	248	75	380
Columbia County [a]	16	5	25
Washington	33	10	50
Total [b]	331	100	506

Note: Sum of addends may not be the same as the total due to rounding.

[a] Construction workers from Columbia County are also included in the Portland MSA; therefore, they are not included in the project total.

[b] LNG terminal total does not include up to 10 specialty workers and managers that may be hired from outside the study area.

Source: Columbia Pacific Building Trades Council, 2005.

NorthernStar estimates that an average of 331 workers would be employed during the 3-year LNG terminal construction period, with a peak workforce of 506 occurring between months 20 and 26. Approximately 75 percent of the construction workforce is expected to commute from the Portland MSA (5 percent of this total would reside in Columbia County). The remaining 25 percent is expected to commute from Clatsop County (15 percent) and Wahkiakum and Cowlitz Counties (10 percent). Workers are expected to commute to the project site daily, and would generally work four 10-hour days per week. The commute between Portland and the LNG terminal is about 80 miles. While this appears to be a long daily commute, sources indicate that compensation for commuting creates an incentive for workers to commute, rather than temporarily relocate (Columbia Pacific Building Trades Council, 2005).

Construction expenditures by NorthernStar would increase economic activity within the counties affected by the project, which would have a multiplier effect on the local economy. The notion of a multiplier effect rests upon the difference between the initial effect of a change, the actual expenditure by NorthernStar, and the total effects of that change. The total increase is calculated using the direct, indirect, and induced effects of the initial change. These effects are best described as:

- Direct Effects. The changes associated with the immediate change in final demand, such as the hiring of local construction workers and purchases of goods and services from local businesses.

- Indirect Effects. The production changes in backward-linked industries caused by the changing needs of the directly affected industries. For example, the additional purchases to address the increased demands for goods and services would be considered indirect effects.

- Induced Effects. The changes in household spending patterns caused by the changes in household income generated from the direct and indirect effects are induced effects.

To calculate this additional impact on the local economy, a data and software program called IMPLAN (IMpact analysis for PLANning) was used to generate multipliers for output (total impact), employee compensation (payroll (i.e., wages and benefits)), and employment. IMPLAN uses an input-output model that examines the relationships between and among industries and assigns values to these based on national, state, and regional data. The most recent data available for this model is from 2004. IMPLAN was originally developed by the FS, in cooperation with the FEMA and the BLM (Olson and Lindall, 1999).

IMPLAN allows the user to build economic models to estimate the impacts of economic changes. Database sources for IMPLAN data are primarily government sources. IMPLAN accounts closely follow the accounting conventions used in the "Input-Output Study of the U.S. Economy" by the BEA) and the rectangular format recommended by the United Nations. For data analysis and manipulation, IMPLAN uses a sectoring scheme that has 509 sectors. This sectoring scheme is based on the North American Industry Classification System (NAICS) and closely follows the 1997 BEA Benchmark Study for the United States. The IMPLAN sector used for the construction portion of this analysis was sector 41 - Other New Construction. This IMPLAN sector includes those activities associated with the main category of Heavy and Civil Engineering Construction (NAICS 237). For the operation portion IMPLAN sector 31 - Natural Gas Distribution was used. This correlates to NAICS sector 2212, which is also Natural Gas Distribution.

IMPLAN analysis focuses on two impacts: economic impact and employment impact. Also included is a discussion of increased payroll, which is part of the total economic impact. Economic impact is calculated for amounts spent directly in the four-county study area (Clatsop and Columbia Counties, Oregon and Wahkiakum and Cowlitz Counties, Washington).[22] Different percentages of the payroll and construction costs are expected to remain in the four-county area. For these reasons, payroll and construction costs are separated for calculation purposes. Expenditures for each category are estimated (direct impact) and the indirect and induced impacts are then calculated. Table 4.8.2-6 shows the estimated economic impact of construction of the LNG terminal.

TABLE 4.8.2-6

Economic Impacts of Construction of the LNG Terminal

		Four-county Area Impact (30 percent of estimated workforce)			
Project Component/Impact	Project Total	Direct Impacts	Output Multiplier [a] (approximate)	Indirect and Induced Effect	Total Four-county Impact
Economic Impact [b]	$600,000,000	$77,591,806	1.87	$68,453,351 [c]	$146,045,157 [c]
Payroll [d]	$87,959,035	$26,387,710	1.97	$25,596,079 [c]	$51,983,789 [c]
Employment [e]	331	99	1.83	82	181

[a] IMPLAN calculates the results of the multipliers based on a per million dollar change in final demand (total direct expenditures).
[b] Payroll and expenditures over 3-year LNG terminal construction period.
[c] Includes dollars spent by workers in the study area during construction.
[d] Payroll over 3-year LNG terminal construction period.
[e] Based on monthly averages.

[22] Although Pacific County could be affected during operation of the LNG terminal because it is located along the waterway, it is not expected to provide a source of workers for either construction or operation of the project and, therefore, was not included in the economic analysis.

Project-related employment and expenditures would have a direct and positive effect on employment and economy within the study area. Total construction costs for the LNG terminal are estimated to be $600 million. NorthernStar estimates that total payroll (which includes both wages and benefits) for the construction of the LNG terminal would be $88 million. Approximately $26.4 million of this would go toward payroll for construction workers from the four-county area with payroll averaging $8.8 million per year for the 3-year construction period. Payroll estimates for construction of the LNG terminal were based on published prevailing rates and do not reflect any negotiated rates that may apply. NorthernStar anticipates that approximately 30 percent of the workers employed for construction of the LNG terminal would commute from the four-county area and would spend their pay locally. Within the four-county area, NorthernStar estimates that total direct expenditures on goods, equipment, and services during construction of the LNG terminal would be $77.6 million.

During construction of the proposed LNG terminal, construction work would increase the second year and decrease during the third year of construction. Direct increases in local payroll during construction of the LNG terminal would be approximately $5.9 million during year 1, $12.5 million during year 2, and $8.1 million during year 3. Of this, 50 percent of these increases would go to workers in Clatsop County, 16 percent to Columbia County, and 34 percent to the Washington counties.

Operation of the Bradwood Landing Project would result in about 65 new permanent positions. In addition, tug operations necessary to support the LNG terminal would require about 40 employees. NorthernStar plans to hire and train local residents for operation of the facility. Based on the commuting patterns at Wauna Mill, which is located less than 3 miles south-southeast of the proposed LNG terminal, NorthernStar estimates that approximately 27 workers would come from Columbia County, 23 from Clatsop County, 12 from Cowlitz County, 2 from Wahkiakum County, and 1 from Clark or Pacific County. Table 4.8.2-7 shows the estimated annual impacts of operation for the project.

TABLE 4.8.2-7

Annual Economic Impacts of Operation of the LNG Terminal

		Four-county Area Impact (98 percent of estimated workforce)			
Impact	Project Total	Direct Impacts	Output Multiplier [a] (approximate)	Indirect and Induced Effect	Total Four-county Impact
Economic Impact (first year) (Includes payroll and expenditures)	$30,000,000	$15,900,000	1.28	$4,452,000	$20,352,000
Annual Payroll	$3,900,000	$3,900,000	1.61	$2,379,000	$6,279,000
Employment	65	65	2.74	113 [b]	178

[a] IMPLAN calculates the results of the multipliers based on per million dollar change in final demand (total direct expenditures).

[b] Does not include the approximately 40 persons required to operate tugs.

The estimated average salary for workers at the facility would be $60,000 per year. Including the direct and indirect impacts, based on the distribution of workers discussed above, there would be an estimated annual income of about $145,000 for workers from Wahkiakum County, $919,000 for workers from Cowlitz County, $1.7 million for workers from Clatsop County, and $2 million for workers in Columbia County. Most indirect and induced employment impacts would be full- and part-time employment in the service sector.

As a portion of the operations cost, NorthernStar would lease three tugs from businesses in the four-county area at an annual cost of $4 million. The IMPLAN multipliers used to calculate the impact of the LNG terminal are for the distribution of natural gas and do not capture the unique nature of an LNG

facility such as the impact of the tugs on the local economy. Therefore, the additional impact is not fully captured in the calculated impacts of operation. For example, a portion of the $4 million would be spent by the local companies to hire approximately 40 crew and support personnel to operate the tugs. This additional local impact on employment is not reflected in the IMPLAN payroll or employment numbers, and would most likely benefit Wahkiakum County since tugs are expected to be stationed across from the LNG terminal in Wahkiakum County.

4.8.2.5 Tax Revenues

Construction and operation of the Bradwood Landing LNG terminal would have beneficial impacts on property and corporate tax revenue in Clatsop County. The LNG terminal would significantly strengthen the property tax base for the local school district and other government services in the local community. Property tax, calculated on the assessed value of the property, would be collected by Clatsop County and distributed to special districts in the county. Any additional public needs in the surrounding counties would need to be covered through other revenue sources including grants. The Clatsop County Assessment and Taxation Department and the Oregon Department of Revenue indicated that the property would most likely be assessed at 100 percent of its market value, which is estimated at $600 million upon project completion (Solheim, 2005; Blacklock, 2005). It is anticipated that the LNG terminal would be located in Tax Code Districts 04-01 and 04-03. Based on the 2006-2007 tax rates for Tax Codes 04-01 and 04-03, NorthernStar would pay approximately $7.8 million in annual property taxes upon completion of the LNG terminal. Of this amount, $4.2 million would go to the Knappa School District. Based on current assessments, the total for all property tax revenue expected in Clatsop County in 2006-2007 is $6,543,300 (Clatsop County, 2007). Based on the current tax rates, property tax revenue for Clatsop County and special districts would increase by 119.2 percent upon completion of the LNG terminal.

The increased property tax base upon construction of the LNG terminal could place the Knappa School District in the situation of having tax revenues that would improve educational opportunities. In general, any shortfall in local tax revenues is funded by state government. The Oregon Department of Revenue requests all school districts to tax at their maximum rate. If they do not, they are penalized by lower funding levels from the state. Any excess beyond requirements can be kept by the school district, which would be the case for the Knappa School District.

Of importance to Knappa Schools is the effect on bond levy rates. Assuming a one-time increase in the Knappa School District's assessed property value when the LNG terminal comes on line, residents of the district may see a decrease in the bond levy rate from 2.45 to 0.61 by 2015 per $1,000 of assessed property value, according to estimates of the Investment Banker for the school district. The total tax rate for the Knappa School District would then be 5.2167 instead of 7.0567. This would result in total property taxes paid by NorthernStar of $6.0 million, $3.1 million of which would be collected due to the school district tax rate.

For the initial years of its operation, through approximately 2010, the project would have little or no state income tax liability because deductions for depreciation and amortization of investments and other expenditures are expected to exceed initial gross income. Beginning in 2011, NorthernStar projects that it would have annual taxable income from the operations in Oregon of about $75 million to $100 million. Based on current tax rates for corporations doing business in Oregon (6.6 percent), NorthernStar would have annual Oregon tax liability of about $5 million to $8 million beginning in 2011.

4.8.2.6 Local Infrastructure and Public Services

A range of public services are provided in the cities and counties in the vicinity of the proposed LNG terminal. Public services in the area include law enforcement and emergency services, schools, and utilities.

Table 4.8.1-4 provides an overview of existing hospitals, ambulance services, fire departments and law enforcement in the areas where socioeconomic effects would occur due to the proposed project. Two hospitals are located in Clatsop County (Columbia Memorial Hospital and Providence Seaside), with a combined total of 105 beds. St. John's Hospital serves Cowlitz County, and residents of Columbia County are served by an outpatient clinic in St. Helens that is open Monday through Friday (Legacy Health Systems, 2006). Wahkiakum County owns the Wahkiakum Family Practice Clinic, which provides family practice care (Wahkiakum County Commission, 2005).

Fire protection at the LNG terminal would be provided by the Westport Wauna Fire District, which is located about 6 miles southeast of the site, and by the Knappa-Svensen-Burnside Rural Fire Protection District (RFPD), located about 10 miles west of the site. The ODF is an oversight agency for Rural Fire Protection Districts in Oregon, and is a responder to forest fires on private and state owned lands. The closest ODF fire fighting unit is located in Clatskanie, Oregon. Wahkiakum County does not currently have a staffed fire department; however, the county does have a volunteer fire protection service.

The Clatsop County Sheriff's Office would be the primary law enforcement agency responsible for the LNG terminal. In 2005, the Clatsop County Sheriff's Office employed 60 officers and had 29 patrol vehicles. Upon completion of construction, NorthernStar would also employ its own security force, thereby reducing need for local public services.

We received comments during the scoping period regarding the current capacity of local public services to respond to an incident or fire at the LNG terminal. NorthernStar has indicated that trained personnel and fire fighting equipment would be maintained at the LNG terminal in the event of an emergency. The Coast Guard has determined that significant gaps exist in fire fighting capability for both shore and water side fire fighting response. In addition, both Clatsop County and the City of Clatskanie have filed requests, through the ODE, that FERC take into account gaps in local services that would need to be filled in order to ensure public safety, and properly respond to an accident or fire at the LNG terminal.

NorthernStar filed its first draft ERP on March 24, 2008. The ERP includes a cost-sharing plan that outlines how NorthernStar would fill resource gaps and supplement the first-responder capabilities of the local communities near its proposed LNG terminal. The ERP is discussed in more detail in section 4.11.6.

A total of 94 schools are located within the areas where socioeconomic effects would occur due to construction of the LNG terminal, with a total enrollment of about 33,300 students (School Tree, 2007). As discussed above, the LNG terminal would be located within the Knappa School District, which consists of one elementary school and one high school. Current enrollment in the Knappa School District is 603 students (School Tree, 2007). Because most workers would be expected to commute from their current residences, only a nominal increase in enrollment at the local public schools would occur as a result of the relocation of construction or operation workers and their families.

No utilities currently serve the site of the LNG terminal and none are available in the immediate vicinity. As a result, NorthernStar would construct an electrical substation, an on-site wastewater

treatment system, and a fire protection system. Power would be supplied by a new 115 kV power line connecting the Bradwood Landing LNG terminal and the existing PacifiCorp electric system. The use and purchase of power from PacifiCorp would not reduce supplies to other users in the local area. The wastewater treatment system is discussed in detail in section 4.3.1.3. The fire suppression system is discussed in section 2.8.1.3. Because the LNG terminal would have its own wastewater treatment, the project would not have an effect on any existing public wastewater treatment facilities. In addition water would be provided by an on-site well and the Columbia River, so no municipal water supply would be necessary.

Fire and other emergencies at the proposed LNG terminal could require the services of local fire departments and emergency response units, as discussed above. Other than the services of local first responders, we do not believe that construction and operation of the LNG terminal would have any other adverse impacts on local infrastructure and public services. The vast majority of the workers at the terminal would commute from within a radius of about 80 miles. As current residents of the region, these workers are already part of the local tax base, and would be accounted for in the provision of local infrastructure and public services by nearby cities and counties. Because few non-local workers would relocate to the area for this project, only a small number of new students would need to be absorbed into the local school district.

4.8.2.7 Transportation and Traffic

Road Traffic

Construction of the Bradwood Landing LNG terminal could affect transportation and traffic in the project area by increasing the number of vehicle trips per day on area roads as a result of commuting and construction vehicle traffic. Construction workers traveling to and from the LNG terminal site could generate up to 1,500 vehicle trips per day (NorthernStar anticipates a peak workforce of up to 506 workers when construction of the LNG terminal is underway). Workers and construction traffic would largely access the LNG terminal via Oregon State Route 30, Clifton Road, and Bradwood Road. It is also possible that workers commuting from Cowlitz and Wahkiakum Counties could travel on Washington State Route 4 and take the Puget Island Ferry to reach the proposed LNG terminal.

Highway 30 is a two-lane, east-west highway that connects Astoria to Portland. Traffic counts completed by the ODOT in 2004 for Highway 30 near the proposed Bradwood Landing LNG terminal site were 6,600 average daily trips; however, traffic levels are higher during the summer tourist season (ODOT, 2004). An independent traffic impact analysis conducted in May 2006 by CTS Engineers, in consultation with the ODOT and Clatsop County, found 6,200 average daily trips over 2 days on Highway 30 at Clifton Road. The traffic count data revealed that the morning peak hour occurs between 6:00 and 7:00 AM and the evening peak hour occurs between 3:00 and 4:00 PM. Truck traffic (vehicles with three or more axles) accounted for about 19 percent of both daily and peak hour traffic volumes through the intersection (CTS Engineers, 2006).

Most of the construction workers would park in the construction parking area located southeast of the Taylorville interchange at Highway 30. From this parking area, the workers would be bussed to the LNG terminal site to the maximum extent possible. A smaller parking area would be provided at the proposed LNG terminal site.

During construction of the Bradwood Landing Project, NorthernStar anticipates an average of 30 trucks per day delivering construction equipment and supplies to the LNG terminal and along the pipeline route. However, during peak construction, up to about 80 trucks would make deliveries to the LNG terminal and along the proposed pipeline route. The increased traffic levels associated with construction

of the LNG terminal would be temporary and limited to the period of construction (about 3 years). To minimize additional impacts on traffic, NorthernStar would minimize trips to and from Bradwood, and would develop a traffic management plan. Some of the traffic minimization techniques proposed by NorthernStar include:

- Use of the railroad to bring in heavy loads of material. These materials include plate steel for the tanks, rebar, concrete, piping, structure steel, pilings, etc.
- An on-site rock quarry may be used for the production of concrete aggregate.
- Construction workers would park their vehicles at the construction parking area on Highway 30. Buses would then be used to move workers to the job site. In addition, NorthernStar has committed to establishing policies to encourage workers to use carpooling and vanpooling to further reduce the potential for traffic impacts.
- Delivery of materials by truck would be scheduled so as to not coincide with movement of the buses bringing construction workers to and from the site.

Following construction, the LNG terminal would operate 24 hours per day, 7 days per week. Peak site activity would vary throughout the day and week depending primarily on the schedule of LNG carrier arrivals. As discussed in section 4.8.2.4, the equivalent of 50 full-time staff would be employed to operate the facility and an additional 15 employees would provide security. The anticipated traffic volume resulting from operation of the LNG terminal, even during peak operation periods, would not significantly increase the existing traffic volumes on local area roadways. Traffic resulting from operation of the LNG terminal is expected to be fewer than 125 vehicle trips per day.

Clifton Road is an approximately 20-foot-wide paved road currently maintained by Clatsop County that intersects with Highway 30. The traffic impact analysis found that, currently, Clifton Road experiences fewer than 50 vehicles per day in this area.

Clifton Road is a two-lane road that is cut into the side of a slope for the most part, and in several places is too narrow for two large trucks to pass safely at normal speed. As the road travels north from Highway 30 and the parking area to Bradwood it loses several hundred feet of elevation. Clifton Road follows Hunt Creek towards Bradwood. To the west of the road the slope rises; to the east of the road the slope falls towards the creek. During the planning process for the Bradwood Landing Project, NorthernStar consulted with the ODOT and Clatsop County regarding modifications to Clifton Road to reduce impacts of traffic associated with the project. As a result of those consultations, prior to construction of the LNG terminal, Clifton Road would be widened to 28 feet, resulting in two 12-foot travel lanes with a 2-foot shoulder on each side of the road. An east-bound turning lane and a west-bound deceleration lane would be installed on Highway 30 at the intersection of Clifton Road. On April 14, 2008, the Clatsop County Board of Commissioners voted to approve variances for NorthernStar's use of Clifton Road (The Daily Astorian, 2008).

About 2.4 miles from Highway 30, Clifton Road intersects with Bradwood Road. After this intersection, Clifton Road continues northwest along the Columbia River to the Town of Clifton. Bradwood Road is currently a 1,150-foot-long gravel road that connects Clifton Road and the LNG terminal site. NorthernStar would widen Bradwood Road to 24 feet by clearing and grading the area directly adjacent to the existing road. Following clearing and grading, the road would be paved in order to accommodate the large trucks required for the project. Impacts on traffic are not anticipated as a result of planned improvements to or increased use of Bradwood Road because it is not currently used by the public.

The existing Hunt Creek Bridge, located on Bradwood Road, is not adequate to withstand the anticipated vehicle loads associated with construction of the project. Therefore, NorthernStar would replace the bridge with a new one built of four 75-feet-long, 3-feet-high, pre-cast concrete deck bulb T-girders. These would be supported on concrete-filled steel piles that would be placed above the MHHW elevation. See section 2.4.1.1 for additional details regarding the Hunt Creek Bridge replacement.

Ship Traffic

Many commercial and recreational vessels utilize the Columbia River. Annual ship traffic at the mouth of the Columbia River in recent years has been roughly 2,000 round-trips.

Dredging of the turning basin may interfere with commercial and recreational vessel use of the Columbia River. Because the temporary mooring of the dredge barges would occupy a relatively large portion of the channel throughout dredging operations, this equipment might present an obstruction to navigation. Transit and mooring of the dredge barges would be required to comply with applicable COE and Coast Guard regulations. In addition, dredging would only occur between November and January, when river use is lowest. Barges would not be used to bring supplies to the LNG terminal during construction.

Operation of the LNG terminal itself would not affect commercial or recreational uses of the Columbia River. None of the structures to be constructed as part of the ship berth would be located within the navigation channel. Navigational marking and operation of the structures would be conducted in accordance with applicable Coast Guard and COE regulations. Impacts on ship traffic associated with the arrival and departure of LNG carriers during operation of the proposed LNG terminal were previously discussed in section 4.8.1.7.

Train Traffic

One set of railroad tracks currently passes through the proposed Bradwood Landing LNG terminal. The PWRR historically connected Portland with Astoria. Although PWRR owns the tracks and appurtenances associated with the railroad, the underlying right-of-way and railroad bridges are owned by the ODOT. It may be possible for NorthernStar to use the rail line for delivery of materials by train during project construction.

Originally known as the Astoria and Columbia River Railroad and completed in 1898, the PWRR is discussed as an historic resource in section 4.9. Passenger train service through the terminal site was abandoned in 1952 due to low ridership.[23] Anecdotal information collected by NorthernStar indicates that, with the exception of the brief period described below, a train has not run through the terminal site since at least 1987. In fact, soil covered the railroad tracks for at least 12 years prior to the clearing of the tracks to allow the Lewis & Clark Explorer Train (LCET) to temporarily operate from 2003 to 2005. From 2003 to 2005, during the bicentennial celebration of the Lewis and Clark expedition, the LCET provided summer-only passenger train service between Portland and Astoria. The LCET was heavily subsidized, and the service was terminated in 2005 when the subsidy ended.

Since the termination of the LCET service, a train has not operated through the Bradwood Landing terminal site. There is currently no traffic on the railroad, and the PWRR has no plans to operate trains west of Wauna. In 2006, a segment of tracks were washed out west of Bradwood, approximately half-way to Astoria. The tracks have not yet been repaired, although the PWRR is in discussions with the local diking districts to repair the dikes and restore the tracks.

[23] http://www.nationalcorridors.org/df/df06022003.shtml

NorthernStar proposes to modify the railroad right-of-way owned by the ODOT. The modification would consist of rerouting the segment of the railroad tracks that runs through the proposed LNG terminal property up to 250 feet south of its present location.

In November 2005, NorthernStar, PWRR, and the ODOT agreed to enter into a Railroad Relocation Agreement. To date, the alignment of the planned relocation has been reviewed and accepted by the railroad management as consistent with their future plans. However, the agreement has not yet been finalized. Therefore, **we recommend that:**

- **NorthernStar should file a copy of the final Railroad Relocation Agreement with the Secretary <u>prior to LNG terminal construction</u>.**

As discussed in section 4.11.4, the proposed relocation of rail track routing would be within the thermal exclusion zone for the LNG tank impoundment area. Therefore, in response to our recommendation in the draft EIS, NorthernStar provided procedures for coordinating with the railroad company to ensure safe rail transit through the Bradwood Landing LNG terminal property.[24]

An upset condition could be an act of nature, such as an earthquake or severe storm; a fire at the terminal or surrounding site; or a hydrocarbon leak. Events that require an emergency response are not likely to occur, or would be very rare (with the exception of severe storms, which are still infrequent). Regardless of the unlikelihood of an upset condition at the facility, it is still necessary to have executable procedures in place for the notification of the railroad. These procedures would only be used if the PWRR resumes train service along the tracks through the proposed Bradwood Landing LNG terminal property.

Because only one set of railroad tracks runs through the Bradwood Landing property, the railroad may schedule future trains so that there is either an east bound train or a west bound train running at any one time. Railroads operate trains on a routine schedules. Therefore, if trains were to run through the LNG terminal property, NorthernStar would know the train schedule in advance, and be able to coordinate its response procedures with the PWRR.

The PWRR has a dispatch operator that is reachable by direct phone line 24 hours per day, 7 days per week. If there is an upset event at the terminal, NorthernStar would call the railroad dispatch operator, who would call the train engineer, and tell the engineer to stop the train short of the terminal until the all clear is given.

<u>Non-Emergency Operational Upsets</u>

In the event of non-emergency operational upsets, a notification shall be made to the PWRR providing the following information:

- Description of upset/activity: scheduled or unscheduled maintenance, equipment failure, etc.
- Location at facility of upset: wharf, control room building, etc.
- Anticipated duration: when will upset condition be remedied; when will routine operations commence?

[24] On October 15, 2007, NorthernStar filed its response to our recommended environmental condition 41 from the draft EIS. This document is available for viewing by the public through the FERC's internet webpage at www.ferc.gov using the elibrary link. Type in Docket no. CP06-365, and the appropriate date, and look up accession number 2007018-0212.

- Any safety issues: description of any issues that may result in an increase, or otherwise influence safety or railroad passage or track use.

- Change of status: any change to operational upset conditions or other information previously reported.

An initial notification to the PWRR would be made as part of the initial action to any facility emergency response. For non-emergency operational upset situations, NorthernStar would notify the PWRR dispatcher when conditions at the terminal return to normal and would include a final recommendation regarding the use of the railroad. The dispatcher would communicate the all clear to the train engineer.

Emergency Response Conditions

A number of emergency response events have specific response plans. These include:

- spill or release
- severe weather
- fire
- bomb threat
- earthquake
- terrorist incident
- LNG carrier response

In the event of an emergency response, an initial notification shall be made to the PWRR consisting of the following information:

- Description of upset/activity: LNG spill, fire, etc.

- Recommendation of immediate action by railroad: whether conditions and/or risks are such that a train should be stopped outside the terminal until the situation improves.

A follow-on notification shall be made providing the following clarifying information as it becomes available:

- Location at facility of emergency: wharf, control room building, etc.

- Anticipated duration of emergency: when will the emergency be remedied; when will terminal and/or Emergency Responders stand down from response operations?

- Any intermediate safety issues: description of any issues which may result in an increase, or otherwise influence safety, railroad passage, or track use; safety related information in addition to that provided in the initial notification.

Recovery actions from an emergency response condition depend on the nature, severity, and in some cases, the duration of the event. Emergency responses may be handled completely by Bradwood Landing terminal personnel or, for responses to events of significant magnitude, it may be appropriate to establish a Unified Command. In the case of a Unified Command structure for the response, the all clear communication to the PWRR dispatcher would be made jointly by the Unified Command and NorthernStar. The dispatcher would communicate the all clear to the train engineer.

4.8.2.8 Recreation and Tourism

Comments were received during scoping regarding the potential project-related impacts on local recreational activities and tourism. Developed recreational facilities near the LNG terminal include Erikson City Park, Strong Waterfront Park and Trail, Elochoman Slough Marina, and Skyline golf course in Cathlamet, about 2.5 miles to the north. Skamokawa Vista Park is located about 4.3 miles from the LNG terminal. We believe that because of this distance, these recreational facilities would not be adversely affected by the construction or operation of the LNG terminal. Recreational activities near the LNG terminal include use of the Columbia River by boaters, including users of the Lower Columbia River Water Trail, and use of public beaches along the river. These activities are discussed in detail in sections 4.7.1.4 and 4.7.2.6. The main impact the LNG terminal may have on recreational river users would be from dredging the maneuvering area adjacent to the navigation channel. Operation of the LNG terminal should not have any direct impacts on recreation, because this parcel is on privately owned land without public access. However, there could be indirect visual impacts on recreational users of the Columbia River, Clatsop State Forest, JHBNWR, the Elochoman Slough Marina, and Skamokawa Vista Park (see section 4.7.2.7).

There are no easily accessible data to measure the current status of tourism in the region that comprises the waterway, LNG terminal, and pipeline components of the Bradwood Landing Project. Tourist activities could include trips to the lower Columbia River and ocean beaches via Highway 30 in Oregon or Highway 4 in Washington, visits to local museums and historical sites, and attendance at local festivals held periodically at Cathlamet, Skamokawa, and Astoria. About 18 ocean-going cruise ships each year come up the Columbia River to dock at Astoria, 24 miles down river from the LNG terminal. In addition, several smaller river cruise vessels travel between Portland and Astoria. The impact of tourism on the local economy includes revenue generated by sales of supplies, food, and beverage services; recreational outfitters (such as the local kayaking companies); and lodging. NorthernStar calculated that the annual tourist industry generates about $361 million in travel spending in Clatsop and Columbia Counties, Oregon, and about $204 million in travel spending in Pacific, Wahkiakum, and Cowlitz Counties, Washington (see table 4.8.2-8).

TABLE 4.8.2-8

Direct Travel Impacts in the Vicinity of the Bradwood Landing Project

Area	Travel Spending ($ million)	Employee Earnings ($ million)	Employment
Oregon	7,367.2	1,793.9	87,590
Clatsop County	351.9	106.8	5,290
Columbia County	26.1	5.0	370
Washington	12,701	3,833	143,660
Cowlitz County	112.8	27.6	1,630
Pacific County	104.0	28.8	2,080
Wahkiakum County	3.1	0.9	60

Sources: Dean Runyan Associates, 2007.
State of Washington, Department of Community, Trade, and Economic Development, 2006.

The operation of the Bradwood LNG terminal would not displace or remove any existing businesses. The closest businesses to the LNG terminal are the Columbia River Front Farm House and Columbia River Front Lodge, which both serve as vacation rental homes, located immediately across the Columbia River on Puget Island at CRM 39. There are at least three other bed and breakfast type accommodations on Puget Island (Redfern Farm, Rog's Retreat, and Columbia River Beach House). We believe that construction and operation of the LNG terminal would have no direct adverse affects on those

commercial establishments. Potential visual impacts on businesses in the vicinity of the LNG terminal are discussed in section 4.7.2.7.

One of the main potential impacts on tourism in the area would be project-related vehicle traffic. This was previously discussed in section 4.8.2.7. The impacts of LNG marine traffic on tourism related to use of the Columbia River was previously discussed in section 4.8.1.7.

4.8.2.9 Environmental Justice

Populations considered potentially affected for the environmental justice analysis due to the proposed LNG terminal include those communities occurring within the Zones of Concern associated with an LNG carrier while docked at the LNG terminal. Tables 4.8.2-9 and 4.8.2-10 describe the ethnic and racial composition and income distribution of these communities, respectively. Within these areas, there are no predominantly low-income or minority communities and the population of Native Americans is less than 2 percent of the total population. About 94 percent of the population of Puget Island is white non-Hispanic. Only 9.4 percent live below federal standards defining poverty. Similarly, 100 percent of the population of Clifton is white non-Hispanic and 14.4 percent live below the poverty line. Minorities comprise a smaller percentage of the population in both Puget Island and Clifton than the county average (6.6 and 6.9 percent, respectively). Poverty levels for both Puget Island and Clifton are slightly higher than Wahkiakum and Clatsop Counties (8.1 and 13.2 percent, respectively). However, based on the rural setting at the proposed LNG terminal site, neither low-income nor minority groups would be disproportionately affected by the project.

TABLE 4.8.2-9

Demographics in the Vicinity of the Bradwood Landing LNG Terminal [a]

State/County/Community	Total Population (2000)	Percent White	Percent Black or African American	Percent American Indian & Alaska Native	Percent Asian	Percent Native Hawaiian & Other Pacific Islander	Percent Other Race	Percent Hispanic or Latino – Any Race	Percent Minority
Oregon	3,421,399	86.5	1.6	1.3	2.9	0.2	7.5	8.0	13.5
Clatsop County	35,630	93.1	0.5	1.0	1.2	0.1	4.1	4.5	6.9
Clifton	33	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Washington	5,894,121	81.8	3.2	1.5	5.4	0.4	7.7	7.4	18.2
Wahkiakum County	3,824	93.4	0.3	1.6	0.5	<0.1	4.1	2.6	6.6
Cathlamet	565	94.1	0.5	1.6	0.8	0.0	3.0	0.5	5.9
Puget Island	798	94.1	0.3	1.7	0.2	0.0	3.7	2.5	5.9

[a] Populations considered potentially affected for the environmental justice analysis for the LNG terminal include those communities occurring within the Zones of Concern associated with an LNG carrier while docked at the LNG terminal.

Source: U.S. Census Bureau, Census 2000

4.8.3 Pipeline Facilities

Construction and operation of the proposed pipeline would occur in Clatsop and Columbia Counties, Oregon and Cowlitz County, Washington. In addition, due to the large construction workforce, socioeconomic effects relating to construction of the pipeline would extend into Wahkiakum County and the Portland MSA, where approximately 86 percent of the construction workforce for the proposed pipeline is expected to reside. Because Columbia County is within the Portland MSA, there is some duplication of data in the discussion below.

TABLE 4.8.2-10

Income Distribution in the Vicinity of the Bradwood Landing LNG Terminal [a]

State/County/Community	Total Population (2000)	Per Capita Income (1999)	Median Household Income (1999)	Percentage of Persons Below Poverty (1999)
Oregon	3,421,399	20,940	40,916	11.6
Clatsop County	35,630	19,515	36,301	13.2
Clifton	33	14,549	28,438	14.4
Washington	5,894,121	22,973	45,776	10.6
Wahkiakum County	3,824	19,063	39,444	8.1
Cathlamet	565	18,588	33,409	15.1
Puget Island	798	22,444	48,906	9.4

[a] Populations considered potentially affected for the environmental justice analysis for the LNG terminal include those communities occurring within the Zones of Concern associated with an LNG carrier while docked at the LNG terminal.

Source: U.S. Census Bureau, Census 2000

4.8.3.1 Population

The counties affected by the pipeline facilities vary widely in their population totals and densities (see table 4.8.2-1). No appreciable changes to the local population distribution or number are expected to occur as a result of the construction and operation of the proposed natural gas sendout pipeline. As described in section 4.8.2.1, NorthernStar indicated that the vast majority of its workers would reside within a radius of about 80 miles; however, NorthernStar has stated that some specialized out-of-state workers with previous pipeline construction experience may be employed for construction of the pipeline. For the purposes of this analysis, we have determined that the minimum number of specialized out-of-state workers required during construction of the proposed pipeline would be 10. Based on the average family size of 3.1 persons described in section 4.8.2.1, if 10 non-local workers are employed and bring their families, about 30 people would relocate to the area during construction of the proposed pipeline. We think the local population could easily absorb 30 more people without adverse effects.

4.8.3.2 Housing

Housing statistics for the counties affected by construction of the proposed pipeline are presented in table 4.8.2-2. Construction and operation of the pipeline facilities are not expected to affect housing in the study area. As discussed in section 4.8.2.1, NorthernStar would use mostly local workers. NorthernStar has estimated that as many as 30 people may temporarily relocate to the area as a result of the project. We think there is sufficient available housing to accommodate all non-local workers and their families.

4.8.3.3 Property Values

Comments were received during scoping regarding loss of income, use, and property value due to the proposed pipeline easements. The easements would give NorthernStar a right-of-way in which to construct, operate, and maintain the pipeline. In return, NorthernStar would compensate the landowner for use of the land. The easement agreement between NorthernStar and the landowner would specify compensation for damage to property during construction, loss of use during construction, and loss of renewable and nonrenewable or other resources. NorthernStar would seek to negotiate a mutually acceptable agreement. However, if the project is authorized by the FERC, that approval conveys with it the right of eminent domain under section 7h of the NGA. Therefore, if negotiations fail to produce an agreement, NorthernStar could initiate condemnation proceedings, and the value of the easement and the amounts for compensatory damages would be determined by the local district or state courts.

The impact a pipeline may have on the value of a tract of land depends on many factors, including the size of the tract, the values of adjacent properties, the presence of other utilities, the current value of the land, and the current land use. Subjective valuation is generally not considered in appraisals. This is not to say that the pipeline would not affect resale values. A potential purchaser of property may make a decision to purchase land based on his or her planned use, such as agricultural, future subdivision, or second home on the property in question. If the presence of a pipeline renders the planned use infeasible, it is possible that a potential purchaser would decide not to purchase the property. However, each potential purchaser has different criteria and differing capabilities to purchase land.

INGAA conducted a national case study to determine if the presence of a pipeline on a piece of property affected the property value or sales price of the property. The *INGAA Foundation Natural Gas Pipeline Impact Study* (INGAA, 2004) found that there was not a significant impact on the sales price of properties located along natural gas pipelines. It was further determined that neither the size of the pipeline (diameter) nor the product carried by a pipeline has any significant impact on sales price. Whatcom County, Washington also analyzed the impacts on property values associated with pipelines to determine the effect the Olympic pipeline explosion had on sales of real estate on or near the pipeline route. Its analysis determined that the explosion of the pipeline, which transported liquid petroleum fuel, had little effect on property values (Whatcom County, 2001).

4.8.3.4 Economy and Employment

The existing economic conditions in the pipeline project area are presented in table 4.8.2-3. As discussed in section 4.8.2.1, most of the labor force for construction of the pipeline facilities is expected to commute to the project area from within an 80-mile radius, including the Portland MSA. Tables 4.8.3-1 and 4.8.3-2 list the estimated construction workforce and the counties of residence that NorthernStar anticipates the workers to commute from, respectively.

TABLE 4.8.3-1

Estimated Construction Workforce for the Pipeline Facilities

Timeframe	Average Number of Workers per Month	Percent of Total Construction Workforce
HDD (months 1 - 8)	12	6.0%
Pipeline Construction (months 9 - 16)	133	74.5%
Peak Construction (month 13)	313	19.5%

TABLE 4.8.3-2

Sources of Construction Workers for the Pipeline Facilities

Location	Average Number of Workers Commuting	Percent of Workers Commuting	Number of Workers Commuting During Peak Construction
Clatsop County	3	2	6
Portland MSA	114	86	269
Columbia County [a]	8	6	19
Cowlitz County	13	10	31
Wahkiakum County	3	2	6
Pipeline Total [b]	133	100	313

Note: Sum of addends may not be the same as the total due to rounding.
[a] Construction workers from Columbia County are also included in the Portland MSA; therefore, they are not included in the project total.
[b] Pipeline total does not include specialty workers that may be hired from outside the study area.
Source: Columbia Pacific Building Trades Council, 2005.

NorthernStar estimates that 313 workers would be employed during peak construction of the pipeline, occurring during month 13 of pipeline construction. Approximately 86 percent of the construction workforce for the pipeline is expected to commute from the Portland MSA, including Columbia County. The remainder would commute from Cowlitz County (10 percent), Clatsop County (2 percent), and Wahkiakum County (2 percent). Workers are expected to commute to the project site daily and would generally work four 10-hour days per week.

Construction expenditures by NorthernStar would increase economic activity within the counties affected by the project, which would have a multiplier effect on the local economy (see section 4.8.2.4). Table 4.8.3-3 shows the estimated economic impact of construction of the pipeline facilities.

TABLE 4.8.3-3

Economic Impacts of Construction of the Pipeline Facilities

		Four-county Area Impact (30 percent of estimated workforce)			
Impact	Project Total	Direct Impacts	Output Multiplier [a] (approximate)	Indirect and Induced Effect	Total Four-county Impact
Economic Impact [b]	$126,000,000	$10,320,000	1.82	$8,542,200	$18,862,200
Payroll [c]	$22,000,000	$4,400,000	1.64	$2,816,000	$7,216,000
Employment [d]	133	27	1.72	36	73

[a] IMPLAN calculates the results of the multipliers based on a per million dollar change in final demand (total direct expenditures).
[b] Payroll and expenditures over 16-month pipeline construction period.
[c] Payroll over 16-month pipeline construction period.
[d] Based on monthly averages.

Project-related employment and expenditures would have a direct and positive effect on employment and economy within the study area. Total construction costs for the pipeline facilities are estimated to be $126 million. NorthernStar estimates that total payroll (which includes both wages and benefits) for the construction of the pipeline facilities would be $22 million. Within the four-county area, NorthernStar estimates that total direct expenditures on goods, equipment, and services during construction of the pipeline facilities would be $10.3 million.

NorthernStar anticipates that the first 8 months of pipeline construction would be required to complete the HDDs. The following 8 months would be required to complete the rest of the pipeline. The average local monthly payroll during pipeline construction would be about $550,000. Based on NorthernStar's estimates for where workers would reside, the average payroll dollars per month generated by workers would be $275,000 in Cowlitz County, $165,000 in Columbia County, and about $55,000 per month in both Wahkiakum and Clatsop Counties.

4.8.3.5 Tax Revenues

Construction and operation of the Bradwood Landing Project would have beneficial impacts on property and corporate tax revenue in the counties affected by the project. Property taxes on the pipeline would be assessed by and paid to Clatsop and Columbia Counties in Oregon and Cowlitz County in Washington. Property taxes for a piece of property are generally based on the actual use of the land. Pipeline construction would not change the general land use, but future construction of aboveground structures on the permanent right-of-way would be precluded. Based on the portion of the pipeline in each of the counties and tax rates from the different taxing entities, the apportioned amounts of the property taxes paid would be approximately $284,029 to Clatsop County, $518,465 to Columbia County,

and $740,250 to Cowlitz County. NorthernStar has estimated that total pipeline property taxes would be $1,542,744.

In addition to the state taxes described above, Washington municipal taxes may apply. Cities and towns in Washington are allowed to impose local Public Utilities and Business and Occupation Taxes. For example, the City of Longview, which is the principal city in Cowlitz County, imposes a Public Utilities Tax of 6 percent of gross receipts on any company in the business of "furnishing or distributing natural gas." It is not clear whether merely transporting natural gas is subject to tax. Longview also imposes a Business and Occupation tax at the rate of 0.2 percent on service businesses. This tax apparently would apply if the city's Public Utilities Tax does not apply. Applying today's rates, NorthernStar estimates that its local tax liability may range between $30,000 and $1,200,000, depending on which tax applies. This liability may be less, and possibly zero, if NorthernStar's gross receipts from gas transportation activities are apportionable outside any city limits.

4.8.3.6 Local Infrastructure and Public Services

As discussed in section 4.8.2.6, a range of public services are provided in the cities and counties in the vicinity of the LNG terminal, which also includes the area of the pipeline. Table 4.8.1-4 provides an overview of existing hospitals, ambulance services, fire departments and law enforcement in the vicinity of the proposed project, including the pipeline. A discussion of the potential impacts of the proposed project on local hospitals, ambulance services, utilities, and schools is provided in section 4.8.2.6. A discussion of potential impacts on local fire protection districts and law enforcement agencies is provided below.

Fire protection along the western portion of the pipeline route in Oregon would be provided by the Westport Wauna Fire District, Knappa-Svensen-Burnside RFPD in Clatsop County, and the Clatskanie RFPD in Columbia County, with support from the ODF for the rural fire protection districts. Along the eastern portion of the pipeline route in Washington the closest fire protection district is the Cowlitz County Fire Protection District No. 6, which serves the Longview area. Due to the largely rural setting through which the proposed pipeline would pass, law enforcement would be provided by the Clatsop County Sheriff's Office, Columbia County Sheriff's Department, and the Cowlitz County Sheriff's Office.

Fire and other emergencies along the proposed route could require the services of local fire departments and law enforcement agencies, as discussed above. Both Clatsop County and the City of Clatskanie, Oregon have commented about concerns that the project may result in a strain on current resources to provide fire protection in the case of an emergency involving the LNG terminal and associated pipeline.

NorthernStar filed its first draft ERP on March 24, 2008. The ERP includes a cost-sharing plan that outlines how NorthernStar would fill resource gaps and supplement the first-responder capabilities of the local communities near its proposed LNG terminal. The ERP is discussed in more detail in section 4.11.6.

In addition, as discussed in section 4.11.9, due to current safety regulations governing the construction design, monitoring, and operation of interstate natural gas pipelines, we believe the potential for an accident involving the sendout pipeline is very low. Therefore, we do not believe that construction and operation of the proposed pipeline would result in adverse impacts on local infrastructure and public services.

4.8.3.7 Transportation and Traffic

Construction of the pipeline facilities could affect transportation and traffic in the project area by increasing the number of vehicle trips per day on area roads as a result of commuting and construction vehicle traffic as well as temporarily closing some minor roads during pipeline construction. A map of the project area is included as figure 2.1-1.

As previously discussed, during construction of the Bradwood Landing Project, NorthernStar anticipates an average of 30 trucks per day delivering construction equipment and supplies to the LNG terminal and along the pipeline route. However, during peak construction, up to about 80 trucks would make deliveries to the LNG terminal and along the proposed pipeline route. NorthernStar is currently consulting with Clatsop County regarding impacts on traffic due to construction vehicle traffic along Clifton Road (see section 4.8.2.7).

Pipeline construction workers would park their vehicles at the construction parking area located southeast of the Taylorville interchange at Highway 30. Buses would then be used to move workers to the job site. In addition, NorthernStar has committed to establishing policies to encourage workers to use carpooling and vanpooling to further reduce the potential for traffic impacts.

Additional vehicle traffic would result from equipment or material deliveries into and out of the proposed pipe storage and contractor yards each day. NorthernStar would use existing public and private roads that intersect the right-of-way to obtain access during construction. Load limits on public roads would be observed to prevent damage to the road surface, road bed, culverts, and bridges. Access road modifications proposed by NorthernStar are limited to grading and the addition of gravel to prevent rutting. Upon completion of the pipeline facilities installation, previously existing roads that were used for access would be returned to original or better condition, or as otherwise requested by the landowner.

NorthernStar would apply for all permits necessary for road access and crossings, and would comply with all permit stipulations. Any special requirements due to traffic volumes and weight limitations would be addressed via this process. Additionally, NorthernStar would coordinate construction activities with jurisdictional highway authorities, emergency responders, school transportation departments, other local groups such as private homeowners associations, and individual homeowners to minimize traffic impacts associated with the construction of the pipeline. Traffic flow for general access, and in particular for emergency response, would be maintained along roads which are the sole access to homes and communities.

NorthernStar and all contractors associated with the project would comply with all posted speed limits, and would exercise good judgment with regard to safe speeds in potentially hazardous situations. Temporary speed limits may be required in work zones to assure safe passage for vehicles, and would be posted where necessary.

Traffic impacts associated with the pipeline construction would be localized and temporary. NorthernStar would video or photograph access roads and crossing locations prior to construction or utilization of the roadway to establish a record of the pre-existing condition. Any damages to roadways associated with the construction of the pipeline, including access, would be repaired to the pre-existing condition. During construction, roadways would be maintained in a passable condition utilizing temporary repairs if necessary.

Pipeline construction across major roads would be accomplished by boring or HDD under the roadbed. Boring requires temporary extra workspace on both sides of the crossing for excavating bore pits to the depth of the pipeline. The bore pits are typically located just outside of the road right-of-way limits; however, site-specific conditions such as the presence of structures or waterbodies may require the

bore pits and temporary extra workspace to be moved within the road right-of-way. Little or no disruption of traffic would occur at road crossings that are bored. Most smaller, unpaved roads and driveways would be open-cut, then restored to preconstruction conditions or better. If an open-cut crossing were to require extensive construction time, provisions would be made for temporary detours or other measures to allow for the safe flow of traffic during construction. Table 4.8.3-4 lists the roads and highways crossed by the pipeline route and NorthernStar's proposed crossing method.

These increased traffic levels associated with construction of the pipeline would be temporary and limited to the period of construction (about 16 months).

We received comments on the draft EIS regarding potential impacts on narrow roads that have been identified by NorthernStar as proposed access roads to be used during construction of the pipeline (e.g., Whitewater Road, in Cowlitz County, Washington). The commentor identified this as a 1.5-lane road with blind corners and no turnouts for passing traffic. It is possible that use of these types of roads would not be feasible without some additional improvements (e.g., widening) to accommodate the large trucks and vehicles that would be required during construction. In addition, the ODOT, in its comments on the draft EIS stated that it would need to reevaluate traffic impacts at the Clifton Road intersection after NorthernStar submits its road approach application. The ODOT identified preliminary mitigation measures that would be required, including construction of a left turn lane on Highway 30 at Clifton Road, widening the highway shoulder to accommodate right turning vehicles, and radii improvements. Therefore, **we recommend that:**

- **NorthernStar should consult with the ODOT, WDOT, and appropriate local agencies in the development of its final traffic management plan. The final traffic management plan should include the design for improvements along Highway 30 and Clifton Road, and measures to reduce impacts on narrow roads that would be used to access the construction right-of-way. <u>Prior to construction</u> of the LNG terminal and pipeline, NorthernStar should file with the Secretary its final traffic management plan, and documentation of consultations with the ODOT, WDOT, and local county government agencies, with the Secretary for the review and written approval of the Director of OEP.**

4.8.3.8 Recreation and Tourism

The Bradwood Landing pipeline would not directly affect any national, state, county, or local parks or designated recreation and public interest areas. The HDD under the Columbia River between MPs 19.0 and 19.8 should avoid impacts on the LCNHT and Lower Columbia River Water Trail, and islands in the Columbia River that form part of the JBHNWR. The Bradley State Scenic Viewpoint is located about 1,000 feet west of MP 1.7. There are parks and recreational facilities in the City of Clatskanie, about 2.5 miles south of the pipeline around MP 13.4, and in the Cities of Longview and Kelso, about 4 miles south of the pipeline in the vicinity of MP 34. These recreational and public use areas are discussed in section 4.7.3.6.

The primary potential impact on recreation and tourism in the area resulting from construction and operation of the pipeline would be project-related vehicle traffic. This was previously discussed in section 4.8.2.7. Visual impacts are addressed in section 4.7.3.7.

