February 2020

Proposed Chehalis River Basin Flood Damage Reduction Project

SEPA Draft Environmental Impact Statement

Appendix A
Air Quality and Greenhouse Gas Discipline Report

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DEPARTMENT OF ECOLOGY
State of Washington

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About this Document

This discipline report has been prepared as part of the Washington Department of Ecology's (Ecology's) State Environmental Policy Act (SEPA) Environmental Impact Statement (EIS) to evaluate a proposal from the Chehalis River Basin Flood Control Zone District (Applicant).

Proposed Action

The Applicant seeks to construct a new flood retention facility and temporary reservoir near Pe Ell, Washington, and make changes to the Chehalis-Centralia Airport levee in Chehalis, Washington. The purpose of the Applicant's proposal is to reduce flooding originating in the Willapa Hills and improve levee integrity at the Chehalis-Centralia Airport to reduce flood damage in the Chehalis-Centralia area.

Time Frames for Evaluation

If permitted, the Applicant expects Flood Retention Expandable (FRE) facility construction would begin in 2025 and operations in 2030, and the Airport Levee Changes construction would occur over a 1-year period between 2025 and 2030. The EIS analyzes probable impacts from the Proposed Action and alternatives for construction during the years 2025 to 2030 and for operations from 2030 to 2080. For purposes of analysis, the term "mid-century" applies to the operational period from approximately 2030 to 2060. The term "late-century" applies to the operational period from approximately 2060 to 2080.

Scenarios Evaluated in the Discipline Report

This report analyzes probable significant environmental impacts from the Proposed Action, the Local Actions Alternative, and the No Action Alternative under the following three flooding scenarios (flow rate is measured at the Grand Mound gage):

- **Major flood:** Water flow rate of 38,800 cubic feet per second (cfs) or greater
- **Catastrophic flood:** Water flow rate of 75,100 cfs
- **Recurring flood:** A major flood or greater that occurs in each of 3 consecutive years

The general area of analysis includes the area in the vicinity of the FRE facility and temporary reservoir; the area in the vicinity of the Airport Levee Changes; and downstream areas of the Chehalis River to approximately river mile 9, just west of Montesano.

Local Actions Alternative

The Local Actions Alternative represents a local and nonstructural approach to reduce flood damage in the Chehalis-Centralia area. It considers a variety of local-scale actions that approximate the Applicant's purpose through improving floodplain function, land use management actions, buying out at-risk properties or structures, improving flood emergency response actions, and increasing water storage from Pe Ell to Centralia. No flood retention facility or Airport Levee Changes would be constructed.

No Action

Under the No Action Alternative, no flood retention facility or Airport Levee Changes would be constructed. Basin-wide large and small scale efforts would continue as part of the Chehalis Basin Strategy work, and local flood damage reduction efforts would continue based on local planning and regulatory actions.

SUMMARY

This report describes the air quality conditions in the study area. It also describes the potential impacts and mitigation for the Proposed Action, Local Actions Alternative, and No Action Alternative.

The study area is located in the southern extent of the Puget Lowland region. Air quality is generally good in the study area during most of the year although air pollution does occasionally reach moderately unhealthy levels, typically during strong temperature inversions in late fall and winter. Air quality in the study area is regulated and enforced by federal, state, and local agencies—the U.S. Environmental Protection Agency (EPA), Ecology, and the Southwest Clean Air Agency (SWCAA); each has its own role in regulating air quality.

The analysis evaluated emissions from construction of the Proposed Action and operation of the Flood Retention Expandable (FRE) facility. Air emissions were estimated for regulated criteria air pollutants, greenhouse gases (GHGs), and diesel particulate matter (DPM, a toxic air pollutant). The results of the analysis indicate that changes in air quality conditions would be present during the construction and operation of the Proposed Action. The largest changes would occur during construction in areas near the FRE facility and airport levee.

Construction and operation impacts of the Proposed Action and alternatives are summarized in Tables A-1 and A-2.

Table A-1
Summary of Air Quality and Greenhouse Gas Impacts from the Proposed Action

IMPACT	IMPACT FINDING	MITIGATION PROPOSED (SUMMARIZED, SEE SECTION 3.2.4)	SIGNIFICANT AND UNAVOIDABLE ADVERSE IMPACT
PROPOSED ACTION (FRE FACILITY AND AIRPORT LEVEE CHANGES) – CONSTRUCTION			
Total GHG emissions for the FRE facility during the 5-year construction period would be 106,890 metric tons/year. Total GHG emissions for the levee construction during the 1-year construction period would be 1,849 metric tons/year. Combined GHG emissions from construction and operation would be 123,439 metric tons.	**Significant**	**AIR-1:** Prepare a GHG Mitigation Plan to reduce 100% of emissions from construction and operation. **AIR-2:** Ensure timber removed from the temporary reservoir area will be used and not burned; for example, in restoration projects. **AIR-3:** Implement an anti-idling policy for equipment and vehicles.	No

IMPACT	IMPACT FINDING	MITIGATION PROPOSED (SUMMARIZED, SEE SECTION 3.2.4)	SIGNIFICANT AND UNAVOIDABLE ADVERSE IMPACT
Carbon monoxide emissions if trees removed are burned.	Moderate	**AIR-2:** Ensure timber removed from the temporary reservoir area will be used and not burned; for example, in restoration projects.	No
Air pollutants and ozone associated with construction at the FRE facility would be below thresholds.	Minor	**AIR-3:** Implement an anti-idling policy for equipment and vehicles.	No
Residential receptors at the RV park and along NW Airport Road near the levee are predicted to experience increased cancer risks of less than 10 in 1 million.	Minor	**AIR-3:** Implement an anti-idling policy for equipment and vehicles.	No
Construction activities would release DPM; however, they would be beyond the 1,000-foot zone of influence for health risks associated with DPM.	Minor	**AIR-3:** Implement an anti-idling policy for equipment and vehicles.	No
PROPOSED ACTION (FRE FACILITY AND AIRPORT LEVEE CHANGES) – OPERATIONS			
GHG emissions related to the FRE facility operations would be 294 metric tons per year and negligible for levee operation. Combined GHG emissions from construction and operation would be 123,439 metric tons.	**Significant** for combined construction and operation emissions	**AIR-1:** Prepare a GHG Mitigation Plan to reduce 100% of emissions from construction and operation.	No
Particulate emissions from dust in the temporary reservoir area after a flood when vegetation is being replanted would be less than the 100-tons-per-year threshold.	Minor	No	No
The levee operation emissions of air pollutants would be negligible.	Minor	No	No
Methane emissions would not likely occur from FRE operations.	No impact	No	No

Table A-2

Summary of Air Quality and Greenhouse Gas Impacts from Alternatives

IMPACT	IMPACT FINDING
LOCAL ACTIONS ALTERNATIVE	
Negligible air pollutants and GHG emissions are expected during construction.	Minor
Additional air pollutants or GHG emissions are not likely during operation.	No Impact
NO ACTION ALTERNATIVE	
Negligible air pollutants and GHG emissions are expected from No Action.	Minor
Additional air pollutants or GHG emissions are not likely from No Action.	No Impact

TABLE OF CONTENTS

ABOUT THIS DOCUMENT .... A-i

SUMMARY .... A-ii

1 INTRODUCTION A-1

1.1 Resource Description A-1

1.2 Regulatory Context A-1

2 METHODOLOGY A-6

2.1 Study Area A-6

2.2 Affected Environment A-6

2.3 Studies and Reports Referenced/Used A-13

2.4 Technical Approach A-17

2.5 Impact Analysis A-18

3 TECHNICAL ANALYSIS AND RESULTS A-19

3.1 Overview A-19

3.2 Proposed Action A-19

3.3 Local Actions Alternative A-31

3.4 No Action Alternative A-32

4 REFERENCES A-33

LIST OF TABLES

Table A-1 Summary of Air Quality and Greenhouse Gas Impacts from the Proposed Action ....A-ii

Table A-2 Summary of Air Quality and Greenhouse Gas Impacts from Alternatives ....A-iv

Table A-3 Regulations, Statutes, and Guidelines for Air Quality and Greenhouse Gases A-2

Table A-4 Federal and State Ambient Air Quality Standards A-4

Table A-5 Estimated Criteria Pollutant and Ozone Precursor Emissions from Construction of the FRE Facility A-22

Table A-6 Estimated Maximum Annual Greenhouse Gas Emissions from Construction of the FRE Facility A-24

Table A-7 Estimated Emissions of Criteria Pollutants and Precursors of Concern for Construction of Airport Levee Changes A-25

Table A-8 Maximum Increase in Health Risk at Nearby Receptors from Levee Construction Activities A-26
Table A-9 Estimated Greenhouse Gas Emissions from Construction of the Airport Levee Changes..... A-27

LIST OF FIGURES

Figure A-1 Air Quality Study Area A-7
Figure A-2 Sensitive Receptors Near FRE Facility A-15
Figure A-3 Sensitive Receptors Near Airport Levee Changes A-16

LIST OF ATTACHMENTS

Attachment A-1 Air Quality and Greenhouse Gas Emissions Calculations

A-1.1: FRE and Levee Calculations

A-1.2: Quarrying and Blasting Calculations

A-1.3: Levee Health Risk Assessment Methodology

1 INTRODUCTION

1.1 Resource Description

The *Air Quality and Greenhouse Gas Discipline Report* addresses criteria air pollutant, toxic air pollutant, and greenhouse gas (GHG) emissions impacts associated with the Proposed Action as well as for the No Action Alternative and Local Actions Alternative.

Air quality refers to the condition of the breathable air with respect to the presence of pollutants identified by the U.S. Environmental Protection Agency (EPA) and Washington Department of Ecology (Ecology) as pervasive in urban environments, and for which state and federal health-based ambient air quality standards have been established. Air quality may be further divided into localized pollutant concentrations that may affect a small area from one or more nearby sources, and regional pollutants, such as ozone, which generally are not directly emitted to the atmosphere but form from regional emissions such as automobile exhaust.

Gases that trap heat in the atmosphere are referred to as GHGs because they capture heat radiated from the sun as it is reflected back into the atmosphere, much like a greenhouse does. The accumulation of GHGs contributes to global climate change. GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), perfluorocarbons, and hydrofluorocarbons.

Air quality in Southwestern Washington is regulated and enforced by federal, state, and local agencies—the EPA, Ecology, and Southwest Clean Air Agency (SWCAA); each has its own role in regulating air quality.

1.2 Regulatory Context

Table A-3 identifies the laws, plans, and policies relevant to the evaluation of air quality and GHGs in the study area.

Table A-3
Regulations, Statutes, and Guidelines for Air Quality and Greenhouse Gases

REGULATION, STATUTE, GUIDELINE	DESCRIPTION
FEDERAL	
Clean Air Act Amendments	Enacted in 1970, as amended in 1977 and 1990, requires EPA to develop and enforce regulations to protect the public from air pollutants and their health impacts.
National Ambient Air Quality Standards (NAAQS)	Specifies the maximum acceptable ambient concentrations for seven criteria air pollutants: carbon monoxide (CO), ozone, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), lead, and particulate matter ($PM_{2.5}$ and PM_{10}); primary NAAQS set limits to protect public health, and secondary NAAQS set limits to protect public welfare; geographic areas where concentrations of a given criteria pollutant violate the NAAQS are classified as nonattainment areas for that pollutant.
STATE	
Washington State General Regulations for Air Pollution Sources (Washington Administrative Code [WAC] 173-400) and Washington State Clean Air Act (Revised Code of Washington [RCW] 70.94)	Establishes the rules and procedures to control or prevent the emissions of air pollutants; provides the regulatory authority to control emissions from stationary sources, reporting requirements, emissions standards, permitting programs, and the control of air toxic emissions.
Washington State Ambient Air Quality Standards (WAC 173-476)	Establishes maximum acceptable levels in the ambient air for particulate matter, lead, SO_2, NO_2, ozone, and CO; Washington adopts current federal NAAQS in state regulations.
Washington State Operating Permit Regulation (WAC 173-401)	Establishes the systematic control of new or modified sources emitting toxic air pollution to prevent air pollution, reduce emissions, and maintain air quality that will protect human health and safety.
Washington State Controls for New Sources of Toxic Air Pollutants (WAC 173-460)	Establishes controls for new and modified sources of toxic air pollutants.
Limiting Greenhouse Gas Emissions (RCW 70.235)	Requires state to reduce overall GHG emissions as compared to a 1990 baseline and report emissions to the governor biannually.
LOCAL	
SWCAA Regulation 400	Regulates stationary sources of air pollution in Clark, Cowlitz, Lewis, Skamania, and Wahkiakum counties.

1.2.1 U.S. Environmental Protection Agency

The 1970 Clean Air Act and subsequent amendments specify regulations for control of the nation's air quality. Following the requirements of the Clean Air Act, EPA sets the criteria for National Ambient Air Quality Standards (NAAQS) and conformity requirements. These ambient air quality standards are intended to protect public health and welfare, and they specify the concentrations of pollutants (with an adequate margin of safety) to which the public can be exposed without adverse health effects. They are designed to protect those segments of the public most susceptible to respiratory distress, including people with asthma, chronic obstructive pulmonary disease (COPD), or other lung diseases, as well as very young people, elderly people, and people engaged in strenuous work or exercise. Most healthy adults can tolerate occasional exposure to air pollution levels that are somewhat above ambient air quality standards without suffering adverse health effects.

As required by the 1970 Clean Air Act, the EPA initially identified six criteria air pollutants that are pervasive in urban environments and for which state and federal health-based ambient air quality standards have been established. Ozone, carbon monoxide (CO), particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead are the six criteria air pollutants originally identified by the EPA. Since then, subsets of PM have been identified for which permissible levels have been established. These include PM_{10} (matter less than or equal to 10 microns in diameter) and $PM_{2.5}$ (matter less than or equal to 2.5 microns in diameter).

Areas of the United States that do not meet the NAAQS for any one or more of the criteria pollutants are designated by the EPA as nonattainment areas. Areas that were once designated nonattainment but are now achieving the NAAQS are termed maintenance areas. Areas that have air pollution levels below the NAAQS are termed attainment areas. In nonattainment areas, states must develop plans to reduce emissions and bring the area back into attainment of the NAAQS.

The NAAQS for these criteria pollutants are separated into two standard categories: the primary and the secondary standards (40 Code of Federal Regulations [CFR] Part 50). The primary standards were created to protect public health; the secondary pollutant standards were established to protect public welfare and the environment.

Table A-4 identifies the primary and secondary NAAQS for the six criteria pollutants for federal and Washington State law.

Table A-4
Federal and State Ambient Air Quality Standards

POLLUTANT	AVERAGING TIME	PRIMARY STANDARD	SECONDARY STANDARD
Ozone	8 hour	0.070 ppm[a]	0.070 ppm
Carbon monoxide (CO)	1 hour	35 ppm	No applicable standard
	8 hour	9 ppm	No applicable standard
Nitrogen dioxide (NO_2)	1 hour	0.100 ppm	No applicable standard
	Annual	0.053 ppm	0.053 ppm
Sulfur dioxide (SO_2)	1 hour	0.075 ppm	No applicable standard
	3 hour	0.5 ppm for state, no applicable standard for federal	0.5 ppm
	Annual	0.02 ppm for state, no applicable standard for federal	No applicable standard
	24 hour	0.14 ppm for state, no applicable standard for federal[b]	No applicable standard
Particulate matter (PM_{10})	24 hour	150 µg/m3[c]	150 µg/m3
Fine particulate matter ($PM_{2.5}$)	24 hour	35 µg/m3[d]	35 µg/m3
	Annual	12 µg/m3	15 µg/m3
Lead	Rolling 3-month average	0.15 µg/m3	0.15 µg/m3

Notes:

a. The 8-hour ozone standard is attained when the 3-year average of the fourth highest daily concentration is 0.08 ppm or less.
b. The 24-hour average concentration for sulfur oxides in the ambient air must not exceed 0.14 ppm by volume more than once per calendar year (Washington Administrative Code 173-476-130).
c. The 24-hour PM_{10} standard is attained when the 3-year average of the 99th percentile of monitored concentrations is less than the standard.
d. The 24-hour $PM_{2.5}$ standard is attained when the 3-year average of the 98th percentile is less than the standard.

ppm: parts per million
µg/m3: micrograms per cubic meter

1.2.2 Washington Department of Ecology

Ecology's Air Quality Program safeguards public health and the environment by preventing and reducing air pollution. Washington's main sources of air pollution are motor vehicles, outdoor burning, and wood smoke associated with home heating during fall and winter. Summertime wildfire smoke also contributes to unhealthy air. Ecology strives to improve air quality throughout the state by overseeing the development and conformity of the State Implementation Plan, which is the state's plan for meeting and maintaining NAAQS. Ecology also oversees the statewide air monitoring network and ensures that monitoring data collected meet the requirements of 40 CFR Part 58.

