Attachment 11
Air Quality and Odor Discipline Report

CAPITOL LAKE – DESCHUTES ESTUARY

Long-Term Management Project Environmental Impact Statement

Air Quality and Odor Discipline Report

Prepared for:

Washington State Department of Enterprise Services

1500 Jefferson Street SE
Olympia, WA 98501

Prepared by:

Ramboll US Corporation and Environmental Science Associates (ESA)

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Executive Summary

This Air Quality and Odor Discipline Report describes the potential impacts of the Capitol Lake – Deschutes Estuary Long-Term Management Project on odor, air quality, and greenhouse gases (GHGs). The Capitol Lake – Deschutes Estuary includes the 260-acre Capitol Lake Basin, located on the Washington State Capitol Campus, in Olympia, Washington. Long-term management strategies and actions are needed to address issues in the Capitol Lake – Deschutes Estuary project area. An Environmental Impact Statement (EIS) is being prepared to document the potential environmental impacts of various alternatives and determine how these alternatives meet the long-term management objectives identified for the watershed.

Potential air quality and odor impacts are evaluated separately. Odor impacts are assessed based on the final configuration for each alternative. Odor impacts associated with construction (i.e., earthwork or equipment exhaust) would be short in duration and infrequent and would therefore not rise to the level of nuisance or be characterized as significant. The potential for odor impacts would be primarily associated with the creation of tideflats within the project area under the Estuary and Hybrid Alternatives. Tideflats can emit sulfur compounds, such as hydrogen sulfide (H_2S), while the tide is out, which can cause odors similar to rotten eggs. Odors could develop while construction activities are ongoing, once the dam is removed and tideflats are exposed. The potential odor impacts of each alternative are assessed qualitatively based on consideration of odor frequency, intensity, duration, and offensiveness, and in understanding existing odor levels and community tolerances at nearby estuaries.

Air quality impacts are assessed for both the annual emissions from construction and from long-term management when recurring maintenance dredging would occur. The emissions from each criteria air pollutant are compared to the general conformity *de minimis* threshold of 100 tons per year. The criteria air pollutants assessed are Carbon Monoxide (CO), Nitrogen Oxide (NO_x), Sulfur Dioxide (SO_2), Volatile Organic Compounds (VOCs), particulate matter less than or equal to about 10 micrometers (microns in diameter) (PM_{10}), and particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$).

The GHG impacts are assessed by estimating the total annual lifetime (30 years) emissions of greenhouse gases (Carbon Dioxide [CO_2], Nitrous Oxide [N_2O], and Methane [CH4]) in metric tonnes of CO_2e from construction and long-term management with recurring maintenance dredging. The total annual GHG emissions are compared to the state mandatory GHG reporting rule threshold (10,000 $MTCO_2e$) and compared to the state-wide annual GHG emissions estimated by Ecology in 2015 (97 million $MTCO_2e$).

The analysis compares potential odor and air quality impacts of the No Action Alternative, as well as three action alternatives (Managed Lake, Estuary, and Hybrid). There is a potential for odors from the No Action Alternative as algae grows and then decays in the lake, which may result in earthy, musty odors. However, odor impacts are expected to be **less-than-significant** given that these odor changes would be infrequent, short in duration, and with low intensity. Conversely, **no impact** from odors are anticipated with the Managed Lake Alternative because no new tideflats would be created, and the lake would be managed to avoid large algae growth. Both the Estuary and Hybrid Alternatives would create additional tideflats to the area, an estimated 152 acres and 119 acres, respectively, with the potential to emit odors in an urban location. Any increase in estuary odors, even though naturally occurring, may be considered to be a significant impact by a portion of the study area population with low tolerance to odor. Conversely, naturally occurring odor from tideflats may not be objectionable, or even considered pleasant, to other portions of the population. The variability in odor perception makes an impact determination subjective. In consideration of the variable frequency, low intensity, and variable duration of odors, odor impacts from the Estuary and Hybrid Alternatives would be **less-than-significant.**

The No Action Alternative would not change any criteria pollutant or GHG emissions; therefore, there would be **no impact** on air quality from this alternative. The annual emission rates for all criteria pollutants are below the general conformity *de minimis* thresholds for both the construction and long-term management phases for all alternatives. The annual GHG emissions for all alternatives are below the 10,000 $MTCO_2e$ GHG reporting threshold. In addition, the GHG emissions represents less than 0.01% of estimated annual 2015 GHG emissions within Washington, and much smaller percentages of worldwide emissions. Both the air quality and GHG emission impacts for the Managed Lake, Estuary, and Hybrid Alternatives would be **less-than-significant**.

While carbon (a greenhouse gas) is typically sequestered in wetland environments, methane (another greenhouse gas) is released from marshes during certain anaerobic conditions. Therefore, the net effect of wetlands on greenhouse gasses can vary widely from a net negative to net positive, depending on the salinity and biomass in the system. While not quantified for the project, the Managed Lake Alternative would likely have slightly lower net positive GHG emissions than the No Action Alternative. Because of the increased salinity levels, less methane would be released under the Estuary and Hybrid Alternatives compared to the No Action or Managed Lake Alternative. Vegetated marshes anticipated to develop in the Estuary and Hybrid Alternatives would also sequester more soil carbon through the biomass and in the soil than would be expected in open water habitats.

Although construction is not expected to significantly affect air quality, construction contractors would be required to comply with all relevant federal, state, and local air quality rules. In addition, implementation of best management practices would reduce emissions during the construction phase of the project. Management practices for reducing the potential for air quality impacts during construction include measures for reducing both exhaust emissions and fugitive dust.

No alternatives would result in significant unavoidable adverse impacts for air quality, GHGs, or odor.

Table ES.1 Summary of Construction Impacts and Mitigation Measures

	Impact Finding	Minimization and other Mitigation Measures	Significant and Unavoidable Adverse Impact
Managed Lake Alternative			
Odor – Release of odiferous emissions from construction-related activities (e.g., excavation, dredging emissions)	Less-than-significant	None	No
Air Quality – Release of criteria air contaminants from construction-related equipment activity	Less-than-significant	BMPs and other measures to minimize impacts are included in Section 5.7.1.1.	No
Greenhouse Gases – Release of greenhouse gas emissions from construction-related equipment activity	Less-than-significant	Same as above.	No
Estuary Alternative			
Odor – Release of odiferous emissions from construction-related activities (e.g., dredging emissions, tideflat exposure)	Less-than-significant	None	No
Air Quality – Release of criteria air contaminants from construction-related equipment activity	Less-than-significant	BMPs and other measures to minimize impacts are included in Section 5.7.1.1.	No
Greenhouse Gases – Release of greenhouse gas emissions from construction-related equipment activity	Less-than-significant	Same as above.	No

	Impact Finding	Minimization and other Mitigation Measures	Significant and Unavoidable Adverse Impact
Hybrid Alternative			
Odor – Release of odiferous emissions from construction-related activities (e.g., dredging emissions, tideflat exposure)	Less-than-significant	None	No
Air Quality – Release of criteria air contaminants from construction-related equipment activity	Less-than-significant	BMPs and other measures to minimize impacts are included in Section 5.7.1.1.	No
Greenhouse Gases – Release of greenhouse gas emissions from construction-related equipment activity	Less-than-significant	Same as above.	No

Table ES.2 Summary of Operations Impacts (including Benefits) and Mitigation Measures

	Impact Finding	Minimization and other Mitigation Measures	Significant and Unavoidable Adverse Impact
No Action			
Odor – Release of odiferous emissions from Capitol Lake Basin (e.g., algae growth)	No Impact	None	No
Air Quality – Release of criteria air contaminants from operation-related equipment activity (e.g., ongoing dam maintenance activity)	No impact	BMPs and other measures to minimize impacts are included in Section 5.7.1.1.	No
Greenhouse Gases – Release of greenhouse gas emissions from Capitol Lake Basin (e.g., methane releases)	Less-than-significant	None	No

	Impact Finding	Minimization and other Mitigation Measures	Significant and Unavoidable Adverse Impact
Managed Lake Alternative			
Odor – Release of odiferous emissions from Capitol Lake Basin	No Impact	None	No
Air Quality – Release of criteria air contaminants from operation-related equipment activity (e.g., maintenance dredging and disposal)	Less-than-significant	BMPs and other measures to minimize impacts are included in Section 5.7.1.1.	No
Greenhouse Gases – Release of greenhouse gas emissions from operation-related equipment activity	Less-than-significant	Same as above.	No
Estuary Alternative			
Odor – Release of odiferous emissions from tideflat exposure	Less-than-significant	None	No
Air Quality – Release of criteria air contaminants from operation-related equipment activity (e.g., maintenance dredging and disposal)	Less-than-significant	BMPs and other measures to minimize impacts are included in Section 5.7.1.1.	No
Greenhouse Gases – Release of greenhouse gas emissions from operation-related equipment activity	Less-than-significant	Same as above.	No
Hybrid Alternative			
Odor – Release of odiferous emissions from tideflat exposure	Less-than-significant	None	No
Air Quality – Release of criteria air contaminants from operation-related equipment activity (e.g., maintenance dredging and disposal)	Less-than-significant	BMPs and other measures to minimize impacts are included in Section 5.7.1.1.	No

	Impact Finding	Minimization and other Mitigation Measures	Significant and Unavoidable Adverse Impact
Greenhouse Gases – Release of greenhouse gas emissions from operation-related equipment activity	Less-than-significant	Same as above.	No

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List of Acronyms and Abbreviations

Acronyms/ Abbreviations	Definition
$\mu g/m^3$	Micrograms per cubic meter
ATSDR	Agency for Toxic Substances & Disease Registry
Attainment/ Nonattainment	A determination and classification made by USEPA indicating whether ambient air quality in an area complies with (i.e., attains) or fails to meet (i.e., nonattainment) the requirements of one or more NAAQS
C2	Category 2
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide, a criteria air pollutant
CO_2	Carbon dioxide
CO_2e	Greenhouse gas equivalents (emissions of all GHGs expressed in terms of their "global warning potential"); carbon dioxide equivalent
D/T	dilutions to threshold
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Study
Enterprise Services	Washington State Department of Enterprise Services
Fugitive dust	Potential air pollutant in the form of dust (or other pollutant) emitted from a non-point or non-mobile source such as dust from a road or from a storage pile caused by wind
GHG	Greenhouse gas - a measure of the potential of a gas to have an effect in the atmosphere that could lead to climate change based on the potential of the gas to cause global warming. This is a standard measure, typically based on a 100-year time horizon, used to compare each GHG with the global warming potential of carbon dioxide (CO_2), the most abundant GHG.
$gS/m^2/year$	grams of sulfur per square meter per year
GWP	Global Warming Potential
H_2S	hydrogen sulfide
IPCC	Intergovernmental Panel on Climate Change
kW	kilowatts
Maintenance area	An area that was once designated as nonattainment that has since come into compliance with the ambient air quality standard but where air quality control measures may remain in effect (in perpetuity)
Metric ton	1,000 kilograms (kg) = 2,204.6 pounds = tonne (see also short ton)

Acronyms/ Abbreviations	Definition
MOVES	USEPA's Mobile Vehicle Emission Simulator
mph	miles per hour
$MTCO_2e$	metric tons carbon dioxide equivalents
N2O	Nitrous oxide
NAA	Nonattainment area
NAAQS	National Ambient Air Quality Standard
NIOSH	National Institute for Occupational Safety and Health (
NO_x	Oxide of nitrogen, a general class of air pollutant without a specific air quality standard but used in monitoring air quality
O3	Ozone
ORCAA	Olympic Region Clean Air Agency
OYC	Olympia Yacht Club
Particulate matter (PM)	Air pollutant comprised of solid or liquid particles; PM is usually characterized based on the particle size. See also PM10 and PM2.5.
Pb	Lead
PM10	"Coarse" inhalable particulate matter with an aerodynamic size less than or equal to 10 micrometers (microns)
PM2.5	"Fine" inhalable particulate matter with an aerodynamic size less than or equal to 2.5 micrometers (microns)
ppb	Parts per billion
ppm	Parts per million
ppt	Parts per thousand
RACT	Reasonably Available Control Technology
SB	Senate Bill
SEPA	State Environmental Policy Act
SF6	Sulfur hexafluoride
SO_2	Sulfur dioxide, a criteria air pollutant
TCAP	Thurston Climate Adaptation Plan
TCMP	Thurston Climate Mitigation Plan
tpy	Tons per year, an estimate of annual emissions
TRPC	Thurston Regional Planning Council
U.S.C.	United States Code

Acronyms/ Abbreviations	Definition
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WRI	World Resources Institute

1.0 Introduction and Project Description

1.1 PROJECT DESCRIPTION

The Capitol Lake – Deschutes Estuary includes the 260-acre Capitol Lake Basin, located on the Washington State Capitol Campus, in Olympia, Washington. The waterbody has long been a valued community amenity. Capitol Lake was formed in 1951 following construction of a dam and provided an important recreational resource. Historically, the Deschutes Estuary was used by local tribes for subsistence and ceremonial purposes. Today, the expansive waterbody is closed to active public use. There are a number of environmental issues including the presence of invasive species, exceedances of water quality (WQ) standards, and inadequate sediment management.

The Washington State Department of Enterprise Services (Enterprise Services) is responsible for the stewardship, preservation, operation, and maintenance of the Capitol Lake Basin. The 260-acre Capitol Lake Basin is maintained by Enterprise Services under long-term lease agreement from the Washington Department of Natural Resources.

In 2016, as part of Phase 1 of long-term planning, a diverse group of stakeholders, in collaboration with the state, identified shared goals for long-term management and agreed an Environmental Impact Statement (EIS) was needed to evaluate a range of alternatives and identify a preferred alternative. In 2018, the state began the EIS process. The EIS evaluates four alternatives, including a Managed Lake, Estuary, Hybrid, and a No Action Alternative.

The long-term management alternatives are evaluated against the shared project goals of: improving water quality; managing sediment accumulation and future deposition; improving ecological functions; and enhancing community use of the resource. Refer to Figure 1.1 for the project area for long-term management. The Final EIS will identify a preferred environmentally and economically sustainable long-term management alternative for the Capitol Lake – Deschutes Estuary.

The EIS process maintains engagement with the existing Work Groups, which include the local governments, resource agencies, and tribe. It also provides for expanded engagement opportunities for the public, such as a community sounding board.

Figure 1.1 Project Area

1.2 SUMMARY OF PROJECT ALTERNATIVES

1.2.1 Managed Lake Alternative

The Managed Lake Alternative would retain the 5th Avenue Dam in its existing configuration. The 5th Avenue Dam would be overhauled to significantly extend the serviceable life of the structure. The reflecting pool within the North Basin would be maintained, and active recreational use would be restored in this area. Sediment would be managed through initial construction dredging and recurring maintenance dredging in the North Basin only. Sediment from construction dredging would be used to create habitat areas in the Middle Basin to support improved ecological function, habitat complexity, and diversity. Sediment would continue to accumulate and over time would promote a transition to freshwater wetlands in the South and Middle Basins. Boardwalks, a 5th Avenue Pedestrian Bridge, a dock, and a boat launch would be constructed for community use.

If selected as the Preferred Alternative, adaptive management plans would be developed to maintain water quality, improve ecological functions, and manage invasive species during the design and permitting process.

1.2.2 Estuary Alternative

Under the Estuary Alternative, the 5th Avenue Dam would be removed, and an approximately 500-foot-wide (150-meter-wide) opening would be established in its place. This would reintroduce tidal hydrology to the Capitol Lake Basin, returning the area to estuarine conditions where saltwater from Budd Inlet would mix with freshwater from the Deschutes River. Sediment would be managed through initial construction dredging in the Capitol Lake Basin and recurring maintenance dredging within West Bay. Dredged materials from construction dredging would be used to create habitat areas in the Middle and North Basins to promote ecological diversity, though tideflats would be the predominant habitat type. Boardwalks, a 5th Avenue Pedestrian Bridge, a dock, and a boat launch would be constructed for community use. This alternative also includes stabilization along the entire length of Deschutes Parkway to avoid undercutting or destabilization from the tidal flow. Existing utilities and other infrastructure would be upgraded and/or protected from reintroduced tidal hydrology and saltwater conditions.