TABLE 4.8.3-4

Roads Crossed by the Bradwood Landing Pipeline Route

Road [a]	MP	State	County	Proposed Crossing Method [b]
Unnamed Road	0.4	OR	Clatsop	HDD
Unnamed Road	0.6	OR	Clatsop	HDD
Unnamed Road	0.7	OR	Clatsop	HDD
Unnamed Road	0.7	OR	Clatsop	HDD
Unnamed Road	2.1	OR	Clatsop	Open-cut
Unnamed Road	2.4	OR	Clatsop	Open-cut
Unnamed Road	3.0	OR	Clatsop	Open-cut
Unnamed Road	3.6	OR	Clatsop	HDD
Unnamed Road	3.7	OR	Clatsop	Open-cut
Unnamed Road	3.9	OR	Clatsop	Open-cut
Unnamed Road	4.7	OR	Clatsop	Open-cut
Unnamed Road	4.8	OR	Clatsop	Open-cut
Unnamed Road	5.7	OR	Clatsop	Open-cut
River Ranch Lane	6.0	OR	Clatsop	Bore
Unnamed Road	6.6	OR	Columbia	Open-cut
Unnamed Road	7.5	OR	Columbia	Open-cut
Unnamed Road	7.8	OR	Columbia	Open-cut
Unnamed Road	8.1	OR	Columbia	Open-cut
Unnamed Road	8.3	OR	Columbia	Open-cut
Unnamed Road	8.4	OR	Columbia	Open-cut
Unnamed Road	8.5	OR	Columbia	HDD
Woodson Road	8.6	OR	Columbia	HDD
Webb District Road	10.0	OR	Columbia	HDD
Midland District Road	10.1	OR	Columbia	HDD
Unnamed Road	10.3	OR	Columbia	Open-cut
Unnamed Road	10.5	OR	Columbia	Open-cut
Unnamed Road	12.3	OR	Columbia	Open-cut
River Front Dike Road	13.2	OR	Columbia	HDD
Erickson Dike Road	13.3	OR	Columbia	HDD
Unnamed Road	13.4	OR	Columbia	Open-cut
Collins Road No. 2	14.2	OR	Columbia	Open-cut
Lewis Road	15.0	OR	Columbia	Open-cut
Unnamed Road	15.5	OR	Columbia	Open-cut
Collins Road No. 1	15.8	OR	Columbia	Open-cut
Hermo Road	16.9	OR	Columbia	Open-cut
Unnamed Road	17.2	OR	Columbia	Open-cut
Unnamed Road	17.4	OR	Columbia	Open-cut
Unnamed Road	17.7	OR	Columbia	Open-cut
Unnamed Road	18.3	OR	Columbia	Open-cut
Unnamed Road	18.8	OR	Columbia	Open-cut
Unnamed Road	18.9	OR	Columbia	Open-cut
Unnamed Road	19.0	OR	Columbia	HDD
WA State Highway 4	19.6	WA	Cowlitz	HDD
Whitewater Road (AKA Old Mill Creek Road)	19.6	WA	Cowlitz	HDD
Robertson Road	20.4	WA	Cowlitz	HDD
Abernathy Creek Road	21.1	WA	Cowlitz	HDD
McAdams Road	21.1	WA	Cowlitz	HDD
Bunker Hill Road	22.2	WA	Cowlitz	Open-cut

TABLE 4.8.3-4 (cont'd)

Roads Crossed by the Bradwood Landing Pipeline Route

Road [a]	MP	State	County	Proposed Crossing Method [b]
Unnamed Road	22.5	WA	Cowlitz	Open-cut
Germany Creek Road	22.9	WA	Cowlitz	Bore
Fall Creek Road	23.0	WA	Cowlitz	Open-cut
Unnamed Road	23.1	WA	Cowlitz	Open-cut
Unnamed Road	23.5	WA	Cowlitz	Open-cut
Unnamed Road	24.6	WA	Cowlitz	Open-cut
Unnamed Road	24.7	WA	Cowlitz	Open-cut
Unnamed Road	25.4	WA	Cowlitz	Open-cut
Eufaula Heights Road	26.3	WA	Cowlitz	Open-cut
Grasseth Poston Road	26.6	WA	Cowlitz	Open-cut
Carlon Loop Road	28.0	WA	Cowlitz	Bore
Coal Creek Road	28.0	WA	Cowlitz	Bore
Unnamed Road	28.6	WA	Cowlitz	Open-cut
Unnamed Road	28.7	WA	Cowlitz	Open-cut
Unnamed Road	28.7	WA	Cowlitz	Open-cut
Unnamed Road	28.9	WA	Cowlitz	Open-cut
Unnamed Road	28.9	WA	Cowlitz	Open-cut
Unnamed Road	29.2	WA	Cowlitz	Open-cut
Unnamed Road	29.2	WA	Cowlitz	Open-cut
Unnamed Road	29.4	WA	Cowlitz	Open-cut
Unnamed Road	29.5	WA	Cowlitz	Open-cut
Columbia Heights Road	31.7	WA	Cowlitz	Open-cut
Unnamed Road	31.9	WA	Cowlitz	Open-cut
Unnamed Road	32.7	WA	Cowlitz	Open-cut
Unnamed Road	32.7	WA	Cowlitz	Open-cut
Unnamed Road	32.7	WA	Cowlitz	Open-cut
Unnamed Road	32.8	WA	Cowlitz	Open-cut
Unnamed Road	32.8	WA	Cowlitz	Open-cut
Stoneyridge Road	33.2	WA	Cowlitz	Open-cut
Westside Highway	34.2	WA	Cowlitz	HDD
Unnamed Road	34.4	WA	Cowlitz	HDD
Unnamed Road	34.4	WA	Cowlitz	HDD
Unnamed Road	34.9	WA	Cowlitz	HDD
Unnamed Road	35.0	WA	Cowlitz	HDD
Unnamed Road	35.2	WA	Cowlitz	HDD
Interstate Highway 5 Service Road – Southbound	35.3	WA	Cowlitz	HDD
Interstate Highway 5 - Southbound	35.3	WA	Cowlitz	HDD
Interstate Highway 5 - Northbound	35.3	WA	Cowlitz	HDD
Interstate Highway 5 Service Road – Northbound	35.3	WA	Cowlitz	HDD
Unnamed Road	35.7	WA	Cowlitz	Open-cut
Unnamed Road	35.8	WA	Cowlitz	Open-cut
Unnamed Road	35.9	WA	Cowlitz	Open-cut
Unnamed Road	36.3	WA	Cowlitz	Open-cut

[a] Roads, railroads, utilities, and pipelines were digitized manually based on photo interpretation and available desktop data.

[b] The crossing methods were identified based on photo interpretations of the crossed features. The actual crossing methods used during construction may vary depending on the conditions and features of the roads and railroads and in accordance with applicable permits.

4.8.3.9 Environmental Justice

Tables 4.8.3-5 and 4.8.3-6 describe the ethnic and racial composition and income distribution of the counties and communities crossed by the pipeline route. There are no predominantly low-income or minority communities in the area surrounding the pipeline facilities. Therefore, these groups would not be disproportionately affected by the project.

TABLE 4.8.3-5

Demographics of Communities Crossed by Bradwood Landing Pipeline Route

State/County/Community	Total Population (2000)	Percent White	Percent Black or African American	Percent American Indian & Alaska Native	Percent Asian	Percent Native Hawaiian & Other Pacific Islander	Percent Other Race	Percent Hispanic or Latino – Any Race	Percent Minority
Oregon	3,421,399	86.5	1.6	1.3	2.9	0.2	7.5	8.0	13.5
Clatsop County	35,630	93.1	0.5	1.0	1.2	0.1	4.1	4.5	6.9
Wauna	2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Columbia County	43,560	94.4	0.2	1.3	0.6	0.1	3.4	2.5	5.6
Washington	5,894,121	81.8	3.2	1.5	5.4	0.4	7.7	7.4	18.2
Cowlitz County	92,948	91.8	0.5	1.5	1.3	0.1	4.8	4.6	8.2
Eufaula Heights	724	94.6	0.6	2.0	0.4	0.0	2.4	0.3	5.4

Source: U.S. Census Bureau, Census 2000

TABLE 4.8.3-6

Income Distribution of Communities Crossed by Bradwood Landing Pipeline Route

State/County/Community	Total Population (2000)	Per Capita Income (1999)	Median Household Income (1999)	Percentage of Persons Below Poverty (1999)
Oregon	3,421,399	20,940	40,916	11.6
Clatsop County	35,630	19,515	36,301	13.2
Wauna	2	14,549	28,438	14.4
Columbia County	43,560	20,078	45,797	9.1
Washington	5,894,121	22,973	45,776	10.6
Cowlitz County	92,948	18,583	39,797	13.9
Eufaula Heights	724	29,648	67,188	2.3

Source: U.S. Census Bureau, Census 2000

4.9 CULTURAL RESOURCES

Section 106 of the NHPA, as amended, requires that the FERC take into account the effects of its undertakings (including authorizations under sections 3 and 7 of the NGA) on properties listed on, or eligible for listing on, the NRHP, and to provide the ACHP an opportunity to comment on the undertaking. NorthernStar, as a non-federal party, is assisting the FERC in meeting its obligations under section 106 and the implementing regulations at 36 CFR 800.

The COE and Coast Guard also have responsibilities for considering effects of their undertakings on historic properties, under the NHPA. However, as lead federal agency for this project, the FERC will address compliance with the act jointly for all cooperating agencies in this EIS.

4.9.1 Results of Cultural Resources Overviews and Inventories

NorthernStar's cultural resources consultant (Historical Research Associates, Inc. (HRA)) conducted archival research and a site file search at both the Oregon and Washington SHPOs in June 2005. HRA met with the Oregon SHPO in July 2005 to discuss the proposed project. The Oregon SHPO indicated that a submerged survey of the proposed turning basin in the Columbia River for the LNG terminal was not necessary. In January 2006, HRA consulted with Washington SHPO about the area of potential effect (APE) for the pipeline. NorthernStar's cultural resources contactors (HRA and URS) have conducted inventories of portions of the APE that were accessible, and have submitted reports to the FERC and the SHPOs. The survey reports included overviews and the results of the inventories, which are discussed below.

4.9.1.1 Waterway for LNG Marine Traffic

In a letter dated November 24, 2006, we requested the opinion of the Washington SHPO about the potential for LNG marine traffic to affect historic properties along the waterway to the proposed Bradwood Landing LNG terminal. In response, the Washington SHPO, in a letter to the FERC dated November 27, 2006, requested a description and map of the APE for the LNG marine transit route.

In a January 4, 2007 data request, we asked NorthernStar to provide the Washington and Oregon SHPOs with maps and a narrative description of the APE for the LNG carrier transit route along the Columbia River from the sea buoy to the proposed Bradwood Landing LNG terminal, and consult with the SHPOs regarding the potential for LNG marine traffic to have any adverse effects on historic properties. In a January 16, 2007 filing, NorthernStar indicated that it would provide the requested data to the SHPOs in early February 2007 and expected to complete consultations on this issue by mid-April 2007. On March 13, 2007, we requested that NorthernStar address the potential impacts LNG marine traffic may have on historic properties along the waterway and within the Zones of Concern. NorthernStar responded to that request with a filing on May 10, 2007.

NorthernStar's May 10, 2007 filing identified 19 known shipwrecks within the Columbia River adjacent to the LNG marine traffic route in Oregon. In addition, 18 shipwrecks have been recorded along the Pacific Coast west of Fort Stevens State Park in Oregon overlapped by the Zones of Concern. One shipwreck, the Isabella, near Astoria, Oregon, is listed on the NRHP. The NRHP eligibility of the other shipwrecks is unknown. LNG marine traffic to the Bradwood Landing LNG terminal would have virtually no potential to impact any of those shipwrecks, because the shipwrecks are situated in shallow water outside of the currently maintained navigation channel, and an LNG carrier that loses steerage and strays away from the navigation channel would likely run aground before reaching the location of any of the shipwrecks.

The LCNHT follows the lower Columbia River to its mouth. While there are numerous campsites related to the 1804-1806 Lewis and Clark expedition along the lower Columbia River, none have been recorded as archaeological sites.

The LCNHP consists of 12 park sites near the mouth of the Columbia River, stretching from Long Beach, Washington to Cannon Beach, Oregon. Two elements of the LCNHP, Cape Disappointment State Park (including the Lewis and Clark Interpretive Center) in Washington, and Fort Stevens State Park in Oregon, would be overlapped by the Zones of Concern for LNG marine traffic in the waterway to the proposed Bradwood Landing LNG terminal. The other 10 elements of the LCNHP are outside of the Zones of Concerns and would not be affected by the project. LNG marine traffic in the waterway would have no adverse effects on the LCNHT and the LCNHP. Our reasons supporting this determination are explained below.

There are multiple sites listed on the NRHP along the shoreline of the Columbia River within the Zones of Concern in the state of Washington, including two historic districts. The Cape Disappointment Historic District was listed on the NRHP in 1975 and covers 18,000 acres. It includes eight structures, including the Cape Disappointment Lighthouse, originally completed in 1856, and the remnants of Fort Canby, a military installation established in 1875. The Skamokawa Historic District was listed on the NRHP in 1976, covers 8,000 acres, and includes 21 primary and 56 secondary structures. At Altoona, the Double-ended Columbia River Gillnet Boat was listed on the NRHP in 1978 as an individual structure. There are three NRHP-listed sites in Cathlamet: the Pioneer Cemetery (45WK58), Kimball-Butler House (45WK59), and Pioneer Church (45WK60).

There are also a number of NRHP-listed sites along the waterway and within the Zones of Concern in Oregon, including the Fort Stevens Military Reservation (35CLT85), added as an individual site in 1971. In Warrenton, the Daniel Knight Warren House is listed on the NRHP as a single dwelling. There are three NRHP Historic Districts in Astoria: the Astoria Downtown Historic District, listed on the NRHP in 1998, encompassing 540 acres and including 61 contributing buildings or structures and 64 non-contributing resources; the Uniontown-Alameda Historic District, listed in 1988, covering 754 acres and including 134 contributing elements and 82 non-contributing; and the Shively-McClure Historic District with 241 contributing and 171 non-contributing resources. Individual structures listed on the NRHP in Astoria include: the Astor Hotel, Astoria Column, Bartlett House, Cherry House, Old City Hall, County Courthouse, Old County Jail, Doughboy Apartments, Elks Building, Elmore Cannery, Elmore Salmon Cannery, Erickson-Larsen Ensemble Building, Erickson-Larsen House, Fire House No. 2, Ferguson House, Fisher House, three Flavel houses, Foard House, Fort Astoria, Gilbert House, two Grace Episcopal Churches, Gray House, Griffin House, Hobson House, Holmes House, Jualo-Palo House, Kinney Cannery, Leinenweber House, Liberty Theater, Lightship Columbia, Macklin House, Noonan-Norblad House, Page House, Post Office, Rovainen House, Seeborg House, Structure at 229 Alameda, Structure at 265 Alameda, Structure at 110 Washington, Svensen Blacksmith Shop, Union Fishermens Coop, Victory Monument, Wharf and Bonded Warehouse, Andrew Young House, and Benjamin Young House.

It is highly unlikely that LNG marine traffic in the waterway to the proposed Bradwood Landing could have any adverse effects on historic properties in the lower Columbia River or along its shoreline. About 125 LNG carriers per year would transit to the proposed terminal, which would represent an increase of about 7 percent in commercial vessel traffic on the Columbia River. In our opinion, use of an existing dredged navigation channel would have little potential to impact submerged historic properties within the navigation channel. In addition, we think the potential for effects on shoreline cultural resources along the LNG marine traffic route would be low. LNG marine traffic should not result in significant shoreline erosion affecting historic properties. Further discussions about LNG marine traffic, and potential shoreline erosion are provided elsewhere in this EIS.

Commentors on our draft EIS raised concerns about the potential for leaks from LNG carriers having impacts on historical parks and trails located along the waterway, and potential visual impacts on visitors to the parks. We discuss potential visual impacts on recreational resources from LNG marine traffic in the waterway in section 4.7.1.5. LNG carriers would be visible to users of the various elements of the LCNHP along the shore of the lower Columbia River for several minutes at a time. These carriers would represent only a minor increase to the current use of the river by commercial vessels.

As discussed in section 4.3.2.2, LNG carriers are double hulled, which would assure that fuel and oil are kept on board, and makes the potential for a fuel or oil spill unlikely. Furthermore, each LNG carrier would maintain a SOPEP as required by international convention.

In the unlikely event of an LNG carrier incident that would result in an LNG spill and fire, effects would vary for different kinds of historic properties, depending upon their location within the different Zones of Concern. There would be less impacts on sites located in Zone 3 compared to sites located in Zone 1. Historic buildings could be affected by a pool fire, while a buried prehistoric site may not. However, a buried archaeological site may be affected by a fire-fighting response, such as the use of bulldozers to clear a fire break. Adverse effects from a project-related fire could be minimized by coordination with fire suppression agencies. NorthernStar indicated that it would produce a Cultural Resources Management Plan that would outline procedures for coordination with first responders in order to protect historic properties in such situations. With the implementation of NorthernStar's proposed safety and security measures and the conditions outlined in the Coast Guard WSR, the possibility of an LNG spill and associated pool fire from an LNG carrier en route to the terminal is very low, and impacts on historic properties along the waterway or within the Zones of Concern would be less than significant.

4.9.1.2 LNG Terminal

A portion of the LCNHT follows the lower Columbia River. The Lewis and Clark expedition camped on November 6, 1805 in the vicinity of Cape Horn, opposite of Puget Island, in modern Wahkiakum County, Washington, toward the end of their journey westward to the Pacific Ocean. The next day they proceeded by canoe, with a local Native American guide, down the north side of the Columbia River, and camped on November 7, 1805 west of Jim Crow Point, opposite of Pillar Rock, in Wahkiakum County, Washington. The Lewis and Clark expedition spent the winter of 1805-1806 at Fort Clatsop, west of modern Astoria, Oregon, and in March of 1806 began their return journey up the Columbia River eastward. Taking their canoes along the south side of the river, they camped on March 23, 1806 just below the mouth of John Day River in Clatsop County, Oregon. On March 24, 1806, they camped at Aldrich Point, Clatsop County, Oregon, and on March 25, 1806, they camped just below the mouth of the Clatskanie River in Columbia County, Oregon (Moulton, 2002). There are no known Lewis and Clark campsites at the Bradwood Landing LNG terminal location.

During their trip through the project area, Lewis and Clark identified the Native Americans near the mouth of the Columbia River on the north (Washington) side as members of the Wahkiakum Tribe, while the Native Americans on the south (Oregon) side were referred to as the Cathlamet Tribe. Modern ethnographers group both the Wahkiakum and Cathlamet bands together within the Cathlamet linguistic division of the Lower Chinook Nation (Silverstein, 1990). Ray (1938) mapped an ethnohistoric Indian village at the mouth of Coal Creek in Cowlitz County, Washington, two villages in the vicinity of the modern town of Cathlamet, Washington, one on Tenasillahe Island, and one near modern Knappa, Oregon. Lewis and Clark noted an Indian cemetery, with the dead entombed in canoes raised above the ground, at the Cathlamet village in the vicinity of Knappa (Moulton, 2002). An archaeological site near Knappa has been recorded as 35CLT37 (also called Hlilusqahih or the Knappa Docks Site), and was listed on the NRHP in 1984. Also listed on the NRHP in 1984 was the Indian Point Site, recorded as 35CLT34, near Svensen, Oregon.

The LCNHT through the project area has not been officially documented or nominated for the NRHP. HRA considers the LCNHT to be potentially eligible for the NRHP. According to the NPS Trail Manager, the LCNHT in this area is not owned or maintained by the NPS, but rather should be managed by the agencies with jurisdiction over the waterway, including the COE and the ODSL (Bowden et al., 2006a).

In response to a comment on the draft EIS from the DOI, FERC staff contacted Dan Wiley, Chief of Integrated Resources Stewardship for the NPS in Omaha, Nebraska, to obtain his comments and concerns about the project prior to the production of this final EIS. Mr. Wiley stated that his main concern about potential project impacts on the LCNHT was that the locations of Lewis and Clark campsites derived from the historical literature may not be correct. However, he indicated that there have been no comprehensive surveys of the LCNHT along the lower Columbia River, or recent investigations by the NPS, or other scholars, to identify new potential locations for Lewis and Clark campsites in the project vicinity (Wiley, 2008)

The Bradwood Landing LNG terminal would have no adverse effects upon the LCNHT, because no physical remnants of the Lewis and Clark expedition have been recorded in the APE, and LNG marine traffic and NorthernStar's proposed dredging for the turning basin is similar to and consistent with current activities in the Columbia River. The Columbia River navigation channel is utilized by about 2,000 commercial ships traveling to upriver ports each year, and is dredged and maintained by the COE. HRA's cultural resources survey of the proposed LNG terminal tract found no archaeological sites that can be associated with the Lewis and Clark expedition. Moreover, the place where the main terminal facilities would be situated at Bradwood Landing is covered with fill from past river dredging; thus any potential archaeological sites pre-dating the twentieth century in this area would be deeply buried beneath the dredge piles.

As a result of its literature review and file search, HRA identified two previous cultural resources investigations that covered portions of the LNG terminal tract, and two other archaeological surveys nearby (one covering part of Tenasillahe Island and one covering a small area on Puget Island). None of these investigations recorded any cultural resources; although one report mentioned an unrecorded prehistoric site at the former townsite of Bradwood. The closest previously recorded site to the LNG terminal is a prehistoric midden, site 35CLT32, located about 2,674 feet northwest of the APE for the terminal, at the southern shore of Clifton Channel.

HRA speculated that there may be an unrecorded prehistoric site at the northeastern end of the parcel controlled by NorthernStar for its LNG terminal, adjacent to where an 1871 river chart showed the location of "Joe's Fishery." This was an historic fishing spot in the Columbia River, on the south side of Puget Island, named after Joe Falangus, a Greek fish buyer who settled at Clifton, Oregon (Helwig, 2000), a town located about 1 mile west of the Bradwood LNG terminal. HRA indicated that it could not find the exact location of the potential Joe's Fishery archaeological site because the construction of the railroad and an historic basalt mining operation may have modified the topography in the area of Hunts Mill Point.

The 1871 river chart labeled the point of Oregon shore adjacent to "Joe's Fishery" as "Hunts Mill Point." Through archival research, HRA identified the location of the historic Henry Hunt homesite and lumber mill, operated from about 1843 to 1852, along Hunt Creek within NorthernStar's LNG terminal property. However, the location of the Hunt mill has not yet been examined with an on-the-ground cultural resources survey, and this potential historic-archaeological site is currently unrecorded.

HRA also mentioned a lumber mill built by A.W. Clark and J.B. Robinson in 1910 and operated by the Oregon Timber and Lumber Company (OTLC). This mill was associated with a logging railroad

that the 1930 Metzger map showed going up along the west side of Hunt Creek from its mouth. The exact location of the OTLC mill has not yet been clearly identified; nor has it been recorded as an historic-archaeological site. The logging railroad has also not yet been recorded.

The Astoria and Columbia River Railroad (ACRR, now called the PWRR) was completed between Astoria and Goble, Oregon in 1898, and was acquired by the Northern Pacific Railroad in 1911 (Helwig, 2000). In the terminal area, historic maps show the rail stop of "Parsons," named after the 1895 landowner. HRA recorded the ACRR within the terminal property as an historic-archaeological site and evaluated the railroad as potentially eligible for the NRHP.

In August 2005, HRA conducted a walkover survey covering 28 acres at NorthernStar's LNG terminal property, with limited shovel testing. The survey recorded historic-archaeological site 35CLT88, which represents the remains of the historic townsite of Bradwood and the associated Bradley-Woodard lumber mill. The physical remains still extant at this site include dock pilings along the shore (representing the remains of the mill dock and logging railroad trestle to the mill); a concrete foundation (related to a mill); a mill pond; a concrete structure (possibly the vault at the former mill office); an open-air pole barn (built about 1985); and associated artifacts, including metal barrels, bottle glass, ceramic sherds, bricks, and concrete, lumber, and metal fragments. The majority of the site is covered with dredge material piles, deposited between 1966 and 2003.

Fred Bradley of Michigan began acquiring timber land in the project area around 1901, and in 1930 formed the Bradwood-Woodard Lumber Company in partnership with Walter Woodard of Cottage Grove, Oregon. They contracted with the COE to bring in dredged material from the Columbia River, on top of which they built a new mill at Parsons, which started operations in 1934, specializing in hemlock and silver fir. The old OTLC logging railroad along Hunt Creek was rebuilt and extended up the slopes of Nicolai Mountain to the south, and was ready for the first trains (using a Shay locomotive engine) to run by 1932. The logging railroad operated until the summer of 1938, and was conveyed on a trestle to a log dump at the river. After that, logs were trucked in, and dumped into the mill pond. The mill complex included a planing mill, chipping mill, wigwag burner and drying kilns, dry storage building, train maintenance building, powerhouse, and main office. Finished lumber was taken out by ships via the dock. West of the mill dock, the U.S. Navy built a pier and observation house in the early 1940s. In 1958, Pacific Power and Light ran a 12-kV electric power line into Bradwood and Clifton. At its peak, operating as the Columbia Hudson Lumber Company, the mill had about 170 employees (Helwig, 2000).

The company town of Bradwood was erected adjacent to the lumber mill by 1934. The town originally consisted of a Main Street lined by 23 homes. Additional buildings included a boarding house, about 13 bachelor's quarters, cookhouse, bathhouse, a nurse's/doctor's office, a union hall, a school (which operated from 1932 to 1942), and a company store, which also housed the post office. At the time of the mill's closing in 1962, there were 47 residences in the town of Bradwood.

A portion of the mill burned in a fire in 1965. Analysis of a 1966 aerial photograph showed only the planing mill, office, train maintenance shop, and another building visible north of the railroad. The logging railroad tracks and trestle had been removed. Most of the houses at the eastern end of Bradwood were still standing in 1966, but the bachelor houses and garages on the west end of town had been torn down. Only eight houses were observed in a 1978 aerial photograph, and the pier to the former Navy observation house had been removed by that date (AMEC, 2005). A former resident visiting Bradwood in 1983 found only the store and four houses, in various states of disrepair, remained. The mill complex was in ruins. The last five residents of Bradwood left in 1985. In 1998, the same visitor noted that all buildings were gone, and the townsite bulldozed (Helwig, 2000).

In 1946 Bradley-Woodard sold the mill to Don Buchanan and Associates, operating as the Bradwood Lumber Company. A year later it passed to the Columbia Hudson Lumber Company. A portion of the townsite was acquired in 1946 by Roy Leonard, the first plant manager and secretary for the Bradley-Woodard Company, and first Bradwood postmaster. The property was acquired by the Starker family in 1977, and then was transferred in 1987 to a partnership which included Kenneth Leahy, who became sole owner in 2001. The Bradwood site has been used to receive materials dredged from the Columbia River by the COE, with documented fill disposal events occurring in 1966 (274,000 cubic yards), 1973 (217,000 cubic yards), and 2002 (382,000 cubic yards). Mr. Leahy intended to sell the dredged material as masonry sand, and export it by rail, but testing of the material indicated it was not suitable for that purpose (AMEC, 2005).

HRA evaluated the Bradwood site as not eligible for the NRHP. NorthernStar provided a copy of its LNG terminal cultural resources survey report to the Oregon SHPO on February 9, 2006. A revised copy of this report (Bowden et al., 2006a) was filed with the FERC on November 16, 2006.

4.9.1.3 Pipeline Facilities

A literature and site file search conducted by HRA in June 2005 revealed that 27 previous archaeological investigations have been conducted within 0.5 mile of the proposed pipeline route. Eight sites have been previously recorded within 150 feet of the pipeline. A 1991 survey of the KB Pipeline, which would be paralleled by a portion of the NorthernStar pipeline, recorded no cultural resources.

The LCNHT follows the lower Columbia River, although the portion of the trail through the project area has not been documented or nominated to the NRHP. The NPS does not own or manage any lands associated with the LCNHT along the lower Columbia River. Ownership of the river is divided between the states of Oregon and Washington, with the shoreline in the project area mostly under private control. No Lewis and Clark campsites have been recorded along the pipeline route. The proposed pipeline would cross under the Columbia River using HDD methods between about MPs 19.0 and 19.6.

During their westward journey down the Columbia River, the Lewis and Clark expedition camped near the mouth of the Kalama River, in what is now Cowlitz County, Washington, on November 5, 1805, and camped near Cape Horn, Wahkiakum County, Washington, on November 6, 1805. In his journal, William Clark mentioned an abandoned Indian village on the north side of the Columbia River, just past the mouth of the Cowlitz River. The next day the expedition stopped briefly at a Wahkiakum Indian village of four houses, where they traded fish hooks for roots, some fish, three dogs, and two otter skins.

On the return trip east, up the Columbia River, the Lewis and Clark expedition camped near the mouth of the Clatskanie River in Columbia County, Oregon, on March 25, 1806. They wrote of visiting a Cathlamet fishing camp on Puget Island, and another Cathlamet camp near the mouth of the Clatskanie River. The next day they camped on an island (maybe Walker or Dibble Island) in the river near present-day Longview. On March 26, 1806, Lewis and Clark noted an "old village" opposite the lower end of what they called "Fannys Island" (probably Crims Island) in Columbia County, Oregon, where they met Cathlamet Indians, giving metals to their chiefs and receiving roots and fish in return (Moulton, 2002).

Meriwether Lewis, on March 27, 1806, indicated that the principal village of the "Skillutes" was located a few miles above the mouth of the Cowlitz River. In 1811, the fur trader Gabriel Franchere called them the "Kreluit" Indians (Franchere, 1854). Ray (1938) clarified that this was probably the Cowlitz tribe, and labeled this village "Mansela."

At Port Westward, archaeological investigations at site 35CO16 yielded numerous aboriginal artifacts and perhaps human remains. The fur trader Alexander Ross in 1811 mentioned "the great Whill Wetz village" was situated on the north side of the Columbia River at Oak Point (Ross, 1849). George Gibbs, who went down the Columbia River by steamboat as part of Issac Stevens' railroad survey expedition in 1853-1855, called this the village of Coonaic. HRA believes that NorthernStar's HDD under the Columbia River should avoid impacting site 35CO16.

HRA pointed out that the pipeline would pass near the Abernathy Cemetery, dating to 1866, including the graves of Alexander Abernathy, one of the first Euro-Americans to settle around Oak Point in the 1850s, and his family. The Abernathy Cemetery, containing about eight headstones, located on the former land claim of Alexander Abernathy, is surrounded by a white rail fence, and currently maintained by the local community (Taylor, 1964). It is illustrated on the USGS topographic quadrangle map at about MP 19.7. The cemetery, which has not yet been recorded as an archaeological site, should be avoided by NorthernStar's HDD under the Columbia River.

At about MP 3.9 the pipeline would cross the ACRR/PWRR, completed in 1898. HRA believes the ACRR is potentially eligible for the NRHP. However, it appears that the portion of the railroad crossed by the pipeline has not yet been recorded or specifically evaluated in terms of integrity. Adverse effects on the railroad would be avoided because the pipeline would be installed beneath the railroad through conventional bore methods.

HRA inspected a 200-foot-wide corridor along the pipeline route in locations where NorthernStar had obtained landowner permission. As of October 2006, about 25.2 miles of the proposed route had been surveyed for cultural resources. No new archaeological sites were recorded during this survey. HRA believes that the proposed Bradwood Landing pipeline should avoid or have no effect on previously identified or recorded sites 35CLT32, 35CO12, 35CO14, 45CW2, the Abernathy Cemetery, and the Bradwood Mill and Town (35CLT88). The project should have no adverse effects on the ACRR, LCNHT, and 35CO16. Previously recorded sites 35CO11 and 45CW124 still need to be evaluated because they are located within parcels which have not yet been surveyed. A revised survey report for the pipeline (Bowden, et al., 2006b) was filed with the FERC on November 16, 2006.

4.9.1.4 Ancillary Facilities

URS conducted a cultural resources inventory of the proposed power line to the LNG terminal, including an alternative power line route and an access road. In total about 82 acres were inspected, including a 100-foot-wide corridor along 1.6 miles for the originally proposed power line route, 1.5 miles for the new preferred alternative, and 3.5 miles along the proposed access road. URS identified seven isolated finds and one site during its power line surveys. All of the isolated finds are remains of historic tree stump springboard scars, recommended as not eligible for listing on the NRHP. The site is a segment of the historic route of U.S. Highway 30 (field designation PL8), originally constructed in about 1921 as a gravel road, paved in about 1930, and abandoned when a new road alignment was built in about 1956. URS believes the road segment it recorded in the APE is not eligible for the NRHP because it lacks integrity.

In addition, URS documented a cultural resources inventory of 5 acres at the intersection of modern Highway 30 and Clifton Road. No cultural resources were identified at this location. On August 21, 2006, NorthernStar filed a revised cultural resources inventory report (McDaniel and Kelly, 2006) covering the power line.

4.9.2 Unanticipated Discovery Plan

The cultural resources inventory report for the LNG terminal, filed February 22, 2006, included a Plan and Procedures for the Unanticipated Discovery of Cultural Resources and Human Remains (Discovery Plan). This plan addressed comments provided by the Oregon SHPO in a January 20, 2006 filing by the ODE on an earlier submitted draft Discovery Plan. A Discovery Plan was filed by NorthernStar for the pipeline on March 14, 2006. The Oregon SHPO requested a revision to the Discovery Plan in its April 4, 2006 review of NorthernStar's cultural resources reports. NorthernStar filed a revised Discovery Plan for the LNG terminal on August 21, 2006, and filed a revised Discovery Plan for the pipeline on November 6, 2006.

4.9.3 Native American Consultation

The FERC acknowledges that it has trust responsibilities to Indian tribes, and so, on July 23, 2003, it issued a "Policy Statement on Consultations with Indian Tribes in Commission Proceedings" in Order 635. That policy statement included the following key objectives:

- The Commission will endeavor to work with Indian tribes on a government-to-government basis, and will seek to address the effects of proposed projects on tribal rights and resources though consultations; and

- The Commission will assure that tribal resources and interests are considered whenever the Commission's actions or decisions have the potential to adversely affect Indian tribes or Indian trust resources.

Our NOI, issued September 13, 2005, described the proposed project, including use of the waterway for LNG marine traffic. The NOI was sent to Indian tribal government leaders and resource agencies, and other Native Americans who may have historically occupied or used the project area, may attach religious or cultural significance to sites in the region, or may be interested in potential project impacts on cultural resources. Copies of the NOI were mailed to the Northwest Regional Office of the U.S. Bureau of Indian Affairs (BIA), CRITFC, Northwest Indian Fisheries Commission, Affiliated Tribes of Northwest Indians, Oregon State Legislative Commission on Indian Services, Washington Governor's Office of Indian Affairs, Confederated Tribes of the Grand Ronde Reservation, Confederated Tribes of the Siletz Reservation, Confederated Tribes of the Warm Springs Reservation, Confederated Tribes of the Umatilla Reservation, Cowlitz Indian Tribe, Chinook Nation, Chehalis Confederated Tribes, Nisqually Tribe, Shoalwater Bay Tribe, Yakama Nation, and Nez Perce Tribe (see table 4.9.3-1). The NOI was also sent to both the Oregon and Washington SHPOs.

In response to our NOI, we received filed written comments about the project from the CRITFC and Nez Perce Tribe. The CRITFC and the Confederated Tribes of the Warm Springs Reservation requested direct consultations with the FERC, and staff made presentations about the project and FERC's review process to the CRITFC on November 17, 2005, and to the Warm Springs Tribal Council on January 24, 2006. Members of the Nez Perce Tribal Council were in attendance during our presentation to the CRITFC. In addition, representatives from the CRITFC and the Nez Perce Tribe attended interagency and public meetings held for this project.

TABLE 4.9.3-1

Native American Consultations for the Bradwood Landing Project

Indian Tribe/Native American Organizations Addressed in the FERC NOI issued September 13, 2005	Date Contacted by NorthernStar	Responses
BIA, Northwest Regional Office, Portland, OR	July 27, 2005 November 28, 2005	September 7, 2007 - commented to the FERC on the draft EIS.
Affiliated Tribes of Northwest Indians, Portland, OR	July 27, 2005 November 28, 2005	December 2, 2005 - Affiliated Tribes of Northwest Indians requested to be informed by NorthernStar of project review status and additional studies.
Oregon Legislative Commission on Indian Services, Salem, OR c/o Karen Quigley, Executive Director	July 27, 2005 November 28, 2005	November 23, 2005 - Commission on Indian Services requested that NorthernStar contact the Siletz and Grand Ronde Tribes.
Confederated Tribes of Grand Ronde, Grand Ronde, OR c/o Cheryle Kennedy, Tribal Chair; and Khani Shultz, Cultural Resources	July 27, 2005 November 28, 2005	August 26 and 30, 2005 – Grande Ronde Tribes requested copies of archaeological survey reports from NorthernStar and to be notified in the event of a discovery during construction.
Confederated Tribes of Siletz, Siletz, OR c/o Delores Pigsley, Tribal Chair; and Robert Kennta, Cultural Resources	July 27, 2005 November 28, 2005	No response documented.
Confederated Tribes of Warm Springs, Warm Springs, OR c/o Olney Patt, Tribal Chair; and Sally Bird, Cultural Resources	July 27, 2005 November 28, 2005	Warm Springs Tribes requested direct consultations with the FERC. January 24, 2006 - FERC staff made presentation to Warm Springs Tribal Council.
Washington Governor's Office of Indian Affairs, Olympia, WA	July 27, 2005 November 28, 2005	No response documented.
Cowlitz Indian Tribe, Longview, WA c/o John Barnett, Tribal Chair; and Mike Iyall, Natural Resources Director	July 27, 2005 November 28, 2005	October 17, 2006 – Cowlitz Indian Tribe wrote a letter to NorthernStar expressing tentative support for the Bradwood Landing Project. Requested that NorthernStar continue to consult with the tribe regarding potential impacts on ecological and cultural resources.
Chinook Nation, Chinook, WA c/o Gary Johnson, Chair	July 27, 2005 November 28, 2005	No response documented.
Chehalis Confederated Tribes, Oakville, WA c/o David Burnett, Tribal Chair	July 27, 2005 November 28, 2005	No response documented.
Nisqually Tribe, Olympia, WA c/o Dorian Sanchez, Tribal Chair	July 27, 2005 November 28, 2005	December 19, 2005 - Nisqually Tribe inquired of NorthernStar if project would be within their territory.
Shoalwater Bay Tribe, Tokeland, WA c/o Chalene Nelson, Tribal Chair	July 27, 2005 November 28, 2005	No response documented.
Yakama Nation, Toppenish, WA c/o Jerry Meninick, Tribal Chair	July 27, 2005 November 28, 205	No response documented.
Columbia River Inter-Tribal Fish Commission, Portland, OR c/o Olney Patt, Executive Director; and Rob Lothrop	July 27, 2005 November 28, 2005	July 14 and October 17, 2005 - CRITFC sent written comments to the FERC. August 8 and October 26, 2005, and January 25 and September 13, 2006 - CRITFC staff attended interagency and public project meetings. November 17, 2005 - FERC staff made presentation to CRITFC. December 21, 2007 – commented to the FERC on the draft EIS
Northwest Indian Fisheries Commission, Olympia, WA	July 27, 2005 November 28, 2005	No response documented.

TABLE 4.9.3-1 (cont'd)

Native American Consultations for the Bradwood Landing Project

Indian Tribe/Native American Organizations Addressed in the FERC NOI issued September 13, 2005	Date Contacted by NorthernStar	Responses
Confederated Tribes of the Umatilla Reservation, Pendleton, WA c/o Antone Minthorn, Tribal Chair; and Carl Merkle, Natural Resources		No response documented.
Nez Perce Tribe, Lapwai, ID c/o Rebecca Miles, Tribal Chair; and Ryan Sedberry, attorney		October 17, 2005 - Nez Perce Tribe sent written comments to the FERC. November 17, 2005 - members of Nez Perce Tribal Council attended presentation by FERC staff to CRITFC. January 25 and September 13, 2006 – tribal representatives attended interagency meetings. December 21, 2007 - commented to the FERC on draft EIS.

The Nez Perce Tribe commented on our draft EIS in a letter to the FERC dated December 21, 2007. Among other issues, the tribe requested continued consultations with the FERC, receipt of notices, and invitations to meetings. In a March 12, 2008 email to the FERC's third-party environmental contractor (NRG), an attorney for the Nez Perce Tribe requested that the tribe be invited to the next meeting between the FERC and the NMFS to discuss revisions to the BA and EFH assessment. As an intervenor, the Nez Perce Tribe already receives all notices issued by the FERC for this proceeding. At this time, no additional meetings are planned between the FERC staff and the NMFS. In a February 7, 2008 telephone call between staff and an attorney representing the Nez Perce Tribe, we requested that the tribe provide more specific information about what it wants in terms of the nature of future consultations.

Both the CRITFC and Nez Perce Tribe expressed concern that the project could affect fishery resources protected by tribal treaty rights. In addition, the Nez Perce Tribe raised concerns about the project-related impacts on the lower Columbia River estuary caused by dredging and other activities. This EIS discusses potential impacts on water resources in section 4.3.2, aquatic resources in section 4.5, and federally-listed threatened and endangered salmon species in section 4.6. Indian treaty fishing rights are discussed in section 4.8.1.7.

In letters dated July 27 and November 28, 2005, NorthernStar provided information about the project to Indian tribes and Native American organizations that may have an interest in potential project impacts on cultural resources. The letters were sent to the BIA, Oregon Legislative Commission on Indian Services, Washington Governor's Office of Indian Affairs, CRITFC, Northwest Indian Fisheries Commission, Affiliated Tribes of Northwest Indians, Confederated Tribes of Grand Ronde, Confederated Tribes of Siletz, Confederated Tribes of Warm Springs, Cowlitz Indian Tribe, Chehalis Confederated Tribes, Nisqually Tribe, Shoalwater Bay Tribe, Yakama Nation, and Chinook Tribe.

In response to NorthernStar's consultation program, the Oregon Legislative Commission on Indian Services emailed HRA, NorthernStar's cultural resources contractor, to indicate that the Confederated Tribes of Grand Ronde and Confederated Tribes of Siletz should be contacted about this project. The Confederated Tribes of Grand Ronde requested that HRA provide the tribe with copies of the results of the cultural resources inventories, and the tribe should be contacted if any native archaeological materials are discovered. The Nisqually Tribe contacted HRA to inquire if the project would cross its traditional territory. The Affiliated Tribes of Northwest Indians contacted HRA to obtain more information about the status of the archaeological survey along the pipeline route. In a letter to NorthernStar, dated October 17, 2006, the Cowlitz Indian Tribe expressed tentative support for the project, but requested that NorthernStar continue to consult with the tribe regarding potential impacts on ecological and cultural resources.

Table 4.9.3-1 summarizes consultations with Native Americans. In addition, the FERC provided copies of the draft EIS to Indian tribes and other Native American organizations listed in Appendix A. No traditional cultural properties were identified within the APE by HRA, the SHPOs, Indian tribes, or other Native American organization.

Since the production of the draft EIS for this project, NorthernStar has not documented any additional consultations with Indian tribes. Nor has it documented that it sent copies of the requested cultural resources reports to the Confederated Tribes of Grande Ronde or other interested tribes. Therefore, **we recommend that:**

- **<u>Prior to construction</u> of the LNG terminal and pipeline, NorthernStar should file with the Secretary:**

  a. **documentation that it re-initiated consultations with all Indian tribes listed on table 4.9.3-1 of the final EIS, and copies of correspondence to and from Indian tribes that expressed interest in its project after the issuance of the draft EIS (in August 2007); and**

  b. **documentation that it provided copies of revised reports of cultural resources investigations to all Indian tribes that have expressed an interest in the project, including the Confederated Tribes of the Grande Ronde Reservation, and copies of any comments the tribes may have on those reports.**

4.9.4 Compliance with the NHPA

We have fulfilled our obligations to address compliance with the Native American Religious Freedom Act, section 101(d)(6) of the NHPA, and 36 CFR 800.2(c)(2). At our request, NorthernStar documented consultations with Indian tribes and appropriate Native American groups that might have an interest in the project. Through our NOI, we contacted Indian tribes that may have historically occupied or used the project area and might attach religious or cultural significance to historic properties in the APE. No tribe identified any traditional cultural properties which may be affected by the project. Nor were any religious, cultural, or sacred sites that may be affected by the project identified by NorthernStar's cultural resources consultant (HRA), or by the SHPOs.

Under the ACHP's regulations for implementing section 106 of the NHPA, the federal agencies consult with the appropriate SHPOs, identify historic properties, and make determinations of project effects. In a letter dated April 4, 2006, the Oregon SHPO commented on the first draft archaeological survey reports submitted by NorthernStar. The Oregon SHPO agreed with HRA that the project would likely not have an adverse effect on either the LCNHT or the ACRR. We concur.

The Oregon SHPO requested that the draft cultural resources reports be revised to address specific comments. In data requests dated February 9, March 7, and June 30, 2006, the FERC staff also requested revisions to the draft survey reports. NorthernStar filed revised inventory reports on August 21 and November 16, 2006, to address staff and SHPO comments.

In a letter addressed to NorthernStar, dated November 22, 2006, the Oregon SHPO commented on the revised cultural resources survey reports. The Oregon SHPO believes effects on previously recorded site 35CO16 are undefined until additional details about the HDD under the Columbia River are provided. Nor can project effects on the historic Hunt Mill be determined until after NorthernStar provides the results of an archaeological investigation of the old mill location. Lastly, the SHPO questioned the evaluation of the mill town of Bradwood, and requested additional data to support HRA's site assessment.

The Washington SHPO commented on HRA's pipeline survey report in a letter to the FERC dated November 27, 2006. The Washington SHPO requested certain changes to the report, and a plan for future actions, including a schedule for future surveys.

We have not yet completed the process of complying with section 106 of the NHPA for NorthernStar's proposed facilities. Cultural resources surveys for the entire proposed pipeline route and associated ancillary facilities have not been completed because landowner permission has not been

obtained for all parcels. Once cultural resources surveys and evaluations are complete, the FERC, in consultations with the cooperating agencies and the Oregon and Washington SHPOs, will make determinations of NRHP eligibility and project effects. If any historic properties would be affected by the proposed project, we would seek ways to resolve adverse effects.

To ensure that the Commission's responsibilities under the NHPA and its implementing regulations are met, **we recommend that:**

- **NorthernStar should defer construction and use of its proposed facilities, including related ancillary areas for staging, storage, temporary work areas, and new or to-be-improved access roads <u>until</u>:**

  a. NorthernStar files with the Secretary all additional required cultural resources survey and evaluation reports, any necessary treatment/avoidance plans, and a cultural resources management plan;

  b. NorthernStar files with the Secretary comments of the Oregon and Washington SHPOs on all cultural resources investigation reports and plans;

  c. the ACHP has been given an opportunity to comment, if any historic properties would be adversely affected by the project; and

  d. the Director of OEP reviews and approves all cultural resources investigation reports and plans, and notifies NorthernStar in writing that treatment plans/mitigation measures may be implemented or construction may proceed.

  All material filed with the Commission containing location, character, and ownership information about cultural resources must have the cover and any relevant pages therein clearly labeled in bold lettering: "CONTAINS PRIVILEGED INFORMATION - DO NOT RELEASE."

4.10 AIR QUALITY AND NOISE

4.10.1 Air Quality

4.10.1.1 Waterway for LNG Marine Traffic

Climate

The proposed waterway for LNG marine traffic would extend from the territorial seas boundary, 12 nautical miles from shore, up the Columbia River to the proposed LNG terminal site at CRM 38. The proposed waterway is within the coastal Columbia River Valley climate region. The climate of the project area is characterized by mild temperatures throughout the year due to the influence of weather systems that have been moderated by traveling over the Pacific Ocean. The normal movement of air masses is from west to east. Rain and drizzle, with fog and low clouds, are frequent from the late fall to early summer months. Warmer, breezy periods with little precipitation are common in the summer and early fall months.

Local winds in the project area generally follow the course of the Columbia River due to terrain effects along the river valley. In the winter, wind speeds reach 20 miles per hour or more about 5 to 10 percent of the time. Visibility is diminished by fog to below 0.5 mile about 3 to 6 days per month. Ice forms occasionally on the river but is seldom heavy enough to affect navigation. Winds during the summer are typically light.

At the mouth of the river, advection fog is common during summer months, with radiation fog affecting the river overall during other months. Precipitation is very common.

Ambient Air Quality Standards

The proposed waterway for LNG marine traffic would pass through both Oregon and Washington. Ambient air quality standards for these states, as well as federal ambient air quality standards, are discussed below

National Ambient Air Quality Standards

The EPA has established National Ambient Air Quality Standards (NAAQS) for seven criteria pollutants: SO_2, CO, nitrogen dioxide (NO_2), ozone, particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and lead. The NAAQS were set at levels the EPA believed were necessary to protect human health (primary standards) and human welfare (secondary standards). The NAAQS along with the appropriate Significant Impact Levels (SIL) and relevant estimated background concentrations for the project area are listed in table 4.10.1-1. Most ambient background concentrations were provided by the ODEQ on January 4, 2006 (CO and NO_2) and March 8, 2006 (PM_{10} and SO_2). In addition, ambient background concentrations for ozone are based on monitoring data collected at Sauvie Island, Oregon.

State Ambient Air Quality Standards: Oregon

For most criteria pollutants, Oregon Ambient Air Quality Standards (OAAQS) are the same as federal NAAQS. However, Oregon has set more stringent standards for SO_2. The Oregon SO_2 standards (in ppm) and equivalent concentrations in $\mu g/m^3$ are shown in table 4.10.1-2.