Ecology operates the air monitoring station closest to the study area at Chehalis-Market Boulevard. This station is approximately 1 mile southwest of the Airport Levee Changes site and 17 miles northeast of the FRE facility site. Fine particle pollution ($PM_{2.5}$) is measured at this location.

1.2.3 Southwest Clean Air Agency

Air quality in Washington State is regulated by Ecology and seven clean air agencies. Clean air agencies regulate air quality within certain counties while Ecology regulates air quality in counties not represented by a clean air agency. The Chehalis Basin is in Lewis County, which is one of five counties that comprise the jurisdiction of the Southwest Clean Air Agency (SWCAA). SWCAA has local authority for setting regulations and permitting of stationary air pollutant sources and construction emissions.

2 METHODOLOGY

2.1 Study Area

The study area for evaluating impacts on air quality is the area in and near the FRE facility site and construction activities, and the areas associated with and near construction and resulting changes to the airport levee (Figure A-1). For inhalation health risks related to diesel particulate matter (DPM), the study area for direct impacts is the immediate area surrounding the construction site that could be affected by construction vehicle and equipment emissions.

2.2 Affected Environment

2.2.1 Climate and Air Quality

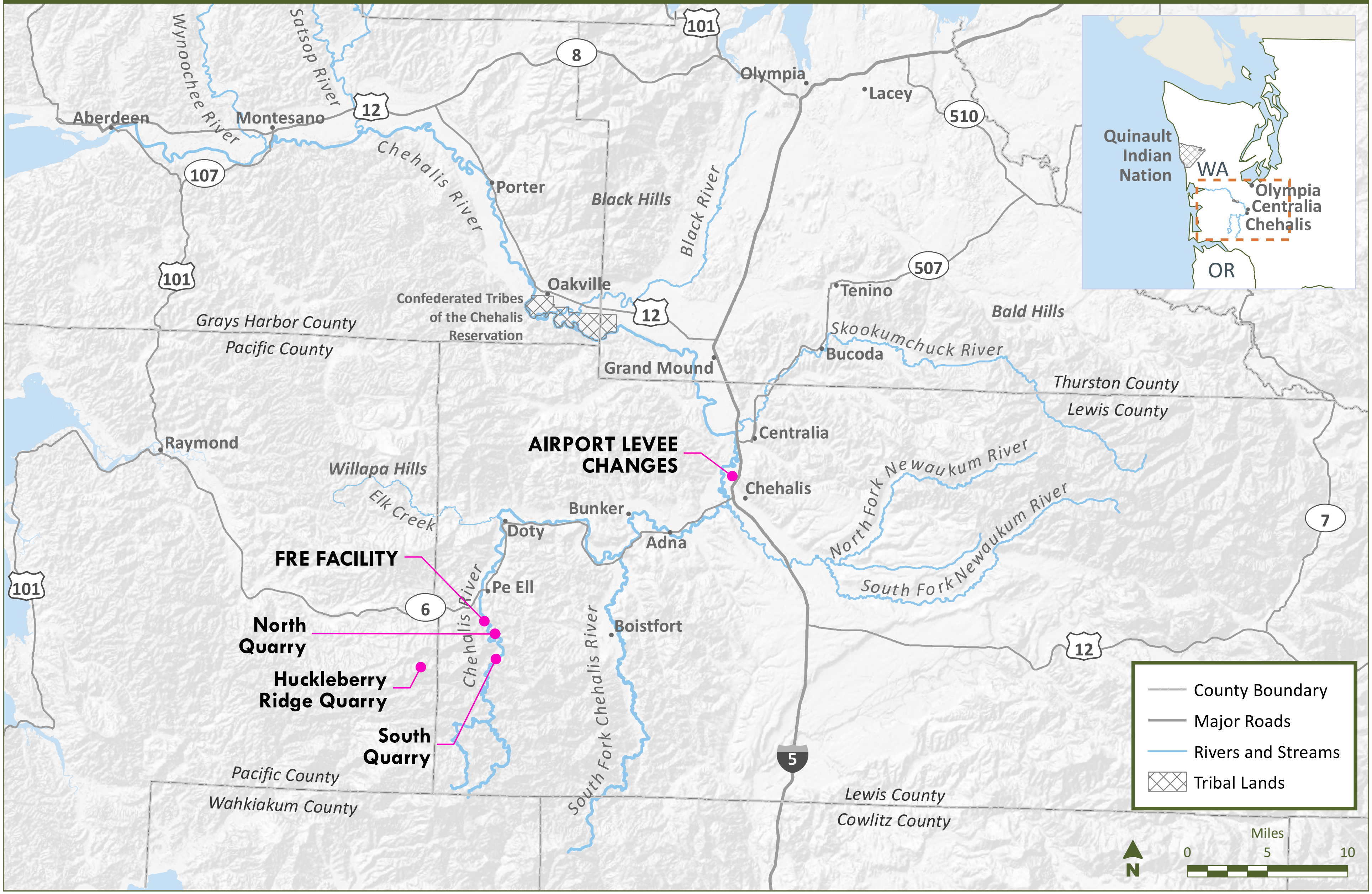
The study area is in the southern extent of the Puget Lowland region, which is composed of a narrow strip of land along the west side of Puget Sound extending from the Strait of Juan de Fuca in the north to the southern cities of Centralia and Chehalis. Buffered by the Olympic and Cascade mountain ranges and Puget Sound, the lowland has a relatively mild, marine climate with cool summers and mild, wet, and cloudy winters.

The prevailing wind direction in the summer is from the north or northwest. The average wind velocity is less than 10 miles per hour. Persistent high-pressure cells often dominate summer weather and create stagnant air conditions. This weather pattern sometimes contributes to the formation of photochemical smog.

During the wet winter season, the prevailing wind direction is from the south or southwest. Cold air occasionally flows southward from the interior of Canada through the Fraser River canyon into the lowland. In the fall and winter, severe storms can produce strong winds that cross the state from the southwest.

Air pollution is usually most noticeable in the late fall and winter, under conditions of clear skies, light wind, and a sharp temperature inversion. Temperature inversions occur when cold air is trapped under warm air, thereby preventing vertical mixing in the atmosphere. Inversions can last several days and prevent pollutants from being dispersed by the wind. Inversions are most likely to occur from October to January.

Figure A-1
Air Quality Study Area



Note: The study area encompasses the area in and near the FRE facility site and construction activities, and the areas associated with and near construction and resulting changes to the airport levee. The study area is in the jurisdiction of the SWCAA.

2.2.2 Attainment Status and General Conformity

EPA designates areas as being attainment, nonattainment, or unclassifiable for regulated air pollutants, as follows:

- **Attainment status** indicates that air quality in an area meets the federal, health-based ambient air quality standards.
- **Nonattainment status** indicates that air quality in an area has violated those standards. When nonattainment areas come back into compliance with federal standards, they are classified as maintenance areas.
- Areas in which EPA is not able to determine an attainment status are designated **unclassifiable**.

The study area is located in areas designated attainment or unclassifiable for criteria pollutants. This designation means that the area is currently meeting air quality standards, and EPA and Ecology expect the area to continue to meet air quality standards. The Proposed Action is in Lewis County in the Southwest Washington region. Portions of Southwest Washington outside of Lewis County are designated as a maintenance area for PM_{10}. Lewis County is designated unclassifiable for SO_2 and is in attainment for all other criteria pollutants.

2.2.3 Pollutants of Concern

Air quality is affected by pollutants generated by both natural and anthropogenic sources. In general, the largest anthropogenic contributors to air emissions are transportation vehicles and power-generating equipment, both of which typically burn fossil fuels. The main pollutants of interest for infrastructure projects are CO, PM, ozone, and NO_2. Both federal and state standards regulate these pollutants, along with two other criteria pollutants, SO_2 and lead. Because ozone is primarily formed by photochemical reactions of precursor chemicals known as volatile organic compounds (VOCs) and oxides of nitrogen (NO_x) in the presence of sunlight, emissions of these precursor chemicals are regulated to control ozone concentrations and achieve attainment of the ozone standards in nonattainment areas.

The major sources of lead emissions have historically been mobile and industrial sources. As a result of the phase-out of leaded gasoline, metal processing is currently the primary source of lead emissions, and there would be no lead emissions associated with the Proposed Action. Emissions of NO_2 associated with the Proposed Action are estimated because they are a precursor to ozone formation and assessed relative to their potential impact on ozone concentrations.

SO_2 is produced by the combustion of sulfur-containing fuels, such as oil, coal, and diesel. Historically, Washington has measured very low levels of SO_2. Because the levels were so low, most monitoring was stopped. SO_2 emissions have dropped over the past 20 years because control measures were added for some sources, some larger SO_2 sources shut down, and the sulfur content of gasoline and diesel fuel was cut by nearly 90% (Ecology 2011). SO_2 emissions would not be appreciably generated by construction and operation of the Proposed Action and, given the attainment status of the region, are not further considered in this analysis.

The largest contributors of pollution related to utility infrastructure projects are construction equipment, motor vehicles, and off-road construction equipment. The main pollutants emitted from these sources are CO, PM, ozone precursors (VOCs and NO_x), GHGs, and toxic air pollutants. Motor vehicles and diesel-powered construction equipment also emit pollutants that contribute to the formation of ground-level ozone. This section describes the main pollutants of concern and their impact on public health and the environment.

2.2.3.1 Carbon Monoxide

CO is an odorless, colorless gas usually formed as the result of the incomplete combustion of fuels. The single largest source of CO is motor vehicles; the highest emissions occur during low travel speeds, stop-and-go driving, cold starts, and hard acceleration. Exposure to high concentrations of CO reduces the oxygen-carrying capacity of the blood and can cause headaches, nausea, dizziness, and fatigue; impair central nervous system function; and induce angina (chest pain) in people with serious heart disease. Very high levels of CO can be fatal. Other significant sources of CO are certain industrial processes and residential wood stoves and fireplaces. For urban areas, internal combustion engines of motor vehicles have been the principal sources of CO in instances when ambient air quality levels have exceeded the NAAQS. The federal CO standards have not been exceeded in the Southwest Washington region since 1995 (SWCAA 2007) and only then in the Vancouver maintenance area, not within Lewis County.

2.2.3.2 Particulate Matter

Atmospheric PM is a class of air pollutants consisting of heterogeneous solid and liquid airborne particles from anthropogenic and natural sources. PM is most commonly measured in two size ranges: PM_{10} and $PM_{2.5}$. PM_{10} refers to particles that have a diameter of less than 10 micrometers. $PM_{2.5}$ refers to particles that have a diameter of less than 2.5 micrometers. PM_{10} includes $PM_{2.5}$, but most clean air agencies have discontinued PM_{10} monitoring and are now focusing on $PM_{2.5}$, due to the fact that scientific studies have shown $PM_{2.5}$ to be a greater concern for human health. $PM_{2.5}$ is also referred to as fine PM. Fine PM is emitted directly from a variety of sources, including wood burning (both outside and in indoor wood stoves and fireplaces), vehicles, and certain industrial processes. It also forms when gases from these sources or from natural sources react in the atmosphere.

An extensive body of scientific evidence shows that exposure to fine PM is linked to a variety of significant health problems, such as increased hospital admissions and emergency department visits for cardiovascular and respiratory problems, including non-fatal heart attacks and premature death. People most at risk from PM pollution exposure include people with heart or lung diseases, older adults, and children. Research indicates that pregnant women, newborns, and people with certain health conditions, such as obesity or diabetes, may also be more susceptible to fine PM-related effects.

Outside of the 2018 and 2019 wildfire seasons, the federal daily $PM_{2.5}$ standard has not been exceeded at the Chehalis-Market Boulevard station since monitoring began in 2010 (Ecology 2019a).

2.2.3.3 Ozone

Ground-level ozone is a secondary air pollutant produced in the atmosphere through a complex series of photochemical reactions involving NO_x and VOCs. VOCs are sometimes referred to as reactive organic gases (ROGs). The main sources of VOCs and NO_x, often referred to as ozone precursors, are combustion processes (including motor vehicle engines) and the evaporation of solvents, paints, and fuels. Ozone levels are usually highest during the afternoon in summertime because of the intense sunlight and the time required for ozone to form in the atmosphere. Ecology currently monitors ozone from May through September in Southwest Washington because this is the period of concern for elevated ozone levels in the Pacific Northwest. Ozone is not monitored at the Chehalis-Market Boulevard station because air quality models and previous monitoring indicate that ozone levels are below the NAAQS in Lewis County. The nearest ozone monitor is located in Yelm in Thurston County, roughly 40 miles northeast of the FRE facility.

Whereas ozone in the stratosphere is beneficial for blocking harmful ultraviolet light, elevated concentrations of ground-level ozone can cause reduced lung function, respiratory irritation, and asthma aggravation. Ozone has also been linked to immune system impairment. People with respiratory conditions should limit outdoor exertion when ozone levels are elevated. Even healthy people may experience respiratory symptoms on a high-ozone day. Ground-level ozone can also damage forests and agricultural crops, interfering with their ability to grow and produce food. Lewis County is designated as an attainment area for the federal ozone standard and, consequently, it is not subject to the application of the de minimis threshold for the ozone precursors VOCs and NO_x (de minimis thresholds are discussed in Section 2.4.1.)

2.2.4 Greenhouse Gases and Climate Change

Gases that trap heat in the atmosphere are referred to as GHGs because, like a greenhouse, they capture heat radiated from the earth. The accumulation of GHGs has been identified as a driving force in global climate change. Definitions of climate change vary between and across regulatory authorities and the scientific community. In general, however, climate change can be described as the changing of the earth’s climate caused by natural fluctuations and anthropogenic activities (i.e., activities relating to, or resulting from the influence of, human beings that alter the composition of the global atmosphere).

The Intergovernmental Panel on Climate Change (IPCC) released a Special Report in 2018 that states, "Human influence on climate has been the dominant cause of observed warming since the mid-20th century." It further states as follows:

> "Temperature rise to date has already resulted in profound alterations to human and natural systems, including increases in droughts, floods, and some other types of extreme weather; sea level rise; and biodiversity loss. These changes are causing unprecedented risks to vulnerable persons and populations" (IPCC 2018).

GHGs naturally trap heat by impeding the exit of solar radiation that has hit the earth and is reflected back into space. This trapping of heat is called a "greenhouse effect." Some GHGs occur naturally and are necessary for keeping the earth's surface habitable. However, increases in the concentrations of these gases in the atmosphere during the last 100 years have decreased the amount of solar radiation reflected back into space, intensifying the natural greenhouse effect and increasing of global average temperature.

The principal GHGs of concern are CO_2, CH_4, N_2O, SF_6, perfluorocarbons, and hydrofluorocarbons. Each of the principal GHGs has a long atmospheric lifetime (1 year to several thousand years). In addition, the potential heat-trapping ability of each of these gases varies significantly. CH_4 is 25 times as potent as CO_2 at trapping heat, while SF_6 is 22,800 times more potent than CO_2. Conventionally, GHGs have been reported as CO_2 equivalents (CO_2e). CO_2e takes into account the relative potency of non-CO_2 GHGs and converts their quantities to an equivalent amount of CO_2 so that emissions can be reported as a single quantity.