If selected as the Preferred Alternative, adaptive management plans would be developed to improve ecological functions and manage invasive species during the design and permitting process.

1.2.3 Hybrid Alternative

Under the Hybrid Alternative, the 5th Avenue Dam would be removed, and an approximately 500-foot-wide (150-meter-wide) opening would be established in its place. Tidal hydrology would be reintroduced to the western portion of the North Basin and to the Middle and South Basins. Within the North Basin, a curved and approximately 2,600-foot-long (790-meter-long) barrier wall with a walkway would be constructed to create an approximately 45-acre saltwater reflecting pool adjacent to Heritage Park. A freshwater (groundwater-fed) reflecting pool was also evaluated for this EIS. Construction and maintenance of this smaller reflecting pool, in addition to restored estuarine conditions in part of the Capitol Lake Basin, gives this alternative its classification as a hybrid. Sediment would be managed through initial construction dredging in the Capitol Lake Basin and recurring maintenance dredging within West Bay. In the Middle and North Basins, constructed habitat areas would promote ecological diversity, though tideflats would be the predominant habitat type. Boardwalks, a 5th Avenue Pedestrian Bridge, a dock, and a boat launch would be constructed for community use. This alternative also includes stabilization along the entire length of Deschutes Parkway to avoid scour or destabilization. Existing utilities and other infrastructure would be upgraded and/or protected from reintroduced tidal hydrology and saltwater conditions.

If selected as the Preferred Alternative, adaptive management plans would be developed before operation of the alternative to improve ecological functions and manage invasive species during the design and permitting process. Adaptive management would also be needed for a freshwater reflecting pool, but not for a saltwater reflecting pool.

1.2.4 No Action Alternative

The No Action Alternative represents the most likely future expected in the absence of implementing a long-term management project. The No Action Alternative would persist if a Preferred Alternative is not identified and/or if funding is not acquired to implement the Preferred Alternative. A No Action Alternative is a required element in a SEPA EIS and provides a baseline against which the impacts of the action alternatives (Managed Lake, Estuary, Hybrid) can be evaluated and compared.

The No Action Alternative would retain the 5th Avenue Dam in its current configuration, with limited repair and maintenance activities, consistent with the scope and scale of those that have received funding and environmental approvals over the past 30 years. In the last 30 years, the repair and maintenance activities have been limited to emergency or high-priority actions, which occur sporadically as a result of need and funding appropriations.

Although Enterprise Services would not implement a long-term management project, current management activities and ongoing projects in the Capitol Lake Basin would continue. Enterprise Services would continue to implement limited nuisance and invasive species management strategies.

In the absence of a long-term management project, it is unlikely that Enterprise Services would be able to procure funding and approvals to manage sediment, improve water quality, improve ecological functions, or enhance community use. The No Action Alternative does not achieve the project goals.

1.3 CONSTRUCTION METHODS FOR THE ACTION ALTERNATIVES

This impact analysis relies on the construction method and anticipated duration for the action alternatives, which are described in detail in Chapter 2 of the EIS.

2.0 Regulatory Context

2.1 RESOURCE DESCRIPTION

The Air Quality and Odor Discipline Report addresses odor, criteria air pollutants, and greenhouse gas (GHG) emission impacts of the construction and operational (post-construction) environment of the Capitol Lake – Deschutes Estuary Long-term Management alternatives.

Odor is a commonly experienced human sensation. The olfactory sense can detect and discriminate thousands of odors. The presence of an odor is the product of small quantities of certain chemicals, or mixtures of chemicals, in the air we breathe. 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 (USEPA) and Washington State 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 is often considered from the perspective of 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 (SF6), perfluorocarbons, and hydrofluorocarbons.

The following section describes the regulatory environment for odor, air quality, and GHGs in the project area.

2.2 FEDERAL, STATE, AND LOCAL LAWS, PLANS, AND POLICIES

2.2.1 Odor

Section 5 of Washington Administrative Code (WAC) 173-400-040 ("General standards for maximum emissions") addresses odors. It states that "*[a]ny person who shall cause or allow the generation of any* *odor from any source or activity which may unreasonably interfere with any other property owner's use and enjoyment of her or his property must use recognized good practice and procedures to reduce these odors to a reasonable minimum."* There are no federal regulations that directly address odors, and odor issues are generally handled through litigation based on nuisance and trespass laws.

Rule 8.5 of the Olympic Region Clean Air Agency (ORCAA) regulations ("Odor Control Measures") requires that Reasonably Available Control Technology (RACT) be employed by stationary sources to mitigate emissions of odor-bearing gases, and that the generation of any odor from any source that unreasonably interferes with the enjoyment of life and property is prohibited. There is also a provision for ORCAA to have the ability to require equipment to be enclosed and ventilated to facilitate the removal or destruction of odorous matter or other air contaminants before emission to the atmosphere.

2.2.2 Air Quality

Air quality is generally assessed in terms of whether air pollutant concentrations are in compliance with ambient air quality standards established to protect human health and welfare. Ambient air quality standards have been established for "criteria" pollutants (e.g., carbon monoxide [CO]; particulate matter with a diameter of 10 microns or less, sometimes referred to as "inhalable PM" [PM_{10}]; particulate matter with a diameter of 2.5 microns or less, sometimes referred to as "fine PM" [$PM_{2.5}$]; nitrogen dioxide [NO_2]; sulfur dioxide [SO_2]; ozone [O_3]; and lead [Pb]). Three agencies have jurisdiction over the ambient air quality at and in the vicinity of Capitol Lake: the USEPA (federal), Ecology (state), and ORCAA (local). These agencies have established regulations that govern the sources and ambient concentrations of pollutants (Table 2.1). Although their regulations are similar in stringency, each agency has established its own ambient air quality standards. Applicable federal, state, and local ambient air quality standards are presented in Table 2.2. These standards have been set at levels that USEPA and Ecology have determined are protective of human health with a margin of safety, including the health of sensitive individuals such as the elderly, the chronically ill, and the very young.

To track air quality conditions over time, Ecology and ORCAA maintain a network of monitoring stations. These stations are generally located where sources of air pollutants are expected to influence ambient concentrations, and so are usually in or near urban areas or close to specific large air pollution sources. Stations are also located in remote areas to provide indications of regional or background air pollution levels.

Based on criteria pollutant monitoring information collected over a period of years, Ecology and USEPA designate regions as being in "attainment" or "nonattainment" of particular air pollutant standards. Attainment status is, therefore, a benchmark of whether air quality in an area complies with the National Ambient Air Quality Standard (NAAQS) for one or more "criteria" air pollutants. A region once designated as a nonattainment area (NAA) for a particular pollutant that has since attained the relevant standard, is considered an air quality "maintenance" area. If the area is able to maintain the standard through two 10-year cycles of review, the area returns to "attainment" status. The area in which the project is located is currently in attainment with all NAAQS. Air pollutants pertinent to the project are described in greater detail in Section 4.

Table 2.1 Federal, State, and Local Laws, Plans, and Policies

Regulatory Program or Policies	Lead Agency	Description
Federal		
Clean Air Act (42 U.S.C. Sec. 7401 et seq.)	USEPA	Clean Air Act Regulatory Setting
National Ambient Air Quality Standards (40 CFR Part 50)	USEPA	Ambient air quality standards for criteria air pollutants
State		
General Standards for Maximum Emissions (WAC 173-400-040)	Ecology	Requires that visible emissions not exceed 20% opacity, that particulate matter not be deposited beyond the property under direct control of the owner or operator of the source in sufficient quantity to interfere unreasonably with the use and enjoyment of the property upon which the material is deposited, that recognized good practice and procedures be used to reduce odors from any source or activity which may unreasonably interfere with any other property owner's use and enjoyment of her or his property, that reasonable precautions be taken to prevent fugitive dust from becoming airborne, and that sources of fugitive dust be maintained and operated to minimize emissions.
Washington State Ambient Air Quality Standards (WAC 173-476)	Ecology	Establishes maximum acceptable levels in the ambient air for particulate matter, lead, SO2, NO2, ozone, and CO; Washington adopts current federal NAAQS in state regulations(see Table 2.2)
Reporting of Emission of Greenhouse Gases (WAC 173-441)	Ecology	Requires facilities that directly emit 10,000 metric tons carbon dioxide equivalents ($MTCO_2e$) or more per year to report GHG emissions to Ecology.
Local		
General Standards for Maximum Visual Emissions (ORCAA Rule 8.2)	ORCAA	Requires emissions from all facilities, sources, and emission units to not exceed 20% opacity.
General Standards for Maximum Particulate Matter (ORCAA Rule 8.3)	ORCAA	Requires that reasonable and/or appropriate precautions be taken to prevent fugitive particulate material from becoming airborne, and that emitted particulate matter not be allowed to deposit beyond the property under direct control of the owner(s) or operator(s) of the source which interferes unreasonably with the use and enjoyment of the property upon which the material is deposited.

Regulatory Program or Policies	Lead Agency	Description
Odor Control Measures (ORCAA Rule 8.5)	ORCAA	Requires that reasonably available control technology (RACT) be installed and operated to mitigate odor-bearing gases, and that emission or generation of any odor from any source not be allowed to unreasonably interfere with another person's use and enjoyment of their property.

Table 2.2 Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Terms of Compliance [a]	Concentration
Inhalable Particulate Matter (PM_{10})		
24-Hour Average	The 3-year average must not exceed	150 µg/m^3
Fine Particulate Matter ($PM_{2.5}$)		
Annual Average	The 3-year average must not exceed	12.0 µg/m^3 [b]
24-Hour Average	The 3-year average of the 98th percentile must not exceed	35 µg/m^3
Sulfur Dioxide (SO_2) [b]		
Annual Average	Must not exceed	0.02 ppm [c]
24-Hour Average	Must not exceed more than once per year	0.10 ppm [c]
3-Hour Average	Must not exceed more than once per year	0.5 ppm [d]
1-Hour Average	The 3-year average of the 99th percentile of daily maximum must not exceed	0.075 ppm
Carbon Monoxide (CO)		
8-Hour Average	Must not exceed more than once per year	9 ppm
1-Hour Average	Must not exceed more than once per year	35 ppm
Ozone (O_3)		
8-Hour Average	The 3-year average of the 4th highest daily maximum must not exceed	0.070 ppm
Nitrogen Dioxide (NO_2)		
Annual Average	The annual mean of 1-hour averages must not exceed	0.053 ppm
1-Hour Average	3-year average of 98th percentile of daily max 1-hour averages must not exceed	0.100 ppm

Note: µg/m^3 = micrograms per cubic meter; ppm = parts per million.

(a) All limits are federal and state air quality standards except as noted. All indicated limits represent primary air quality standards intended to protect human health.

(b) There is also a federal 15.0 µg/m^3 annual average secondary standard for $PM_{2.5}$ to protect public welfare.

(c) Washington State standards; annual and 24-hour SO_2 standards were revoked from federal rules in 2010.

(d) Washington State standard; there is also a federal 0.5 ppm 3-hour average secondary standard for SO_2 to protect public welfare.

2.2.2.1 General Conformity

Federal air quality "conformity" rules require review of some projects in areas that are designated as nonattainment or maintenance for one or more air pollutants. The general conformity rules apply to the portions of projects that are subject to permits or approvals by federal agencies.

Actions and plans in nonattainment and maintenance areas that require an approval or permit from a federal agency are subject to review under the general air quality conformity rule. This rule is intended to prevent a project or action from causing a new air quality problem due to potential violations of an ambient air quality standard or actions that might worsen any existing problem by extending the time it takes to attain the standard. Very importantly, the emissions subject to review under the general conformity rule must be subject to continuing control of the reviewing federal agency that issues the approval or permit. The general conformity *de minimis* thresholds are used to serve as a point of reference for the annual emissions totals of the Capitol Lake- Deschutes Estuary Project, including those to which general conformity regulations are not applicable. Conformity thresholds were designed to be protective of airsheds that have a status of nonattainment or maintenance and have federal agency oversight. Technically, a general conformity determination is limited in the emission sources that are be considered, such that only those sources which the federal entity can demonstrate having "continuing program responsibility" for should be included. However, by including all sources, the *de minimis* threshold serves as a more rigorous and protective limit to meet. The specific actions and pollutants considered are described in Section 3 *(Methodology)*.

2.2.3 Greenhouse Gases

There are no specific emission reduction requirements or targets applicable to the project or the project area, nor are there any generally accepted emission level "impact" thresholds with which to assess the potential significance of localized or global impacts related to GHG emissions. Instead, there are State policies and programs intended to consider and reduce GHG emissions over time, as described below.

Executive Order No. 07-02, issued by Gov. Christine Gregoire in 2007, established goals for Washington regarding reductions in climate pollution, increases in jobs, and reductions in expenditures on imported fuel. The Executive Order established Washington's goals for reducing greenhouse gas emissions as follows:

- To reach 1990 levels of GHG emissions by 2020
- To reach 25% below 1990 emission levels by 2035
- To reach 50% below 1990 emission levels by 2050

The Order was intended to address climate change, grow the clean energy economy, and move Washington toward energy independence. In 2007, the Washington Legislature passed SB 6001, which among other things adopted the language of Executive Order No. 07-02 into statute.

In 2008, the Washington Legislature built on SB 6001 by passing the Greenhouse Gas Emissions Bill (E2SHB 2815). While SB 6001 set targets to reduce emissions, the E2SHB 2815 made those targets state-wide requirements (RCW 70.235.020) and directed the State to submit a comprehensive greenhouse gas reduction plan to the Legislature by December 1, 2008. As part of the plan, Ecology was mandated to develop a system for reporting and monitoring greenhouse gas emissions within the state and a design for regional multi-sector, market-based system to reduce statewide greenhouse gas emissions, consistent with the requirements in RCW 70.235.020.

In 2008, Ecology issued a memorandum stating that climate change and greenhouse gas emissions should be included in all State Environmental Policy Act (SEPA) analyses and committed to providing further clarification and analysis tools.

Executive Order 09-05, issued by Gov. Gregoire in 2009, ordered Washington State agencies to reduce climate-changing GHG emissions, to increase transportation and fuel-conservation options for Washington residents, and to protect the State's water supplies and coastal areas. This Executive Order directed State agencies to develop a regional emissions reduction program; develop emission reduction strategies and industry emissions benchmarks to ensure that 2020 reduction targets are met; work on low-carbon fuel standards or alternative requirements to reduce carbon emissions from the transportations sector; address rising sea levels and the risks to water supplies; and increase transit options (e.g., buses, light rail, and rid-share programs) and give Washington residents more choices for reducing the effect of transportation emissions.

On December 1, 2010, Ecology adopted Chapter 173-441 WAC – Reporting of Emission of Greenhouse Gases. This rule aligned the State's greenhouse gas reporting requirements with USEPA regulations, and required facilities that directly emit 10,000 metric tons of carbon dioxide equivalents ($MTCO_2e$) or more per year, as well as fuel suppliers that supply fuels in the state that would result in 10,000 $MTCO_2e$ when combusted, to report their GHG emissions to Ecology. Requirements for reporting began on January 1, 2012.

In 2011, Ecology issued internal guidance to assist its staff to determine which projects should have GHG emissions evaluated under SEPA and how to perform those evaluations. In April 2016, Ecology removed the internal guidance from its website to allow revisions and updates to incorporate new scientific information, as well as to be consistent with federal greenhouse gas emissions guidance and Ecology policies.