TABLE 4.10.1-1

National Ambient Air Quality Standards

Air Pollutant	Averaging Period	Background Level	Primary Standard	Secondary Standard	Percent of Primary NAAQS	SIL for NAAQS
SO_2 ($\mu g/m^3$)	3-Hour [a]	65	NA	1,300	NA	25
	24-Hour [a]	30	365	NA	0.08	5
	Annual [b]	5	80	NA	0.06	1
CO ($\mu g/m^3$)	1-Hour [a]	2,000	40,000	NA	0.05	2,000
	8-Hour [a]	1,400	10,000	NA	0.14	500
NO_2 ($\mu g/m^3$)	Annual [b]	15	100	100	0.15	1
Ozone (ppm)	1-Hour [a]	0.077	0.12	0.12	0.64	NA
	8-Hour [c]	0.061	0.08	0.08	0.76	NA
PM_{10} ($\mu g/m^3$)	24-Hour [a]	30	150	150	0.20	5 (1.0 in Oregon)
	Annual [b]	15	50 [f]	50 [f]	0.31	1 (0.2 in Oregon)
$PM_{2.5}$ ($\mu g/m^3$)	24-Hour [d]	NA	35	35	NA	NA
	Annual [b]	NA	15	15	NA	NA
Lead [e]	NA	NA	NA	NA	NA	NA

[a] The second highest designation indicates that the concentration listed is representative of the second highest concentration measured at the monitoring station.
[b] The annual average concentration.
[c] The fourth highest designation indicates that the concentration listed is representative of the fourth highest concentration measured at the monitoring station.
[d] The 98th percentile 24-hour concentration.
[e] Lead is not monitored in Oregon or Washington.
[f] The historical annual PM_{10} NAAQS was revoked, effective December 18, 2006.
$\mu g/m^3$ micrograms per cubic meter

TABLE 4.10.1-2

Oregon SO_2 Ambient Air Quality Standards

Averaging Period	Oregon Standards	
	Ppm	Equivalent $\mu g/m^3$
1-Hour [a]	NA	NA
1-Hour [b]	NA	NA
3-Hour [a]	0.50	1,300
24-Hour [a]	0.10	260
Annual [a]	0.020	52

[a] Not to be exceeded more than once per calendar year.
[b] Not to be exceeded more than twice per 7-day period.

State Ambient Air Quality Standards: Washington

For most criteria pollutants, Washington Ambient Air Quality Standards (WAAQS) are the same as federal NAAQS. However, Washington has standards for total suspended particulates (TSP) and has set more stringent standards for SO_2. The Washington TSP and SO_2 standards (in ppm) and equivalent concentrations in $\mu g/m^3$ are shown in table 4.10.1-3.

TABLE 4.10.1-3

Washington TSP and SO_2 Ambient Air Quality Standards

	TSP Standards	SO_2 Standards	
Averaging Period	μg/m^3	ppm	Equivalent μg/m^3
1-Hour [a]	NA	0.40	NA
1-Hour [b]	NA	0.25	NA
3-Hour [a]	NA	NA	NA
24-Hour [a]	150	0.10	260
Annual [a]	60	0.020	52

[a] Not to be exceeded more than once per calendar year.
[b] Not to be exceeded more than twice per 7-day period.

Existing Air Quality

The counties along the proposed waterway for LNG marine traffic are Clatsop County in Oregon and Wahkiakum and Pacific Counties in Washington. These counties are currently designated as attainment or unclassifiable for all NAAQS criteria pollutants. Marine vessels are a primary source of air pollution, with a secondary contribution from nearby industrial facilities. Operation of the proposed project would result in additional marine vessel emissions from the arriving and departing LNG carriers as well as supporting tug boats and escort boats.

Air Quality Control Regions

Air Quality Control Regions (AQCR) were established by the EPA and local agencies, in accordance with section 107 of the CAA, as a means to implement the CAA and comply with the NAAQS through state implementation plans. The AQCRs are intra- and interstate regions such as large metropolitan areas where the improvement of the air quality in one portion of the AQCR requires emission reductions throughout the AQCR. The counties crossed by the project's marine traffic along the proposed waterway are Clatstop County, Oregon, which is in the Northwest Oregon Intrastate AQCR (40 CFR 81.249); Wahkiakum County, Washington, which is in the Portland Interstate AQCR (40 CFR 81.51); and Pacific County, Washington, which is in the Olympic-Northwest Washington Intrastate AQCR (40 CFR 81.187).

Regulatory Requirements for Air Quality

The entire LNG marine transit route is an attainment area and therefore not subject to a General Conformity determination. LNG carriers are mobile sources and thus not subject to permitting under the CAA.

Air Quality Impacts and Mitigation

LNG carriers are mobile sources that transit the Pacific Ocean. As the LNG carriers enter the waterway, they would be assisted by two tugboats and a waterside security escort during their journey along the Columbia River. Estimated criteria and GHG emissions from LNG carriers, tugs, and security vessels are summarized in tables 4.10.1-4 and 4.10.1-5.

TABLE 4.10.1-4

Estimated Air Emissions from the LNG Carriers, Tugs, and Security Vessels (PM_{10}, SO_2, NO_x, and CO)

	PM_{10}		SO_2 [a]		NO_x		CO	
Source	maximum lb/hr	Tpy	maximum lb/hr	tpy	maximum lb/hr	tpy	maximum lb/hr	Tpy
Security Vessels [b]	0.1	0.1	0.0	0.0	0.5	0.3	1.2	1.2
Tugs [c]	4.4	5.2	1.3	1.6	175.6	209.6	21.2	24.8
LNG Carriers [d]	17.8	7.0	1,630.1	644.6	706.4	278.9	106.5	43.4
Total	22.8	12.8	1,641.1	655.0	894.6	499.8	135.7	75.6

[a] The SO_2 emissions from the LNG carriers are based on an estimated fuel sulfur content of 4.5 weight percent for ship main engines and generators in transit. Emissions from LNG carriers at berth are based on burning bog with a side stream of liquid fuel.

[b] Emissions from security vessels are based on those vessels utilizing gasoline-powered outboard motors. Two security vessels would accompany each LNG carrier to/from berth to Astoria. One security vessel would be on standby during docking while the LNG carrier is in port.

[c] Emissions from tugs providing both upriver and downriver LNG carrier support estimated assuming the tugs would be based in Longview. Two tugs would escort each LNG carrier from Buoy 10 to port. A third additional tug would travel from Longview to the Bradwood Landing Terminal to provide berthing/unberthing support.

[d] Emissions from LNG carriers in transit include both upriver and downriver operations.

TABLE 4.10.1-5

Estimated Air Emissions from the LNG Carriers, Tugs, and Security Vessels (VOCs, CO_2, and CH_4)

	VOCs		CO_2		CH_4 [a]	
Source	lb/hr	lb/hr	lb/hr	tpy	lb/hr	Tpy
Security Vessels [b]	2.8	2.2	971	986	--	--
Tugs [c]	2.1	2.4	11,768	14,028	--	--
LNG Carriers (transit) [d]	11.9	5.1	46,066	19,007	--	--
LNG carriers (at berth)	2.8	2.6	3,065	2,785	20.0	18.2
Total	19.6	12.3	61,870	36,806	20.0	18.2

[a] Emission factors of CH_4 from the combustion of liquid fuel in ship engines are not available and have therefore been assumed to be negligible.

[b] Emissions from security vessels are based on those vessels utilizing gasoline-powered outboard motors. Two security vessels would accompany each the LNG carrier to/from berth to Astoria. One security vessel would be on standby during docking while the LNG carrier is in port.

[c] Emissions from tugs providing both upriver and downriver LNG carrier support estimated assuming the tugs would be based in Longview. Two tugs would escort the LNG carrier from Buoy 10 to port. A third additional tug would travel from Longview to the Bradwood Landing terminal to provide berthing/unberthing support.

[d] Emissions from LNG carriers in transit include both upriver and downriver operations.

Emission estimates are based on transit between entry into U.S. waters (approximately 24 nautical miles beyond the mouth of the Columbia River) and the proposed Bradwood Landing terminal, and assume slow cruise speeds and maneuvering speeds. The ships used to transport LNG to and from the LNG terminal would be under the jurisdiction of the Coast Guard, which has the authority to dictate ship speed and navigation.

Ships are anticipated to deliver LNG to the proposed terminal approximately 125 times per year, with each delivery lasting up to 24 hours. Due to the limited number of ships and the short time frame of each visit, LNG carriers are expected to be present at the terminal approximately 34 percent of the year. Receptors close to the LNG carrier route may experience elevated levels of regulated pollutants.

Although the emissions from marine vessel traffic are large, the emissions would be periodic and transient. Therefore we do not expect regionally significant air quality impacts would occur.

NorthernStar completed an air dispersion modeling analysis of the LNG carrier emissions from the on-board electrical generator during hotelling operations (Bradwood Landing Evaluation of AAQS and Prevention of Significant Deterioration (PSD) Increment Consumption from LNG Carrier Vessel Emissions during Offloading, July 13, 2006). Using an EPA-approved dispersion model, impacts of criteria pollutants from the LNG carriers plus the preliminary modeled impacts from the LNG terminal, competing sources, and background concentrations were added together and compared to the applicable federal NAAQS and Prevention of Significant Deterioration (PSD) Increments. Detailed results are presented in section 4.10.1.2.

If a marine LNG spill occurred, any unignited LNG would vaporize; because LNG is mostly composed of methane. No criteria air pollutants would be associated with the vaporized LNG. However, methane is considered a GHG and may contribute to global warming. The dispersion of the methane vapors would cause a temporary decrease in the ambient air quality. Wildlife and humans occupying the water's surface near the release could intercept the vapor cloud prior to dispersion and suffer asphyxiation. The duration of exposure to any substantial pollutant concentrations would be short and would not pose a significant health risk to sensitive receptors given the distance to shore from a potential LNG spill. Therefore, there would be no significant impacts on air quality in the unlikely event of a marine LNG spill.

However, if ignition to the vapor cloud would occur, combustion emissions would be released to the atmosphere. Natural gas combustion typically is not complete in spill scenarios. The products of incomplete combustion of natural gas include criteria pollutants, hazardous air pollutants, unburned hydrocarbons, and soot (carbon particulates). The maximum increases in ambient air pollutant concentrations due to the natural gas vapor cloud fire would occur downwind of the LNG spill. These ambient air pollutant concentrations would likely exceed short-term NAAQS and State Ambient Air Quality Standards over the duration of the fire as well as soot deposition and diminished visibility due to soot transport. In the more populated areas of the transit route receptors would be exposed to higher pollutant concentrations for the short duration of the fire. The types and amounts of emissions from the ignition of an LNG pool would depend on many factors, but the emissions to any one localized area would be temporary and depend on weather and other conditions along the waterway. Emissions at a particular location that would arise from ignited vegetation and any nearby man-made structures would likely have greater levels of unburned hydrocarbons and hazardous air pollutants. Any acute exposures to smoke from LNG and induced fires may lead to range of problems such as a worsening of asthma conditions, irritation of the eyes, nose and throat, and difficulty breathing. In sensitive populations (children, elderly, chronically ill) symptoms of exposure may be of greater magnitude.

4.10.1.2 LNG Terminal

Climate

The proposed Bradwood Landing LNG terminal would be located in Clatsop County, Oregon, within the coastal Columbia River Valley climate region, described in section 4.10.1.1. Clatsop County is one of the six counties designated as the Northwest Region by the ODEQ.

The National Weather Service (NWS) maintains a climate station at the Astoria Regional Airport in Astoria, Oregon, located in Clatsop County and the Kelso-Longview Regional Airport in Cowlitz County, Washington. Climate data from these stations are available from the Western Regional Climate

Center from January 1, 1899 to the present. These data should be representative of conditions in the area of the proposed terminal.

Ambient Air Quality Standards

The federal and Oregon ambient air quality standards applicable to this portion of the project are discussed in 4.10.1.1 above.

Existing Air Quality

Clatsop County is currently designated as attainment or unclassifiable for all NAAQS criteria pollutants. Motor vehicles are a primary source of air pollution, with large industrial facilities accounting for less than 15 percent of most types of criteria pollutants. Other sources of air pollution include human activities such as outdoor burning, using wood stoves, and using non-road vehicles (e.g., gasoline-powered lawn mowers, motor boats, etc.).

Construction of the proposed terminal would cause temporary combustion emissions associated with operating construction equipment and vehicles. Fugitive dust would also be generated by site preparation activities and equipment travel. These emissions would occur during the projected 36-month construction period. The bulk of long-term emissions for the Bradwood Landing Project would be emitted from stationary sources at the proposed LNG terminal.

Air Quality Control Regions

The Bradwood Landing LNG terminal would be located in the Northwest Oregon Intrastate AQCR (40 CFR 81.249).

Regulatory Requirements for Air Quality

Emissions from all phases of construction and operation of the proposed LNG terminal would be subject to applicable state and federal air regulations. Most air quality regulatory programs address emissions from stationary sources of air pollution; these programs would primarily affect ongoing operations at the proposed LNG terminal. Air quality regulations affecting LNG terminal construction are primarily concerned with reducing emissions associated with construction equipment and fugitive dust.

The new stationary air emission sources associated with operating the proposed LNG terminal include seven SCVs, one emergency generator, and one diesel firewater pump. These stationary sources are listed in table 4.10.1-6.

TABLE 4.10.1-6

Stationary Source Information

Air Emission Source (quantity)	Heat Rating (MMBtu/hr)	Horsepower Rating (bhp)	Energy Source
SCVs (7)	120 (each)	NA	Natural Gas
Emergency Generator (1)	5.52	1075	Diesel Fuel
Emergency Firewater Pump (1)	1.21	405	Diesel Fuel

bhp brake horsepower
MMBtu/hr million British thermal units per hour

The proposed terminal air emission sources are regulated at the federal level by the CAA, as amended, and at the state level by OAR. In addition to state regulations, the federal regulations established as a result of the CAA that are potentially applicable to the project include:

- Mobile Source Regulations;
- New Source Performance Standards (NSPS);
- PSD review or nonattainment New Source Review;
- Nonattainment New Source Review;
- Title V Operating Permits;
- National Emission Standards for Hazardous Air Pollutants (NESHAP);
- Federal Class I Area Protection;
- General Conformity; and
- Chemical Accident Prevention.

Federal Air Quality Requirements

Mobile Source Regulations

Title II of the CAA Amendments of 1990 – These regulations contain provisions relating to highway and off-road mobile sources and are aimed at reducing pollution from heavy-duty diesel engines, including marine and locomotive engines.

40 CFR 69, 80, and 86, Final Rule, Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements – This rule requires a reduction in emissions from on-road diesel engines and establishes sulfur limits for diesel fuel. Currently, the requirements are for new engines only and the standards will begin to take effect in model year 2007. Although the emissions standards are for new engines only, the reduced sulfur diesel fuel, which is required to have a sulfur content less than 0.05 percent (500 parts per million by weight (ppmw)), a limit that was lowered to 15 ppmw starting in June 2006, would also reduce particulate and SO_x emissions from existing diesel engines.

40 CFR 9 and 69 et al., Final Rule, Control of Emissions of Air Pollution from Non-road Diesel Engines and Fuel – This rule requires emissions reductions from non-road diesel engines by establishing emissions limits and sulfur content limits. This rule targets agricultural equipment, construction equipment, and other non-road diesel engines. As with the previous rule, the reduced sulfur fuel would lower emissions from existing diesel engines even though the emissions limits would only apply to new engines.

Both non-road and highway use vehicles and construction equipment used for the project would be required to use the new low sulfur diesel fuel as soon as it is commercially available.

New Source Performance Standards

NSPS regulations (40 CFR 60) establish pollutant emission limits and monitoring, reporting, and recordkeeping requirements for various emission sources based on source type and size. The NSPS apply to new, modified, or reconstructed sources.

Subpart Db of 40 CFR 60 applies to industrial, commercial, or institutional steam generating units that are modified, constructed, or reconstructed after June 19, 1984 and have maximum heat input rates of more than 29 MW or 100 million British thermal units per hour (MMBtu/hr). Subpart Db establishes specific emissions limits for SO_2 (for coal and oil fired units) and PM (for coal fired units). The SCVs

proposed for this project would be designed to have direct contact and intermixing of the combustion gases and the heat transfer medium, and available EPA guidance states that these units should not be considered "steam generating units;" therefore, the requirements of NSPS Db do not apply.

Subpart Kb of 40 CFR 60 applies to any volatile organic liquid storage unit that is modified, constructed, or reconstructed after July 23, 1984 and that has a capacity of 40 m^3 or greater. Subpart Kb exempts large tanks that store a liquid with a maximum true vapor pressure of less than 3.5 kilopascals (kPa). The two LNG storage tanks at the proposed terminal would each have a nominal capacity of 160,000 m^3 and store liquids with a maximum true vapor pressure of less than 3.5 kPa based on the maximum pressure expected during the warmest calendar month. Consequently, the LNG storage tanks would not be subject to Subpart Kb.

Subpart IIII of 40 CFR 60 applies to stationary compression ignition internal combustion engines that are modified, constructed, or reconstructed after July 11, 2005. The emergency generator and fire pump engine would be subject to this regulation. The manufacturers of post-2007 units must certify that the engines would comply with the standards for the useful life of the engine. The Bradwood Landing Project emergency engines would be ordered after 2008 and would comply with these standards.

Prevention of Significant Deterioration

Title I of the CAA establishes guidelines for the preconstruction/modification review of large air emission sources. Construction of sources in attainment areas must be reviewed in accordance with the PSD regulations. To be classified as a new major PSD source, the potential emissions from the source must be: either greater than 100 tons per year (tpy) for any pollutant regulated by the EPA under the CAA for sources that are among the 28 source categories listed in section 169 of the CAA, or greater than 250 tpy for any pollutant regulated by the EPA under the CAA for sources that are not among the 28 source categories listed in section 169 of the CAA. A BACT analysis and detailed dispersion modeling are required if a facility is classified as a major PSD source.

The applicability threshold for PSD review for the proposed LNG terminal is 250 tpy, based upon a determination by the ODEQ that the facility does not include any sources among the 28 listed source categories. Tables 4.10.1-7 and 4.10.1-8 present the annual maximum potential criteria pollutant and GHG emissions from the proposed LNG terminal and relevant PSD threshold criteria. We have removed lead from the list of criteria pollutants because emissions of lead from the SCVs and from fugitive emission leaks would be zero due t o an absence of lead contamination in the vaporized LNG.

As shown in tables 4.10.1-7 and 4.10.1-8, the maximum emissions from the proposed LNG terminal would be less than 250 tpy for each of the criteria pollutants. Therefore, the proposed LNG terminal would not be a federal major source and would not be subject to PSD review.

Nonattainment New Source Review

Title I of the CAA establishes guidelines for the preconstruction/modification review of large air emission sources. Construction of sources in nonattainment areas must be reviewed in accordance with the New Source Review regulations. As discussed above for the waterway and LNG terminal and in section 4.10.1.3 for the pipeline, the entire project area is located in attainment or unclassifiable areas. Consequently, nonattainment New Source Review does not apply to this project.

TABLE 4.10.1-7

Operating Air Emissions Summary for Proposed LNG Terminal (NO_x, CO, SO_2, and $PM_{10}/PM_{2.5}$) [a]

	NO_x		CO		SO_2		$PM_{10}/PM_{2.5}$	
Emission Unit (Quantity)	tpy	lb/hr[b]	tpy	lb/hr[b]	tpy	lb/hr[b]	tpy	lb/hr[b]
SCVs (7) [c]	121.9	27.8	199.3	45.5	0.1	2E-2	13.4	3.4
Emergency Firewater Pump (1) [d]	0.3	12.5	0.1	2.7	3E-2	0.8	2E-2	0.9
Emergency Generator (1) [d]	0.4	14.0	0.2	5.9	2E-2	4.4	2E-2	0.8
Fugitive Emissions	NA	NA	NA	NA	NA	NA	NA	NA
Total [e]	122.6	54.3	199.6	54.1	0.2	5.2	13.4	5.1
PSD Threshold Criteria	250	NA	250	NA	250	NA	250	NA

[a] Emissions of beryllium, mercury, sulfuric acid mist, asbestos, vinyl chloride, fluorides, hydrogen sulfide, total reduced sulfur, reduced sulfur compounds, chlorofluorocarbons, halons, and ozone depleting substances are negligible.
[b] Maximum hourly emissions.
[c] The calculations for the SCVs assume seven heaters operating at maximum capacity (120 MMBtu/hour/unit).
[d] Emergency generator and firewater pump potential emissions calculations based on 52-hour-per-year operation.
[e] Total emission rates in lb/hr assume that the firewater pump and emergency generator are both operating.
NS not significant

TABLE 4.10.1-8

Operating Air Emissions Summary for Proposed LNG Terminal (VOCs, Pb, CO_2, and CH_4) [a]

	VOCs		CO_2		CH_4	
Emission Unit (Quantity)	tpy	lb/hr[b]	tpy[f]	lb/hr[f]	tpy	lb/hr[b]
SCVs (7) [c]	19.9	4.5	65,500	314,170	NE	NE
Emergency Firewater Pump (1) [d]	3E-2	1.0	NE	NE	NE	NE
Emergency Generator (1) [d]	2E-2	0.8	NE	NE	NE	NE
Fugitive Emissions	4.6	1.1	NE	NE	NE	NE
Total [e]	24.5	7.4	65,500	314,170	NE	NE
PSD Threshold Criteria	250	NA	NA	NA	NA	NA

[a] Emissions of beryllium, mercury, sulfuric acid mist, asbestos, vinyl chloride, fluorides, hydrogen sulfide, total reduced sulfur, reduced sulfur compounds, chlorofluorocarbons, halons, and ozone depleting substances are negligible.
[b] Maximum hourly emissions.
[c] The calculations for the SCVs assume seven heaters operating at maximum capacity (120 MMBtu/hour/unit).
[d] Emergency generator and firewater pump potential emissions calculations based on 52-hour-per-year operation.
[e] Total emission rates in lb/hr assume that the firewater pump and emergency generator are both operating.
[f] Emissions of CO_2 from the SCVs are based on a terminal sendout rate of 1 Bscfd and assuming 1.31% of the sendout (26,000 lbs/hr of natural gas) is used to fuel the SCVs during the vaporization process.
NE not estimated
NA not applicable

Title V Operating Permits

Title V of the CAA requires states to establish an air operating permit program. The requirements of Title V are outlined in 40 CFR 70 and the permits required by these regulations are often referred to as Part 70 permits. The EPA has delegated the authority to issue Part 70 permits to the ODEQ. Part 70 permit program requirements are codified in OAR 340-218 and fee requirements are codified in OAR 340-220.

If a facility's potential to emit exceeds the criteria pollutant or hazardous air pollutant (HAP) thresholds, the facility is considered a Title V major source. Under Part 70, the major source threshold

for an air emission source in Oregon is 100 tpy for PM_{10}, $PM_{2.5}$, SO_2, CO, NO_x, VOCs, or lead. As shown in tables 4.10.1-4 and 4.10.1-5, the potential emissions for NO_2 (the primary component of NO_x) and CO at the proposed LNG terminal exceed 100 tpy. Therefore, the LNG terminal would be a major source of air emissions and would require a Part 70 permit.

The Title V major source HAP thresholds for a source are 10 tpy of any single HAP or 25 tpy of all HAPs in aggregate. Potential HAP emissions from the proposed LNG terminal (in aggregate) would be 6.94 tpy from stationary sources, which are below the major source thresholds.

National Emission Standards for Hazardous Air Pollutants

The NESHAPs, codified in 40 CFR 61 and 63, regulate HAP emissions. Part 61 was promulgated prior to the 1990 Clean Air Act Amendments (CAAA) and regulates only eight types of hazardous substances (asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride).

The 1990 CAAA established a list of 189 HAPs; resulting in the promulgation of Part 63. Part 63, also known as the Maximum Achievable Control Technology (MACT) standards, regulates HAP emissions from major sources of HAP emissions and specific source categories that emit HAPs. Part 63 defines a major source of HAPs as any source that has the potential to emit 10 tpy of any single HAP or 25 tpy of HAPs in aggregate.

LNG storage and processing facilities are not one of the source categories regulated by Part 61; therefore, the requirements of Part 61 are not applicable to the proposed facility. Part 63 establishes HAP emission standards for marine vessel loading operations (Subpart Y); oil and gas production facilities (Subpart HH); natural gas transmission and storage facilities (Subpart HHH); industrial, commercial, and institutional boilers and process heaters (Subpart DDDDD); and reciprocating internal combustion engines (Subpart ZZZZ). These subparts establish requirements for major sources of HAPs only. As indicated above, the potential HAP emissions (in aggregate) from LNG terminal stationary sources would be 6.94 tpy. The single largest HAP emitted by the terminal would be hexane with a potential to emit of 6.49 tpy. Therefore, the LNG facility would not be a major source of HAPs and would not be subject to the NESHAPs.

Federal Class I Area Protection

The U.S. Congress designated certain lands as Mandatory Federal Class I (Class I) areas in 1977. Class I areas were designated because the air quality was considered a special feature of the area (e.g., national parks or wilderness area). These Class I areas, and any other areas that have been redesignated Class I areas since 1977, are given special protection under the PSD program. The PSD program establishes air pollution increment increases that are allowed by new or modified air pollution sources. If the new stationary source is required to comply with PSD program requirements and is near a Class I area, the source is required to determine its impacts at the nearby Class I area(s). The source is also required to notify the appropriate federal land manager(s) for the nearby Class I area(s).

As explained previously, the proposed LNG terminal would not be subject to PSD regulations. The proposed pipeline also would not be subject to PSD regulations. Therefore, federal Class I area protection provisions would not apply to this project; however, impacts on Class I areas are discussed below and shown in table 4.10.1-12.

General Conformity

A conformity analysis must be conducted if a federal action will generate emissions that will exceed the conformity thresholds levels (*de minimis*) of the pollutant(s) for which an air basin is designated as a nonattainment area or a maintenance area. Because the project area would not be located in a nonattainment or maintenance area, general conformity would not apply to the Bradwood Landing project.

Chemical Accident Prevention

The chemical accident prevention provisions, codified in 40 CFR 68, are federal regulations designed to prevent the release of hazardous materials in the event of an accident and minimize potential impacts if a release does occur. Portions of 40 CFR 68 are incorporated by reference in OAR 340-244-0230. Oregon regulations reference the federal list of substances and threshold quantities for determining applicability to stationary sources. If a stationary source stores, handles, or processes one or more substances on this list in a quantity equal to or greater than specified in the regulation, the facility must prepare and submit a *Risk Management Plan* (RMP). If a facility does not have a listed substance on site, or the quantity of a listed substance is below the applicability threshold, the facility does not have to prepare an RMP. In the latter case, the facility still must comply with requirements of the general duty provisions in section 112(r)(1) of the 1990 CAAA if there is any regulated substance or other extremely hazardous substance on site.

Stationary sources are defined in 40 CFR 68 as any buildings, structures, equipment, installations, or substance-emitting stationary activities belonging to the same industrial group, located on one or more contiguous properties, under the control of the same person (or persons under common control), and from which an accidental release may occur. However, the federal definition also states that the term "stationary source" does not apply to transportation, including storage incidental to transportation, of any regulated substance or any other extremely hazardous substance. The term "transportation" includes transportation subject to oversight or regulation under 49 CFR 192, 193, or 195 or a state natural gas or hazardous liquid program for which the state has in effect a certification to DOT under 49 USC § 60105. Based on federal definitions excluding transportation and storage incidental to transportation, an RMP is not required for this facility based on federal regulations.

<u>State Air Quality Requirements</u>

Oregon Construction Permit

Oregon requires each facility that will be subject to the Oregon Title V permit program to obtain a permit to construct before beginning to construct, install, establish, develop, or operate any air contaminant source (OAR 340-216). To meet this requirement, NorthernStar initially submitted an application to the ODEQ in April 2006 for an Air Contaminant Discharge Permit (ACDP) addressing both construction and operation of the LNG terminal. The ODEQ requested that NorthernStar obtain site specific meteorological data and use the data to refine their air dispersion modeling results. NorthernStar provided this information in March 2007 and supplemental information in April 2007. The ODEQ determined that the application was incomplete because it did not include a Land Use Compatibility Statement. The ODEQ stated that it would work informally on the permit application while NorthernStar works to resolve land use issues with Clatsop County.

Oregon Title V Permit

As mentioned previously, the Bradwood Landing LNG terminal's projected potential emissions would trigger Oregon Title V permit requirements (OAR 340-218). NorthernStar would obtain a Title V permit before commencing operations and would pay Title V operating permit fees (OAR 340-220).

Plant Site Emission Limits

Facilities that require Oregon Title V permits and/or an ACDP must obtain plant site emission limits (PSEL) for all regulated pollutants (OAR 340-222-0020). These PSELs are incorporated into the facility's Title V permit and/or ACDP. For pollutants whose potential to emit exceeds significant emission rates (SER), the proposed LNG terminal would likely receive site-specific PSELs set equal to the facility's potential to emit. Table 4.10.1-9 shows the projected potential to emit for criteria pollutants. Based on this information, the proposed terminal would be likely to receive source-specific PSELs for CO and NO_x. Generic PSELs equal to the relevant SERs would likely be set for PM_{10}, SO_2, and VOCs, as well as other pollutants.

TABLE 4.10.1-9

Significant Emission Rates and Terminal Potential to Emit

Pollutant	Significant Emission Rate (tpy)	Potential to Emit (tpy)
CO	100	199.6
NO_x	40	122.6
PM_{10}	15	13.4
SO_2	40	0.2
VOCs	40	24.5

Air Quality Impact Analysis

Under Oregon regulations in OAR 340-222-0041(3)(C), an Air Quality Impact Analysis (AQIA) is required for any criteria pollutant that exceeds the SER threshold. NO_x, which will be modeled as NO_2, and CO emissions would exceed the SER and would be included in the air quality analysis.

Dispersion modeling methods would estimate the maximum off-site ambient concentrations for project emissions that exceed the SER. The maximum off-site concentrations would then be compared to the following Oregon SILs:

- CO: 2,000 $\mu g/m^3$ based on a 1-hour average and 500 $\mu g/m^3$ based on an 8-hour average; and
- NO_x: 1 $\mu g/m^3$ based on an annual average.

For pollutants with maximum off-site ambient concentrations less than the applicable SIL, no further impact assessment would be required and compliance with NAAQS is demonstrated. If impacts are significant, a more refined analysis would be required to demonstrate compliance with NAAQS. The refined analysis must show that total modeled impacts plus total competing NAAQS source impacts plus general back concentrations would be less than the NAAQS for all averaging times.

The ODEQ mandated that NorthernStar model the impact associated with operational emissions from the stationary sources, as well as emissions from LNG carriers (see section 4.10.1.1). Due to the lack of representative ambient air quality data, the ODEQ requested that NorthernStar collect

meteorological data for one year at the site of the proposed terminal. This data collection was completed in February 2007 and NorthernStar conducted air dispersion modeling using the site-specific meteorological data. Results of the modeling analysis are documented in a March 22, 2007 Air Quality Modeling Report to the ODEQ.

The analysis included a review of the proposed terminal emissions. Based on the review, CO and NO_x were required to be modeled for comparison to applicable air quality standards. The modeling analysis was conducted using the American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC) modeling program (AERMOD), version 07026, with PRIME downwash algorithms, processed site-specific meteorological data, and USGS digital elevation model terrain data. NorthernStar requested and obtained from the ODEQ competing source information, which was included in the impacts analysis, along with appropriate background concentrations.

The terminal sources of CO and NO_x were modeled to determine if predicted impacts would exceed the SILs. The maximum modeled off-site concentrations were predicted to exceed the 8-hour CO and annual NO_x SILs and to be below the 1-hour CO SIL. As a result, background concentrations were added to the maximum modeled concentrations from the terminal plus the competing sources for comparison to the CO and NO_x AAQS. Table 4.10.1-10 documents the results of the AAQS compliance demonstration and shows that emissions from the terminal are expected to be below the NAAQS and OAAQS.

TABLE 4.10.1-10

AAQS Dispersion Modeling Results Summary (Terminal)

Pollutant	Averaging Period	Terminal +Competing Source Modeled Concentration ($\mu g/m^3$)	Background Concentration [a] ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Standard Exceeded (Yes/No)
CO	1-hr	1,721	2,000	3,721	40,000	No
	8-hr	544	1,400	1,944	10,000	No
NO_2	Annual	21.6 [b]	15	36.6	100	No

[a] Background concentrations provided by Mark Bailey of the ODEQ.
[b] Annual NO_x results reduced by Ozone Limiting default factor of 0.75 to estimate equivalent NO_2 concentration.

The modeled project impacts were also evaluated for compliance with the applicable PSD increment thresholds. There are no PSD increments for CO. The NO_2 PSD increment is 25 $\mu g/m^3$. As required, the terminal plus the competing source modeled concentrations were compared to the increment. Since the modeled concentration of 21.6 $\mu g/m^3$ was below the applicable increment, no further analysis was required.

A prior modeling analysis conducted by NorthernStar dated July 13, 2006 documented the results of modeling the LNG carrier emissions, while hotelling, from the on-board electrical generator. The modeling was conducted using AERMOD with local meteorological data, since the site specific meteorological data was not yet available. The analysis included an assessment of the proposed CO, NO_2, PM_{10}, and SO_2 emissions for comparison to the applicable AAQS and increments. Table 4.10.1-11 below documents the results of the analysis. It should be noted that the estimated emission rates from the LNG carriers listed in tables 4.10.1-4 and 4.10.1-5 have been updated and are lower than those used for the modeling analysis conducted in July 2006. As a result, the impacts presented in table 4.10.1-11 are conservative. The estimated impacts are below the NAAQS and OAAQS; therefore, we do not expect significant air quality impacts.

TABLE 4.10.1-11

AAQS Dispersion Modeling Results Summary (Terminal and LNG Carrier)

Pollutant	Averaging Period	LNG Carrier Modeled Concentration ($\mu g/m^3$)	Background Concentration [a] ($\mu g/m^3$)	Total Impact [b] ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Standard Exceeded (Yes/No)
CO	1-hr	96.2	2,000	3,721	40,000	No
	8-hr	17.5	1,400	1,944	10,000	No
NO_2	Annual	0.75 [c]	15	37.4	100	No
PM_{10}	24-hr	1.24	30	31.2	150	No
	Annual	0.02	15	15.0	50	No
SO_2	3-hr	501.21	65	566.2	1300	No
	24-hr	83.2	30	113.2	365	No
	Annual	0.98	15	16.0	80	No

[a] Background concentrations provided by Mark Bailey of the ODEQ.

[b] Total Impacts listed for CO and NO_2 include modeled concentrations from the LNG carriers, terminal plus competing sources (from table 4.10.1-10), and background. Total impacts listed for PM_{10} and SO_2 include modeled concentrations from the LNG carrier and background only since the emissions from the terminal of those pollutants do not exceed the ODEQ's Air Quality Impact Analysis (AQIA) thresholds and did not require an analysis.

[c] Annual NO_x results reduced by Ozone Limiting default factor of 0.75 to estimate equivalent NO_2 concentration.

Since the project would be located within 200 kilometers of a federal Class I area, modeling was also conducted to demonstrate compliance with the Class I area NO_2 increment of 2.5 $\mu g/m^3$. Table 4.10.1-12 presents the modeled annual average NO_2 concentrations for comparison to the significance level.

TABLE 4.10.1-12

Class I Area Dispersion Modeling Results Summary (Terminal)

Area Name	State	Distance/ Direction from Terminal (km)	Terminal Modeled Concentration [a] ($\mu g/m^3$)	Class I Area Significance Level ($\mu g/m^3$)	Significance Level Exceeded (Yes/No)
Columbia River Gorge National Scenic Area [b]	Oregon and Washington	100 / ESE	0.01	0.10	No
Mount Rainer Nation Park	Washington	137 / NE	0.03	0.10	No
Mount Adams Wilderness Area	Washington	145 / East	0.02	0.10	No
Mount Hood Wilderness Area	Oregon	150 / SE	0.02	0.10	No
Goat Rocks Wilderness Area	Washington	153 / ENE	0.02	0.10	No
Olympic National Park	Washington	154 / North	0.02	0.10	No

[a] Values listed above are the maximum concentration 50 km from the terminal in the direction specific to each area of interest.

[b] Not a federal Class I Area but required by the ODEQ to be analyzed.

All modeled concentrations at distances of 50 kilometers from the terminal would be below the significance level; therefore, no further analysis was required to demonstrate acceptable project impacts. Based upon this screening we do not anticipate significant impacts on Class I areas.

Oregon Major New Source Review

Oregon implements a Major New Source Review Program encompassing new facility construction or modification in nonattainment and attainment/unclassifiable areas (OAR 340-224).

Because the planned project is located in attainment/unclassifiable areas for all criteria pollutants, only the PSD portion of Oregon's Major New Source Review Program is potentially applicable. The Oregon Major New Source Review Program uses the same applicability determination as is used for the federal PSD program. As mentioned previously, projected potential emissions from the proposed Bradwood Landing LNG terminal would not exceed the federal major source PSD threshold. Therefore, the proposed facility would not be subject to Oregon's Major New Source Review Program.

General Emission Standards

The proposed LNG terminal would be subject to three provisions from Oregon's general emission standards in OAR 340-226. The first provision mandates that particulate emissions from any individual source may not exceed 0.1 grains per standard cubic foot of effluent (OAR 340-226-210).

The second provision requires that certain emission units at stationary sources meet Typically Achievable Control Technology (TACT). The SCVs would be subject to TACT because the Bradwood Landing LNG facility would require a permit, and the SCVs each would have emissions of more than 1 tpy and would not be subject to major source New Source Review, New Source Performance Standards, or other emission limits specified in OAR 340-226-130(2)(a). Procedures for identifying air pollution control equipment and emission reduction processes that meet TACT are not included within Oregon's regulatory text. However, if the ODEQ notifies NorthernStar that it intends to make a TACT determination for the SCVs, then the proposed facility would need to submit any requested information and comply with the final TACT determination.

Finally, the general emission standards also mandate that "the highest and best practicable treatment and control of air contaminant emissions must in every case be provided." However, a source is deemed to be in compliance with the "highest and best" requirement if it is in compliance with all other applicable requirements in OAR 340, Divisions 200 through 268. Because NorthernStar intends to comply with each applicable requirement, the Bradwood Landing LNG terminal facility would be in compliance with the "highest and best practicable treatment."

Fuel Burning Equipment and Fuel Sulfur Content

The proposed LNG terminal would use fuel burning equipment that would be subject to particulate limits and fuel sulfur content limits under OAR 340-228. Under this rule, "fuel burning equipment" is defined as equipment (other than internal combustion engines) whose purpose is to produce heat or power by indirect heat transfer. Several of the standards in OAR 340-228 would not apply to certain emission units, as follows.

- The firewater pump would be exempt from this rule because it would be an internal combustion engine.
- The SCVs would be exempt from SO_2 limits because they burn natural gas.
- The emergency generator would be exempt from SO_2 limits because its heat input capacity is less than 150 MMBtu/hr.

However, particulate limits would apply to the SCVs and the emergency generator. This equipment would be subject to an emission limit of 0.1 grain of particulate per standard cubic foot of effluent. In addition, two sulfur content limits would apply to fuels that are sold, distributed, or used by the proposed facility (with the exception of fuel used exclusively for propulsion and auxiliary power for vessels, railroad locomotives, or diesel motor vehicles).

- Residual fuel oil may not contain more than 1.75 percent sulfur by weight.

- Distillate fuel oil may not contain more than 0.3 percent sulfur by weight for ASTM (American Society for Testing and Materials) Grade 1 fuel oil, or 0.5 percent sulfur by weight for ASTM Grade 2 fuel oil.

Visible Emission and Nuisance Requirements

State visible emissions and nuisance abatement regulations are codified in OAR 340-208. Both construction and operation phases of the proposed LNG terminal would be subject to visible emission limits stated in terms of opacity. In Oregon, the LNG terminal may not emit contaminants causing opacity to equal or exceed 20 percent in any period or periods aggregating more than 3 minutes in any hour. In addition, no person may create an observable deposition of particulate matter on another person's property (OAR 340-208-540).

The state of Oregon imposes specific fugitive emission control requirements on facilities that are located within "special control areas" or are determined to be a nuisance by the ODEQ. The proposed Bradwood Landing LNG terminal would not be located in a special control area because it would not be located in counties or basins listed in OAR 340-204-0070, nor would it be located within 3 miles of the corporate limits of a city having a population of 4,000 people or more. Fugitive emission requirements within OAR 340-208-210 would apply to the facility only if it were deemed to be a nuisance. If the ODEQ determined that the project was a nuisance, NorthernStar would need to enter into a Best Work Practices Agreement with the ODEQ. NorthernStar's terminal ESC Plan contains BMPs for dust suppression, which would include the use of groundwater from the on-site well. No chemicals would be used for dust suppression.

Energy Facility Siting Requirements (Oregon Department of Energy)

Most large energy facilities in Oregon are under the jurisdiction of the Oregon Energy Facility Siting Council (Council). The Oregon legislature determines what types of energy facilities require Council review. An energy facility developer must apply to the Council for a site certificate and must supply information about the proposed facility and the proposed site.

In 1997, the Oregon legislature gave the Energy Facility Siting Council authority to set CO_2 emissions standards for new energy facilities. Division 24 of the Council's rules, beginning at OAR 345-024-0500, contains specific standards for base load gas plants, non-base load (peaking) power plants and non-generating energy facilities that emit carbon dioxide. The standard for non-generating energy facilities is expressed as a rate of emissions per horsepower hour: 0.504 pounds of CO_2/hp-hr. CO_2 would be formed during the operation of the Bradwood Landing LNG terminal as a primary product of diesel and gas combustion in the SCVs, emergency generator, and emergency firewater pump engine. In 2005, the Council had initiated development of additional criteria for LNG terminals.

The EPAct of 2005 contains a provision that the FERC has exclusive jurisdiction over LNG import facilities. As a result, the Council has stated that it would not be asserting jurisdiction over LNG import terminals. As well, the ODE stopped all work related to rulemaking for LNG facilities.

Oregon Governor Ted Kulongoski directed state agencies to participate in the FERC's review of any LNG import terminals in Oregon. He designated the ODE as the lead agency in working with FERC on proposed projects, including the coordination of state agency response on any application. The Governor also designated the ODE as the state's lead agency for working with FERC on LNG import terminal safety and security issues.

Although the Council acknowledges that the FERC has jurisdiction over the siting of LNG import terminals and there are no specific standards for LNG facilities, the ODE has requested that the Bradwood Landing Project voluntarily comply with the CO_2 standards for non-generating energy facilities. CO_2 is not a federally regulated pollutant but is considered a GHG, along with other gases such as methane and chlorofluorocarbons. GHG emissions are the primary driver of the increase in global mean temperature, known as global warming. NorthernStar has agreed to voluntarily comply with the ODE's request.

Air Quality Impacts and Mitigation

Construction of the proposed LNG terminal would have temporary adverse impacts on air quality due to fugitive dust emissions. Construction at the terminal site would include dredging of the river channel to accommodate LNG carriers, construction of the wharf and docking facilities, and construction and installation of on-site equipment. Construction at the proposed terminal site would occur over approximately 3 years.

NorthernStar proposes to reduce fugitive emissions from terminal construction areas. When dust is considered to be a possibility during a specific site construction activity in the terminal area, mitigation measures would be included in the task-specific method statement for the work. The terminal ESC Plan states that the ODEQ's BMPs for dust control (EP-13) would be followed to stabilize soil from wind erosion and to reduce dust generated by construction activities. However, NorthernStar would use only water, which would be obtained from the on-site water well, and would not use other types of dust palliatives. Stockpiled materials would be stabilized either by applying water or by covering. Dust control would be provided daily (or as often as needed depending on wind conditions, time of year, and the physical conditions of the site). Water applied for dust control would be applied evenly and without over-watering to avoid runoff that could result in erosion.

The concrete plant located at the terminal site would be operated in a manner designed to minimize the risk of cement dust releases. The environmental coordinator would conduct regular inspections to ensure that BMPs are employed to reduce fugitive dust emissions. In addition, NorthernStar proposes to pave Bradwood Road, which provides access to the area from paved Clifton Road.

Construction of the LNG terminal would also result in tailpipe emissions from a variety of sources, including cranes, forklifts, front end loaders, dump trucks, graders, generators, vibratory rollers, concrete pumps and trucks, water trucks, and pick-up trucks. Non-road construction vehicle emissions were estimated using emission factors from the EPA AP-42 compilation. During construction of the LNG terminal, construction equipment is assumed to operate 10 hours per day, 5 days per week, with the exception of the dredge and associated equipment. In tables 4.10.1-13 and 4.10.1-14, the estimated construction emissions are summarized. In addition, total NO_x, CO, and VOC emissions during construction of the LNG terminal are compared to regional air emissions estimated from 2002 ODEQ data for Clatsop and Columbia Counties.

Impacts associated with construction vehicles are difficult to estimate based on the time and space variant characteristics of the emissions. Estimates are complicated by the fact that the construction equipment would not follow defined paths (such as paved roadways) and would frequently change speed and direction. Furthermore, due to the intermittent and temporary nature of these emissions, their long-term impact on air quality would be minimal. In addition, the primary pollutants emitted by the construction vehicles would be NO_x and CO. The ambient air quality standard for NO_2 is an annual average and the CO standards are significantly higher than any other standards (see table 4.10.1-1). For these reasons, the short-term and intermittent NO_2 and CO emissions from the construction vehicles are not expected to exceed the NAAQS for NO_2 or CO.

TABLE 4.10.1-13

Estimated Total and Peak Hourly Construction Emissions for LNG Terminal (NO_x, CO, SO_2, and PM_{10})

	NO_x		CO		SO_2		PM_{10}	
Emission Source	tons [a]	lb/hr	tons [a]	lb/hr	tons [a]	lb/hr	tons [a]	lb/hr
LNG Terminal								
Construction Equipment	583.3	149.6	716.8	183.8	84.2	21.6	33.9	8.7
Dredging Equipment	83.6	232.1	15.8	44.0	4.0	11.1	4.6	12.7
Construction Tug	12.5	312.7	1.0	24.8	3.1	77.1	0.3	7.8
Earth-Moving Fugitives	0.0	0.0	0.0	0.0	0.0	0.0	24.3	6.2
Commuter and Delivery Vehicles	1.5	0.4	3.1	0.8	neg	0.0	79.6	20.4
Natural Gas to Purge Nitrogen	0.0	NE	0.0	NE	0.0	NE	0.0	NE
Construction Total [b]	680.9	694.8	736.7	253.4	91.3	109.8	142.7	55.8
ODEQ Regional Estimates [c]	6,500.0	NA	32,600	NA	NA	NA	NA	NA
Percent of Regional Emissions	10.5	NA	2.3	NA	NA	NA	NA	NA

[a] These emission levels represent total emissions for the 3-year construction period for the terminal and the 7-month construction period for the pipeline.

[b] The total construction emissions are summed for the entire construction period and peak hourly emissions. These emission numbers are conservative because peak hourly emissions from the LNG terminal construction activities are expected to occur at different times during the project, which would result in lower emissions that are presented in the table.

[c] The regional NO_2, CO, and VOC emission estimates include man-made emissions in Clatsop and Columbia Counties.

neg ne gligible

NA not applicable

NE no estimate

TABLE 4.10.1-14

Estimated Total and Peak Hourly Construction Emissions for LNG Terminal ($PM_{2.5}$, VOCs, CO_2, and CH_4)

	$PM_{2.5}$		VOCs		CO_2		CH_4	
Emission Source	tons [a]	lb/hr	tons [a]	lb/hr	tons [a]	lb/hr	tons [a]	lb/hr
LNG Terminal								
Construction Equipment	33.9	8.7	21.2	5.4	41,758.0	10,707.0	185.8	47.7
Dredging Equipment	4.1	11.3	3.2	8.8	4,466.0	12,406.0	15.3	42.4
Construction Tug	0.3	7.8	0.1	2.0	819.0	20,480.0	Neg	neg
Earth-Moving Fugitives	2.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Commuter and Delivery Vehicles	8.2	2.1	4.0	1.0	332.0	85.1	<0.1	<0.1
Natural Gas Purge Nitrogen	0.0	NE	15.5	NE	0.0	NE	460.0	NE
Construction Total [b]	48.9	30.5	44.0	17.2	47,375.0	43,678.0	661.1	90.1
ODEQ Regional Estimates [c]	NA	NA	960.0	NA	NA	NA	NA	NA
Percent of Regional Emissions	NA	NA	4.6	NA	NA	NA	NA	NA

[a] These emission levels represent total emissions for the 3-year construction period for the terminal and the 7-month construction period for the pipeline.

[b] The total construction emissions are summed for the entire construction period and peak hourly emissions. These emission numbers are conservative because peak hourly emissions from the LNG terminal construction activities are expected to occur at different times during the project, which would result in lower emissions than are presented in the table.

[c] The regional NO_2, CO, and VOC emission estimates include man-made emissions in Clatsop and Columbia Counties.

neg negligible

NA not applicable

NE no estimate

To reduce tailpipe emissions from vehicles, NorthernStar proposes to use the following measures to reduce emissions from construction equipment and commuter vehicles:

- limit truck idling as much as possible;
- properly maintain construction equipment in accordance with manufacturers' specifications or standard practices;
- encourage construction workers to carpool to the construction site; and
- implement a shuttle service to or from retail services and food establishments during lunch hours, or provide lunch services at the site.

Operation of the LNG terminal would result in air emissions from: stationary equipment (SCVs and emergency engines), LNG carriers, security vessels, and tugs. The Bradwood Landing LNG terminal would operate 24 hours per day, 7 days per week (8,760 hours per year). Typically, six SCVs would operate to achieve an average LNG sendout rate of 1.0 Bcfd. To achieve a peak sendout rate of 1.3 Bcfd, the seventh SCV would also operate. The diesel firewater pump and the diesel emergency generator would be operated on an emergency basis and for 1 hour each week for testing. Results of an AQIA evaluating operation of the proposed LNG terminal are discussed above in the State Air Quality Requirements section.

During LNG unloading operations, the proposed terminal would include a vapor management system to handle the BOG. During normal operations, no vapors would be discharged to the atmosphere; instead, vapors would be contained and recycled or used for fuel. In the event of non-routine conditions such as evacuating vapors from equipment before maintenance or to avoid overpressure conditions, vapors would be vented to the atmosphere. The vapor management system would include a vent to discharge vapors at a safe elevation. No flares would be used at the terminal facility.