The primary human-made processes that release GHGs include the combustion of fossil fuels for transportation, heating, and electricity generation; agricultural practices that release CH_4, such as livestock production and crop residue decomposition; and industrial processes that release smaller amounts of high global warming potential gases such as SF_6, perfluorocarbons, and hydrofluorocarbons. Deforestation and land cover conversion have also been identified as contributing to climate change by reducing the earth's capacity to remove CO_2 from the air and altering the earth's albedo (surface reflectance), thus allowing more solar radiation to be absorbed.

In 2017, Washington produced about 97.5 million gross metric tons of CO_2e ($MMTCO_2e$[1]; Ecology 2019b). Ecology found that transportation is the largest source, at 44.6% of the state's GHG emissions, followed by residential, commercial, and industrial energy use at 23.7%, and electricity consumption (both in-state and out-of-state) at 16.7%. The sources of the remaining 15% of emissions are agriculture, waste management, and industrial processes (Ecology 2019b).

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[1] The abbreviation for "million metric tons" is MMT; thus, million metric tons of CO_2 equivalents is written as $MMTCO_2e$.

Climate change impacts from increasing GHGs have been included in the future conditions for all salient resource areas analyzed in this EIS. The *Proposed Project Description and Alternatives Appendix* includes additional information on how climate change is included throughout the analyses (Anchor QEA 2020). A report issued by the Climate Impact Group at the University of Washington in November 2015 (Mauger et al. 2015) identifies risks to infrastructure and human health in the Puget Sound region, including the Chehalis Basin, from climate change. More intense heat waves and higher flood risks are predicted, along with the indirect effects of increased wildfire frequency, shortage of summer water supply, shifting infectious disease dynamics, and decreased air quality.

Climate change projections for the region from the Climate Impacts Group identify likely future changes in air temperature. The Pacific Northwest experienced a total average annual warming of about 1.3°F, or 0.11°F per decade, from 1895 to 2011. Regionally downscaled climate models project increases in annual temperature of 3.3°F to 9.7°F by 2070 to 2099 (compared to the period 1970 to 1999), depending on total global emissions of heat-trapping gases. These increases are projected to be the largest in the summer (Mote et al. 2014).

Globally, winds are maintained by the temperature gradient from the equator to the poles. Global climate change models show that temperature warms poles and higher latitudes more than the equator and lower latitudes, which causes a lower temperature gradient and would likely result in weaker winds (Ren 2010). Regionally, coastal wind velocities could increase due to a faster temperature increase on land compared to water, which would increase the coastal thermal gradients that drive winds (Stephens 2008).

For information on how future conditions modeling of flood scenarios accounted for anticipated changes to hydrological and meteorological conditions associated with climate change, see the *Water Discipline Report* (ESA 2020).

2.2.5 Toxic Air Pollutants

Other pollutants known to cause cancer or other serious health effects are called air toxics. In addition to regulating the criteria pollutants, the Clean Air Act identifies 188 air toxics, also known as hazardous air pollutants (HAPs). The EPA assessed and identified a subset of 21 HAPs emitted by mobile sources, which are set forth in an EPA final rule, Control of Emissions of Hazardous Air Pollutants from Mobile Sources (40 Federal Register 59, 80, 85, and 86).

Among the 21 HAPs, EPA designated seven priority mobile source air toxics: acrolein, benzene, formaldehyde, DPM/diesel exhaust organic gases, naphthalene, polycyclic organic matter, and 1,3-butadiene. Exposure to the latter six pollutants for long durations at sufficient concentrations can increase the chances of cancer and other serious health effects, such as immune system dysfunctions and neurological, reproductive, developmental, and respiratory disorders. For example, the Puget Sound Clean Air Agency conducted a study of air toxics in Tacoma and Seattle in 2010 and determined that, of the 21 toxic air contaminants of concern, DPM emissions are the largest contributor to potential cancer risk in the Puget Sound area (PSCAA 2010).

2.2.6 Sensitive Receptors

Air quality does not affect each person in the same way, and some groups are more sensitive to adverse health effects than others. Population subgroups most sensitive to the health effects of air pollutants include children; elderly people; population subgroups with higher rates of respiratory diseases, such as asthma and COPD; and subgroups with other environmental or occupational health exposures (e.g., poor indoor air quality) that affect cardiovascular or respiratory diseases. Populations associated with facilities such as schools, sports fields, children's daycare centers, hospitals, and nursing and convalescent homes congregate people at greater risk than the general public due to their greater susceptibility to poor air quality.

People using parks and playgrounds can be more exposed to air pollutants when there is poor air quality because people engaged in strenuous work or exercise have increased breathing rates; however, exposure times are generally far shorter for parks and playground users than for people in residential locations and schools, and these shorter exposure times typically limit overall exposure to pollutants. People tend to be more exposed to air in residential land-use areas compared to in commercial and industrial areas because people generally spend longer periods of time at their residences.

2.2.6.1 Sensitive Receptors in the Vicinity of the FRE Facility

The closest sensitive receptors to the proposed FRE facility and quarry areas are rural residences along Wells Road, approximately 3,000 feet north of the proposed FRE facility. These receptors are identified in Figure A-2. Sensitive receptors are also located on Muller Road, approximately 4,200 feet from the proposed FRE facility.

2.2.6.2 Sensitive Receptors in the Vicinity of the Airport Levee Changes

The closest sensitive receptors to the proposed Airport Levee Changes are multifamily residences along NW Airport Road and NW River Street, some of which are as close as 75 feet from proposed work areas. These receptors are identified in Figure A-3.

2.3 Studies and Reports Referenced/Used

EPA mobile emission factors were used to calculate emissions from motor vehicles, including trucks used to haul concrete and other materials and construction worker travel. EPA off-road emission factors were used to calculate emissions from off-road equipment used to construct the FRE facility and for the Airport Levee Changes. Emissions factors and calculation equations from EPA's AP-42 compendium (EPA 2006) were used to calculate fugitive dust emissions in terms of PM_{10} and $PM_{2.5}$.

The AMS/EPA Regulatory Model (EPA 2004; AERMOD Version 18081) was used to estimate localized concentrations of pollutants, where warranted, and to estimate increased cancer risk resulting from DPM emissions.

The following studies, reports, and models were used to identify and evaluate potential air quality and GHG impacts:

- *Chehalis Basin Strategy Programmatic Environmental Impact Statement* (Ecology 2017)
- *2017 Washington State Greenhouse Gas Emissions Data* (Ecology 2019b)
- MOtor Vehicle Emissions Simulator (MOVES; EPA 2014)
- MOVES NON-ROAD mode (EPA 2014)
- *Our Nation's Air* (EPA 2017)
- *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews* (CEQ 2016; withdrawn 2017)
- *Compilation of Air Pollutant Emission Factors* (EPA 1995)
- *User's Guide for the AMS/EPA Regulatory Model (AERMOD)* (EPA 2004)

Figure A-2
Sensitive Receptors Near FRE Facility

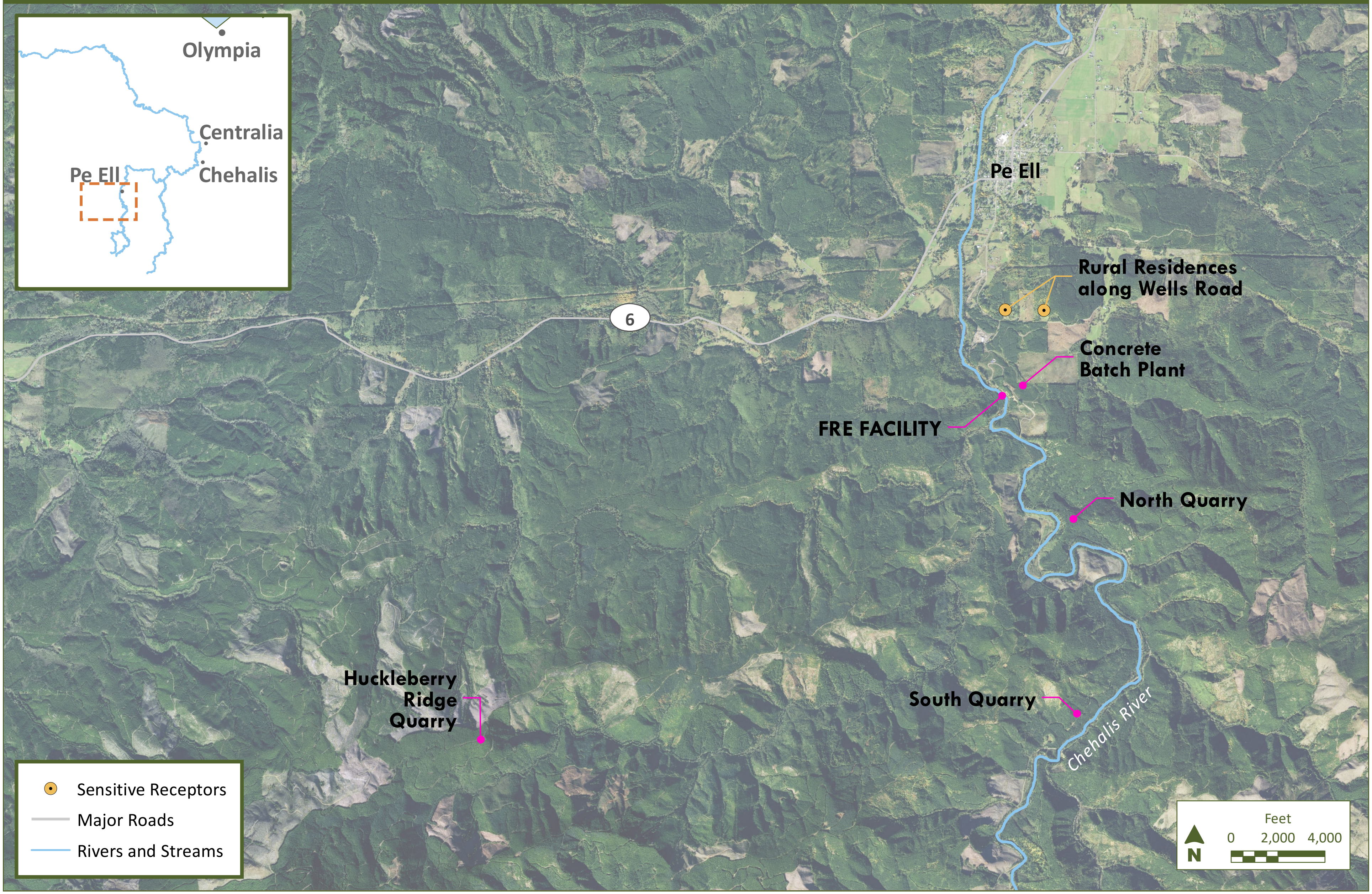
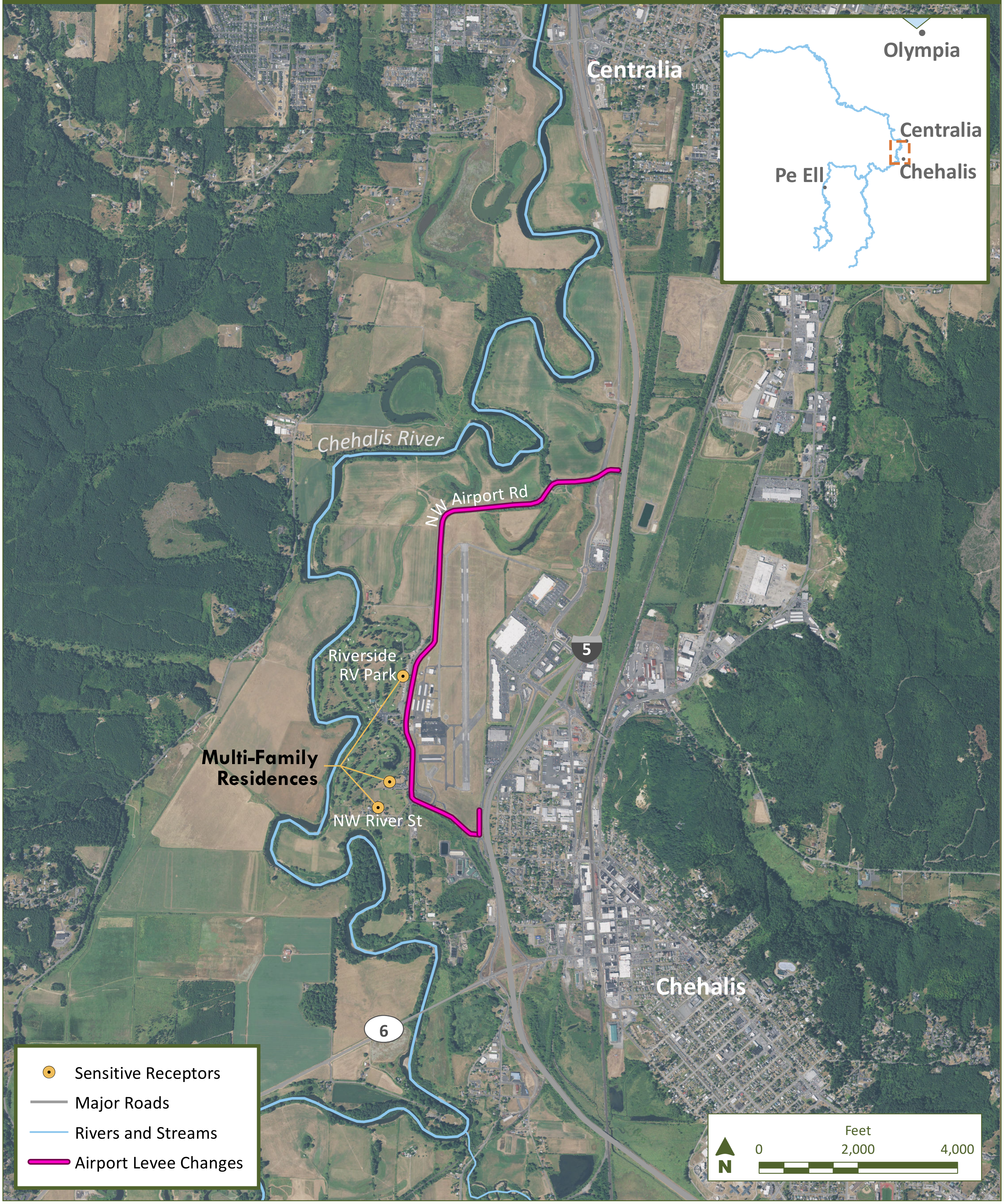


Figure A-3
Sensitive Receptors Near Airport Levee Changes



2.4 Technical Approach

2.4.1 Air Quality

The analysis of air quality evaluated emissions from construction of the Proposed Action. Air emissions were estimated for the criteria air pollutants CO, NO_2, SO_2, $PM_{2.5}$, and PM_{10}. VOCs were also included; along with NO_x, VOCs are an important precursor to ozone. DPM was considered and evaluated where appropriate with respect to the potential to increase cancer risk.

Construction-related emissions of criteria pollutants were estimated based on anticipated construction scenarios provided by the Chehalis River Basin Flood Control Zone District (Applicant) and equipment inventories for other dam and levee projects of similar size. The following sources of emissions were evaluated:

- Off-road equipment used to construct the FRE facility and the Airport Levee Changes
- On-road vehicles used to haul materials to and from both the FRE facility site and the airport levee site
- On-road vehicles used for construction worker commutes
- PM (dust) emissions from stockpiling, handling, processing (including concrete batch plant operations and rock crushing) and dumping of materials
- PM (dust) emissions from land clearing

Calculated annual emissions were compared to the de minimis thresholds for a CO or PM_{10} maintenance area of 100 tons per year. The de minimis thresholds established by EPA represent the quantity of emissions of a pollutant in a nonattainment or maintenance area above which the need for a conformity assessment with the State Implementation Plan is required. While Lewis County is not designated a nonattainment or maintenance area, other portions of Southwest Washington are designated as a maintenance area for PM_{10}. Therefore, the EPA de minimis level of 100 tons per year was conservatively applied as a threshold of a potential significant impact.

