5.8 Greenhouse Gas Emissions and Climate Change

This section provides two different evaluations. The first evaluation describes the estimated greenhouse gas emissions that would result from construction and operation of the Proposed Action (Section 5.8.1, *Greenhouse Gas Emissions*). The second evaluation assesses the potential impacts on the Proposed Action that may occur from future changes in climate such as increased severe flooding or changes in precipitation (Section 5.8.2, *Climate Change Impacts on the Proposed Action*).

5.8.1 Greenhouse Gas Emissions

Greenhouse gases are air pollutants that trap solar energy in the atmosphere and contribute to global warming and climate change. Greenhouse gases are emitted from natural sources and are removed from the atmosphere by natural processes. Greenhouse gases are also emitted from human processes, which are now outpacing the natural processes that remove greenhouse gases from the atmosphere. Identifying and reducing excess greenhouse gas emissions from human processes are critical to reducing climate change. Greenhouse gases are global, rather than local, air pollutants with worldwide impacts.

5.8.1.1 Greenhouse Effect

The Earth retains outgoing thermal energy and incoming solar energy in the atmosphere, thus maintaining temperatures suitable for biological life. This retention of energy by the atmosphere is known as the greenhouse effect.[1] When solar radiation reaches the Earth, most of the solar radiation is absorbed by the Earth's surface, reflected by the Earth's surface and atmosphere, or—to a lesser degree—absorbed by the Earth's atmosphere. Simultaneously, the Earth radiates its own heat and energy out into the Earth's atmosphere and space. Factors such as the reflectivity of the Earth's surface, the abundance of water vapor, or the extent of cloud cover affects the degree to which solar radiation may be absorbed and reflected. Figure 5.8-1 shows how the energy flows to and from Earth and the role that the greenhouse effect plays in maintaining heat in the atmosphere.

The composition of gases in the Earth's atmosphere determines the amount of energy absorbed and reemitted by the atmosphere or simply reflected back into space. The predominant gases in the Earth's atmosphere, nitrogen and oxygen (which together account for nearly 90% of the atmosphere), exert little to no greenhouse effect. Some naturally occurring gases, such as carbon dioxide (CO_2), methane, and nitrous oxide trap outgoing energy and contribute to the greenhouse effect. Additionally, manufactured pollutants, such as hydrofluorocarbons, can contribute to the

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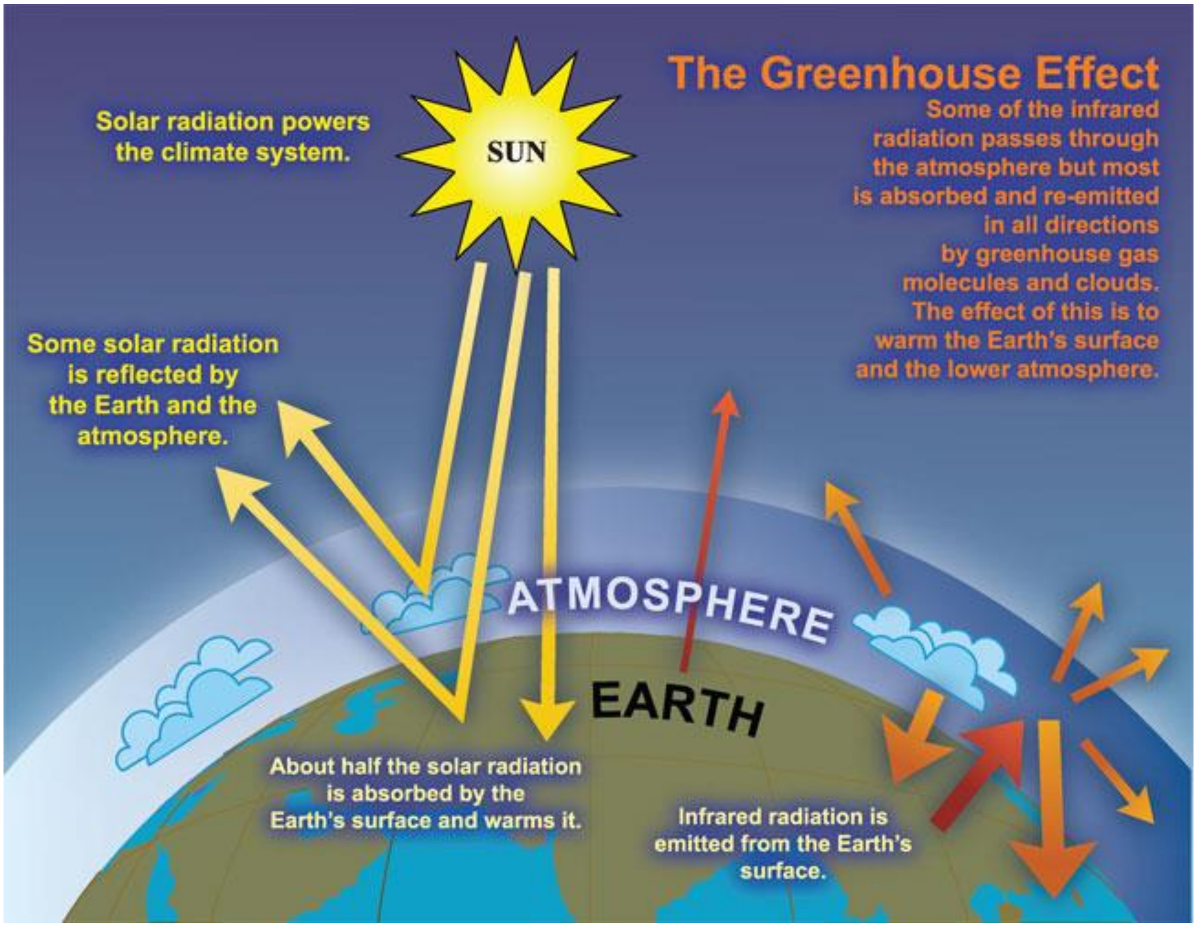
[1] The Intergovernmental Panel on Climate Change (2013) defines the greenhouse effect as follows:
The infrared radiative effect of all infrared-absorbing constituents in the atmosphere. Greenhouse gases, clouds, and (to a small extent) aerosols absorb terrestrial radiation emitted by the Earth's surface and elsewhere in the atmosphere. These substances emit infrared radiation in all directions, but, everything else being equal, the net amount emitted to space is normally less than would have been emitted in the absence of these absorbers because of the decline of temperature with altitude in the troposphere and the consequent weakening of emission. An increase in the concentration of greenhouse gases increases the magnitude of this effect; the difference is sometimes called the enhanced greenhouse effect. The change in a greenhouse gas concentration because of anthropogenic emissions contributes to an instantaneous radiative forcing. Surface temperature and troposphere warm in response to this forcing, gradually restoring the radiative balance at the top of the atmosphere.

greenhouse effect. Unlike most air pollutants (e.g., sulfur dioxide and particulate matter) that have only a local impact on air quality, greenhouse gases affect the atmosphere equally, regardless of where they are emitted, and thus they are truly global pollutants. A ton of CO_2 emissions in Asia affects the global atmosphere to the same degree as a ton of CO_2 emissions in the United States.

Figure 5.8-1. Model of the Natural Greenhouse Effect



Source: Intergovernmental Panel on Climate Change 2007

The extent to which a given greenhouse gas traps energy in the atmosphere and contributes to the overall greenhouse effect is characterized by its global-warming potential. Some gases are more effective at trapping heat, while others may be longer-lived in the atmosphere. The reference gas against which others are compared is carbon dioxide, and global warming potential is thus expressed in terms of carbon dioxide equivalent (CO_2e). The unit CO_2e represents both a gas's ability to trap heat and the rate at which it breaks down in the atmosphere. Most analyses use 100 years as the period of reference for global warming potential. For example, 1 unit of carbon dioxide has a 100-year global warming potential of 1, whereas an equivalent amount of methane has a global warming potential of 25. For this analysis, a 100-year period is used. Table 5.8-1 presents the

100-year global warming potentials from the IPCC Fourth Assessment Report for the greenhouse gases included in the analysis.[2]

Table 5.8-1. Global Warming Potentials

Greenhouse Gas	IPCC Fourth Assessment Report 100-Year Global Warming Potential
Carbon dioxide	1
Methane	25
Nitrous oxide	298

Source: Intergovernmental Panel on Climate Change 2007

Greenhouse gas emissions occur from both natural as well as human (anthropogenic) sources. Natural sources include decomposition of organic matter and aerobic respiration. Anthropogenic greenhouse gas emissions are predominantly from the combustion of fossil fuels, although industrial processes, land-use change, agriculture, and waste management are also contributors.

Atmospheric concentrations of greenhouse gases have increased since the Industrial Revolution, but the natural processes that remove those greenhouse gases from the atmosphere have not increased proportionally. Additionally, concentrations of long-lived manufactured pollutants such as hydrofluorocarbons have increased in recent decades. As the atmospheric concentrations of greenhouse gases increase, the atmosphere's ability to retain heat increases as well. Since the instrumental record began in 1895, the average temperature in the United States has risen by approximately 1.3 to 1.9 degrees Fahrenheit (°F) (U.S. Global Change Research Program 2014). Furthermore, these average temperatures are expected to increase at a faster pace in the 21st century, by 2.5°F to 11°F above preindustrial levels by 2100 (U.S. Global Change Research Program 2014).

The increase of greenhouse gas emissions in the atmosphere has been determined to pose risks to human and natural systems (Intergovernmental Panel on Climate Change 2014). Higher global surface temperatures cause widespread changes in the Earth's climate system. These changes may adversely affect weather patterns, biodiversity, human health, and infrastructure. A discussion of projected climate change in Cowlitz County and Washington State is provided in Section 5.8.2.4, *Existing and Future Conditions*.

5.8.1.2 Regulatory Setting

Laws and regulations relevant to greenhouse gases are summarized in Table 5.8-2.

[2] While additional greenhouse gases (HFCs, PFCs, SF_6) were considered for this analysis as per the Council on Environmental Quality (2016) guidance, carbon dioxide, methane, and nitrous oxide are the greenhouse gases emitted from the fossil fuel combustion and vegetation and wetland activities considered in the analysis.

Table 5.8-2. Regulations, Statutes, and Guidelines for Greenhouse Gases

Regulation, Statute, Guideline	Description
Federal	
Clean Air Act of 1963 (42 USC 7401) as amended	In 2007, the U.S. Supreme Court ruled that greenhouse gases are air pollutants under the Clean Air Act.
Carbon Pollution Emissions Guidelines for Existing Stationary Sources: Electric Utility Generating Units	In 2015, under the Clean Power Plan, EPA set state-specific target emissions reductions to reduce carbon dioxide emissions in the power sector by 32% below 2005 levels by 2030 (80 FR 64661).
United States Submittal to the United Nations Framework on Climate Change	U.S. and other nations submitted INDC to the United Nations in 2015.
State	
Limiting Greenhouse Gas Emissions (RCW 70.235)	Requires state to reduce overall greenhouse gas emissions as compared to a 1990 baseline and report emissions to the governor biannually. Specific goals include achieving 1990 greenhouse gas emissions levels by 2020; 25% below 1990 levels by 2035; and 50% below 1990 levels by 2050 or 70% below the State's expected emissions that year.
Washington Clean Air Act (RCW 70.94)	Establishes rules regarding preservation of air quality and penalties for violations. Carbon dioxide mitigation fees are evaluated as part of the permit required by the Clean Air Act (RCW 70.94.892) to reflect requirements from RCW 80.70. RCW 70.94.151 states that the department will be responsible for adopting rules requiring reporting of emissions defined by 70.235.010 from facility, source, site, or fossil fuel supplier that meet or exceed 10,000 metric tons of CO_2e annually.
Washington Carbon Pollution and Clean Energy Action (Executive Order 14-04, 2014)	In April 2014, Governor Inslee established the Governor's Carbon Emissions Reduction Taskforce to provide recommendations to the 2015 legislative session on the design and implementation of carbon emissions limits and market mechanisms program for Washington State. The task force delivered its findings in November 2014, noting that a harmonized, comprehensive emissions-based or price-based policy approach would add unique features to an overall carbon emissions reduction policy framework.
Washington Clean Air Rule (WAC 173-442)	Establishes requirements to cap and reduce greenhouse gas emissions. Parties covered under the Clean Air Rule are required to reduce their covered greenhouse gas emissions along an emissions reduction pathway by reducing their emissions or by obtaining emission reductions from other covered parties, in-state emissions reduction projects, or out-of-state emissions market (cap & trade) programs. The Clean Air Rule covers two-thirds of Washington's greenhouse gas emissions.