Finally, NorthernStar would implement a policy to address local complaints regarding nuisance emissions. NorthernStar proposes to set up a contact telephone number that would allow citizens to call the site environmental coordinator and report nuisance emissions. The proposed policy would include a requirement to respond to complaints by conducting a terminal inspection and take corrective action. A written report of the complaint and actions taken would be kept on file at the facility.

4.10.1.3 Pipeline Facilities

Climate

The associated proposed 36.3-mile natural gas sendout pipeline would cross Clatsop and Columbia Counties in Oregon and Cowlitz County in Washington. The proposed pipeline route is within the coastal Columbia River Valley climate region, described in section 4.10.1.1. Clatsop and Columbia Counties are two of the six counties designated as the Northwest Region by the ODEQ.

Climate data from the NWS climate stations at Astoria Regional Airport in Clatsop County and the Kelso-Longview Regional Airport in Cowlitz County are available from the Western Regional Climate Center from January 1, 1899 to the present. These data should be representative of conditions in the area of the proposed pipeline route.

Ambient Air Quality Standards

The NAAQS and state AAQS applicable to the counties where the pipeline would be constructed are described in section 4.10.1.1.

Existing Air Quality

Clatsop, Columbia, and Cowlitz Counties are all currently designated as attainment or unclassifiable for all NAAQS criteria pollutants. Motor vehicles are a primary source of air pollution in each county, with large industrial facilities accounting for less than 15 percent of most types of criteria pollutants. Cowlitz County in Washington has some concentrated industrial development, including paper mills and power plants. Other sources of air pollution in both states include human activities such as outdoor burning, using wood stoves, and using non-road vehicles (e.g., gasoline-powered lawn mowers, motor boats, etc.).

Construction of the proposed pipeline would cause temporary gasoline and diesel combustion emissions associated with operating construction equipment and vehicles. Fugitive dust would also be generated by site preparation activities and equipment travel. These emissions would occur during the projected 7-month construction period.

Air Quality Control Regions

Like the Bradwood Landing LNG terminal, the Clatsop County portion of the proposed pipeline would be located in the Northwest Oregon Intrastate AQCR (40 CFR 81.249). The remaining portion of the pipeline in Columbia and Cowlitz counties would be located in the Portland Interstate AQCR (40 CFR 81.51).

Regulatory Requirements for Air Quality

Emissions from all phases of construction and operation of the proposed pipeline would be subject to applicable state and federal air regulations. Most air quality regulatory programs address emissions from stationary sources of air pollution. Because no compression facilities are proposed for the pipeline, there will be few air quality compliance requirements applicable to ongoing pipeline operations. Air quality regulations affecting pipeline construction are primarily concerned with reducing emissions associated with construction equipment and fugitive dust.

The proposed pipeline air emission sources are regulated at the federal level by the CAA, as amended, and at the state level by OAR and Washington's SWCAA.

Federal Air Quality Requirements

The federal air quality requirements that pertain to the Bradwood Landing Project are discussed above in section 4.10.1.2. Specific regulations applicable to the proposed pipeline would be those applicable to emissions from mobile sources (i.e., construction equipment) and fugitive dust emissions.

State Air Quality Requirements

The Oregon state air general emission standards, discussed in section 4.10.1.2 relative to the LNG terminal, would also be applicable to the proposed pipeline.

In Oregon, the construction and operation phases of the proposed pipeline would be subject to visible emission limits stated in terms of opacity. The pipeline project may not emit contaminants causing opacity to equal or exceed 20 percent in any period or periods aggregating more than 3 minutes in any hour. In addition, no person may create an observable deposition of particulate matter on another person's property (OAR 340-208-540).

In Washington, SWCAA Regulation 400-040 imposes fugitive dust emission controls on activities such as pipeline construction. These rules require that persons take reasonable precautions to prevent the release of air contaminants from the construction activities.

A new Washington regulation (SWCAA Regulation 400-045) became effective on December 15, 2005, that creates a permit program for non-road internal combustion engines that, in aggregate, equal or exceed 200 horsepower. However, NorthernStar would not be required to obtain permits under this regulation for non-road internal combustion engines used to construct the pipeline in Washington (Safford, 2006).

Air Quality Impacts and Mitigation

Construction of the proposed pipeline would have temporary adverse impacts on air quality due to fugitive dust emissions. Construction of the pipeline would occur over approximately 7 months.

During pipeline construction, NorthernStar would employ one or more of the following methods to reduce fugitive dust emissions:

- apply water or chemical dust suppressants to disturbed land;
- reduce vehicle speeds on paved and unpaved roads;
- minimize material transfer distances;
- return disturbed areas to normal vegetation as soon as possible;
- minimize travel on disturbed or stabilized land; and
- stop construction activities if high winds and/or very low humidity cause excessive dust.

Construction of the pipeline would also result in tailpipe emissions from a variety of sources, including miscellaneous trucks, bulldozers, backhoes, and side-boom tractors. Non-road construction vehicle emissions were estimated using emission factors from the EPA AP-42 compilation. The estimated construction emissions are summarized in tables 4.10.1-15 and 4.10.1-16. In addition, total NO_x, CO, and VOC emissions for the pipeline construction are compared to regional air emissions estimated from 2002 ODEQ data for Clatsop and Columbia Counties.

As discussed in section 4.10.1.2, the short-term and intermittent NO_2 and CO emissions from the construction vehicles are not expected to exceed the NAAQS for NO_2 or CO. In section 4.10.1.2, we describe specific measures NorthernStar proposes to reduce tailpipe emissions from construction equipment and commuter vehicles, as well as its proposal to implement a policy to address local complaints regarding nuisance emissions.

TABLE 4.10.1-15

Estimated Total and Peak Hourly Construction Emissions for Pipeline (NO_x, CO, SO_2, and PM_{10})

	NO_x		CO		SO_2		PM_{10}	
Emission Source	tons [a]	lb/hr	tons [a]	lb/hr	tons [a]	lb/hr	tons [a]	lb/hr
Pipeline								
Construction Equipment	277.3	120.0	343.6	148.7	42.1	14.4	31.0	13.4
Earth-Moving Fugitives	NA	NA	NA	NA	NA	NA	12.3	5.3
Commuter and Delivery Vehicles	NE	NE	NE	NE	NE	NE	NE	NE
Construction Total [b]	277.3	120.0	343.6	148.7	42.1	14.4	31.0	13.4
ODEQ Regional Estimates [c]	6,500	NA	32,600	NA	NA	NA	NA	NA
Percent of Regional Emissions	4.3	NA	1.1	NA	NA	NA	NA	NA

[a] These emission levels represent total emissions for the 3-year construction period for the terminal and the 7-month construction period for the pipeline.
[b] The total construction emissions are summed for the entire construction period and peak hourly emissions. [c] The regional NO_2, CO, and VOC emission estimates include man-made emissions in Clatsop and Columbia Counties.
NA not applicable
NE no estimate

TABLE 4.10.1-16

Estimated Total and Peak Hourly Construction Emissions for Pipeline ($PM_{2.5}$, VOCs, CO_2, and CH_4)

	$PM_{2.5}$		VOCs		CO_2		CH_4	
Emission Source	tons [a]	lb/hr	tons [a]	lb/hr	tons [a]	lb/hr	tons [a]	lb/hr
Pipeline								
Construction Equipment	31.0	13.4	40.3	17.4	21,773	9,442	75	32.5
Earth-Moving Fugitives	12.3	5.3	0	0	0	0	0	0
Commuter and Delivery Vehicles	NE	NE	NE	NE	NE	NE	NE	NE
Construction Total [b]	31.0	13.4	40.3	17.4	21,773	9,442	75	32.5
ODEQ Regional Estimates [c]	NA	NA	960	NA	NA	NA	NA	NA
Percent of Regional Emissions	NA	NA	4.2	NA	NA	NA	NA	NA

[a] These emission levels represent total emissions for the 3-year construction period for the terminal and the 7-month construction period for the pipeline.
[b] The total construction emissions are summed for the entire construction period and peak hourly emissions. [c] The regional NO_2, CO, and VOC emission estimates include man-made emissions in Clatsop and Columbia Counties.
NA not applicable
NE no estimate

4.10.1.4 Greenhouse Gas Emissions

We received several comments regarding the emissions of GHGs from the project. The principle GHGs are methane, CO_2, nitrous oxide (N_2O), and various fluorinated gases which trap heat in the atmosphere and are the primary drivers of the increase in global mean temperature, known as global warming. No fluorinated gases would be emitted by the project, so we need only look at N_2O, methane and CO_2. There are no federal regulations at this time limiting the emissions of CO_2; however, emissions of N_2O are regulated through limitations of NO_x emissions under NSPS and federal permits. Methane emissions are limited by valve and pipe leak standards.

Emissions of GHGs are typically estimated as carbon equivalents, or carbon dioxide equivalents. The GHGs are ranked by their global warming potential (GWP). The GWP is a ratio relative to CO_2 which is based on the properties of the GHGs to absorb solar radiation as well as the residence time

within the atmosphere (Intergovernmental Panel on Climate Change, 2007). Thus CO_2 has a GWP of 1. Methane has a GWP of approximately 21, and N_2O has a GWP of approximately 310. NorthernStar has estimated the emissions of CO_2 and some of the methane from the project. It should be noted that we do not have estimates of the N_2O and all of the methane emissions so the total amount of GHG equivalents may be larger.

We estimate that construction of the terminal and associated pipeline would emit approximately 146,000 tons of CO_2 during the entire construction period and annual operations would emit an estimated 102,000 tons of CO_2. Although the GHG emissions appear large, the operational emissions are less than 1/100th of 1 percent of the 2006 U.S. Greenhouse Gas Inventory (EPA 2007) of 7.2 Gigatons. The GHG emissions of this natural gas project would be much less than GHG emission for an equivalent oil or coal project, as explained in Section 3.1.1.3.

We received a May 7, 2008 LNG and Natural Gas Review by the ODE (2008b), filed on May 9, 2008 through a letter from the Governor of Oregon. The report included a literature review, summary and comparison of life-cycle assessments of LNG-based natural gas, domestic natural gas, synthetic gas (syngas), and coal. A life-cycle assessment looks at all the CO_2 emitted during the entire "life" of the fuels, from extraction, transportation, processing, and end use. It should be noted that this is very different from the approach the EPA takes in regard to regulation of criteria pollutants, which typically regulate emissions at the point of release. There have been numerous pieces of draft legislation introduced in the United States Senate and House of Representatives that propose in some fashion to regulate the emission of GHG. Some of these draft bills would impose upon importers of fuels some sort of GHG reporting, while others do not and would leave it to the discretion of the EPA. There are two primary regulatory frameworks that have been proposed in the draft legislation. One regulatory framework would be a "cap and trade" system, which would cap the overall emssions while developing a market to buy and sell emission allotments of CO_2. The second approach would impose a carbon tax on fuels, thus penalizing use of the most carbon intensive fuels. This summary is not intended to be a comprehensive list of proposals, merely a brief description of the two primary methods to regulate CO_2. Should the United States government decide to regulate the emission of CO_2 and other GHG, it is not known at this time how the legislation and implementing regulations would be crafted.

Intrinsic in the ODE's analysis is that carbon capture and storage (CCS) would be a viable technology within 20 years. CCS involves removing a portion of the CO_2 from combustion emissions and injecting it into geologic formations so that it does not enter the atmosphere. To this point, only limited trials have been attempted for capturing carbon. Carbon sequestering is not economically or technologically feasible at this time; although it has been used in the production of syngas. The ODE admits that "it is difficult to assess when CCS will become a commercial technology."

The ODE determined that for electric generation, the life-cycle emissions of CO_2 for LNG is approximately the same as for syngas with upstream carbon sequestration, is significantly less than coal, and is greater than domestic sources of natural gas. It should be noted that without the CCS in the syngas creation process, the emissions of CO_2 from the life cycle of syngas are significantly greater than LNG-sourced natural gas. In general we do not dispute the ODE's contention that domestically produced natural gas would have lower life-cycle emissions of CO_2 than LNG-sourced natural gas. However, natural gas from LNG would only produce between 6 to 12 percent more GHG than domestic natural gas transported by interstate pipelines if both were combusted in conventional electric power plants. The ODE added the GHG associated with fuels used to liqueify the natural gas into LNG, ship it long distances in LNG carriers, and vaporize it back into natural gas at the import terminal as part of its equation for determining the life-cycle emissions for LNG.

The ODE contends that the importation and vaporization of LNG would hinder Oregon's effort to meet 1990 levels of GHG by 2020. This determination relies upon a number of assumptions, including: that the LNG facility must also include CO_2 emissions from the transportation of the LNG (and possibly extraction and processing); that the natural gas would be used primarily in Oregon; and that the natural gas would not displace more carbon intensive fuels such as coal and fuel oil. Without federal regulatory guidance, it is difficult for us to postulate what might be required by future GHG rules. While it is certainly possible that the LNG facility may delay meeting Oregon's GHG 2020 target, it is also possible that under systems such as a cap and trade or a carbon tax regulatory framework that it may accelerate Oregon's ability to meet its GHG goals by 2020.

4.10.2 Noise

Noise would be generated by LNG marine traffic along the waterway, during construction and operation of the LNG terminal, and during construction of the pipeline. At any location, both the magnitude and frequency of environmental noise may vary considerably over the course of the day and throughout the week. This variation is caused in part by changing weather conditions and the effects of seasonal vegetative cover. Federal agencies use two measures to relate the time-varying quality of environmental noise to its known effect on people. The $L_{eq(24)}$ is the level of steady sound with the same total (equivalent) energy as the time-varying sound of interest, averaged over a 24-hour period. A second measure, the L_{dn} is calculated by adding 10 dB on the A-weighted scale (dBA) to the nighttime sound levels between the hours of 10 PM and 7 AM to account for the greater sensitivity of people to sound during the nighttime hours. The A-weighted scale is used because human hearing is less sensitive to low and high frequencies than mid-range frequencies.

Noise Regulations

In 1974, the EPA published Information on *Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (EPA, 1974). This publication evaluates the effects of environmental noise with respect to health and safety. The document provides information for state and local governments to use in developing their own ambient noise standards. The EPA has determined that in order to protect the public from activity interference and annoyance outdoors in residential areas, noise levels should not exceed an L_{dn} of 55 dBA. An L_{dn} of 55 dBA is equivalent to a continuous noise level of 48.6 dBA for facilities that operate at a constant level of noise. The FERC has adopted this criterion for new compression and associated facilities, and it is used here to assess the potential noise impact from operation of the LNG terminal.

No noise regulations associated with the adjacent receiving properties have been identified in relation to the waterway for LNG marine traffic.

<u>Oregon Administrative Noise Regulation</u>

The noise program of the ODEQ is promulgated under ORS Chapter 467 and OAR 340-035-035, Noise Control Regulations for Industry and Commerce. While the noise regulations are no longer enforced by the ODEQ, the regulations still remain in effect.

Because the Bradwood Lumber Mill has been abandoned for over 45 years without substantial commercial operations, the site of the proposed LNG terminal would be considered a "Previously Unused Industrial or Commercial Site" as defined in OAR 340-035-0015(47). According to OAR 340-035-035(1)(b)(B), no new noise source should increase ambient noise levels, L_{10} or L_{50}, by more than 10 dBA in 1 hour, or exceed a daytime noise level (7 AM to 10 PM) of L_{50} 55 dBA, L_{10} 60 dBA, or L_1 65 dBA; or a nighttime noise level (10 PM to 7 AM) of L_{50} 50 dBA, L_{10} 55 dBA, or L_1 60 dBA.

OAR 340-035-035 section 5 lists exemptions for emergency equipment, warning devices not operating continuously for more than 5 minutes, sounds that originate on construction sites, and sounds created in construction or maintenance of capital equipment.

The ODEQ noise regulations also have a provision for the designation of "quiet areas" (OAR 340-035-015(50)). However, no indication has been found that such a quiet area has been designated within the general area of the proposed LNG terminal.

Statistical noise level descriptors, such as those cited in the ODEQ regulations (L_{50}, L_{10}, L_1) are nearly impossible to predict without extremely detailed knowledge of exactly what type of equipment would be present and precisely when each piece would be in operation, for how long, and at what load. Instead conservative estimates were constructed above the L_{eq} noise level, and assumptions have been made that the predicted L_{eq} level would be approximately equal to the stated L_{50} level, and the L_{eq} level was used as a basis for determining noise impacts relative to the ODEQ standard.

Clatsop County, Oregon has a noise ordinance that would: 1) restrict blasting with 1,000 feet of a dwelling; and 2) restrict unreasonably loud noise that disturbs the peace and tranquility of any neighborhood or person between the hours of 10 PM and 7 AM. However, this ordinance does not have any quantitative thresholds for noise restrictions.

Washington Administrative Code

The rules establishing maximum permissible noise levels are contained in WAC Chapter 173-60, relating to maximum environmental noise levels. WAC Chapter 173-60 establishes three classes of environmental designations for noise abatement (EDNA), which are the areas or zones within which the maximum permissible noise levels are set. These EDNA zones are defined with respect to land use and can usually be transferred to previously-established classifications in existing zoning ordinances or comprehensive plans.

The maximum environmental noise level from an industrial area (EDNA Class C) at a residential area (EDNA Class A) is 60 dBA during the day and 50 dBA at night (10 PM to 7 AM). Noise from temporary daytime construction activities and blasting is exempt from these limits.

No local noise regulations were identified for either Wahkiakum County, Washington or the town of Cathlamet, Washington.

Threshold Summary

Based on a review of the current regulations the following noise thresholds are identified for comparison with projected noise levels:

- the 55 dBA L_{dn} for any 24-hour period;
- an average daytime L_{eq} of 60 dBA in Washington or 55 dBA in Oregon; and
- an average nighttime (10 PM to 7 AM) Leq of 50 dBA in Washington and Oregon.

4.10.2.1 Waterway for LNG Marine Traffic

Existing Noise Levels

Existing noise levels are dependent on the size, frequency, and type of vessel traffic using the waterway. Ongoing dredging activities also contribute to the overall background noise. Tugs and LNG

carriers are known to produce noise at 61 and 64.3 dBA, respectively, at a distance of 300 feet (FEED Expansion, 2005). When no vessel or dredging activities are present, background noise ranges from rural residential (40 – 45 dBA) to wilderness (35 dBA).

Operational Impacts

As discussed above, the intermittent operation of LNG carriers and tugs in the waterway will contribute to an increase in the background noise level. There would be a temporary noticeable increase in noise to the receptors along the waterway as an LNG carrier and escort vessels pass; however, given the relatively low frequency of ship and tug traffic, the overall day and nighttime-weighted noise level should not change significantly from existing background conditions. The noise levels from LNG carriers and tugs during docking and unloading at the LNG terminal are addressed below under the LNG terminal (see section 4.10.2.2) and the impact on aquatic resources is discussed in sections 4.5.1.1 and 4.6.2.1.

4.10.2.2 LNG Terminal

Existing Noise Levels

A series of long- and short-term noise measurements were conducted at nearby noise-sensitive areas (NSAs) January 4-6, 2006. The nearest NSAs are listed in table 4.10.2-1 and shown on figure 4.10.2-1.

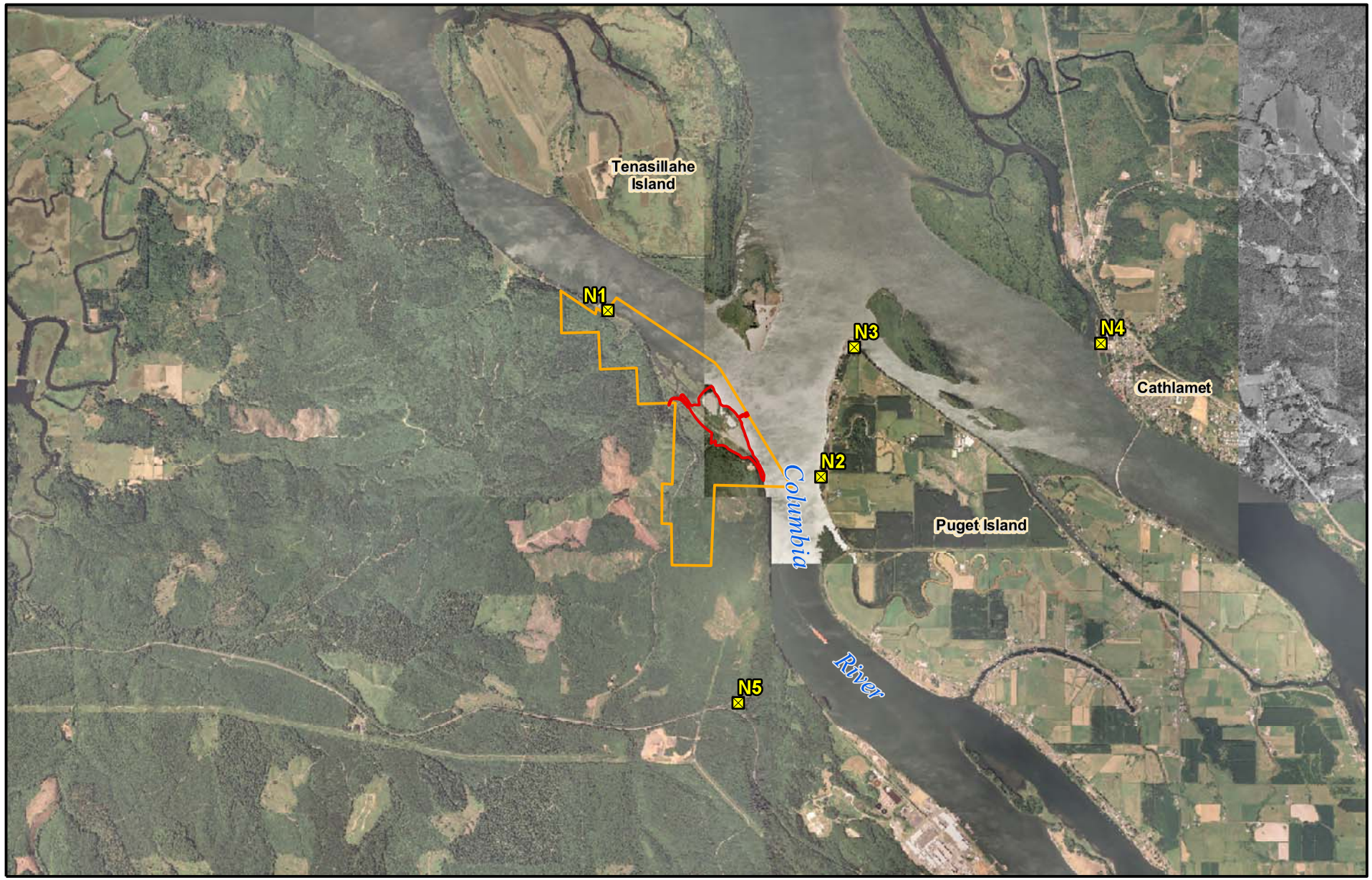
TABLE 4.10.2-1

Nearest Noise-Sensitive Areas

Description	Distance to Property Line	Direction
N1	Directly Adjacent	north
N2	1,000 feet	east
N3	4,224 feet	east
N4	11,880 feet	east
N5	6,067 feet	south

These sites were chosen to be generally representative of the closest noise-sensitive land uses in each general direction from the site. N1, a small cluster of homes off of Clifton Road northwest of the proposed LNG terminal site, was selected to represent the closest NSA to the northwest along the Columbia River. N2, representing a group of riverfront homes on Puget Island, was selected to represent the closest NSAs to the east across the channel on Puget Island. Location N3, near the northern tip of the island but shielded from river-related noise, was selected to be representative of inland sites on Puget Island with lower existing ambient levels, but maximum project related noise. N4, at Elochoman Slough Marina in Cathlamet, Washington, was selected to be representative of a noise-sensitive recreational land use (including picnic areas, boat slips, and RV camping sites). N5, at the Bradley State Scenic Viewpoint, was selected to be the closest recreational NSA to the south of the proposed LNG terminal site. The five identified sites were used for both noise measurements and to predict future noise levels due to proposed LNG terminal construction and operation.

Meteorological conditions during the period available for noise measurements were adequate to obtain sufficient noise measurement data. The noise measurements were sufficient to estimate daytime and nighttime equivalent sound levels (L_{eq}) and day-night noise levels (L_{dn}) for NSAs nearest to the proposed LNG terminal site.



Noise Measurement Location
Terminal Construction Area
Northern Star Property
0 1,500 3,000 6,000 Feet

Figure 4.10.2-1
Bradwood Landing Project
Noise Sensitive Areas / Noise Measurement Locations

Existing audible noise sources were noted during the site visit and noise measurements. In general, the selected noise measurement and analysis sites were representative of typical semi-rural conditions, with a variety of noise sources contributing to the existing ambient noise levels.

The measured daytime and nighttime ambient L_{eq} levels and the calculated L_{dn} levels are summarized in table 4.10.2-2.

TABLE 4.10.2-2

Background Noise Levels at Property Line and Nearest NSAs

Monitoring Location	Day L_{eq} (dBA)	Night L_{eq} (dBA)	L_{dn} (dBA)
N1 – Community of Clifton	44	35	44
N2 - Puget Island Across from the LNG Terminal	43	41	48
N3 - North End of Puget Island	44	38	46
N4 - Cathlamet Marina	51	45	53
N5 - Bradley Scenic Viewshed	52	48	55

Construction and Operational Impacts

Potential impacts from the Bradwood Landing LNG terminal could be caused by short-term increases in noise during construction and increases in noise due to operation of the project in the long term. These potential noise increases were compared with the FERC and local noise standards for permissible noise at NSAs.

Construction Noise

Construction activities associated with the proposed LNG terminal could contribute temporary noise in and around the project area over a 36-month construction period. The most prevalent of these multiple sound sources are engine-driven construction equipment. Examples of these are excavators, compactors, front-end loaders, bulldozers, graders, backhoes, trucks, cranes, forklifts, welding machines, electrical generators, dredges, supply vessels, and tugboats.

Heavy equipment (e.g., bulldozers, loaders, and dump trucks) would be the primary noise source during the excavation phase. Noise levels from construction equipment would typically range from 65 to 85 dBA at 50 feet from the source. Estimated noise levels from typical construction equipment are listed in table 4.10.2-3. Noise generated during excavation would be primarily from diesel engine exhaust.

TABLE 4.10.2-3

Estimated Construction Equipment Noise

Equipment Type	Noise at 50 feet (dBA)
Heavy Equipment	85
Air Compressors	84
Welders	67
Concrete Truck	71
Miscellaneous Trucks (Pick-ups, etc.)	65

Source: EPA, 1971

Typical construction activities would occur between 7 AM and 7 PM, 5 days per week. During concentrated periods, construction may include longer hours and additional days of the week to complete

a particular construction phase more efficiently. For example, pile driving would occur between the hours of 7 AM and 10 PM for an estimated 60 days spread over up to a 4-month period. However, NorthernStar has proposed that all noise-producing construction activities would be limited to daytime hours (7 AM to 10 PM), except for dredging activities (due to limits on the time period over which dredging may occur). Dredging would be conducted for up to 24 hours per day for approximately 48 to72 days near the beginning of the project. Dredging noise is expected to range from 51 to 66 dBA at the nearest NSAs. Due to the nature of the noise from dredging and the length of time, we anticipate significant potential impacts due to noise from dredging activities. To ensure that noise levels at NSAs near the dredging locations sites do not experience significant noise impacts, **we recommend that**:

- **<u>Prior to LNG terminal construction</u>, NorthernStar should file with the Secretary, for review and written approval by the Director of OEP, a finalized dredging noise mitigation plan. This plan should identify all noise mitigation which NorthernStar would implement during dredging to reduce noise at the NSAs. Specifically, during dredging operations NorthernStar should monitor noise and make all reasonable efforts to restrict noise increases from operations to no more than 10 dBA above ambient if the resulting impact is above 55 dBA L_{dn}.**

Some construction activities at the proposed LNG terminal can produce high vibration levels, such as pile driving, sub-grade soil densification, and blasting. However, vibration levels traveling in soil drop off quickly with distance. The ground vibration level for typical pile driving would generally not be perceptible beyond about 500 feet (Hendricks, 2002). Because the closest vibration sensitive areas are approximately 2,500 to 3,000 feet away, construction vibration would be considered imperceptible at all vibration sensitive areas.

Recent technical literature presents a wide variation in underwater source noise levels and acoustical propagation under different conditions. A wide variety of values for impact pile driver noise are given for various driver-type/pile-type combinations. Based on preliminary engineering for the LNG terminal, steel pipe piles with diameters of 48-inch, 54-inch, 84-inch, and 96-inch-diameter steel piles are anticipated to be used for the wharf and mooring or breasting dolphins. Driving 96-inch-diameter steel piles using an impact hammer has been shown to generate peak sound pressure levels of up to 227 dB re: 1 μPa at 16 feet (Hastings and Popper, 2005). However, NorthernStar proposes to implement several measures to minimize underwater sound pressure levels, including the use of vibratory pile drivers, bubble curtains, and pile caps between the hammer and piles (see section 4.5.2.1).

<u>Operational Noise</u>

NorthernStar conducted noise attenuation modeling to predict noise levels that would be generated by operation of the LNG terminal. Activities that could generate noise at the proposed LNG terminal during typical operations would include ship mooring and unloading, and the operation of a number of pumps, compressors, SCVs, fans, and blowers. Equipment noise data from manufacturers and previously completed noise surveys associated with similar equipment was used to estimate the operational noise. The operational equipment list and associated noise sound power levels are presented in table 4.10.2-4.

The LNG carrier was modeled as a line source, and the tugboats were modeled as an area source surrounding the LNG carrier. Both were modeled as operating for 210 minutes per day to represent approximately two LNG carriers coming and unloading per week taking approximately 24 hours each for unloading operations.

TABLE 4.10.2-4

Operational Equipment List

Name (Model Number)	Measurement Type	Sound Power by Center Octave Frequency (Hz)								Overall dBA	Reference Distance
		63	125	250	500	1,000	2,000	4,000	8,000		
BOG Compressor (2DL250-2S_1) [a]	Sound Power Level	77.9	82.9	86.4	82.4	81.9	79.4	75.4	68.4	86.7	1 m
Ignited Relief Valve [a]	Sound Power Level at Stack Tip	136	130	124	117	109	101	93	84	101	1 m
Unignited Relief Valve [a]	Sound Power Level at Stack Tip	48	44	39	34	31	30	33	39	41.6	1 m
SCV [b]	NA	NA	NA	NA	NA	NA	NA	NA	NA	118	1 m
LNG Booster Pump (30-PBA66801) [c]	Sound Power Level	93	94	96	98	96	95	94	89	102	1 m
Instrument Air Compressor (40-CBE95201) [c]	Sound Power Level	93	99	97	100	95	89	93	79	101	1 m
Tugs [d]	Sound Pressure Level	NA	NA	NA	NA	NA	NA	NA	NA	96.6	5 ft
LNG Carrier [d]	Sound Pressure Level	NA	NA	NA	NA	NA	NA	NA	NA	61.8	400 ft

NA not applicable

Sources:

[a] Data provided by NorthernStar and/or Whessoe.

[b] DOT, 2004.

[c] Vista del Sol, 2004.

[d] FEED Expansion, 2005.

The model predicted noise levels at five NSA locations utilizing Scantech Inc.'s Cadna/A software. Modeling results for each of these NSA locations are presented in table 4.10.2-5.

TABLE 4.10.2-5

Predicted L_{dn} Noise Levels at Nearest NSAs

NSA	Distance (feet) and Direction to Property Line	Existing Ambient L_{dn} (dBA)	Predicted Facility Contribution (dBA)	Ambient + Facility (dBA)	Predicted Increase in Ambient (dBA)
N1 - Community of Clifton	Directly Adjacent north	44	40.4	45.6	1.6
N2 - Puget Island Across from LNG Terminal	1,000 east	48	50.2	52.2	4.2
N3 - North End of Puget Island	4,224 east	46	47.9	50.1	4.1
N4 - Cathlamet Marina	11,880 east	53	<35	53	0.0
N5 - Bradley Scenic Viewshed	6,067 south	55	<35	55	0.0

The highest predicted facility noise level is 50.2 dBA L_{dn} at NSA location N2, which is below the FERC L_{dn} of 55 dBA. Noise from the LNG terminal may be perceptible during relatively quiet periods.

To minimize the noise impact on nearby NSAs from LNG terminal operations, NorthernStar would incorporate the following noise attenuation measures, as appropriate, to meet the FERC and local requirements:

- noise barriers or enclosures to block sound transmission from operating equipment;
- valves with "low-noise" trims;
- acoustical insulation for aboveground piping; and
- selection of equipment types with the least noise emissions.

Given the predicted slight exceedance of the state noise limit of L_{eq} of 50 dBA (nighttime) and recognizing that actual results may be different from those obtained from modeling, **we recommend that:**

- **NorthernStar should file a noise survey for the LNG terminal with the Secretary <u>no later than 60 days</u> after placing the LNG terminal in service. If the noise attributable to the operation of the LNG terminal exceeds 55 dBA L_{dn} at any nearby NSAs, NorthernStar should file a report on what changes are needed and should install additional noise controls to meet the level <u>within 1 year</u> of the in-service date. NorthernStar should confirm compliance with these requirements by filing a second noise survey with the Secretary <u>no later than 60 days</u> after it installs the additional noise controls.**

4.10.2.3 Pipeline Facilities

Existing Noise Levels

The proposed Bradwood Landing pipeline would primarily cross a rural landscape of forested open space and farmland. However, the Wauna Mill is located between approximate MPs 3.0 to 4.0 and the PGE Beaver Power Plant is situated near the Columbia River crossing at MP 19.0. The only potential NSAs are residences along the route. On the Oregon portion of the corridor, three residences are con firmed within 50 feet of the proposed pipeline construction work area, based on property access (see table 4.7.3-7). There are more rural residences and low-density rural/suburban subdivisions along the Washington portion of the corridor, including six structures within 50 feet of the pipeline construction work area (see table 4.7.3-7).

HDD operations would create noise during construction of the pipeline and pressure reduction valves would create intermittent noise during operation of the pipeline. Existing sound levels for each of the HDD sites and pressure reduction valve sites are presented in tables 4.10.2-6 and 4.10.2-7. In all cases, existing sound levels were estimated. Noise levels were estimated based on low density, rural land use patterns except where major highways are near the nearest NSA. Where highways are nearby, noise levels were estimated based on traffic volumes.

Day ($L_{eq(day)}$) and night ($L_{eq(night)}$) equivalent sound levels for rural areas were estimated from measurements presented in *Community Noise* (EPA, 1971). Day-night average sound levels for areas near highways were calculated using methodology from *Noise Assessment Guidelines* (U.S. Department of Housing and Urban Development (HUD), 1984).

Construction and Operational Impacts

Potential impacts from the Bradwood Landing pipeline could be caused by short-term increases in noise during construction and increases in noise at valve sites due to operation of the project in the long term.

TABLE 4.10.2-6

Existing Sound Levels for HDD Sites

Location	Drill No.	Site Type	Work Days	NSA Distance (feet)	NSA Direction	Existing Noise Levels (dBA) $L_{(day)}$	$L_{(night)}$	L_{dn}
Bradwood Landing LNG Terminal	1	Entry	305	3,100	east	39	32	40.4
		Exit	305	4,000	east	39	32	40.4
Wauna Mill	2	Entry	19	2,300	southeast	NA [a]	NA [a]	58.5
		Exit	19	1,000	south	NA [a]	NA [a]	58.5
Driscoll Slough	3	Entry	32	500	south	39	32	40.4 [b]
		Exit	32	900	west	39	32	40.4 [b]
Westport Slough	4	Entry	40	2,700	east	39	32	40.4
		Exit	40	300	north	39	32	40.4
Woodson Rd. and Drainage Dist. Channel	5	Entry	19	400	north	39	32	40.4
		Exit	19	700	north	39	32	40.4
Midland Canal	6	Entry	19	1,000	northwest	39	32	40.4
		Exit	19	1,800	northeast	39	32	40.4
Clatskanie River	7	Entry	19	30	southwest	39	32	40.4
		Exit	19	1,700	west	39	32	40.4
Columbia River	8	Entry	37	500	north	NA [a]	NA [a]	46.5
		Exit	37	3,500	north	39	32	40.4 [c]
Creek	9	Entry	52	450	south	39	32	40.4
		Exit	23	400	southwest	39	32	40.4
Creek	10	Entry	52	450	south	39	32	40.4
		Exit	29	200	north	39	32	40.4
Germany Creek	11	Entry	12	750	southwest	39	32	40.4
		Exit	12	1,800	east	39	32	40.4
Cowlitz River	12	Entry	23	300	south	NA [a]	NA [a]	65.0
		Exit	23	600	east	39	32	40.4
Interstate Hwy 5	13	Entry	12	100	southeast	NA [a]	NA [a]	71.6
		Exit	12	300	west	NA [a]	NA [a]	40.4

[a] L_{dn} based on traffic volumes on nearby highways using HUD (1984) methodology; L_d and L_n are not estimated separately in this method.

[b] Noise levels based on "rural" land use; actual levels may be higher due to proximity to the Wauna Mill northwest of the drill site.

[c] Noise levels based on "rural" land use; actual levels may be higher due to proximity to the nearby tank farm.

TABLE 4.10.2-7

Existing Sound Levels for Valve Sites

Location	Valve No.	NSA Distance (feet)	NSA Direction	$L_{eq(day)}$ (dBA)	$L_{eq(night)}$ (dBA)	L_{dn} (dBA)
Georgia-Pacific Wauna Mill	1	1,000	south	NA	NA	58.5
Northwest Natural	2	400	north	39	32	40.4
PGE Beaver Power Plant	3	3,100	north	39	32	40.4
Williams Northwest Pipeline	4	400	southwest	39	32	40.4

Construction Noise

Construction activities associated with the proposed pipeline could contribute temporary noise in and around the project area. Increases in noise levels during construction of the pipeline would be limited to areas close to the construction activity. The magnitude of the impact would depend on the noise level generated by various equipment types, duration of the construction activity, and distance between the noise source and the receptor. Construction equipment would include miscellaneous trucks, bulldozers, backhoes, and side-boom tractors. Noise levels from construction equipment would typically range from 65 to 85 dBA at 50 feet from the source. At the nearest NSA, which is located about 23 feet from the pipeline centerline, noise levels could range as high as 79 to 99 dBA, assuming a worst-case scenario of equipment passing within 10 feet of the residence.

Impacts due to construction noise would be short term and temporary at any one place because of the assembly line method of pipeline construction. Pipeline construction activity would be limited to daytime hours between 7 AM and 7 PM, which would further minimize noise impacts. However, 24-hour HDD operations may be necessary at some locations depending on conditions. In these instances, measures such as use of "critical" class equipment mufflers or temporary noise barriers would be used to mitigate impacts on nearby residences. Consequently we believe that noise associated with pipeline construction would have minimal impacts on residences along the construction right-of-way.

Estimated noise levels for the entry locations of the HDD operations are presented in table 4.10.2-8. Noise levels at the HDD exit locations would be very similar to normal pipeline construction noise levels.

Noise levels for entry locations were based on actual field measurements at a large diameter pipeline directional drilling operation. As noted in table 4.10.2-8, noise effects were estimated for three different levels of noise control, one with "standard" mufflers, one with "critical" class mufflers (term from Caterpillar), and one with both "critical" class mufflers plus a temporary noise barrier. All of the jurisdictions crossed by the proposed pipeline have exemptions from noise regulations for construction activities.

HDD activities would generate noise impacts on the surrounding area. Each borehole would take from several days to weeks to complete and the drilling equipment would operate 24 hours per day. There is a significant potential for high nighttime noise levels at several HDD locations resulting from these construction activities. As indicated in table 4.10.2-8, without significant mitigation, noise can exceed 55 dBA at NSAs at most of the HDD sites. A noise increase of 3 dBA is rarely noticed, whereas a noise increase of 6 dBA is noticeable and a 10 dBA increase is perceived as a doubling of ambient sound. NorthernStar has prepared an HDD noise mitigation plan identifying the noise mitigation measures to be implemented during HDD activities to reduce noise levels at nearby NSAs. The plan provides for NorthernStar to monitor noise during HDD activities and make all reasonable efforts to restrict noise increases from HDD operations to no more than 10 dBA above ambient noise levels if the resulting impact is above 55 dBA L_{dn}. To ensure that noise levels at NSAs near the HDD sites do not experience significant noise impacts, **we recommend that:**

- **<u>Prior to pipeline construction</u>, NorthernStar should file with the Secretary, for the review and written approval of the Director of OEP, a finalized noise mitigation plan for HDD sites Nos. 3, 5, 7, 8, 9, 10, 11, 12, 13, as identified in table 4.10.2-6 of the final EIS. This plan should identify all noise mitigation that NorthernStar would implement during drilling activity to reduce noise at any nearby NSAs. Specifically, during HDD operations NorthernStar should monitor noise and make all reasonable efforts to restrict noise increases from HDD operations to no more than 10 dBA above ambient if the resulting impact is above 55 dBA L_{dn}.**

TABLE 4.10.2-8

Estimated Sound Levels for HDD Sites

Location	Drill No.	Site Type	Work Days	NSA Distance (feet)	NSA Direction	HDD Noise (dBA) Standard [a]	Critical [b]	Barrier [c]
Bradwood Landing LNG Terminal	1	Entry	305	3,100	East	49.1	37.1	28.6
		Exit	305	4,000	East	NA	NA	NA
Wauna Mill	2	Entry	19	2,300	southeast	52.4	40.4	30.6
		Exit	19	1,000	South	NA	NA	NA
Driscoll Slough	3	Entry	32	500	South	65.8	53.8	42.7
		Exit	32	900	West	NA	NA	NA
Westport Slough	4	Entry	40	2,700	East	53.8	41.8	32.0
		Exit	40	300	North	NA	NA	NA
Woodson Rd. and Drainage Dist. Channel	5	Entry	19	400	North	67.5	55.5	44.2
		Exit	19	700	North	NA	NA	NA
Midland Canal	6	Entry	19	1,000	northwest	60.9	48.9	38.3
		Exit	19	1,800	northeast	NA	NA	NA
Clatskanie River	7	Entry	19	30	southwest	73.9	61.9	49.0
		Exit	19	1,700	West	NA	NA	NA
Columbia River	8	Entry	37	500	North	67.5	55.5	44.2
		Exit	37	3,500	North	NA	NA	NA
Creek	9	Entry	52	450	South	66.6	54.6	43.4
		Exit	23	400	southwest	NA	NA	NA
Creek	10	Entry	52	450	South	66.6	54.6	43.4
		Exit	29	200	North	NA	NA	NA
Germany Creek	11	Entry	12	750	southwest	62.5	50.5	39.8
		Exit	12	1,800	East	NA	NA	NA
Cowlitz River	12	Entry	23	300	South	72.2	60.2	47.9
		Exit	23	600	East	NA	NA	NA
Interstate Hwy 5	13	Entry	12	100	southeast	73.9	61.9	49.0
		Exit	12	300	West	NA	NA	NA

[a] HDD engines fitted with standard mufflers.
[b] HDD engines fitted with critical mufflers; increases attenuation by approximately 12 dBA.
[c] HDD engines fitted with critical mufflers and shielded by temporary barriers.
NA not applicable

Operational Noise

Operation of the proposed pipeline would generate noise at only four locations where pressure reduction valves for taps would be located aboveground. A valve supplier has indicated the maximum sound pressure level for the valve type would be approximately 115 dBA at 3 feet from the valve. Because these facilities would operate 24 hours per day, it would be necessary to meet the nighttime standards specified in the applicable noise codes. Table 4.10.2-9 provides a summary of the estimated noise associated with the valves at the nearest NSAs. Noise attenuation would be provided to meet the 55 dBA L_{dn} noise standard.

TABLE 4.10.2-9

Estimated Sound Levels for Valve Sites

Location	Valve No.	NSA Distance (feet)	NSA Direction	Standard (dBA)	7 dB [a] Attenuation (dBA)	15 dB [a] Attenuation (dBA)
Wauna Mill	1	1,000	south	62.5	55.5	47.5
Northwest Natural	2	400	north	71.9	64.9	56.9
PGE Beaver Power Plant	3	3,100	north	48.3	41.3	33.3
Williams Northwest Pipeline	4	400	southwest	71.9	64.9	56.9

[a] The manufacturer refers to noise attenuation of 7 dB as "Type 1" attenuation and 15 dB as "Type 2" attenuation.

Based on the preliminary engineering and the noise estimates shown above, the Northwest Natural and Williams Northwest pipeline valves would likely require additional noise control beyond selection of particular valve types. When detailed engineering evaluations are developed, the noise estimates for the NSAs near these two valves will be reevaluated. If necessary, the valves would be provided with enclosures to ensure the noise levels are below applicable standards. NorthernStar has prepared a noise mitigation plan for the Wauna Mill, Northwest Natural, and Williams Northwest pipeline valves to reduce noise at the NSAs to meet 55 dBA L_{dn}. Due to the potential for significant permanent impacts at homes near to these valve sites, **we recommend that:**

- **NorthernStar should file noise surveys with the Secretary <u>no later than 60 days</u> after placing the Wauna Mill, Northwest Natural, PGE Beaver Power Plant, and Williams Northwest pipeline valves into service. If the noise attributable to the operation of the authorized pipeline valves exceeds an L_{dn} of 55 dBA at any nearby NSAs, NorthernStar should file a report on what changes are needed and shall install the additional noise controls to meet the level <u>within 1 year</u> of the in-service date. NorthernStar should confirm compliance with the above requirement by filing a second noise survey with the Secretary <u>no later than 60 days</u> after it installs the additional noise controls.**

If NorthernStar verifies that noise impacts have been mitigated, as indicated by the recommendations, we believe that the construction and operation of the Bradwood Landing Project would not result in significant noise impacts on local residents.

4.11 RELIABILITY AND SAFETY

Three federal agencies share in the oversight of the safety and security of LNG import terminals: the FERC, the Coast Guard, and the DOT. The FERC authorizes the siting and construction of LNG import terminals and is the lead federal agency under NEPA to analyze the environmental, safety, security, and cryogenic design of proposed facilities. The Coast Guard has authority over safety of the LNG marine traffic and the marine transfer area. The Coast Guard also has authority over security of the LNG carriers and the entire LNG facility. In conjunction with this, the Coast Guard determines the suitability of waterways for LNG marine traffic by issuing an LOR. The DOT has exclusive authority to promulgate and enforce safety regulations and standards over the onshore LNG facilities beginning at the last valve immediately before the LNG storage tanks.

In February 2004, the three participating agencies entered into an Interagency Agreement to assure that they work in a coordinated manner to address the full range of issues regarding safety and security at LNG import terminals, including the terminal facilities and tanker operations, and to maximize the exchange of information related to the safety and security aspects of the LNG facilities and related marine operations. The FERC closely coordinates its pre-authorization review of the proposal with the Coast Guard and the DOT to ensure a seamless safety and security review.

The operation of the proposed Bradwood Landing LNG terminal poses a potential hazard that could affect the public safety without strict design and operational measures to control potential accidents. The primary concerns are those events that could lead to an LNG spill of sufficient magnitude to create an off-site hazard, including events occurring during the course of LNG carrier transits. However, it is also important to recognize the stringent requirements for the design, construction, operation and maintenance of the facility as well as the extensive safety systems to detect and control potential hazards.

With the exception of the October 20, 1944 fire at the LNG facility in Cleveland, Ohio, the operating history of U.S. LNG facilities has been free of LNG safety-related incidents resulting in adverse effects to the public or the environment. The 1944 Cleveland incident was attributed to the use of materials inadequately suited for cryogenic temperatures and the lack of spill impoundments at the site.[25] More recently, an operational accident occurred in 1979 at the Cove Point LNG facility in Lusby, Maryland, when a pump seal failed, resulting in gas vapors entering an electrical conduit and settling in a confined space. When a worker switched off a circuit breaker, the gas ignited, resulting in heavy damage to the building and a worker fatality. Lessons learned from this accident resulted in changing the national fire codes, with the participation of the FERC, to ensure that the situation would not occur again. The proposed facilities would be designed, constructed, and operated in compliance with these codes.

On January 19, 2004, a blast occurred at Sonatrach's Skikda, Algeria LNG liquefaction facility that killed 27 and injured 56 workers. No members of the public were injured. Preliminary findings of the accident investigation suggest that a cold hydrocarbon leak occurred at Liquefaction Train 40 and was introduced to the high-pressure steam boiler by the combustion air fan. An explosion developed inside the boiler firebox which subsequently triggered a larger explosion of the hydrocarbon vapors in the immediate vicinity. The resulting fire damaged the adjacent liquefaction process and liquefied petroleum gas separation equipment of Train 40, and spread to Trains 20 and 30. Although Trains 10, 20, and 30 had been modernized in 1998-1999, Train 40 had been operating with its original equipment since start-up in 1981.

Although there are major differences between the equipment involved in the accident at Skikda and that proposed by NorthernStar (i.e., high-pressure steam boilers that power refrigerant compressors

[25] For a description of the incident and the findings of the investigation, see "Report on the Investigation of the Fire at the Liquefaction, Storage, and Regasification Plant of the East Ohio Gas Co., Cleveland, Ohio, October 20, 1944," U.S. Bureau of Mines. February 1946.

would not be used here nor are they used at any LNG facility under the FERC's jurisdiction), the sequence of cascading events identifies potential failure modes that warrant further evaluation. As a result, we have provided a recommendation in section 4.11.2, *Cryogenic Design and Technical Review*, to address this issue.

A discussion of the principal properties and hazards associated with LNG is presented in section 4.11.1. A summary of our preliminary design and technical review of the cryogenic aspects of the LNG terminal is presented in section 4.11.2. Storage and retention systems are discussed in section 4.11.3. An analysis of the thermal radiation and flammable vapor cloud hazards resulting from a credible land-based LNG spill is presented in section 4.11.4, while the safety aspects of LNG transportation by ship is discussed and summarized in section 4.11.5. Emergency response and evacuation planning is discussed in section 4.11.6, and conclusions on marine safety is discussed in section 4.11.7. A discussion on security awareness related to terrorism is presented in section 4.11.8 and the reliability and safety issues related to the natural gas pipeline are discussed in section 4.11.9.