Construction would involve the use of predominantly diesel-powered construction equipment, which generates DPM. While DPM has not been identified as a hazardous air pollutant by EPA, Ecology has identified DPM as the toxic air pollutant most harmful to Washington citizens (Ecology 2019c). Consequently, the analysis addresses the potential for localized health risk impacts from DPM using two methodologies. First, for construction activity in and around the FRE facility, potential impacts are addressed qualitatively based on the distance from existing sensitive receptors and studies indicating adequate distances sufficient to avoid potential DPM impacts. Second, for the airport levee site, a screening-level health risk assessment was conducted to estimate the increased cancer risk associated with DPM exposure to residences that would be as close as 50 to 100 feet from work areas.

SWCAA was also contacted to determine whether the proposed concrete batch plant, temporary quarry, or blasting activities will require air quality permits, emissions control, and any operational restrictions (Saint Claire 2019; Section 3.2.3).

Once constructed, operational emissions are anticipated to be periodic from the FRE facility and at the airport levee from vehicle and equipment used for maintenance and operations during major floods or larger. However, exposure of the temporary reservoir area where trees are removed would result in windblown PM known as "fugitive dust." These fugitive dust emissions are calculated as operational emissions associated with the FRE facility.

2.4.2 Greenhouse Gases

The GHG analysis considered the same sources cited above for air quality that generate GHGs from combustion sources, primarily on-road and off-road engines. Additional considerations include the following:

- GHGs generated during construction and operations of the Proposed Action
- GHGs generated at the batch plant during the production of concrete used in FRE facility construction
- Loss of active sequestered GHGs as a result of tree removal for the Proposed Action
- Combustion of felled trees from the temporary reservoir area, if burned

2.5 Impact Analysis

Air quality in Lewis County is in attainment with all federal and state air quality standards. While Lewis County is not designated a nonattainment or maintenance area, other portions of Southwest Washington are designated as a maintenance area for CO and PM_{10}. Therefore, the EPA de minimis level of 100 tons per year was conservatively applied as a threshold of a potential significant impact.

GHG emissions and their resulting concentrations are a global concern and, therefore, are not dependent on local air quality or the proximity of existing sources. Various GHG intensity considerations are proposed in federal and state regulations and guidance. For example, the proposed Washington State Clean Air Rule (Washington Administrative Code [WAC] 173-442) establishes an initial compliance threshold for GHG emissions of 100,000 metric tons of CO_2e per year. Similarly, the EPA Tailoring Rule (40 CFR Parts 51, 52, 70 et seq.) 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 GHG emissions.

3 TECHNICAL ANALYSIS AND RESULTS

3.1 Overview

This section describes the probable air quality and GHG impacts from the Proposed Action (Section 3.2), Local Actions Alternative (Section 3.3), and No Action Alternative (Section 3.4). The section also evaluates required permit conditions and planning document requirements that could address the impacts identified (Section 3.2.3). When probable significant adverse environmental impacts remain after considering these, the report identifies mitigation measures that could avoid, minimize, or reduce the identified impact below the level of significance (Section 3.2.4).

3.2 Proposed Action

3.2.1 Impacts from Construction

Construction activities of the Proposed Action that could result in air quality and GHG impacts include the following:

- Use of off-road equipment to construct the FRE facility and the Airport Levee Changes
- Use of off-road vehicles to transport quarried materials to the processing and batch plant area
- Use of on-road vehicles to haul materials to and from both the FRE facility site and the airport levee site
- Use of on-road vehicles for construction worker commutes
- Quarrying and rock processing
- Batch plant concrete production
- Tree removal in the temporary reservoir area
- Land clearing
- Stockpiling, handling, processing, and removal of materials

Construction of the FRE facility is estimated to last for 5 years, from 2025 to 2030, and 1 year for the Airport Levee Changes within this time frame.

3.2.1.1 Direct

3.2.1.1.1 Flood Retention Expandable Facility

Criteria Pollutant Emissions

Direct air quality impacts associated with construction of the FRE facility would result from multiple sources, including the following:

- Exhaust emissions from equipment used to construct the FRE facility
- Exhaust emissions from truck trips to bring materials to the work site, including sand, fly ash, and cement to the concrete batch plant

- Exhaust emissions from daily truck trips to bring quarried rock to the batch plant for processing
- Fugitive dust emissions from loading and unloading of quarry trucks and from truck travel on paved and unpaved roads
- Exhaust emissions from off-road equipment used in quarrying and rock processing
- Fugitive particulate emissions from blasting, rock processing, and the concrete batch plant
- Exhaust emission from construction worker trips
- Fugitive particulate emissions from land clearing for the temporary reservoir
- Open burning of forest residues from land clearing if burning is employed

Off-Road Equipment Emissions. A project-specific inventory of equipment to be used in construction of the FRE facility was not available at the time of this analysis. To approximate equipment-related construction emissions, an inventory from a dam construction project of similar size (the *Sites Reservoir Project Environmental Impact Report/EIS*) was scaled to estimate the type of off-road equipment (Bureau of Reclamation 2017). The Sites Reservoir project included a dam of the same height as the proposed FRE facility and a slightly longer crest length, and therefore represents a conservative estimate for the construction effort for the Proposed Action. Estimated off-road equipment hours were used in conjunction with off-road equipment emission factors generated by EPA's MOVES program specific to Lewis County to estimate exhaust emissions (EPA 2014).

On-Road Truck Emissions. Emissions from trucks bringing materials from off-site locations to the FRE facility and from trucks hauling logs from temporary reservoir clearing were calculated using truck trip estimates provided by the Applicant and on-road emission factors generated by EPA's MOVES program specific to Lewis County for single-unit long-haul diesel trucks (EPA 2014). Approximately 35% of these truck trips are for hauling of logs while the remaining 65% are vendor trips to the FRE facility site.

Quarry Truck Emissions. Emissions from off-road trucks (CAT 769C) transporting quarried materials to the processing and batch plant area were calculated using truck trip estimates provided by the Applicant and off-road emission factors generated by EPA's MOVES program specific to Lewis County for off-road trucks (EPA 2014).

Particulate Emissions from Fugitive Dust from Trucks. Fugitive dust emissions from truck travel on roadways were calculated using the methodology published in EPA's AP-42 compendium of emission factors (EPA 2006, Chapter 13.2) and were based on vehicle miles travelled on both paved and unpaved roads. Fugitive dust emissions were also calculated from truck loading and unloading based on the volume of aggregate necessary to manufacture the concrete volume predicted for the FRE facility elements and the methodology published in Chapter 13.2 (EPA 2006).

Exhaust Emissions from Quarrying. A project-specific inventory of equipment to use in quarrying was not available at the time of this analysis. An inventory of equipment necessary was estimated based on an equipment inventory compiled for operations of another quarry project (San Rafael Rock quarry; ESA 2009).

Particulate Emissions from Fugitive Dust Generated by Blasting and Rock Processing. A project-specific inventory of equipment to use in rock processing was not available at the time of this analysis. To approximate equipment-related construction emissions, an equipment inventory was estimated to be similar to that from a rock processing facility in Brisbane, California (ESA 2017) that included jaw crushers, cone crushers, screening equipment, and a conveyor. Project-specific aggregate throughput was estimated assuming the quantity of aggregate necessary to meet the concrete demand for the Proposed Action. Emissions from blasting assumed a blast production rate of 370 tons per 100 square feet blast and calculation methodology of the San Diego County Air Pollution Control District.

Batch Plant Emissions. Emissions from batch plant operations were estimated using an assumed annual project concrete demand of 185,820 cubic yards (or 929,100 cubic yards over 5 years) and emission factors from Chapter 11.12 of AP-42 for concrete batching (EPA 2006).

Construction Worker Trips. Construction worker trips were calculated based on 1.25 workers per equipment in that phase, resulting in one round trip per worker (CAPCOA 2017).

Fugitive Particulate Emissions from Land Clearing for the Temporary Reservoir. Particulate emissions from clearing 485 acres for the temporary reservoir were estimated using emission factors from Chapters 13.2 and 11.9 of AP-42.

Open Burning of Forest Residues from Land Clearing. Emissions from burning of organic forest residues during the land clearing stage for the temporary reservoir were calculated using emission factors from Chapter 2.5 of AP-42 and assuming 485 acres cleared over 5 years and a load factor of 70 tons per acre. The Applicant does not state how the timber removed from the temporary reservoir area will be used; therefore, for purposes of this assessment, the air quality analysis evaluates emissions from burning the wood. This is a conservative approach that evaluates a reasonably foreseeable available disposal option for cleared vegetation with the highest level of emissions.

Table A-5 summarizes the air pollutants emissions associated with each of the above sources. Calculations are presented in Attachment A-1. As can be seen in Table A-5, the total of sulfur oxides (SO_x), PM_{10}, and $PM_{2.5}$ pollutant emissions and precursor emissions (VOCs and NO_x) would be less than the 100-tons-per-year threshold that would apply to a federally designated marginal nonattainment area. However, if the cleared logs are burned, emissions of CO would exceed the 100-tons-per-year threshold. The carbon monoxide impacts from burning the timber would be **moderate**. A mitigation measure has been added in Section 3.2.4 to reduce emissions of CO by using the timber instead of burning it; for example, providing large woody material for restoration projects in the Chehalis River Basin. With this mitigation measure, the CO emissions would be below the 100-tons-per-year threshold. With the proposed mitigation measure, emissions associated with construction of the FRE facility would be a **minor** adverse impact with respect to emissions of criteria air pollutants and ozone precursors. An Air Discharge Permit and Permit for Nonroad Engines would be required by SWCAA for FRE facility construction and would likely include measures to reduce air pollutant emissions. SWCAA may impose measures, such as restricting open burning on days of predicted elevated wind speed and use of equipment with EPA-certified engines.

Table A-5

Estimated Criteria Pollutant and Ozone Precursor Emissions from Construction of the FRE Facility

PROJECT CONSTRUCTION ELEMENT	POLLUTANT AND PRECURSOR EMISSIONS (TONS/YEAR)					
	VOC	NO_X	CO	SO_X	PM_{10}	$PM_{2.5}$
Construction Off-Road Equipment Emissions for FRE Facility Construction	0.03	2.76	0.86	0.04	0.17	0.16
Construction Off-Road Equipment Emissions for Clearing and Grubbing	0.008	1.07	0.33	0.02	0.07	0.07
On-Road Truck Emissions[a]	0.003	0.04	0.02	<0.001	0.005	0.002
Quarry Truck Emissions	0.001	0.16	0.04	0.003	0.01	0.009
Quarry Truck Paved Road Dust Emissions	N/A	N/A	N/A	N/A	0.039	0.01
Quarry Truck Unpaved Road Dust Emissions	N/A	N/A	N/A	N/A	6.86	0.69
Quarry Truck Loading Fugitive Dust	N/A	N/A	N/A	N/A	2.36	0.38
Quarry Truck Unloading at Batch Plant	N/A	N/A	N/A	N/A	2.36	0.38
Quarry Off-Road Equipment Emissions	0.008	0.93	0.30	0.01	0.07	0.07
Aggregate Processing Particulate Emissions	N/A	N/A	N/A	N/A	0.80	0.16
Blasting Particulate Emissions[b]	N/A	N/A	N/A	N/A	1.78	1.78
Batch Plant Emissions	N/A	N/A	N/A	N/A	0.50	0.07
Construction Worker Trips	0.008	0.03	0.57	<0.001	0.01	0.002
Land Clearing for Temporary Reservoir	N/A	N/A	N/A	N/A	0.78	0.43
Open Burning of Forest Residue from Land Clearing	64.5	N/A	475	N/A	57.7	57.7
Total	**64.5**	**4.99**	**477**	**0.073**	**73.5**	**61.9**

Notes: N/A indicates "not applicable" because these sources are only emitters of fugitive dust and not combustion sources, or emission factors for these pollutants or precursors are not provided by the source material.

a. Approximately 35% of these truck emissions are attributable to off-haul of logs from temporary reservoir clearing.
b. $PM_{2.5}$ from blasting conservatively assumed to be equivalent to PM_{10} as AP-42 does not have a separate $PM_{2.5}$ emission factor (EPA 2006).

Toxic Air Pollutants

DPM is defined in state regulations as a toxic air pollutant (WAC 173-460-150). Construction would involve the use of predominantly small diesel-powered construction equipment, which generates DPM. Construction activities and quarrying activities for the FRE facility would occur over 3,000 feet or more from the nearest sensitive receptor that could be potentially impacted by localized DPM concentrations. Existing research on DPM exposure with distance indicates that cancer risk from DPM sources declines rapidly at distances between 500 feet and 1,000 feet (CARB 2005). Additionally, agencies that recommend an analysis of health risk impacts from DPM identify a zone of exposure of 1,000 feet, beyond which impacts are assumed not to be significant (BAAQMD 2017). Because the FRE facility construction and quarrying areas would be well beyond a zone of influence of 1,000 feet of the nearest residences, health risk impacts from DPM emissions during construction would be a **minor a**dverse impact. DPM emissions could also be reduced through mitigation identified in Section 3.2.4.

Greenhouse Gases

The GHG analysis considered the same sources cited earlier for air quality, which generate GHGs from combustion sources, primarily on-road and off-road engines. Table A-6 presents a summary of GHG emissions associated with each source. Calculations are presented in Attachment A-1.

The proposed FRE facility construction would include the on-site manufacturing of concrete. Because the emission estimates in Table A-6 include the energy used to quarry aggregate and to transport aggregate, fly ash, cement, and sand, these emission estimates directly consider the embodied emissions for the vast majority of materials used for FRE facility construction.

The Applicant would acquire the entire temporary reservoir inundation area, converting it from commercial forestland to a reservoir land use. The Applicant would remove all non-flood-tolerant trees (primarily Douglas fir, which is currently used for commercial sale) from the inundation zones prior to construction for a total of over approximately 485 acres over the 5-year construction period. As commercially grown trees, these trees would eventually have been harvested for commercial sale and the land replanted. The Applicant intends to revegetate the area using scrub-shrub vegetation, but taking this acreage out of active tree growth would result in loss of carbon sequestration. Assuming a removal of 27,000 logs (trees) and a Douglas fir-specific sequestration rate of 0.0447 metric tons of CO_2 per year (CAPCOA 2017), the transfer of forested land to the temporary reservoir inundation area would result in a sequestration loss of 1,207 metric tons of CO_2 per year. Table A-6 identifies emissions from construction actions.

The Applicant does not state how the timber and other vegetation removed from the temporary reservoir area would be used. Therefore, for purposes of this analysis, the GHG analysis evaluates emissions from burning the wood. Burning would accelerate the release of stored carbon that would otherwise occur during decay over an extended time. This is a conservative approach that evaluates a reasonably foreseeable available disposal option for cleared vegetation with the highest level of GHG emissions. A mitigation measure has been added in Section 3.2.4 to reduce emissions by using the timber instead of burning it; for example, providing large woody material for restoration projects in the Chehalis Basin. With this mitigation measure, the GHG emissions would be reduced by approximately 50%.

Table A-6
Estimated Maximum Annual Greenhouse Gas Emissions from Construction of the FRE Facility

PROJECT CONSTRUCTION ELEMENT	CO_2 EMISSIONS (METRIC TONS/YEAR)
FRE Facility Construction Off-Road Equipment Emissions	4,853
Temporary Reservoir Clearing and Grubbing Equipment Emissions	2,056
On-Road Truck Emissions	17
Quarry Truck Emissions	475
Quarry Off-Road Equipment Emissions	1,896
Construction Worker Trips	107
Loss of Carbon Sequestration from Tree Removal in Temporary Reservoir	1,207
Release of Stored Carbon from Removed Trees and Vegetation (Open Burning)	10,767
Total	**21,378**

Source: Calculated by Environmental Science Associates

The GHG impact of constructing the proposed FRE facility would be 21,378 metric tons of CO_2 per year for a total of 106,890 metric tons of CO_2 over the 5-year construction period. GHG emissions from construction would be limited to the approximate 5-year construction period and would not represent an ongoing addition to the State of Washington's GHG inventory.. The GHG emissions for burning of trees and vegetation would be 10,611 metric tons of CO_2 per year for a total of 53,055 metric tons of CO_2 over the 5-year construction period. A mitigation measure has been added for the Applicant to use trees, for example in restoration projects, instead of burning.