Regulation, Statute, Guideline	Description
Washington's Leadership on Climate Change (Executive Order 09-05, 2009)	In 2009, Governor Gregoire ordered the state to assess the effectiveness of various greenhouse gas reduction strategies by estimating emissions, quantifying necessary reductions, and identifying strategies and actions that could be used to meet the 2020 target. Assessments were done across multiple sectors and sources of emissions, including industrial facilities, the electricity sector, low-carbon fuel standards, vehicle miles traveled, coal plants, and forestry.
Path to a Low-Carbon Economy: An Interim Plan to Address Washington's Greenhouse Gas Emissions (2010)	The second Climate Comprehensive Plan report to the Governor and State Legislature outlines a plan to achieve emissions reductions to 1990 levels by 2020, as required by RCW 70.235.
Local	
No local laws or regulations apply to greenhouse gas emissions.	

Notes:
[a] Executive Office of the President 2013
USC = United States Code; EPA = U.S. Environmental Protection Agency; INDC = Intended Nationally Determined Contribution; FR = *Federal Register*; CO_2e = carbon dioxide equivalent; RCW = Revised Code of Washington

5.8.1.3 Study Area

The study area for greenhouse gas emissions for Cowlitz County, as a SEPA co-lead agency, is defined as Cowlitz County. For the Washington State Department of Ecology (Ecology) as a SEPA co-lead agency, greenhouse gas emissions were studied based on the expected transportation routes and emissions from the combustion of coal. While the study areas for the co-lead agencies are different, the analysis used the same approach to calculate greenhouse gas emissions attributable to the Proposed Action.

5.8.1.4 Methods

This section describes the sources of information and methods used to evaluate the greenhouse gas emissions associated with the construction and operation of the Proposed Action and the No-Action Alternative. The *SEPA Greenhouse Gas Emissions Technical Report* (ICF 2017a) provides detailed descriptions of the methods summarized below.

Information Sources

The following sources of information were used to identify the existing conditions relevant to greenhouse gas emissions in the study areas.

- *SEPA Coal Market Assessment Technical Report* (ICF 2017b) and emissions data used to evaluate the greenhouse gas emissions.
- *SEPA Air Quality Technical Report* (ICF 2017c)
- *SEPA Energy and Natural Resources Technical Report* (ICF 2017d)
- *SEPA Rail Transportation Technical Report* (ICF and Hellerworx 2017)
- *SEPA Vessel Transportation Technical Report* (ICF 2017f)

- *SEPA Vegetation Technical Report* (ICF 2017g)
- *SEPA Vehicle Transportation Technical Report* (ICF and DKS Associates 2017h)

To estimate the greenhouse gases emitted as a result of the activities and processes described in the above reports, the greenhouse gas analysis combined those reports' estimates of fuel consumption and vehicle operation with greenhouse gas emission factors to estimate greenhouse gas emissions for construction and operation aspects of the Proposed Action. The greenhouse gas emission factors were drawn from the following sources.

- *Appendix D: Emissions Estimation Methodology for Ocean-Going Vessels* (California Air Resources Board 2011)
- *Global Maritime Trade Lane Emissions Factors* (Clean Cargo Working Group 2014)
- *CO_2 Emission Factors for Coal Study for International Coals* (Energy Information Agency 1994)
- AP-42, Section 3.4, *Large Stationary Diesel and All Stationary Dual-fuel Engines* (U.S. Environmental Protection Agency 1996)
- *NONROAD Model (Non-road engines, equipment, and vehicles)* (U.S. Environmental Protection Agency 2009a)
- *Emission Factors for Locomotives* (U.S. Environmental Protection Agency 2009b)
- *MOVES (Motor Vehicle Emission Simulator)* (U.S. Environmental Protection Agency 2014)
- *U.S. Greenhouse Gas Inventory Report: 1990–2013* (U.S. Environmental Protection Agency 2015)
- *U.S. Greenhouse Gas Inventory Report: 1990–2014* (U.S. Environmental Protection Agency 2016b)
- *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (Intergovernmental Panel on Climate Change 2006)
- *Coal Mine Methane Country Profiles* (Global Methane Initiative 2015)
- *International Energy Statistics* (Energy Information Agency 2017)

Impact Analysis

The following methods were used to evaluate the potential impacts of the Proposed Action and the No-Action Alternative on greenhouse gas emissions. This section also describes the method for estimating the greenhouse gas emissions associated with each emissions source.

Scope of the Analysis

The Proposed Action would emit greenhouse gases during construction and operation. Emissions in Cowlitz County would come predominantly from the combustion of fossil fuels for construction and operation of the Proposed Action. Emissions outside of Cowlitz County would also result from the changes due to rail and vessel transportation and combustion of coal, both domestically and internationally, related to the Proposed Action. This analysis includes activity data from the reports identified in Section 5.8.1.4, *Methods,* to estimate emissions in and outside of Cowlitz County. Additionally, this greenhouse gas analysis evaluates emissions scenarios based on the flow of coal to and through the coal export terminal.

Geographically, the analysis of greenhouse gas emissions from the Proposed Action includes emissions from the transport of Powder River Basin and Uinta Basin coals from mines to the coal export terminal in Cowlitz County, final transport to Asia, and the end-use combustion of coal in Asia. The analysis also considers changes in coal combustion and emissions elsewhere that could occur when imported coal from the Proposed Action substitutes other coal. The substitution of natural gas for coal in the United States because of an increase in domestic coal prices is also evaluated. The greenhouse gas emissions analysis considers the following elements.

- **Analysis period.** To be consistent with activity data from the other technical reports prepared for the Proposed Action, this analysis considers construction, operation, rail and vessel transport, and fossil fuel combustion emissions from 2018 through 2038.
- **Emissions in Cowlitz County.** Greenhouse gas emissions in Cowlitz County are estimated for the construction and operation of the Proposed Action. These are described in *Method for Impact Analysis*, *Sources of Emissions in Cowlitz County*. Greenhouse gas emissions are measured in CO_2e, which is based on the global warming potential factors consistent with the Intergovernmental Panel on Climate Change Fourth Assessment Report (2007) for carbon dioxide, methane, and nitrous oxide.[3]
- **Emissions outside of Cowlitz County.** Greenhouse gas emissions from the Proposed Action outside of Cowlitz County are estimated. These are described below in *Method for Impact Analysis*, *Emissions Outside of Cowlitz County*. Greenhouse gas emissions calculations are characterized in terms of CO_2e.
- **Induced demand for energy.** This analysis addresses coal combustion in Asia that would result from the increased supply of coal related to the Proposed Action. As described in the *SEPA Coal Market Assessment Technical Report*, the addition of 44 million metric tons of coal to the Asian market would increase supply and lower international coal prices. Asian coal markets would respond to lower prices by consuming more coal overall. This additional demand for coal that would result from more supply and lower prices is referred to as induced demand.
- **Displacement of other energy sources.** Coal transported through the coal export terminal could displace other energy sources, nationally and internationally. Depending on the scenario, coal transported through the terminal could affect coal production in Australia, China, Canada, India, Indonesia, Russia, and South Africa, and could affect coal consumption throughout Asia. Conversely, in the United States, natural gas could be used as a substitute for coal combustion. The analysis of greenhouse gas emissions considers this displacement.
- **Coal market assessment scenarios.** Each coal market assessment scenario represents a range of greenhouse gas emissions estimates, based on economic and policy projections through 2040. For each scenario, the greenhouse gas emissions from Asian coal combustion, U.S. coal combustion, and U.S. natural gas combustion are influenced by factors such as coal prices, transportation costs, demand for thermal coal, U.S. and international climate policies, and competing energy sources. Estimates of coal transport, coal consumption, and natural gas substitution are informed by projections in the *SEPA Coal Market Assessment Technical Report*, which considers four scenarios based on economic and policy projections through 2040. The scenarios represent a range of greenhouse gas emissions estimates determined using a

[3] The U.S. Greenhouse Gas Emissions Inventory covers six greenhouse gases; however, since the Proposed Action does not include refrigeration or other actions that would influence fluorinated gases, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride were not included in the estimate of greenhouse gas emissions.

multidimensional model. The four scenarios and their key concepts are described below. The four scenarios were compared against a baseline representing conditions where the Proposed Action would not be built.

- **2015 U.S. and International Energy Policy Scenario.** The 2015 U.S. and International Energy Policy scenario includes U.S. and international climate policies as the defining feature of this scenario. The U.S. climate policy is modeled using a representation of the Clean Power Plan. The final Clean Power Plan was released in August 2015.[4] The international climate policy is modeled by using the international coal demand in the International Energy Agency's 2015 World Energy Outlook New Policies scenario.[5] This scenario more accurately reflects current global conditions compared to the other scenarios and is the preferred scenario for the co-lead agencies for purposes of this analysis.
- **No Clean Power Plan Scenario.** The No Clean Power Plan scenario represents the state of the energy markets as of 2016. It does not include implementation of the Clean Power Plan. The No Clean Power Plan scenario uses the base set of assumptions and assumes that no additional national or international climate policies will be enacted beyond those implemented by mid-2015.
- **Lower Bound Scenario.** The Lower Bound scenario represents a plausible low estimate of global CO_2 emissions from coal combustion. This scenario is designed to be a plausible and reasonable lower bound of global CO_2 emissions and does not attempt to model an absolute lowest bound of CO_2 emissions. The energy markets under the Lower Bound scenario could reflect a large component of renewable energy resulting in reduced demand for coal combustion.
- **Upper Bound Scenario.** The Upper Bound scenario represents an upper bound estimate of global CO_2 emissions from coal combustion and uses assumptions that could maximize the amount of induced demand from the Proposed Action. International coal plant construction and thus coal demand is assumed higher in this scenario than in all the other scenarios. This higher demand causes both international coal consumption and prices to increase. This scenario does not attempt to model an absolute upper bound of global CO_2 emissions or CO_2 emissions that would result from the Proposed Action.[6]

Table 5.8-3 summarizes the characteristics of the four scenarios. For each scenario, the table provides the following information.

- **Purpose:** the characteristics that the scenario is intended to represent.
- **U.S. coal markets:** the domestic coal market reaction to changes in supply and pricing.
- **Asian coal markets:** the international coal market reaction to changes in supply and pricing.
- **Coal prices:** the increases and decreases in coal production and transportation costs relative to the No Clean Power Plan scenario. Coal prices are modeled relative to the No Clean Power Plan

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[4] On August 3, 2015, EPA released the final Clean Power Plan, which regulates CO_2 emissions from existing fossil fuel generation sources under Section 111(d) of the Clean Air Act.

[5] The 2015 World Energy Outlook New Policies scenario incorporates the policies and measures that affect energy markets that had been adopted by non-U.S. countries as of mid-2015 and other relevant intentions that have been announced, even when the precise implementing measures have not been fully defined.

[6] Due to uncertainty over future coal consumption trends, the coal market assessment constructed the Upper and Lower Bound scenarios to illustrate a broad range of outcomes but not the most extreme possibilities.

scenario rather than the other scenarios because it uses the base set of assumptions without modifications.

- **Climate policy:** climate policy considered for each scenario.

Method for Assembling an Emissions Time Series

Because greenhouse gases accumulate in the atmosphere, this assessment characterizes greenhouse gases over the full analysis period (2018 through 2038) for each year as well as for each scenario. The analysis assumes construction of the coal export terminal would occur between 2018 and 2020. The analysis assumes the coal export terminal would become fully operational in 2021, and reach full capacity by 2028. The time series was estimated from existing data and assembled as follows.

- **Coal market assessment.** The greenhouse gas analysis uses modeling performed in multiple year increments including 2025, 2030, and 2040 provided by the *SEPA Coal Market Assessment Technical Report*. Therefore, since 2028 is not modeled, 2025 is initially modeled to include all 44 million metric tons of coal in 2025, and is scaled down proportionately. The years between 2025 and 2030 are then interpolated to develop annual greenhouse gas emissions from activity data for transport and greenhouse gas emissions from coal and natural gas combustion.
- **Activity data.** The activity data that characterize coal export terminal operations represent conditions in 2028, when the coal export terminal is expected to be fully operational. These data do not reflect the coal export terminal startup, in which the coal throughput increases from zero immediately after construction in 2020 to full capacity of 44 million metric tons of coal by 2028. Emissions estimates are proportional to throughput and can be expressed as emissions per unit of coal throughput.