4.11.1 LNG Hazards

LNG's principal hazards result from its cryogenic temperature (-260° F), flammability, and vapor dispersion characteristics. As a liquid, LNG will neither burn nor explode. Although it can cause freeze burns and, depending on the length of exposure, more serious injury or death, its extremely cold state does not present a significant hazard to the public, which rarely, if ever, comes in contact with it as a liquid. As a cryogenic liquid, LNG will quickly cool materials it contacts, causing extreme thermal stress in materials not specifically designed for ultra-cold conditions. Such thermal stresses could subsequently subject the material to brittleness, fracture, or other loss of tensile strength. These hazards, however, are not substantially different from the hazards associated with the storage and transportation of liquid oxygen (-296° F) or several other cryogenic gases that have been routinely produced and transported in the United States.

LNG vaporizes rapidly when exposed to ambient heat sources such as water or soil. When released from its containment vessel and/or transfer system, LNG will generally produce 620 to 630 standard cubic feet of natural gas for each cubic foot of liquid. A large quantity of LNG spilled without ignition would form a vapor cloud that would travel with the prevailing wind until it either dispersed below the flammable limits or encountered an ignition source. If a large quantity of LNG is spilled in the presence of an ignition source, the resulting pool fire would produce high levels of radiant heat in the area surrounding the LNG pool.

A rapid phase transition (RPT) can occur when a portion of LNG spilled onto water changes from liquid to gas, virtually instantaneously. Unlike an explosion that releases energy and combustion products from a chemical reaction, an RPT is the result of heat transferred to the liquid inducing a change to the vapor state. The rapid expansion from the liquid to vapor state can cause locally large overpressures. RPTs have been observed during LNG test spills onto water. In some test cases, the events were strong enough to damage test equipment in the immediate vicinity of the LNG release point. The sizes of the overpressure events have been generally small and are estimated to be equivalent to several pounds of trinitrotoluene (TNT). Although such a small overpressure is not expected to cause significant damage to an LNG vessel, the RPT may increase the rate of LNG pool spreading and the LNG vaporization rate for a spill on water. The Government Accounting Office (GAO) released a report in February 2007 (GAO 2007 [GAO Report]) presenting a survey of experts in areas related to LNG risk, hazards, and consequence modeling. As presented in Appendix III of the GAO Report, the 19 LNG risk and hazard experts unanimously agreed that RPT "would be very unlikely to have a direct effect on the public"

Methane vapors, the primary component of natural gas, are colorless, odorless and tasteless, and are classified as a simple asphyxiant. Methane vapors may cause extreme health hazards, including death, if inhaled in significant quantities within a limited time. Although very cold methane vapors may cause freeze burns, any cloud resulting from an LNG spill would be continuously mixing with the warmer air surrounding the spill site. Dispersion modeling indicates the majority of the cloud would generally be within 25° F of the surrounding atmospheric temperature, with colder temperatures closest to the spill source. In addition, this modeling estimates that most of the cloud would be below concentrations resulting in oxygen deprivation effects, including asphyxiation, with the highest methane concentrations closest to the spill source. Therefore, asphyxiation and freezing normally represent a negligible risk to the public from LNG facilities. Also, as presented in Appendix III of the GAO Report, the 19 LNG risk and hazard experts unanimously agreed that asphyxiation would represent a negligible risk to the public.

Although LNG will not burn, methane vapors in a 5 to 15 percent mixture by volume with air are flammable. Once a flammable vapor-air mixture from an LNG spill has been ignited, the flame front will propagate back to the spill site if the vapor concentration along this path is sufficiently high to support the combustion process. Combustible materials within the flammable portion of the cloud may be within the flame and could be ignited. However, any events leading to a containment failure would most likely be accompanied by a number of ignition sources. The result would be an LNG pool fire, and subsequent radiant heat hazards, rather than the formation of a large unconfined vapor cloud.

Although, LNG is not explosive as it is normally transported and stored, natural gas vapors (primarily methane) can explode if contained within a confined space, such as a building or structure, and ignited. Occasionally, various parties have expressed the energy content of an LNG storage tank, or LNG carrier, in equivalent tons of TNT as an implied measure of explosive potential. However, such a simplistic analogy fails to consider that explosive forces are not just a function of the total energy content but also of the rate of energy release. For a detonation to occur, the rate of energy release must be nearly instantaneous, such as with a TNT charge initiated by a blasting cap. Unlike TNT or other explosives which inherently contain an oxidizer, an unconfined vapor cloud must be mixed with oxygen within the flammability range of the fuel for combustion to occur. For a large unconfined vapor cloud, the flammability range tends to exist at the mixing zone at the edges of the cloud. When ignited, flame speeds about 20 to 25 meters per second (66 to 82 ft/s) and local over pressures up to 0.2 psig have been estimated for unconfined methane-rich vapor clouds, well below the flame speeds and over pressures associated with detonation.

The potential for unconfined LNG vapor cloud detonations was investigated by the Coast Guard in the late 1970s at the Naval Weapons Center at China Lake, California. These experiments, as well as other subsequent tests, are mentioned in Appendix C of the Sandia Report. Using methane, the primary component of natural gas, several experiments were conducted to determine if unconfined vapor clouds would detonate. The tests indicated unconfined methane-air mixtures could be ignited, but no test produced unconfined detonation. There is no evidence suggesting that methane-air mixtures will detonate in unconfined open areas.

Further tests were conducted in the late 1970s to examine the level of sensitivity of an unconfined cloud to the presence of heavier hydrocarbons such as ethane and propane. As stated in section 5 of Appendix C of the Sandia Report, detonation sensitivity is affected by the level of refinement of natural gas stored as LNG. The series of tests on ambient-temperature fuel mixtures of methane-ethane and methane-propane indicated that the addition of heavier hydrocarbons influenced the tendency of an unconfined vapor cloud to detonate. Less processed product with greater amounts of heavier hydrocarbons is more sensitive to detonation. During these experiments, all successful detonations were initiated with an explosive charge in well-mixed vapor clouds at correct stoichiometric proportions. These are not representative of conditions which would be expected during a large-scale LNG spill. The

precise timing, necessary mixing, and required amount of initiating explosives render the possibility for detonation of a large unconfined vapor cloud as unrealistic. Detonation of an unconfined natural gas cloud is extremely difficult to achieve and is generally considered by scientists and researchers to be very unlikely to occur during an LNG spill.

Consequently, the primary hazards to the public from an LNG spill either on land or water would be from dispersion of the flammable vapors or from radiant heat generated by a pool fire.

4.11.2 Cryogenic Design and Technical Review

As part of its application and in response to the FERC staff's data requests, NorthernStar provided a front-end engineering design (FEED) for the proposed project. The FEED and technical review emphasizes the engineering design and safety concepts as well as the projected operational reliability of the proposed facilities. The principle areas of coverage include: materials in cryogenic environments; insulation systems; cryogenic safety; thermodynamics; heat transfer; instrumentation; cryogenic processes; and other relevant safety systems.

Study and evaluation of information for the proposed design and installation of the Bradwood Landing LNG terminal have been performed by the FERC staff. The FEED and specifications submitted for the proposed facilities to date are considered to be preliminary but would be the basis for any detailed design to follow. Although preliminary, this filed information provides an adequate basis to evaluate the safety and reliability of the proposed project. A significant amount of the design involving final selection of equipment manufacturers, process conditions, and resolution of some safety related issues would be completed in the next phase of the project development if authorization is granted by the Commission. This information would need to be filed with the FERC staff for review and approval.

As a result of the technical review of the information provided by NorthernStar in the submittal documents, a number of concerns were identified by the FERC staff relating to the reliability, operability, and safety of the proposed design. In response to the staff's questions, NorthernStar provided written responses prior to the technical conference held on September 13, 2006, and in a subsequent submittal on October 25, 2006, with revised FEED information. After review of the revised information, the FERC staff notes several areas of concern that require additional consideration and/or action on behalf of the company. Follow up on those items requiring additional action should be documented in reports to be filed with the FERC. As a result, **we recommend that:**

The following measures should apply to NorthernStar LNG Terminal design and construction details. Information pertaining to these specific recommendations should be filed with the Secretary for review and approval by the Director of OEP either: prior to initial site preparation; prior to construction of final design; prior to commissioning; or prior to commencement of service as indicated by each specific condition. Specific engineering, vulnerability, or detailed design information meeting the criteria specified in Order No. 683 (Docket No. RM06-24-000), including security information, should be submitted as critical energy infrastructure information (CEII) pursuant to 18 CFR 388.112. *See Critical Energy Infrastructure Information*, Order No. 683, 71 Fed. Reg. 58,273 (October 3, 2006). FERC Stats. & Regs. ¶ 31,228 (2006). Information pertaining to items such as: offsite emergency response; procedures for public notification and evacuation; and construction and operating reporting requirements would be subject to public disclosure. This information should be submitted a minimum of 30 days before approval to proceed is required.

- **Complete plan drawings and a list of the hazard detection equipment should be filed <u>prior to initial site preparation</u>. The list should include the instrument tag number,**

type and location, alarm locations, and shutdown functions of the proposed hazard detection equipment. Plan drawings should clearly show the location of all detection equipment.

- **NorthernStar should provide a technical review of its proposed facility design that:**

  a. identifies all combustion/ventilation air intake equipment and the distances to any possible hydrocarbon release (LNG, flammable refrigerants, flammable liquids and flammable gases); and

  b. demonstrates that these areas are adequately covered by hazard detection devices and indicate how these devices would isolate or shutdown any combustion equipment whose continued operation could add to or sustain an emergency.

  NorthernStar should file this review <u>prior to initial site preparation</u>.

- **Complete plan drawings and a list of the fixed and wheeled dry-chemical, fire extinguishing, and other hazard control equipment should be filed <u>prior to initial site preparation</u>. The list should include the equipment tag number, type, size, equipment covered, and automatic and manual remote signals initiating discharge of the units. Plan drawings should clearly show the planned location of all fixed and wheeled extinguishers.**

- **Facility plans showing the proposed location of, and area covered by, each monitor, hydrant, deluge system, hose, and sprinkler, as well as piping and instrumentation diagrams, of the firewater system should be filed <u>prior to initial site preparation</u>.**

- **A copy of the hazard design review and list of recommendations that are to be incorporated in the final facility design should be filed <u>prior to initial site preparation</u>.**

- **The <u>final design</u> of the fixed and wheeled dry-chemical, fire extinguishing hazard control equipment should identify manufacturer and model.**

- **The <u>final design</u> should include an updated fire protection evaluation carried out in accordance with the requirements of NFPA 59A, 2001 edition, chapter 9.1.2.**

- **The <u>final design</u> should include a minimum of eight permanent bench marks located equally spaced around the top of the concrete base slab for each LNG tank.**

- **The <u>final design</u> should include a discretionary vent valve for each LNG tank, operable through the distributed control system.**

- **The <u>final design</u> should include a shutoff valve at the suction and discharge of each high pressure LNG pump.**

- **The <u>final design</u> should specify that dual temperature elements and transmitters are provided for low temperature alarm and shutdown at the discharge of each vaporizer.**

- **The final design should include a check valve between the LNG vaporizer discharge shutoff valve and the discharge manual isolation valve.**

- **The final design should include a pilot relief valve or operated vent valve sized for thermal relief at the discharge of the vaporizer.**

- **The final design should include provisions for the future installation of LNG pumps for the vapor return KO drum and the boil-off compressor suction drum.**

- **The final design should specify that for LNG and natural gas service, branch piping and piping nipples less than 2 inches are to be no less than schedule 160.**

- **The final design should specify that spiral wound gaskets for LNG, natural gas service, or other hydrocarbon fluid service are to be equipped with inner and outer stainless steel retaining rings.**

- **The final design should specify that piping and equipment that may be cooled with liquid nitrogen are to be designed for liquid nitrogen temperatures, with regard to allowable movement and stresses.**

- **The final design should specify that the wharf area switchboards are connected to the backup generator.**

- **The final design should include details of the shutdown logic, including cause and effect matrices for alarms and shutdowns.**

- **The final design should include emergency shutdown of equipment and systems activated by hazard detection devices for flammable gas, fire, and cryogenic spills, when applicable.**

- **The final design should include details of the air gaps to be installed downstream of all seals or isolations installed at the interface between a flammable fluid system and an electrical conduit or wiring system. Each air gap should vent to a safe location and be equipped with a leak detection device that: should continuously monitor for the presence of a flammable fluid; should alarm the hazardous condition; and should shut down the appropriate systems.**

- **The final design should include a hazard and operability review of the completed design. A copy of the review and a list of the recommendations should be filed with the Secretary.**

- **The final design should provide up-to-date Piping & Instrument Diagrams (P&IDs) including a description of the instrumentation and control philosophy, type of instrumentation (pneumatic, electronic), use of computer technology, and control room display and operation. Drawings and all information should be clearly legible on 11- by 17-inch paper and the piping legend and symbology should be in accordance with accepted practice. All drawings should be filed in black and white. The following information should be included on the P&IDs:**

  a. equipment tag number, name, size, duty, capacity and design conditions;

b. **piping with line number, piping class specification, size and insulation;**

c. **LNG tank pipe penetration size or nozzle schedule;**

d. **piping specification breaks and insulation limits;**

e. **isolation flanges, blinds and insulating flanges;**

f. **valve type, in accordance with the piping legend symbol;**

g. **all control valves numbered;**

h. **all valve operator types and valve fail position;**

i. **instrumentation numbered;**

j. **control loops including software connections;**

k. **alarm and shutdown set points;**

l. **shutdown interlocks;**

m. **relief valves numbered, with set point;**

n. **relief valve inlet and outlet piping size;**

o. **car sealed valves and blinds;**

p. **equipment insulation;**

q. **drawing revision number and date;**

r. **all manual valves numbered, including check, vent, drain, and car sealed valves; and**

s. **alarm and shutdown set points.**

- **The final design should specify that all hazard detection equipment should include redundancy, fault detection, and fault alarm monitoring.**

- **All valves including drain, vent, main, and car sealed valves should be tagged in the field during construction and prior to commissioning.**

- **The design details and procedures to record and to prevent the tank fill rate from exceeding the maximum fill rate specified by the tank designer should be filed prior to commissioning.**

- **A tabulated list of the proposed hand-held fire extinguishers should be filed prior to commissioning. The information should include a list with the equipment number, type, size, number, and location. Plan drawings should include the type, size, and number of all hand-held fire extinguishers.**

- **Operation and Maintenance procedures and manuals, as well as safety procedure manuals, should be filed prior to commissioning.**

- **The FERC staff should be notified of any proposed revisions to the security plan and physical security of the facility prior to commencement of service.**

- **Progress on construction of the LNG terminal should be reported in monthly reports filed with the Secretary. Details should include a summary of activities, projected schedule for completion, problems encountered and remedial actions taken. Problems of significant magnitude should be reported to the FERC <u>within 24 hours</u>.**

In addition, the following measures should apply throughout the life of the facility:

- **The facility should be subject to regular FERC staff technical reviews and site inspections on at least an annual basis or more frequently as circumstances indicate. Prior to each FERC staff technical review and site inspection, NorthernStar should respond to a specific data request including information relating to possible design and operating conditions that may have been imposed by other agencies or organizations. Up-to-date detailed piping and instrumentation diagrams reflecting facility modifications and provision of other pertinent information not included in the semi-annual reports described below, including facility events that have taken place since the previously submitted semi-annual report, should be submitted.**

- **<u>Semi-annual</u> operational reports should be filed with the Secretary to identify changes in facility design and operating conditions, abnormal operating experiences, activities (including ship arrivals, quantity and composition of imported LNG, vaporization quantities, boil-off/flash gas, etc.), plant modifications including future plans and progress thereof. Abnormalities should include, but not be limited to: unloading/shipping problems, potential hazardous conditions from off-site vessels, storage tank stratification or rollover, geysering, storage tank pressure excursions, cold spots on the storage tanks, storage tank vibrations and/or vibrations in associated cryogenic piping, storage tank settlement, significant equipment or instrumentation malfunctions or failures, non-scheduled maintenance or repair (and reasons therefore), relative movement of storage tank inner vessels, vapor or liquid releases, fires involving natural gas and/or from other sources, negative pressure (vacuum) within a storage tank and higher than predicted boiloff rates. Adverse weather conditions and the effect on the facility also should be reported. Reports should be submitted <u>within 45 days</u> after each period ending <u>June 30 and December 31</u>. In addition to the above items, a section entitled "Significant plant modifications proposed for the next 12 months (dates)" also should be included in the semi-annual operational reports. Such information would provide the FERC staff with early notice of anticipated future construction/maintenance projects at the LNG facility.**

- **In the event the temperature of any region of any secondary containment becomes less than the minimum specified operating temperature for the material, the Commission should be notified <u>within 24 hours</u> and procedures for corrective action should be specified.**

- **Significant non-scheduled events, including safety-related incidents (i.e., LNG or natural gas releases, fires, explosions, mechanical failures, unusual over pressurization, and major injuries) and security related incidents (i.e., attempts to enter site, suspicious activities) should be reported to the FERC staff. In the event an abnormality is of significant magnitude to threaten public or employee safety, cause significant property damage, or interrupt service, notification shall be made <u>immediately</u>, without unduly interfering with any necessary or appropriate**

emergency repair, alarm, or other emergency procedure. In all instances, notification should be made to the Commission staff <u>within 24 hours</u>. This notification practice should be incorporated into the LNG facility's emergency plan. Examples of reportable LNG-related incidents include:

a. fire;

b. explosion;

c. estimated property damage of $50,000 or more;

d. death or personal injury necessitating in-patient hospitalization;

e. free flow of LNG that results in pooling;

f. unintended movement or abnormal loading by environmental causes, such as an earthquake, landslide, or flood, that impairs the serviceability, structural integrity, or reliability of an LNG facility that contains, controls, or processes gas or LNG;

g. any crack or other material defect that impairs the structural integrity or reliability of an LNG facility that contains, controls, or processes gas or LNG;

h. any malfunction or operating error that causes the pressure of a pipeline or LNG facility that contains or processes gas or LNG to rise above its maximum allowable operating pressure (or working pressure for LNG facilities) plus the build-up allowed for operation of pressure limiting or control devices;

i. a leak in an LNG facility that contains or processes gas or LNG that constitutes an emergency;

j. inner tank leakage, ineffective insulation, or frost heave that impairs the structural integrity of an LNG storage tank;

k. any condition that could lead to a hazard and cause a 20 percent reduction in operating pressure or shutdown of operation of a pipeline or an LNG facility;

l. safety-related incidents to LNG vessels occurring at or en route to and from the LNG facility; or

m. an event that is significant in the judgment of the operator and/or management even though it did not meet the above criteria or the guidelines set forth in an LNG facility's incident management plan.

In the event of an incident, the Director of OEP has delegated authority to take whatever steps are necessary to ensure operational reliability and to protect human life, health, property or the environment, including authority to direct the LNG facility to cease operations. Following the initial company notification, the Commission staff would determine the need for an on-site inspection by the Commission staff, and the timing of an initial incident report (normally within 10 days) and follow-up reports.

4.11.3 Storage and Retention Systems

LNG storage tanks come in a variety of categories. The following are descriptions of the tank designs most commonly used worldwide:

- single containment cylindrical metal tanks (predominantly used in the United States);
- spherical storage tanks (predominantly used in LNG carriers);
- double containment cylindrical metal inner tank and metal or concrete outer tank (commonly thought of as an LNG tank with a high wall dike);
- full containment cylindrical metal inner tank and metal or concrete outer tank (several authorized by the Commission; several applications currently proposed to the Commission, including this project);
- pre-stressed cylindrical concrete tank with an internal metal membrane (membrane tank) (none in the United States); and
- cryogenic cylindrical concrete tank, internal cryogenic tank, and pre-stressed concrete outer tank (one operational in the United States; the remainder worldwide).

These tank categories are described in Annex H of the European Standard for LNG facilities (EN 1473) and are summarized below for the LNG storage tanks commonly found in proposals before the Commission.

H.1 Single containment tank

A single primary container and generally an outer shell designed and constructed so that only the primary container is required to meet the low temperature ductility requirements for storage of the product.

The outer shell (if any) of a single containment storage tank is primarily for the retention and protection of insulation and to contain the purge gas pressure, but is not designed to contain refrigerated liquid in the event of leakage from the primary container.

An aboveground single containment tank should be surrounded by a bund (dike) wall to contain any leakage. Examples of single containment are depicted on figure H.1.

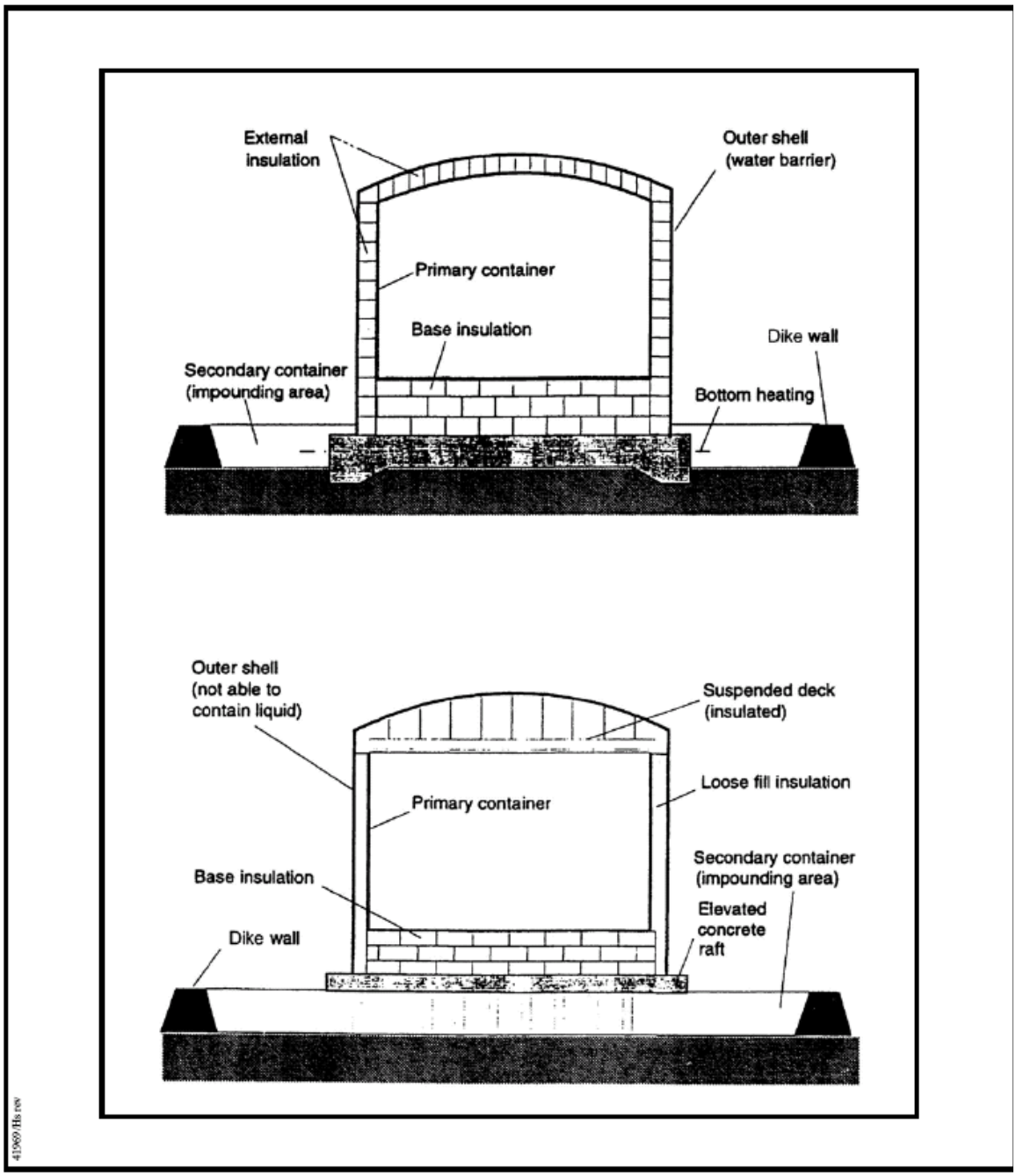


Figure H.1
Examples of Single Containment Tanks

H.3 Double containment tank

A double containment tank is designed and constructed so that both the inner self-supporting primary container and the secondary container are capable of independently containing the refrigerated liquid stored. To minimize the pool of escaping liquid, the secondary container should be located at a distance not exceeding 6 meters from the primary container.

The primary container contains the refrigerated liquid under normal operating conditions. The secondary container is intended to contain any leakage of the refrigerated liquid, but it is not intended to contain any vapor resulting from this leakage.

Examples of double containment tanks are shown on figure H.3. Figure H.3 does not imply that the secondary container is necessarily as high as the primary container.

H.4 Full containment tank

A full containment tank is designed and constructed so that both the self supporting primary container and the secondary container are capable of independently containing the refrigerated liquid stored and one of them can contain its vapor. The secondary container can be 3 to 6 feet (1 to 2 meters) in distance from the primary container.

The primary container contains the refrigerated liquid under normal operating conditions. The outer roof is supported by the secondary container. The secondary container should be capable both of containing the refrigerated liquid and of controlled venting of the vapor resulting from product leakage after a credible event. Examples of full containment tanks are given on figure H.4.

Single-, double-, and full-containment LNG storage tanks have been authorized by the FERC for use at new LNG import facilities or expansions of existing terminals. To date, only single- and double-containment tanks have been constructed and operated. Several full-containment tanks have started construction in the United States, while approximately 50 have been constructed worldwide. During the review of earlier proposals, a number of issues surfaced concerning the applicability of existing codes and regulations for full-containment tanks. Specifically, the term "full containment" does not appear in the Federal Safety Standards in 49 CFR 193. As a result, some project proponents have made the assumption that to design and construct a full-containment tank in accordance with EN 1473 will satisfy the U.S. codes and standards.

For example, it has been suggested that thermal exclusion zones are not required for a full-containment tank because EN 1473 does not consider a tank fire scenario for full-containment tanks with a pre-stressed concrete wall and concrete roof. The staffs of the FERC and the DOT do not agree because Part 193 does not exclude full-containment tanks from thermal exclusion zone requirements. As a result, a thermal exclusion zone analysis is required for an LNG storage tank fire at the top of the secondary container (see section 4.11.4 *Siting Requirements-Thermal and Dispersion Exclusion Zones*).

Further, EN 1473 does not specify a minimum distance to the property line for full-containment tanks because no tank fire scenario is considered. However, NFPA 59A, 2001 edition, requires a separation of 0.7 times the tank diameter from the property line. NorthernStar's proposed tank separation distance to the property line meets this separation requirement.

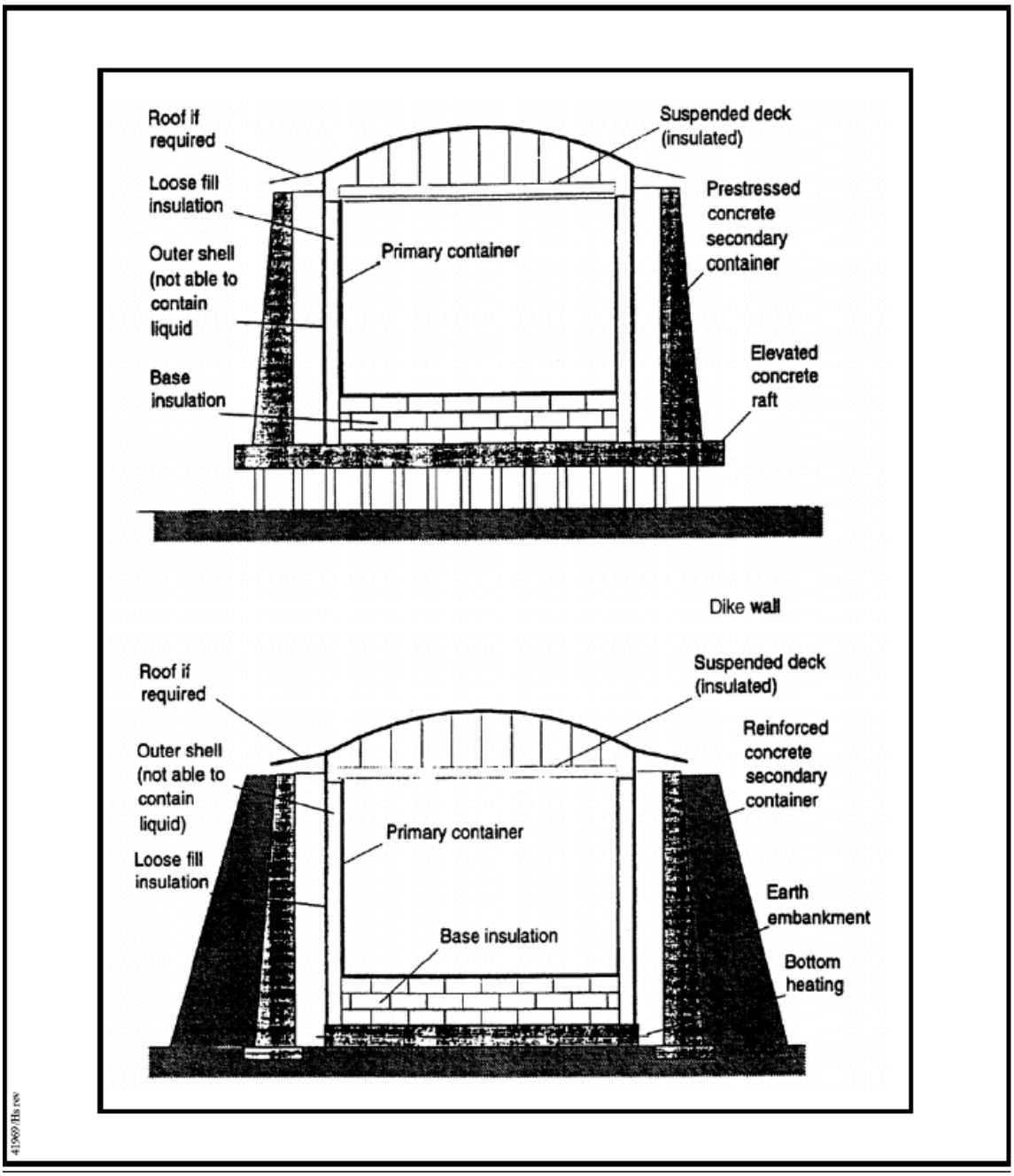


Figure H.3
Examples of Double Containment Tanks

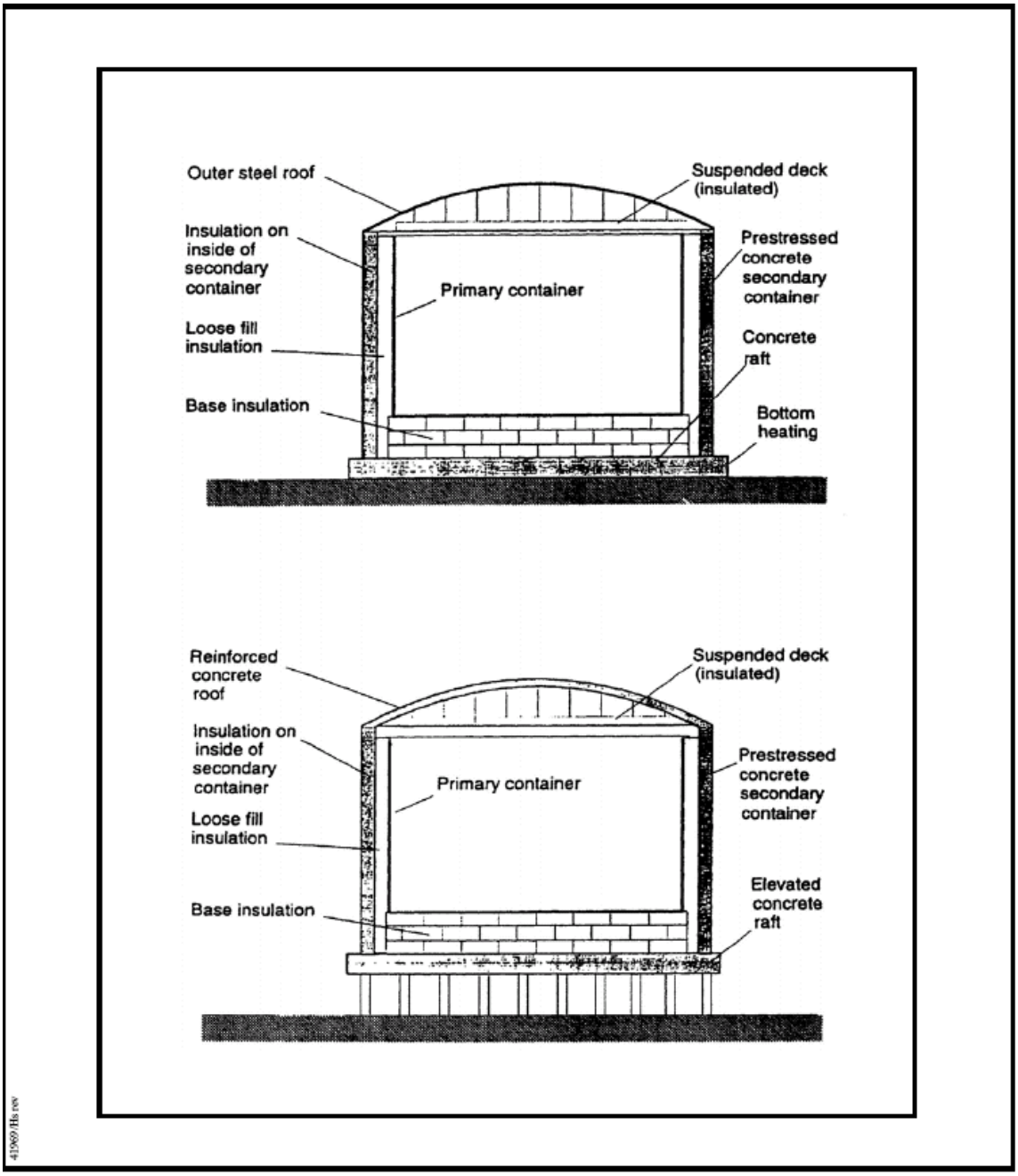


Figure H.4
Examples of Full Containment Tanks

Another issue regarding the full-containment design is that the tank outer wall (secondary containment) serves as the impoundment, a concept allowed under Parts 193.2161 and 193.2167, and under the "exception" on figure 2.2.2.6 of NFPA 59A, 2001 edition. A specific concern is the dual function of the concrete secondary container - it serves both the operational function of holding the insulation and gas pressure, and a safety function of containing liquid in the event of an inner tank failure. Conversely, in single- and double-containment tanks, independent systems provide operational and safety functions. While recognition must be given to the benefits of a concrete secondary container with respect to external events, such as projectiles or small aircraft, its ability to provide the dual functions while retaining its integrity has not been convincingly supported for all scenarios. This becomes increasingly important as proposed site acreage is reduced and buffer zones between adjacent properties are minimized. As such, the FERC staff considers it prudent design practice to provide some form of barrier to prevent liquid from flowing to an unintended area (i.e., outside the plant property) in the event that the storage tank primary and secondary containers fail.

Concerns have also been expressed that the barrier could be considered a containment and prohibit certain equipment being located within the barrier and/or may conflict with other parts of the various codes with respect to hazardous and electrical code classifications. Other concerns are that the barrier could be considered an impounding area that would require new thermal and vapor cloud calculations. The purpose of the barrier is to prevent liquid from flowing off the plant property, and it is not the intent to define a containment or impounding area for thermal radiation or flammable vapor exclusion zone calculations or other code requirements.

NorthernStar proposes to install a tertiary earthen berm around the LNG facility. The structure would be constructed to an elevation of 5 feet above the finished grade level and would enclose the area around the tanks and the process area. The structure's volumetric capacity would contain a single LNG tank's maximum liquid capacity. This berm would confine LNG on the project site in the event of any hypothetical catastrophic event.

4.11.4 Siting Requirements – Thermal and Dispersion Exclusion Zones

Regulatory Requirements

The LNG facilities proposed in this project must comply with the siting requirements of 49 CFR 193, Subpart B. On March 30, 2000, the DOT revised 49 CFR 193 to incorporate the 1996 edition of NFPA 59A into the LNG regulations. On April 9, 2004, the DOT further revised 49 CFR 193 to incorporate the 2001 edition of NFPA 59A. The following sections specifically address siting requirements:

- **Part 193.2001, Scope of part**, excludes any matter <u>other than siting provisions</u> pertaining to marine cargo transfer systems between the marine vessel and the last manifold or valve immediately before a storage tank.

- **Part 193.2051, Scope**, states that each LNG facility designed, replaced, relocated or significantly altered after March 31, 2000, must be provided with siting requirements in accordance with subpart B and NFPA 59A, 2001 edition. In the event of a conflict with NFPA 59A, then Part 193 prevails.

- **Part 193.2057, Thermal radiation protection**, requires that each LNG container and LNG transfer system have thermal exclusion zones based on three radiation flux levels in accordance with section 2.2.3.2 of NFPA 59A, 2001 edition.

- **Part 193.2059, Flammable vapor-gas dispersion protection**, requires that each LNG container and LNG transfer system have a dispersion exclusion zone in accordance with sections 2.2.3.3 and 2.2.3.4 of NFPA 59A, 2001 edition.

- **Part 193.2155(b), Structural requirements,** requires that an LNG storage tank must be at least 1 mile from the ends of an airport runway and 0.25 mile from the nearest point on a runway.

For the following LNG facilities that are proposed in this project, we have identified the applicable siting requirements from Part 193 and NFPA 59A, 2001 edition:

- Two 1,006,000-barrel (160,000 m^3) full containment LNG storage tanks - Parts 193.2057 and 2059 require the establishment of thermal and flammable vapor exclusion zones for LNG tanks. NFPA 59A, 2001 edition, section 2.2.3.2 specifies four thermal exclusion zones based on the design spill and the impounding area. NFPA 59A, 2001 edition, sections 2.2.3.3 and 2.2.3.4 specify a flammable vapor exclusion zone for the design spill which is determined with section 2.2.3.5.

- One LNG carrier unloading berth and a marine cargo transfer system consisting of a total of four marine unloading arms, three 16-inch-diameter liquid transfer arms, and one 16-inch-diameter vapor return arm. A 32-inch-diameter transfer line would carry the LNG to the onshore storage tanks - Parts 193.2001, 2057, and 2059 require thermal and flammable vapor exclusion zones for the transfer system. NFPA 59A, 2001 edition, does not address LNG transfer systems.

- Six 2,353 gpm in-tank pumps (three per tank with a spare pump tube); and five 2,398 gpm sendout pumps - Parts 193.2057 and 2059 require thermal and flammable vapor exclusion zones. NFPA 59A, 2001 edition, section 2.2.3.2 specifies the thermal exclusion zone and section 2.2.3.3 and 2.2.3.4 specify the flammable vapor exclusion zone based on the design spill in a process area.

- Seven SCVs - Same requirements as for LNG pumps.

The incorporation of the NFPA 59A requirements into Part 193 has resulted in some confusion and possible misinterpretation in applying the siting requirements. Parts 193.2057 and 2059 require exclusion zones for LNG transfer systems, which are defined to include transfer piping. However, NFPA 59A only requires exclusion zones for "transfer areas" which are defined as the part of the plant where liquids are introduced or removed from the facility such as truck loading or ship unloading areas. The definition of transfer area in NFPA 59A specifically excludes permanent plant piping such as cargo transfer lines. Additionally, NFPA 59A section 2.2.3.1 specifically excludes transfer area at the water edge of marine terminals. When the DOT originally incorporated NFPA 59A into its regulations, it removed the requirement for impounding systems around transfer piping (old Part 193.2149). In the preamble to the final rule, the DOT determined that the most likely sources of leaks within an LNG plant are LNG storage tanks, cargo transfer areas, and vaporizers and process equipment, which are all addressed in NFPA 59A section 2.2.1.2. The result is that while Part 193 retains exclusion zones for LNG transfer systems, neither Part 193 nor NFPA 59A requires the impoundment from which to base the calculations. We do not believe that this was the intent, nor do we believe that omitting containment for transfer piping is a sound engineering practice. The FERC staff will continue to require containment for all LNG transfer piping within a plant site.

The incorporation of NFPA 59A also changed the way in which design spills and impoundment capacities may be determined. Under section 2.2.2.2, the capacity of impounding areas for vaporization, process, or LNG transfer areas must equal the greatest volume during a 10-minute period from any single accidental leakage source or during a shorter time period based upon demonstrable surveillance and shutdown provisions acceptable to the authority having jurisdiction. Similar criteria appear in section 2.2.3.5 for determining the design spill used in thermal and flammable vapor exclusion zone calculations. Prior to the incorporation of NFPA 59A the design spill in Part 193 assumed the rupture of a single transfer pipe with the greatest overall flow capacity, for not less than 10 minutes (old Part 193.2059(d)). As a result, the spill rate for vaporization, process, or LNG transfer areas may be assumed to be a "leakage source" rather than a full pipe rupture; however, the spill duration must be 10 minutes unless the authority having jurisdiction (i.e., DOT's PHMSA), determines that a shorter time is acceptable. Again, given the confusion in applying the two requirements, the FERC staff will continue to utilize the 10-minute spill criterion at the maximum flow possible for containment sizing. This will ensure that impoundments are sized for a catastrophic failure, while recognizing that less conservative spill scenarios may be appropriate to calculate exclusion zones. In giving recognition to the integrity of all-welded transfer piping, the determination of the single accidental leakage source should be based on an evaluation of all small diameter attachments to the transfer piping for instrumentation, pressure relief, recirculation, etc., and any flanges that may be used at valves or other equipment, in order to determine the largest spill rate. This approach is the result of discussion with DOT's PHMSA concerning the basis for design spills and application to exclusion zone determinations for proposals before the Commission.

Impoundment Systems and Design Spills

NorthernStar proposes two full-containment LNG storage tanks in which the outer tank wall serves as the impoundment system. The outer tank would have an impounding volumetric capacity of 50,562,155 gallons, which exceeds the 110 percent requirement by 1,121,891 gallons when accounting for the volume of perlite in the annular space.

The tank and vaporizer area would include the LNG tanks, a portion of the unloading line and recirculation line and the sendout area. An impoundment basin would be located in the tank area and spills from the tank, vaporizer, and unloading line would be routed to the impoundment basin by a series of collection troughs. The largest potential LNG spill volume would be from the unloading line during an unloading operation. A spill from this line over a 10-minute period would result in a spill volume of 529,091 gallons at the maximum unloading rate of 52,834 gpm (12,000 cubic meters per hour (m^3/hr)) accounting for LNG in the piping. This volume was used in the sizing of the tank area impoundment basin. The basin dimensions were designed to be 60 feet by 60 feet by 20 feet which gives an available sump capacity of 538,632 gallons. This spill would be completely contained by the impoundment located in the tank area.

The jetty area would include the larger portion of the unloading and recirculation lines. An impoundment basin would be located in the onshore side of the unloading lines, and spills from the unloading line would be routed to the impoundment basin by a series of collection troughs. The largest potential LNG spill volume would be from the unloading line during an unloading operation. A spill from this line over a 10-minute period would result in a spill volume of 529,091 gallons at the maximum unloading rate of 52,834 gpm (12,000 m^3/hr). This volume was used in the sizing of the jetty area impoundment basin. The basin dimensions were designed to be 60 feet by 60 feet by 20 feet which gives an available sump capacity of 538,632 gallons. This spill would be completely contained by the impoundment located in the jetty area.

Although both the tank area and jetty area sump capacities would be acceptable to contain the spill, the FERC staff has concerns as to whether the collection troughs feeding the sumps, which range from 4-feet wide to 7-feet wide by 1-foot 8-inches high, are adequately sized to handle such a spill.

NorthernStar filed comments on the draft EIS stating that it disagreed that this spill would be the proper design basis for sizing its troughs. NorthernStar attached correspondence between the FERC and DOT which provided clarification on appropriate sizing and design spills.[26] NorthernStar incorrectly continues to use the criteria for a "design spill" as a "sizing spill." As stated in the third paragraph of the FERC's April 19, 2005 letter, "FERC staff presently uses the greatest overall flow volume for sizing impoundments." The greatest overall flow volume used for sizing impoundments, and the associated troughs, would be the unloading line rate. As stated above and also in the draft EIS, "the FERC staff will continue to utilize the 10-minute spill criterion at the maximum flow possible for containment sizing." As a result, **we recommend that:**

- **<u>Prior to initial site preparation</u>, NorthernStar should file with the Secretary for review and written approval by the Director of OEP calculations or a re-designed configuration showing how the troughs feeding the impoundment sumps would adequately handle a spill from the unloading line at the maximum unloading line rate.**

The calculation of thermal and flammable vapor exclusion zones for the proposed LNG facility are based on the dimensions of the proposed spill containment systems and the design spills according to 49 CFR 193 and NFPA 59A, 2001 edition. In accordance with section 2.2.3.5 of NFPA 59A, 2001 edition, the design spill for an LNG storage tank with no penetrations below the liquid level is defined as the largest flow from any single line that could be pumped into the impounding area with the tank withdrawal pumps considered to be operating at full rated capacity over a 10-minute period. In its analysis, NorthernStar modeled a spill of the full flow from a guillotine rupture of the common discharge header of the LNG in-tank pumps. However, NorthernStar included a future third tank in the calculations even though only two tanks were proposed in this application. For the proposed design, the design spill would be a guillotine rupture of the discharge header for the in-tank pumps. Since each pump is rated at 2,353 gpm and there are three pumps per tank, the resulting 10-minute design spill would be 70,590 gallons. This spill would be completely contained by the impoundment located in the tank area.

NFPA 59A, 2001 edition, section 2.2.3.5 also defines design spills for impounding areas serving only vaporization, process, or LNG transfer areas as the flow from any single accidental leakage source for a 10-minute duration. After a review of the piping and instrumentation diagrams for small diameter attachments, the FERC staff determined the design spill for the jetty area sump and tank area sump to be the rupture of a 6-inch-diameter purge line or a 6-inch-diameter recycle line attached to the unloading line. This 10-minute design spill would generate a volume of 140,320 gallons and would be contained in either the jetty area sump or the tank area sump.

The FERC staff also examined spill scenarios from the vaporizer piping, high pressure sendout pump piping, and instrument connections and determined that the full guillotine rupture and 6-inch-diameter attachment design spills were the controlling spills. Table 4.11.4-1 presents the impounding areas and spill size volumes used to determine adequate impounding capacity, as well as the design spills used in the thermal radiation and flammable gas dispersion modeling.

[26] The correspondence letters between the FERC and DOT can be found on the FERC's eLibrary. Document numbers 20050615-0176 and 20050615-0177.

TABLE 4.11.4-1 **Impoundment Areas**			
Source	Spill Size (gallons)	Impoundment System	Impoundment Size (gallons)
Impoundment Sizing Spills:			
LNG Storage Tank	45,805,758	Outer Tank Concrete Wall	52,118,481
Unloading Line	529,091	Jetty Area Sump or Tank Area Sump	538,632
Design Spills:			
Tank - Pump Discharge Header	70,590	Tank Area Sump	538,632
Unloading Line - 6-inch connection	140,320	Jetty Area Sump	538,632

We received a comment on the apparent discrepancy between sizes of design spills analyzed for this project and those used in previous proposals. Determination of the design spill is based on a project specific review of the submitted engineering material in accordance with the criteria established in 49 CFR 193. Prior to 2000, the design spill specified by Part 193 for all plant areas resulted from the rupture of a single transfer pipe with the greatest overall flow capacity, discharging at maximum potential capacity. As explained above, the incorporation of NFPA 59A in 2000 altered the design spill definition in 49 CFR 193.

While the design spill for LNG storage tanks is plainly described by NFPA 59A, the design spill in vaporization, process, or LNG transfer areas is specified as a "single accidental leakage source." However, neither Part 193 nor NFPA 59A provides a definition for this term. As the commentor points out, a wide range of spill sources has been used by applicants in their proposals before the Commission. This range has been from guillotine ruptures of unloading lines to the failure of a 1-inch-diameter instrument connection.

In order to determine appropriate procedures for the selection of the "single accidental leakage source," FERC staff consulted with the DOT in a letter dated April 19, 2005. As clarified in DOT's response dated May 5, 2005, the single accidental leakage source would be considered a rupture of a connection to the transfer piping, while the greatest overall flow volume in the area should be used for sizing impoundments. The determination of a single accidental leakage source has been based on facility-specific review of piping and instrumentation diagrams to identify small diameter attachments to the transfer piping for instrumentation, pressure relief, recirculation, etc, and any flanges that may be used at valves or other equipment, in order to determine the largest spill rate. This approach ensures that impoundments are sized for a catastrophic failure that could result from an external event or intentional act, while recognizing that a more likely rupture would be used to calculate flammable vapor exclusion zones. In addition, any event sufficient to create a full breach of large diameter cryogenic piping would likely result in a number of ignition sources which would lead to an LNG pool fire and subsequent radiant heat hazards. Given that impoundments are required to be sized to handle catastrophic failures, radiant heat calculations are dependent on the surface area dimensions of the impoundment rather than on the size of the design spill.

Thermal Exclusion Zone

If a large quantity of LNG is spilled in the presence of an ignition source, the resulting LNG pool fire could cause high levels of radiant heat in the area surrounding the impoundment. Exclusion distances for various flux levels were calculated according to 49 CFR 193.2057 and section 2.2.3.2 of NFPA 59A, 2001 edition, using the "LNGFIRE III" computer program model developed by the Gas Research Institute. NFPA 59A, 2001 edition, establishes certain atmospheric conditions (0 mph wind speed, 70 °F, and 50 percent relative humidity), which are to be used in calculating the distances. However, Part

193.2057 supersedes these requirements and stipulates that wind speed, ambient temperature, and relative humidity which produce the maximum exclusion distances must be used, except for conditions that occur less than 5 percent of the time based on recorded data for the area. For its analysis, NorthernStar selected the following ambient conditions to produce the maximum distances: wind speed of 20 mph, ambient temperature of 37 °F, and 59 percent relative humidity. The FERC staff agrees with the selection of these conditions and these conditions yield longer distances than the 0 mph wind speed, 70 °F ambient temperature, and 50 percent relative humidity specified in NFPA 59A, 2001 edition.