Combined GHG emissions for construction and operation of the FRE facility and Airport Levee Changes would equal 123,439 metric tons and be a **significant** adverse impact. See Section 3.2.1.1.2 for construction emissions of the Airport Levee Changes and Section 3.2.2 for emissions from operation of the Proposed Action. To address the potential impacts of GHG emissions from construction and operation of the Proposed Action, mitigation has been added for the Applicant to prepare and implement a GHG Mitigation Plan that mitigates for 100% of the GHG emissions. The plan must be approved by Ecology and must be ready to implement prior to the start of construction. 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 Washington State projects are preferred and all projects must meet all five criteria (e.g., using internationally recognized protocols). For example, carbon credits could be purchased through existing carbon markets, or restoration or afforestation projects.

3.2.1.1.2 *Airport Levee Changes*

Criteria Air Pollutants

Direct air quality impacts associated with the Airport Levee Changes would result from multiple sources, including the following:

- Exhaust emissions from equipment used to construct levee changes
- Exhaust emissions from truck trips to bring material to the levee site
- Fugitive dust emissions from unloading of soil trucks
- Exhaust emission from construction worker trips

Table A-7 summarizes the air pollutants emissions associated with each of the above sources. Calculations are presented in Attachment A-1. As evident in Table A-7, the total of all criteria pollutant emissions and precursor emissions (VOCs and NO_x) would be less than the 100 tons-per-year threshold that would apply to a marginal federal nonattainment area. Additionally, the Proposed Action is not located in a federal nonattainment area, and emissions associated with construction of the Airport Levee Changes would be a **minor** adverse impact with respect to emissions of criteria air pollutants.

Table A-7

Estimated Emissions of Criteria Pollutants and Precursors of Concern for Construction of Airport Levee Changes

PROJECT CONSTRUCTION ELEMENT	POLLUTANT AND PRECURSOR EMISSIONS (TONS/YEAR)					
	VOC	NO_X	CO	SO_X	PM_{10}	$PM_{2.5}$
Levee Construction Off-Road Equipment Emissions	0.007	0.78	0.24	0.01	0.06	0.05
On-Road Truck Emissions	0.008	0.088	0.040	<0.001	0.012	0.004
Levee Truck Unloading Fugitive Dust	N/A	N/A	N/A	N/A	2.36	0.38
Construction Worker Trips	0.008	0.009	0.18	<0.001	0.004	<0.001
Total	**0.023**	**0.88**	**0.46**	**0.01**	**2.44**	**0.43**

Source: Calculated by Environmental Science Associates

Toxic Air Pollutants

Construction activities for the Airport Levee Changes would involve the use of predominantly diesel-powered construction equipment, which generates DPM. For DPM, WAC Section 173-460-090 establishes an acceptable source impact limit of 1 in 100,000 (10 in 1 million) additional lifetime cancer risk. Construction activities for the levee would occur as close as 50 feet from the nearest sensitive receptors. A health risk assessment was conducted to estimate the level of increased cancer risk associated with a 1-year construction period along the levee.

Risk characterization combines the maximum annual average ground-level DPM concentration and the cancer potency factor from a dose-response analysis to estimate the potential inhalation cancer risk from exposure to DPM emissions (see Attachment A-1 for full methodology details).

In performing health risk calculations, carcinogenic compounds are not considered to have threshold levels (i.e., dose levels below which there are no risks). Any exposure will have some associated risk. Incremental health risks associated with exposure to carcinogenic compounds are defined in terms of the probability of developing cancer as a result of exposure to a chemical at a given concentration. Table A-8 presents the maximum increased health risks associated with levee construction activities. As shown in the table, residential receptors at the RV park and along NW Airport Road are predicted to experience increased cancer risks of less than 10 in 1 million. This would be considered a **minor** adverse impact. DPM emissions could also be reduced through mitigation identified in Section 3.2.4.

Table A-8
Maximum Increase in Health Risk at Nearby Receptors from Levee Construction Activities

SENSITIVE RECEPTOR TYPE	MAXIMUM INCREASED CANCER RISK (PER MILLION)
Residential Receptor – RV Park	4.84
Residential Receptor – NW Airport Road	4.20
Residential Receptor – NW River Street	0.71

Source: Calculated by Environmental Science Associates; see Attachment A-1 for full methodology details

Greenhouse Gases

The GHG analysis considered the same sources for the Airport Levee Changes cited above for air quality, which generate GHGs from combustion sources, primarily on-road and off-road engines. Table A-9 summarizes the GHG emissions associated with each source. Calculations are presented in Attachment A-1. GHG emissions from levee construction would be limited to the 1-year construction period and would not represent an ongoing burden to the State of Washington's GHG inventory. The Airport Levee Changes and the FRE facility comprise the Proposed Action.

Combined GHG emissions for construction and operation of the FRE facility and Airport Levee Changes would equal 123,439 metric tons, inclusive of a 50-year operational period, and be a **significant** adverse impact. See Section 3.2.1.1.1 for construction emissions of the FRE facility and Section 3.2.2 for emissions from operation of the Proposed Action. To address the potential impacts of GHG emissions from construction and operation of the Proposed Action, mitigation has been added for the Applicant to prepare and implement a GHG Mitigation Plan that mitigates for 100% of the GHG emissions. The plan must be approved by Ecology and must be ready to implement prior to the start of construction. 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 Washington State projects are preferred and all projects must meet all five criteria (e.g., using internationally recognized protocols). For example, carbon credits could be purchased through existing carbon markets, or restoration or afforestation projects. GHG emissions could also be reduced through the mitigation identified in Section 3.2.4.

Table A-9
Estimated Greenhouse Gas Emissions from Construction of the Airport Levee Changes

PROJECT CONSTRUCTION ELEMENT	CO_2 EMISSIONS (METRIC TONS/YEAR)
Levee Construction Off-Road Equipment Emissions	1,749
On-Road Truck Emissions	66
Construction Worker Trips	34
Total	**1,849**

Source: Calculated by Environmental Science Associates

3.2.1.2 Indirect

3.2.1.2.1 Flood Retention Expandable Facility

No indirect adverse impacts on air quality or GHGs from construction of the FRE facility are anticipated.

3.2.1.2.2 Airport Levee Changes

No indirect adverse impacts on air quality or GHGs from construction of the Airport Levee Changes are anticipated.

3.2.2 Impacts from Operation

This section describes the impacts from the temporary reservoir (during inundation and during periods when the temporary reservoir would not be filled), operation of the FRE facility, and post-construction vegetation management and debris removal.

3.2.2.1 Direct

3.2.2.1.1 Flood Retention Expandable Facility

Methane ($CH_{4,}$) emissions could potentially be generated during inundation of the temporary reservoir as a result of flooded organic matter and anaerobic sediment conditions. However, the infrequent and short inundation periods, coupled with relatively low temperatures, would preclude the proliferation of methanogens and limit methane generation and emissions (Anchor QEA 2019). The temporary reservoir use would have **no adverse effect**. Hydrogen sulfide is generated in anaerobic sediments and water, but high concentrations of hydrogen sulfide in temporary reservoir discharges are rare. The FRE facility would operate infrequently and transiently, typically during colder months, and drain a forested watershed; therefore, there would be no noxious odors or hydrogen sulfide impacts (Anchor QEA 2019).

After the 485 acres in the temporary reservoir are cleared of trees, the exposed soils would be subject to wind erosion during periods when the temporary reservoir is not filled, estimated at 6 of every 7 years. Particulate emissions associated with wind erosion of cleared land were calculated using emissions factors published by EPA in Section 11.9 of its AP-42 compendium of emission factors. Based on an exposed acreage of 485 acres, the exposed temporary reservoir would generate windblown dust of approximately 32 tons per year of PM_{10} and 19 tons per year of $PM_{2.5}$. These operational particulate emissions would be less than the 100-tons-per-year threshold that would apply to a marginal federal nonattainment area. This approach is conservative and does not include the reduction of dust from replanting vegetation between flood events. The Applicant will replant flood-tolerant vegetation in these areas and this would reduce erosion and dust. Additionally, the Proposed Action is not located in a federal nonattainment area, and particulate emissions associated with wind exposure of the temporary reservoir would be a **minor** adverse impact with respect to emissions of criteria air pollutants.

Vehicle trips would be generated for regular maintenance of the FRE facility, clearing and moving debris after a flood, vegetation maintenance, and transporting fish when the temporary reservoir is filled. Inundation of the temporary reservoir is anticipated to occur on average approximately once every 7 years. Emissions from equipment used for post-construction vegetation management and moving debris were calculated assuming one-seventh of those associated with the initial clearing analyzed earlier for construction. These emissions would be 0.2 tons per year of NO_x and substantially less for all other pollutants and precursors. Emissions from fish transport, similar to construction, are assumed to be marginal in comparison. These operational particulate emissions would be less than the 100-tons-per-year threshold that would apply to a marginal federal nonattainment area, and this would be a **minor** adverse impact with respect to emissions of criteria air pollutants.

Using the same methodology, GHG emissions would be approximately 294 metric tons per year. There would be a marginal use of electricity for lighting and pumping so GHG emissions from increased electrical demand for lighting and pumping would be negligible. Combined GHG emissions for construction and operation of the FRE facility and Airport Levee Changes would equal 123,439 metric tons, inclusive of a 50-year operational period, and be a **significant** adverse impact. See Section 3.2.1 for construction emissions of the Proposed Action.

3.2.2.1.2 Airport Levee Changes

During operations of the airport levee, there would be a few vehicle trips per year for maintenance. Combined GHG emissions for construction and operation of the FRE facility and Airport Levee Changes would equal 123,439 metric tons and be a **significant** adverse impact. See Section 3.2.1 for construction emissions of the Proposed Action.

3.2.2.2 Indirect

3.2.2.2.1 Flood Retention Expandable Facility

No indirect adverse impacts on air quality or GHGs from operation of the FRE facility are anticipated.

3.2.2.2.2 Airport Levee Changes

No indirect adverse impacts on air quality or GHGs from operation of the Airport Levee Changes are anticipated.

3.2.3 Required Permits

The following permits would be required for the Proposed Action:

- **Air Discharge Permit (SWCAA):** Under Regulation SWCAA 400-109, this permit would be required for quarrying, inclusive of rock processing, operation of the concrete batch plant, and blasting. This permit would be required for construction activities proposed for the FRE facility.
- **Permit for Nonroad Engines (SWCAA):** Under Regulation SWCAA 400-045, this permit would be required for operation of nonroad engines with an aggregate horsepower exceeding 500 horsepower and for construction work lasting 1 year or more. This permit would be required for construction activities proposed for both the FRE facility and the Airport Levee Changes.
- **Open Burning Permit (SWCAA):** Under Regulation SWCAA 425-060, this permit would be required for burning debris after land clearing and would therefore be required for construction activities proposed for the FRE facility.

SWCAA will likely identify additional measures to control construction emissions through its permitting process for the required permits identified herein. Such measures may include restrictions on open burning on days of predicted elevated wind speeds, and use of equipment with EPA-certified engines.

3.2.4 Proposed Mitigation Measures

This section describes the mitigation measures being proposed for the Applicant to implement that would reduce impacts related to air pollutant and GHG 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 permits, plans, and authorizations.

The Applicant will implement the following measures to mitigate air pollutant and GHG emissions:

- **AIR-1 (GHG Mitigation Plan)**: To address the potential impacts of GHG emissions attributable to the Proposed Action, mitigation is proposed for the Applicant to prepare and implement a GHG Mitigation Plan that mitigates for 100% of the 123,439 metric tons of GHG emissions from construction and operation. The plan must be approved by Ecology and must be ready to implement prior to the start of construction. 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 Washington State projects are preferred, and all projects must meet all five criteria (e.g., using internationally recognized protocols). For example, carbon credits could be purchased through existing carbon markets or restoration projects.

- **AIR-2:** To reduce CO and GHG emissions, mitigation is proposed for the Applicant to ensure the timber removed from the temporary reservoir area for construction and the large woody material removed during operations will be used and not burned, for example, in restoration projects in the Chehalis River or tributaries.
- **AIR-3:** To reduce DPM and GHG emissions, mitigation is proposed for the Applicant to implement an anti-idling policy for FRE facility and levee construction and operations.

3.2.5 Significant and Unavoidable Adverse Environmental Impacts

Compliance with laws and with implementation of the mitigation measures described in Section 3.2.4, there would be **no significant and unavoidable adverse** air pollutant or GHG impacts from construction or operation of either the FRE facility or the Airport Levee Changes.

3.3 Local Actions Alternative

3.3.1 Impacts from Construction

This section analyzes the potential impacts from construction of local actions such as strategic floodproofing (elevating buildings, building berms or floodwalls), floodplain storage improvement (placing wood in rivers, restoring riparian areas, reforesting floodplain areas), and channel migration protection (placement of wood in rivers).

3.3.1.1 Direct

Of the six local action measures identified under this alternative, three may result in the need for construction activities. Floodproofing existing structures could result in localized construction projects for buildings within the floodplains. This activity would likely occur sporadically, as funding mechanisms become available and would reasonably be expected to result in negligible air pollutants and GHG emissions over an extended period of time.

Likewise, floodplain storage improvements and channel migration protection would also be expected to result in sporadic, localized construction activity over an extended period of time and, therefore, would result in negligible air pollutants and GHG emissions. Consequently, construction activities under the Local Actions Alternative would result be a **minor** adverse impact with respect to air pollutant and GHG emissions.

3.3.1.2 Indirect

No indirect adverse impacts on air quality or GHGs from construction of the Local Actions Alternative are anticipated.

3.3.2 Impacts from Operation

This section analyzes the potential impacts from operation and implementation of local actions, such as adopting higher development and construction standards, strategic floodproofing, buy-out of at-risk properties or structures, floodplain storage improvement, channel migration protection, and early flood warning systems.

3.3.2.1 Direct

No direct adverse impacts on air quality or GHGs from operation of the Local Actions Alternative are anticipated.

3.3.2.2 Indirect

No indirect adverse impacts on air quality or GHGs from operation of the Local Actions Alternative are anticipated.

3.4 No Action Alternative

The No Action Alternative would result **in no adverse impacts** with respect to air pollutant and GHG emissions.

4 REFERENCES

Anchor QEA, 2019. *Reservoir Water Quality Report*. Chehalis River Basin Flood Damage Reduction Proposed Project. Prepared for Washington Department of Ecology and U.S. Army Corps of Engineers. April 2019.

Anchor QEA, 2020. *Proposed Project Description and Alternatives.* Proposed Chehalis River Basin Flood Damage Reduction Project. SEPA Draft Environmental Impact Statement Appendix 1. Prepared for Washington Department of Ecology. February 2020.

BAAQMD (Bay Area Air Quality Management District), 2017. *California Air Quality Act Air Quality Guidelines*. May 2017.

Bureau of Reclamation, 2017. *Sites Reservoir Project Draft Environmental Impact Report/Environmental Impact Statement*. Last updated August 2017; accessed April 24, 2019. Accessed at: https://www.sitesproject.org/resources/environmental-review/draft-environmental-impact-report-environmental-impact-statement/.

CAPCOA (California Air Pollution Control Officers Association), 2017. California Emissions Estimator Model, version 2016.3.2. Accessed November 2017. Accessed at: http://www.caleemod.com/.

CARB (California Air Resources Board), 2005. *Air Quality and Land Use Handbook: A Community Health Perspective*. April 2005.