Gov. Jay Inslee issued Executive Order 14-04 in 2014, which established steps to be taken to address the effects of climate change and how to reduce carbon pollution in Washington. This Executive Order superseded Executive Orders 07-02 and 09-05. Some of the key areas addressed by the Order include carbon pollution, clean transportation, and clean technology.

On April 30, 2020, Ecology announced the beginning of the rulemaking process as per the Directive of the Governor #19-18. This initiative would create a new rule, Chapter 173-445 WAC, Greenhouse Gas Assessment for Projects and would help address analysis and mitigation of greenhouse gas emissions for environmental assessments of industrial and fossil fuel projects. The new rule is slated to be completed by Summer 2021.

In 2018, the Thurston Regional Planning Council adopted the Thurston Climate Adaptation Plan (TCAP) to guide Thurston County and the broad South Puget Sound region in developing strategies for adaptation and response to climate change (TRPC 2018). This 22-member intergovernmental board has a mission to provide visionary leadership on regional plans, policies, and issues. The TCAP includes a number of Guiding Principles.

The Guiding Principles support increased resiliency through achievable, flexible, and where possible, measurable and replicable climate adaptation strategies. Relating to greenhouse gas emissions, the Guiding Principle states: "*Identify and leverage climate change adaptation strategies and actions with mitigation co-benefits, such as reducing, capturing, and storing greenhouse gas emissions…*"(TRPC 2018).

In 2021, collaborating jurisdictions adopted the Thurston Climate Mitigation Plan (TCMP) to address local contributions to the causes of climate change (TRPC 2021). The plan includes emissions reduction targets of reducing net communitywide greenhouse gas emissions 45% below 2015 levels by 2030 and 85% below 2015 levels by 2050. The TCAP and TCMP together form a comprehensive Climate Action Plan for the Thurston Region.

3.0 Methodology

3.1 DATA SOURCES AND COLLECTION

The air quality analysis uses data sources that include relevant USEPA reports and standard computer tools, as well as odor studies, particularly those concerned with hydrogen sulfide (H_2S). These data sources are listed in Table 3.1.

Table 3.1 Data Sources used in the Analysis

Data Source	Data Utilized
Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emission Inventories (USEPA 2020)	Harbor craft default propulsion and auxiliary power Harbor craft default propulsion and auxiliary load factors Power rating for dredge vessels Emission factors for C2 Uncontrolled Engines
MOVES2014b	Emission rates for off-road construction activities Emission rates for on-road vehicles
Biogenic Sulfur Compounds and the Global Sulfur Cycle (Aneja et al. 1982)	H2S emission rates of natural water processes
United States Geological Survey, Cyanobacterial (Blue-Green Algal) Blooms: Tastes, Odors, and Toxins (Graham et al. 2010)	Potential odors associated with algae growth and decay
Emission Factors for Greenhouse Gas Inventories (USEPA 2020a)	Diesel fuel CO2 emission factor Ships and boats emission factor Construction/mining equipment emission factor

3.2 SELECTION OF THE STUDY AREA

For assessing air quality and odor impacts, the study area is the project area and the surrounding ambient air that has the potential to be influenced by the project, based on the scope and nature of the construction and post-construction air emissions, as well as the nature of the topography and meteorological conditions in the area. In this case, the study area is generally defined as the project area and adjacent areas. Based on the nature and quantities of the air pollutant emissions and potential odors generated by the action alternatives, the impacted area is not expected to extend far from the project area.

3.3 ANALYSIS OF IMPACTS

3.3.1 Odor

Construction-related activities typically do not result in the generation of problematic odor emissions; odor complaints associated with construction are rare because the resulting odors would be intermittent over the 4- to 8-years of construction. Odors would generally be limited in duration and frequency such that any odors are unlikely to rise to a level that would be considered a nuisance. From construction activities, odors can be generated from a number of activities, including earth work, equipment exhaust, and a variety of site-specific processes. When odor issues arise, they are generally addressed on a case-by-case basis, which would likely be addressed in coordination with ORCAA or legal avenues. For this reason, construction, initial dredging, and maintenance dredging odors are not described in this analysis. However, for alternatives involving removal of the dam, when the dam is no longer in place and tideflats are exposed, it is expected that the odor environment will be similar to that described in the post-construction scenarios. The analysis of odor impacts focuses on the post-construction, steady-state conditions associated with each alternative (i.e., long-term/operations).

The potential impacts from odor are assessed in response to comments received during the EIS scoping period concerning the potential odor associated with the creation of tideflats with the Estuary or Hybrid Lake Alternative. While there is little quantitative comparable data in the literature, a more qualitative assessment can be made to describe the potential for odor impacts. As detailed in Section 4, odors and their impacts are best characterized through consideration of an odor's frequency, intensity, duration, and offensiveness. For each alternative, these characteristics are considered in understanding the potential for significant odor impacts. The presence of odor alone is not considered a significant impact, as odors are often present without being problematic. However, if the intersection of the four characteristics are expected to drive problematic odor impacts, impacts are considered significant.

For this odor analysis, the magnitude of long-term post-construction impacts is considered less-than-significant or significant, as follows:

- **Less-than-significant**—Impacts are considered less-than-significant if the odors are not expected to have a combination of high frequency, high intensity, long duration, offensive characteristic, and/or have some of the characteristics in locations with significant population, such that malodor issues may arise.

- **Significant**—Impacts are considered significant if the odor impacts are expected to have a combination of high frequency, high intensity, long duration, offensive characteristic, and/or have these characteristics in locations with significant populations, such that malodor issues may arise.

3.3.2 Air Quality

Potential air quality impacts attributable to the project are assessed by calculating total emissions of criteria air pollutants (i.e., for NO_x, SO_2, CO, VOCs, PM_{10}, and $PM_{2.5}$) for both the construction and post-construction phases. The general conformity *de minimis* thresholds listed in Section 2.3.3 are used as an indication of the project's potential significance or non-significance. The *de minimis* values that are used in this assessment, which are specific to maintenance areas, are summarized in Table 3.2. While the project is in an attainment area for all pollutants, maintenance area thresholds are used in this analysis for all pollutants as a conservative indication of significance or non-significance.

Table 3.2 General Conformity *De Minimis* Thresholds for Maintenance Areas

Pollutant	General Conformity *De Minimis* Thresholds (tpy)
CO	100
NO_x	100
VOC	100
SO_2	100
PM10	100
PM2.5	100

3.3.2.1 *Identification of Construction Impacts for Criteria Air Pollutants*

The air quality impacts from the construction phase of the project are assessed by calculating (estimating) the total project emissions of each criteria pollutant (i.e., NO_x, SO_2, CO, VOC, PM_{10}, $PM_{2.5}$) from equipment associated with construction phase activities. Equipment types identified for each alternative are separated into four categories to facilitate emission calculations: harbor craft, dredging vessels, construction equipment, and on-road trucks. The construction activity would, like most construction, create localized dust, exhaust, and associated odors that may be noticeable in near proximity to the activity.

Harbor craft emissions are calculated using the following parameters: propulsion power, propulsion load factor, auxiliary power, auxiliary load factor, hours of activity, and emission factors for each pollutant. All harbor craft parameters and emission factors are summarized in Appendix A and follow the guidance provided by the USEPA for port-related emission inventories and the guidance provided by the USEPA for port related emission inventories. For sources where the propulsion power, auxiliary power, or load factors are not available, default values from "Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emission Inventories" are used based on assumed harbor craft ship types (USEPA 2020). Emission factors for the worst-case engine category (i.e., Category 2 [C2] engines that are assumed to pre-date nonroad engine emission standards [uncontrolled]) are used for all harbor craft to ensure conservative estimates.

The dredging vessel emission calculations use similar methodology as the harbor craft emission calculations. Two types of dredging vessels are used: a "Clamshell Dredge," and a "Hydraulic Cutterhead Dredge," which are assumed to be equivalent to a USEPA-defined bucket dredge and a hydraulic pipeline cutterhead dredge, respectively. Unlike harbor craft, dredging vessel emissions are calculated using a total power rating of 1,600 kilowatts (kW) for the bucket dredge and 7,161 kW for the hydraulic pipeline cutterhead dredge, as well as a single average load factor for all dredging vessels (0.66). These parameters are obtained from "Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emission Inventories." Like harbor craft, dredging vessels are assumed to be powered by uncontrolled C2 engines; all parameters and emission factors used to calculate dredge vessel emission are provided in Appendix A.

Construction equipment emissions are calculated based on equipment category descriptions and activity data combined with emission factors obtained using the NONROAD portion of USEPA's MOVES2014b emissions inventory model. The NONROAD portion of the MOVES model is the standard approach for estimating emissions from non-road equipment in the U.S., except for non-recreation vessel and locomotive emissions. The NONROAD model is executed using default power ratings for the following equipment categories: excavators, tractors/loaders/backhoes, cranes, rollers, bore/drill rigs, graders, skid steer loaders, forklifts, and other construction equipment. To provide conservative emission factors, the construction equipment categories are consistent with a 2021 fleet year distribution, even though construction would occur later, and lower emission rates may be present in later construction years. Later years would have lower emission rates as the older high-emitting engines would be removed from the fleet and newer lower emitting engines would enter the fleet. The average of January and July emission factors were used to develop a single emission factor that reflected the effects of both summer and winter months, and all construction equipment was assumed to be diesel fueled. The emission factors obtained from NONROAD for construction equipment are provided in Appendix A.

The on-road vehicle emission calculations for the construction phase use equipment descriptions and activity data, combined with emission factors obtained using USEPA's MOVES emission inventory model. Emission factors are obtained for three vehicle categories: short-haul combination trucks, light commercial trucks, and single unit short-haul trucks. To provide conservative emission factors, MOVES was executed assuming that all vehicles would always be operated at 60 miles per hour (mph) resulting in greater miles traveled, although they would actually be traveling much shorter distances and at slower speeds at the project site. The greater miles traveled results in higher emissions. It is also assumed that the vehicles would be consistent with a 2021 fleet year distribution, even though construction would occur later and lower emission rates may be present in later construction years. Similar to NONROAD, later years would have lower emission rates and the older high-emitting engines would be removed from the fleet and newer lower emitting engines would enter the fleet. The emission factors obtained from MOVES are provided in Appendix A.

The total emissions from the equipment associated with the initial dredge were summed and then annualized over the 3-calendar year period. For all other construction emissions, the analysis conservatively assumed a 6-year duration of the highest intensity construction activity/emissions for the Estuary and Hybrid Alternatives, and a 5-year construction duration for the Managed Lake Alternative based on preliminary construction schedule information. These equipment emissions were totaled and then divided by the 5 or 6-year period. The total annual emissions for comparison against the general conformity *de minimis* is the sum of the annual emissions for dredging and for all other construction activities. This summing is only required because of the distinctly different timelines for dredging and other construction.

For this air quality analysis, the magnitude of short-term construction phase impacts is considered less-than-significant or significant, as follows:

- **Less-than-significant**—Impacts are considered less-than-significant if the total tons of each pollutant emitted per year are less than the general conformity *de minimis* thresholds.
- **Significant**—Impacts are considered significant if the total tons of each pollutant emitted per year are greater than the general conformity *de minimis* thresholds.

3.3.2.2 Identification of Post-construction Impacts for Criteria Air Pollutants

Similar to the construction phase impacts described above, long-term post-construction emission impacts are determined by calculating total emissions of the same pollutants using the same methods. Post-construction emissions are assumed to primarily from equipment used for recurring long-term maintenance dredging, which uses similar equipment as the initial construction dredge. The maintenance dredging is broken into five activity units (e.g., dredge unit, tow unit, scow unit, offload unit, and load-out unit). The hours of operation for each activity unit depend on the material removal rate of the excavator or the dredge in that unit. The equipment in the tow unit assumes the same operating hours as the dredge unit. To be conservative, the hours of operation for the dredge and tow units assume that a 10-cubic yard dredge would operate, which would take longer to remove the material than a larger volume dredge, resulting in higher (conservative) emissions estimates.

All action alternatives include maintenance dredging to manage sediment. The highest volume dredge event was evaluated to obtain a conservative emissions estimate. For the Hybrid and the Estuary Alternatives, the highest volume maintenance dredge occurs at year 24 and year 20, respectively, after project construction. During these years, the Olympia Yacht Club (OYC), the marinas, the port/turning basin, and access areas would be dredged, removing an estimated 350,400 cubic yards of accumulated sediment. All areas are conservatively assumed to be dredged concurrently, condensing most of the activity to one calendar year, which increases the annual emissions. Most of this dredging is expected be completed within one in-water work window (7 months); given the estimated volume of material to be removed, an additional 2 months of work may be needed in the next annual in-water work window.

The maintenance dredge for the Managed Lake Alternative only occurs once within the 30-year project time horizon. It is assumed to span 3 years (18 months of work broken into three, 6 month in-water work windows) and 472,000 cubic yards of material is dredged.

To estimate the emissions, this analysis evaluated two feasible methods of disposal, including upland disposal at a landfill, and in-water disposal at a non-dispersive site in Puget Sound, between Anderson and Ketron Islands. The number of truck trips are the same for the Hybrid and Estuary Alternatives, but are different for the Managed Lake Alternative because less material is dredged during a single in-water work window, resulting in less truck trips.

The total miles traveled by the haul trucks for every scenario is estimated using one-way trip distance of 250 miles, which is a conservative but representative distance to upland disposal locations that are capable of accepting this volume of material. The distance could be reduced once the final landfill location is identified, based on sediment quality and the presence of invasive species.

In-water disposal is only feasible for the Estuary and Hybrid Alternatives. Under these alternatives, the dredge material could be barged to a location between Anderson and Ketron Islands for disposal. There would be no upland offload or load-out units used in this process. The vessel activity associated with this disposal would be roughly 10 hours of tug operation per day, in addition to the dredging activities.

The general conformity regulations, while not applicable to this project, serve to protect regions that have deteriorated air quality from getting worse. Under these regulations, project emissions, on an annual basis, are screened against a *de minimis* threshold. Below the threshold, the emissions are assumed to not contribute to further degradation of the air quality in the region. In excess of the *de minimis* threshold, the emissions require further review. For this analysis, the *de minimis* thresholds are used to characterize significance. The maximum annual emissions associated with each alternative are screened against this threshold and any other year will have fewer emissions and less impact.

For this air quality analysis, the magnitude of long-term post-construction impacts is considered less-than-significant or significant, as follows:

- **Less-than-significant**—Impacts are considered less-than-significant if the total tons of each pollutant emitted per year are less than the general conformity *de minimis* thresholds.
- **Significant**—Impacts are considered significant if the total tons of each pollutant emitted per year are greater than the general conformity *de minimis* thresholds.

3.3.3 Greenhouse Gases

The GHGs of primary importance for combustion sources are CO_2, CH_4, and N_2O. Because CO_2 is the most abundant of these gases, GHGs are typically quantified in terms of CO_2e (carbon dioxide equivalent), where the mass emission of each component GHG is weighted based on its relative longevity in the atmosphere using a “global warming potential” factor.

The GHGs are calculated using the same methods as the criteria air pollutant calculations as described above. However, because the NONROAD model does not provide N_2O emission factors for harbor craft, dredging vessels, and construction equipment, N_2O emissions are calculated for these equipment types using emission factors based on fuel use and equipment-specific fuel use rates. Emission factors were obtained from USEPA guidance and combined with equipment-specific diesel fuel use rates calculated using CO_2 emissions (USEPA 2020). The CO_2 emissions are calculated using the NONROAD model and a diesel fuel combustion CO_2 emission factor from USEPA guidance (USEPA 2020a).

Similar to the construction phase impacts, post-construction emission impacts are determined by calculating total emissions of the same pollutants from the dredging equipment and using the same methods. The approaches and methods described in Section 3.3.2.2 and used for the criteria pollutant assessment also apply for GHGs. Where the air quality analysis considers the largest maintenance dredge event in terms of volume, the GHG calculation considers the entire lifetime of the project and includes the construction and any subsequent maintenance dredges. These total emissions are annualized over 30-years.