Table 5.8-3. Coal Market Assessment Scenarios Definitions in Relation to the Baseline Assumptions

Scenario	Purpose	U.S. Coal Market Conditions (Relative to Base Assumptions)	Asian Coal Market Conditions (Relative to Base Assumptions)	Coal Prices (Relative to Base Assumptions)	Climate Policy
2015 U.S. and International Energy Policy	Represents impacts of an international climate policy on the coal market as proposed by mid-2015 and the Clean Power Plan	Coal consumption in the United States is lower due to implementation of the Clean Power Plan	Coal consumption is lower due to the implementation of greenhouse gas reduction policies	Both domestic and international coal prices are lower due to the lower overall coal demand	Climate policy resembling implementation of the Clean Power Plan and implementation of international greenhouse gas reduction policies proposed as of mid-2015
No Clean Power Plan	Represents the state of energy markets in the absence of new climate policies	No change from base assumptions	No change from base assumptions	No change from base assumptions	No climate policy implemented in the United States and only those international policies that have been fully implemented by mid-2015
Lower Bound	Represents energy markets where renewable penetration is high and international coal prices and demand are low, making domestic coal exports less attractive to international markets	Coal consumption in the United States is lower due to implementation of the Clean Power Plan and higher assumed Powder River Basin and Uinta Basin coal prices and rail transportation costs	• Lower assumed coal demand due to increased renewables • Lower coal prices due to lower demand	• Higher Powder River Basin and Uinta Basin coal prices due to assumed higher production costs • Lower international coal prices, due to assumed lower production costs	Climate policy resembling implementation of the Clean Power Plan and implementation of international greenhouse gas reduction policies announced as of mid-2015
Upper Bound	Represents energy markets where coal consumption is high, leading to high international demand and prices, making domestic coal exports more attractive to international markets	Higher coal demand due to lower Powder River Basin and Uinta Basin coal prices	Higher coal demand resulting in higher coal prices	• Lower Powder River Basin and Uinta Basin coal prices due to assumed lower production costs • Higher international coal prices due to increased demand and assumed higher production costs	No climate policy

5.8.1.5 Existing Conditions

This section describes the existing environmental conditions in the study areas related to greenhouse gas emissions that could be affected by the construction and operation of the Proposed Action and the No-Action Alternative.

As discussed in Section 5.8.1.1, *Greenhouse Effect,* greenhouse gas emissions trap heat in the atmosphere and increase surface temperatures on the Earth, which contribute to global warming and climate change. The climate impacts of global warming include sea-level rise, changes in precipitation and snowpack patterns, ocean acidification, wildfire seasons, and fluctuations in surface temperatures.

In 2012, Washington State was responsible for contributing 92.0 million metric tons of CO_2e. Of that 2012 total for Washington State, 42.5 million metric tons of CO_2e (46.2%) are attributable to the transportation sector, and 12.1 million metric tons of CO_2e (13.2%) are attributable to coal combustion in the electricity sector (Washington State Department of Ecology 2016).

Near the project area, greenhouse gas emission sources include locomotives for rail traffic along the BNSF Spur (approximately seven trains per day), Reynolds Lead (approximately two trains per day), vehicular traffic on area roadways, ongoing operations of the existing bulk product terminal in the Applicant's leased area, and other industrial uses along the Columbia River. The *SEPA Greenhouse Gas Technical Report* provides estimates of selected greenhouse gas emissions near the project area.

Method for Impact Analysis

This section provides an overview of the method for calculating greenhouse gas emissions in the study areas for each source. More information about each method is described in the *SEPA Greenhouse Gas Emissions Technical Report*.

Sources of Emissions in Cowlitz County

As previously described, greenhouse gas emissions were estimated from construction, operation, and transportation in Cowlitz County. Changes in greenhouse gas emissions in Cowlitz County were calculated from the following activities related to the Proposed Action.

- **Upland and wetland land-cover change.** The Proposed Action during construction would clear vegetation and remove surface soil, both of which sequester carbon dioxide (remove carbon dioxide from the atmosphere).
- **Dock dredging during terminal construction and operations—sediment carbon.** Dock dredging operations during the construction and operations phase of the Proposed Action would release sediment carbon.
- **Coal export terminal construction.** The Proposed Action during construction would generate greenhouse gas emissions from operation of construction equipment and transport of employees and construction materials to the project area. Energy use from dock dredging during construction is also included in this category.
- **Employee commuting.** The Proposed Action during construction and operations would generate greenhouse gas emissions from construction workers commuting to and from the project area, and during operations, daily employee commuting to and from the project area.

- **Rail transport.** The Proposed Action during operations would require rail transport of coal in Cowlitz County and in the project area.
    - Rail transport in Cowlitz County to and from the coal export terminal on the BNSF Railway Company (BNSF) main line, BNSF Spur, and Reynolds Lead.
    - Rail operations in the project area, including emissions from movement, switching, and idling on site.
- **Vehicle-crossing delay.** The Proposed Action during operations would increase vehicle delay at at-grade rail crossings. Engine idling would generate greenhouse gas emissions.
- **Coal export terminal operation.** The Proposed Action during operations would generate greenhouse gas emissions from equipment such as loaders, maintenance vehicles, and cranes. Energy use from maintenance dock dredging during operations is also included.
- **Vessel idling and tugboat use at the coal export terminal.** The Proposed Action during operations would generate greenhouse gas emissions from vessel maneuvering into and then idling at the loading area. Additionally, tugboats assisting in vessel maneuvering would generate greenhouse gas emissions.
- **Vessel transport.** The Proposed Action during operations would generate greenhouse gas emissions from vessels transporting coal in Cowlitz County from the project area down the Columbia River to the border of Cowlitz County, and vessels traveling up the Columbia River to the project area.

Sources of Emissions Outside of Cowlitz County

To assess broader potential impacts on Washington State, changes in greenhouse gas emissions outside Cowlitz County were calculated from the following activities related to the Proposed Action.

- **Materials for coal export terminal construction.** Emissions associated with the production of materials used in the initial construction of the coal export terminal.
- **Rail transport.** The Proposed Action during operations would require rail transport from mines in the Powder River Basin in Montana and Wyoming and the Uinta Basin in Utah and Colorado to the project area (see Section 5.1, *Rail Transportation*, for expected routes for Proposed Action-related trains). Relative rail traffic by coal market scenario and year was determined based on the *SEPA Coal Market Assessment Technical Report*.
- **Coal export terminal electricity consumption.** The Proposed Action during operations would consume electricity, generating greenhouse gas emissions from fuel combustion emissions at off-site power plants.
- **Helicopter and pilot boat trips.** The Proposed Action during operations would generate greenhouse gas emissions from helicopter and pilot boat transfers along the Columbia River outside of Cowlitz County.
- **Vessel transport.** The Proposed Action during operations would generate greenhouse gas emissions from vessels transporting coal outside of Cowlitz County.
    - Vessel transport of coal in Washington State beyond Cowlitz County to 3 nautical miles past the mouth of the Columbia River.

- Vessel transport of coal in international waters to markets in China, Hong Kong, Japan, South Korea, and Taiwan and the estimated 40% of returning vessels with only ballast water based on an analysis of Automatic Identified System (AIS) data from 2016.

- **Market effects on coal combustion in Asia and the United States.** The Proposed Action would generate greenhouse gas emissions from Proposed Action-related coal combustion in the United States and the Pacific Basin.

- **Induced natural gas consumption in the United States.** The Proposed Action during operations would change greenhouse gas emissions due to changes in the coal market. As coal prices increase due to the increased demand for coal to export, natural gas consumption in the United States is expected to increase. While greenhouse gas emissions from coal combustion would decrease, emissions from natural gas combustion would increase.

5.8.1.6 Impacts

This section describes the greenhouse gas emissions that would result from construction and operation of the Proposed Action and the No-Action Alternative. Detailed emissions by scenario are available in the *SEPA Greenhouse Gas Emissions Technical Report* and *SEPA Coal Market Assessment Technical Report*.

Proposed Action

This section describes the greenhouse gas emissions that could occur in the study areas as a result of construction and operation of the Proposed Action.

Greenhouse gas emissions are presented as 2028 emissions (the assumed first year of full export capacity operation for the coal export terminal) and total net emissions over the 2018 through 2038 analysis period. The total net emissions are the sum of emissions for the total analysis period, including construction beginning in 2018 and operation of the Proposed Action through 2038.

This section presents the aggregated results for each of the emissions sources described in Section 5.8.1.4, *Methods*. Details of the emissions associated with each source are available in the *SEPA Greenhouse Gas Emissions Technical Report.*

Construction—Cowlitz County

Construction-related activities associated with the Proposed Action would result in greenhouse gas emissions of 27,812 metric tons of CO_2e in Cowlitz County for all scenarios as described below. As explained in Chapter 2, *Project Objectives, Proposed Action*, *and Alternatives,* construction-related activities include demolishing existing structures and preparing the site, constructing the rail loop and dock, and constructing supporting infrastructure (i.e., conveyors and transfer towers).

Initial construction was assumed to occur over an 18-month period (2018 to 2020). Consequently, except for upland and wetland land-cover change and emissions from dock dredging, the total greenhouse gas construction-related emissions from 2018 to 2020 are 1.5 times the initial 12-month period (Table 5.8-4). For construction emissions from lost sequestration related to upland and wetland land-cover change, the emissions occur in the first year, while dock-dredging emissions are split evenly over 2 years. Construction-related greenhouse gas emissions would be the same across all four scenarios.

Table 5.8-4. Construction Greenhouse Gas Emissions within Cowlitz County (metric tons of CO_2e)[a]

Source	Scenario: 2015 U.S. and International Energy Policy	Lower Bound	Upper Bound	No Clean Power Plan
Upland and Wetland Land-Cover Change ($MtCO_2e$)[b]				
Emissions During 12 Months of Construction Period	11,771	11,771	11,771	11,771
Total Emissions 2018–2020	11,821	11,821	11,821	11,821
Dock Dredging—Sediment Carbon ($MtCO_2e$)				
Emissions During 12 Months of Construction Period	1,919	1,919	1,919	1,919
Total Emissions 2018–2020[c]	3,838	3,838	3,838	3,838
Construction Equipment ($MtCO_2e$)				
Emissions During 12 Months of Construction Period	5,538	5,538	5,538	5,538
Total Emissions 2018–2020[c,d]	8,401	8,401	8,401	8,401
Construction Worker Commuting ($MtCO_2e$)				
Emissions During 12 Months of Construction Period	465	465	465	465
Total Emissions 2018–2020[d]	698	698	698	698
Construction Trucks ($MtCO_2e$)				
Emissions During 12 Months of Construction Period	1,081	1,081	1,081	1,081
Total Emissions 2018–2020[d]	1,621	1,621	1,621	1,621
Construction Barges ($MtCO_2e$)				
Emissions During 12 Months of Construction Period	955	955	955	955
Total Emissions 2018–2020[d]	1,433	1,433	1,433	1,433
Subtotal Construction Emissions ($MtCO_2e$)				
Emissions During 12 Months of Construction Period	21,729	21,729	21,729	21,729
Total Emissions, 2018–2020[d]	27,812	27,812	27,812	27,812

Notes:

[a] Greenhouse gas emissions are shown as metric tons of CO_2e because emissions within Cowlitz County are relatively small compared to emissions outside of Cowlitz County.

[b] Loss of accumulated carbon stocks during construction plus the loss of ongoing carbon sequestration.

[c] According to the Applicant, dredging during the construction period is expected to occur over two annual approved work periods to coincide with fish protection during the construction phase. Therefore, emissions during 12-month construction period are assumed to be half of the total emissions during the entire construction period from 2018–2020.

[d] Construction emissions occur over an 18-month period prior to the operation of the coal export terminal; therefore, emissions from 2021 through 2038 are zero. Given the 18-month period for construction, total construction emissions are those for the 12-month period multiplied by 1.5. Construction equipment also includes energy use from dredging; the apportioning methodology is detailed in note "c" above.

$MtCO_2e$ = metric tons of carbon dioxide equivalent

Construction—Outside of Cowlitz County

Construction-related activities associated with the Proposed Action would result in greenhouse gas emissions outside of Cowlitz County of 0.19 million metric tons of CO_2e for all scenarios. Construction-related activities outside of Cowlitz County include embedded greenhouse gas emissions from the materials used to construct the bulk export terminal.

Initial construction was assumed to occur over an 18-month period (2018 to 2020). Emissions from embedded greenhouse gas emissions in construction materials are apportioned throughout the construction period. Consequently, the total construction-related greenhouse gas emissions from 2018 to 2020 are 1.5 times the initial 12-month period (Table 5.8-5).

Construction greenhouse gas emissions would be the same across all four scenarios.