CEQ (Council on Environmental Quality), 2016. *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews*, August 1, 2016 (Withdrawn, March 28, 2017). Accessed November 20, 2017. Accessed at: https://ceq.doe.gov/guidance/ceq_guidance_nepa-ghg-climate_final_guidance.html.

Ecology (Washington Department of Ecology), 2011. *ECOconnect News Letter*. Last updated May 18, 2011; accessed April 24, 2019. Accessed at: http://ecologywa.blogspot.com/2011/05/air-time-rounding-up-some-air-quality.html.

Ecology, 2017. *Chehalis Basin Strategy Programmatic Environmental Impact Statement.* Prepared for the Governor's Chehalis Basin Work Group. June 2, 2017. Accessed at: http://chehalisbasinstrategy.com/programmatic-eis-2/.

Ecology, 2019a. Yearly report for Washington's Air Monitoring Network on-line tool. Accessed April 24, 2019. Accessed at: https://fortress.wa.gov/ecy/enviwa/.

Ecology, 2019b. 2017 *Washington State Greenhouse Gas Data.* Accessed at: https://ecology.wa.gov/Air-Climate/Climate-change/Greenhouse-gases/2017-greenhouse-gas-data

Ecology, 2019c. *Diesel Emission*. Accessed April 24, 2019. Accessed at: https://ecology.wa.gov/Air-Climate/Air-quality/Vehicle-emissions/Diesel-emissions.

EPA (U.S. Environmental Protection Agency), 1995. *Compilation of Air Pollutant Emission Factors.* Publication AP-42. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Accessed at: www.epa.gov/ttnchie1/ap42. January 1995.

EPA, 2004. *User's Guide for the AMS/EPA Regulatory Model (AERMOD)*. Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division, Research Triangle Park, North Carolina, EPA-454/B-03-001. September 2004.

EPA, 2006. *AP-42 5th Edition Volume 1, Chapter 13, Miscellaneous Sources.* Accessed at: https://www3.epa.gov/ttn/chief/ap42/ch13/index.html.

EPA, 2014. "MOtor Vehicle Emission Simulator (MOVES)." Includes NON-ROAD mode. Versions 2014a and 2014b. Accessed at: https://www.epa.gov/moves.

EPA, 2017. *Our Nation's Air.* Accessed at: https://gispub.epa.gov/air/trendsreport/2017/#highlights

ESA (Environmental Science Associates), 2009. *San Rafael Rock Quarry Amended Reclamation Plan and Amended Surface Mining and Quarrying Permit combined Final Environmental Impact Report.* Accessed April 24, 2019. Accessed at: https://www.marincounty.org/-/media/files/departments/pw/land-use/feir-volume-i_revised-deir.pdf.

ESA, 2017. *Baylands Soil Processing Use Permit and Grading Plan, Brisbane, California; Air Quality and Greenhouse Gas Evaluation Technical Report.* March 2017.

ESA, 2020. *Water Resources Discipline Report*. Proposed Chehalis River Basin Flood Damage Reduction Project. SEPA Draft Environmental Impact Statement Appendix N. Prepared for Washington Department of Ecology. February 2020.

IPCC (Intergovernmental Panel on Climate Change), 2018. Framing and Context. *In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* Editors, Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield. In Press.

Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. *State of Knowledge: Climate Change in Puget Sound.* Prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. Accessed at: https://cig.uw.edu/news-and-events/publications/state-of-knowledge-climate-change-in-puget-sound/.

Mote, P., A.K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder, 2014. "Chapter 21: Northwest." *Climate Change Impacts in the United States: The Third National Climate Assessment*. Editors, J.M. Melillo, T.C. Richmond, and G.W. Yohe. U.S. Global Change Research Program, 487-513. Accessed at: https://nca2014.globalchange.gov/downloads.

PSCAA (Puget Sound Clean Air Agency), 2010. *Tacoma and Seattle Area Air Toxics Evaluation.* October 29, 2010.

Ren, D., 2010. "Effects of global warming on wind energy availability." *Journal of Renewable and Sustainable Energy* 2(5). American Institute of Physics. Updated September 1, 2010. Accessed at: http://scitation.aip.org/content/aip/journal/jrse/2/5/10.1063/1.3486072.

Saint Claire, John (Southwest Clean Air Agency), 2019. Personal communication with Chris Sanchez, Environmental Science Associates. April 1, 2019.

Stephens, T., 2008. S*tronger Coastal Winds Due to Climate Change May Have Far-Reaching Effects.* December 18. Accessed at: https://news.ucsc.edu/2008/12/2644.html.

SWCAA (Southwest Clean Air Agency), 2007. *2007 Annual Report.* Accessed at: http://www.swcleanair.org/docs/annualreports/anrpt2007.pdf.

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Attachment A-1
Air Quality and Greenhouse Gas Emissions Calculations

A-1.1: FRE and Levee Calculations

A-1.2: Quarrying and Blasting Calculations

A-1.3: Levee Health Risk Assessment Methodology

A-1.1
FRE and Levee Calculations

Estimated Equipment hours for Chehalis FRE Construction

Using Sites Golden Gate Dam As a Proxy https://www.sitesproject.org/wp-content/uploads/2018/03/03-Project_Description_SitesDraftEIR-EIS_August2017.pdf

	Height above base (feet)	Crest Length (Feet)			
Golden Get Dam Statistics:	270	2250	Duration all dams =	3626 days	
			Duration Golden Gate Dam =	1949 days	5 years
			Percentage GG Dam =	0.537507	
Chehalis FRE stats:	270	1220			

1. DAM

Equipment hours from Sites appendix: **Dams**

Equipment	days for all dams	days GG Dam	Hours per equipment	Equip # est.	Days per year	Hours/year	Emission Factors (g/operating hr[c]) NOx	PM10	CO2	ROG	SOx	CO	PM2.5
Bulldzer	9402	5054	10	4	1011	10107	23.87448	1.784193	74583.95	0.232298	0.495523	6.872251	1.730667
Compactor	8136	4373	10	3	875	8746	15.58784	0.991488	2162.781	0.338377	0.019881	9.606501	0.961743
Concrete pumper	1077	579	10	0	116	1158	18.33424	2.20668	2042.991	0.33671	0.01878	14.45773	2.140479
Concrete truck	343	184	10	0	37	369	39.55669	2.590641	132985.8	0.353282	0.88044	10.33874	2.512922
crane	0	0		0	0	0	30.33916	1.686969	54271.06	0.287503	0.365965	7.15765	1.63636
Dump Truck	440	237	10	0	47	473	39.55669	2.590641	132985.8	0.353282	0.88044	10.33874	2.512922
Fuel Truck	1880	1011	10	1	202	2021	39.55669	2.590641	132985.8	0.353282	0.88044	10.33874	2.512922
Fork Lift	47	25	10	0	5	51	43.2261	0.629735	30065	0.043439	0.197953	2.61029	0.610842
Geneator	43	23	10	0	5	46	104.5016	7.553154	21914.17	0.945773	0.171338	49.69261	7.326561
Grader	4068	2187	10	2	437	4373	23.31316	1.737061	73222.16	0.226859	0.486404	6.681407	1.68495
Loader	1888	1015	10	1	203	2030	33.9221	2.628046	72839.53	0.328012	0.488853	11.15184	2.549204
Off-road truck	14755	7931	10	6	1586	15862	39.55669	2.590641	132985.8	0.353282	0.88044	10.33874	2.512922
Pile Driver	1035	556	10	0	111	1113	431.1178	21.09527	54520.37	3.920765	0.492104	103.6746	20.46241
Scraper	3604	1937	10	1	387	3874	140.7462	8.536908	133794.1	0.956727	0.925079	51.96218	8.280801
Water Truck	3761	2022	10	2	404	4043	39.55669	2.590641	132985.8	0.353282	0.88044	10.33874	2.512922
			Total	21									

Conversion factor grams to tons = 907184.7

	Emissions in tons/year NOx	PM10	CO2	VOC	SOx	CO	PM2.5
Bulldzer	0.265994	0.019878	830.9673	0.002588	0.005521	0.076566	0.019282
Compactor	0.150285	0.009559	20.85171	0.003262	0.000192	0.092618	0.009272
Concrete pumper	0.023399	0.002816	2.607357	0.00043	2.4E-05	0.018452	0.002732
Concrete truck	0.016078	0.001053	54.05274	0.000144	0.000358	0.004202	0.001021
crane	0	0	0	0	0	0	0
Dump Truck	0.020625	0.001351	69.33879	0.000184	0.000459	0.005391	0.00131
Fuel Truck	0.088124	0.005771	296.2657	0.000787	0.001961	0.023033	0.005598
Fork Lift	0.002407	3.51E-05	1.67447	2.42E-06	1.1E-05	0.000145	3.4E-05
Geneator	0.005325	0.000385	1.116636	4.82E-05	8.73E-06	0.002532	0.000373
Grader	0.112383	0.008374	352.9732	0.001094	0.002345	0.032208	0.008122
Loader	0.075893	0.00588	162.9624	0.000734	0.001094	0.02495	0.005703
Off-road truck	0.691636	0.045297	2325.213	0.006177	0.015394	0.18077	0.043938
Pile Driver	0.528755	0.025873	66.86786	0.004809	0.000604	0.127154	0.025097
Scraper	0.60109	0.036459	571.3996	0.004086	0.003951	0.221917	0.035365
Water Truck	0.176296	0.011546	592.6891	0.001575	0.003924	0.046078	0.0112
Total	**2.758291**	**0.174276**	**5348.98**	**0.025919**	**0.035845**	**0.856015**	**0.169048**
Metric Tons =							

Conversion factor tons to metric tons = 0.907185

Metric tons = 4852.515

Estimated On-Road Emissions for Chehalis FRE Construction

Transport distances: 20 miles — Standard assumption for haul trips w/o defined source

Suppliers to batch plant trips = 6000 From applicant via e-mail (04/05/19)
Reservoir Clearing (logs) = 3200 From applicant via e-mail (04/05/19)
Trips per year = 1840 (5 year construction period)

Vehicle Emission Factors (d) — g/mile

	NOx	PM10 (e)	CO2	VOC(f)	SOx	CO	PM2.5
Single Unit Long-Haul Truck, Diesel	0.875472	0.118374	721.9165	0.077165	0.006037	0.392108	0.039147

d From MOVES2014b for Lewis County, WA; speed and model years aggregated. Road type rural unrestricted and rural restricted (75% unrestricted for workers, 90% unrestricted for haul trucks)
e PM10 and PM2.5 includes brakewear and tirewear
f Non-methane Organic Chemicals

Conversion factor grams to tons = 907184.7

	Emissions in tons/year						
	NOx	**PM10**	**CO2**	**VOC**	**SOx**	**CO**	**PM2.5**
Haul trucks	3.55E-02	4.80E-03	2.93E+01	3.13E-03	2.45E-04	1.59E-02	1.59E-03

Conversion factor tons to metric tons = 0.907185
Metric tons = 26.57

Estimated On-Road Emissions for Chehalis Airport Levee Improvement Construction

Vehicle Emission Factorsd	NOx	PM10e	CO2	VOCf	SOx	CO	PM2.5
	g/mile						
Passenger Car, Gas	0.045303	0.02297	222.3433	0.015007	0.001479	1.044883	0.004899
Passenger Truck, Gas	0.085449	0.025215	294.8907	0.019472	0.001962	1.454192	0.005889
Composite truck/car	0.065376	0.024092	258.617	0.01724	0.001721	1.249537	0.005394

d From MOVES2014b for Lewis County, WA; speed and model years aggregated. Road type rural unrestricted and rural restricted (75% unrestricted for workers, 90% unrestricted for haul trucks)
e PM10 and PM2.5 includes brakewear and tirewear
f Non-methane Organic Chemicals

Worker trips for all construction phases is based on 1.25 workers per equipment in that phase resulting in one roundtrip per worker (CAPCOA, 2017)

	1.25	worker/equipment
workers =	39.83924	workers
Worker trips =	79.67848	trips/day
Worker trip length =	20	miles
Daily VMT =	1593.57	miles/day
Annual VMT =	414328.1	miles/yr

Assume workers 50% passenger truck and 50% passenger car > Composite emission factor above

Conversion factor grams to tons = 907184.7

Emissions in tons/year

	NOx	PM10	CO2	VOC	SOx	CO	PM2.5
Workers	0.029858	0.011003	118.1152	0.007874	0.000786	0.570687	0.002464

Conversion factor tons to metric tons = 0.907185

Metric Tons = 107.1523

Dust Calculations -Loading and Unloading of Soils

Loads per year =	2290	Round truck trips		
Truck capacity =	16	cy/truck	(CalEEMod default for material off-haul)	
Annual load/unload volume =	36640	cubic yards		
Volume to mass Conversion =	1	cubic yard =	1.264166 ton	CalEEMod Appendix A
Daily load/unload mass =	46319.05	tons		

Emission Factor equasion from AP-42 Section 13.2.4

$$E = k(0.0032) \times \frac{(U/5)^{1.3}}{(M/2)^{1.4}}$$

where:
E = emission factor
k = particle size multiplier (dimensionless)
U = mean wind speed, meters per second (m/s) (miles per hour [mph])
M = material moisture content (%)

k (PM10) =	0.35		Ap-42 Page 13.2.4-4
k (PM2.5) =	0.053		Ap-42 Page 13.2.4-4
U =	4.1	mph	https://weatherspark.com/y/782/Average-Weather-in-Chehalis-Washington-United-States-Year-Round#Sections-Wind
M =	0.11		Ap-42 Table 13.2.4-1 for fill materials

Epm10 =	5.02E-02	lb/ton
Epm2.5 =	7.60E-03	lb/ton

PM10 emissions =	2325.03	pound per year	=	1.162513	ton/yr
PM2.5 Emissions =	352.08	pound per year	=	0.176038	ton/yr

Concrete Quantities for FRE

Source: Applicant FRE Supplement Design Report
PDF page 159 (Page J-6 of appendix J: Construction Cost Opinion)

Element	CY of concrete
Diversion tunnel	1200
RCC	892000
Dam Crest Concrete	5400
WQ Intake Tower	5800
Flip bucket	5800
Spillway	8700
Sluice basin	8600
Sluice basin	1600
Total RCC =	892000
TotalConventional =	37100
Total Concrete =	929100

Concrete ratios: cement : Sand : agregate

M35	1:0.5:1	CY Required
Aggregate requirement =	40.00%	371640
Cement & Flyash =	40.00%	371640
Sand =	20.00%	185820

Truck trip for hauling

Assume truck capacity of: 16 CY

Truckloads

Aggregate requirement =	23228	Loads	These are on-site trips since aggregate is quarried on-site
Cement & Flyash =	23228	Loads	
Sand =	11614	Loads	
Total offsite loads =	34841		
Total offsite oneway trips =	69683		

Estimated On-Road Emissions for Chehalis FRE Construction

Transport distances: 20 miles Stanmdard assu,ption for haul trips w/odefined source

Suppliers to batch plant trips = 6000 From applicant via e-mail (04/05/19)
Reservoir Clearing (logs) = 3200 From applicant via e-mail (04/05/19)
Trips per year = 1200 (5 year construction period)

Vehicle Emission Factors (d)	g/mile						
	NOx	PM10 (e)	CO2	VOC(f)	SOx	CO	PM2.5
Single Unit Long-Haul Truck, Diesel	0.875472	0.118374	721.9165	0.077165	0.006037	0.392108	0.039147

d From MOVES2014b for Lewis County, WA; speed and model years aggregated. Road type rural unrestricted and rural restricted (75% unrestricted for workers, 90% unrestricted for haul trucks)
e PM10 and PM2.5 includes brakewear and tirewear
f Non-methane Organic Chemicals

Conversion factor grams to tons = 907184.7

	Emissions in tons/year						
	NOx	**PM10**	**CO2**	**VOC**	**SOx**	**CO**	**PM2.5**
Haul trucks	2.32E-02	3.13E-03	1.91E+01	2.04E-03	1.60E-04	1.04E-02	1.04E-03