For this GHG analysis, the magnitude of impacts is considered less-than-significant or significant, as follows:

- **Less-than-significant**—Impacts are considered less-than-significant if the total annual GHG emissions are less than the state mandatory GHG reporting rule threshold (10,000 $MTCO_2e$).
- **Significant**—Impacts are considered significant if the total annual GHG emissions are greater than the state mandatory GHG reporting rule threshold (10,000 $MTCO_2e$).

4.0 Affected Environment

4.1 ODOR

Odor is a commonly experienced human sensation. Odor is a human perception that results from small quantities of certain chemicals in the air we breathe. These chemicals cause nerve endings in the nose and mouth area to send signals to the brain that we interpret as an odor. A certain quantity of these chemicals must be present before we can detect an odor, and that quantity will vary from person to person, with some people being more sensitive to odors than others.

Important issues in understanding odors include intensity or strength, duration and frequency of the odor, as well as whether the nature of the odor is offensive (e.g., raw sewage), or not (e.g., roses).

1. **Nature of the Odor**. Some odors are perceived as offensive, such as sewage or rotting garbage. Others are perceived as pleasant, such as flowers, baking bread, or chocolate. Scientists have created a scale for the pleasantness or unpleasantness of the nature of the odor called the *hedonic tone*. It is a simple scale that is very subjective from one person to the next.
2. **Strength of the Odor.** Odor strength is by its nature subjective, but there are developments in the field that have reduced, to some degree, the subjectivity of odor measurements, which include various methods to quantify intensity. These methods have generally been applied in communities that have significant odor complaints associated with specific facilities. Measurements are frequently taken as a means of demonstrating compliance with odor regulations.
3. **Duration of the Odor.** The duration of the odor is simply the length of time that an odor persisted at a location.
4. **Frequency of the Odor.** Frequency refers to how often an odor was present at a particular location.

A method commonly used to characterize odor strength is "dilutions to threshold" (D/T), which is based on the concept that odor-containing air can be diluted by mixing it with odor-free air until reaching the point where the odor can just barely be detected by 50% of the population. The point at which 50% of the population can just barley detect a particular odor is called "threshold of detection," which varies from chemical to chemical and is not well characterized for mixtures of chemicals. Nonetheless, even complex mixtures of chemicals that produce odors (e.g., diesel exhaust) can be mixed with odor-free air to eventually identify the point at which it can just barely be detected. For certain chemical compounds, this detection threshold has been well established, and given concentrations of those compounds can be assumed to produce an expected odor strength. The simple emission of an odorous compound does not indicate that it can be observed by the human nose – such emissions would likely be observed only if emitted to produce a concentration in excess of the detecting threshold.

Odors produced by tideflats have not been studied in depth, and the literature on associated quantitative odor emissions is sparse. Most of the literature that is available focuses on sulfur compound emissions, which have been quantified per unit of tide-influenced area. These emissions are often driven by H_2S – a gas with a characteristic odor of rotten eggs and an odor detection limit with a range that spans from 0.5 to 300 parts per billion (ppb) depending on the studies considered (ATSDR 2016). This wide range of odor detection limits serves as evidence of the variability in how people respond to H_2S differently. In a single location and time, while some individuals may not notice any smell, others may be able to detect and possibly recognize an odor. Emissions of H_2S are produced by a variety of sources such as power plants, pulp and paper mills, sewage treatment plants, animal feeding operations, and geothermal activity; it is also the byproduct of anaerobic digestion in tideflats, marshes, and swamps. For naturally produced H_2S, the two primary sources include geothermal activity and anaerobic digestion. Simply put, anaerobic digestion is the decomposition of organic materials in the absence of oxygen.

Concentrations arising from tideflats, salt marshes, and decomposition more generally would not approach levels that pose health concerns. A review of the Toxicological Profile for H_2S published by the Agency for Toxic Substances & Disease Registry (ATSDR) points out that concentrations of H_2S from natural sources vary depending on nearby sources. In an extreme example, a seaweed and shellfish die-off in Rhode Island once caused H_2S concentrations in excess of 90 ppb (less than the mid-point of the odor detection limit for H_2S). This extreme scenario concentration can be contrasted against the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit of 10,000 ppb – the recommended maximum concentration that workers can be exposed to for up to 10 minutes. Clearly, even in the ATSDR example, the concentrations from naturally derived H_2S emissions do not rise to the level of a health concern. Ambient H_2S air concentrations in the Olympia area are not readily available for use in characterizing existing odor conditions. However, ORCAA logs odor complaints received from the public.

For a specific project, and in the absence of reliable quantitative data on odors, it is useful to qualitatively describe the odors using each of the characteristics (frequency, intensity, duration, and offensiveness). However, estuaries are inherently complex and not easily classified for all of these characteristics. The frequency and duration of odors produced by estuaries are related to the change in tides and the changing extents of the tidal vertical range. For odor frequency (e.g., daily, weekly, monthly), it is known that two low tides occur twice within 24 hours, but those two tides are not equal in magnitude, and while one may result in the production of odors, the other may not. Further, tides vary by month and by year as shown, by example, in **Error! Reference source not found.**. Similarly, the d uration of odor production depends on the magnitude of the tides and the duration of low tide exposure. The intensity of odors produced by estuaries is low in comparison to the odor intensities produced by most industrial H_2S sources and is not expected to result in concentrations of H_2S that are in excess of recommended health limits. The offensiveness of estuary odors is very subjective; while some may find the odor natural and pleasant, others may find it offensive.

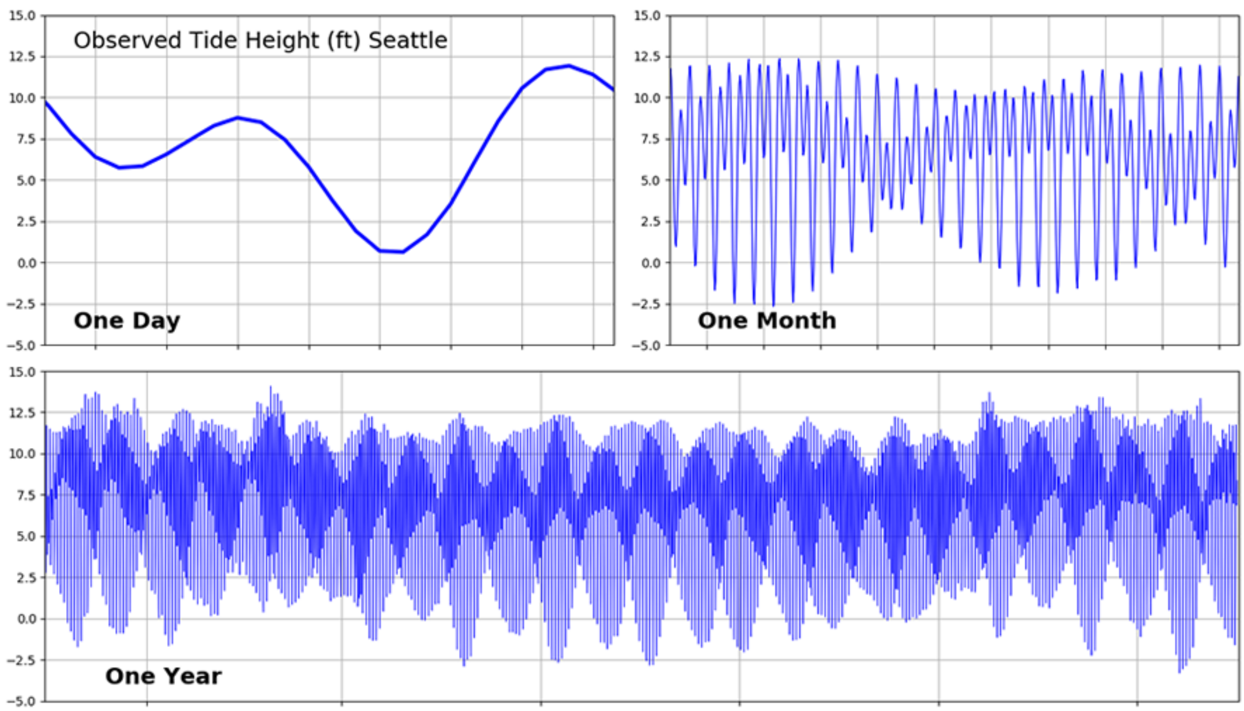

Figure 4.1 Example of Tide Cycles in the Pacific Northwest Across Various Time Ranges (adapted from https://faculty.washington.edu/pmacc/LO/tides_background.html)

Existing potential sources of odor in the vicinity of the project area are existing tideflats along the east and west bay of Budd Inlet. ORCAA provided an accounting of all odor complaints from March 2015 through March 2020. During this 5-year period, the primary sources of odor complaints were burning garbage, as well as smoke from woodstoves and burn piles, all of which accounted for approximately 86% of the total odor complaints. Other recurring sources of odor complaints received by ORCAA were from a hot-mix asphalt plant, Ostroms Mushroom Farm, and Crown Cork and Seal Co. A summary of odor complaints is provided in Table 4.1. Notably, there were no odor complaints associated with tide fluctuations and associated natural odor-producing sources, and there were no odor complaints during a 2016 drawdown of Capitol Lake.

Table 4.1 Summary of Odor Complaints

Odor Source	Number of Complaints [a]	Percentage
Burning garbage, smoke from woodstoves and burn piles	284	86
Hot-mix asphalt plant	6	2
Ostroms Mushroom Farm	8	2
Crown Cork and Seal Co.	13	4
Other[b]	16	5
Unknown	4	1

Notes:
[a] Odor complaints provided by ORCAA from March 2015 to March 2020.
[b] Include one-time event such as roof work, spray coating and paint odor.

4.2 AIR QUALITY

Existing sources of air pollution in the vicinity of the project include industrial-zoned areas and transportation corridors, including marine diesel-fueled vessels and both diesel and gas vehicles on the nearby roadways. Criteria air pollutants of primary concern are NO_2, PM_{10}, and $PM_{2.5}$. Other pollutants include ozone precursors (i.e., hydrocarbons and nitrogen oxides [NO_X]), SO_2, ozone, lead, and CO. Given the setting, industrial and transportation sources likely comprise the largest contributors to ambient pollutant concentrations in the vicinity of the project. Smoke from residential wood combustion, one of the main sources of air pollution in Washington State, may also be a significant contributor to ambient particulate matter concentrations during the winter months.

The pollutants of primary concern are described in more detail below.

4.2.1 Inhalable Particulate Matter

Particulate matter air pollution is generated by industrial activities and fuel combustion sources like marine vessels, residential wood burning, locomotives, motor vehicle engines and tires, as well as other sources. Federal, state, and local regulations set limits for particulate concentrations in the air based on the size of the particles and the related potential threat to health.

There are currently health-based ambient air quality standards for PM_{10} and $PM_{2.5}$ (see Table 2.2). The latter size fraction and even smaller (ultra-fine) particles are now considered the most dangerous size fractions of airborne particulate matter because such small particles (e.g., a typical human hair is about 100 microns in diameter) can be breathed deeply into lungs. In addition, such particles are often associated with toxic substances that are deleterious in their own right that can adsorb to the particles and be carried into respiratory system. USEPA has linked a variety of significant health problems to the exposure of such particles, including irregular heartbeat, aggravated asthma, and decreased lung function. People at risk from exposure to particle pollution are those with pre-existing heart or lung disease, older individuals, and children.

The area in which the project is located is in attainment for all $PM_{2.5}$ standards. The $PM_{2.5}$ maintenance area nearest to the project area encompasses a portion of the City of Tacoma and the surrounding lowland areas in Pierce County. The project area is located in a former PM_{10} maintenance area that encompasses a portion of Thurston County (Ecology 2020). The area was designated as nonattainment during the period of 1992 to 1999 due to exceedances of the PM10 24-hour standard, primarily caused by smoke from woodstoves and fireplaces. In 2000, the area implemented a 20-year maintenance plan, which concluded on December 4, 2020. The area is now in attainment for PM10 and is no longer required to adhere to the maintenance plan.

4.2.2 Ozone

Ozone is a highly reactive form of oxygen created by sunlight-activated chemical transformation of nitrogen oxides and volatile organic compounds (i.e., hydrocarbons) in the atmosphere. Ozone problems tend to be regional in nature because the atmospheric chemical reactions that produce ozone occur over a period of time, during which ozone precursors can be transported far from their sources. Transportation sources, including large marine vessels, locomotives, trucks, and general traffic, are some of the sources that produce ozone precursors. Because ozone is typically not emitted directly by sources, only very sophisticated air quality models are capable of assessing ozone formation in the atmosphere, and such models are typically used for regional assessments of air quality plans. Thus, ozone modeling is not typically performed for project-specific reviews, and ozone was not considered in this project-specific air quality analysis.

The project area is in attainment for ozone.

4.2.3 Sulfur Dioxide

SO_2 is a colorless, corrosive gas produced by burning fossil fuels like coal and oil that contain sulfur, and by industrial facilities such as smelters, paper mills, power plants, and steel manufacturing plants. Except near large sources of SO_2, ambient SO_2 concentrations are typically well below federal standards. Sources of SO_2 in the project vicinity include industry, vessels in transit and generating electrical power while moored (called hoteling), and vehicles traveling on nearby roadways.

The project area is in attainment for SO_2.

4.2.4 Carbon Monoxide

Carbon monoxide is the product of incomplete combustion. It is generated by transportation sources and other fuel-burning activities like residential space heating, especially heating with solid fuels like coal or wood. Carbon monoxide is usually the pollutant of greatest concern related to roadway transportation sources because it is the pollutant emitted in the greatest quantity for which short-term health standards exist. CO is a pollutant whose impact is usually localized, and CO concentrations typically diminish within a short distance of roads. The highest ambient concentrations of CO usually occur near congested roadways and intersections during wintertime periods of air stagnation.

The project area is in attainment for CO.

4.2.5 Nitrogen Oxides

Collectively, nitric oxide (NO) and nitrogen dioxide (NO_2) are commonly called oxides of nitrogen or NO_x. Other oxides of nitrogen, including nitrous acid and nitric acid, are part of the nitrogen oxide family. Of this family of gasses, NO_2 is the only component for which ambient air quality standards have been established. An annual average standard for NO_2 has been in effect for many years.

The project area is in attainment for NO_2.

4.3 GREENHOUSE GASES AND GLOBAL CLIMATE CHANGE

The phenomena of natural and human-caused effects on the atmosphere that cause changes in long-term meteorological patterns is known as climate change. Because of the importance of the greenhouse effect and related atmospheric warming to climate change, the gases that affect such warming are referred to as GHGs. The GHGs of primary importance are CO_2, methane, and nitrous oxide. Because CO_2 is the most abundant of these gases, GHGs are usually quantified in terms of CO_2e, based on their relative longevity in the atmosphere and the related "global warming potential" of these constituents. CO_2 is not considered an air "pollutant" that causes direct health-related effects, so ambient air quality standards have <u>not</u> been developed for it to gauge whether ambient air concentrations are acceptable at a given location.

Fuel combustion associated with transportation is a significant source of GHG emissions, primarily through use of gasoline and diesel fuels in vehicles. National estimates indicate that the transportation sector, including on-road, construction, airplanes, and vessels, accounted for approximately 29% of total domestic GHG emissions as CO_2e from fossil fuels in 2017 (USEPA 2019). In an analysis of 2017 emissions in Washington, Ecology estimated that transportation accounted for approximately 45% of statewide GHG emissions (Ecology 2017); this large fraction, as compared to other states, is due to a smaller portion of GHG emissions from electrical generation because Washington relies heavily on hydropower for electricity.