Table 5.8-5. Construction Greenhouse Gas Emissions Outside of Cowlitz County (million metric tons of CO_2e)

	Scenario			
Source	**2015 U.S. and International Energy Policy**	**Lower Bound**	**Upper Bound**	**No Clean Power Plan**
Materials for Coal Export Terminal Construction ($MMTCO_2e$)				
Emissions During 12 Months of Construction Period	0.12	0.12	0.12	0.12
Total Emissions 2018–2020[a]	0.19	0.19	0.19	0.19
Subtotal—Construction Emissions Outside of Cowlitz County ($MMTCO_2e$)				
Emissions During 12 Months of Construction Period	0.12	0.12	0.12	0.12
Total Emissions, 2018–2020[a]	0.19	0.19	0.19	0.19

Notes:
[a] Construction emissions occur over an 18-month period prior to the operation of the coal export terminal; therefore, emissions from 2021 through 2038 are zero. Given the 18-month period for construction, total construction emissions are those for the 12-month period multiplied by 1.5.
$MMtCO_2e$ = million metric tons of carbon dioxide equivalent

Operations—Cowlitz County

Operation of the Proposed Action would result in annual greenhouse gas emissions of between 39,628 and 39,640 metric tons of CO_2e in Cowlitz County for all scenarios. Operations-related activities are described in Chapter 2, *Project Objectives, Proposed Action*, *and Alternatives*.

Greenhouse gas emissions in Cowlitz County during operations are primarily driven by rail transport of coal, vessel idling and tugboat use at the coal export terminal, and vessel transport of coal (Table 5.8-6). The greenhouse gas emissions are presented in terms of the 2028 emissions (the assumed first year of full export capacity operation for the coal export terminal) and total net emissions from 2021 (when export operation begins) to 2038. Greenhouse gas emissions in Cowlitz County would be the same across all four scenarios.

Table 5.8-6. Operations—Cowlitz County Greenhouse Gas Emissions (metric tons of CO_2e)[a]

	Scenario			
Source	**2015 U.S. and International Energy Policy**	**Lower Bound**	**Upper Bound**	**No Clean Power Plan**
Vegetation and Soil Removal ($MtCO_2e$)				
Annual Emissions, 2028	17	17	17	17
Total Emissions, 2021–2038	300	300	300	300
Dock Dredging—Sediment Carbon ($MtCO_2e$)				
Emissions During 12 Months of Construction Period	768	768	768	768
Total Emissions 2018–2020[a]	13,816	13,816	13,816	13,816
Rail Transport ($MtCO_2e$)				
Annual Emissions, 2028	21,862	21,862	21,850	21,862
Total Emissions, 2021–2038	311,811	312,023	311,506	312,023
Vehicle-Crossing Delay ($MtCO_2e$)				
Annual Emissions, 2028	171	171	171	171
Total Emissions, 2021–2038	2,439	2,439	2,439	2,439
Coal Export Terminal Equipment Operation ($MtCO_2e$)				
Annual Emissions, 2028	983	983	983	983
Total Emissions, 2021–2038	14,332	14,332	14,332	14,332
Vessel Idling and Tugboat Use at the Coal Export Terminal ($MtCO_2e$)				
Annual Emissions, 2028	7,338	7,338	7,338	7,338
Total Emissions, 2021–2038	104,740	104,740	104,740	104,740
Vessel Transport ($MtCO_2e$)				
Annual Emissions, 2028	8,227	8,227	8,227	8,227
Total Emissions, 2021–2038	117,417	117,417	117,417	117,417
Employee Commuting ($MtCO_2e$)				
Annual Emissions, 2028	275	275	275	275
Total Emissions, 2021–2038	3,922	3,922	3,922	3,922
Subtotal—Cowlitz County Emissions ($MtCO_2e$)				
Annual Emissions, 2028	39,640	39,640	39,628	39,640
Total Emissions, 2021–2038	568,778	568,990	568,472	568,990

Notes:

[a] Greenhouse gas emissions are shown as metric tons of CO_2e because emissions within Cowlitz County are relatively small compared to emissions outside of Cowlitz County.

$MtCO_2e$ = metric tons of carbon dioxide equivalent

Operations—Outside of Cowlitz County

For full coal export terminal operations in 2028, the Proposed Action would result in an annual increase in greenhouse gas emissions outside of Cowlitz County of 1.15 million metric tons of CO_2e for the preferred 2015 U.S. and International Energy Policy scenario. Operations-related activities are described in Chapter 2, *Project Objectives, Proposed Action*, *and Alternatives*.

Greenhouse gas emissions outside of Cowlitz County during operations are primarily driven by coal combustion in Asia and the United States, while international vessel transportation and domestic rail transportation are also large drivers of emissions (Table 5.8-7). The greenhouse gas emissions are presented in terms of the 2028 emissions (the first year of full export capacity operation for the coal export terminal) and total net emissions from 2021 (when export operation begins) to 2038.

Table 5.8-7. Operations—Emissions Outside of Cowlitz County (million metric tons of CO_2e)[a]

	Scenario			
Source	**2015 U.S. and International Energy Policy**	**Lower Bound**	**Upper Bound**	**No Clean Power Plan**
Rail Transport ($MMTCO_2e$)				
Annual Emissions, 2028	0.99	1.07	0.95	0.95
Total Emissions, 2021–2038	13.92	15.25	13.41	13.58
Coal Export Terminal Electricity Consumption ($MMTCO_2e$)				
Annual Emissions, 2028	<0.005	<0.005	<0.005	<0.005
Total Emissions, 2021–2038	<0.005	<0.005	<0.005	<0.005
Helicopter and Pilot Boat Trips ($MMTCO_2e$)				
Annual Emissions, 2028	<0.005	<0.005	<0.005	<0.005
Total Emissions, 2021–2038	0.01	0.01	0.01	0.01
Vessel Transport ($MMTCO_2e$)[b]				
Annual Emissions, 2028	1.02	1.14	1.13	0.94
Total Emissions, 2021–2038	15.31	16.31	17.01	13.47
Coal Combustion in Asia and the United States ($MMTCO_2e$)[b]				
Annual Emissions, 2028	-0.93	-8.48	52.92	1.83
Total Emissions, 2021–2038	-8.55	-101.44	749.46	23.91
Induced Natural Gas Consumption in the United States ($MMTCO_2e$)[b]				
Annual Emissions, 2028	0.07	2.42	-0.02	<0.005
Total Emissions, 2021–2038	0.89	27.78	-0.24	<0.005
Subtotal—Emissions Outside of Cowlitz County ($MMTCO_2e$)				
Annual Emissions, 2028	**1.15**	**-3.84**	**54.97**	**3.72**
Total Emissions, 2021–2038	**21.58**	**-42.09**	**779.64**	**50.97**

Notes:

[a] Emissions outside of Cowlitz County include U.S. domestic emissions and international emissions.

[b] Emissions for these sources are presented as net emissions. Net greenhouse emissions represent the difference between the Proposed Action and the no-action for each scenario as defined in the *SEPA Coal Market Assessment Technical Report*.

$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Total Greenhouse Gas Emissions

This section presents the aggregate results of each of the emissions sources described previously. The total emissions are the sum of emissions for the total analysis period, including construction beginning in 2018 and operation through 2038.

Table 5.8-8 shows the greenhouse gas emissions in Cowlitz County from construction and operation of the Proposed Action (Table 5.8-8) as 0.60 million metric tons of CO_2e over the analysis period. These emissions are approximately the same for each of the four scenarios, as they are emitted in proportion to throughput and are only influenced by outside economic factors. The largest contributors to the emissions are transportation-related emissions, including locomotive operation and vessel transport in Cowlitz County. Together, these two sources contribute about 72% of the emissions generated in Cowlitz County.

Table 5.8-8. Total Greenhouse Gas Emissions in Cowlitz County (million metric tons of CO_2e)

	Scenario			
Period	**2015 U.S. and International Energy Policy**	**Lower Bound**	**Upper Bound**	**No Clean Power Plan**
Annual Emissions, 2028 ($MMTCO_2e$)	0.04	0.04	0.04	0.04
Total Emissions, 2018–2038 ($MMTCO_2e$)	0.60	0.60	0.60	0.60

Notes:
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Table 5.8-9 shows the annual greenhouse gas emissions in Washington State (not including Cowlitz County) in 2028 from transportation for the preferred 2015 U.S. and International Energy Policy scenario is 0.33 million metric tons of CO_2e. Emissions in Washington State (outside of Cowlitz County) are approximately nine times as high as emissions in Cowlitz County, largely driven by the greater distances traveled by trains and vessels outside of Cowlitz County. Rail transport constitutes about 97% of the emissions generated within Washington State and outside of Cowlitz County (Table 5.8-9).

Table 5.8-9. Total Greenhouse Gas Emissions in Washington State, Excluding Cowlitz County (million metric tons of CO_2e)

	Scenario			
Period	**2015 U.S. and International Energy Policy**	**Lower Bound**	**Upper Bound**	**No Clean Power Plan**
Annual Emissions, 2028	0.33	0.33	0.32	0.33
Total Emissions, 2018–2038	4.57	4.77	4.27	4.77

$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

Table 5.8-10 summarizes the total *net*[7] greenhouse gas emissions for each scenario compared to the base conditions for each scenario. The net annual greenhouse gas emissions for the preferred 2015 U.S. and International Energy Policy scenario in analysis year 2028 are 1.19 million metric tons of CO_2e. The total net emissions for the preferred 2015 U.S. and International Energy Policy scenario during construction, initial operations, and full operations is described in more detail in the *Assessing Significance* subsection (Table 5.8-11).

Table 5.8-10. Total Net Emissions (million metric tons of CO_2e)[a]

	Scenario			
Period	**2015 U.S. and International Energy Policy**	**Lower Bound**	**Upper Bound**	**No Clean Power Plan**
Net Annual Emissions, 2028[b]	1.19	-3.80	55.01	3.76
Total Net Emissions, 2018–2038[b]	22.36	-41.31	780.42	51.75

Notes:

[a] Net greenhouse gas emissions represent the difference between each Proposed Action scenario and the no-action specific to each scenario in the *SEPA Coal Market Assessment Technical Report*.

[b] Scenarios where net emissions are negative are due to domestic coal displacement. For scenarios with positive net emissions, increases in emissions from Asian coal substitution, induced demand, domestic rail transportation, and international vessel transportation outweigh decreases in emissions from domestic coal displacement.

$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

The uncertainty associated with estimating coal extraction emissions is high compared to other sources of emissions included in the analysis. Coal extraction emissions are driven by methane emissions from mining and post-mining operations (e.g., transportation and handling), where estimates can vary by as much as +/- 300% depending on the mining method (i.e., surface or underground), computation method, and data availability. Information on extraction emissions is disclosed in the *SEPA Greenhouse Gas Emissions Technical Report*.

[7] Net greenhouse gas emissions represent the difference between each Proposed Action scenario and the No-Action specific to each scenario in the *SEPA Coal Market Assessment Technical Report*.

Assessing Significance

The scenarios described in the *SEPA Coal Market Assessment Technical Report* identify a range of net emissions attributable to the Proposed Action. The 2015 U.S. and International Energy Policy scenario is intended to represent existing conditions under which the Proposed Action would operate. The 2015 U.S. and International Energy Policy is the most representative of current U.S. policy of the scenarios modeled, and consequently is the preferred scenario for the analysis (Table 5.8-11). The average net annual emissions during full operations for this scenario is an increase of 1.99 million metric tons CO_2e.

Table 5.8-11. Greenhouse Gas Emissions for the 2015 U.S. and International Energy Policy Scenario (million metric tons of CO_2e)

Phase	Years	Greenhouse Gas Emissions	Average Annual Emissions
Construction Emissions	2018–2020	0.21	0.07
Total Net Emissions for Initial Operation	2021–2027	0.30	0.04
Total Net Emissions for Full Operations	2028–2038	21.85	1.99
Total Emissions	**2018–2038**	**22.36**	

Notes:
$MMTCO_2e$ = million metric tons of carbon dioxide equivalent

The average annual amount of emissions for operations in Table 5.8-11 exceeds various intensity considerations that are proposed in federal and state regulations and guidance. For example, the Washington State Clean Air Rule establishes an initial compliance threshold for greenhouse gas emissions of 100,000 metric tons of CO_2e per year. Similarly, the EPA Tailoring Rule, 40 CFR Parts 51, 52, 70 et al. applies to sources that emit more than 75,000 short tons of CO_2e per year.

These standards provide guidance on assessing the significance of various levels of greenhouse gas emissions. Since the net greenhouse gas emissions attributable to the Proposed Action in the preferred scenario exceed these standards, the emissions are considered significant impacts. The climate change impacts resulting from this increase to greenhouse gases would persist for a long period, beyond the analysis period, and are considered permanent and, while global in nature, would affect Washington State. Based on these considerations, emissions attributable to operations of the Proposed Action under the 2015 U.S. and International Energy Policy scenario are considered adverse and significant.