Conversion factor tons to metric tons = 0.907185
Metric tons = 17.33

A-1.2
Quarrying and Blasting Calculations

Estimated Emissions from Quarrying Activities for FRE

Quarry to batch plant truck trips

Transport distances:

North quarry:	2.7	miles	Paved road	assume 0.5 mile of unpaved	From 1/9/19 letter in "Attachment.pdf":
South Quarry:	6.5	miles	Paved road	assume 0.5 mile of unpaved	From 1/9/19 letter in "Attachment.pdf":
Huckleberry Ridge Quarry:	8.2	miles	1.4 paved	assume 6.8 unpaved	From 1/9/19 letter in "Attachment.pdf":

Trip frequencies

Quarry trips to batch plant total = 55000 From applicant via e-mail (04/05/19)
Trips per year = 11000 (5 year construction period)

Speed assumption: 20 mph From 1/9/19 letter in "Attachment.pdf":
Use South Quarry distance as average
Hours per trip = 0.325 hour/trip
Annual Hours = 3575 hours/year

Exhaust Emissions

	NOx	PM10	CO2	ROG	SOx	CO	PM2.5
	MOVES Emission Factor g/operating hr[c]						
Off highway CAT 769C							
Off-highway Trucks	39.55669	2.590641	132985.8	0.353282	0.88044	10.33874	2.512922

Conversion factor grams to tons = 907184.7

	Emissions in tons/year						
Equipment	NOx	PM10	CO2	VOC	SOx	CO	PM2.5
Off-highway Trucks	0.155884	0.010209	524.0655	0.001392	0.00347	0.040743	0.009903

Conversion factor tons to metric tons = 0.907185
Metric tons = 475.4244

A. Emissions from equipment operation Equipment type and number from San Rafael Rock Quarry EIR (ESA Project 205145)

Hours/day = 10
Days/year = 260
Hours/year = 2600

	NOx	PM10	CO2	ROG	SOx	CO	PM2.5
Equipment/b/	MOVES Emission Factor g/operating hr[c]						
Wheeled Loaders	33.9221	2.628046	72839.53	0.328012	0.488853	11.15184	2.549204
Excavator	21.02322	1.540977	43579.16	0.112966	0.289064	6.309188	1.494748
Bulldozer	23.87448	1.784193	74583.95	0.232298	0.495523	6.872251	1.730667

				Emissions in tons/year						
Equipment/b/	#	Hours/yr	Total hr/yr	NOx	PM10	CO2	VOC	SOx	CO	PM2.5
Wheeled Loaders	7	2600	18200	0.680547	0.052724	1461.311	0.006581	0.009807	0.223729	0.051142
Excavator	3	2600	7800	0.180758	0.013249	374.6948	0.000971	0.002485	0.054247	0.012852
Bulldozer	1	2600	2600	0.068424	0.005114	213.7583	0.000666	0.00142	0.019696	0.00496
Total Equipment Exhaust =				**0.92973**	**0.071087**	**2049.764**	**0.008218**	**0.013713**	**0.297672**	**0.068954**
	11									

Conversion factor tons to metric tons = 0.907185
Metric tons = 1859.516

Calculation Of Entrained Road Dust from Quarrying

Calculation of On-road entrained road dust emission factors

Eext = [k (sL)0.91 x (W)1.02] (1 – P/4N)
Where:
Eext = annual or other long-term average emission factor in the same units as k,
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m2),
W = average weight (tons) of all the vehicles traveling the road (2.4 tons)
P = number of “wet” days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

k =	0.0022	lb PM10/VMT	From AP-42 Table 13.2.1-1	
	0.00054	lb PM2.5/VMT		
sL =	0.2	g/m2	Ubiquitous baseline for 500 to 50000 ADT	
W =	2.4	tons	CalEEMod default for CA	This is average weight of all vehicls on the roadway, not just trucks)
P =	180			
N =	365			
Eext =	1.09E-03	lbs PM10/VMT		
Eext =	2.67E-04	lbs PM2.5/VMT		

Calculation of Off-road entrained road dust emission Factors

The following equation is used to calculate the fugitive dust emissions associated with unpaved roads

Edust= k(s/12)^a X (W/3)^b

Where:
E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
a = empirical constant
b = empirical constant

k =	1.8	lb PM10/VMT	From AP-42 Table 13.2.2-2
	0.18	lb PM2.5/VMT	
s =	8.5	%	From AP-42 Table 13.2.2-1
W =	25	Tons	Assumed CAT 796C
a =	0.9	unitless	From AP-42 Table 13.2.2-2
b =	0.3	unitless	From AP-42 Table 13.2.2-2

Edust =	2.493056052	lbs PM10/VMT
Edust =	0.249305605	lbs PM2.5/VMT

Transport distances:

North quarry:	2.7	miles	Paved road	assume 0.25 mile of unpaved	From 1/9/19 letter in "Attachment.pdf":
South Quarry:	6.5	miles	Paved road	assume 0.25 mile of unpaved	From 1/9/19 letter in "Attachment.pdf":
Huckleberry Ridge Quarry:	8.2	miles	1.4 paved		

Using South Quarry as worst case (Huckleberry Ridge is identified as the least ppreferrred option due to extesive road work and costs)

Quarry trips to batch plant total = 55000 From applicant via e-mail (04/05/19)

Trips per year = 11000 (5 year construction period)

Annual VMT for on-road truck travel = 71500 VMT
Annual VMT for off-road truck travel = 5500 VMT

On-Road PM-10 =	3.89E-02	ton/year
On Road PM2.5 =	9.56E-03	ton/year
Off-road PM-10 =	6.855904	ton/year
Off-roaf PM2.5 =	0.68559	ton/year

Calculations of Emmission from Blasting Activity at the Quarry

Methodology from San Diego County APCD for PM10					https://www.sandiegocounty.gov/content/dam/sdc/apcd/PDF/Toxics_Program/
Annual load/unload mass =	93962.95	tons			
Blast Production =	370	tons	per	100	square ft
Annual 100 squre feet blasts need	253.9539				
PM10 emission rate =	0.007	pounds/100 square toot blast			
PM10 emissions =	1.777677				

/APCD_blasting1.pdf

Emissions from Aggregate Processing

Aggregate Demand   Based on Conmcrete Demand

Source: Applicant FRE Supplement Design Report
PDF page 159   (Page J-6 of appendix J: Construction Cost Opinion)

Element	CY of concrete
Diversion tunnel	1200
RCC	892000
Dam Crest Concrete	5400
WQ Intake Tower	5800
Flip bucket	5800
Spillway	8700
Sluice basin	8600
Sluice basin	1600
Total RCC =	892000
TotalConventional =	37100
Total Concrete =	**929100**

Aggregate needed			
Concrete ratios: cement : Sand : agregate			
M35	1:0.5:1		CY Required
Aggregate requirement =		40.00%	**371640**
Cement & Flyash =		40.00%	371640
Sand =		20.00%	185820

Construction Period = 5 years

Annual Aggregate Production =	74328	CY/year			
Work days/year =	260	days/yr			
Workhour/day =	10	hours/day			
hours/yr =	2600	hours/yr			
Hourly production rate =	28.588	CY/hr			
Hourly production rate =	36.135	ton/hr	1.264	tons/cy	From CalEEMod Appendix A, 2016

Table
Estimated PM Emissions From Aggregate Crushing Operations - Uncontrolled

Production Rate estimates

Hourly Process Rate (ton)	36
Daily Process Rate (tons)	361
Daily Process Rate (yd3) =	286
Annual Process Rate (yd^3) =	74,328
Annual Process Rate (ton) =	93,951

Processing Equipment Emissions

Plant	Equipment	Process Rate (ton/hr)	Number of Transfers	Daily Operation (hours)	Uncontrolled Emission Factor PM2.5 (lb/ton)	Uncontrolled Emission Factor PM10 (lb/ton)	PM10 Emissions Hourly (lb/hr)	PM10 Emissions Daily (lb/day)	PM10 Emissions Annual (ton/yr)	PM2.5 Emissions Hourly (lb/hr)	PM2.5 Emissions Daily (lb/day)	PM2.5 Emissions Annual (ton/yr)
Main Plant	**Jaw Crusher**	36	1	10	0.00044	0.0024	0.09	0.87	0.11	0.02	0.16	0.02
Main Plant	**Three Deck Screen**	36	3	10	0.00059	0.0087	0.94	9.43	0.41	0.06	0.64	0.08
Main Plant	**Primary Cone Crusher**	36	1	10	0.00044	0.0024	0.09	0.87	0.11	0.02	0.16	0.02
Main Plant	**Secondary Cone Crusher**	36	1	10	0.00044	0.0024	0.09	0.87	0.11	0.02	0.16	0.02
Main Plant	**Conveyor Tranfer Point**	36	1	10	3.11E-04	0.00110	0.04	0.40	0.05	0.01	0.11	0.01
	Total Agregate Processing Equipment						***1.24***	***12.43***	***0.80***	***0.12***	***1.23***	***0.16***

Emissions Factors from AP-42 Table 11.19.2-2
http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s1902.pdf

Calculation of Batch Plant Emissions

Star Concete Batch Plant Proposed for Redwood City based on annual throughput of 730,000 Tons/year

Stationary Source Emissions	PM10 Emission Factor	PM2.5 Emission Factor	Material	PM10	PM2.5
	(lbs/ton)	(lbs/ton)	tons/year	tons/year	tons/year
Aggregate Transfer	0.0033	0.0005	312,532	0.15	0.02
Sand Transfer	0.00099	0.00015	275,105	0.04	0.01
Cement Unloading	0.00034	0.00005	83,773	0.01	0.00
Cement supplement (fly ash) unloading	0.0049	0.0007	14,866	0.04	0.01
Weigh Hopper Loading	0.0028	0.0004	730,000	0.25	0.04
Mixer Loading (central mix)	0.0055	0.0008	730,000	0.27	0.04
Active and Inactive Storage Piles				0.22	0.03
Total				0.99	0.14

Project Concrete demend (five year)= 929100 CY
Project annual concrete demand = 185820 CY

Conversion factor: 1 CY of concrete = 2.03 tons

Project Concrete demend (five year)= 1886073 Ton
Project annual concrete demand = 371640 Ton

Ratio of project throughput to throughput of Star Concrete = 0.509096

Scaled Project Batch Plant based on annual throughput

Stationary Source Emissions	PM10 Emission Factor	PM2.5 Emission Factor	Material	PM10	PM2.5
	(lbs/ton)	(lbs/ton)	tons/year	tons/year	tons/year
Aggregate Transfer	0.0033	0.0005	159,109	7.88E-02	1.19E-02
Sand Transfer	0.00099	0.00015	140,055	2.08E-02	3.15E-03
Cement Unloading	0.00034	0.00005	42,649	7.25E-03	1.07E-03
Cement supplement (fly ash) unloading	0.0049	0.0007	7,568	1.85E-02	2.65E-03
Weigh Hopper Loading	0.0028	0.0004	371,640	1.26E-01	1.79E-02
Mixer Loading (central mix)	0.0055	0.0008	371,640	1.38E-01	2.01E-02
Active and Inactive Storage Piles				1.13E-01	1.69E-02
Total				5.02E-01	7.38E-02

Permit Handbook	Weight	Percentage
Aggregate	1865	0.463492
Sand	1428	0.354888
Cement	491	0.122024
Cement supplement	73	0.018142
Water	166.8	0.041453
Total	4023.8	lbs/yard

Dust Calculations -Loading Rock from Quarrying

Annual process rate volume =	74,328	cubic yards	(From aggregate processing calculation spreadsheet)		
Volume to mass Conversion =	1	cubic yard =	1.264166	ton	CalEEMod Appendix A
Daily load/unload mass =	93962.95	tons			

Emission Factor equasion from AP-42 Section 13.2.4

$$E = k(0.0032) \times \frac{(U/5)^{1.3}}{(M/2)^{1.4}}$$

where:
E = emission factor
k = particle size multiplier (dimensionless)
U = mean wind speed, meters per second (m/s) (miles per hour [mph])
M = material moisture content (%)

k (PM10) =	0.35		Ap-42 Page 13.2.4-4
k (PM2.5) =	0.053		Ap-42 Page 13.2.4-4
U =	4.1	mph	https://weatherspark.com/y/782/Average-Weather-in-Chehalis-Washington-United-States-Year-Round#Sections-Wind
M =	0.11		Ap-42 Table 13.2.4-1 for fill materials

Epm10 =	5.02E-02	lb/ton
Epm2.5 =	7.60E-03	lb/ton

PM10 emissions =	4716.55	pound per year	=	2.358277	ton/yr
PM2.5 Emissions =	714.22	pound per year	=	0.357111	ton/yr

Dust Calculations -Loading and Unloading of aggregates for Batch plant processing

Annual Hours = 33800 hours/year

Truck capacity = 16 cy/truck (CalEEMod default for material off-haul)

Annual process rate volume = 74328 cubic yards (From aggregate processing calculation spreadsheet)

Volume to mass Conversion = 1 cubic yard = 1.264166 ton CalEEMod Appendix A

Annual load/unload mass = 93962.95 tons

Emission Factor equasion from AP-42 Section 13.2.4

$$E = k(0.0032) \times \frac{(U/5)^{1.3}}{(M/2)^{1.4}}$$

where:
E = emission factor
k = particle size multiplier (dimensionless)
U = mean wind speed, meters per second (m/s) (miles per hour [mph])
M = material moisture content (%)

k (PM10) =	0.35		Ap-42 Page 13.2.4-4
k (PM2.5) =	0.053		Ap-42 Page 13.2.4-4
U =	4.1	mph	https://weatherspark.com/y/782/Average-Weather-in-Chehalis-Washington-United-States-Year-Round#Sections-Wind
M =	0.11		Ap-42 Table 13.2.4-1 for fill materials

Epm10 = 5.02E-02 lb/ton
Epm2.5 = 7.60E-03 lb/ton

PM10 emissions =	4716.55	pound per year	=	2.358277	ton/yr
PM2.5 Emissions =	714.22	pound per year	=	0.357111	ton/yr

A-1.3
Levee Health Risk Assessment Methodology

Methods

The methods and assumptions used in this HRA are consistent with the guidance recommended by OEHHA's *Air Toxic Hot Spots Program Risk Assessment Guidelines* (2015). The OEHHA methodology used in this assessment uses a dose-response assessment to characterize risk from cancer due to inhaled TACs. Refer to Appendix A for the calculation and modeling files used in the screening HRA.

Based on the OEHHA guidance, the evaluation of potential health risks uses the following standard four-step risk assessment process:

1. hazard identification;
2. exposure assessment;
3. dose-response assessment; and
4. risk characterization.

Each step is described in detail below.

Hazard Identification

The hazard identification process is undertaken to determine what TACs would potentially be present in the assessment area, and if present, identifies what the pollutants of concern are along with their potential adverse health effects. In this HRA, the primary hazard is DPM emissions from operation of off-road construction equipment. DPM from heavy duty trucks was considered along the truck haul routes contained within the project construction zone. Truck haul routes outside of the main construction area were not considered, since contributions from haul trucks within the project radius would represent the worst case DPM emissions of the sensitive receptors surrounding the proposed project site. In addition, total on-road truck emissions for all travel locations are minor compared to off-road construction equipment emissions.

DPM historically has been used as a surrogate measure of exposure for whole diesel exhaust emissions. Diesel exhaust is a complex mixture of thousands of gases and fine particles (commonly known as soot). Diesel exhaust particles and gases are suspended in the air due to thermal buoyancy and the small size of the particles. The composition of diesel exhaust varies depending on engine type, operating conditions, fuel composition, lubricating oil, and presence of an emission control system. One of the main characteristics of diesel exhaust is the release of particles at a relative rate approximately 20 times greater than from gasoline exhaust, on an equivalent fuel basis. Diesel particulates are mainly aggregates of spherical carbon particles coated with inorganic and organic substances. The inorganic fraction primarily consists of small carbon (elemental carbon) particles ranging from 0.01 to 0.08 micron in diameter. The organic fraction consists of soluble organic compounds (CARB 1998).