Under 49 CFR 193.2057, the LNG storage tank impoundment must have a thermal exclusion zone in accordance with NFPA 59A, 2001 edition. The referenced section 2.2.3.2 of NFPA 59A, 2001 edition, requires thermal radiation distances ranging from 1,600 to 10,000 British thermal units per square foot per hour (Btu/ft^2-hr) to be calculated for a volume of LNG determined in accordance with section 2.2.2.1.

Thermal radiation distances calculated for 1,600 to 10,000 Btu/ft^2-hr incident flux levels for an LNG storage tank impoundment fire were based on the outer tank's concrete wall diameter (254 feet) as the pool diameter and the flame height equal to the top of the concrete wall (135.5 feet). The target height was set at ground level (0 feet). The resulting distances would be 377 feet for the 10,000 Btu/ft^2-hr zone; 714 feet for the 3,000 Btu/ft^2-hr zone; and 912 feet for the 1,600 Btu/ft^2-hr zone (see figure 4.11.4-1). However, because the exclusion zones would extend over the Columbia River, a recommendation has been added in section 4.11.6, *Emergency Response and Evacuation Plan*, to ensure that recreational boaters would be warned in the unlikely event that the potential for a fire exists in any of these impoundments.

As required by section 2.2.3.6 of NFPA 59A, 2001 edition, heat flux from a fire over the impounding area would not cause damage to any LNG marine carrier, which would prevent its movement. However, the 10,000 Btu/ft^2-hr zone would extend over the proposed relocation of rail track routing within the facility's property line as discussed in section 2.1.3.6. A description of historical, current, and anticipated rail traffic which includes the type of rail traffic (cargo, passenger, etc.), type of cargo, and frequency of all rail traffic that may utilize the railroad tracks adjacent to the facility is provided in section 4.8.2.7. There is currently no traffic on the railroad, and the PWRR has no plans to operate trains west of Wauna. In 2006, a segment of track was washed out west of Bradwood, approximately half-way to Astoria. In response to our recommendation in the DEIS, NorthernStar filed detailed procedures for coordinating with the railroad company to ensure safe rail transit through the Bradwood Landing LNG facility property, which are described in section 4.8.2.7.

In addition, the thermal radiation distances were determined for the 1,600-Btu/ft^2-hr incident flux level centered on the tank area sump and jetty area sump. The 1,600 Btu/ft^2-hr zone would extend 318 feet from the center of the tank area sump and from the center of the jetty area sump (see figure 4.11.4-1). This zone would not extend past the property line of the site.

The LNG terminal would occupy 40 acres of land within a 411-acre site controlled by NorthernStar, which is largely surrounded by forest. The potential for a forest fire in the area around the LNG terminal would be minimized by an existing forest free buffer zone around the LNG terminal. The forest free buffer zone would be between the 40 acre LNG terminal boundary and the outer boundary of the 411-acre site and is comprised of sparse vegetation which minimizes the risk for a forest fire.

The thermal exclusion zones would remain on the LNG terminal site and would be in compliance with 49 CFR 193.2057. Table 4.11.4-2 presents the maximum distances for incident flux levels ranging from 1,600 to 10,000 Btu/ft^2-hr, as calculated by the FERC staff.

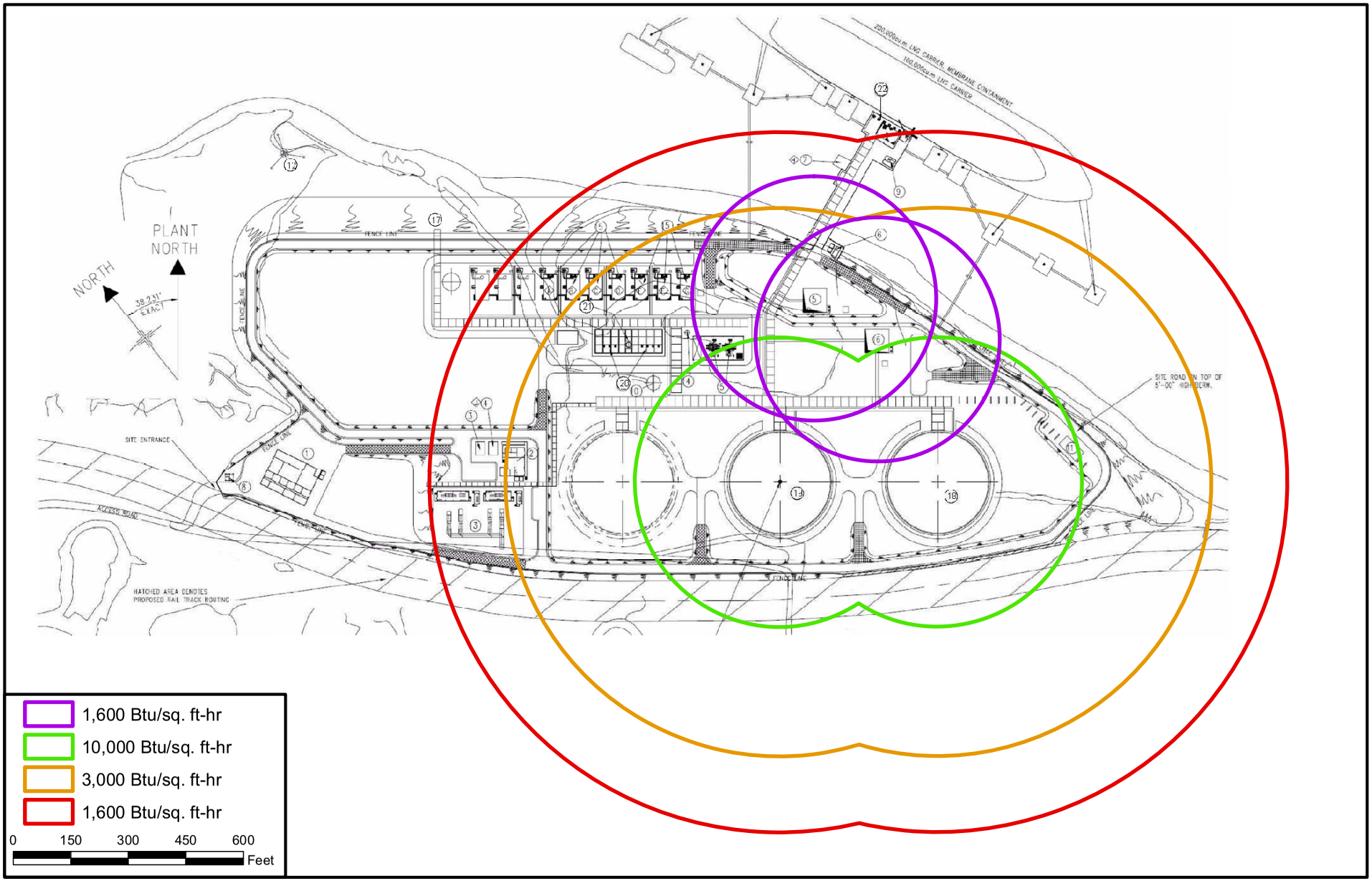


Figure 4.11.4-1
Bradwood Landing Project
Thermal Radiation Zones

TABLE 4.11.4-2

Thermal Exclusion Zones

Source	Exclusion Area NFPA 59A, 2001 edition, section 2-2.3.2(a)	Incident Flux (Btu/ft^2-hr) a	Exclusion Zone (feet)
LNG Storage Tank Impoundment	Outdoor assembly area occupied by 50 or more people.	1,600	912
LNG Storage Tank Impoundment	Off-site structures used for occupancies or residences.	3,000	714
LNG Storage Tank Impoundment	Property line that can be built upon.	10,000	377
Jetty Area Sump and Tank Area Sump	Property line that can be built upon.	1,600	318

[a] The 1,600 Btu/ft^2-hr flux level is associated with an exposed person experiencing burns within about 30 seconds. At 3,000 Btu/ft^2-hr, an exposed person would experience burns within 10 seconds; however, a wooden structure would not be expected to burn and affords protection to sheltered persons. At 10,000 Btu/ft^2-hr, clothing and wood can ignite spontaneously.

Vapor Dispersion Zone

A large quantity of LNG spilled without ignition would form a flammable vapor cloud that would travel with the prevailing wind until it either dispersed below the flammable limits or encountered an ignition source. Sections 2.2.3.3 and 2.2.3.4 of NFPA 59A, 2001 edition, and Part 193.2059 require that provisions be made to minimize the possibility of flammable vapors reaching a property line that can be built upon and that would result in a distinct hazard. Part 193.2059 requires that dispersion distances be calculated for a 2.5 percent average gas concentration (one-half the lower flammability limit (LFL) of LNG vapor) under meteorological conditions which result in the longest downwind distances at least 90 percent of the time. Alternatively, maximum downwind distances may be estimated for stability Class F, a wind speed of 4.5 mph, 50 percent relative humidity, and the average regional temperature. The section allows the use of the DEGADIS (Dense Gas Dispersion Model), or the FEM3A model, to compute dispersion distances. Design spills into impounding areas serving LNG containers, transfer systems, and piping are to be determined in accordance with section 2.2.3.5 of NFPA 59A, 2001 edition. In accordance with section 2.2.3.3 of NFPA 59A, 2001 edition, an average concentration of methane in air of one-half of the LFL cannot cross the property line from a design spill into each tank impoundment. In this case, compliance with section 2.2.3.3 would also meet the requirements of section 2.2.3.4 of NFPA 59A, 2001 edition.

In performing the vapor dispersion analysis required by 49 CFR 193.2059, NorthernStar selected a wind speed of 4.5 mph, an atmospheric temperature of 52 °F, a relative humidity of 50 percent, and atmospheric stability Class F. The FERC staff agrees with the selection of these conditions. As discussed previously in section 4.11.4, the design spill for the jetty area sump and tank area sump would be the rupture of a 6-inch-diameter purge line or the rupture of a 6-inch-diameter recycle line attached to the unloading line. This 10-minute design spill would generate a volume of 140,320 gallons and would be contained in either the jetty area sump or the tank area sump. In its application, NorthernStar used SOURCE5 to determine the source strength and equivalent radius of the design spill. NorthernStar provided thermal properties of the proposed sumps which are as follows: thermal conductivity of 0.32 W/M K; density of 801 kg/m^3; and a heat capacity of 790 J/kg K. The output source strength and equivalent radius from SOURCE5 were inputted into DEGADIS using the atmospheric properties described above. This spill would result in a distance of 325 feet to the 2.5 percent average gas concentration isopleths (see figure 4.11.4-2). The distance of 243 feet reported in the draft EIS was a typographical error and is incorrect.

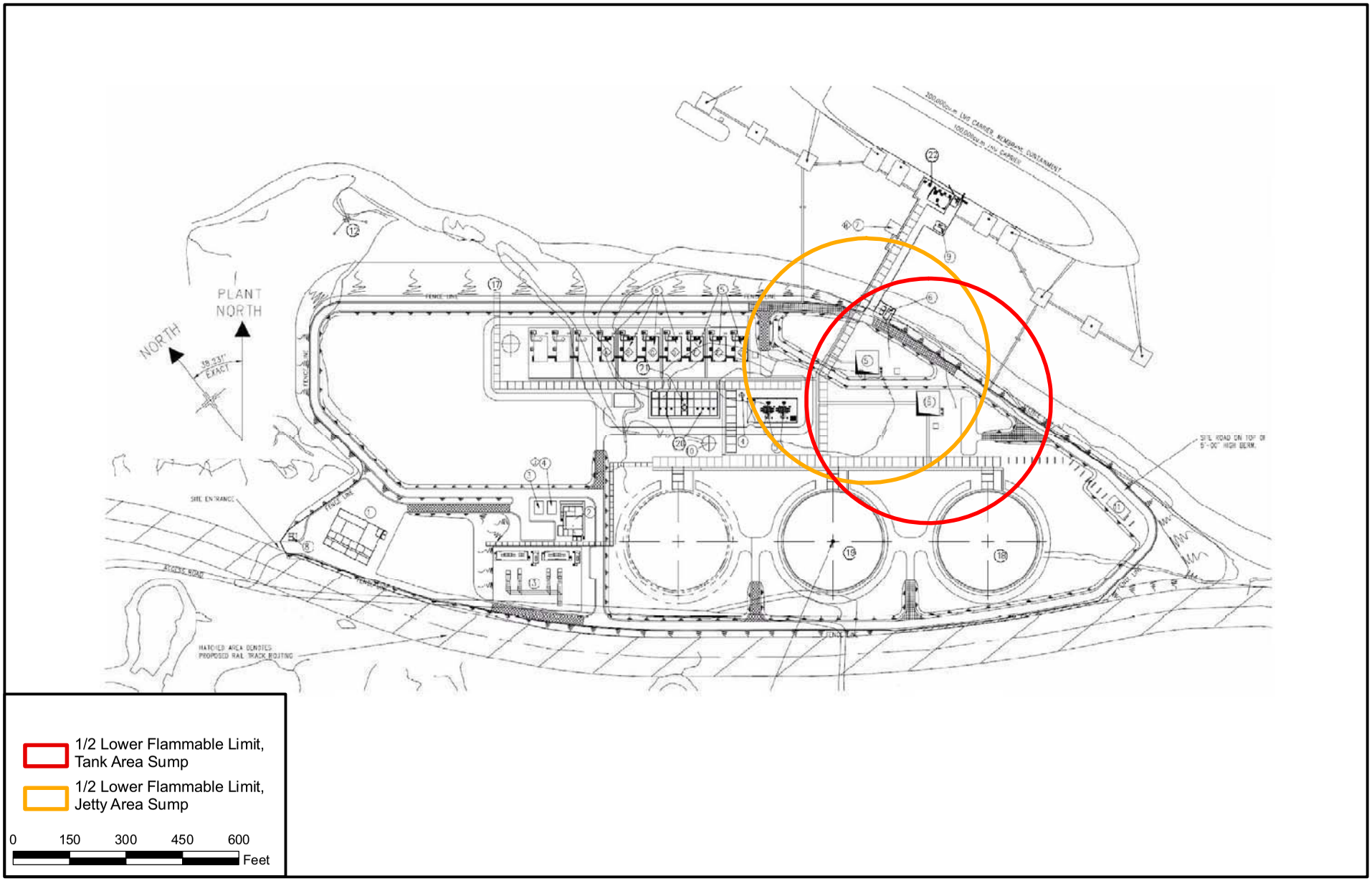


Figure 4.11.4-2
Bradwood Landing Project
Vapor Dispersion Zones

Although the flammable vapor dispersion exclusion zones associated with these design spills would extend off-site into the navigation channel, there are no prohibited land uses within them. Subsequently, the proposed terminal location would satisfy the vapor exclusion zone requirements of 49 CFR 193.2059. However, because the exclusion zone would extend over the Columbia River, a recommendation has been added in section 4.11.6, *Emergency Response and Evacuation Plan*, to ensure that recreational boaters would be warned in the unlikely event that LNG vapor may disperse over the waterway.

We received a comment that a 4.5 mph (2.0 m/s) wind speed is not conservative with the use of DEGADIS and that the vapor dispersion methodology cannot account for obstructions to the vapor flow or any holdup of LNG vapor by either the dock area or tank area sumps. The vapor dispersion and source calculations were done in accordance with the regulations under 49 CFR 193 and are consistent with methodologies in the May 28, 1982 and June 29, 1983 Formal Interpretations by the DOT regarding vapor dispersion distances and vapor holdup/scooping. For the DEGADIS model, longer downwind vapor dispersion distances are produced at lower wind speeds. Using wind speeds higher than 4.5 mph (2 m/s) would reduce the downwind dispersion distances in DEGADIS, resulting in a less conservative result. In addition, higher wind speeds generally correspond to more atmospheric instability, which will further reduce the downwind dispersion distance.

While DEGADIS cannot depict terrain and actual geometries, calculations that take into account the obstruction of flow, such as from storage tanks and the earthen berm, would result in shorter dispersion distances due to enhanced turbulent mixing in the wake of such structures. The source strength methodology does not account for "wind scooping" and vapor expansion effects that may produce higher initial source strengths and longer dispersion distances. To investigate the possible effects to the calculations, FERC staff adjusted the vapor production model to eliminate all vapor retention and used the resulting source production curve as input to DEGADIS. Although the downwind distance to the one-half LFL would be larger using this method, it would still not extend beyond the facility property line onto any adjacent land.

4.11.5 LNG Carrier Safety

Since 1959, LNG has been transported by ship without a major release of cargo or a major accident involving an LNG carrier. Over the last 45 years, LNG carriers have made over 44,000 voyages worldwide. Starting in 1971, LNG began arriving at the Distrigas facility in Everett, Massachusetts. To date, more than 680 cargoes, with volumes ranging from 60,000 to 138,000 m^3, have been delivered into the Port of Boston without incident. During 2005, a total of 275 cargoes of LNG were imported into the United States. During 2006, 226 cargoes of LNG were imported into the United States. For 36 years, LNG shipping operations have been safely conducted in the United States.

4.11.5.1 History

During the more than 44,000 voyages that have been completed since the inception of LNG maritime transportation, there has not been a serious accident at sea or in a port which resulted in a spill due to rupturing of the cargo tanks. However, insurance records, industry sources, and public websites identify a number of incidents involving LNG carriers, including minor collisions with other vessels of all sizes, groundings, minor LNG releases during cargo unloading operations, and mechanical/equipment failures typical of large vessels. Some of the more significant LNG carrier incidents are described below:

Pollenger had an LNG spill onto the steel cover of cargo tank number one during unloading at Everett, Massachusetts in April 1979. The spill caused cracking of the steel plate.

El Paso Paul Kayser grounded on a rock in June 1979 in the Straits of Gibraltar during a loaded voyage from Algeria to the United States. Extensive bottom damage to the ballast tanks resulted; however, the cargo tanks were not damaged, and no cargo was released. The complete cargo of LNG was subsequently transferred to another LNG carrier and delivered to its United States destination.

LNG Taurus grounded in December 1980 near the entrance to Taboata Harbor, Japan. The grounding resulted in extensive bottom damage, but the cargo tanks were not affected. The ship was refloated and the cargo unloaded.

Isabella had LNG spill onto its deck due to a cargo tank overflow in June 1985, causing severe cracking of the steelwork. The spill had been attributed to a cargo valve failure during discharging of cargo.

Tellier was blown by severe winds from its docking berth at Skikda, Algeria in February 1989 causing damage to the loading arms and the ship and shore piping. The cargo loading had been secured just before the wind struck, but the loading arms had not been drained. Consequently, the LNG remaining in the loading arms spilled onto the deck causing fracture of some plating.

Mostefa Ben Boulaid had LNG spill onto its deck during loading operations in Algeria in 2002. The spill, which is believed to have been caused by overflow rather than a mechanical failure, caused significant brittle fracturing of the steelwork. The ship was required to discharge its cargo, after which it proceeded to dock for repair.

Khannur had a cargo tank overfill into the ship's vapor handling system on September 10, 2001, during unloading at Everett, Massachusetts. Approximately 100 gallons of LNG were vented and sprayed onto the protective decking over the cargo tank dome, resulting in several cracks. After re-inspection by the Coast Guard, the Khannur was allowed to discharge its LNG cargo.

Norman Lady was struck by the USS Oklahoma City nuclear submarine while the submarine was rising to periscope depth near the Strait of Gibraltar in November 2002. The 87,000-m^3 LNG carrier, which had just unloaded its cargo at Barcelona, Spain, sustained only minor damage to the outer layer of its double hull but no damage to its cargo tanks.

Tenaga Lima grounded on rocks while proceeding to open sea east of Mopko, South Korea due to strong current in November 2004. The shell plating was torn open and fractured over an approximate area of 20 feet by 80 feet, and internal breaches allowed water to enter the insulation space between the primary and secondary membranes. The ship was refloated, repaired, and returned to service.

Golar Freeze moved away from its docking berth during unloading on March 14, 2006, in Savannah, Georgia. The powered emergency release couplings on the unloading arms activated as designed, and transfer operations were shut down.

Catalunya Spirit lost propulsion and became adrift 35 miles east of Chatham, Massachusetts on February 11, 2008. Four tugs towed the vessel to a safe anchorage for repairs. The Catalunya Spirit was repaired and taken to port to discharge its cargo.

4.11.5.2 LNG Carrier Construction

In 1980, at the initial peak of LNG import activity in the United States, the Coast Guard published the report *Liquefied Natural Gas and Liquefied Petroleum Gas – Views and Practices – Policy and Safety*. The report summarized the Coast Guard's extensive research into the safety hazards of LNG

and its view that "...the nature of both LNG and liquid petroleum gas (LPG) presents an acceptable risk for transportation in maritime commerce." This is due to the fact that LNG carriers are well constructed, robust vessels designed to withstand low-energy-type incidents that are prevalent in harbors and during docking operations. Moreover, safety measures, both equipment and training, are planned and designed into these LNG carriers to prevent or control all types of potential incidents. The Sandia National laboratory reached a similar conclusion in 2005 in its report.

The world's LNG carrier fleet currently exceeds 218 carriers. Currently, all of the ships in the LNG fleet operate under a foreign flag with foreign crews. The LNG carriers used to import LNG to the United States would be constructed and operated in accordance with the IMO's *Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk*, the SOLAS, and 46 CFR Part 154, which contain the U.S. safety standards for vessels carrying bulk liquefied natural gas. Foreign flag LNG carriers are required to possess a valid IMO Certificate of Fitness and a Coast Guard COC.

As required by the IMO conventions and design standards, hold spaces and insulation areas on an LNG carrier are equipped with gas detection and low temperature alarms. These devices monitor for leaks of LNG into the insulation between primary and secondary LNG cargo tank barriers. In addition, hazard detection systems are also provided to monitor the hull structure adjacent to the cargo tank, compressor rooms, motor rooms, cargo control rooms, enclosed spaces in the cargo area, specific ventilation hoods and gas ducts, and air locks.

LNG carriers are equipped with a firewater system with the ability to supply at least two jets of water to any part of the deck in the cargo area and parts of the cargo containment and tank covers above-deck. A water spray system is also available for cooling, fire prevention, and crew protection in specific areas. Furthermore, certain areas of LNG carriers are fitted with dry chemical powder-type extinguishing systems and CO_2 smothering systems for fighting fires.

In 1993, amendments to the IMO's *Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk* require all tankers to have monitoring equipment with an alarm facility which is activated by detection of over-pressure or under-pressure conditions within a cargo tank. In addition, the cargo tanks are heavily instrumented, with gas detection equipment in the hold and inter-barrier spaces, temperature sensors, and pressure gauges. See section 2.1.1.7 for further discussion.

As a result of the terrorist attacks that occurred on September 11, 2001, the IMO agreed to new amendments to the 1974 SOLAS addressing port facility and ship security. The *International Ship and Port Facility Security (ISPS) Code* was adopted in 2003 by the IMO. This code requires both ships and ports to conduct vulnerability assessments and to develop security plans. The purpose of the code is to prevent and suppress terrorism against ships; improve security aboard ships and ashore; and reduce the risk of passengers, crew, and port personnel on board ships and in port areas, for vessels and cargoes. All LNG carriers as well as other cargo vessels 300 gross tons and larger, and ports servicing those regulated vessels, must adhere to these IMO and SOLAS standards. Some of the IMO requirements are as follows:

<u>For ships</u>:

- Ships must develop security plans and have a Vessel Security Officer (VSO);
- Ships must be provided with a ship security alert system. These alarms transmit ship-to-shore security alerts to a competent authority designated by the Administration, which may include the company, identifying the ship, its location, and indication that the security of the ship is under threat or has been compromised;

- Ships must have a comprehensive security plan for international port facilities, focusing on areas having direct contact with ships; and

- Ships may have certain equipment onboard to help maintain or enhance the physical security of the ship.

For port facilities:

- Ports must develop a port facility security plan and have a Facility Security Officer (FSO); and

- Certain security equipment may be required to maintain or enhance the physical security of the facility.

For both ships and ports:

- Access must be monitored and controlled;
- Activities of people and cargo must be monitored;
- Security of communications and that they are readily available must be ensured; and
- A Declaration of Security must be completed and signed by the FSO and VSO.

4.11.5.3 Hazards

The history of LNG shipping has been free of major incidents, and none have resulted in significant quantities of cargo being released (see section 4.11.5.1). No incidents have occurred at existing LNG terminals during the 50 years of operation that resulted in any significant quantities of cargoes being released. However, the possibility of an LNG spill from a ship over the duration of the proposed project must be considered. If an LNG spill were to occur, the primary hazard to the public would be the impact of radiant heat from a pool fire. If an LNG release were to occur without ignition, an ignitable gas cloud could form and present a hazard. This section presents the results of analyses specific to LNG carriers to determine distances for these hazards, and describes how the hazard distances would be managed if the Project is approved.

Historically, the events most likely to cause a significant release of LNG were a ship casualty such as:

- a grounding sufficiently severe to puncture an LNG cargo tank;
- a vessel colliding with an LNG carrier in transit;
- an LNG carrier alliding[27] with the terminal or a structure in the waterway; or
- a vessel alliding with an LNG carrier while moored at the terminal.

However, the attacks on September 11, 2001, have made the public keenly aware of an additional risk that must be considered in the evaluation of marine safety and security:

- a deliberate attack on an LNG carrier by a terrorist group.

To result in a spill of LNG, any of the above events would need to occur with sufficient impact to breach an LNG carrier's double hull and cargo tanks. All LNG carriers used to deliver LNG to the proposed project would have double-hull construction, with the inner and outer hulls separated by about

[27] "Alliding" is the action of dashing against or striking upon a stationary object (for example, the running of one ship upon another ship that is docked) – distinguished from "collision," which is used to refer to two moving ships striking one another.

10 feet. Furthermore, the cargo tanks are normally separated from the inner hull by a layer of insulation approximately 1-foot thick.

As a result, many grounding incidents severe enough to cause a cargo spill on a single-bottom oil tanker would be unable to penetrate both inner and outer hulls of an LNG carrier. An earlier Federal Power Commission (FPC) (predecessor to the FERC) study estimated that the double-bottom of an LNG carrier would be sufficient to prevent cargo tank penetration in about 85 percent of the cases that penetrated a single-bottom oil tanker. Previous incidents with LNG carriers have primarily involved grounding, and none of these have resulted in the breach of the double hull and subsequent release of LNG cargo.

The probability of an LNG carrier sustaining cargo tank damage in a collision would depend on several factors – the displacement and construction of both the struck and striking vessels, the velocity of the striking vessel and its angle of impact with the struck vessel, and the location of the point of impact. The previous FPC study estimated that the additional protection afforded by the double hull would be effective in low-energy collisions; overall, it would prevent cargo tank penetration in about 25 percent of the cases that penetrated a single-hull oil tanker.

In 1995, to assist the Coast Guard in San Juan, Puerto Rico, EcoEléctrica L.P. prepared an analysis of the damage that could result from an oil tanker striking an LNG carrier at berth (FERC, 1996). The analysis assumed a 125,000 m^3 LNG carrier and an 82,000-dead-weight-ton tanker carrying number 6 fuel oil without tug assistance. The analysis determined the minimum striking speed to penetrate the cargo tanks of an LNG carrier for a range of potential collision angles. The resulting minimum striking speeds are presented in table 4.11.5-1 for the two principal cargo systems.

TABLE 4.11.5-1

Minimum Striking Speed to Penetrate LNG Cargo Tanks

	Minimum Striking Speed (knots)	
Angle of Impact	Spherical Tanks	Membrane Tanks
Greater than 60 degrees	4.5	3.0
45 degrees	6.3	4.0
30 degrees	9.0	6.0
15 degrees	18.0	12.0

For membrane tanks, the critical beam-on striking speed is 3.0 knots; for spherical tanks, the critical beam-on speed is 4.5 knots. For both containment types, lower angles of impact result in much greater minimum striking speeds to penetrate LNG cargo tanks. In the July/August 2002 issue of *LNG Journal*, the Society of International Gas Tanker & Terminal Operators General Manager provides a table that indicates the critical speed necessary for a 20,000-ton vessel to puncture the outer hull of an LNG carrier is 7.3 knots. For a 93,000-ton ship, the impact speed is 3.2 knots. In neither case does such an impact result in damage to the LNG cargo containment system, nor does it result in release of LNG.

The Sandia Report included an LNG cargo tank breach analysis using modern finite element modeling and explosive shock physics modeling to estimate a range of breach sizes for both credible accidental and intentional LNG spill events. The analysis of accidental events found that groundings, collisions with small vessels, and low-speed (less than 7 knots) collisions with large vessels striking at 90 degrees could cause minor ship damage but would not result in a cargo spill. This is due to the protection provided by the double-hull structure, the insulation layer, and the primary cargo tank of an LNG carrier.

High-speed (12 knots) collisions with large vessels striking at 90 degrees were found to potentially cause cargo tank breach areas of 0.5 to 1.5 m^2.

In the event of a collision or allision of sufficient magnitude to rupture an LNG cargo tank, it is likely that sparks or flames would ignite the flammable vapors at the spill site. In a grounding of sufficient magnitude to rupture an LNG cargo tank, the damage would occur underwater, and the potential for ignition would be less than for collisions or allisions. In this case, an LNG spill would rapidly vaporize on water and form a potentially flammable cloud. If not ignited, the flammable vapor cloud would drift downwind until the effects of dispersion would dilute the vapors below the LFL for methane. The maximum range of potentially flammable vapors, or the distance to the LFL, is a function of the volume of LNG spilled, the rate of the spill, and the prevailing meteorological conditions. If the flammable vapor cloud encountered an ignition source, the cloud would burn back to the spill site.

The final EIS for the Calcasieu LNG Project (FERC, 1976) analyzed the maximum range of a flammable vapor cloud and hazardous radiation levels from an instantaneous one-tank spill. As was consistent with risk analyses at that time and for nearly 25 years thereafter, the instantaneous spillage of one cargo tank was considered to be the "worst-case" scenario. Physical constraints on maximum vessel speeds and maximum depths of penetration required to rupture one LNG cargo tank render the possibility of an instantaneous release of more than one cargo tank to be implausible. This is not to imply that the loss of multiple cargo tanks could never occur, but that the extent of the hazard would not exceed that of the instantaneous spillage of one tank.

For an instantaneous one-tank spill with ignition, the final EIS for the Calcasieu LNG Project estimated that a hazardous thermal radiation level of 5,300 Btu/ft^2-hr would extend 3,595 feet from the center of the spill. For an instantaneous one-tank spill without ignition, the final EIS for the Yukon Pacific LNG Project (FERC, 1995) estimated that potentially flammable vapors could travel up to 3.3 miles, with a 10-mph wind and typical atmospheric stability.

In October 2001, the use of a one-tank instantaneous release as the worst-case scenario was reexamined by Quest Consultants, Inc (Quest) as part of an effort by the DOE to determine the hazards associated with reopening the Distrigas LNG import terminal following the terrorist attacks of September 11, 2001. It was determined that time-release spills through 1-meter and 5-meter diameter holes would more accurately simulate credible worst-case damage scenarios. The maximum flammable vapor cloud and radiation hazards were calculated for the two spill scenarios. For a spill on water with ignition, the maximum distance to a radiant flux level of 1,500 Btu/ft^2-hr was estimated to be 1,770 feet. For a spill on water without ignition, a flammable vapor cloud of 2.5 miles was estimated. In November 2003, in response to comments concerning its October 2001 study, Quest clarified that its study applied only to LNG spills resulting from a collision with a large ship in Boston's Outer Harbor, where waves would restrict the spreading of LNG on water.

Since the Quest study, there has been an emergence of studies by various parties to define the worst-case scenario that would result from a deliberate terrorist attack on an LNG carrier and the subsequent release of cargo. Distances have been estimated to range from 1,770 to 4,200 feet for a thermal radiation level of 1,500 Btu/ft^2-hr. Part of the reason for the apparent discrepancies is the lack of large-scale historical incidents, and the need to extrapolate small-scale field test data to a worst-case event. This inevitably leads to differing conservative assumptions among the various parties. For example, some models calculate a time-release cargo discharge through 1-meter or 5-meter diameter holes, while others assume that the cargo tank empties instantaneously.

As a result, the FERC commissioned a study by ABSG to search and review the literature on experimental LNG spills and on consequence methodologies that are applicable to modeling incidents of

LNG spills on water. Further, the goal of the study was to identify appropriate methods for estimating flammable vapor and thermal radiation hazard distances for potential LNG carrier cargo releases during transit and while at berth. The resulting study, *Consequence Assessment Methods for Incidents Involving Releases from Liquefied Natural Gas Carriers*, was released for public comment on May 14, 2004. On June 18, 2004, the FERC staff's responses to comments on the consequence assessment methods were issued. In addition, the model was updated to include a lower limit on the characteristic wind speed. As discussed in greater detail in the staff's responses, various components of the consequence assessment methodologies were revised based on comments received. The revised methodology provides procedures for calculating: (1) the rate of release of LNG from a cargo tank penetration for various-sized holes; (2) the spreading of an unconfined LNG pool on water for both continuous spills and rapid (nearly instantaneous) releases; (3) the rate of vapor generation from an unconfined spill on water; (4) thermal radiation distances for LNG pool fires on water; and (5) flammable vapor dispersion distances.

A detailed evaluation of the consequences of a terrorist attack on a modern membrane LNG carrier was prepared by Lloyds Register North America for the Weaver's Cove LNG Project. The study evaluated the consequences of attacks on an LNG carrier by missiles and explosives. Finite element analysis was used to evaluate the effect of various-sized charges on both the outer and inner hulls. A 1-meter diameter hole of the inner hull at the waterline was found to be the worst-case scenario for hazard consequence assessments. This finding is consistent with the attack on the double-hull oil tanker *Limberg* which caused greater than a 5-meter diameter hole on the outer hull, but only minor damage to the inner hull. A failure modes and effects analysis was used to understand internal LNG release characteristics, and a residual strength analysis was used to investigate damage scenarios for a loaded LNG tanker.

As discussed above, the Sandia Report included an LNG cargo tank breach analysis, using modern finite element modeling and explosive shock physics modeling to estimate a range of breach sizes for credible accidental and intentional LNG spill events. For intentional scenarios, the size of the cargo tank hole depends on the location of the ship and source of threat. Intentional breach areas were estimated to range from 2 to 12 m^2. In most cases, an intentional breaching scenario would not result in a nominal hole of more than 5 to 7 m^2, which is a more appropriate range to use in calculating potential hazards from spills. These hole sizes are equivalent to circular hole diameters of 2.5 and 3 meters.

The Sandia Report also included guidance on risk management for intentional spills, based on the findings that the most significant impacts to public safety and property exist within approximately 500 meters (1,640 feet) of a spill due to thermal hazards from a fire, with lower public health and safety impacts beyond 1,600 meters (approximately 1 mile). Large unignited LNG vapor releases were found to be unlikely, but could extend from nominally 2,500 meters (8,200 feet) to a conservative maximum distance of 3,500 meters (11,500 feet) for an intentional spill.

Cascading damage due to brittle fracture from exposure to cryogenic liquid or fire-induced damage to foam insulation was evaluated in the Sandia Report and, while possible under certain conditions, is not likely to involve more than two or three cargo tanks. Cascading events are not expected to increase the overall fire hazard by more than 20 to 30 percent (1,920 to 2,080 meters (6,300 to 6,825 feet)) but would increase the expected fire duration. RPTs are possible for large spills, but the effects would be localized near the spill source and should not cause extensive structural damage.

In February 2007, the U.S. General Accounting Office (GAO) published a report (GAO, 2007) that assessed recent studies, including the Sandia study, that have been conducted on the consequences of an LNG spill resulting from a terrorist attack on an LNG carrier. The GAO's panel of experts agreed that the most likely public safety impact of an LNG spill would be the radiant heat from a pool fire. Although the GAO report characterizes disagreements among the panel of experts, the majority felt the Sandia calculations were either accurate or overly conservative. The Sandia Report concluded that damage due

to brittle fracture from exposure to cryogenic liquid or fire-induced damage was possible under certain conditions and would increase the duration of the event. The majority of the GAO expert panel agreed with Sandia that cascading events are not expected to significantly increase the overall fire hazard. The disagreement cited in the GAO report concerned the need for future research and clarifying uncertainties, rather than the Sandia's conclusions on cascading failures.

As part of the waterway suitability review process, the Coast Guard uses criteria developed by Sandia to define the outer limits of the hazard zones for assessing potential risks associated with the proposal. The Sandia analysis was based on LNG vessels of 148,000 m^3. Therefore, the proposed Zones of Concern are based on the assumption that LNG vessels traveling to the Bradwood LNG terminal would have capacities of no greater than 148,000 m^3. Should NorthernStar wish to receive larger LNG vessels in the future, the Sandia Report would have to be revisited to determine any changes to the Zones of Concern, the WSA/WSR would have to be review to determine if the safety and security measurements are adequate to accommodate the larger LNG vessels, and supplemental review would be required. The Zones of Concern used in the waterway review were:

- Zone 1 – impacts on structures and organisms are expected to be significant within 500 meters (1,640 feet). The outer perimeter of Zone 1 is the distance to thermal hazards of 37.5 kW/m^2 from a pool fire.

- Zone 2 – impacts would be significant but reduced, and damage from radiant heat levels are expected to transition from severe to minimal between 500 and 1,600 meters (1,640 and 5,250 feet). The outer perimeter of Zone 2 is the distance to thermal hazards of 5 kW/m^2 from a pool fire.

- Zone 3 – impacts on people and property from a pool fire or an unignited LNG spill that does not ignite are expected to be minimal between 1,600 meters (5,250 feet) and a conservative maximum distance of 3,500 meters (11,500 feet). The outer perimeter of Zone 3 should be considered the vapor cloud dispersion distance to the LFL from a worst case unignited release. Impacts to people and property could be significant if the vapor cloud reaches an ignition source and burns back to the source.

The severity of impacts within Zones 1 through 3 would depend on the location of the incident relative to a specific area, the scope of the incident, and whether the released LNG ignited or dispersed. This could be a significant impact, being most severe in Zone 1 and decreasing outward through Zones 2 and 3. However, because of the implementation of safety and security measures during marine transit, the likelihood of a marine LNG spill is remote and an unlikely event.

Based on the breach sizes identified in the Sandia Report, the methodology described in the ABSG study, and revised in the FERC staff's responses to comments, was also used to calculate the thermal radiation and flammable vapor dispersion distances. In the case of the penetration of the largest cargo tank of a 140,000-m^3 LNG carrier, a potential spill of 23,000 m^3 is estimated for the volume of LNG above the waterline. The estimated pool spread results and thermal radiation hazard distances are identified in table 4.11.5-2 below. Thermal radiation calculations are based on an ambient temperature of 52 °F, a relative humidity of 50 percent, and an 18-mph wind speed.

TABLE 4.11.5-2 **LNG Spills on Water (using ABSG Methodology)**					
LNG Release and Spread					
Hole Area	0.8 m^2	1.5 m^2	5 m^2	7 m^2	12 m^2
Hole Diameter	1.0 m	1.4 m	2.5 m	3.0 m	3.9 m
Spill Time	94.0 minutes	48.0 minutes	15.0 minutes	10.4 minutes	6.2 minutes
Pool Fire Calculations					
Maximum Pool Radius	341 feet	476 feet	817 feet	938 feet	1,102 feet
Fire Duration	94.1 minutes	48.1 minutes	15.2 minutes	10.7 minutes	6.5 minutes
Distance to:					
1,600 Btu/ft^2-hr	2,154 feet	2,777 feet	4,163 feet	4,630 feet	5,225 feet
3,000 Btu/ft^2-hr	1,675 feet	2,150 feet	3,205 feet	3,560 feet	4,013 feet
10,000 Btu/ft^2-hr	1,013 feet	1,289 feet	1,902 feet	2,108 feet	2,371 feet

Flammable vapor dispersion calculations were based on an atmospheric temperature of 52 ºF, 50 percent relative humidity, a 4.5-mile per hour wind speed and atmospheric stability Class F. Based on a 1-meter diameter hole, an unignited release would result in an estimated pool radius of 421 feet. The unignited vapor cloud would extend to 10,237 feet to the LFL and 13,618 feet to one-half the LFL. It is important to identify certain key assumptions of conditions that must exist in order to achieve these vapor cloud distances. First it would be necessary for an event to create a 1-meter diameter hole by penetrating the outer hull, the inner hull, and cargo containment without ignition. Far more credible is that the event creating a 1-meter diameter hole would also result in a number of ignition sources which would lead to an LNG pool fire and subsequent thermal radiation hazards. It is also unlikely that a flammable vapor cloud could achieve these distances over land surfaces without encountering an ignition source, and subsequently burning back to the source.

The results of these calculations are in agreement with the Zones of Concern used by the Coast Guard in assessing the waterway suitability and are in agreement with the Sandia report. These intentional breach scenarios provide guidance to the Coast Guard in developing the operating restrictions for LNG carrier movements in the waterway, as well as in establishing potential impact areas for emergency response and evacuation planning. By focusing on the "worst-case" scenario for LNG transportation, there is a tendency to dismiss the potential hazards for other fuels and products commonly transported on our waterways. Some of the previously identified studies that calculate long hazard distances for LNG cargo fires also estimate similarly long distances for gasoline, propane, and jet fuel cargo fires. Also, it should not be assumed that the hazard distances identified are the assured outcome of an LNG carrier accident or attack, given the conservatisms in the models and the level of damage required to yield such large scale releases. Further, these "worst-case" intentional breach scenarios should not be misconstrued as defining an exclusionary zone. Rather the average most probable "worst-case" scenarios provide guidance in developing the operating restrictions for LNG carrier movements in the Columbia River navigation channel, as well as in establishing potential impact areas for emergency response and evacuation planning.

For the project, NorthernStar proposes to receive LNG carriers with capacities up to 200,000 m^3. However, based on existing uncertainties for larger ships, the Coast Guard COTP Portland would require that NorthernStar must either complete a site-specific analysis for the largest sized LNG vessel or limit arrivals to vessels with a cargo capacity no greater than 148,000 m^3 until additional analysis addressing vessels with higher cargo capacities is completed.

4.11.5.4 LNG Carrier Transit to the Bradwood Landing LNG Project

Imported LNG could be obtained from exporting terminals throughout the world and delivered by LNG carriers to the proposed project. Exporting countries include Algeria, Australia, Brunei, Indonesia, Malaysia, Nigeria, Oman, Qatar, Trinidad, and United Arab Emirates. In 2007, LNG imports to the United States included: 59 percent from Trinidad, 15 percent from Egypt, 12 percent from Nigeria, 10 percent from Algeria, 2 percent from Qatar, and 2 percent from Equatorial Guinea.

Carrier Routes

The Columbia River navigation channel extends from CRM -2 (within the Pacific Ocean) to CRM 106.5 at Vancouver, Washington. From the territorial sea, LNG carriers would enter the Columbia River navigation channel within U.S. territorial waters at CRM -2 and would transit about 38 miles up the Columbia River to the proposed Bradwood Landing LNG terminal. LNG carriers would normally enter the mouth of the Columbia River about 3 hours before high tide. Two tugs would be required to escort the LNG carriers upriver, at least one of which must be a tractor tug, which would be made up as soon as it is safe to do so. The primary tug would be tethered at the direction of the pilot. A third tug would be required to assist with turning and mooring. All three tugs, which would be provided by NorthernStar, would be at least 60 Ton Astern Bollard Pull or larger and equipped with Class 1 fire fighting equipment.

The channel between CRM -2 and CRM 3 is 2,640 feet wide and is presently authorized and maintained to a depth of 55 feet within the northerly 2,000 feet, while the remaining 640 feet is maintained to a depth of 48 feet. From CRM 3 to the proposed Bradwood Landing LNG terminal site at CRM 38, the channel is at least 600 feet wide and 40 to 43 feet in depth. The COE's Columbia River Channel Improvement Project, which includes deepening of the navigation channel to 43 feet, will be completed before the LNG terminal would go into operation.

There are a number of major ports along the lower Columbia River, including Astoria, St. Helens, and Portland on the Oregon side of the river and the ports of Longview, Kalama, and Vancouver on the Washington side. With the exception of Astoria, all of these ports are upstream from the project site at CRM 38. The only bridge in the lower river below Longview, Washington (CRM 66) is at Astoria (CRM 13.5). The Astoria-Megler Bridge has a vertical clearance of 205 feet and a horizontal clearance of 1,070 feet. There are two anchorages located on either side of the channel adjacent to Astoria, referred to as the Astoria North Anchorage and the Astoria South Anchorage. Anchorages are used for temporarily holding ships while they are waiting to proceed upstream or downstream. However, these anchorages would not be used for LNG carriers.

All ships are required to have a Columbia River Bar Pilot between the sea buoy and Astoria, and a Columbia River Pilot upstream of Astoria. The pilots, supervised by the Oregon Board of Pilot Commissioners, are responsible for scheduling, monitoring of weather conditions, and establishing working conditions. The pilots maintain bridge-to-bridge communication and coordinate vessel passing operations through a vessel information system allowing pilots to ascertain probable passing points with other ships in the river.

The LNG carriers would dock at a specially constructed ship berth and maneuvering basin east of the LNG terminal site. The berth would be over 1,000 feet from the main navigation channel, providing a safe distance from the main channel for passing vessels. All maneuvering and docking of the LNG carriers at the berth would be carried out under tug assistance and pilot supervision. Docking, LNG offloading, and undocking would take about 24 hours.

WST conducted a vessel maneuvering simulation study for the stretch of the Columbia River from Pillar Rock Reach to Driscoll Reach and for the ship berth and maneuvering area at the Bradwood Landing terminal (WST, 2005). The study included the transit of a 140,000 m^3 as well as a future 200,000 m^3 LNG carrier through the Columbia River navigation channel at its current depth and width. The study indicated that LNG carriers could safely maneuver the approach to the LNG terminal and ship berth with the assistance of three tugs.

In addition to the WST study, in April 2006, four Columbia River Pilots conducted simulator analyses of LNG carriers transiting the Columbia River navigation channel at the Pacific Maritime Institute in Seattle, Washington. They concluded that the LNG carriers handled similar to other large vessels. They were able to navigate the channel in all conditions normally encountered on the Columbia River and looked at many situations involving other vessels. The ships could be handled satisfactorily when meeting other vessel traffic in the straight legs but would require extra room on the turns, where meeting other traffic should be avoided. The pilots determined that restrictions on night transits would not be necessary, although an initial period of daytime only transits would be prudent until the pilots obtain experience with the LNG carriers.

Hazard Zones Associated with the Proposed Routes

LNG carriers would traverse primarily offshore waters with the exception of approximately 38 miles of the Columbia River navigation channel to the LNG terminal. The LNG carrier would transit the channel at a speed of 8 to 12 knots, resulting in areas within the Zones of Concern being exposed to a potential transient thermal hazard for up to 15 minutes (see figure 2.1.2-1).

Communities located within the Zones of Concern (see figure 2.1.2-1) along the Washington side of the waterway include portions of Pillar Rock, Rockland, and Bayview that are overlapped by Zone 1; Altoona, Brookfield, and Skamokawa in Zone 2; and portions of Pigeon Bluff and Cathlamet in Zone 3. The western one-third of Puget Island is within the Zones of Concern, with about 22 structures overlapped by Zone 1, about 52 structures within Zone 2, and additional homes and farm areas in Zone 3. On the Oregon side of the waterway, in Clatsop County, waterfront portions of the communities of Hammond, Warrenton, and Astoria are overlapped by Zone 1; other portions of Warrenton and Astoria are in Zone 2; and parts of Warrenton, Astoria, and Clifton are in Zone 3. The potential impacts that LNG marine traffic along the waterway may have on existing residences, populations, housing, property values, and public services and infrastructure at these communities are discussed further in sections 4.7.1.2, 4.7.2.3, and 4.8.1.

In addition, a temporary hazard would exist around the slip during part of the 12- to 14-hour period while the LNG carrier is at the dock and unloading cargo. A fire associated with a potential spill resulting from a nominal cargo tank hole of an intentional event could expose the LNG storage tanks at the LNG terminal to a thermal radiation level of 10,000 Btu/ft^2-hr for up to 20 minutes. Depending on the duration of the incident, damage to the LNG storage tanks at the terminal could compound the event. However, this compounded event would not create exclusion zones larger than the zones calculated for an LNG storage tank fire in section 4.11.4 and, therefore, would not create any additional risks for the public.

4.11.5.5 Requirements for LNG Carrier Operations in the Columbia River

The Coast Guard exercises regulatory authority over LNG facilities that affect the safety and security of port areas and navigable waterways under Executive Order 10173; the Magnuson Act (50 USC § 191); the Ports and Waterways Safety Act of 1972, as amended (33 USC § 1221, et seq.); and the Maritime Transportation Security Act of 2002 (46 USC § 701). The Coast Guard is responsible for

matters related to navigation safety, vessel engineering and safety standards, and all matters pertaining to the safety of facilities or equipment located in or adjacent to navigable waters up to the last valve immediately before the receiving tanks. The Coast Guard also has authority for LNG facility security plan review, approval and compliance verification as provided in Title 33 CFR Part 105, and siting as it pertains to the management of vessel traffic in and around the LNG facility.

The Coast Guard regulations in 33 CFR 127 apply to the marine transfer area of waterfront facilities between the LNG carrier and the last manifold or valve located immediately before a storage tank. Title 33 CFR 127 regulates the design, construction, equipment, operations, inspections, maintenance, testing, personnel training, firefighting, and security of LNG waterfront facilities. The safety systems, including communications, ESD, gas detection, and fire protection, must comply with the regulations in 33 CFR 127. Under 33 CFR 127.019, NorthernStar would be required to submit two copies of its Operations and Emergency Manuals to the COTP for examination.

Title 33 CFR 127 separates cargo transfer operations into three distinct phases: Preliminary Transfer Inspection (section 127.315); Declaration of Inspection (section 127.317); and LNG Transfer (section 127.319). These different sections require specific actions to be completed prior to and during the transfer. Additionally, there are specific actions required in the case of a release of LNG (section 127.321).