Under the Proposed Action, 44 million metric tons of coal would pass through the coal export terminal at full operation. Downstream combustion emissions from this coal would be approximately 90 million tons of CO_2e per year. However, not all of the emissions are attributable to the Proposed Action because some of the coal being shipped from the coal export terminal could displace other coal shipped from other areas and change transportation pathways. According to model results for the preferred 2015 U.S. and International Energy Policy scenario, average annual net emissions from the Proposed Action at full operation would be approximately 2.2% (i.e., 1.99 million metric tons of CO_2e) of the combustion emissions from the coal that passes through the coal export terminal.

Market Effects on Coal Combustion and Emissions

The Applicant proposes to export up to 44 million metric tons of coal each year. Modeling was done to identify the changes in the coal markets and the resulting changes in potential greenhouse gas emissions that could be attributed to the Proposed Action. The changes in the market, transportation pathways, use of natural gas to replace coal, and other factors described previously and in the *SEPA Coal Market Assessment Technical Report*, will result in net changes of global greenhouse gas emissions.

The purpose of the coal market assessment is to identify how changes in the domestic and international coal prices affect the resulting net greenhouse gas emissions for each scenario. In summary, the Proposed Action would have the following market impacts, regardless of scenario.

- It would increase coal supplied to international markets.
- The increase in supply would decrease international coal prices.
- The decrease in international coal prices would increase the international demand for U.S. coal.
- The increase in international demand would increase U.S. coal prices.
- The increase in U.S. coal prices would reduce domestic coal demand.

Impacts on Coal and Natural Gas Combustion Relative to the No Clean Power Plan Scenario

The table below compares how coal and natural gas combustion change in response to market and policy conditions. The No Clean Power Plan scenario compares the emissions relative to the no-action, whereas the rest of the scenarios indicate whether emissions have increased or decreased relative to the no-action and then indicate whether the magnitude of this increase or decrease is greater than or less than the increase or decrease from the No Clean Power Plan scenario.

Scenario	U.S. Coal Combustion	Asian Coal Combustion	U.S. Natural Gas Combustion
No Clean Power Plan	Decrease in domestic coal emissions compared to the no-action due to slight decrease in coal consumption.	Increase in Asian coal emissions compared to the no-action due to the change in the mix of coal consumed.	Increase in domestic natural gas emissions compared to the no-action due to the slight decrease in coal consumption.
2015 U.S. and International Energy Policy	Decrease in domestic coal emissions compared to the no-action.	Increase in Asian coal emissions compared to the no-action.	Increase in domestic natural gas emissions compared to the no-action.
	Magnitude of decrease is greater than of the No Clean Power Plan due to greater sensitivity to coal price changes due to overall lower electric demand.	Magnitude of increase is less than that of the No Clean Power Plan due to a different mix of coals consumed.	Magnitude of increase is greater than that of the No Clean Power Plan due to the greater decrease in coal consumption.
Lower Bound	Decrease in domestic coal emissions compared to the no-action.	Decrease in Asian coal emissions compared to the no-action.	Increase in domestic natural gas emissions compared to the no-action.
	Magnitude of the decrease is greater than that of the No Clean Power Plan due to the higher assumed production costs in the Powder River Basin that result in higher coal prices in the Proposed Action that results in greater reduction of domestic coal consumption.	Magnitude of the decrease is less than in the No Clean Power Plan. In both scenarios the changes in Asian coal combustion emissions are due only to changes in the mix of coal consumed.	Magnitude of the increase in natural gas emissions is greater than in the No Clean Power Plan due to the greater reduction in coal consumption.
Upper Bound	Increase in domestic coal emissions compared to the no-action.	Increase in Asian coal emissions compared to the no-action.	Decrease in domestic natural gas emissions compared to the no-action.
	Magnitude of the decrease is greater than in the No Clean Power Plan scenario due to the higher overall demand for coal	Magnitude of the increase is greater than in the No Clean Power Plan scenario because the higher assumed production costs of international coal producers results in greater induced demand.	Magnitude of decrease is greater than in the No Clean Power Plan scenario because of the greater change in domestic coal consumption.

The largest contributor to net emissions is the extent to which coal and natural gas combustion are influenced in Asia and the United States. In the No Clean Power Plan and Lower Bound scenarios, the largest contributor to the net emissions is the displacement of coal combustion in the United States, driven by an increase in coal prices in response to the Proposed Action. Coal displacement results in a reduction of greenhouse gas emissions. In the Upper Bound scenario, the emissions induced demand from lower coal prices in Asia in response to the Proposed Action outweighs the emissions from domestic coal displacement, resulting in positive net emissions. For additional information on the impacts on the coal market and emissions across the four scenarios, see the *SEPA Greenhouse Gas Emissions Technical Report*.

No-Action Alternative

Under the No-Action Alternative, the Applicant would not construct the coal export terminal. The Applicant would continue with current and future increased operations in the project area. The project area could be developed for other industrial uses including an expanded bulk product terminal or other industrial uses. The Applicant has indicated that, over the long term, it would expand the existing bulk product terminal and develop new facilities to handle more products such as calcine petroleum coke, coal tar pitch, and cement.

Alternative uses of the project area, as described in Chapter 2, *Project Objectives, Proposed Action, and Alternatives*, would be expected to result in an estimated annual increase of 0.0012 million metric tons of CO_2e relative to current conditions in Cowlitz County for locomotive combustion, vessel combustion, and truck transport (Table 5.8-12).

Table 5.8-12. No-Action Alternative Annual Average Emissions from Rail, Vessel, and Haul Trucks Operating within Cowlitz County

Source	Maximum Annual Average Emissions (million metric tons of CO_2e)
Locomotive Combustion	0.0005
Vessel Combustion	0.0004
Haul Trucks	0.0002
Total	**0.0012**

5.8.1.7 Required Permits

No permits related to greenhouse gas emissions would be required for the Proposed Action.

5.8.1.8 Proposed Mitigation Measures

This section describes the mitigation measures that would reduce greenhouse gas emissions from construction and operation of the Proposed Action. These mitigation measures would be implemented in addition to project design measures, best management practices, and compliance with environmental permits, plans, and authorizations that are assumed as part of the Proposed Action and described below.

Applicant Mitigation

The Applicant will implement the following measures to mitigate greenhouse gas emissions.

MM GHG-1. Provide Fuel Efficiency Training to Equipment Operators.

To reduce greenhouse gas emissions from construction equipment, the Applicant will provide a fuel efficiency training program to locomotive, vessel, and construction equipment operators.

MM GHG-2. Implement an Anti-Idling Policy.

To reduce emissions from vessel and locomotive idling in the project area, the Applicant will implement an anti-idling policy.

MM GHG-3. Reduce Emissions from Cars.

The Applicant will evaluate the use of electric cars for company cars, incentivize the use of electric vehicles by providing charging stations, and develop an incentive program for carpooling.

MM GHG-4. Mitigate for Impacts on Washington State from Net Greenhouse Gas Emissions Attributable to the Proposed Action.

Under the 2015 U.S. and International Energy Policy scenario, which best reflects the current policy requirements and conditions, the average net greenhouse gas emissions for operations from 2028 to 2038 would be 1.99 million metric tons of CO_2e per year.

To address the potential impacts of greenhouse gas emissions attributable to the Proposed Action, the Applicant will prepare a greenhouse gas mitigation plan that mitigates for 100% of the greenhouse gas emissions identified in the 2015 U.S. and International Energy Policy scenario. For operations at maximum capacity this is 1.99 million metric tons CO_2e per year from 2028 through 2038. The plan must be approved by the Washington State Department of Ecology. For mitigation that occurs in Cowlitz County, the plan will be approved by Cowlitz County and Ecology. The plan must be ready to implement prior to the start of full operations. The measures described in the plan may include a range of mitigation options. The measures must achieve emissions reductions that are real, permanent, enforceable, verifiable, and additional. The emissions reductions may occur in Washington State or outside of Washington State but must be demonstrated to meet all five criteria (e.g., using internationally recognized protocols). For example, carbon credits could be purchased through existing carbon markets, or through on-site reductions achieved through efficiency measures or changes in technology.

5.8.1.9 Unavoidable and Significant Adverse Environmental Impacts

Implementation of the proposed mitigation measures described above would reduce impacts from greenhouse gas emissions and there would be no unavoidable and significant adverse environmental impacts from greenhouse gas emissions.

5.8.2 Climate Change Impacts on the Proposed Action

This section summarizes potential impacts *on* the study area that may occur from changes in climate such as increased flooding or changes in low water.[8] The impacts are evaluated in two categories: the potential impacts of climate change on the Proposed Action (e.g., impact of increased precipitation on the Proposed Action), and the impact of climate change on other resource areas to determine if it may modify the impacts of the Proposed Action. The study area includes the project area, access roads, and rail leading to the project area. The international scientific community is in agreement that human activities have contributed—and continue to contribute—to climate change. One of the primary causes of climate change is the emissions of greenhouse gases, which trap heat in the atmosphere. As discussed above, the Proposed Action would contribute to worldwide greenhouse gas emissions. Analysis of greenhouse gas emissions related to the Proposed Action and proposed mitigation measures from greenhouse emissions are discussed in Section 5.8.1, *Greenhouse Gas Emissions*. Studies have found, in general, that climate change could result in changes in precipitation, temperature, ocean acidification, and storm intensity and could increase risks of damage from flooding, drought, heat waves, winds, and storm surge. This section discusses existing and future conditions.

The changing climate could affect the Proposed Action and resources within the study area. This section describes potential climate change impacts in the study area related to the construction and operation of the Proposed Action and No-Action Alternative.

Greenhouse gases affect the atmosphere equally, regardless of where they are emitted, and thus they are global pollutants. A ton of CO_2 emissions in Asia affects the global atmosphere to the same degree as a ton of CO_2 emissions in the United States. The increase of greenhouse gas emissions in the atmosphere has been determined to pose risks to human and natural systems (Intergovernmental Panel on Climate Change 2014). Higher global surface temperatures cause widespread changes in the Earth's climate system. These changes may adversely affect weather patterns, biodiversity, human health, and infrastructure. The risk of increased impacts from natural variation is predicted to be incrementally magnified by climate change.

The 2016 CEQ greenhouse gas guidance stated, "It is now well established that rising global atmospheric greenhouse gas emissions concentrations are significantly affecting the Earth's climate." The guidance recommended agencies use projected greenhouse gas emissions as a proxy for assessing potential climate change effects for environmental reviews. It also recommended agencies quantify projected "direct and indirect GHG emissions, taking into account available data and GHG quantification tools that are suitable."

The net increase in greenhouse gas emissions under the preferred scenario identified in Section 5.8.1, *Greenhouse Gas Emissions,* would increase the risk and magnitude of projected climate change impacts. The potential climate change impacts from global climate change that would affect Cowlitz County and Washington State are described in this section.

[8] See Sections 5.8.1.3 through 5.8.1.6 for examination of greenhouse gas emissions from the Proposed Action.

5.8.2.1 Regulatory Setting

Laws and regulations relevant to climate change are summarized in Table 5.8-13.

Table 5.8-13. Regulations, Statutes, and Guidelines for Climate Change

Regulation, Statute, Guideline	Description
Federal	
Clean Air Act of 1963 (42 USC 7401)	Directs the control of air pollutants nationally. The U.S. Supreme Court in 2007 established that greenhouse gases are air pollutants, and are therefore covered under this Act.
State	
Requirements of Strategy—Initial Climate Change Response Strategy (RCW 43.21M.020)	Directs state agencies to develop an integrated climate change response strategy to enable state, tribal, and local governments and public and private organizations to prepare for and adapt to the impacts of changing climate conditions. Outlines strategies for protecting human health, safeguarding infrastructure and transportation systems, improving water management, reducing losses to agriculture and forestry, protecting sensitive and vulnerable species, and supporting communities by involving the public.
Washington State Growth Management Act (WAC 365-195-920, RCW 36.70A)	Requires state and local governments to use "best available science" when developing policies and development regulations. Suggests using adaptive management as an interim approach for managing scientific uncertainty.
Local	
No local laws or regulations apply to climate change.	

Notes:
USC = United States Code; RCW = Revised Code of Washington; WAC = Washington Administrative Code

5.8.2.2 Study Area

The study area for potential impacts from climate change effects is defined as the project area for the Proposed Action and the access roads and rail leading to the project area. The study area is the same as the study areas set for other specific resource areas.