Exposure Assessment

The degree of the residences exposure to DPM from project construction activities was evaluated under the exposure assessment portion of the HRA. This assessment involves the quantification of DPM emissions and dispersion modeling. The amount of DPM emissions generated by construction activities was determined using particulate matter with an aerodynamic diameter equal to or less than 10 microns (PM10) from diesel exhaust as a surrogate. OEHHA guidance indicates that the cancer potency factor to be used to evaluate cancer risks were developed based on whole (gas and particulate matter) diesel exhaust, and that the surrogate for whole diesel exhaust is DPM, with PM10 serving as the basis for the potential risk calculations (OEHHA, 2003).

The greatest potential for TAC emissions would be related to DPM emissions associated with off-road heavy equipment operations during demolition, grading and excavation, and construction activities. The potential exposure through other pathways (e.g., ingestion) requires substance and site-specific data, and the specific parameters for DPM are not known for these pathways (CARB, 1998). OEHHA developed necessary data to evaluate carcinogenicity of DPM through the inhalation pathway only. Once determined, the dose is multiplied by the compound-specific inhalation cancer potency factor to derive the cancer risk estimate. The dose takes into account the concentration at a sensitive receptor. The cancer potency factor is compound-specific.

Emissions Inventory

Emissions analyzed in the HRA were based on the air quality emissions estimates for the project prepared for the Discipline Report

The US Environmental Protection Agency's (USEPA) MOtor Vehicle Emission Simulator (MOVES) is a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics. The latest version, MOVES2014, was used to generate hourly emission factors for nonroad equipment specific to the project county of Lewis County, WA. For the airline road levee improvements, total unmitigated offroad construction DPM emissions are 0.0565 tons per year. This annual tonnage represents the "worst-case" annual construction emissions and was conservatively applied to the entire year of construction.

Emission Rates

A unitized emission rate concept for the source was modeled with an emission rate of 1 gram/second (g/s). The modeled concentration at each receptor ([μ/m^3]/[g/s]) represents a "dispersion factor," which was then multiplied by the actual emission rate of the source to determine actual concentrations.

The emission rates would vary day to day, with some days having no emissions. For simplicity, the model assumed a constant emission rate during an entire year.

Dispersion Modeling

Dispersion modeling predicts the air pollutant concentrations due to emissions from a source at defined receptor point locations. The most current version (18081) of the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) was used in the modeling analysis for this project. The AERMOD model is a USEPA-approved model that was introduced to incorporate air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources and both simple and complex terrain. The AERMOD model requires numerous inputs, such as meteorological data, source parameters, topographical data, and receptor characteristics. Where project-specific information is not available, default parameter sets that are designed to produce conservative (i.e., overestimates of) air concentrations were utilized (USEPA 2018). **Table 1**, **Overall AERMOD Modeling Parameters**, summarizes the overall modeling parameters used in AERMOD. For values not listed, defaults were used. Refer to Appendix A for the AERMOD modeling outputs used in the screening HRA.

TABLE 1
OVERALL AERMOD MODELING PARAMETERS

Pathway	Description	Parameter
Control	Rural/Urban	Rural
	Terrain	Elevated
	Model Version	AERMOD v 18081
Receptor	Receptor Height	1.5 m
Meteorology	Surface Station	OLYMPIA, WA (24227) / CHEHALIS, WA (00119)
	Upper Air Station	SALEM, OR (24232)
	MET Years	2014-2018
	Base Elevation (MSL)	61 m

ABBREVIATIONS: m = meters

SOURCES:
1. Lakes Environmental Software, 2019. Order #MET1914124 AERMOD-Ready Station Met Data. April 10, 2019.
2. National Oceanic and Atmospheric Administration, 2019. File Transfer Protocol (FTP) Directory 2014-2018.

Meteorological Data

The nearest meteorological surface station is located at the Chehalis–Centralia Airport: WBAN code of 00119. The Chehalis-Centralia Airport does not record one-minute automated surface observing system (ASOS) data, which is required for accurate AERMOD results. The Olympia Regional Airport, WBAN code of 24227, is approximately 31 kilometers north of the project site and has the required 1-minute ASOS data available. Meteorological data for both stations was processed using AERMET v18081. Chehalis-Centralia Airport was processed without the AERMINUTE data and the Olympia Regional Airport was processed twice: once without AERMINUTE and once with AERMINUTE. The results of the three separate AERMOD runs were all required to predict particulate matter concentrations at the receptors and their aggregation is discussed below.

Source Parameters

Source parameters are required to model the dispersion of emissions. Off-road construction equipment was modeled as an area source within AERMOD using the same release parameters used in a San Francisco Citywide HRA, which evaluates the cumulative lifetime cancer risks and annual average exhaust $PM_{2.5}$ concentrations from existing known sources of air pollution as part of the development of a Community Risk Reduction Plan (CRRP) (referred to as the CRRP-HRA). Parameters from the CRRP-

HRA include a release height of 3.89 meters and an initial vertical dimension of 1.4 meters for Off-Road sources (BAAQMD, SF DPH & SF Planning, 2012). Construction activities at the site were modeled as a single line area source occupying the 3070 meters of levee to be repaired. **Table 2**, **Source Modeling Parameters for Off-Road Construction Equipment**, summarizes the source modeling parameters used in AERMOD.

TABLE 2
SOURCE MODELING PARAMETERS FOR OFF-ROAD CONSTRUCTION EQUIPMENT

Source	Project Component	Source Type	Source Dimension	Number of Sources	Release Height [m]	Initial Vertical Dimension [m]
Off-Road Construction Equipment	Levee Improvement	Line Area	Length: 3070 m Width: 30 m	1	3.89	1.4

ABBREVIATIONS: m = meters

SOURCES:

Sensitive Receptors

Sensitive receptors were formed in 20 meter by 20 meter grids within the residential areas existing in the nearest to the project parameters. The three areas of focus were the housing along the northern face of NW River Street, housing on the west of NW Airport Road, and the RV Park further north on Airport Rd. near River Side Golf Course. There are no schools or daycares within 1,000 feet of this site. Receptor heights were set at 1.5 meters to represent flagpole receptor concentrations.

Adjustment to Modeling Output

As discussed, because the nearest meteorological station (the Chehalis–Centralia Airport) does not have a complete dataset, three separate AERMOD runs were all required to predict particulate matter concentrations. The results of the three models were then aggregated to achieve an adjusted "dispersion factor" that is more representative of the meteorological conditions near the levee repair site **(Equation 1)**. Each receptor was individually adjusted i.e. the spatially varying nature of the scaling factor was applied.

$$\mathbf{DF_{D,\mathit{i}} = DF_{C,\mathit{i}} \times [DF_{A,\mathit{i}} / DF_{B,\mathit{i}}]} \qquad \textbf{(Equation 1)}$$

Where:

DF_D = adjusted dispersion factor, [μg/m^3]/[g/s]

DF_A = dispersion factor with Olympia MET data with 1-miniute ASOS, [μg/m^3]/[g/s]

DF_B = dispersion factor with Olympia MET data without 1-minute ASOS, [μg/m^3]/[g/s]

DF_C = dispersion factor with Chehalis MET data without 1-minute ASOS, [μg/m^3]/[g/s]

i = any one modeled receptor

The maximum adjusted “dispersion factor” at each of the three residential areas of focus were then evaluated in the health risk assessment.

Dose-Response Assessment

The dose-response assessment is the process of characterizing the relationship between exposure to diesel exhaust and the incidence of an adverse health effect in exposed populations.

The estimation of potential inhalation cancer risk posed by exposure to DPM requires a cancer potency factor. Cancer potency factors are expressed as the upper bound probability of developing cancer assuming continuous lifetime exposure to diesel exhaust at a dose of one milligram per kilogram of body weight, and are expressed in units of inverse dose as a potency slope (i.e., $[mg/kg/day]^{-1}$). A cancer potency factor when multiplied by the dose of a carcinogen gives the associated lifetime cancer risk. OEHHA’s recommended cancer potency factor for DPM is 1.1 $(mg/kg/day)^{-1}$. The estimation of potential inhalation chronic non-cancer effects posed by exposure to DPM requires a chronic reference exposure level (REL). A chronic REL is a concentration level (that is expressed in units of $\mu g/m^3$ for inhalation exposures), at or below which no adverse health effects are anticipated following long-term exposure. OEEHA’s recommended chronic REL for DPM is 5 $\mu g/m^3$ (CARB & OEHHA, 2017). The chronic hazard index target organ for DPM is the respiratory system.

Risk Characterization

Risk characterization combines the maximum annual average ground-level DPM concentration from the exposure assessment and the cancer potency factor and chronic REL from the dose-response analysis to estimate the potential inhalation cancer risk from exposure to DPM emissions.

In performing health risk calculations, carcinogenic compounds are not considered to have threshold levels (i.e., dose levels below which there are no risks). Any exposure, therefore, will have some associated risk. Incremental health risks associated with exposure to carcinogenic compounds is defined in terms of the probability of developing cancer as a result of exposure to a chemical at a given concentration. Under a deterministic approach (i.e., point estimate methodology), the cancer risk probability is determined by multiplying the chemical’s annual concentration by its unit risk factor (URF). The URF for DPM recommended by the Scientific Review Panel[1] is 3.0×10^{-4} $\mu g/m^3$ (CARB, 1998). This value corresponds to a Cancer Potency Factor (CPF) of 1.1 per milligram/kilogram (body weight) per day (mg/kg(bw)-day) (CARB & OEHHA, 2017). The URF for DPM means that for receptors with an annual average concentration of 1 $\mu g/m^3$ in the ambient air, the probability of contracting cancer over a 70-year lifetime of exposure is 300 in 1 million. The URF also assumes that a person is exposed continuously for a 70-year lifetime. This approach for calculating cancer risk is intended to result in conservative (i.e., health protective) estimates of health impacts and is used for assessing risks to sensitive receptors. The estimation of cancer risk generally uses the following algorithms (OEHHA, 2015):

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1 The Scientific Review Panel is charged with evaluating the risk assessments of substances proposed for identification as toxic air contaminants by CARB, OEHHA, and the Department of Pesticide Regulation (DPR), and the review of guidelines prepared by OEHHA.

Cancer Risk = Dose inhalation × Inhalation CPF × ASF × ED/AT × FAH (Equation 2)

Where:

Cancer Risk = residential inhalation cancer risk

Dose inhalation (mg/kg-day) = C_{AIR} × DBR × A × EF × 10^{-6} (Equation 3)

Inhalation CPF = inhalation cancer potency factor ($[mg/kg/day]^{-1}$)

ASF = age sensitivity factor for a specified age group (unitless)

ED = exposure duration for a specified age group (years)

AT = averaging time period over which exposure is averaged in days (years)

FAH = fraction of time at home (unitless)

Where:

C_{AIR} = concentration of compound in air in micrograms per cubic meter ($\mu g/m^3$)

DBR = daily breathing rate in liter per kilogram of body weight per day (L/kg-body weight/day)

A = inhalation absorption factor (1 for DPM, unitless)

EF = exposure frequency in days per year (unitless, days/365 days)

10^{-6} = micrograms to milligrams conversion, liters to cubic meters conversion

The OEHHA-recommended values for the parameters listed above were used in the HRA analysis. The daily breathing rate (DBR) used in the analysis was based on OEHHA recommendations, which vary depending on age, as shown in **Table 3, Daily Breathing Rates, Fraction of Time at Home, and Age Sensitivity Factors**. The recommended residential exposure frequency (EF) is 350 days per year, which is equivalent to 0.96 (350 days / 365 days a year). The inhalation absorption factor (A) is assumed to be 1 for inhalation based risk assessment. As indicated in Equation 2 above, each age group has different exposure parameters that require cancer risk to be calculated separately for each age group. Values for fraction of time at home (FAH) also vary depending on age, as shown in Table 3. Once dose is calculated, cancer risk is calculated by accounting for cancer potency of the specific pollutant, and the age sensitivity factor (ASF), which also varies by age as shown in Table 3.

TABLE 3
DAILY BREATHING RATES, FRACTION OF TIME AT HOME, AND AGE SENSITIVITY FACTORS

Parameter	3rd Trimester	Age 0 < 2
Daily Breathing Rate (DBR) [a] (L/kg-body weight/day)	361	1,090
Exposure Frequency (EF) [b]	0.96	0.96
Fraction of Time at Home (FAH) for residential receptors [c]	0.85	0.85
Age Sensitivity Factor (ASF)	10	10

NOTES:
[a] Daily breathing rate for residential receptor is based on the OEHHA 95th percentile values (Table 5.6).
[b] The recommended residential exposure frequency (EF) is 350 days per year, which is equivalent to 0.96 (350 days / 365 days a year).
[c] Fraction of time at home is set to 0.85 for residential since the nearest school has an unmitigated cancer risk of <1 per million (see Table 2 below), per OEHHA Table 8.4. FAH is not applicable to school receptors.

SOURCE: Office of Environmental Health Hazard Assessment, 2015. *Air Toxics Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments*. February.

The estimation of non-cancer inhalation chronic risk uses the following algorithm (OEHHA, 2015):

Hazard Quotient = C_{air} / REL **(Equation 4)**

Where:

Hazard Quotient = chronic non-cancer hazard

C_{AIR} = concentration of compound in air in micrograms per cubic meter (μg/m^3)

REL = Chronic non-cancer Reference Exposure Level for substance (μg/m^3)

As noted above, the REL for DPM is 5 μg/m^3 (CARB & OEHHA, 2017). The chronic hazard index target organ for DPM is the respiratory system.

Health Risk Calculations

The resulting health risk calculations were performed using a the OEHHA guidance and the results of the AERMOD dispersion model. **Table 4, Maximum Increase in Health Risk from Construction Emissions for Off-Site Sensitive Receptors - Unmitigated** summarizes the carcinogenic risk for the maximum impacted sensitive receptors for the unmitigated scenario.

For carcinogenic exposures, the cancer risk from DPM emissions for the unmitigated construction scenario is estimated to result in a maximum carcinogenic risk of approximately 19.7 per one million for the improvement project. Under the mitigated construction scenario, the proposed project is estimated to result in a maximum incremental increase in carcinogenic risk of 1.5 per one million. The maximum impact for the project would occur at the residential land uses directly east of the site. As discussed previously, the lifetime exposure under OEHHA guidelines takes into account early life (infant and children) exposure. It should be noted that the calculated cancer risk assumes sensitive receptors (residential uses) would not have any emission controls such as mechanical filtration and exposure would occur with windows open. This HRA focuses on residential impacts and does not include impacts for on-site or off-site workers. Although off-site workers may be in close proximity to the proposed project site, their intermittent exposure duration would be less than that of a residence (8 hours compared to 24 hours) and adult breathing rates compared to children are also lower (e.g. 261 for age 16<30 versus 1,090 for age 0<2 years). Therefore, worker impacts would be less than that of a residence.

TABLE 4
MAXIMUM INCREASE IN HEALTH RISK FROM CONSTRUCTION EMISSIONS FOR OFF-SITE SENSITIVE RECEPTORS - UNMITIGATED

Project Component / Sensitive Receptor Type	Maximum Cancer Risk (# in one million)	Maximum Non-Cancer Risk (Chronic Hazard Index)
Improvement Project		
Residential Receptor – RV Park	4.84	0.02
Residential Receptor – Airport Road	4.20	0.01
Residential Receptor – NW River Street	0.71	<0.001

Health risk calculations are provided in Appendix A

The process of assessing health risks and impacts includes a degree of uncertainty. The level of uncertainty is dependent on the availability of data and the extent to which assumptions are relied upon in cases where the data are incomplete or unknown. All HRAs rely upon scientific studies in order to reduce the level of uncertainty; however, it is not possible to completely eliminate uncertainty from the analysis. Where assumptions are used to substitute for incomplete or unknown data, it is standard practice in performing HRAs to err on the side of health protection in order to avoid underestimating or underreporting the risk to the public by assessing risk on the most sensitive populations, such as children and the elderly.