For additional context, Ecology estimated state-wide annual GHG emissions in 2015 at approximately 97 *million* $MTCO_2e$ (Ecology 2015). Annual worldwide GHG emissions for 2010 were estimated by the World Resources Institute (WRI) to be approximately 46 *billion* $MTCO_2e$ (USEPA 2014).

4.4 CARBON SEQUESTRATION

Coastal wetland environments remove CO_2 from the atmosphere and sequester the carbon as biomass, dead organic matter, and soil carbon (IPCC 2013). The environmental service of wetland carbon sequestration is often referred to as "blue carbon."

While carbon is typically sequestered in wetland environments, CH_4 emissions occur in marshes when anaerobic conditions allow microbes to decompose organic matter and produce CH_4. This occurs in brackish and freshwater wetlands, with freshwater systems producing approximately three times the amount of methane of brackish systems (Poffenbarger et al. 2011). Saline wetland systems, however, with salinities greater than 18 parts per thousand (ppt) emit negligible amounts of methane (Poffenbarger et al. 2011). Methane has a 100-year Global Warming Potential (GWP) of 28, relative to CO_2, which means the effect of each tonne of CH_4 on the atmosphere in 100 years is 28 times greater than that of a tonne of CO_2. Therefore, the net effect of wetlands on greenhouse gasses can vary widely from a net negative to net positive, depending on the salinity and biomass in the system. The relative greenhouse gas sequestration or emissions expected under the alternatives are described in Section 5.0.

5.0 Impacts and Mitigation Measures

5.1 OVERVIEW

This section describes the probable air quality and odor impacts from the No Action Alternative and the action alternatives (Managed Lake, Estuary, and Hybrid Alternatives). This section also identifies mitigation measures that could avoid, minimize, or reduce the identified impact below the level of significance.

5.2 NO ACTION ALTERNATIVE

As described in Section 1.3, the No Action Alternative represents no change to the current configuration of the Capitol Lake – Deschutes Estuary. Without any construction phase or post-construction phase activities, this alternative would not result in any additional impacts associated with air quality or GHGs. Vehicle trips and equipment use associated with limited, ongoing maintenance of the 5th Avenue Dam would have a negligible air emission.

With the No Action Alternative, algae would continue to periodically grow on the lake. Based on a study done by the U.S. Geological Survey (USGS), algae blooms can release cyanotoxins that co-occur with odor-causing compounds. These compounds may result in an unpleasant earthy, musty odor (Graham et al. 2010). The character of the algae-based odors is likely quite different from those associated with tideflats in the Puget Sound, with higher duration of odor emissions and frequency of observation due to the lack of influence by tides. However, the odors produced from the No Action Alternative would have little change from existing conditions where impacts are infrequent, short in duration, and with low intensity, resulting in a **less-than-significant impact.**

Under the No Action Alternative, Capitol Lake would remain a freshwater system. The freshwater system would likely have the highest net positive GHG emissions of any alternative because freshwater wetlands within the system would emit methane, have reduced capacity to sequester soil carbon, and have low potential for biomass storage. The No Action Alternative does not promote consistency with Guiding Principles in the 2017 Thurston Climate Adaptation Plan, which calls for identifying and leveraging climate change adaptation strategies and actions with mitigation co-benefits, such as reducing, capturing, and storing GHG emissions, along with enhancing resiliency for climate adaptation.

5.3 IMPACTS COMMON TO ALL ACTION ALTERNATIVES

5.3.1 Impacts from Construction

The activities common to all action alternatives during the construction phase include:

- Initial dredging
- Habitat area establishment
- Construction of boardwalks in the South and Middle Basins
- Construction of a dock in the Middle Basin and hand-carried boat launch in the North Basin
- Construction of a 5th Avenue pedestrian bridge
- Construction staging and access

Such activities could result in temporary, localized increases in particulate concentrations due to emissions from construction-related sources. For example, dust from construction activities such as grading, sloping, and filling could contribute to ambient concentrations of suspended particulate matter.

All action alternatives have similar categories of construction sources, such as: harbor craft, dredging vessels, and on-road vehicles. However, the equipment counts, types, and the hours of operation are different for each alternative. The emissions are estimated separately for each alternative due to these differences in emission source activity. These differences are described generally in the following sections; Appendix A provides tables of sources and operating hours used to calculate air pollutant emissions.

5.3.2 Impacts from Operation

Impacts associated with all action alternatives during the post-construction phase would primarily be caused by recurring maintenance dredging.

Post-construction emissions are assumed to be emitted primarily by equipment used for maintenance dredging, which is similar to equipment used for the initial construction dredge. The maintenance dredging is broken into five activity units (e.g., dredge unit, tow unit, scow unit, offload unit, and load out unit). The hours of operation for each activity unit depend on the material removal rate of the excavator or the dredge in that unit. The equipment in the tow unit is assumed to have the same operating hours as the equipment in the dredge unit. In comparison to the construction dredging, the maintenance dredging would require more material to be moved offsite, resulting in additional emissions. For upland disposal, the total miles traveled by haul trucks assumes a one-way trip distance of 250 miles and total miles traveled for each on-road vehicle was scaled by the number of truck trips required. There are no permitted upland disposal locations within Thurston County that would take the dredged material, so a reasonable location farther from the project area was assumed.

Emission totals for each alternative are summarized in the following sections, and the equipment and operating hours used to determine air quality impacts are found in Appendix A.

5.4 MANAGED LAKE ALTERNATIVE

5.4.1 Odor

Under the Managed Lake Alternative, Capitol Lake Basin is anticipated to generate few odors because no new tideflats would be created, and the lake would be managed to avoid large algae growth. There have been no complaints logged with ORCAA over the past 5 years regarding existing odor from the project area, and the alternative is not expected to increase the potential for odor generation. Algal blooms are expected to be less frequent under the Managed Lake Alternative than the No Action Alternative. As a result, there would be no increase in odors compared to the No Action Alternative and no new odor-related impacts **(no impacts)**.

5.4.2 Air Quality

5.4.2.1 Impacts from Construction

Initial dredging operations would be the primary source of air pollutants and air quality impacts associated with the Managed Lake Alternative. Among the action alternatives, the Managed Lake Alternative involves less equipment and operating hours due to lower dredge operating duration and volume, which results in lower emissions of each pollutant. The calculated air pollutant emission rates are summarized in Table 5.1. The total annual emissions of each pollutant are less than the general conformity *de minimis* thresholds; therefore, the air quality impacts associated with the construction phase of this alternative would be **less-than-significant.**

Table 5.1 Construction Air Pollutant Emissions from the Managed Lake Alternative

Pollutant	Project Emissions (tpy)	General Conformity *De Minimis* Threshold (tpy)	Greater Than *De Minimis*?
CO	14	100	No
NO_x	65	100	No
VOC	1	100	No
SO_2	0.04	100	No
PM_{10}	1	100	No
$PM_{2.5}$	1	100	No

5.4.2.2 Impacts from Operation – Upland Disposal

For the Managed Lake Alternative, maintenance dredging would be required 20 years after project construction (and occurring with increased frequency thereafter). During the evaluated time horizon of 30 years, the total estimated volume of sediment removed during maintenance dredging is estimated at 472,000 cubic yards (361,000 cubic meters). Air quality impacts during the post-construction phase would primarily be associated with this recurring maintenance dredging and the associated haul of material. This activity uses very similar equipment to that used during the initial dredge, with the most notable exception that an excavator may be used to dredge the lake in place of a hydraulic or mechanical dredge unit. The hours of operation for each activity unit (e.g., dredge unit, tow unit, scow unit, offload unit, and load out unit) depend on the material removal rate of the excavator in that unit. The dredged material would be transported by trucks to a landfill, with an assumed distance of 250 miles from the project area. The total annual emissions associated with post-construction phase maintenance dredging are summarized in Table 5.2. The total emissions are less than the general conformity *de minimis* values and, therefore, air quality impacts associated with the post-construction phase of the Managed Lake Alternative would be **less-than-significant**.

Table 5.2 Post-Construction Air Pollutant Emissions for the Managed Lake Alternative

Pollutant	Project Emissions (tpy)	General Conformity *De Minimis* Threshold (tpy)	Greater Than *De Minimis*?
CO	8.0	100	No
NO_x	26.5	100	No
VOC	1.7	100	No
SO_2	0.06	100	No
PM_{10}	1.8	100	No
$PM_{2.5}$	1.0	100	No

5.4.2.3 Impacts from Operation – In-Water Disposal

In-water disposal is not feasible under the Managed Lake Alternative.

5.4.3 Greenhouse Gas Emissions

The GHG emissions associated with construction and post-construction of the Managed Lake Alternative are calculated using the same methods applied to the criteria air pollutants. The construction-related GHG assessment is based on estimates of emissions from construction using expected construction equipment and the time all such equipment would be active. Compared to the other action alternatives, the Managed Lake Alternative involves less equipment and operating hours due to lower dredge volume (total, over the 30-year time horizon) and, therefore, lower emissions of GHGs overall. The post-construction GHG assessment of the Managed Lake Alternative is based on estimates of emissions from maintenance dredging. Over the 30-year time horizon evaluated in the EIS, the Managed Lake Alternative only requires one maintenance dredge of approximately 472,000 cubic yards, 20 years after the initial construction. The operating hours are estimated based on the rate of material removal and the total volume dredged. The construction and post-construction emissions associated with maintenance dredging are combined and then annualized over the lifetime of the project (30 years).

The Managed Lake Alternative would generate lower levels of construction-related GHG emissions than the Estuary or Hybrid Alternatives. The GHG emissions are well below reporting thresholds but would contribute to GHG emissions cumulatively.

To provide the most conservative analysis, these calculations do not quantify or consider any potential efforts to reduce either GHG emissions or resource consumption by incorporating sustainable features into the project.

Table 5.3 Estimated GHG Emissions ($MTCO_2e$) – Managed Lake Alternative

Project Emissions by Disposal Scenario	Components	CO_2	CH_4	N_2O	Lifespan Emissions [a]	Annual Emissions [b]
Upland Disposal	Construction	13,206	3	165	32,308	1,077
	Operation	18,858	20	55		

Notes:

[a] Estimated lifespan emissions are based on an assumed average useful life of about 30 years.

[b] Annual emissions estimates are based on dividing total emissions by assumed facility useful lifespan as indicated in note (a) above.

The Managed Lake Alternative is expected to produce about 32,308 $MTCO_2e$ (see Table 5.3) over a 30-year lifespan. Annually, this corresponds to about 1,077 $MTCO_2e$. Because there are no generally accepted emission level thresholds against which to assess potential localized or global consequences of GHG emissions, the Ecology GHG reporting threshold of 10,000 $MTCO_2e$ or more per year is used for comparison purposes only. The estimated annual GHG emissions for this alternative are less than this threshold. As mentioned in Section 4.2, in the Washington State GHG emissions inventory for 1990 – 2015, Ecology estimated that state-wide annual GHG emissions in 2015 were about 97 million $MTCO_2e$. Estimated annual worldwide GHG emissions for 2010 were about 46 billion $MTCO_2e$. Therefore, the annual GHG emissions represents less than 0.01% of estimated annual 2015 GHG emissions within Washington, and much smaller percentages of worldwide emissions.

It is important to note that the scale of global climate change is so large that the impacts from one project, no matter the size, would almost certainly have no discernible effect on increasing or decreasing global climate change. In reality, any such effects can only be considered on a "cumulative" basis. However, any project involving construction and post-construction emissions contributes cumulatively to GHG emissions.

The GHG emissions associated with the Managed Lake Alternative would contribute to the cumulative carbon footprint of Thurston County, but the small contribution of GHG emissions from this alternative would be **less than significant.** Considering the cumulative contribution for this alternative, the Managed Lake Alternative generates the least construction- and operation-related GHG emissions of the action alternatives. Within the context of regional GHG emission goals described in the 2020 Thurston Climate Mitigation Plan to reduce GHG emissions 45% below 2015 levels by 2030 and 85% below 2015 levels by 2050, this alternative is the lowest long-term generator of GHG emissions from construction and operation activities.

The freshwater system under the Managed Lake Alternative is expected to capture and sequester slightly more carbon than the No Action Alternative, but would still have net positive GHG emissions. The Managed Lake Alternative does not promote consistency with Guiding Principles in the 2017 Thurston Climate Adaptation Plan, which calls for identifying and leveraging climate change adaptation strategies and actions with mitigation co-benefits, such as reducing, capturing and storing greenhouse gas emissions.

5.4.4 Carbon Sequestration

Habitat areas planned for the Managed Lake Alternative are designed to support forested wetlands in addition to marsh communities. Forested wetlands sequester more carbon as biomass when compared to marsh plant communities alone. The advantage of increased biomass storage within forested wetlands has not been quantitatively assessed relative to the reduction in methane emissions and increase in soil carbon anticipated for the Estuary and Hybrid Alternatives (see Sections 5.5.4 and 5.6.4). However, the Managed Lake Alternative would be expected to have a slightly lower net positive greenhouse gas emissions than the No Action Alternative.

5.5 ESTUARY ALTERNATIVE

5.5.1 Odor

Compared to the Managed Lake Alternative, there would be an increase in odor potential associated with the Estuary Alternative. The configuration associated with the Estuary Alternative would include the addition of approximately 152 acres of new tideflats to the area.

As described in Section 4.0, tideflats with oxygen-starved organic material in the sediment can produce low levels of hydrogen sulfide, which can create odors that smell like rotten eggs (Washington State Department of Health No Date). The potential frequency of these odors would be limited to times when the tide is out (twice per day, although most of the North Basin would be submerged for most of the tidal cycle). As the tide goes in and out, the amount of estuary exposed would change, effectively creating a temporal gradient of odor emission rate. The influence of tide-driven changes in the odor environment are commonplace along the coast of the South Sound region. Within 15 miles of the project area, there are many estuaries varying in size and composition, such as Mud Bay, Kennedy Creek, Ellis Cove, Woodard Bay, and Nisqually. The closest nearby estuary, Mud Bay on lower Eld Inlet, is roughly 5 miles to the west of the project area and has approximately 60 acres of tideflats and salt marsh. The largest nearby estuary, Nisqually Estuary, is roughly 10 miles away from the project area and has approximately 1,000 acres of combined tideflats and salt marshes (USFWS 2012). Comparisons to these nearby estuaries provides some context for estimating potential odor levels and odor tolerances in the study area.

Based on ORCAA records, only a single odor complaint has been lodged across their jurisdiction that includes the word "tide," and that complaint (from 2007) was not near a shoreline. While odor complaints are only one indication of possible odor issues, there is no other clear evidence that these nearby estuaries promote deleterious odor conditions for the nearby communities. The presence of restaurants and other commercial activity along the waterfront further contributes to the notion that the naturally occurring odors are limited.

For context, the average emission rate per unit area of a tideflat is 0.044 grams of sulfur per square meter per year (gS/m^2/year), as compared with salt marshes, which have an average per area emission rate of approximately 0.55 gS/m^2/year, ranging as high as 72 gS/m^2/year (Aneja et al. 1982). Given that Estuary Alternative would primarily add tideflat area with some salt marsh areas and the Nisqually Estuary has over six times the acreage of combined tideflat and salt marsh, the odor generation of the Estuary Alternative is expected to be comparatively low. Odor emission rates are not constant, and natural phenomenon can occur that result in elevated H2S generation at times (e.g., the die-off in Rhode Island highlighted by the ATSDR), but, on average, H2S-based odor generation from the tideflat is expected to be lower than that of a combined tideflat and salt marsh of equal size, or of the odor experienced at the Nisqually Estuary. Other variables related to geography and prevailing winds influence odor concentrations at these locations. However, regional stagnation events have not driven odor complaints associated with estuaries.