5.8.2.3 Methods

This section describes the sources of information and methods used to identify projected changes in climate and to evaluate the impacts of climate change on the construction and operation of the Proposed Action and No-Action Alternative.

Information Sources

The following sources provided information on historical climate and projected changes in climate for southwestern Washington State.

- **National Climate Change Viewer.** The U.S. Geological Survey (USGS) National Climate Change Viewer (U.S. Geological Survey 2014a) contains historical and future climate projections at watershed, state, and county levels for the continental United States.

  The viewer contains multimodel ensemble data (mean model), combining the results from 30 independent climate models developed by researchers around the world under the coordination of the Fifth Coupled Model Intercomparison Project (CMIP5).[9] Multimodel data increase the robustness of projections and provide information on the level of uncertainty in the direction and magnitude of future climate trends. Climate information in the viewer has been *downscaled*, or processed using statistical analysis to provide projections with higher geographic resolution of temperature, precipitation, and snowfall. Historical values and future projections of temperature were examined for Cowlitz County where the Proposed Action would be located. Historical values and future projections of precipitation and snowfall were examined for the Lower Columbia River Basin.

- **2014 National Climate Assessment.** The 2014 National Climate Assessment was conducted by the U.S. Global Change Research Program (2014). This assessment summarizes the current and future impacts of climate change in the United States. Its findings, which have undergone extensive public and expert peer review, were compiled by a team of more than 300 experts guided by the 60-member Federal Advisory Committee of the National Academy of Sciences. The report uses multimodel ensemble projections developed under CMIP5, supplemented by information from an earlier phase of the project, CMIP3, where necessary.

Information on the potential impacts of climate change on resource areas was drawn from a diverse set of scientific literature, with reliance on two primary information sources:

- **2014 National Climate Assessment**. In addition to providing information on climate change projections, the National Climate Assessment also provides a summary of the potential impacts of climate change on a wide range of resource areas.
- **Climate Change Impacts and Adaptation in Washington State**. In 2013 the University of Washington produced a summary State of the Knowledge report on the likely effects of climate change on Washington State (University of Washington 2013). The report provides technical summaries detailing observed and projected changes for Washington's climate, water resources, forests, species and ecosystems, coasts and ocean, infrastructure, agriculture, and human health. The report draws from major international, United States, and Pacific Northwest assessment reports.

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[9] CMIP5 is the fifth phase of the World Climate Research Programme's Coupled Model Intercomparison Project, which has established a standard set of simulations for coordinated climate experiments among international climate modeling groups. CMIP5 data are accessible over the internet and have been used in the Intergovernmental Panel on Climate Change's Fifth Assessment Report, an internationally vetted and authoritative report on global climate change. A list of the climate models can be found in Appendix 5 of the National Climate Change Viewer Tutorial (U.S. Geological Survey 2014b).

Impact Analysis

The following methods were used to evaluate the potential impacts of climate change on the Proposed Action.

For each potential climate change impact, this analysis determined how changes in climate could affect the Proposed Action or No-Action Alternative by comparing climate change projections against the following data.

- Historical records of relevant events or climate hazards.
- Current maps and risk or hazard indices (e.g., flood rate insurance maps, wildfire hazard maps).
- Established temperature or precipitation thresholds at which climate impacts are expected to become more severe.
- Information on engineering, design, and operational characteristics of the coal export terminal.

To evaluate how climate change may modify the impacts of the Proposed Action on the other resource areas, scientific literature on how climate change may impact resource areas (see key sources above) was coupled with information in the technical reports on the Proposed Action's impact on resource areas. Based on this information, a qualitative description of how climate change may exacerbate or alleviate the Proposed Action was developed.

5.8.2.4 Existing and Future Conditions

Temperatures have increased across the Pacific Northwest by 1.3 degrees Fahrenheit (°F) since 1895. Precipitation has increased but these increases are small and vary by location within the region. Under the changing climate, temperatures could rise by as much as 9.7°F by the end of the century. Future trends in average precipitation are uncertain and could increase or decrease, but summer precipitation is projected to decrease by as much as 30% by 2100.

The average snowpack over the Cascade Mountains has declined by about 20% since 1950. In the future, snowpack is expected to continue its downward trend, causing declines in snowmelt. Glaciers in the Cascades and Olympic Mountains are decreasing. According to Elsner et al. (2010), the snow water equivalent on April 1 could decline by almost half (46%) by the 2040s and virtually disappear by the 2080s, greatly reducing streamflow in some areas.

The incidence of extreme precipitation may have increased over time, but it has not yet been demonstrated to be statistically significant. It varies with location within the region. Under the changing climate in the Pacific Northwest, the number of days with daily rainfall greater than 1 inch could increase by 13% between 2041 and 2070.

Sea levels are rising but uplift of the land in parts of the Pacific Northwest mitigates possible impacts from sea-level rise. By contrast, areas around Puget Sound are subsiding and causing larger-than-average increases in sea levels. For the Pacific Northwest, sea-level rise is expected to be as little as 5 inches or less to greater than 4 feet by the end of the century. The impacts of the El Niño South Oscillation phenomenon on climate variability can be significant. During El Niño years, regional sea levels can increase by 4 to 12 inches and last for many months.

Climatic changes in precipitation could have far-reaching effects for the Pacific Northwest. Reduced summer rainfall and reductions in snowmelt could result in reduced streamflow. Increases in extreme precipitation could lead to increased flooding, especially in basins that derive their water from both rainfall and snowfall. Rising sea levels could also lead to flooding. Increasing temperatures and reduced precipitation could lead to an increase in wildfires, which are driven, in part, by water deficits. By the 2080s, the median area burned annually in the Pacific Northwest could quadruple compared to the 1916-to-2007 period (Mote et al. 2014).

Ocean acidification is the decrease of pH of ocean water over an extended period caused by the uptake of carbon dioxide from the atmosphere. This results in changes in seawater carbonate chemistry that can affect marine organisms such as shellfish. Biological impacts from ocean acidification are expected to vary but could be significant.

This section describes the historical and projected climate conditions in the study area that include changes in temperature, precipitation, and snowfall.

Historical and Projected Changes in Temperature

One of the most notable characteristics of climate change is the increase in temperatures over time.

Historical Temperatures

Washington State has a varied climate with significant differences in temperature and precipitation on the east and west sides of the Cascade Mountains. Temperatures across the Pacific Northwest have increased from 1895 to 2011 by 1.3°F (Mote et al. 2014). West of the Cascades, where the study area is located, the climate is characterized by mild temperatures and heavy annual precipitation. From 1950 to 2005, the highest monthly average temperatures in Cowlitz County were more than 75°F, cooler than Washington State as a whole (77.5°F) but warmer than the lower Columbia River Basin of which it is part (73.4°F). The highest monthly average temperature in Cowlitz County over this period was 77.2°F (August) (U.S. Geological Survey 2014a). In general, the lowest monthly average temperatures in Cowlitz County during winter were below 31.6°F from 1950 to 2005. The area has experienced a warming trend in the past 50 years; the annual average maximum temperatures have increased by 0.9°F (U.S. Geological Survey 2014a).

Projected Temperatures—Near-Term Future

In the near-term future (2025 to 2049), seasonal temperatures in the study area are projected to increase. In Cowlitz County, hot summer temperatures could rise by as much as 4.3°F in the high greenhouse gas emissions scenario from 2025 to 2049,[10] compared to baseline (U.S. Geological Survey 2014a). Cold winter temperatures are projected to increase by 2.4 to 3.0°F in moderate and high greenhouse gas emissions scenarios over this period.

Projected Temperatures—Midterm Future

The warming trend continues into the midterm future (2050 to 2075), when hot summer temperatures in Cowlitz County are projected to increase by 5.4 to 7.2°F. Coldest temperatures are expected to increase by as much as 5.2°F. These increases will likely bring the coldest temperatures near to or above the freezing point. While some models project higher or lower increases in temperature, all 30 models agree that temperatures will increase in Cowlitz County. Table 5.8-14 summarizes these historical and projected changes in temperature.

[10] Greenhouse gas scenarios are based on the flow of coal from mines through transport to export terminals, distribution to local and global markets, and combustion. Section 5.8.1, *Greenhouse Gas Emissions*, provides a discussion of these scenarios.

Table 5.8-14. Historical and Projected Changes in Temperature in Cowlitz County, Washington

Historical Climate and Observed Changes (1950–2005)	Near-Term Projected Changes (2025–2049 Compared to 1950–2005)	Midterm Projected Changes (2050–2075 Compared to 1950–2005)	Level of Certainty in Projections
The average monthly summer and winter temperatures (approximately 75°F and 32°F, respectively) reflect the moderate climate of the area.	Summer and winter temperature extremes are projected to increase.	Summer and winter temperature extremes are projected to increase.	There is excellent agreement across models on the direction of change.
Highest average monthly summer temperatures (top 10%, or 90th percentile) were above 75.0°F. Max monthly average temperature for August was 77.2°F.	90th percentile temperature is projected to increase by 3.8 to 4.3°F under moderate and high emissions scenarios.	90th percentile temperature is projected to increase by 5.4 to 7.2°F under moderate and high emissions scenarios.	Monthly average temperature is projected to increase in all months across all models compared to 1950–2005.
Lowest monthly average winter temperatures (10th percentile) were below 31.6°F.	10th percentile temperature is projected to increase by 2.4 to 3.0°F under moderate and high emissions scenarios.	10th percentile temperature is projected to increase by 4.0 to 5.2°F under moderate and high emissions.	Monthly average temperature is projected to increase in all months across all models compared to 1950–2005.

Historical and Projected Changes in Precipitation

Precipitation in the Pacific Northwest affects Columbia River water levels. The Columbia River is the fourth largest river in North America. It is influenced by multiple river basins from multiple states and British Columbia, Canada. The geographic and hydrologic characteristics of the river, which drains an approximately 259,000-square-mile basin, are suited to beneficial multipurpose storage development. Since the 1930s, numerous dams, both federal and private, have been built to store water for flood control, to generate hydroelectric power, and for other purposes. Total storage capacity of these dams is about 25% of the 156-million-acre-foot average annual runoff volume for the Columbia River at the mouth of the river at the Pacific Ocean. Federal projects in the basin have 19,900 megawatts of existing hydroelectric capacity, and non-federal projects add 10,700 megawatts (U.S. Army Corps of Engineers 2015).

The primary concerns about precipitation are whether there is enough precipitation (e.g., drought conditions), when it occurs (winter snowpack levels), and whether the precipitation is delivered in extreme events, which can cause significant damage.

Washington State defines drought as 75% of normal water conditions (Revised Code of Washington [RCW] 43.83B.400). In the past century, drought occurred from 1928 to 1932, 1992 to 1994, and 1996 to 1997, and most recently in 2015. Drought has caused shipping costs to rise, sometimes requiring wheat growers to move their product by rail or truck instead of barge transport. Washington State estimates that it will experience severe or extreme drought 5% of the time in the future and more frequently east of the Cascade Mountains (Washington State Emergency

Management Division 2012). The 2015 drought emergency affected all of Washington State (Washington State Department of Ecology 2015).

Extreme precipitation, especially during the winter, has frequently led to flooding events in the Pacific Northwest. Major flooding in western Washington in January 2009 closed Interstate 5, heavily damaged the Howard Hanson Dam, and put tens of thousands of people at risk. (Warner et al. 2012). A key driver of these precipitation events is the phenomenon of atmospheric rivers that form in the Pacific Ocean and move eastward toward the Pacific Northwest. In December 2015, an atmospheric river formed and made landfall along the Washington coast, resulting in approximately 16 inches of precipitation over 3 days across Oregon, Washington, and British Columbia. Although future trends in average precipitation are very uncertain and could increase or decrease, summer precipitation is projected to decrease significantly.

The incidence of extreme precipitation events may have increased over time, but it has not yet been demonstrated to be statistically significant. It varies with location within the region. Under the changing climate in the Pacific Northwest, the number of days with daily rainfall of more than 1 inch could increase by 13% from 2041 to 2070.

Historical Precipitation

According to the National Climate Assessment (Mote et al. 2014), the anticipated change in annual precipitation in the Pacific Northwest (2030 to 2059) ranges from decreases (-11%) to increases (+12%) for scenarios ranging from low to high greenhouse gas emissions (Intergovernmental Panel on Climate Change 2000). This variability makes the analysis of potential impacts problematic. Typically, average monthly precipitation is greatest in winter (December through February) and least in summer (June through August) (U.S. Geological Survey 2014a). From 1950 to 2005, precipitation in the lower Columbia River Basin averaged 0.40 inch per day in winter (U.S. Geological Survey 2014a) and about half that in spring (0.22 inch) and fall (0.25 inch). By contrast, only 0.07 inch per day fell during the summer months.