As required by its regulations (section 127.009), the Coast Guard is responsible for issuing an LOR as to the suitability of the waterway for LNG marine traffic with respect to the following items:

- information submitted under Section 127.007:
    - the physical location of the facility;
    - a description of the facility;
    - the LNG vessels' characteristics and the frequency of LNG shipments to or from the facility; and
    - charts showing waterway channels and identifying commercial, industrial, environmentally sensitive, and residential areas in and adjacent to the waterway used by the LNG vessels en route to the facility, within 25 kilometers (15.5 miles) of the facility.
- density and character of marine traffic;
- locks, bridges, or other manmade obstructions in the waterway; and
- the following factors adjacent to the facility:
    - depth of water;
    - tidal range;
    - protection from high seas;
    - natural hazards, including reefs, rocks, and sandbars;
    - underwater pipes and cables; and
    - distance of berthed vessels from the channel and the width of the channel.

The process of preparing the LOR begins when an applicant submits an LOI to the COTP. In accordance with 33 CFR 127.007, NorthernStar submitted an LOI to the Coast Guard on January 18, 2005 (see Appendix G). On September 9, 2005, the Coast Guard issued a notice in the Federal Register requesting comments pertaining specifically to the maritime safety and security aspects of the proposed LNG facility. In preparation for issuance of an LOR and the completion of certain other regulatory mandates, the comments received were incorporated into a formalized risk assessment process to assess the safety and security aspects of the facility, adjacent poor areas, and navigable waterways. The Coast Guard held a public meeting jointly with the FERC on September 29, 2005, pursuant to the notice. The Coast Guard's comment period ended on October 6, 2005.

The NVIC 05-05 provides Coast Guard COTPs/FMSCs, members of the LNG industry, and port stakeholders with guidance on assessing the suitability of a waterway for LNG marine traffic that takes into account conventional navigation safety/waterway management issues contemplated by the existing LOI/LOR process, but in addition, would also take completely into account MARSEC implications. In accordance with this guidance, each LNG project applicant is to submit a WSA to the cognizant COTP. The WSA process addresses the transportation of LNG from an LNG carrier's entrance into U.S. territorial waters, through its transit to and from the LNG receiving facility, including operations at the LNG carrier/facility interface. In addition, the WSA should address the navigational safety issues and port security issues introduced by the proposed LNG operations. The NVIC 05-05 also provides specific guidance on the timing and scope of the WSA.

NorthernStar's Waterway Suitability Assessment

NorthernStar submitted a preliminary WSA for the proposed project to the Coast Guard in December 2005. Based on feedback from the Coast Guard and other stakeholders, NorthernStar prepared a follow-on WSA, which was submitted to the Coast Guard in May 2006. The Coast Guard, with input from the Area Maritime Security Committee, local law enforcement, and emergency response organizations, has reviewed NorthernStar's WSA in accordance with the guidance in NVIC 05-05. The WSA review focused on the navigation safety and maritime security risks posed by LNG marine traffic, and the measures needed to responsibly manage these security risks.

Coast Guard Waterway Suitability Report

Based on the WSA review and consultations, the Coast Guard advised the FERC in its WSR dated February 28, 2007, that to make the Columbia River suitable for the LNG marine traffic associated with the Bradwood Landing Project, specific risk mitigation measures would be necessary. These measures are further detailed in the WSR (see Appendix G) and include, among others, the following operational conditions:

- a 500-yard moving safety/security zone around the LNG vessel during transit of the waterway where no other vessel may enter without first obtaining permission from the COTP;
- a 200-yard fixed security zone while the LNG vessel is moored at the LNG terminal;
- a 50-yard security zone around the LNG terminal when there is not a vessel at the dock;
- submission by NorthernStar of a Facility Security Plan for Coast Guard approval;

- a restriction on the size of LNG carriers transiting the Columbia River navigation channel to a capacity of 148,000 m^3 until a completed site-specific risk analysis for larger ships is approved by the COTP;

- one-way LNG marine traffic along certain portions of the waterway such as at turns;

- submission to the COTP by NorthernStar of an annual update of its WSA to evaluate if any conditions in the waterway have changed that would require issuance of a new LOR;

- requirement that LNG vessels must board a Pilot(s) at least 5 miles before the CR Buoy, and for at least the first 6 months, at least two Pilots must be present throughout the transit;

- requirement that for the first 6 months, all transits must be during daylight hours;

- annual Coast Guard inspections of LNG vessels and facilities;

- escort of the vessel by at least two tugs along the waterway with a third to assist with turning and mooring where all three tugs will be at least 60 Ton Astern Bollard Pull or larger and equipped with Class 1 firefighting capability;

- simulator training for pilots and tug operators who have responsibility for LNG traffic; and

- implementation of a Coast Guard-approved *LNG Vessel Transit Management Plan.*

In addition, the WSR recommends additional facilities and infrastructure to make the waterway suitable for LNG marine traffic. The Coast Guard consulted with a variety of stakeholders, including state and local emergency responders, Marine Pilots, towing industry representatives, members of the Port Waterway Safety Committee, and the Area Maritime Security Committee to preliminarily identify the additional resources, public and/or private, that would be needed to implement prevention and mitigation strategies necessary for LNG operations. These measures include:

- upgrades to navigational aids including installation of three aids at Bradwood, a PORTS station at Bradwood contracted with NOAA to provide real time river level, current, and WX data, and a Doppler docking station;

- installation of a real time system for data collection on the Columbia River Bar conditions including an immersion study of deep-draft LNG vessels;

- augmentation of shoreside firefighting capabilities to provide protection services to the facility as well as communities along the transit route;

- implementation of a public notification system to notify the public along the transit route;

- increased gas detection capability, maintenance, and training to initial responders;

- implementation of a Regional Communication Plan and associated equipment to ensure that the facility, associated command centers, emergency responders, Coast Guard, tug operators, escort vessels, and pilots are able to communicate effectively;

- improvements to the Columbia River's Vessel Traffic Information System, including augmentation of a camera monitoring system capable of monitoring the entire route and detecting vessel traffic in wind, rain, fog, and dark conditions, installation of an AIS repeater located in Astoria; and

- availability of Coast Guard as well as other safety and security resources, including additional safety measures when a cruise ship is in port, security boardings, waterway monitoring, shoreline patrols, and vessel escorts to implement the additional security measures.

In addition to the above measures, additional specific measures, and, where applicable, the resources needed to implement them, are described in a separate supplementary report from the Coast Guard to the FERC on February 28, 2007. This supplementary report, and the specific details of these measures, have been designated Sensitive Security Information as defined in 49 CFR 1520. Because any unauthorized disclosure of details of these measures could be employed to circumvent the proposed security measures, it is not releasable to the public. These additional measures may include security boardings, surveillance and monitoring, patrols, vessel escorts, and additional security measures. Additionally, any security plan is a dynamic document that is subject to change with advances in technologies and improvements in intelligence gathering.

As the Coast Guard has determined that additional measures beyond those proposed by NorthernStar in the WSA would be required to responsibly manage the maritime safety and security risks associated with the LNG marine traffic, **we recommend that:**

- **<u>Throughout the life of the facility</u>, NorthernStar should ensure that the facility and any LNG vessel transiting to and from the facility comply with all requirements set forth by the Coast Guard Captain of the Port Sector Portland, including all risk mitigation measures recommended in the WSR.**

After completion of the final EIS, the Coast Guard will complete its review and issue an LOR to address the suitability of the waterway for LNG transport. If the Coast Guard issues an LOR finding the waterway suitable for LNG marine traffic with conditions, the necessary security measures would be further developed into the detailed *LNG Vessel Transit Management Plan,* which would become the basis for appropriate security measures for each MARSEC threat level. This plan would clearly spell out roles, responsibilities, and specific procedures for an LNG carrier transiting the Columbia River navigation channel up to the proposed Bradwood Landing LNG terminal, as well as for all agencies involved in implementing security and safety during the operation. Prior to the LNG carrier being granted permission to enter the shipping channels, both the vessel and facility would be required to be in full compliance with the Maritime Transportation Security Act and International Ship and Port Facility Security Code, and the security protocols to be established by the COTP in the *LNG Vessel Transit Management Plan*. The plan may include security measures such as: Coast Guard and other law enforcement agency vessels enforcing safety and security zones around the LNG carriers while in transit and moored at the terminal; shoreside surveillance and monitoring; and other prevention/mitigation strategies.

We recognize that the *LNG Vessel Transit Management Plan* would be a dynamic document that would be prepared well before import operations would commence, and that the port's overall security picture may change over that time period. New port activities may commence, infrastructure may be added, or population density may change. Improvements in technology to detect, deter, and defend against intentional acts may also develop. Therefore, **we recommend that:**

- **NorthernStar, until commencement of service, should <u>annually</u> review its WSA relating to LNG marine traffic for the project; update the assessment to reflect**

changing conditions which may impact the suitability of the waterway for LNG marine traffic; provide the updated assessment to the cognizant COTP/FMSC for review and validation and if appropriate, further action by the COTP/FMSC relating to LNG marine traffic; and provide a copy to the FERC staff.

In addition, NorthernStar would provide security for the terminal according to a Facility Security Plan that must be prepared under 33 CFR 105. This plan would need to be approved by the Coast Guard COTP. The requirements of this plan may include:

- a Facility Security Assessment to identify site vulnerabilities, possible security threats, consequences of an attack, and facility protective measures;
- procedures for responding to security incidents;
- a designated FSO responsible for implementing and periodically updating the Facility Security Plan and Assessment;
- scalable security measures to provide increasing levels of security at increasing MARSEC levels;
- security exercises at least once each calendar year and drills at least every 3 months; and
- mandatory reporting of all breaches of security and security incidents.
- Security at the facility would be provided by both active and passive systems. In accordance with federal regulations, the entire site would be surrounded by a protective enclosure (i.e., a fence) with sufficient strength to deter unauthorized access. The enclosure would also be illuminated with not less than 2.2 lux between sunset and sunrise. Intrusion detection systems and day/night camera coverage would identify unauthorized access. A separate security staff would conduct periodic patrols of the plant, and screen visitors and contractors. The security staff may also assist in maintaining security of the marine terminal during cargo unloading. NorthernStar would be required to submit their Facility Security Plan to the COTP for approval 60 days before commencement of operations.

Impact of Vessel Security Requirements

The potential impacts of the proposed LNG marine traffic for the Bradwood Landing Project on other commercial and recreational boaters can be addressed in relation to several general security requirements: 1) a moving safety/security zone for inbound LNG carriers; 2) a security zone around a moored LNG carrier; and 3) other measures as deemed appropriate.

If the Coast Guard issues an LOR finding the waterway suitable for LNG marine traffic with the conditions referenced in the WSR, the Coast Guard would promulgate a moving safety/security zone that would affect other vessels. Pursuant to such a regulation, no vessel would be allowed to enter the safety/security zone without first obtaining permission from the Coast Guard COTP. If the Coast Guard issues an LOR finding the waterway suitable for LNG marine traffic with conditions, it is anticipated that the LNG carriers would transit about 40 miles along the Columbia River navigation channel to the proposed LNG terminal. For the majority of this trip, an LNG carrier would travel at an average speed of 8 to 12 knots. Based on these assumed speeds and allowing time for pilot boarding and tug connecting, it

would take about 5.5 hours for LNG carriers to complete the trip to the LNG terminal. Additional time would be required to maneuver the LNG carrier into the berth.

If a moving safety/security zone during transit, a fixed security zone at the terminal, and one-way traffic in designated areas were implemented, they would affect other commercial and recreational traffic using the channel. The magnitude of the effect would also be influenced by other factors, such as the amount of time it takes to obtain a pilot and other competing ship traffic in the federal navigation channel.

If the proposed LNG terminal is constructed, and if the Coast Guard issues an LOR finding the waterway suitable for LNG marine traffic with the conditions described above under *Coast Guard Waterway Suitability Report*, as many as 125 LNG carriers for the Bradwood Landing LNG terminal could potentially move in and out of the Columbia River navigation channel every year. This is an increase in vessel traffic of about 25 percent for large, deep-draft vessels currently transiting these waterways but only a 7 percent increase overall. Other shipping activities would be moderately affected by this increase in traffic; however, based on the relatively modest current level of shipping activity, the impact is not expected to be substantial. The impacts of LNG marine traffic and associated security requirements on recreational and commercial vessel traffic are discussed in further detail in sections 4.7.1.4 and 4.8.1.7, respectively.

Anchors for the three navigational aides that would be placed to mark the northern edge of the maneuvering basin at the Bradwood Landing LNG terminal would have a localized short-term impact on the riverbed. The light from these navigational aides would be designed so as to have minimal impact on marine life.

Tugboats would have associated air emissions (see section 4.10.1.1); however, because the waterway is an attainment area and the tugs are a transient, mobile source, no significant air quality impacts are anticipated. Nor would the noise associated with the tugboats be likely to unduly disturb wildlife or the human population given their current presence along the waterway. Furthermore, the tugs would enhance safety, security, and fire-fighting capabilities.

The WSR would require a number of upgraded or new safety and security systems and procedures. The FERC has received comments on this and other LNG terminal proposals expressing concern about the cost of applying additional security measures and the potential burden on local taxpayers. Additional funding for state and local resources would be provided by NorthernStar to the extent called for by the Cost-Sharing Plan to be developed with the pertinent state and local agencies, discussed in section 4.11.6 *Emergency Response and Evacuation Planning*.

4.11.6 Emergency Response and Evacuation Planning

Prior to commencing service, NorthernStar would be required to prepare emergency procedure manuals in accordance with 49 CFR 193.2509 that provide for: a) responding to controllable emergencies and recognizing an uncontrollable emergency; b) taking action to minimize harm to the public including the possible need to evacuate the public; and c) coordination and cooperation with appropriate local officials. Specifically, section 193.2509(b)(3) requires, "Coordinating with appropriate local officials in preparation of an emergency evacuation plan…"

While the exclusion zones evaluated for the onshore facility in section 4.11.4 and the consequence areas for marine spills in section 4.11.5.3 provide guidance on the maximum extent of potential hazards, they should not be assumed to represent the evacuation zone for <u>*every*</u> potential incident. As with any other fuel or hazardous material, the actual severity of the incident would determine what area needs to be evacuated, if any, rather than a worst-case maximum zone. It is

anticipated that the emergency evacuation plans would identify evacuation distances based upon increasing severity of events.

On several LNG import terminal proposals, a number of organizations and individuals (including the ODE and Clatsop County on the Bradwood Landing Project) commented on the need to consider emergency response procedures. Section 3A(e) of the NGA, added by section 311 of the EPAct of 2005, stipulates that in any order authorizing an LNG terminal, the Commission shall require the LNG terminal operator to develop an ERP in consultation with the Coast Guard and state and local agencies. The FERC must approve the ERP prior to any final approval to begin construction.

In July 2006, NorthernStar began developing an ERP and was provided a copy of the FERC staff's prepared guidance for developing ERPs titled "Draft Guidance for LNG Terminal Operator's Emergency Response Plan" (Draft Guidance). In 2007, NorthernStar provided Clatsop County a draft ERP to review. PBS&J, an engineering consulting company, was contracted by Clatsop County to perform a review of NorthernStar's draft ERP. PBS&J's completed review, issued in July 2007, included a list of gaps between the FERC's Draft Guidance and NorthernStar's draft ERP. PBS&J provided a list of recommendations to NorthernStar detailing how the draft ERP could be improved. After PBS&J's review, NorthernStar revised its draft ERP and supplied it to Clatsop County for additional review. In November 2007, PBS&J published a second report detailing how most of their recommendations had been incorporated into NorthernStar's draft ERP. However, several recommendations were still outstanding.

On March 24, 2008, NorthernStar filed the draft ERP with the FERC for review. The draft ERP consists of incident specific plans and an Emergency Management Plan (EMP). The EMP consists of two parts: the EMP base plan, which has nine sections detailing the general purpose, philosophy, organization, responsibility, systems and layout, and the concept of operation for the LNG terminal; and the supporting annexes which cover warnings and notifications, communications, public affairs, evacuation, emergency vessel departure, emergency training, and material safety sheets.

From our initial review of the draft ERP and associated EMP, additional effort would be required to fully meet the requirements of recommendation number 62 in the draft EIS. Key items include the development of a comprehensive Cost-Sharing Plan to cover the costs of state and local resources responsible for security and safety; and documentation of consultation and coordination with the appropriate state and local agencies and Coast Guard in developing the plan. Further, it would be prudent to condense the more than 300 pages in the ERP and EMP documents into a single, user-friendly plan that would provide clear, concise guidance for the various responsible agencies. An outstanding recommendation in the PBS&J report also addressed this issue and should be incorporated into a final plan. As a result, **we continue to recommend that**:

- **NorthernStar should develop an ERP (including evacuation) and coordinate procedures with the Coast Guard, state, county, and local emergency planning groups; fire departments; state and local law enforcement; and appropriate federal agencies. This plan should include at a minimum:**

  a. designated contacts with state and local emergency response agencies;

  b. scalable procedures for the prompt notification of appropriate local officials and emergency response agencies based on the level and severity of potential incidents;

c. **procedures for notifying residents and recreational users within areas of potential hazard;**

d. **evacuation routes/methods for residents and other public use areas that are within any transient hazard areas along the route of the LNG vessel transit;**

e. **locations of permanent sirens and other warning devices; and**

f. **an "emergency coordinator" on each LNG vessel to activate sirens and other warning devices.**

The ERP should be filed with the Secretary for review and written approval by the Director of OEP <u>prior to initial site preparation</u>. NorthernStar should notify the FERC staff of all planning meetings in advance and should report progress on the development of its ERP at <u>3-month intervals</u>.

As required by the EPAct of 2005, FERC must review and approve each ERP prior to initial site preparation. Accordingly, FERC staff ensures that appropriate state and local agencies have been involved in preparing the plan and that the Coast Guard has been consulted and concurs. The ERP typically addresses the structure of the incident management organization of the LNG terminal, procedures for responding to emergencies within the LNG Terminal, and procedures for emergency evacuation adjacent to the LNG Terminal and along LNG vessel transit route. The ERP also includes plans for initial and continuing training of plant operators and local responders along with provisions for annual emergency response drills by terminal emergency personnel, first responders, emergency response agencies, and appropriate federal, state and local officials. We also review documentation that the required consultation with the Coast Guard and state and local agencies has been completed through correspondence with consulting agencies, and minutes or notes of coordination meetings.

The FERC has also received comments, including comments from the ODE, Oregon Department of Justice, and Clatsop County, expressing concern that the local community would have to bear some of the cost of ensuring the security and emergency management of the LNG facility and the LNG vessels while in transit and unloading at the berth. Section 3A(e) specifies that the ERP shall include a Cost-Sharing Plan that contains a description of any direct cost reimbursements NorthernStar agrees to provide to any state and local agencies with responsibility for security and safety at the LNG terminal and near vessels that serve the facility. Therefore, **we recommend that:**

- **The ERP should include a Cost-Sharing Plan identifying the mechanisms for funding all project-specific security/emergency management costs that would be imposed on state and local agencies. In addition to the funding of direct transit-related security/emergency management costs, this comprehensive plan should include funding mechanisms for the capital costs associated with any necessary security/emergency management equipment and personnel base. The Cost-Sharing Plan should be filed with the Secretary for review and written approval by the Director of OEP <u>prior to initial site preparation</u>.**

The cost-sharing plan must specify what the LNG terminal operator would provide to cover the cost of the state and local resources required to manage the security of the LNG terminal and LNG vessel, and the state and local resources required for safety and emergency management, including:

- Direct reimbursement for any per-transit security and/or emergency management costs (for example overtime for police or fire department personnel);

- Capital costs associated with security/emergency management equipment and personnel base (for example patrol boats, fire fighting equipment); and

- Annual costs for providing specialized training for local fire departments, mutual aid departments, and emergency response personnel; and for conducting exercises.

The cost sharing plan must include the LNG terminal operator's letter of commitment with agency acknowledgement for each state and local agency designated to receive resources.

4.11.7 Conclusions on Marine Traffic Safety

The operational safety of LNG carriers is under the jurisdiction of the Coast Guard. If the Coast Guard issues an LOR determining suitability of the waterway for LNG marine traffic with conditions, operational restrictions that may be imposed by the Coast Guard would minimize the potential for a hazardous event occurring in the Columbia River and affecting the safety of the nearby public.

Since 1959, LNG has been transported by ship without a major release of cargo or a major accident involving an LNG carrier. Over the last 45 years, LNG carriers have made over 44,000 voyages worldwide. Based on the extensive operational experience of LNG shipping and the structural design of an LNG carrier, the likelihood of a cargo containment failure and subsequent LNG spill from a vessel casualty - collision, grounding, or allision - is highly unlikely. For intentional spills, the impacts to public safety and property could exist within the Zones of Concern. The severity of impacts within the zones would depend on the location of the incident relative to a specific area, the scope of the incident, and whether the released LNG is ignited or dispersed. However, if the Coast Guard issues a LOR finding the waterway suitable for LNG marine traffic with the conditions referenced under *Coast Guard Waterway Suitability Report*, the Coast Guard would control the transit of the LNG vessel through the harbor and while unloading cargo. The security provisions and operational controls that would be imposed by the Coast Guard, and the local pilots, to direct movement of LNG carriers would maintain the risk of a marine LNG spill, either with or without ignition, at acceptable levels. Therefore, the NorthernStar LNG Project would be unlikely to result in a significant impact within the Zones of Concern because it is unlikely that a substantial cargo release would occur.

4.11.8 Terrorism and Security Issues

The security requirements for the onshore component of the proposed project are governed by 49 CFR 193, Subpart J - Security. This subpart includes requirements for conducting security inspections and patrols, liaison with local law enforcement officials, design and construction of protective enclosures, lighting, monitoring, alternative power sources, and warning signs. Requirements for maintaining safety of the marine terminal are in the Coast Guard's regulations in 33 CFR 127. Requirements for maintaining security of the marine terminal are in 33 CFR 105.

In the aftermath of the terrorist attacks that occurred on September 11, 2001, terrorism has become a very real concern for the facilities under the Commission's jurisdiction. The FERC, like other federal agencies, is faced with a dilemma in how much information can be offered to the public while still providing a significant level of protection to the facility. Consequently, the FERC has removed energy facility design plans and location information from its website to ensure that sensitive information filed under CEII is not readily available (RM02-4-000 and PL02-1-000 issued February 20, 2003).

Since September 11, 2001, the FERC has been involved with other federal agencies in developing a coordinated approach to protecting the energy facilities of the United States. The FERC continues to coordinate with these agencies, specifically with the Coast Guard, to address this issue. The Coast Guard

now requires arriving ships to provide it with a 96-hour advance notice of arrival that includes key information about the vessel and its crew, which allows the Coast Guard to conduct a terrorism risk assessment and put in place appropriate mitigation before the ship reaches the navigation channel. In addition, interstate natural gas companies are actively involved with several industry groups to chart how best to address security measures in the current environment. A Security Task Force has been created and is addressing ways to improve pipeline security practices, strengthen communications within the industry and the interface with government, and extend public outreach efforts.

On October 22, 2003, the Coast Guard issued a series of six final rules, which promulgated the maritime security requirements of the Marine Transportation Security Act of 2002: Implementation of National Maritime Security Initiatives; Area Maritime Security; Vessel Security; Facility Security; Outer Continental Shelf Facility Security; and the Automatic Identification System. The entire series of rulemakings establishes a new subchapter H in 33 CFR. In support of the rulemakings, the Coast Guard applied a risk-based decision-making process to comprehensively evaluate the relative risks of various target and attack mode combinations and scenarios for those vessel types and port facilities that pose a risk of a security incident. This approach provides a more realistic estimation of risk than a simple worst-case outcome assessment. Risk management principles acknowledge that while risk generally cannot be eliminated, it can be reduced by adjusting operations to lower consequences, threats, or vulnerability - recognizing that it is easier to reduce vulnerabilities by adding security measures.

On December 29, 2003, all terminal owners or operators subject to 33 CFR 105 were required to submit a Facility Security Assessment and Facility Security Plan to the Coast Guard COTP for review and approval. The Facility Security Plans were required to be implemented no later than July 1, 2004, or for facilities constructed after July 1, 2004, 60 days prior to operations. Some of the principal owner or operator responsibilities include:

- designating a FSO with a general knowledge of current security threats and patterns, risk assessment methodology, and the responsibility for implementing the Facility Security Plan and Assessment and performing an annual audit for the life of the project;

- conducting a Facility Security Assessment to identify site vulnerabilities, possible security threats and consequences of an attack, and facility protective measures;

- developing a Facility Security Plan based on the Facility Security Assessment, with procedures for responding to transportation security incidents; notification and coordination with local, state, and federal authorities; prevention of unauthorized access; measures and equipment to prevent or deter dangerous substances and devices; training; and evacuation;

- implementing scalable security measures to provide increasing levels of security at increasing MARSEC levels for facility access control, restricted areas, cargo handling, vessel stores and bunkers, and monitoring;

- conducting security exercises at least once each calendar year and drills at least every 3 months; and

- reporting of all breaches of security and security incidents.

Increased security awareness has occurred throughout the industry and the nation. President Bush established the Department of Homeland Security with the mission of coordinating the efforts of all executive departments and agencies to detect, prepare for, prevent, protect against, respond to, and

recover from terrorist attacks within the United States. The Commission, in cooperation with other federal agencies and industry trade groups, has joined in the efforts to protect the energy infrastructure, including the more than 300,000 miles of interstate natural gas transmission pipeline and associated LNG facilities.

Safety and security are important considerations in any Commission action. The attacks of September 11, 2001 have changed the way pipeline operators as well as regulators must consider terrorism, both in approving new projects and in operating existing facilities. However, the likelihood of future acts of terrorism or sabotage occurring at the proposed terminal expansion, or at any of the myriad of natural gas pipeline or energy facilities throughout the United States is unpredictable given the disparate motives and abilities of terrorist groups. It is possible that a release from the LNG storage tanks could be caused by an intentional act, such as a terrorist attack. Although an intentional breach scenario could result in greater thermal radiation in the immediate vicinity of the release, such scenarios are typically associated with the desire to inflict damage to major infrastructure and population and commercial centers. However, existing and proposed security measures discussed in this section make significant impacts to human life and property from a terrorist attack unlikely. The continuing need to construct facilities to support the future natural gas pipeline infrastructure is not diminished from the threat of any such unpredictable acts.

4.11.9 Pipeline Facilities

The transportation of natural gas by pipeline involves some risk to the public in the event of an accident and subsequent release of gas. The greatest hazard is a fire or explosion following a major pipeline rupture.

Methane, the primary component of natural gas, is colorless, odorless, and tasteless. It is not toxic, but is classified as a simple asphyxiate, possessing a slight inhalation hazard. If breathed in high concentration, oxygen deficiency can result in serious injury or death.

Methane has an ignition temperature of 1,000ºF and is flammable at concentrations between 5.0 and 15.0 percent in air. Unconfined mixtures of methane in air are not explosive. However, a flammable concentration within an enclosed space in the presence of an ignition source can explode. Methane is buoyant at atmospheric temperatures and disperses rapidly in air.

4.11.9.1 Safety Standards

The DOT is mandated to provide pipeline safety under 49 USC § 601. The PHMSA Office of Pipeline Safety (OPS) administers the national regulatory program to ensure the safe transportation of natural gas and other hazardous materials by pipeline. It develops safety regulations and other approaches to risk management that ensure safety in the design, construction, testing, operation, maintenance, and emergency response of pipeline facilities. Many of the regulations are written as performance standards which set the level of safety to be attained and allow the pipeline operator to use various technologies to achieve safety. The PHMSA ensures that people and the environment are protected from the risk of pipeline incidents. This work is shared with state agency partners and others at the federal, state, and local level. Section 5(a) of the Natural Gas Pipeline Safety Act provides for a state agency to assume all aspects of the safety program for intrastate facilities by adopting and enforcing the federal standards, while section 5(b) permits a state agency that does not qualify under section 5(a) to perform certain inspection and monitoring functions. A state may also act as the DOT's agent to inspect interstate facilities within its boundaries; however, the DOT is responsible for enforcement action. The majority of the states have either 5(a) certifications or 5(b) agreements, while nine states act as interstate agents.

The DOT pipeline standards are published in 49 CFR Parts 190-199. Part 192 of 49 CFR specifically addresses natural gas pipeline safety issues.

Under a Memorandum of Understanding on Natural Gas Transportation Facilities (Memorandum) dated January 15, 1993, between the DOT and the FERC, the DOT has the exclusive authority to promulgate federal safety standards used in the transportation of natural gas. Section 157.14(a)(9)(vi) of the FERC's regulations require that an applicant certify that it will design, install, inspect, test, construct, operate, replace, and maintain the facility for which a certificate is requested in accordance with federal safety standards and plans for maintenance and inspection, or shall certify that it has been granted a waiver of the requirements of the safety standards by the DOT in accordance with section 3(e) of the Natural Gas Pipeline Safety Act. The FERC accepts this certification and does not impose additional safety standards other than the DOT standards. If the Commission becomes aware of an existing or potential safety problem, there is a provision in the Memorandum to promptly alert the DOT. The Memorandum also provides for referring complaints and inquiries made by state and local governments and the general public involving safety matters related to pipeline under the Commission's jurisdiction.

The FERC also participates as a member of the DOT's Technical Pipeline Safety Standards Committee which determines if proposed safety regulations are reasonable, feasible, and practicable.

The pipeline and aboveground facilities associated with the Bradwood Landing Project must be designed, constructed, operated, and maintained in accordance with the DOT Minimum Federal Safety Standards in 49 CFR Part 192. The regulations are intended to ensure adequate protection for the public and to prevent natural gas facility accidents and failures. Part 192 specifies material selection and qualification, minimum design requirements, and protection from internal, external, and atmospheric corrosion.

Part 192 also defines area classifications, based on population density in the vicinity of the pipeline, and specifies more rigorous safety requirements for populated areas. The class location unit is an area that extends 220 yards on either side of the centerline of any continuous 1-mile length of pipeline. The four area classifications are defined as follows:

- Class 1 – Location with 10 or fewer buildings intended for human occupancy.
- Class 2 – Location with more than 10 but less than 46 buildings intended for human occupancy.
- Class 3 – Location with 46 or more buildings intended for human occupancy or where the pipeline lies within 100 yards of any building, or small well-defined outside area occupied by 20 or more people on at least 5 days per week for 10 weeks in any 12-month period.
- Class 4 – Location where buildings with four or more stories aboveground are prevalent.

Class locations representing more populated areas require higher safety factors in pipeline design, testing, and operation. Pipelines constructed on land in Class 1 locations must be installed with a minimum depth of cover of 30 inches in normal soil and 18 inches in consolidated rock. Class 2, 3, and 4 locations, as well as drainage ditches of public roads and railroad crossings, require a minimum cover of 36 inches in normal soil and 24 inches in consolidated rock.

Class locations also specify the maximum distance to a sectionalizing block valve (e.g., 10.0 miles in Class 1, 7.5 miles in Class 2, 4.0 miles in Class 3, and 2.5 miles in Class 4). Pipe wall thickness

and pipeline design pressures, hydrostatic test pressures, maximum allowable operating pressure, inspection and testing of welds, and frequency of pipeline patrols and leak surveys must also conform to higher standards in more populated areas. Approximately 2.9 miles of the proposed pipeline would be within Class 3 locations, 10.9 miles would be within Class 2 locations, and the remaining 22.4 would be within Class 1 locations.

DOT regulations at 49 CFR 192.179, entitled Transmission Line Valves, require that each point of any Class 3 pipeline be within 4 miles from a mainline valve unless the DOT Administrator finds that an alternate spacing would offer an equivalent measure of safety. NorthernStar has identified a Class 3 pipeline segment between MPs 13.17 and 13.43 with the nearest mainline valve at MP 18.8. Therefore, **we recommend that:**

- **<u>Prior to construction</u>, NorthernStar should either submit a determination from the DOT documenting agreement with the proposed pipeline valve locations, or submit for the review and written approval by the Director of OEP modified pipeline design plans demonstrating compliance with 49 CFR 192.179.**

If a subsequent increase in population density adjacent to the right-of-way indicates a change in class location for the pipeline, NorthernStar would be required to reduce the maximum allowable operating pressure or replace the segment with pipe of sufficient grade and wall thickness, if applicable, to comply with the DOT code of regulations for the new class location.

In 2002, Congress passed an act to strengthen the Nation's pipeline safety laws. The Pipeline Safety Improvement Act of 2002 (HR 3609) was passed by Congress on November 15, 2002, and signed into law by the President in December 2002. As of December 17, 2004, gas transmission operators must develop and follow a written integrity management program that contains all the elements described in §192.911 and addresses the risks on each covered transmission pipeline segment. Specifically, the law establishes an integrity management program which applies to all high consequence areas (HCAs). The DOT (68 Federal Register 69778, 69 Federal Register 18228, and 69 Federal Register 29903) defines HCAs as they relate to the different class zones, potential impact circles, or areas containing an identified site as defined in §192.903 of the DOT regulations.

The OPS published a series of rules from August 6, 2002 to May 26, 2004 (69 Federal Register 29903), that defines HCAs where a gas pipeline accident could do considerable harm to people and their property and requires an integrity management program to minimize the potential for an accident. This definition satisfies, in part, the Congressional mandate in 49 USC 60109 for the OPS to prescribe standards that establish criteria for identifying each gas pipeline facility in a high-density population area.

The HCAs may be defined in one of two ways. In the first method an HCA includes:

- current Class 3 and 4 locations,
- any area in Class 1 or 2 where the potential impact radius[28] is greater than 660 feet and there are 20 or more buildings intended for human occupancy within the potential impact circle,[29] or

[28] The potential impact radius is calculated as the product of 0.69 and the square root of the MAOP of the pipeline in psi multiplied by the pipeline diameter in inches.

[29] The potential impact circle is a circle of radius equal to the potential impact radius.

- any area in Class 1 or 2 where the potential impact circle includes an identified site.[30]

In the second method an HCA includes any area within a potential impact circle which contains:

- 20 or more buildings intended for human occupancy, or
- an identified site.

Once a pipeline operator has determined the HCAs on its pipeline, it must apply the elements of its integrity management program to those segments of the pipeline within HCAs. The DOT regulations specify the requirements for the integrity management plan at § 192.911. NorthernStar has identified 13 HCAs that are crossed by and adjacent to the proposed pipeline route (see table 4.11.9-1).

TABLE 4.11.9-1

High Consequence Areas Crossed by and Adjacent to the Bradwood Landing Pipeline [a]

Beginning MP	Ending MP	Criteria	Distance To Pipeline	Land Use	Comments
0.00	0.15	Class 3	< 660 feet	Future LNG Terminal Site	
3.25	4.10	Class 3	< 660 feet	Wauna Industrial Site	
7.94	8.86	Identified Site	850 feet	Jones Beach ATV Sand Dunes	Potential for 20+ ATVs
13.17	13.43	Class 3	300 feet	Boat Launch/Storage	Potential for 20+ boaters
13.08	13.48	Identified Site	700 feet	Boat Storage/Launch, Fish Processing	Potential for 20+ boaters
18.00	18.91	Class 3	< 660 feet	Port Westward Industrial Site	End 36-inch pipeline
18.91	19.05	Class 3	< 660 feet	Port Westward Industrial Site	Begin 30-inch pipeline
34.00	34.38	Class 3	50-1000 feet	Cowlitz River Beach	Public Access Beach 20+ boaters
34.38	34.63	Class 3	200 feet	Scales/Truck shop	Potential for 5 to 20 workers
34.88	35.09	Identified Site	740 feet	Restaurant/Outside Bar	Potential for 20 or more people
35.09	35.40	Identified Site	550 feet	Interstate Highway 5 truck scale	Potential for 20 or more people
35.40	35.80	Identified Site	500 feet	Church	Potential for 20 or more people

[a] For 36-inch-diameter pipeline with a Maximum Allowable Operating Pressure (MAOP) of 1,280 pounds per square inch (psi), the radius for the potential impact circle is 889 feet; for 30-inch-diameter pipeline with a MAOP of 1280 psi, the radius for the potential impact circle is 741 feet.

The pipeline integrity management rule for HCAs requires inspection of the entire pipeline in HCAs every 7 years.

Part 192 prescribes the minimum standards for operating and maintaining pipeline facilities, including the requirement to establish a written plan governing these activities. Under section 192.615, each pipeline operator must also establish an emergency plan that includes procedures to minimize the hazards in a natural gas pipeline emergency. Key elements of the plan include procedures for:

- receiving, identifying, and classifying emergency events, gas leakage, fires, explosions, and natural disasters;

[30] An identified site is an outside area or open structure that is occupied by 20 or more persons on at least 50 days in any 12-month period; a building that is occupied by 20 or more persons on at least 5 days per week for any 10 weeks in any 12-month period; or a facility that is occupied by persons who are confined, are of impaired mobility, or would be difficult to evacuate.

- establishing and maintaining communications with local fire, police, and public officials, and coordinating emergency response;
- emergency shutdown of system and safe restoration of service;
- making personnel, equipment, tools, and materials available at the scene of an emergency; and
- protecting people first and then property, and making them safe from actual or potential hazards.

Part 192 requires that each operator must establish and maintain liaison with appropriate fire, police, and public officials to learn the resources and responsibilities of each organization that may respond to a natural gas pipeline emergency, and to coordinate mutual assistance. The operator must also establish a continuing education program to enable customers, the public, government officials, and those engaged in excavation activities to recognize a gas pipeline emergency and report it to appropriate public officials. NorthernStar would provide the appropriate training to local emergency service personnel before the pipeline is placed in service. No additional specialized local fire protection equipment would be required to handle pipeline emergencies.

4.11.9.2 Pipeline Accident Data

Since February 9, 1970, 49 CFR Part 191 has required all operators of transmission and gathering systems to notify the DOT of any reportable incident and to submit a report on form F7100.2 within 20 days. Reportable incidents are defined as any leaks that:

- caused a death or personal injury requiring hospitalization;
- required taking any segment of transmission line out of service;
- resulted in gas ignition;
- caused estimated damage to the property of the operator, or others, or both, of a total of $5,000 or more;
- required immediate repair on a transmission line;
- occurred while testing with gas or another medium; or
- in the judgment of the operator was significant, even though it did not meet the above criteria.

The DOT changed reporting requirements after June 1984 to reduce the amount of data collected. Since that date, operators must only report incidents that involve property damage of more than $50,000, injury, death, release of gas, or that are otherwise considered significant by the operator. Table 4.11.9-2 presents a summary of incident data for the 1970 to 1984 period, as well as more recent incident data for 1986 through 2005, recognizing the difference in reporting requirements. The 14.5-year period from

1970 through June 1984, which provides a larger universe of data and more basic report information than subsequent years, has been subject to detailed analysis, as discussed in the following sections.[31]

TABLE 4.11.9-2

Natural Gas Service Incidents by Cause

	Incidents per 1,000 miles of Pipeline (percentage)	
Cause	1970-1984	1986-2005
Outside force	0.70 (53.8)	0.10 (38.5)
Corrosion	0.22 (16.9)	0.06 (23.1)
Construction or material defect	0.27 (20.8)	0.04 (15.4)
Other	0.11 (8.5)	0.06 (23.1)
Total	1.30	0.26

During the 14.5-year period, 5,862 service incidents were reported over the more than 300,000 total miles of natural gas transmission and gathering systems nationwide. Service incidents, defined as failures that occur during pipeline operation, have remained fairly constant over this period with no clear upward or downward trend in annual totals. In addition, 2,013 test failures were reported. Correction of test failures removed defects from the pipeline before operation.

Additional insight into the nature of service incidents may be found by examining the primary factors that caused the failures. Table 4.11.9-2 provides a percentage distribution of the causal factors as well as the annual frequency of each factor per 1,000 miles of pipeline in service.

The dominant incident cause is outside forces, constituting 53.8 percent of all service incidents. Outside forces incidents result from the encroachment of mechanical equipment such as bulldozers and backhoes; earth movements due to soil settlement, washouts, or geologic hazards; weather effects such as winds, storms, and thermal strains; and willful damage.

Table 4.11.9-3 shows that human error in equipment usage was responsible for approximately 75 percent of outside forces incidents. Since April 1982, operators have been required to participate in "One Call" public utility programs in populated areas to minimize unauthorized excavation activities in the vicinity of pipelines. The "One Call" program is a service used by public utilities and some private sector companies (e.g., oil pipelines and cable television) to provide preconstruction information to contractors or other maintenance workers on the underground location of pipes, cables, and culverts. The 1986 through 2005 data show that the portion of incidents caused by outside forces has decreased to 38.5 percent.

TABLE 4.11.9-3

Outside Forces Incidents by Cause (1970-1984)

Cause	Percent
Equipment operated by outside party	67.1
Equipment operated by or for operator	7.3
Earth movement	13.3
Weather	10.8
Other	1.5

[31] Jones, D.J., G.S. Kramer, D.N. Gideon, and R.J. Eiber, 1986. "An Analysis of Reportable Incidents for Natural Gas Transportation and Gathering Lines 1970 Through June 1984." NG-18 Report No. 158, Pipeline Research Committee of the American Gas Association.

The pipelines included in the data set in table 4.11.9-2 vary widely in terms of age, pipe diameter, and level of corrosion control. Each variable influences the incident frequency that may be expected for a specific segment of pipeline.

The frequency of service incidents is strongly dependent on pipeline age. While pipelines installed since 1950 exhibit a fairly constant level of service incident frequency, pipelines installed before that time have a significantly higher rate, partially due to corrosion. Older pipelines have a higher frequency of corrosion incidents (including stress corrosion cracking, the failure of ductile metals subjected to constant stress in a corrosive environment), since corrosion is a time-dependent process. Further, new pipe generally uses more advanced coatings and cathodic protection to reduce corrosion potential.

Older pipelines have a higher frequency of outside forces incidents partly because their location may be less well known and less well marked than newer lines. In addition, the older pipelines contain a disproportionate number of smaller diameter pipelines, which have a greater rate of outside forces incidents. Small diameter pipelines are more easily crushed or broken by mechanical equipment or earth movements.

Table 4.11.9-4 clearly demonstrates the effectiveness of corrosion control in reducing the incidence of failures caused by external corrosion. The use of both an external protective coating and a cathodic protection system, required on all pipelines installed after July 1971, significantly reduces the rate of failure compared to unprotected or partially protected pipe. The data shows that bare, cathodically protected pipe actually has a higher corrosion rate than unprotected pipe. This anomaly reflects the retrofitting of cathodic protection to actively corroding spots on pipes.

TABLE 4.11.9-4

External Corrosion by Level of Control (1970-1984)

Corrosion Control	Incidents per 1,000 miles per Year
None-bare pipe	0.42
Cathodic protection only	0.97
Coated only	0.40
Coated and cathodic protection	0.11

The WUTC notes that there have been four gas transmission rupture incidents in Washington caused by weather-related outside forces, two of which occurred near the proposed project area. On March 16, 1995, Williams Northwest experienced a rupture in the 26-inch pipeline near Castle Rock, Washington. The same line experienced a weather-related rupture on February 9, 1997 near Kalama, Washington. Both of these rupture incidents were linked to heavy rainfall, ground saturation, and increase in groundwater (WUTC, Undated). On November 9, 2006, record rains eroded the Toutle River bank near Castle Rock and exposed approximately 400 feet of Williams Northwest pipeline. Approximately 100 feet of river bank sediment was washed away; however, the exposed pipe did not rupture (Daily News, 2006b) and was subsequently restored by Williams.

The May 1, 2003 rupture of the Williams Northwest pipeline (constructed in 1956) near Lake Tapps, Washington (east of Tacoma) caused the release of natural gas for over an hour and evacuation of local residences, a school, and a business (DOT, 2003a). Subsequent investigation into the cause of the Lake Tapps release found that the rupture was caused by stress corrosion cracking (DOT, 2003b). The same pipeline experienced a release on December 13, 2003 near Toledo,Washington (approximately 20 miles north of Kelso) resulting in gas seepage for approximately 3 hours, no igniton, fatalities or injuries, and voluntary evacuation of four residences (Bellingham, 2003; DOT, 2003b). On December 19, 2003,

OPS and WUTC issued a corrective action order which required Williams to shut down Williams Northwest and either replace the 298-mile pipeline or prove that the line was resistant to stress corrosion cracking (DOT, 2003b; WUTC 2003). Williams filed an application with the FERC to replace the pipeline and was authorized to complete this activity on September 13, 2005 (FERC, 2005).

Investigation of an April 15, 2002 rupture of the Williams Northwest pipeline near Kalama found that the pipeline was laid directly on native material when constructed in 1956. The failure was caused by rock impingement on the pipeline (WUTC, 2002).

4.11.9.3 Impact on Public Safety

The service incident data summarized in table 4.11.9-2 include pipeline failures of all magnitudes with widely varying consequences. Approximately two-thirds of the incidents were classified as leaks, and the remaining third classified as ruptures, implying a more serious failure.

Table 4.11.9-5 presents the average annual fatalities that occurred on natural gas transmission and gathering lines from 1970 to 2005. Fatalities between 1970 and June 1984 have been separated into employees and nonemployees, to better identify a fatality rate experienced by the general public. Of the total 5.0 nationwide average, fatalities among the public averaged 2.6 per year over this period. The simplified reporting requirements in effect after June 1984 do not differentiate between employees and nonemployees. However, the data show that the total annual average for the period 1984 through 2005 decreased to 3.6 fatalities per year. Subtracting two major offshore incidents in 1989, which do not reflect the risk to the onshore public, yields a total annual rate of 2.8 fatalities per year for this period.

TABLE 4.11.9-5

Annual Average Fatalities - Natural Gas Transmission and Gathering Systems [a, b]

Year	Employees	Nonemployees	Total
1970-June 1984	2.4	2.6	5.0
1984-2005 [c]	-	-	3.6
1984-2005 [c]	-	-	2.8 [d]

[a] 1970 through June 1984 - American Gas Association, 1986.
[b] DOT Hazardous Materials Information System.
[c] Employee/nonemployee breakdown not available after June 1984.
[d] Without 18 offshore fatalities occurring in 1989 - 11 fatalities resulted from a fishing vessel striking an offshore pipeline and 7 fatalities resulted from explosion on an offshore production platform.

The nationwide totals of accidental fatalities from various manmade and natural hazards are listed in table 4.11.9-6 in order to provide a relative measure of the industry-wide safety of natural gas pipelines. Direct comparisons between accident categories should be made cautiously, however, because individual exposures to hazards are not uniform among all categories. Nevertheless, the average of 2.6 public fatalities per year is relatively small considering the more than 300,000 miles of transmission and gathering lines in service nationwide. Furthermore, the fatality rate is approximately two orders of magnitude (100 times) lower than the fatalities from natural hazards such as lightning, tornados, floods, earthquakes, etc.

TABLE 4.11.9-6

Nationwide Accidental Deaths [a]

Type of Accident	Fatalities
All accidents	90,523
Motor vehicles	43,649
Falls	14,985
Drowning	3,488
Poisoning	9,510
Fires and burns	3,791
Suffocation by ingested object	3,206
Tornado, flood, earthquake, etc. (1984-93 average)	181
All liquid and gas pipelines (1978-87 average) [b]	27
Gas transmission and gathering lines nonemployees only (1970-84 average) [c]	2.6

[a] All data, unless otherwise noted, reflects 1996 statistics from the U.S. Department of Commerce, Bureau of the Census, "Statistical Abstract of the U.S. 118th Edition."

[b] U.S. Department of Transportation, "Annual Report on Pipeline Safety - Calendar Year 1987."

[c] American Gas Association, 1986.

The available data show that natural gas pipelines continue to be a safe, reliable means of energy transportation. Based on approximately 301,000 miles in service, the rate of public fatalities for the nationwide mix of transmission and gathering lines in service is 0.01 per year per 1,000 miles of pipeline. Using this rate, the Bradwood Landing Project might result in a public fatality every 2,762 years. This would represent a slight increase in risk to the nearby public.

4.12 CUMULATIVE IMPACTS

Cumulative impacts may result when the environmental effects associated with a proposed project are added to temporary (construction-related) or permanent (operations-related) impacts associated with past, present, or reasonably foreseeable future projects. Although the individual impact of each separate project might not be significant, the additive or synergistic effects of multiple projects could be significant. This cumulative analysis focuses on potential impacts from the proposed project on resource areas or issues where their incremental contribution would be potentially significant when added to the potential impacts of other actions.

An action must first meet three criteria to be a candidate for inclusion in the cumulative analysis. The action must:

- affect a resource (e.g., marine biological resources) or resources potentially affected by the proposed project;
- cause this impact within all, or part of, the project area; and
- cause this impact within all, or part of, the timespan for the potential impact from the proposed project.

Existing environmental conditions in the vicinity of the proposed Bradwood Landing Project reflect the extensive changes brought about by long-term human occupancy and use of the project area. For example, native vegetative communities in the project area have been substantially altered from their pre-Euro-American settlement condition by timber harvest, agricultural practices, introduction of non-native species, and commercial/industrial and residential developments, while fisheries have been affected by commercial harvest and physical alteration of rivers and streams used by anadromous species.

Table 4.12-1 lists present or reasonably foreseeable future projects or activities that may cumulatively or additively impact resources that would be affected by construction and operation of the Bradwood Landing Project. Currently, we are aware of one other potential LNG import terminal project along the lower Columbia River: the Oregon LNG project at Warrenton, Oregon. LNG import terminals at Port Westward and Tansy Point are not considered reasonably foreseeable projects because initiation of FERC's review process, which would require the applicants to provide information detailing the scope and magnitude of expected impacts, has not occurred. Therefore, the speculative projects at Port Westward and Tansy Point will not be included in this cumulative impacts analysis.

The FERC approved Oregon LNG's request to implement the Commission's Pre-filing Process on June 19, 2007 (FERC Docket No. PF07-10). The Oregon LNG Project consists of an LNG import terminal proposed to be located on 96 acres at the eastern Skipanon Peninsula along the Columbia River in Warrenton, Oregon. A 121-mile sendout natural gas pipeline would extend southeast and connect with the Williams Northwest Pipeline system in Clackamas County. The LNG terminal would receive up to about 100 LNG carriers annually, and 1.2 million cubic yards of material would be dredged for the turning basin and berth.