The Capitol Lake – Deschutes Estuary location is unique in that it is in a downtown area with a larger population. The land use characteristics of the nearby estuaries described above include residential and some commercial uses (e.g., waterfront restaurants), but do not have the same scale of urban and residential interface that is found in the study area. To that end, comparisons to these adjacent estuaries are useful for understanding the tolerance for estuary odors by residents and limited commercial activity but may not capture the tolerance of individual exposures in downtown Olympia or in nearby residential areas. In consideration of the potentially lower odor tolerance of downtown visitors and nearby residential populations to estuary odors, understanding the potential odor impacts of the Estuary Alternative requires consideration of the multiple odor characteristics described in Section 4.1 (e.g., odor frequency, intensity, duration, and offensiveness).

Any increase in estuary odors may be considered a significant impact by a portion of the study area population with low tolerance to odor. However, the offensiveness of estuary odors is very subjective; some may find it objectionable, while others may find the odor of an estuary natural and pleasant. In consideration of the potential odor frequency, intensity, and duration, odor impacts from the Estuary Alternative would be **less-than-significant** based on: (1) the variable tides and tidal range of the Puget Sound, which would result in inconsistent odor production frequency and durations; (2) the low intensity of odors expected to be produced by the estuary, similar to estuaries elsewhere within Puget Sound; and (3) the naturally occurring character of the odor produced by estuaries. Even with the low and variable odor detection threshold of H2S, a portion of the population that perceives this odor may find it offensive and would consider any increase in estuary odors to be a significant impact.

Notably, historic anecdotal evidence of pre-dam odors is not reliable because they cannot be attributed to specific odor sources given the industrial activities, sewage management approaches, and other unknown contributors in the region at the time.

5.5.2 Air Quality

5.5.2.1 Impacts from Construction

Initial dredging operations would be the primary source of air pollutant emissions associated with the Estuary Alternative. The calculated air pollutant emission rates are summarized in Table 5.4. The total annual emissions of each pollutant are less than the general conformity *de minimis* thresholds; therefore, the air quality impacts associated with the construction phase of this alternative would be **less-than-significant.**

Table 5.4 Construction Air Pollutant Emission from the Estuary Alternative

Pollutant	Project Emissions (tpy)	General Conformity *De Minimis* Thresholds (tpy)	Greater Than *De Minimis*?
CO	18	100	No
NO_x	84	100	No
VOC	1	100	No
SO_2	0.05	100	No
PM10	2	100	No
PM2.5	1	100	No

5.5.2.2 Impacts from Operation – Upland Disposal

For the Estuary Alternative, maintenance dredging would occur within impact areas of West Bay to avoid adverse effects on navigation from sedimentation. Maintenance dredging would occur at the OYC, private marinas, the port/turning basin, and access areas. Sediment would accumulate at different rates within each area, resulting in a varied dredge cycle at each location. Air quality impacts from post-construction would primarily be associated with these recurring maintenance dredging activities. The equipment used for this activity is expected to vary based on dredged area, but would be similar to that used during the initial dredge. The maintenance dredge cycle with the largest volume (350,400 cubic yards) of material removed was assessed. This is expected to occur during year 24, which is the year when all areas within West Bay are expected to be dredged during the same dredge event. For each maintenance dredging event, all areas are conservatively assumed to be dredged concurrently, condensing most of the activity to one calendar year, which increases the annual emissions. Most of this dredging would be completed within one in-water work window (7 months);

given the estimated volume of material to be removed, an additional 2 months of work may be needed in the next annual in-water work window. Under this disposal option, the dredged material would be transloaded at the Port and transported by trucks to a landfill, with an assumed distance of 250 miles from the project area. Although the dredged material is assumed to be disposed in-water, emissions were calculated for upland disposal to evaluate potential impacts to air quality and general conformity if the sediment was determined not suitable for in-water based on future sampling. The total emissions associated with maintenance dredging are summarized in Table 5.5. The total emissions are less than the general conformity *de minimis* values (although emissions of NO_x are just shy of this threshold value); therefore, post-construction air quality impacts associated with this alternative would be **less-than-significant**.

Table 5.5 Maximum Annual Air Pollutant Emissions for the Estuary Alternative – Upland Disposal

Pollutant	Project Emissions (tpy)	General Conformity *De Minimis* Thresholds (tpy)	Greater Than *De Minimis*?
CO	22.9	100	No
NO_x	99.6	100	No
VOC	3.3	100	No
SO_2	0.12	100	No
PM_{10}	3.7	100	No
$PM_{2.5}$	2.4	100	No

5.5.2.3 Impacts from Operation – In-Water Disposal

The maintenance dredging with in-water disposal uses the same equipment and assumptions as upland disposal with two main exceptions. For the maintenance dredging with in-water disposal, the dredge material would be barged to a non-dispersive in-water disposal location between Anderson and Ketron Islands. Equipment for offload or load-out unit activities would not be needed. The vessel activity associated with this disposal would be roughly 10 hours of tug operation per day, in addition to the dredging activities.

The total emissions associated with maintenance dredging are summarized in Table 5.6. The total emissions are less than the general conformity *de minimis* values; therefore, post-construction air quality impacts associated with this alternative would be **less-than-significant**.

Table 5.6 Maximum Annual Air Pollutant Emissions for the Estuary Alternative – In-Water Disposal

Pollutant	Project Emissions (tpy)	General Conformity *De Minimis* Thresholds (tpy)	Greater Than *De Minimis*?
CO	14	100	No
NO_x	75	100	No
VOC	0.8	100	No
SO_2	0.04	100	No
PM_{10}	1.2	100	No
$PM_{2.5}$	1.2	100	No

5.5.3 Greenhouse Gas Emissions

The GHG emissions associated with construction and operation of the Estuary Alternative are calculated using the same methods applied to the criteria air pollutants. The construction-related GHG assessment is based on estimates of emissions from construction using expected construction equipment and the time all such equipment would be active. The post-construction GHG assessment for this alternative is based on estimates of emissions from recurring maintenance dredging.

The Estuary Alternative would generate higher levels of GHG emissions during construction than the Managed Lake Alternative. The GHG emissions are well below reporting thresholds but would contribute to GHG emissions cumulatively.

Based on the estimated rate of sediment accumulation, the OYC is expected to be dredged every 6 years, the marinas and the port/turning basin are expected to be dredged every 12 years, and the access area is expected to be dredged once every 24 years. The combined maintenance dredges are expected to remove a total of 700,200 cubic yards of sediment over the 30-year project horizon. The operating hours are assumed based on the rate of material removal and the total volume dredged. The construction and post-construction emissions are combined and then annualized over the lifetime of the project (30 years).

The estimates of GHG emissions do not consider any potential efforts to reduce either GHG emissions and/or resource consumption by incorporating sustainable features into the project.

Table 5.7 Estimated GHG Emissions ($MTCO_2e$) – Estuary Alternative

Project Emissions by Disposal Scenario	Components	CO2	CH4	N2O	Lifespan Emissions [a]	Annual Emissions [b]
Upland Disposal	Construction	17,190	4.87	210	49,998	1,667
	Operation	32,418	29.42	145		
In-Water Disposal	Construction	17,190	4.87	210	26,316	877
	Operation	8,782	0.96	128		

Notes:

[a] Estimated lifespan emissions are based on an assumed average useful life of about 30 years.

[b] Annual emissions estimates are based on dividing total emissions by assumed facility useful lifespan as indicated in note (a) above.

Under the Estuary Alternative, upland disposal would produce more metric tons of CO_2e than in-water disposal – estimated at approximately 49,998 $MTCO_2e$ (see Table 5.7) over a 30-year lifespan. Annually, this corresponds to about 1,667 $MTCO_2e$, and calculated emissions are the second highest of the three action alternatives. With in-water disposal, the total metric tons of CO_2e emitted is estimated at 26,316 $MTCO_2e$, with an annual rate of emissions estimated at 877 $MTCO_2e$. This disposal option would result in the lowest calculated emissions of the alternatives.

Similar to evaluating GHG emissions from the Managed Lake Alternative, the annual GHG emissions of either disposal option are below the 10,000 $MTCO_2e$ GHG reporting threshold. In addition, the GHG emissions represents less than 0.01% of estimated annual 2015 GHG emissions within Washington, and much smaller percentages of worldwide emissions.

The GHG emissions associated with the Estuary Alternative would contribute to the cumulative carbon footprint of Thurston County, but the small contribution of GHG emissions from this alternative would be **less-than-significant**.

Within the context of the regional GHG emission goals described in the 2020 Thurston Climate Mitigation Plan to reduce GHG emissions 45% below 2015 levels by 2030 and 85% below 2015 levels by 2050, the Estuary Alternative is less consistent than the Managed Lake or No Action Alternative in terms of reducing long-term GHG emissions associated with construction and operation activities.

However, the Estuary Alternative promotes the greatest level of consistency with the Guiding Principles in the 2017 Thurston Climate Adaptation Plan, which calls for identifying and leveraging climate change adaptation strategies and actions with mitigation co-benefits, such as reducing, capturing, and storing greenhouse gas emissions (see below, *Carbon Sequestration*), along with enhancing resiliency for climate adaptation.

5.5.4 Carbon Sequestration

Under future conditions, the Estuary Alternative would be saline in the North Basin (100 acres, with assumed salinity greater than 18 ppt), brackish in the Middle Basin and Percival Cove (126 acres, with assumed salinity from 18 ppt, decreasing to 5 ppt), and fresh or oligohaline in the South Basin (10 acres, with salinity assumed between 5 and 0 ppt). Because of the increased salinities, less methane would be released compared to the No Action or Managed Lake Alternative. Vegetated marshes anticipated to develop in the Estuary Alternative would also sequester more soil carbon through the biomass in the soil than would be expected in open water habitats.

5.6 HYBRID ALTERNATIVE

5.6.1 Odor

Based on tideflat area exposure, the Hybrid Alternative is expected produce slightly lower odor when compared to the Estuary Alternative, but still an increase when compared to the Managed Lake Alternative. The configuration associated with the Hybrid Alternative would include approximately 119 acres of tideflats, compared to 152 acres under the Estuary Alternative.

As with the Estuary Alternative, the potential for post-construction odor impacts from the Hybrid Alternative is **less-than-significant.**

5.6.2 Air Quality

5.6.2.1 Impacts from Construction

Initial dredging operations would be the primary source of air pollutants and air quality impacts associated with the Hybrid Alternative. Among the action alternatives, this involves the most equipment and operating hours, and, therefore, the largest emissions of each pollutant. The calculated air pollutant emission rates are summarized in Table 5.8. The total annual emissions of each pollutant are less than the general conformity *de minimis* thresholds; therefore, the air quality impacts associated with the construction phase of this alternative would be **less-than-significant**.

Table 5.8 Construction Air Pollutant Emission for the Hybrid Alternative

Pollutant	Project Emissions (tpy)	General Conformity *De Minimis* Thresholds (tpy)	Greater Than *De Minimis*?
CO	18	100	No
NO_x	86	100	No
VOC	1	100	No
SO_2	0.05	100	No
PM_{10}	2	100	No
$PM_{2.5}$	1	100	No

5.6.2.2 *Impacts from Operation – Upland Disposal*

Similar to the Estuary Alternative, maintenance dredging would need to occur at four different resource areas within West Bay to avoid sedimentation impacts on navigation. Sediment would accumulate at different rates within each area, resulting in a varied dredge cycle at each location. Air quality impacts from post-construction would primarily be associated with these recurring maintenance dredging activities. The equipment used for this activity would vary based on dredged area but would be similar to that used during the initial dredge. The maintenance dredge with the largest volume (350,400 cubic yards) of material removed was assessed. This is expected to occur during year 20, the year when all areas within West Bay are expected to be dredged during the same dredge event.

The total emissions associated with maintenance dredging are summarized in Table 5.9, and are the same as the Estuary Alternative given that the same volume of material would be removed, with the same equipment. The only difference between the Estuary and Hybrid Alternative dredge assumptions is that the peak dredge event occurs sooner and more often under the Hybrid Alternative. The total emissions are less than the general conformity *de minimis* values (although emissions of NO_x are just shy of this threshold value); therefore, post-construction air quality impacts associated with this alternative would be **less-than-significant**.

Table 5.9 Post-Construction Air Pollutant Emissions for the Hybrid Alternative – Upland Disposal

Pollutant	Project Emissions (tpy)	General Conformity *De Minimis* Threshold (tpy)	Greater Than *De Minimis*?
CO	22.9	100	No
NO_x	99.6	100	No
VOC	3.3	100	No
SO_2	0.12	100	No
PM_{10}	3.7	100	No
$PM_{2.5}$	2.4	100	No

5.6.2.3 *Impacts from Operation – In-Water Disposal*

The maintenance dredging with in-water disposal uses the same equipment and assumptions as upland disposal, with the same exceptions as described for the Estuary Alternative.

The total emissions associated with maintenance dredging are summarized in Table 5.10, and are the same as the Estuary Alternative given that the same volume of material would be removed, with the same equipment. The only difference between the Estuary and Hybrid Alternative dredge assumptions is that the peak dredge event occurs sooner under the Hybrid Alternative. The total emissions are less than the general conformity *de minimis* values; therefore, post-construction air quality impacts associated with this alternative would be **less-than-significant**.

Table 5-10 Post-Construction Air Pollutant Emissions for the Hybrid Alternative– In-Water Disposal

Pollutant	Project Emissions (tpy)	General Conformity *De Minimis* Thresholds (tpy)	Greater Than *De Minimis*?
CO	14	100	No
NO_x	75	100	No
VOC	0.8	100	No
SO_2	0.04	100	No
PM_{10}	1.2	100	No
$PM_{2.5}$	1.2	100	No

5.6.3 Greenhouse Gas Emissions

The GHG emissions associated with construction and operation of the Hybrid Alternative are calculated using the same methods applied to the criteria air pollutants. The construction-related GHG assessment is based on estimates of emissions from construction using expected construction equipment and the time all such equipment would be active. The post-construction GHG assessment of the Hybrid Alternative is based on estimates of emissions from recurring maintenance dredging.

Of the three action alternatives, the Hybrid Alternative would generate the highest levels of GHG emissions during construction. The GHG emissions are well below reporting thresholds but would contribute to GHG emissions cumulatively.

Based on the estimated rate of sediment accumulation over the 30-year time horizon evaluated, the OYC is expected to be dredged every 5 years, the marinas and the port/turning basin are expected to be dredged every 10 years, and the access area is expected to be dredged once every 20 years. The combined maintenance dredges are expected to remove a total of 985,200 cubic yards of sediment over the 30-year project horizon. The operating hours are assumed based on the rate of material removal and the total volume dredged. The construction and post-construction emissions are combined and then annualized over the lifetime of the project (30 years).

The estimates of GHG emissions do not consider any potential efforts to reduce GHG emissions and/or resource consumption by incorporating sustainable features into the project.

Table 5.11 Estimated GHG Emissions ($MTCO_2e$) – Hybrid Alternative

Project Emissions by Disposal Scenario	Components	CO2	CH4	N2O	Lifespan Emissions [a]	Annual Emissions [b]
Upland Disposal	Construction	18,381	5	226	64,806	2,160
	Operation	45,940	41	211.14		
In-Water Disposal	Construction	18,381	5	226	31,495	1,050
	Operation	12,695	1	185		

Notes:

[a] Estimated lifespan emissions are based on an assumed average useful life of about 30 years.

[b] Annual emissions estimates are based on dividing total emissions by assumed facility useful lifespan as indicated in note (a) above.

Under the Hybrid Alternative, upland disposal would produce more metric tons of CO_2e than in-water disposal – estimated at approximately 64,806 $MTCO_2e$ (see Table 5.11) over a 30-year lifespan. Annually, this corresponds to about 2,160 $MTCO_2e$. With in-water disposal, the total metric tons of CO_2e emitted is estimated at 31,495 $MTCO_2e$, with an annual rate of emissions estimated at 1,050 $MTCO_2e$. The emissions from this disposal option would be higher than in-water disposal under the Estuary Alternative, but lower than the emissions assumed under the Managed Lake Alternative (for upland disposal).