Projected Precipitation—Near-Term Future

In the near term, the model indicates slight increases in the winter, spring, and fall compared to the 1950 to 2005 average. The largest increase in precipitation is projected to occur in fall (4.1 to 2.1%) and winter (2.3 to 4.8%). Very little increase is projected for the spring (0 to 1%) (U.S. Geological Survey 2014a). By contrast, summers in the near-term future are projected to become drier by 10 to 12%, although some climate models disagree and instead project that summer precipitation will remain the same or increase (U.S. Geological Survey 2014a). Overall, model agreement on precipitation is not strong. For example, in some cases, 19 models project decreases in June precipitation and 11 indicate increases for the near-term future. Agreement for the month of August, however, was closer, with 26 models showing decreases and only four demonstrating increases.

Projected Precipitation—Midterm Future

Similar changes are projected to continue in the midterm future: the winter, spring, and fall seasons could become wetter, while summers could become drier. In the lower Columbia River Basin, winter and fall precipitation levels are projected to increase by 4.9 to 7.1% and 3.6 to 1.5%, respectively, while spring levels remain relatively constant (0 to 1.8% increase) in moderate and high greenhouse gas emissions scenarios compared to the 1950 to 2005 average. Extreme precipitation events could increase by 5.0 to 6.1% in the near-term future and 6.1 to 8.0% in the midterm future (U.S.

Geological Survey 2014a), but studies of past trends in observed changes in extreme precipitation have yielded ambiguous results (Mote et al. 2014). Model discrepancies are similar with most models showing increases and others showing decreases. Table 5.8-15Table 5.8-15 summarizes these historical and projected changes in precipitation.

Table 5.8-15. Historical and Projected Changes in Precipitation in the Lower Columbia River Basin

Historical Climate and Observed Changes (1950–2005)	Near-Term Projected Changes (2025–2049 Compared to 1950–2005)	Midterm Projected Changes (2050–2075 Compared to 1950–2005)	Level of Certainty in Projections
Average annual precipitation was 0.24 inch/day.	Wetter winter, spring, and fall seasons; possible drier summers.	Wetter winter, spring, and fall seasons; possible drier summers.	Some models show increases in precipitation while others show decreases. Incidence of extreme precipitation is more likely to increase.
The highest (90th percentile) monthly average precipitation was 0.43 inch/day.	Change in average precipitation by season under moderate and high emissions scenarios. Winter: +2 to 5% Spring: 0 to +1% Summer: -10 to -12% Fall: +4 to +2%	Change in average precipitation by under moderate and high emissions scenarios Winter: +5 to +7% Spring: +0 to +2% Summer: -10 to -16% Fall: +4 to +2%	A majority of models (18 to 26 of 30, depending on the scenario and timeframe) project that precipitation will decrease in the summer.
The lowest (10th percentile) monthly average precipitation was 0.06 inch/day.	Intensity of extreme precipitation could increase. 90th percentile precipitation is projected to increase by 5 to 6% under moderate and high emissions scenarios	Intensity of extreme precipitation could increase. 90th percentile precipitation is projected to increase by 6 to 8% under moderate and high emissions scenarios	Most models (20 of 30) project an increase in extreme precipitation.

Historical and Projected Changes in Snowpack

Melting snowpack from the Canadian Rockies and the Cascade Mountains provides much of the water flowing in the Columbia River. In contrast to the variable projections in overall precipitation, the anticipated changes in snowfall and snowpack are large and model agreement is very high. Significant projected declines in snowpack could greatly reduce stream flow in some areas.

Historical Snowfall

Average annual snowfall was 5.6 inches per month from 1950 to 2005. Average winter and spring snowfall, when virtually all snowfall occurs, was about 29.7 and 33.3 inches, respectively. However, since 1950, snowpack in the Pacific Northwest has declined by about 20%.

Projected Snowfall—Near-Term Future

Annual snowfall is expected to decline by 39 to 45% in the near-term future for the moderate and high greenhouse gas emissions scenarios. This substantial decrease is projected to occur within relatively narrow bands (winter: 33 to 40%; spring: 41 to 47%). All models indicate decreases in annual, winter, and spring snowfall (U.S. Geological Survey 2014a).

Projected Snowfall—Midterm Future

In the midterm future, declining snowfall is expected to intensify. Winter snowfall could decline by as much as 62% (ranging from 49 to 62% under the moderate and high emissions scenarios); spring snowfall could decrease by as much as 75% under the moderate emissions scenario and 68% under the high emissions scenario. All models agree that snowfall will decline over time. Table 5.8-16 summarizes these historical and projected changes in snowfall.

Table 5.8-16. Historical and Projected Changes in Snow in the Lower Columbia River Basin

Historical Climate and Observed Changes (1950–2005)	Near-Term Projected Changes (2025–2049 Compared to 1950–2005)	Midterm Projected Changes (2050–2075 Compared to 1950–2005)	Level of Certainty in Projections
Heaviest snowfall occurs in the winter and spring leading to high average annual snowfall totals	Average annual, winter, and spring snowfall will likely decline under the moderate and high emissions scenarios in the near term	Average annual, winter and spring snowfall will likely decline under the moderate and high emissions scenarios in the mid-term	All models agree on the direction of change
Average annual snowfall was 5.6 inches/month	Change in average monthly snowfall could decline by 39 to 45%	Change in average monthly snowfall could decline by 54 to 66%	All models agree on the direction of the change
Average winter and spring snowfall was 29.7 and 33.3 inches, respectively	Change in average winter and spring snowfall under moderate and high emissions scenarios • Winter: -33 to -40% • Spring: -41 to -47%	Change in average winter and spring snowfall under moderate and high emissions scenarios • Winter: -49 to -62% • Spring: -75 to -68%	All models agree that snowfall will decline in the winter and spring in near– and midterms

Sea-Level Rise

Sea levels are rising. However, some areas of the Pacific Northwest are experiencing uplift; by contrast, areas around Puget Sound are subsiding and experiencing larger-than-average impacts from rising sea levels. Sea-level rise along shorelines in the Pacific Northwest is expected to be as little as 5 inches or less to more than 4 feet by the end of the century. The impacts of the El Niño Southern Oscillation phenomenon on climate variability can be significant. During El Niño years, regional sea levels can increase by 4 to 12 inches and last for many months.

5.8.2.5 Impacts

This section describes the potential impacts related to climate change that could (1) affect construction and operation of the Proposed Action or No-Action Alternative in the study area (e.g., low water levels affecting ship movement) and (2) exacerbate or alleviate impacts to the surrounding area from the Proposed Action's construction and operations (e.g., warming temperatures will drive secondary aerosol formation, which when coupled with increased fossil fuel combustion from Proposed Action equipment use, will create greater air pollutant concentrations).

Proposed Action

This section describes the potential impacts of climate change on the construction and operation of the Proposed Action that could occur within the study area.

Cause Possible Service Disruptions from Low Water Levels

Changes to precipitation could have far-reaching effects for the Pacific Northwest. Reduced summer rainfall and reductions in snowmelt will probably result in reduced stream flow. This trend could cause tradeoffs among the many water uses, including transport, agriculture, recreation, and others. Decreased snowfall in the Lower Columbia River Basin, especially in the winter and spring, coupled with potential declines in rainfall in the summer could lead to abnormally low levels of water in the Columbia River. Low water levels could impede the passage of large ships to and from the docks at the project area.

Proposed Action-related Panamax ships would berth at two docks (Docks 2 and 3) to receive coal shipments. Panamax ships are midsized cargo ships, the largest that could fit through the Panama Canal prior to expansion. They have a capacity of 60,000- to 100,000-deadweight tonnage and require a draft of 42 to 49 feet. The depth of the Columbia River at the project area varies by season. If precipitation from snow and rain cause Columbia River water levels to decline, shipping could be restricted or more dredging could be required more frequently.

The Columbia River at the project area experiences tidal fluctuation, although less than at the mouth of the river. Tidal forces could replace some or all of the water needed for ship passage in the event of low runoff from reduced snowmelt and rainfall. The potential for low water disruptions could also be reduced by future sea-level rise. However, because the project area is approximately 50 miles inland from the Columbia River estuary and protected by levees, the impact of sea-level rise at the project area is expected to be minimal. The Columbia River is also highly managed to provide water for multiple competing uses. For example, low water levels upstream of the project area have constrained recreational boating at times.

Cause Possible Damage and Service Disruptions from Flooding

Potential precipitation increases and intense downpours could cause flooding in basins that derive their water from both rainfall and snowfall, such as the Cowlitz River or Columbia River. Rising sea levels could also lead to flooding of public and private property, roads, and railways.

Water levels in the Columbia River vary by season and year, depending on the snow mass in the upper watershed. Historic crests on the Columbia River range from 13 to 24 feet with flood stage at 13.5 feet. Historic crests on the Cowlitz River range from 21 to 29.5 feet and have been recorded well above flood stage (21 feet). Above 28.5 feet, major flooding is expected. This flood stage could overtop the levee and increase erosion (ICF 2017). The project area is on the Columbia River, about 5 miles from the confluence of the Columbia and Cowlitz Rivers (ICF 2017). The study area is protected from flooding by a levee maintained by the Consolidated Diking Improvement District (CDID) #1, which is 34 feet above the Columbia River Datum. It is also protected by a system of sloughs, ditches, and drains. The Federal Emergency Management Agency classifies the project area as Zone B in its Flood Insurance Rate Map, meaning the area has a 0.2% chance of flooding in any given year.

Under current conditions, flooding is expected to be minimal at the project area (ICF 2017). In the future, flooding could be of concern, particularly from the Cowlitz River. In August 2014, the U.S. Army Corps of Engineers found that sediment buildup on the Cowlitz River was increasing the potential for flooding. Without further action, the flood risk level on the river (0.6%) would be exceeded by 2018 (U.S. Army Corps of Engineers 2014). While future precipitation is somewhat uncertain, the mean model indicates increases in fall and winter precipitation for both the near and midterm futures, which could increase flood risk. Because the project area is approximately 50 miles inland from the Columbia River estuary, the main impact of sea-level rise at the project area is expected to be minimal, but sea-level rise could exacerbate the potential for flooding at discrete locations.

Additionally, wetlands provide an important buffer for absorbing increased runoff and river overflow during severe precipitation events. The project area currently includes almost 27 acres of natural wetland habitat. Under the Proposed Action, 24.10 acres would be permanently filled. The loss of these wetlands would cause a reduction in flood mitigation and stormwater treatment capacity.

The BNSF Spur and Reynolds Lead that would carry Proposed Action-related trains to the project area could be subjected to flooding. The rail line crosses the Cowlitz River near the confluence with the Columbia River and runs near the rivers for the 5 miles to the project area. Because historical and recent crests have been reported on the Cowlitz River, flood risk from sedimentation is increasing, and future precipitation could increase, flooding of the Reynolds Lead is possible. Cowlitz River flooding at this location would likely disrupt rail and terminal operations, and ballast supporting the rail line could be dislodged. Therefore, Proposed Action-related trains could be affected by a Cowlitz River flood.

Cause Possible Service Disruptions from Wildfires

Wildfire is a threat in Washington State. Cowlitz County is considered a high-risk area (Washington State Emergency Planning Division 2012c). A wildfire could affect the project area from the undeveloped areas adjacent to the project area or a Proposed Action-related train in the study area. Wildfires in Cowlitz County numbered more than 350 from 2004 to 2013, burning more than 561 acres. In late summer and early fall, dry easterly winds can produce extreme fire conditions. This threat has increased over time because of four climate-related factors: earlier snowmelt, higher summer temperatures, longer fire season, and an expanded vulnerable area of high-elevation forests (Washington State Emergency Planning Division 2012c). Increasing temperatures, extreme heat events, and drought could have an effect on fire regimes in Washington State by influencing the length of the fire season and contributing to drier conditions and the availability of readily combustible fuel for fires (Mote et al. 2014). By the 2080s, the median area burned annually in the Pacific Northwest could quadruple compared to the 1916 to 2007 period (Mote et al. 2014).

Maximum temperatures are predicted to increase while summer precipitation is predicted to decrease in the study area, although there is some disagreement among the models, and some indicate that summers could become slightly wetter. Hotter and drier summers would increase the likelihood of wildfires.

The impacts from construction and operations of the Proposed Action could be compounded by climate change. The following subsections qualitatively examine climate change effects on other resource areas to determine instances where the environment could be modified by the effects of climate change.