The FERC accepted the Palomar Project (PF07-13-000) for Pre-filing review on August 30, 2007. This project would consist of a 220-mile-long, 36-inch-diameter natural gas pipeline from the existing GTN pipeline near Madris, Oregon, potentially connecting with the Bradwood Landing Project.

TABLE 4.12-1

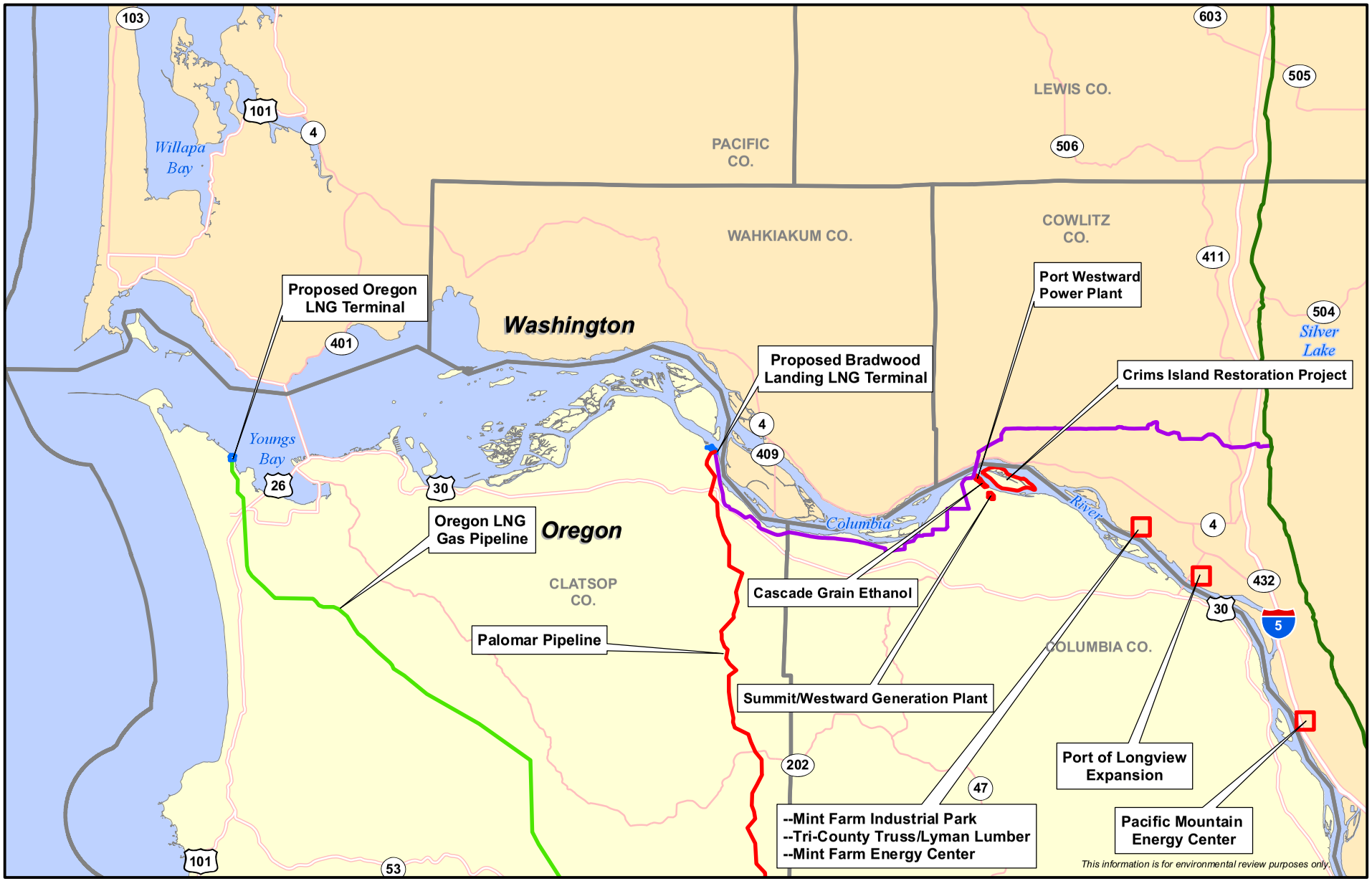
Existing or Proposed Activities Cumulatively Affecting Resources of Concern for the Bradwood Landing Project

Activity/Project	Description	Estimated Timeframe
Logging	Past and ongoing logging operations by companies such as Weyerhaeuser, Plum Creek, Boise Cascade, and Longview Fibre.	Ongoing
Dredging		
Columbia & Lower Willamette Navigation Project	Maintenance dredging of the Columbia River between CRMs 3 and 106.5, and to RM 11 in the Willamette River (within the City of Portland).	Ongoing
Mouth of the Columbia River	Annual maintenance of a 0.5-mile-wide navigation channel for about 6 miles between the Columbia River and Pacific Ocean.	Ongoing
Columbia River Channel Improvement Project	A combined ecosystem restoration and channel deepening project. Ecosystem restoration began in 2006 and primary dredging will be conducted through April 2008. Maintenance of the Columbia River Channel will be ongoing.	Through April 2008/ Ongoing
Maintenance Dredging Projects	Various maintenance dredging projects at the Port of Astoria, Port of Ilwaco, and the mouth of the Skipanon River	Ongoing
Restoration		
Salmon Recovery Strategy	Long-term strategy to recover threatened and endangered fish in the Columbia River Basin through increased water flow, habitat improvements, increased estuary productivity, hatchery reforms, selective fisheries, and reduced load following.	Ongoing
Crims Island Habitat Restoration	Restoration of tidal connectivity to emergent and forested marsh habitat and restoration of tidal marsh and riparian forest habitats.	2005 – 2008
Commercial Shipping	Past and ongoing cargo shipping between the mouth of the Columbia River and southern Idaho.	Ongoing
Commercial and Recreational Fishing	The lower Columbia River supports a number of valuable commercial and recreational fisheries, including salmon, steelhead, white and green sturgeon, eulachon, and bottom fish.	Ongoing
Recreational Boating	Past and ongoing recreational boating along the lower Columbia River includes kayaking, sailing, waterskiing, personal watercraft, and canoeing.	Ongoing
Cruise Ships	Seasonal cruise ship traffic occurring between the mouth of the Columbia River and the Port of Astoria.	Ongoing
Energy, Industrial, and Commercial Development		
Federal Columbia River Power System	System of hydropower projects on the Columbia River and lower Snake River. The closest of the 31 hydropower projects to the proposed Bradwood Landing LNG terminal is the Bonneville Dam, about 120 miles upriver.	Existing
Mist Underground Gas Storage Facility	Underground natural gas storage facility located near Clatskanie, Oregon.	Existing
Southwest Washington/ Northwest Oregon Reinforcement 500-kV Transmission Line Project	Electric transmission line expansion project; final route to be determined.	On Hold
Pacific Mountain Energy Center	An Integrated Gasification Combined Cycle power plant that will include one or two 300 MW combustion turbines and be located at the Port of Kalama, Washington.	2012
Oregon LNG Project	An LNG import terminal proposed to be located on 96 acres at the eastern Skipanon Peninsula along the Columbia River in Warrenton, Oregon. A 121-mile sendout natural gas pipeline would extend southeast and connect with the Williams Northwest Pipeline system in Clackamas County. The LNG terminal would receive up to about 100 LNG carriers annually, and 1.2 million cubic yards of material would be dredged for the turning basin and berth.	2009 – 2012 (construction)
Palomar Pipeline	A 220-mile-long, 36-inch-diameter, bidirectional natural gas pipeline from near Madras, Oregon to near Molalla, Oregon, then northwest to interconnect with various points on Northwest Natural's distribution system, with a potential extension to the Bradwood Landing pipeline.	2010 – 2012

TABLE 4.12-1 (cont'd)

Existing or Proposed Activities Cumulatively Affecting Resources of Concern for the Bradwood Landing Project

Activity/Project	Description	Estimated Timeframe
Port of Vancouver Columbia Gateway Project	Approximately 450 acres of new maritime and industrial development and more than 550 acres of wetland and habitat enhancement.	Potentially within the next 10-15 years
Port of Longview	The Port of Longview has 8 marine terminals and 300 acres of available industrial property located on the Columbia River, 66 miles from the Pacific Ocean. Industries located at and serviced by the Port include steel, over-dimensional, heavy-lift, forest products, dry bulk, and general cargo.	
Port of Longview Expansion	Construction and operation of a new terminal (Berth 8).	1999 – 2000
Mint Farm Industrial Park	The Mint Farm Industrial Park includes nearly 350 acres of land available for industrial development and is located in the City of Longview. Industries currently located at the park include steel and gelatin manufacturing.	
Tri-County Truss/Lyman Lumber	A 37-acre parcel that will have three companies in operation by 2010, including: TCT Truss-Longview, Woodinville Construction Services, and Woodinville Lumber-South.	2006 – 2010
Mint Farm Energy Center	Construction and operation of a natural gas-fired power plant located within the Mint Farm Industrial Park in Longview, Oregon.	TBD
Port Westward Industrial Area	The Port Westward Industrial Area is owned by the Port of St. Helens and includes over 800 acres of industrial land, including a deep-draft marine facility.	
Beaver Power Plant	PGE currently operates a 545 MW power plant.	Existing
Port Westward Power Plant	Construction and operation of a 400 MW natural gas-fired, combined-cycle combustion turbine plant adjacent to PGE's existing Beaver Power Plant. Plant includes a transmission line connecting to the Trojan Switchyard in Rainier, Oregon.	2004 – 2007
Cascade Grains Ethanol Plant	Construction and operation of a 100 million-gallon-per-year ethanol production facility.	2006 – 2008
Praxair CO_2 Plant	Adjacent to Cascade Grain. Would use CO_2 produced by the ethanol plant for commercial purposes.	2009
Summit/Westward Cogeneration Project	Natural gas combined-cycle combustion turbine system with 520-MW capability. In March of 2006, Westward Energy filed a request with Oregon Every Facility Siting for a Sixth Amended Site Certificate.	On hold
Columbia County	Road improvements and waterline expansion projects	Ongoing through 2009



Proposed Pipeline Route
Existing Williams Northwest Pipeline System
Proposed LNG Terminal Site
Other Project
0 4 8 Miles

Figure 4.12-1
Bradwood Landing Project
Existing or Proposed Activities Cumulatively Affecting Resources of Concern for the Bradwood Landing Project

Like the Bradwood Landing Project, both the Oregon LNG and Palomar projects would have components in Clatsop County, Oregon. Both the Oregon LNG and the Palomar projects, if expeditiously reviewed and authorized by the FERC, could be constructed within a time frame that overlaps with the construction of the Bradwood Landing Project, if it is authorized in 2008.

Other projects not involving the transmission of natural gas with the potential to cumulatively impact resources are generally concentrated into three general areas, including the Port Westward Industrial Area, Mint Farm Industrial Park, and Port of Longview (see figure 4.12-1). Construction schedules for the future projects depend on factors such as economics, funding, and politics. Projects and activities included in this analysis are generally those of comparable magnitude and nature of impact in the area that would be affected by the Bradwood Landing Project. More geographically distant projects were not assessed because their impact would generally be localized and, therefore, would not contribute significantly to cumulative impacts in the proposed project area. Cumulative impacts that could most directly be associated with the Bradwood Landing Project are discussed below.

We received a number of comments regarding the cumulative impacts of several natural gas projects currently proposed in Oregon, specifically Bradwood Landing, Oregon LNG, and Palomar pipeline. Because of the locations of these projects, the only resources that have potential for cumulative impacts would be air quality, certain socioeconomic resources, and in the case of Oregon LNG, resources that could be affected by dredging and LNG marine traffic. However, we have also provided information on other resources in this section in response to the comments we received.

4.12.1 Geology and Soils

The proposed Bradwood Landing LNG Project would have impacts on near-surface geology and soils. NorthernStar proposes to minimize these impacts through implementation of their ESC Plans and SWPPP as well as our Procedures. We are recommending that NorthernStar revise its pipeline ESC Plan and SWPP to include the measures from the FERC's Plan that provide greater protections. The final design for the Bradwood Landing LNG terminal would include detailed construction specifications, such as deep foundations and vibroflotation to compact soils and mitigate for seismic hazards. Along the pipeline route, NorthernStar would conduct additional studies and produce a Final Pipeline Design Geotechnical Report that provides measures to mitigate for the crossing of potential landslide hazards.

Because the direct effects would be highly localized, cumulative impacts on near-surface geology and soils would only occur if other projects are constructed in the immediate vicinity of the proposed Bradwood Landing Project. The Port Westward Industrial Area is about 12 miles from the proposed LNG terminal site and crossed by the proposed pipeline between MPs 18.0 and 19.0. Construction of the projects within the Port Westward Industrial Area, such as the Port Westward Power Plant, Summit/Westward Cogeneration Project, and the Cascade Grains Ethanol Plant, would require significant excavation or grading and would thus have impacts on near-surface geology and soils. However, construction of these three projects is currently scheduled to be completed before general construction of the pipeline. While there would be potential for cumulative impacts on geological resources and soils if these projects were constructed concurrently with the pipeline, any cumulative impact on geology and soils would be minimized by the implementation of erosion control and restoration measures during construction and restoration of the projects. Consequently, any potential cumulative impacts on geological resources and soils would be minor.

We have no information about impacts on soils or geological resources along the proposed Palomar pipeline, because Palomar has not yet filed its first draft environmental Resource Reports with the FERC. However, only a small portion of the Palomar pipeline would be constructed in proximity to

the Bradwood Landing Project. Consequently, we would not expect a significant cumulative impact on soils and geologic resources.

The Oregon LNG import terminal would be located in an area where dredged materials were deposited, and consists of soils that have a high potential for erosion and poor revegetation potential. About 10 acres at the terminal are classified as prime farmland, although the area was never farmed. The Oregon LNG sendout pipeline would cross 155 mapped soil units. About 45 percent of the route would cross soils which have high potential for water erosion, and 47 percent of the route would cross soils with poor potential for revegetation. About 58 percent of the pipeline route would cross soils classified as prime, unique, or important farmland. Oregon LNG would mitigate impacts on soils by following the FERC's Plan, and its own project-specific Agricultural Impact Mitigation Plan.

Like the Bradwood Landing Project, the Oregon LNG Project would be located within the area influenced by the CSZ. In the case of a seismic event, peak ground accelerations would occur at the proposed Oregon LNG import terminal site, and would decrease along the pipeline eastward. The proposed Oregon LNG pipeline would cross numerous earthquake faults, including the Gales Creek Fault Zone, Mount Angel Fault Canby-Molalla Fault, and Newberg Fault. The Oregon LNG terminal would be located within a mapped tsunami inundation boundary, and risks of inundation are high until about MP 2 of the sendout pipeline. There is also the potential for landslides between MPs 6 and 60 of the pipeline, where it would cross steep slopes over unstable underlying geologic formations. To mitigate for the potential for liquefaction at the Oregon LNG terminal as a result of an earthquake, Oregon LNG would perform ground improvements below critical facilities, including driving piles and jet grouting or cement soil mixing. Along the pipeline route, Oregon LNG would attempt to avoid steep slopes and landslide hazard areas. In situations where these areas cannot be avoided, Oregon LNG would conduct a geological evaluation, install strain gauges where soil creep is anticipated, bury the pipe deeper at some locations, follow the FERC's Plan, and use proper construction and drainage techniques.

Shoreline erosion along the Columbia River is caused by river currents, wind waves, and ship wakes. River currents can erode banks and carry sediment away from the shoreline. Wind waves and ship wakes can also erode banks but they only move sediment locally within the shallow water zone near the shore. The amount of erosion that occurs at a particular location depends on the interaction between the eroding forces of river currents and waves and the resisting forces of the river bank (COE, 1999). As discussed in section 4.1.2.3, the size of waves produced by a vessel passing through a channel depends on the characteristics and speed of the vessel and the characteristics of the channel. However, speed is the most important factor influencing the size of waves produced by a vessel. Large waves contain more energy than small waves and thus, have a greater ability to erode river banks. NorthernStar commissioned a study of wave generation by LNG carriers compared to other large ships along the Columbia River, which indicated that waves generated by LNG carriers for the Bradwood Landing Project would be only slightly larger than those generated by other large ships along the Columbia River operating at the same speed.

Operation of the Bradwood Landing Project and other projects (i.e., Tri-County Truss/Lyman Lumber) would result in increased ship transit up and down the Columbia River. Also, the Oregon LNG Project would, if approved, add an estimated 100 LNG carriers per year transiting to CRM 11.5 beginning as early as 2012. The overall increase in ship traffic would be offset at least in part by the general decreasing trend in ship traffic volume in recent years. The Columbia River Channel Improvement Project will allow larger, deeper draft ships to travel the river.

In a 100-year flood, water may rise up to 9 feet above the current elevation at the location proposed for the Oregon LNG terminal. Oregon LNG indicated that it would need to conduct an evaluation to determine appropriate shoreline erosion control measures for its proposed LNG terminal.

In conclusion, we have determined that the potential impacts on geology and soils, considering the Bradwood Landing Project cumulatively with other past, present, and reasonably foreseeable projects, would not be significant.

4.12.2 Waterbodies and Wetlands

As discussed in sections 4.3.2.2 and 4.3.2.3, the Columbia River is currently considered marginally healthy by the COE, and is water quality limited for temperature, mercury, and arsenic. These water quality conditions reflect both historic and modern activities within and along the river. There are several plans currently in place to improve environmental conditions within the Columbia River, including the *Lower Columbia River Salmon Recovery and Fish & Wildlife Plan*, which was adopted by the NMFS as the *Interim Regional Recovery Plan of the Washington Management Unit for the Lower Columbia River* on February 3, 2006; the *Northwest Power and Conservation Council Fish and Wildlife Program Subbasin Plan for the Lower Columbia Mainstem and Estuary*; the *Lower Columbia River Estuary Program Comprehensive Conservation and Management Plan*; and the *Lower Columbia River Salmon Recovery and Fish & Wildlife Plan,* which is currently being drafted.

In the foreseeable future, there will likely be a number of projects or activities that result in additional stresses on water quality in the lower Columbia River basin, including several of the waterfront projects listed in table 4.12-1 (e.g., Tri-County Truss/Lyman Lumber, Beaver Power Plant, Port Westward Power Plant, Cascade Grains Ethanol Plant, Columbia Tidal Energy Hydroelectric Project, Mint Farm Energy Center, and ongoing maintenance dredging) as well as the Bradwood Landing Project and the Oregon LNG Project.

The Bradwood Landing Project would affect surface water quality (see sections 4.3.2, 4.5.1, and 4.5.2). Specific project-related activities that could have impacts on waterbodies include dredging, dredge disposal, hydostatic testing, water intake by LNG carriers at the berth for ballast and engine cooling, water disposal from operation of SCVs at the LNG terminal, wastewater and stormwater runoff, upland clearing and grading, and pipeline installation. Those activities may:

- increase water turbidity;
- increase water temperature;
- increase erosion;
- cause the filling of wetlands; and
- introduce hazardous materials through potential spills.

Potential construction impacts on waterbodies would be minimized by NorthernStar's compliance with our Plan and Procedures, as well as its SWPPP, ESC Plans, and HDD Contingency Plan. Nevertheless, the Bradwood Landing Project could contribute to cumulative impacts on water quality when considered in combination with other past, present, and reasonably foreseeable projects that may also have impacts on waterbodies within the lower Columbia River basin. The Oregon LNG Project would have impacts on water quality similar to the Bradwood Landing Project. The Oregon LNG sendout pipeline would cross about 190 waterbodies. The proposed Palomar pipeline would cross about 180 waterbodies. Oregon LNG and Palomar would also follow the FERC's Procedures to lessen or mitigate impacts on waterbodies.

Impacts from dredging could be compounded if other significant dredging projects were conducted concurrently at a nearby location (e.g., the Columbia River Channel Improvement Project). The COE is expected to complete its deepening of the navigation channel in the area of the Bradwood Landing site before construction on the proposed LNG terminal would begin. In addition, smaller maintenance dredging projects on the Columbia River are in the preliminary stages, including at the Port

of Astoria, the Port of Ilwaco, and at the mouth of the Skipanon River. The volumes of dredged material at these sites would be much less than the proposed project (Ellis, 2008). Oregon LNG expects that construction of its terminal berth and turning basin would require dredging of about 1,275,000 cubic yards of material. It has not yet stated its preferred placement location for those dredged materials. Permits for dredging in Oregon would be needed from the COE and ODSL, and these agencies would likely impose conditions to mitigate for impacts. There would be a permanent loss of some existing wetlands as a result of construction and operation the proposed Bradwood Landing Project, Oregon LNG Project, Palomar Project, and other reasonably foreseeable future projects located within the Port Westward Industrial Area and Mint Farm Industrial Park. The Bradwood Landing Project would temporarily impact about 15 acres of wetlands at the terminal and 76 acres along the pipeline during construction, and permanently affect about 28 acres total of wetlands during operation of the project. The Oregon LNG terminal would temporarily impact about 21 acres of wetlands during construction, and permanently impact about 15 acres of wetlands during operation. Its sendout pipeline would cross about 240 wetlands. NorthernStar, Oregon LNG, and Palomar would all follow the FERC's Procedures to reduce impacts on wetlands.

The primary cumulative impact associated with dredging is turbidity. Turbidity impacts associated with the projects discussed in this section would be of a short duration and would not be expected to overlap spatially with the Bradwood Landing Project. That is, the turbidity plumes associated with dredging would not likely be additive. Consequently, turbidity impacts are cumulative only in the sense that a single body of water would incur these impacts. Given the volume and dynamic nature of the Columbia River, we would not expect water quality impacts to be cumulatively significant.

These projects would need to obtain permits from the COE, ODSL, ODEQ and WDE to cross or fill wetlands. NorthernStar has drafted a Compensatory Mitigation Plan that proposes measures to be implemented to mitigate for temporary and permanent wetland impacts. That plan calls for the creation of new wetlands or restoration and improvement of habitats at three locations (Hunt Creek, Svensen Island, and Delameter Creek). Oregon LNG also drafted a conceptual *Waterbody and Wetland Construction and Mitigation Procedures Plan* that indicates that it would restore wetlands temporarily impacted, replace lost wetland functions within the same watershed, and purchase mitigation credits. Therefore, the creation of new wetlands and the enhancement of existing wetlands would result in a net increase in regional wetland resources.

4.12.3 Vegetation and Wildlife

When projects are constructed in close proximity at or close to the same time, they have a cumulative impact on vegetation and wildlife occurring in the area where the projects are built. Vegetative clearing and grading and other construction activities associated with the Bradwood Landing Project, along with other construction projects, would result in the removal of vegetation; alteration of wildlife habitat; and displacement of wildlife. Other secondary impacts on vegetation and wildlife include edge effects along the pipeline right-of-way in cleared forest, increased opportunities for predation, and establishment of invasive plant species. These effects would be greatest if the other projects were to be constructed within the same timeframe and geographic area as the Bradwood Landing Project, impacting similar habitats used by the same species.

The proposed Bradwood Landing pipeline would be located adjacent to the existing KB pipeline for 8.0 miles (22 percent of the total route). Construction of the pipeline would affect about 553 acres; of which about 180 acres would be forest. Impacts on forest are considered more severe then effects on other vegetation because a 30-foot-wide corridor over the centerline would be kept permanently cleared of large trees (totaling about 54 acres along the Bradwood Landing pipeline), while it would take some time for forest to regenerate in the temporary work areas. NorthernStar would reduce impacts on

vegetation through implementation of the measures outlined in its pipeline ESC Plan in Oregon and its SWPPP in Washington, and its Noxious Weed and Soil-borne Disease Control Plan. Except within 15 feet of the pipeline, in-kind trees would be replanted, and NorthernStar's proposed tree planting exceeds the revegetation requirements of the FERC staff's Plan and Procedures.

The majority of the areas within the Port Westward Industrial Area, Mint Farm Industrial Park, and Port of Longview have previously been cleared for industrial development. Because native vegetative communities have been substantially altered at these areas, the cumulative impact of these proposed projects on vegetation is expected to be minor.

About 30 percent of the route for the Oregon LNG sendout pipeline would follow existing rights-of-way, along roads, railroads, and power lines. About 38 percent of the route of the proposed Palomar pipeline would parallel existing rights-of-way. Construction of the Oregon LNG pipeline would affect a total of about 1,461 acres. Forested land along the Oregon LNG pipeline includes the Coastal Uplands, Volcanoes, Willapa Hills, and Willamette River Gallery Forest ecosystems, where construction is expected to clear a total of about 670 acres. Construction of the Palomar pipeline would affect about 3,070 acres. At this time we do not have an estimate for the amount of forest that may be cleared along the Palomar pipeline, but it would cross portions of the Mount Hood National Forest, and Tillamook and Clatsop State Forests.

Cumulative impacts on vegetative communities would be minimized for the FERC regulated projects (Bradwood Landing, Oregon LNG, and Palomar) because they would follow the FERC staff's Plan and Procedures, and implement restoration plans, including reseeding and replanting of vegetation. They may also implement project-specific mitigation measures designed to minimize the potential for erosion, and control the spread of noxious weeds, thereby reducing the degree and duration of their cumulative impacts on vegetation. For example, the Oregon LNG pipeline would cross portions of the Clatsop and Tillamook State Forests, and when crossing those lands Oregon LNG would implement measures consistent with the Northwest Oregon State Forest Management Plan.

Construction of the Bradwood Landing Project at the same time as other projects listed in table 4.12-1 could cause cumulative impacts on coldwater anadromous fisheries, and designated EFH. The geographic extent and duration of disturbances to waterbodies that may affect aquatic species would be minimized for the FERC regulated projects, because they would follow the FERC staff's Plan and Procedures, and would implement project-specific mitigation plans. Additionally, the projects that would involve direct in-stream impacts on anadromous fisheries and other waterbodies designated as EFH would need permits and authorizations from the COE, ODSL, and WDE, and would consult with the ODFW, WDFW, NMFS and FWS. These agencies would require measures to mitigate impacts on aquatic resources. NorthernStar's SEI would be a voluntary program to ensure the future recovery of salmon and the lower Columbia River ecosystem, separate from its other mandatory avoidance and mitigation measures

There are currently about 1,800 commercial ships that call on ports along the lower Columbia River, with about 66 percent of this traffic docking at Portland, 18 percent docking at Vancouver, and 10 percent docking at Longview. We estimate that all of these commercial ships combined intake as much as 10.4 billion gallons per year in ballast water while at dock. We estimate that LNG carriers at the Bradwood Landing LNG terminal berth may take in about 3.1 billion gallons of ballast water per year. LNG carriers at the proposed Oregon LNG terminal may take in an additional 1.3 billion gallons of ballast water per year. The average flow of the Columbia River past Bradwood Landing is about 136 billion gallons per day. The additive water withdrawals for ballast of all current commercial ship traffic on the lower Columbia River, plus future traffic in LNG carriers docking at the Bradwood Landing and Oregon LNG terminals, would total about 14.8 billion gallons per year, which represents about 0.03

percent of the average river flow. To reduce impacts on juvenile fish from intakes for carrier ballast at the Bradwood Landing terminal, NorthernStar would screen all river water withdrawals. We are recommending that either all LNG carriers calling at the Bradwood Landing terminal be retrofitted to use NorthernStar's filtered water system, or NorthernStar would need to file another system design to deliver screened water to non-retrofitted LNG carriers.

The Bradwood Landing Project, in combination with the other projects that may take place in the general geographic region and same time period may have cumulative impacts on animal and plant species and their critical habitat that are listed as threatened or endangered federally and/or by the States of Oregon and Washington. We have identified 36 federally listed threatened and endangered species in the Bradwood Landing project area. The project may affect 13 salmonid ESU/DPS, and the Columbian white-tailed deer. NorthernStar has committed to implement its Compensatory Mitigation Plan, which has been designed to exceed existing mitigation standards and would result in substantially larger areas being restored and/or protected than would be lost to permanent impacts and would be restored to a higher level of ecosystem function. Although the Compensatory Mitigation Plan would benefit a variety of aquatic and terrestrial species, it was designed with additional emphasis on protection and restoration of habitat for federally listed salmonids and the Columbian white-tailed deer. We produced a BA and EFH Assessment for the Bradwood Landing Project in March 2007 that is currently being revised to address comments from the FWS and NMFS.

Along the route of the Palomar pipeline, Palomar identified potential habitat for 20 federally listed species, including the marbled murrelet and the northern spotted owl, and 17 state listed species. Oregon LNG identified 15 fish species, 4 sea turtles, 8 marine mammals, 4 bird species, 1 invertebrate, and 2 plants that are federally listed within its project area.

Both Palomar and Oregon LNG would need to provide a plan for the mitigation of impacts on listed species, prepared in consultation with the ODFW, FWS, and NMFS. Using those mitigation plans, the FERC would produce BA and EFH Assessments for these projects, for review by the FWS and NMFS, who, in their BOs for these projects, may require additional conditions to protect or mitigate impacts on sensitive species. Therefore, although construction and operation of the Bradwood Landing Project along with the other potential projects and activities would result in impacts on aquatic and terrestrial resources, cumulative impacts on federally listed species and their designated critical habitat would be minimized through consultations with the NMFS and FWS, as required under the ESA.

4.12.4 Land Use, Recreation and Special Interest Areas, and Visual Resources

The proposed project and the other foreseeable future projects would result in both temporary and permanent changes to current land uses. The Bradwood Landing LNG terminal would be constructed on a tract of land that was previously used as a lumber mill and for dredged material placement. On March 20, 2008, Clatsop County changed the land use zoning for the proposed Bradwood Landing Project so that the terminal and pipeline would be allowed uses, with certain conditions. The proposed pipeline route would affect agricultural, forest, rangeland, open, commercial/residential, and water land uses. NorthernStar would continue to consult with Columbia County, Oregon, and Cowlitz County, Washington about the installation of its pipeline in a manner that would be consistent with county land use plans and guidelines. Cowlitz County, Washington can adopt this EIS for its SEPA needs.

The majority of the projects listed in table 4.12-1 occur within the Port Westward Industrial Area and Mint Farm Industrial Park, which occupy about 1,150 acres of land. These areas have been developed specifically for commercial and industrial facilities, and significant impacts on land use would not be expected.

About 35 percent of the proposed Palomar pipeline would cross public lands, including about 2 miles of land administered by the BLM, 47 miles within the Mount Hood National Forest, and 24 miles of state of Oregon lands. However, we have no additional data, yet, about potential land use conflicts related to the Palomar Project. The Bradwood Landing pipeline would have no direct impacts on national, state, or local parks or recreational facilities. It would avoid islands that form a part of the JBHNFW, and the Lower Columbia River Water Trail, by using the HDD method to cross under the Columbia River. The Oregon LNG sendout pipeline would cross one proposed national wildlife refuge and two state forests. The Oregon LNG terminal would be located on a 96 acre parcel owned by the ODSL and leased to the Port of Astoria, within the City of Warrenton, that is zoned for industrial development. The proposed sendout pipeline for the Oregon LNG Project would cross mostly forest (48 percent) and agricultural land (44 percent). We discussed how impacts on vegetation would be addressed above.

The Bradwood Landing Project, in combination with the other foreseeable regional projects listed on table 4.12-1 could result in cumulative impacts on recreational or special interest areas if these projects would affect the same area or feature (e.g., trails) at the same time. As discussed in section 4.7.1.4, high levels of recreational fishing and boating occur during the summer months along the lower Columbia River (averaging about 300 private fishing boats in the waters of the Columbia River estuary per day between June and August). River users may be affected by the additional marine traffic of 275 LNG carriers per year entering the lower Columbia River navigation channel going to the Bradwood Landing Project and Oregon LNG Project combined. However, the LNG carriers on the waterway to the Oregon LNG terminal would only transit about 11.5 miles up the Columbia River from its mouth to the location of the terminal in Warrenton. Because recreational users of the Columbia River have always had to account for commercial ship traffic, no significant additional cumulative impacts on these activities are likely. Recreational boats would merely need to briefly move out of the way of passing LNG carriers, much as they currently do for other commercial ships. In addition, the Coast Guard, in its WSR and LOR, would impose conditions on LNG carriers in the water to protect and resolve conflicts with other river users.

LNG marine traffic on the waterway to either the Bradwood Landing LNG terminal or the Oregon LNG terminal would pass by parks and trails that would be overlapped by the Zones of Concern. This includes elements of the LCNHP at Fort Stevens and Cape Disappointment State Parks, the LCNHT, the Lower Columbia River Water Trail, Hammond Marina, and the Warrenton Waterfront Trail and Carruthers Park. However, with the implementation of the Coast Guard's requirements for safety and security, the likelihood of an incident resulting in an LNG spill is extremely low, and users of regional parks and trails should not be adversely affected by these proposed projects. Visual impacts on park and trail visitors from LNG marine traffic would be limited, because the viewshed already includes commercial ship traffic of up to 2,000 vessels per year, and because the LNG carriers would take only a few minutes to travel through the viewshed in the waterway at speeds between 8 to 12 knots.

Most of the projects listed in table 4.12-1 are located in previously developed commercial or industrial areas associated with the Port Westward Industrial Area, Port of Longview, and Mint Farm Industrial Area. Construction and operation of new buildings or structures associated with these projects, including those at the proposed LNG terminal, would have a permanent effect on visual resources. However, the cumulative impacts would not be significant, because the facilities would be seen in the context of existing facilities in the area and would not adversely affect the viewshed from sensitive locations or change the character of the landscape in terms of either physical characteristics or land uses. The existing facilities at the Port Westward Industrial Area, Port of Longview, and Mint Farm Industrial Area would screen, backdrop, and otherwise minimize the overall impact on visual resources from these projects to less than significant levels.

The most visible elements of the LNG projects would be the LNG storage tanks, which would be about 170 feet high and 260 feet wide. Other visual elements associated with the LNG project include nonjurisdictional power lines. The Oregon LNG Project would contribute to cumulative visual impacts along the waterway but would be 27 miles from the Bradwood Landing Project. The Oregon LNG terminal would be visible to viewers in Warrenton and Astoria, with a combined population of about 14,000 people. The Bradwood Landing LNG terminal would be most readily visible to residents of Clifton, Puget Island, and Cathlamet, with a combined population of about 1,370 people. NorthernStar would reduce visual impacts of its terminal by implementing a lighting plan, painting the storage tanks to blend into the background of the forested hills, and planting trees along the berm around the process area.

The Bradwood Landing, Oregon LNG, and Palomar pipelines would be installed beneath the ground surface. Once their rights-of-way are properly restored and revegetated, they should not represent significant visual elements, subordinated within the existing landscape character, with the exception of the treeless portion of their permanent easements through what is currently forest. We have discussed impacts of those projects on vegetation above. The cumulative visual impacts of these combined projects would be reduced within the context of the existing landscape, which already includes land uses that have altered that landscape, including timber harvesting activities, farming and other agricultural activities, industrial, commercial, and residential developments, and infrastructure such as roads and power lines.

4.12.5 Socioeconomics

Present and reasonably foreseeable future projects and activities could cumulatively impact socioeconomic conditions in the project area. Employment, housing, infrastructure, public services, and traffic could experience both beneficial and detrimental impacts. None of the projects appear to have environmental justice issues.

Economy and Employment

The projects considered in this section would have cumulative effects on employment during construction if more than one project is built at the same time. The Bradwood Landing Project expects to employ up to 750 workers during the peak construction months. NorthernStar anticipates that most of the labor force for construction of the project would come from the four-county project area, or from the Portland MSA. Approximately 20 non-local specialty workers and managers may be hired for the Bradwood Landing Project. If several of the larger projects, such as the Summit/Westward Cogeneration, Palomar, and Oregon LNG projects, are built simultaneously, the demand for workers could exceed the local supply of appropriately skilled labor. Construction of the Oregon LNG terminal is expected to require an average of 456 construction workers during a 44-month-long period, with 60 percent being hired within Oregon. The Portland MSA and four-county project area has a civilian labor force of about 5,893,060 people and an average unemployment rate of 6.6 percent. This suggests that the local labor force could meet some of the employment needs induced by construction of these projects, although it is unknown whether a sufficient number of these unemployed persons have the necessary skills to work on these projects. If all the major projects in the region are constructed during the same time period, and the demand for local workers exceeds supply, it is assumed that the remainder of the employment positions would be filled by non-local hires.

Operation of the Bradwood Landing Project would employ about 65 permanent workers. In addition, tug operations required to support the terminal would require about 40 employees. The Oregon LNG Project would likely have 63 permanent operational employees. Based on the current commuting patterns of workers at Wauna Mill, almost all of the operational workers for the LNG terminal projects are expected to come from the local four-county area. Additional tug operators may need to be brought in from outside of the area if not enough local workers that are trained or willing to be trained are available.

These projects are expected to have cumulative benefits for the local economy in terms of direct payroll expenditures, purchase of supplies and materials, indirect employment in service sector, and taxes. As discussed in sections 4.8.2.4 and 4.8.3.4, the estimated payroll for the proposed Bradwood Landing Project would be about $110 million during the construction phase, and direct expenditures for goods, equipment, and services would total $88 million. The total indirect and induced effect of the Bradwood Landing Project would be about $77 million, with annual property taxes anticipated to be $7.7 million during operation of the LNG terminal. The Oregon LNG Project estimates that it could spend up to a total of $361 million on labor costs, and $672 million on material purchases. Annual property taxes during operation of the Oregon LNG terminal would be about $6.8 million to Clatsop County, Oregon.

Housing

NorthernStar would mostly employ local workers who would reside within commuting distance of the project. For the proposed Bradwood Landing Project, an estimated maximum of 20 housing units would be needed per month to accommodate the non-resident construction workforce. If 40 percent of the work force hired by the Oregon LNG Project were non-local, about 300 workers may require housing. The non-local workers would be expected to rent houses, apartments, hotel/motel rooms, or stay in recreational vehicle camps. The total housing unit vacancy rate in Clatsop County, Oregon is about 25 percent. According to Oregon LNG, the vacancy rates for hotels/motels in Astoria range from almost 80 percent in the winter to 50 percent in the summer. We estimated that there were a total of about 1.2 million housing units in the four counties affected by the Bradwood Landing Project and the Portland MSA (see section 4.8.2.2). Given the vacancy rates, the number of housing units, and the availability of hotel/motel rooms and campgrounds in the region, it is not anticipated that construction crews would encounter difficulty in finding temporary housing. If construction occurs concurrently with other projects, temporary housing would still be available but may be slightly more difficult to find and/or more expensive to secure during the summer tourist season. Regardless, these effects would be temporary, lasting only for the duration of construction, and there would be no long-term cumulative effect on housing.

Infrastructure and Public Services

The cumulative impact of the Bradwood Landing Project and the other projects listed in table 4.12-1 on infrastructure and public services would depend on the number of projects under construction at one time. The area has a relatively small number of police, fire, and emergency service personnel (see section 4.8.1.6, 4.8.2.6, and 4.8.3.6); therefore, if several projects were to be constructed at once, the incremental demands of those projects could become difficult for police, fire, and emergency service personnel to address.

NorthernStar has indicated that trained personnel and fire fighting equipment would be maintained at the LNG terminal in the event of an emergency. NorthernStar has produced a draft ERP, which, in accordance with the EPAct, includes a cost-sharing plan that outlines how NorthernStar would fill resource gaps and supplement the first-responder capabilities of the local communities near its proposed LNG terminal. The draft ERP will be reviewed by the FERC and Coast Guard, and revised accordingly. The Oregon LNG Project would also be required to have an ERP and cost-sharing agreement for emergency services in place. The additional emergency resources required for a second LNG facility on the lower Columbia River may be less than those needed for the first because a fire or other incident would be unlikely to occur at both facilities or on two LNG carriers at the same time. Therefore, it is possible that certain emergency response resources could be shared. With implementation of the ERPs, no long-term cumulative effect on infrastructure and public services is anticipated.

Transportation and Traffic

Road Traffic

The cumulative impacts associated with the construction of several of the projects listed in table 4.12-1 at the same time would include construction equipment traffic and worker commuting traffic. Both construction equipment and workers constructing the Bradwood Landing LNG Project would use Highway 30 as a main access route in Oregon, but construction equipment and workers may also travel on Highway 4 in Washington. Both Highway 30 and Highway 4 may be used during construction of other projects in Longview and Port Westward. Construction of the Oregon LNG terminal is expected to mainly have traffic impacts on Highway 105 and Highway 101 in the Warrenton/Astoria area; thus it would not add cumulative impacts on traffic for the roads used by construction vehicles for the Bradwood Landing Project.

As discussed in section 4.8.2.7, an independent traffic study for the Bradwood Landing Project counted 6,200 daily trips along Highway 30 at Clifton Road. During construction of its LNG terminal, NorthernStar anticipates an average of 30 project-related trucks a day. NorthernStar would make improvements to Clifton Road to handle construction traffic. In addition, it would bus in workers from a parking lot near Taylorville. We have recommended that NorthernStar produce a final traffic management plan, in consultation with Clatsop County and ODOT, to mitigate impacts on other road traffic.

Pipeline construction equipment would use local access roads and the right-of-way. Some roads crossed by the pipeline may be open cut, which could temporarily disrupt other road traffic. However, these roads are in rural areas that do not have high volumes of traffic. NorthernStar would apply for necessary local permits for road crossings and comply with permit stipulations. NorthernStar would consult with the affected counties to address traffic flow and control issues and minimize impacts. Potential cumulative impacts on road traffic from construction of any of these projects located in close geographic proximity during the same time period would be minor and short term.

Ship Traffic

Annual commercial ship traffic at the mouth of the Columbia River in recent years has been roughly 2,000 round-trips, with a downward trend since 2000 (Kraley, 2006). It is estimated that the number of ship trips along the Columbia River has decreased by roughly 25 percent in the last 20 years while the volume of cargo has remained relatively stable. This indicates a greater reliance on bigger ships, many of which are similar in size to the LNG carriers that could transit to the Oregon LNG terminal or Bradwood Landing. In order to better accommodate the large vessels making calls on ports along the Columbia River, the COE is deepening the navigation channel from 40 to 43 feet (Columbia River Channel Coalition, 2006).

If both the Oregon LNG Project and the Bradwood Landing Project were authorized and built within a similar time period, there may be as many as 275 LNG carriers per year entering the lower Columbia River. That would represent an increase of about 14 percent above current levels of commercial ship traffic, but would still not approach historic highs in past commercial ship traffic on the Columbia River.

Operation of the Tri-County Truss/Lyman Lumber facilities at the Mint Farm Industrial Park would also result in an increase in ship traffic along the Columbia River, although the quantity of additional ship traffic these facilities would generate is currently unknown. In addition, the Port of Vancouver Columbia Gateway project could add about 365 deep-draft cargo ships per year. However,

the industrial development district levy that would have funded the project failed to pass in August 2007. The Port of Vancouver indicates that the project could "potentially" be developed in 10 to 15 years (Port of Vancouver, 2008). However, because shipping activity within the Columbia River would remain below historic levels, combined with the fact that the Columbia River is currently undergoing channel deepening to better accommodate large vessel traffic, we do not expect that operation of other projects would have significant cumulative impacts on commercial ship traffic on the Columbia River.

LNG marine traffic on the waterway may cause some delays for other commercial ship traffic, due to the timing of crossing of the Columbia River Bar, safety and security zones, and non-passing zones. However, a study conducted for NorthernStar indicated that half the time an LNG carrier would be crossing the bar it would not encounter any other commercial ships, and only 20 percent of the time would an LNG carrier cause a delay for another commercial ship at the bar. The worst case scenario is that another ship would have to wait an entire tidal cycle to cross the bar. However, with proposed navigation protocols, scheduling priorities, pro-active communication between LNG carriers and other commercial ships, and coordination between pilots and the Coast Guard, delays would be minimized.

4.12.6 Cultural Resources

There are no statutory requirements that privately developed projects protect cultural resources, unless a federal license, permit, or funding would be involved, or the project would affect other public lands. Under Oregon regulations, permits would be required from the Oregon SHPO in order to conduct cultural resources surveys on non-federal public lands, and to excavate archaeological sites on non-federal public and private lands. If there is a federal nexus, the project must comply with section 106 of the NHPA and take the impacts of the undertaking on historic properties into consideration. The proposed projects listed in table 4.12-1 that are defined as federal actions, such as Oregon LNG and Palomar Pipeline, would need to consult with the SHPO, identify historic properties that may be affected, and implement measures to resolve impacts on affected properties. Non-federal actions would need to comply with whatever conditions may be imposed by the state or local permitting agencies with regards to the protection of cultural resources.

We have not yet completed compliance with section 106 of the NHPA for the FERC regulated projects, because surveys for the entire APE cannot be done until after the FERC issues an Order, and the applicants would have access to lands where it was previously denied. There is a known significant archaeological site (35CO16) at Port Westward that Columbia County should take into consideration when planning or authorizing future actions in its Industrial Zone. The Bradwood Landing pipeline would avoid impacts on site 35CO16 by using an HDD under the Columbia River. We and the SHPO agree that the Bradwood Landing Project would not adversely affect the LCNHT and ACRR. Along the Oregon LNG pipeline, nine sites were identified that require additional work to evaluate their NRHP eligibility. However, the Oregon LNG pipeline and Bradwood Landing pipeline are not located in the same geographic area, and would not have cumulative impacts on cultural resources.

4.12.7 Air Quality and Noise

Construction of most of the reasonably foreseeable future projects listed in table 4.12-1 would involve the use of heavy equipment that would produce noise, air contaminants, and dust that would contribute cumulatively to impacts on air and noise quality. The counties that could be affected by the Bradwood Landing Project are currently in attainment with air quality standards, or are unclassified. Cumulative impacts on air quality would be limited primarily to areas where more than one project is proposed within the same airshed. Portions of the Oregon LNG and Bradwood Landing Project would overlap, especially for LNG carrier traffic in the waterway up to CRM 11.5; and both proposed LNG import terminals would be located in Clatsop County, Oregon. We estimate that if both the Oregon LNG

Project and the Bradwood Landing Project are authorized and built, there would be cumulative impacts on local air quality from LNG marine traffic in the waterway. It is not currently feasible to exactly model air quality impacts from combined LNG carrier traffic due to the complexity of modeling moving LNG carriers, changing topography along the river, and microclimates along the waterway. From a cumulative impact standpoint, operation of both the Oregon LNG and Bradwood Landing terminals would increase county emissions of NO_x and SO_2, primarily due to ship emissions as shown in table 4.12.7-1.

TABLE 4.12.7-1

Estimated Operational LNG Project Emissions in Clatsop County, Oregon

Facility	NO_X (tpy)	CO (tpy)	VOC (tpy)	SO_2 (tpy)	PM_{10} (tpy)
Bradwood Landing Project	622.4	275.2	44.1	655.2	26.2
Oregon LNG Project	499	138	27.4	624.7	16.6
Total	1121.4	413.2	71.5	1,279.9	42.8
County Inventory	6,500[a]	32,000[a]	4,224[b]	1,134[b]	6,970[b]
Increase in County Inventory (percent)	17.3	1.3	1.7	112.9	0.6

[a] Provided by ODEQ.
[b] EPA, 2001.

It should be noted that the inventory data we have for VOCs, SO_2, and PM_{10} is not current; the newest data available for these pollutants is from 2001. Data for NO_x and CO inventories were obtained from the ODEQ and is more representative of current emission inventories. In addition, both Oregon LNG and Bradwood Landing would each have to obtain air quality permits from the ODEQ. Those permits would contain conditions and stipulations that may minimize cumulative impacts on air quality.

Because the other projects listed in table 4.12-1 are located over a large area; have varying construction schedules; and must adhere to federal, state, and local regulations for the protection of ambient air quality; it is impossible to quantitatively determine the incremental cumulative impacts that the Bradwood Landing Project would have in combination with these facilities and activities. As stated above, although Oregon LNG and Bradwood Landing may have large impacts on county emissions, it is unlikely that the addition of these facilities would have significant impacts on overall regional quality, although some degradation of overall air quality would be anticipated.

Noise impacts are particularly localized and attenuate quickly as the distance from the noise source increases. Therefore, cumulative impacts on noise associated with construction and operation of these projects would be unlikely.

4.12.8 Reliability and Safety

Impacts on reliability and public safety would be mitigated through the implementation of applicable federal, state, and local rules and regulations for each individual project. The specific rules and regulations that apply to each individual project would ensure that the applicable design standards are implemented to protect the public and to prevent accidents and failures. The LNG terminal facilities would be sited, designed, constructed, operated, and maintained in compliance with the federal safety standards summarized in table 2.8.1-1. The pipelines and aboveground facilities associated with the Bradwood Landing Project, Oregon LNG Project, and Palomar Pipeline would be designed, constructed, operated, and maintained in accordance with DOT Minimum Federal Safety Standards in 49 CFR 192.

4.12.9 Cumulative Impact Conclusions

We conclude that construction of the projects listed in table 4.12-1, especially if they are constructed on an overlapping timeline with the Bradwood Landing Project, has the potential to contribute cumulative impacts on the project area. The greatest potential for cumulative impacts is associated with the Oregon LNG Project. The type of project, construction methods, and impacts would be similar for the two projects. Each of these projects would result in temporary and minor effects during construction, but each project would be designed to avoid or minimize impacts on water quality, marine resources, and marine transportation. Additionally, significant impacts on sensitive resources resulting from these projects would be mitigated, and mitigation generally leads to the avoidance or minimization of cumulative impacts.

We recognize that unanticipated accidents during construction or operation could result in potential undefined impacts. However, a meaningful evaluation of those potential impacts is impossible, as quantification of potential impacts would be speculative at best. Accordingly, we consider project monitoring and mitigation programs to be critical in addressing unanticipated impacts, should they occur. With NorthernStar's proposed construction and operation methods, and strict adherence to our recommendations, federal and state regulations, and permitting requirements, impacts associated with the Bradwood Landing Project would be minimized, and would not constitute a significant impact in combination with other past, present, or reasonably foreseeable projects.