Similar to evaluating GHG emissions from the other alternatives, the annual GHG emissions are below the 10,000 $MTCO_2e$ GHG reporting threshold. In addition, the GHG emissions represents less than 0.01% of estimated annual 2015 GHG emissions within Washington, and much smaller percentages of worldwide emissions.

The GHG emissions associated with the Hybrid Alternative are the highest of the three action alternatives and would contribute to the cumulative carbon footprint of Thurston County. However, the small contribution of GHG emissions from this alternative would be **less-than-significant**.

Within the context of the regional GHG emission goals described in the 2020 Thurston Climate Mitigation Plan to reduce GHG emissions 45% below 2015 levels by 2030 and 85% below 2015 levels by 2050, the Hybrid Alternative is the least consistent in terms of reducing long-term GHG emissions associated with construction and operation activities.

However, the Hybrid Alternative provides more consistency than the Managed Lake Alternative with the Guiding Principles in the 2017 Thurston Climate Adaptation Plan by improving the ability to reduce, capture, and store greenhouse gas emissions (see below, *Carbon Sequestration*), but less than the Estuary Alternative.

5.6.4 Carbon Sequestration

The Hybrid Alternative would have slightly less net carbon sequestration when compared to the Estuary Alternative because of the decreased area of saline marsh in the North Basin. However, compared to the No Action and Managed Lake Alternatives, the Hybrid Alternative would still result in more carbon sequestration and less methane releases in the North and Middle Basins.

5.7 AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES

5.7.1 Measures Common to All Action Alternatives

5.7.1.1 Construction

Although construction would not significantly affect air quality, construction contractors would be required to comply with all relevant federal, state, and local air quality rules. In addition, implementation of best management practices would reduce emissions related to the construction phase of the project. Management practices for reducing the potential for air quality impacts during construction include measures for reducing both exhaust emissions and fugitive dust. The Washington Associated General Contractors Guide to Handling Fugitive Dust from Construction Projects suggest a number of methods for controlling dust and reducing the potential exposure of people to emissions from diesel equipment. A list of the control measures that would be considered during construction follows:

- Require Tier 2 or better engines for off-road equipment.
- Require model year 2007 or newer engines for heavy duty vehicles (exempt trucks that are operated < 100 hours/yr on this job).
- Require the use of biofuel B20, or offer contractor incentive for this fuel.
- Require contractor to have idle reduction plan or ensure that project specifications have a maximum idle time of 5 minutes; however, if equipment requires, in the colder months idle times may be extended to achieve adequate equipment performance.
- Use only equipment and trucks that are maintained in optimal operational condition.
- Require all off-road equipment to have emission reduction equipment (e.g., require participation in Puget Sound Region Diesel Solutions, a program designed to reduce air pollution from diesel, by project sponsors and contractors).
- Use carpooling or other trip-reduction strategies for construction workers.
- Spray exposed soil with water or other suppressant to reduce emissions of particulate matter and deposition of particulate matter.
- Pave or use gravel on staging areas and roads that would be exposed for long periods.
- Cover all trucks transporting materials, wetting materials in trucks, or providing adequate freeboard (space from the top of the material to the top of the truck bed), to reduce particulate matter emissions and deposition during transport.

- Provide wheel washers to remove particulate matter that would otherwise be carried offsite by vehicles to decrease deposition of particulate matter on area roadways.
- Cover dirt, gravel, and debris piles as needed to reduce dust and wind-blown debris.
- Stage construction to minimize overall transportation system congestion and delays to reduce regional emissions of pollutants during construction.
- Implement best management practices for dredging and materials handling activities that influence air quality to minimize emissions.

5.7.1.2 Operation

Post-construction, the only activity under any of the action alternatives that would have the potential to impact air quality is recurring maintenance dredging. The mitigation methods for maintenance dredging would be the same to those listed above.

5.7.2 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts related to air quality or odor are expected as a result of any of the project action alternatives.

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Appendix A Emission Factors and Parameters

Managed Lake Alternative

Table A-1. On Road and Non-Road Construction Source Emission Factors

Description - Combined	Hours of Activity	Source	Units	CO	NOx	VOC	SO2	PM10	PM25	CO2	CH4	N2O [1]
Hand Held Vib Plate Comp 25"	65.00	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
CAT CS-76 SD Vib Comp SM	65.00	MOVES2014b	g/hr	28.1399	77.3806	4.9028	0.2182	4.3269	4.1970	30452.7262	0.3944	4.9028
CAT 12M Articulated Frm Grdr	65.00	MOVES2014b	g/hr	26.8282	69.0800	4.6982	0.4498	5.5538	5.3872	64824.4768	0.3680	4.6982
CAT 966H F.E. Loader 5.5cy	4.00	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT D6T LGP Dozer	3244.24	MOVES2014b	g/hr	58.4031	173.3421	8.9059	0.5889	9.6335	9.3445	82733.5114	0.6115	8.9059
CAT D6T Dozer	2075.88	MOVES2014b	g/hr	58.4031	173.3421	8.9059	0.5889	9.6335	9.3445	82733.5114	0.6115	8.9059
CAT 345D L Excavator 2.36cy	827.06	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 374DL Excavator 5cy	9471.90	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 385CL Excavator 5cy	362.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
MANITOWOC 555 150t	64.00	MOVES2014b	g/hr	46.1477	177.5623	10.8716	0.4053	7.9392	7.7011	52936.6618	0.7417	10.8716
Forklift Truck RT 3t	128.00	MOVES2014b	g/hr	42.6570	97.7189	6.6663	0.2363	6.3267	6.1369	32519.6642	0.4516	6.6663
Forklift Truck RT 8t	6726.14	MOVES2014b	g/hr	42.6570	97.7189	6.6663	0.2363	6.3267	6.1369	32519.6642	0.4516	6.6663
Floating Booster - 12"	1973.24	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
APE 50 Vibratory Hammer	6702.14	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
Backhoe Loader, 48 H.P.	11.10	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
LD Truck 4x2 1t	48073.00	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
LD Truck 4x4 1.75t	46.12	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
LD Truck 4x4 Crw 1.75t	3244.24	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
On Hwy End Dump 10-12cy	100.74	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
On Hwy Truck 70K	1490.04	MOVES2014b	g/mi	0.8270	3.6951	0.1965	0.0138	0.2360	0.1249	1641.7802	0.0423	0.0019
On Hwy Water Tanker 4K gal	79.12	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023

Notes: [1] N2O emission factors calculated using the following formula: [(tons of CO2 emitted) * (1 kg / 0.001102311 tons) * (1 gal of fuel / 10.21 kg CO2) * (0.47 g N2O / gal of fuel)] / (hours of source operation)

Table A-2. Harbor Craft and Dredge Construction

Description - Combined	Hours of Activity	Propulsion Power (kW)	Propulsion Load factor	Auxiliary Power (kW)	Auxiliary Load Factor
Crew/Survey Boat	4622.00	464.00	0.45	36.00	0.43
Flat Deck Barge 1575 Ton	2106.08	0.00	0.00	622.00	0.43
Hyd Cutterhead Dredge 12"	1973.24	7161.00	0.66	0.00	0.00
Floating Pipeline - 12"	4177.24	0.00	0.00	0.00	0.00
Shore Pipeline - 12"	4177.24	0.00	0.00	0.00	0.00
Inland Tug - 700hp	6217.38	521.99	0.52	285.00	0.43
Runabout 16ft	1973.24	149.00	0.45	0.00	0.00

Notes:
Pipeline Emissions (Floating and Shoreline) assumed to be negligable.
Inland Tug propulsion power was provided (700hp)
Inland Tug propulsion power was provided (380hp)
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix G.

Managed Lake Alternative

Table A-3. Harbor Craft and Dredge Emission Factors

Pollutant	Propulsion EF (g/kWh)	Auxiliary EF (g/kWh)
NOx [a]	13.3600	13.3600
PM10 [b]	0.2100	0.2100
PM25 [b]	0.2036	0.2036
VOC [c]	0.1411	0.1411
CO [d]	2.4800	2.4800
SO2 [e]	0.0062	0.0062
CH4 [c]	0.0027	0.0027
CO2	679.4600	679.4600

Notes: All EF are conservatively assumed to be C2 Engine Category and uncontrolled

a - Table H.1 Category 1 and 2 NOx Emission Factors (g/kWh) pg 168
b - Table H.2 Category 1 and 2 PM ULSD Emission Factors (g/kWh), page 172
c - Table H.4 Category 1 and 2 HC, VOC and CH4 Emission Factors (g/kWh)
d - Table H.5 Category 1 and 2 Co Emission Factors (g/kWh)
e - Table H.6 Average Harbor Craft Emission Factors by Engine Tier
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix H

Table A-4. On Road and Non-Road Post Construction Source Emission Factors

Description - Combined	Hours of Activity	Source	Units	CO	NOx	VOC	SO2	PM10	PM25	CO2	CH4	N2O [1]
Floating Booster - 12"	2523.25	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
On Hwy End Dump 10-12cy	See Miles Traveled	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
On Hwy Truck 70K	See Miles Traveled	MOVES2014b	g/mi	0.8270	3.6951	0.1965	0.0138	0.2360	0.1249	1641.7802	0.0423	0.0019

Notes: [1] N2O emission factors calculated using the following formula: [(tons of CO2 emitted) * (1 kg / 0.001102311 tons) * (1 gal of fuel / 10.21 kg CO2) * (0.47 g N2O / gal of fuel)] / (hours of source operation)

Table A-5. Harbor Craft and Dredge Post Construction

Description - Combined	Hours of Activity	Propulsion Power (kW)	Propulsion Load factor	Auxiliary Power (kW)	Auxiliary Load Factor
Clamshell Dredge - 21cy	2523.25	1600.00	0.66	0.00	0.00
Floating Pipeline - 12"	5341.59	0.00	0.00	0.00	0.00
Shore Pipeline - 12"	5341.59	0.00	0.00	0.00	0.00
Inland Tug - 700hp	7950.39	521.99	0.52	285.00	0.43
Runabout 16ft	2523.25	149.00	0.45	0.00	0.00

Notes:
Pipeline Emissions (Floating and Shoreline) assumed to be negligable.
Inland Tug propulsion power was provided (700hp)
Inland Tug propulsion power was provided (380hp)
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix G.

Estuary Alternative

Table A-6. On Road and Non-Road Construction Source Emission Factors

Description - Combined	Hours of Activity	Source	Units	CO	NOx	VOC	SO2	PM10	PM25	CO2	CH4	N2O [1]
Portable Air Comp - 250-cfm	110.00	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
Hand Held Vib Plate Comp	147.42	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
CAT CS-76 SD Vib Comp	147.42	MOVES2014b	g/hr	28.1399	77.3806	4.9028	0.2182	4.3269	4.1970	30452.7262	0.3944	4.9028
AC CM592 Hyd Track Drill	275.00	MOVES2014b	g/hr	118.6336	396.3625	29.7173	0.3845	20.6651	20.0452	42131.7172	1.3153	29.7173
CAT 12M Articulated Frm Grdr	531.37	MOVES2014b	g/hr	26.8282	69.0800	4.6982	0.4498	5.5538	5.3872	64824.4768	0.3680	4.6982
CAT 950H F.E. Loader 4cy	80.00	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT 966H F.E. Loader 5.5cy	457.51	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT D6T LGP Dozer	4167.33	MOVES2014b	g/hr	58.4031	173.3421	8.9059	0.5889	9.6335	9.3445	82733.5114	0.6115	8.9059
CAT D6T Dozer	165.66	MOVES2014b	g/hr	58.4031	173.3421	8.9059	0.5889	9.6335	9.3445	82733.5114	0.6115	8.9059
CAT 232B Skid Steer Loader	180.00	MOVES2014b	g/hr	77.8493	69.3503	15.7229	0.0738	11.2288	10.8920	8209.0423	0.5684	15.7229
CAT 430E-IT Backhoe	415.00	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT 450E Backhoe	500.00	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT 345D L Excavator 2.36cy	1057.83	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 365CL Excavator 3.68cy 50	50.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 374DL Excavator 5cy	9400.25	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 385CL Excavator 5cy	80.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 308DCR Excavator 0.4cy	70.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 336D L Excavator 1.56cy	100.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
MANITOWOC 555 150t	64.00	MOVES2014b	g/hr	46.1477	177.5623	10.8716	0.4053	7.9392	7.7011	52936.6618	0.7417	10.8716
Forklift Truck RT 3t	543.00	MOVES2014b	g/hr	42.6570	97.7189	6.6663	0.2363	6.3267	6.1369	32519.6642	0.4516	6.6663
Forklift Truck RT 8t	7143.56	MOVES2014b	g/hr	42.6570	97.7189	6.6663	0.2363	6.3267	6.1369	32519.6642	0.4516	6.6663
GROVE RT700E RT Crane 50mt	110.00	MOVES2014b	g/hr	46.1477	177.5623	10.8716	0.4053	7.9392	7.7011	52936.6618	0.7417	10.8716
Floating Booster - 12"	2607.60	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
APE 50 Vibratory Hammer	6888.30	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
Hyd. Excavator, 1.5 C.Y.	17.24	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
Backhoe Loader, 48 H.P.	11.10	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
S.P. Crane, 4x4, 5 Ton	166.00	MOVES2014b	g/hr	46.1477	177.5623	10.8716	0.4053	7.9392	7.7011	52936.6618	0.7417	10.8716
On Hwy Flatbed Truck 20K	500.00	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
LD Truck 4x2 1.75t	250.00	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
LD Truck 4x2 1t	64097.00	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
LD Truck 4x4 1.75t	697.66	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
LD Truck 4x4 Crw 1.75t	4582.33	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
On Hwy End Dump 10-12cy	4718.65	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
On Hwy Truck 70K	1582.06	MOVES2014b	g/mi	0.8270	3.6951	0.1965	0.0138	0.2360	0.1249	1641.7802	0.0423	0.0019
On Hwy Water Tanker 4K gal	313.08	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
On Hwy Water Tanker 2.5K gal	70.00	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
Dump Truck, 12 C.Y., 400 H.P.	34.48	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023

Notes: [1] N2O emission factors calculated using the following formula: [(tons of CO2 emitted) * (1 kg / 0.001102311 tons) * (1 gal of fuel / 10.21 kg CO2) * (0.47 g N2O / gal of fuel)] / (hours of source operation)

Table A-7. Harbor Craft and Dredge Construction

Description - Combined	Hours of Activity	Propulsion Power (kW)	Propulsion Load factor	Auxiliary Power (kW)	Auxiliary Load Factor
Crane Barge - 150 Ton	40.00	0.00	0.00	622.00	0.43
Clamshell Dredge - 21cy	99.16	1600.00	0.66	0.00	0.00
Crew/Survey Boat	6273.00	464.00	0.45	36.00	0.43
Flat Deck Barge 564 Ton	40.00	0.00	0.00	622.00	0.43
Flat Deck Barge 1253 Ton	110.00	0.00	0.00	622.00	0.43
Flat Deck Barge 1575 Ton	2380.16	0.00	0.00	622.00	0.43
Flat Deck Barge 4867 Ton	110.00	0.00	0.00	622.00	0.43
Dump Scow - 1,500cy	99.16	464.00	0.45	36.00	0.43
Work Tugboat	110.00	3512.00	0.50	285.00	0.43
Hyd Cutterhead Dredge 12"	2607.60	7161.00	0.66	0.00	0.00
Floating Pipeline - 12"	4811.60	0.00	0.00	0.00	0.00
Shore Pipeline - 12"	4811.60	0.00	0.00	0.00	0.00
Inland Tug - 700hp	6990.90	521.99	0.52	285.00	0.43
Runabout 16ft	2607.60	149.00	0.45	0.00	0.00
Inland Tug - 380hp	274.08	283.37	0.52	205.00	0.43

Notes:
Pipeline Emissions (Floating and Shoreline) assumed to be negligable.
Inland Tug propulsion power was provided (700hp)
Inland Tug propulsion power was provided (380hp)
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix G.