Potential for Increased Risk of Strain on Fire Protection Services

As described in Chapter 3, Section 3.2, *Social and Community Resources*, construction and operation of the Proposed Action would place new demand on Cowlitz Fire & Rescue protection services. This demand could be compounded by the increasing risk of wildfires from warmer, drier conditions induced by climate change (University of Washington 2013). These conditions are specifically due to projected increases in global and regional average temperatures and reductions in summer precipitation volumes. However, fire risk in the project area would be addressed because the Applicant would be required to install fire and life safety systems in the project area according to fire code standards. These systems would be regularly inspected and maintained. The Applicant would also maintain a surface water storage pond with a reserve of 0.36 million gallons for fire suppression.

Potential for Increased Risk of Flooding to Cultural Resources

Potential climate change impacts associated with construction and operations of the Proposed Action could affect the CDID #1 levee, which is historically significant.

Climate change is expected to increase the frequency of heavy rainfall events throughout the Pacific Northwest, where the number of days with precipitation greater than 1 inch is expected to increase 13% by 2050 (University of Washington 2013). The Proposed Action would fill existing wetlands with impervious surfaces, reducing the area's natural capacity to control stormwater. The combination of projected increases in heavy precipitation events and the expansion of impervious surfaces has the potential to increase the amount of stormwater generated which would be collected, treated, stored, or discharged to the Columbia River. The Proposed Action would construct a new on-site stormwater capture and treatment system. The Applicant would operate the terminal under a National Pollutant Discharge Elimination System (NPDES) Industrial Stormwater Permit that would need to be issued for the Proposed Action. The NPDES permit would outline specific terms and conditions, and would be required to adhere to the terms and conditions of that permit, which would reduce the risk of impacts from climate change affecting the proposed export terminal, the Columbia River, or the CDID #1 levee.

Potential for Increased Risk of Erosion and Landslides

Climate change could affect geology and soils. For example, increases in the frequency of heavy precipitation events could result in high river flows and flooding and generate greater risks for riverside erosion and landslides. Sea-level rise could also increase the likelihood for flooding and erosion in the project area since the location is a tidally influenced segment of the river. However, the project area is within a federally designated diking district. Warming temperatures that create greater rainfall in place of typical snowfall upstream could alter the timing of seasonal flow conditions, such as the timing of spring high-flow events or summer low-flow periods (University of Washington 2013). Decreased rainfall in the spring and summer may increase the likelihood of wind-driven erosion of soils, due to changes in soil moisture content (U.S. Global Change Research Program 2014).

As described in Chapter 4, Section 4.1, *Geology and Soils*, the topography in the project area is relatively flat, minimizing the risk of landslides. While soils along the river have a high to moderate capacity for erosion, there is a slight risk for erosion on-site due to protective shoreline armoring, and the combination of a levee with a flat gradient. After construction is complete, the project area would be approximately 90% impervious surfaces, essentially eliminating any risk of erosion within the project area. The project area is near an active deep-seated landslide on the south flank of Mount Solo, but is more than 50 feet from its edge, which is the minimum distance required by the Cowlitz County Critical Areas Ordinance for landslide hazards. While periods of prolonged and intense rainfall (including multiyear periods) could activate this landslide, the extent to which climate change could potentially affect any shift in the landslide in terms of distances traveled or shifts in the leading edge of the landslide toward the project area cannot be predicted.

Potential for Increased Risk of Negative Water Quality Impacts

Climate change-induced impacts to local water quality from the Proposed Action would be associated with increased precipitation, combined with a decrease in local wetlands. Surface and groundwater resources could be affected by intense and sustained precipitation events that could overwhelm the stormwater facilities and inadvertently discharge untreated stormwater that could carry pollutants and debris, including coal dust, from the project area. Pollution that entered these local resources could degrade local water quality, which could affect aquatic and terrestrial species and aquatic habitats.

With reduced wetlands to capture and filter stormwater flows, and coal terminal operations producing potential contaminants, surface and groundwater resources could be vulnerable to greater pollution during flood events or periods of sustained precipitation. If not treated, polluted stormwater runoff could seep into the groundwater or discharge to surface waters and degrade water quality. However, the local soils have low permeability for both shallow and deep aquifers, which reduces the risk of polluted water reaching the groundwater table, as described in Chapter 4, Section 4.4, *Groundwater*. Further, stormwater generated within the project area would be collected, treated, and either stored on-site for re-use or discharged to the Columbia River. Stormwater discharged to the Columbia River would be treated to meet the NPDES permit requirements. The Applicant would be required to update the NPDES discharge permit every 5 years which would address future changes in stormwater and discharges.

Potential for Increased Risk of Invasive or Noxious Weed Proliferation

As described in Chapter 4, Section 4.6, *Vegetation*, construction of the Proposed Action would remove over 26 acres of non-wetland vegetation. Operations of the Proposed Action could result in the introduction of invasive or noxious weeds from trains or vessels calling to the project area, which could increase the risk of impacts to native vegetation in and directly adjacent to the project area. Further, climate change could result in conditions favorable to the growth of unwanted invasive or noxious weeds, which are adapted to the changing climate and may be well suited to colonizing highly disturbed areas.

Climate change can support the colonization of invasive species or noxious weeds, where changes in local conditions, such as variations in precipitation events and/or temperature, are more suitable to nonnative plants, which may have a greater adaptive capacity (Bradley et al. 2010). This combination of climate change and Proposed Action impacts could threaten native vegetation populations in and near the project area. However, even if climate change compounds the colonization of invasive species or noxious weeds, the Applicant would monitor for noxious weeds on disturbed land during construction and operations, which would limit the potential for noxious weeds to colonize the project area and disturbed areas adjacent to the project area. In addition, the Applicant would be required to prevent the potential establishment and spread of noxious weeds per Washington State noxious weed regulations (RCW 17.10).

Potential for Increased Strain on Fish Populations and Tribal Resources

As described in Chapter 4, Section 4.7, *Fish,* local fish populations are dependent on a sustained level of water quality, specific temperatures, specific habitat, and other environmental conditions, which may be at risk as climate change impacts are coupled with changes resulting from the Proposed Action. As described in Chapter 3, Section 3.5, *Tribal Resources*, tribal resources are also centered on local fish populations and the habitats that sustain them. Stress from the Proposed Action to fish populations, particularly salmonids, could be also be compounded by warming freshwater temperatures, and downstream ocean acidification effects that reduce salmonid prey, and could hinder growth and survival of native fish populations (University of Washington 2015).

Potential for Increased Risk of Wildlife Habitat Disruption and Population Strain

As described in Chapter 4, Section 4.8, *Wildlife*, the Proposed Action could disrupt local wildlife habitats during operations, which could be compounded by stressors to wildlife populations from climate change. Wildlife includes common species of birds, rodents, mammals, amphibians, reptiles, and invertebrates. Climate change could promote the proliferation of invasive wildlife species that have a higher adaptive capacity in Washington State and the Columbia River (University of Washington 2013).

Construction activities would alter or permanently remove 59 acres of aquatic habitat, and permanently remove 24.10 acres of wetland and 26.26 acres of upland terrestrial habitats. These impacts could disrupt normal wildlife behavior patterns. Climate change could further alter habitat conditions and wildlife species' life-cycle events through changes in seasonal weather patterns (i.e., changes in seasonal air and water temperatures, seasonal precipitation patterns) (U.S. Global Change Research Program 2014). Combined Proposed Action and potential climate change impacts may threaten native wildlife populations while promoting climatic shifts in weather and subsequent changes in habitat conditions that provide more suitable conditions to the proliferation of invasive species, which could have a greater capacity for adapting to these changed and variable conditions.

Potential for Increased Strain on Energy and Natural Resources

As described in Chapter 4, Section 4.9, *Energy and Natural Resources*, the coal export terminal would consume 6,624,000 kilowatt hours annually during operations, which represents an average of 4% of Cowlitz Public Utility District's (PUD's) electricity demand. Cowlitz PUD currently sources 82.5% of electricity from hydropower sources (Cowlitz Public Utility District 2016). Climate change is projected to intensify summer droughts in the Northwest through longer dry periods and increasing temperatures (U.S. Global Change Research Program 2014), which will reduce summer streamflows and limit the output of hydropower facilities (Seattle City Light 2015). Climate change will also reduce snowpack upstream of hydropower facilities and the project area due to higher average temperatures, creating greater risks for surface water shortages and reduced summer flows (University of Washington 2013).

Washington State depends heavily on hydropower for electricity. Approximately 75% of its electricity comes from hydropower generated by its systems of rivers and dams. The rivers also supply water for irrigation, municipalities, and industry. Drought-induced loss of hydropower could raise costs. As the supply of locally generated hydropower is reduced, utilities must seek additional sources of electricity, which could drive up electricity prices for construction and operation of the Proposed Action (Washington State Emergency Management Division 2012). As described in Chapter 4, Sections 4.2, *Surface Water and Floodplains,* and 4.4, *Groundwater*, the Proposed Action would increase on-site water demands. Total annual consumption of water is estimated at 3,387 acre-feet, where 89% would be sourced from existing groundwater wells and 11% from stormwater reuse facilities on-site; there would be no need for new wells. The existing groundwater wells draw from a deep aquifer with low permeability, reducing the capacity for natural recharge.

Climate change could induce longer, drier summers, which coupled with a decreasing snowpack may reduce river water levels during droughts, forcing local services to rely more on groundwater resources. Historically, the low permeability of the local aquifers and unaffected recharge from the Columbia River would make any groundwater recharge impacts from the Proposed Action negligible; however, the projected increase in the frequency and severity of droughts due to climate change could affect groundwater recharge. If groundwater recharge were to diminish due to an increase in the frequency and severity of droughts, any subsequent increased reliance on groundwater during times of drought could create greater risks for overdraft conditions, where groundwater is being withdrawn faster than it can be recharged. However, Proposed Action operations would withdraw groundwater under a state-approved water right which would avoid or limit such an impact from occurring. If climate change were to affect groundwater supply in the project area, the water rights adjudication process would likely address this issue. The adjudication process is key to resolving and preventing water conflicts of increasing water demands and water supply impacts of climate change.

Potential to Exacerbate Air Quality Impacts

As described in Section 5.6, *Air Quality*, air quality impacts reflect air pollutant emissions from the Proposed Action. Recent research has shown secondary aerosols are primarily driven by increasing temperatures and humidity (Hessberg et al. 2009). With rising average temperatures due to climate change, secondary organic aerosol formation could be accelerated. Secondary aerosols generate particulate matter concentrations from volatile organic compounds (VOCs).

During Proposed Action operations, increased VOC emissions will come from fossil fuel combustion due to equipment and vehicle use on-site. Warming temperatures from climate change could drive secondary aerosol formation, and when combined with greater local VOC emissions, could create increased air quality risks within and near the project area. Higher temperatures can also lead to increased ground level ozone formation, where VOCs and nitrous oxide emissions from equipment and vehicle use are precursors to this reaction (Union of Concerned Scientists 2011).

Prolonged summer droughts from climate change could create risks for wind erosion, which are a source of particulate matter. These droughts can also create greater risks of regional wildfires, which can affect air quality in the surrounding area through spiked particulate matter emissions. Drought effects may compound the air quality impacts associated with greater fossil fuel combustion from operations.

No-Action Alternative

Under the No-Action Alternative, the Applicant would not construct the coal export terminal and potential climate change impacts related to construction and operation of the Proposed Action would not occur. The Applicant would continue with current and future increased operations in the project area. The project area could be developed for other industrial uses, including an expanded bulk product terminal or other industrial uses. The Applicant has indicated that, over the long term, it would expand the existing bulk product terminal and develop new facilities to handle more products such as calcine petroleum coke, coal tar pitch, and cement.

Ongoing and expanded operations in the project area would be affected by climate change as described for the Proposed Action. These impacts could include possible service disruptions from low water levels, flooding, and wildfires, as well as impacts to local resource areas.

5.8.2.6 Required Permits

No permits related to climate change would be required for the Proposed Action.

5.8.2.7 Proposed Mitigation Measures

Potential impacts on the Proposed Action project area from changes in climate, such as increased flooding or changes in precipitation are not considered significant and would not necessitate mitigation.[11] Proposed mitigation related to greenhouse gas emissions resulting from the Proposed Action are discussed in Section 5.8.1.8, *Proposed Mitigation Measures*.

5.8.2.8 Unavoidable and Significant Adverse Environmental Impacts

There would be no unavoidable and significant adverse environmental impacts on the Proposed Action project area from climate change.

[11] See Section 5.8.1.8, *Proposed Mitigation Measures*, for proposed mitigation measures to reduce impacts from greenhouse gas emissions attributable to the Proposed Action.