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Table A-8. Harbor Craft and Dredge Emission Factors

Pollutant	Propulsion EF (g/kWh)	Auxiliary EF (g/kWh)
NOx [a]	13.3600	13.3600
PM10 [b]	0.2100	0.2100
PM25 [b]	0.2036	0.2036
VOC [c]	0.1411	0.1411
CO [d]	2.4800	2.4800
SO2 [e]	0.0062	0.0062
CH4 [c]	0.0027	0.0027
CO2	679.4600	679.4600

Notes: All EF are conservatively assumed to be C2 Engine Category and uncontrolled

a - Table H.1 Category 1 and 2 NOx Emission Factors (g/kWh)
b - Table H.2 Category 1 and 2 PM ULSD Emission Factors (g/kWh)
c - Table H.4 Category 1 and 2 HC, VOC and CH4 Emission Factors (g/kWh)
d - Table H.5 Category 1 and 2 Co Emission Factors (g/kWh)
e - Table H.6 Average Harbor Craft Emission Factors by Engine Tier
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix H

Table A-9. On Road and Non-Road Post Construction Source Emission Factors

Description - Combined	Hours of Activity	Source	Units	CO	NOx	VOC	SO2	PM10	PM25	CO2	CH4	N2O [1]
CAT 336D L Excavator 1.56cy	723.50	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 365CL Excavator 3.68cy	4197.22	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
LD Truck 4x4 1.75t	2162.96	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
On Hwy Water Tanker 4K gal	2321.30	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
Portable Welder	436.46	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
Street Sweeper	2321.30	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
On Hwy Truck 70K	See Miles Traveled	MOVES2014b	g/mi	0.8270	3.6951	0.1965	0.0138	0.2360	0.1249	1641.7802	0.0423	0.0019

Notes: [1] N2O emission factors calculated using the following formula: [(tons of CO2 emitted) * (1 kg / 0.001102311 tons) * (1 gal of fuel / 10.21 kg CO2) * (0.47 g N2O / gal of fuel)] / (hours of source operation)

Table A-10. Harbor Craft and Dredge Post Construction

Description - Combined	Hours of Activity	Propulsion Power (kW)	Propulsion Load factor	Auxiliary Power (kW)	Auxiliary Load Factor
Dump Scow - 1,500cy	2096.33	464.00	0.45	36.00	0.43
Clamshell Dredge - 21cy	2096.33	1600.00	0.66	0.00	0.00
Inland Tug - 700hp	436.46	464.00	0.45	36.00	0.43
Inland Tug - 4000hp	2096.33	2982.80	0.52	285.00	0.43
Runabout 16ft	2532.79	149.00	0.45	0.00	0.00

Notes:
Pipeline Emissions (Floating and Shoreline) assumed to be negligable.
Inland Tug propulsion power was provided (700hp)
Inland Tug propulsion power was provided (380hp)
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix G.

Estuary Alternative

Table A-11. On Road and Non-Road Post Construction Source Emission Factors - Offshore Disposal

Description - Combined	Hours of Activity	Source	Units	CO	NOx	VOC	SO2	PM10	PM25	CO2	CH4	N2O [1]
CAT 336D L Excavator 1.56cy	723.50	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
Portable Welder	436.46	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126

Notes: [1] N2O emission factors calculated using the following formula: [(tons of CO2 emitted) * (1 kg / 0.001102311 tons) * (1 gal of fuel / 10.21 kg CO2) * (0.47 g N2O / gal of fuel)] / (hours of source operation)

Table A-12. Harbor Craft and Dredge Post Construction - Offshore Disposal

Description - Combined	Hours of Activity	Propulsion Power (kW)	Propulsion Load factor	Auxiliary Power (kW)	Auxiliary Load Factor
Dump Scow - 1,500cy	2096.33	464.00	0.45	36.00	0.43
Clamshell Dredge - 21cy	2096.33	1600.00	0.66	0.00	0.00
Inland Tug - 4000hp	2096.33	2982.80	0.52	285.00	0.43
Inland Tug - 700hp	436.46	521.99	0.52	285.00	0.43
Runabout 16ft	2532.79	149.00	0.45	0.00	0.00

Notes:
Pipeline Emissions (Floating and Shoreline) assumed to be negligable.
Inland Tug propulsion power was provided (700hp)
Inland Tug propulsion power was provided (380hp)
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix G.

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Table A-13. On Road and Non-Road Construction Source Emission Factors

Description - Combined	Hours of Activity	Source	Units	CO	NOx	VOC	SO2	PM10	PM25	CO2	CH4	N2O [1]
Portable Air Comp - 185-cfm	90.91	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
Portable Air Comp - 250-cfm	1836.97	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
Hand Held Vib Plate Comp 25"	147.42	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
CAT CS-76 SD Vib Comp SM	147.42	MOVES2014b	g/hr	28.1399	77.3806	4.9028	0.2182	4.3269	4.1970	30452.7262	0.3944	4.9028
AC CM592 Hyd Track Drill	275.00	MOVES2014b	g/hr	118.6336	396.3625	29.7173	0.3845	20.6651	20.0452	42131.7172	1.3153	29.7173
CAT 12M Articulated Frm Grdr	531.37	MOVES2014b	g/hr	26.8282	69.0800	4.6982	0.4498	5.5538	5.3872	64824.4768	0.3680	4.6982
CAT 950H F.E. Loader 4cy	80.00	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT 966H F.E. Loader 5.5cy	457.51	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT D6T LGP Dozer	3743.09	MOVES2014b	g/hr	58.4031	173.3421	8.9059	0.5889	9.6335	9.3445	82733.5114	0.6115	8.9059
CAT D6T Dozer	165.66	MOVES2014b	g/hr	58.4031	173.3421	8.9059	0.5889	9.6335	9.3445	82733.5114	0.6115	8.9059
CAT 232B Skid Steer Loader	180.00	MOVES2014b	g/hr	77.8493	69.3503	15.7229	0.0738	11.2288	10.8920	8209.0423	0.5684	15.7229
CAT 430E-IT Backhoe	415.00	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT 450E Backhoe	500.00	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
CAT 345D L Excavator 2.36cy	2330.45	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 365CL Excavator 3.68cy	50.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 374DL Excavator 5cy	10747.75	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 385CL Excavator 5cy	80.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 308DCR Excavator 0.4cy	70.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 336D L Excavator 1.56cy	100.00	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
10000w Small GenSet	1726.97	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
MANITOWOC 555 150t	64.00	MOVES2014b	g/hr	46.1477	177.5623	10.8716	0.4053	7.9392	7.7011	52936.6618	0.7417	10.8716
Forklift Truck RT 3t	543.00	MOVES2014b	g/hr	42.6570	97.7189	6.6663	0.2363	6.3267	6.1369	32519.6642	0.4516	6.6663
Forklift Truck RT 8t	9778.83	MOVES2014b	g/hr	42.6570	97.7189	6.6663	0.2363	6.3267	6.1369	32519.6642	0.4516	6.6663
GROVE RT640E RT Crane, 36.3	439.20	MOVES2014b	g/hr	46.1477	177.5623	10.8716	0.4053	7.9392	7.7011	52936.6618	0.7417	10.8716
GROVE RT700E RT Crane 50mt	110.00	MOVES2014b	g/hr	46.1477	177.5623	10.8716	0.4053	7.9392	7.7011	52936.6618	0.7417	10.8716
Floating Booster - 12"	2607.60	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
APE 50 Vibratory Hammer	8235.80	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
Hyd. Excavator, 1.5 C.Y.	17.24	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
Backhoe Loader, 48 H.P.	11.10	MOVES2014b	g/hr	101.8233	109.7517	22.0096	0.1194	15.5557	15.0891	13016.7088	1.1061	22.0096
S.P. Crane, 4x4, 5 Ton	166.00	MOVES2014b	g/hr	46.1477	177.5623	10.8716	0.4053	7.9392	7.7011	52936.6618	0.7417	10.8716
On Hwy Flatbed Truck 20K	500.00	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
LD Truck 4x2 1.75t	250.00	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
LD Truck 4x2 1t	64097.00	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
LD Truck 4x4 1.75t	1458.80	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
LD Truck 4x4 Crw 1.75t	4158.09	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
On Hwy End Dump 10-12cy	4718.65	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
On Hwy Truck 70K	1747.60	MOVES2014b	g/mi	0.8270	3.6951	0.1965	0.0138	0.2360	0.1249	1641.7802	0.0423	0.0019
On Hwy Water Tanker 4K gal	313.08	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
On Hwy Water Tanker 2.5K gal	70.00	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
Dump Truck, 12 C.Y., 400 H.P.	34.48	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023

Notes: [1] N2O emission factors calculated using the following formula: [(tons of CO2 emitted) * (1 kg / 0.001102311 tons) * (1 gal of fuel / 10.21 kg CO2) * (0.47 g N2O / gal of fuel)] / (hours of source operation)

Table A-14. Harbor Craft and Dredge Construction

Description - Combined	Hours of Activity	Propulsion Power (kW)	Propulsion Load factor	Auxiliary Power (kW)	Auxiliary Load Factor
Crane Barge - 150 Ton	40.00	0.00	0.00	622.00	0.43
Clamshell Dredge - 21cy	99.16	1600.00	0.66	0.00	0.00
Crew/Survey Boat	6272.50	464.00	0.45	36.00	0.43
Flat Deck Barge 564 Ton	40.00	0.00	0.00	622.00	0.43
Flat Deck Barge 1253 Ton	110.00	0.00	0.00	622.00	0.43
Flat Deck Barge 1575 Ton	3945.01	0.00	0.00	622.00	0.43
Flat Deck Barge 4867 Ton	110.00	0.00	0.00	622.00	0.43
Dump Scow - 1,500cy	99.16	464.00	0.45	36.00	0.43
Work Tugboat	110.00	3512.00	0.50	285.00	0.43
Hyd Cutterhead Dredge 12"	2607.60	7161.00	0.66	0.00	0.00
Floating Pipeline - 12"	4811.60	0.00	0.00	0.00	0.00
Shore Pipeline - 12"	4811.60	0.00	0.00	0.00	0.00
Inland Tug - 700hp	7545.07	521.99	0.52	285.00	0.43
Runabout 16ft	2607.60	149.00	0.45	0.00	0.00
Inland Tug - 380hp	274.08	283.37	0.52	205.00	0.43

Notes:
Pipeline Emissions (Floating and Shoreline) assumed to be negligable.
Inland Tug propulsion power was provided (700hp)
Inland Tug propulsion power was provided (380hp)
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix G.

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Table A-15. Harbor Craft and Dredge Emission Factors

Pollutant	Propulsion EF (g/kWh)	Auxiliary EF (g/kWh)
NOx [a]	13.3600	13.3600
PM10 [b]	0.2100	0.2100
PM25 [b]	0.2036	0.2036
VOC [c]	0.1411	0.1411
CO [d]	2.4800	2.4800
SO2 [e]	0.0062	0.0062
CH4 [c]	0.0027	0.0027
CO2	679.4600	679.4600

Notes: All EF are conservatively assumed to be C2 Engine Category and uncontrolled

a - Table H.1 Category 1 and 2 NOx Emission Factors (g/kWh) pg 168
b - Table H.2 Category 1 and 2 PM ULSD Emission Factors (g/kWh), page 172
c - Table H.4 Category 1 and 2 HC, VOC and CH4 Emission Factors (g/kWh)
d - Table H.5 Category 1 and 2 Co Emission Factors (g/kWh)
e - Table H.6 Average Harbor Craft Emission Factors by Engine Tier
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix H

Table A-16. On Road and Non-Road Post Construction Source Emission Factors

Description - Combined	Hours of Activity	Source	Units	CO	NOx	VOC	SO2	PM10	PM25	CO2	CH4	N2O [1]
CAT 336D L Excavator 1.56cy	723.50	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
CAT 365CL Excavator 3.68cy	4197.22	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
LD Truck 4x4 1.75t	2162.96	MOVES2014b	g/mi	2.0612	1.0902	0.1832	0.0047	0.0891	0.0557	551.0843	0.0214	0.0015
On Hwy Water Tanker 4K gal	2321.30	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
Portable Welder	436.46	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126
Street Sweeper	2321.30	MOVES2014b	g/mi	0.8911	2.4956	0.2547	0.0086	0.2583	0.1238	1025.0137	0.0503	0.0023
On Hwy Truck 70K	See Miles Traveled	MOVES2014b	g/mi	0.8270	3.6951	0.1965	0.0138	0.2360	0.1249	1641.7802	0.0423	0.0019

Notes: [1] N2O emission factors calculated using the following formula: [(tons of CO2 emitted) * (1 kg / 0.001102311 tons) * (1 gal of fuel / 10.21 kg CO2) * (0.47 g N2O / gal of fuel)] / (hours of source operation)

Table A-17. Harbor Craft and Dredge Post Construction Parameters

Description - Combined	Hours of Activity	Propulsion Power (kW)	Propulsion Load factor	Auxiliary Power (kW)	Auxiliary Load Factor
Dump Scow - 1,500cy	2096.33	464.00	0.45	36.00	0.43
Clamshell Dredge - 21cy	2096.33	1600.00	0.66	0.00	0.00
Inland Tug - 700hp	436.46	464.00	0.45	36.00	0.43
Inland Tug - 4000hp	2096.33	2982.80	0.52	285.00	0.43
Runabout 16ft	2532.79	149.00	0.45	0.00	0.00

Notes:
Pipeline Emissions (Floating and Shoreline) assumed to be negligable.
Inland Tug propulsion power was provided (700hp)
Inland Tug propulsion power was provided (380hp)
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix G.

Hybrid Lake Alternative

Table A-18. On Road and Non-Road Post Construction Source Emission Factors - Offshore Disposal

Description - Combined	Hours of Activity	Source	Units	CO	NOx	VOC	SO2	PM10	PM25	CO2	CH4	N2O [1]
CAT 336D L Excavator 1.56cy	723.50	MOVES2014b	g/hr	22.7136	73.1671	3.7028	0.3770	4.4634	4.3295	54731.4412	0.3154	3.7028
Portable Welder	436.46	MOVES2014b	g/hr	316.4307	713.7511	42.9126	0.9220	42.6033	41.3252	105018.6893	2.5291	42.9126

Notes: [1] N2O emission factors calculated using the following formula: [(tons of CO2 emitted) * (1 kg / 0.001102311 tons) * (1 gal of fuel / 10.21 kg CO2) * (0.47 g N2O / gal of fuel)] / (hours of source operation)

Table A-19. Harbor Craft and Dredge Post Construction - Offshore Disposal

Description - Combined	Hours of Activity	Propulsion Power (kW)	Propulsion Load factor	Auxiliary Power (kW)	Auxiliary Load Factor
Dump Scow - 1,500cy	2096.33	464.00	0.45	36.00	0.43
Clamshell Dredge - 21cy	2096.33	1600.00	0.66	0.00	0.00
Inland Tug - 4000hp	2096.33	2982.80	0.52	285.00	0.43
Inland Tug - 700hp	436.46	521.99	0.52	285.00	0.43
Runabout 16ft	2532.79	149.00	0.45	0.00	0.00

Notes:
Pipeline Emissions (Floating and Shoreline) assumed to be negligable.
Inland Tug propulsion power was provided (700hp)
Inland Tug propulsion power was provided (380hp)
Source: Methodologies for Estimating Port-Related and Goods Movement Movile Source Emission Inventories EPA-420-D-20-001, Feb 2020) Appendix G.