Appendix C

2025 Greenhouse Gas Emissions Analysis

GREENHOUSE GAS EMISSIONS ANALYSIS

ATLANTIC COAST OF MARYLAND
SHORELINE PROTECTION PROJECT
OCEAN CITY, WORCESTER COUNTY, MARYLAND

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LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
AC	Atlantic coast
CEQ	Council on Environmental Quality
CH_4	Carbon monoxide
CO_2	Carbon dioxide
CO_{2e}	Carbon dioxide equivalents
CSNA	Climate Solutions Act Now
CY	Cubic yard
ECB	Engineering and Construction Bulletin
EO	Executive order
EPA	US Environmental Protection Agency
GGRA	Greenhouse Gas Reduction Act
GHG	Greenhouse gas
GWP	Global warming potential
HP	horsepower
MMT	Million metric tons
N_2O	Nitrous oxide
NEPA	National Environmental Policy Act
SCGHG	Social cost of GHG emissions
USACE	US Army Corps of Engineers
UTV	Utility terrain vehicle

1 BACKGROUND

This greenhouse gas (GHG) emissions analysis was performed as a component to the Atlantic Coast (AC) of Maryland, Shoreline Protection Project, Supplemental Environmental Assessment, managed by the US Army Corps of Engineers (USACE), Baltimore District, Civil Project Management Branch. The analysis was completed to quantify anticipated emissions in order to determine if the actions taken during the Atlantic Coast (AC) of Maryland, Shoreline Protection Project have the potential for positive or negative GHG impacts. These impacts are based on the type of construction proposed, extent of activities impacting GHG emissions, and potential positive impacts on GHG emissions (i.e., GHG sequestration) associated with ecosystem restoration.

As documented in the Supplemental Environmental Assessment, the AC of Maryland, Shoreline Protection Project, the recommended Alternative herein referred to as ‘the Alternative’, is located in the Town of Ocean City, Worchester County, Maryland. The Alternative includes dredging 900,000 cubic yards (CYs) of sand from the borrow area known as Weaver Shoal, located in Federal waters approximately 7.2 miles offshore of Ocean City, Maryland for placement along 8.3 miles of shoreline in Ocean City and along 1,500 feet of shoreline in Sussex County, Delaware. Project activities consist of an 8.3-mile elevated beach berm backed by a 1.4-mile concrete capped steel pile bulkhead and a 6.9-mile vegetative sand dune, with a 1,500-foot transition into Sussex County, Delaware. This is generally done every four years to reduce the risk of coastal storm damage.

Emissions relative to the Alternative include short-term Direct Emissions from construction equipment used to dredge the material and place along the shoreline. The Alternative does not involve the construction of buildings or equipment that would produce additional emissions once built, therefore no long-term emissions, indirect emissions, downstream emissions, or upstream emissions exist.

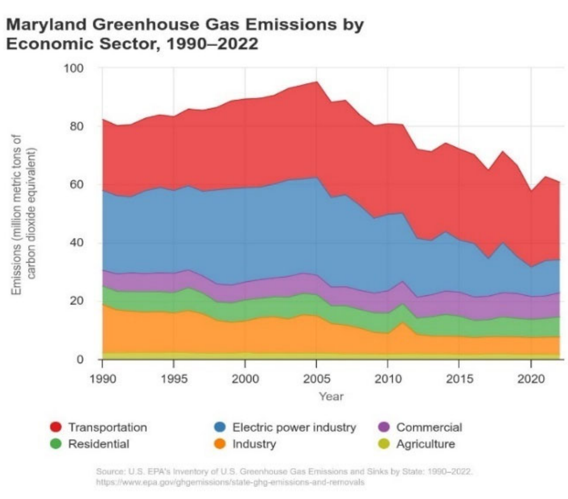

Figure 1-1: Maryland GHG Emissions by Sector

Under the No Federal Action Alternative, the Alternative (i.e., dredging of the borrow area) would not take place. Under the No Federal Action Alternative, no GHG emissions would be produced. It is expected that the same number of people would still enjoy the beach in this area.

1.1 Regional Greenhouse Gas Emissions

The US Environmental Protection Agency’s (EPA’s) *Greenhouse Gas Inventory Data Explorer* is an interactive tool that provides access to the

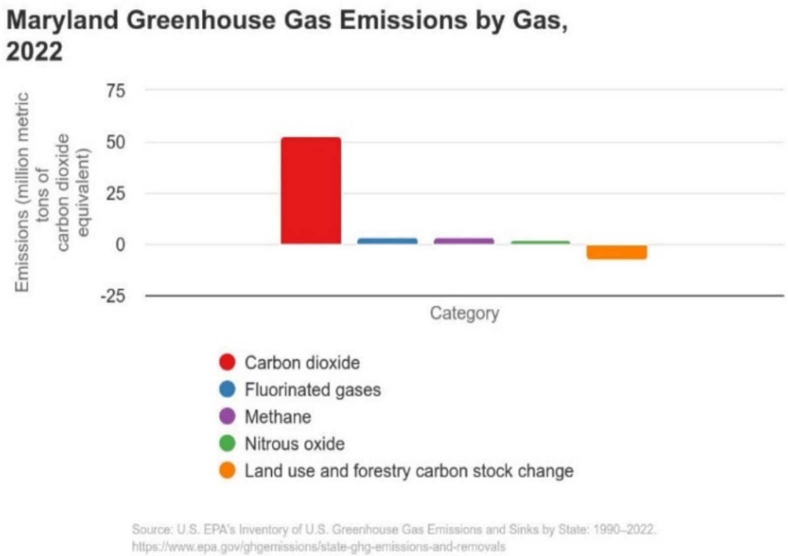

Figure 1-2: Maryland GHG Emissions by Gas

EPA's annual *Inventory of US GHG Emissions and Sinks by State*. From the most recent data provided in 2022, the gross total of GHG emissions in the US was approximately 6,343 million metric tons (MMT) of carbon dioxide (CO_2) equivalent (excluding the land sector). In the same year the gross total of GHG emissions in Maryland, the location of this Project, was approximately 57 MMT of CO_2 equivalent or approximately 0.9% of the US total GHG emissions (GHG Inventory Data Explorer, EPA.gov).

As identified in **Figure 1-1,** Maryland follows the US with the Transportation sector contributing the highest amount of GHG to the total emission rate at 43.9 percent [%]. The electric power industry (18.6%), Commercial (13.7%), Residential (11.4%), Industry (9.9%), and Agriculture (2.6%) sectors comprise the remaining total of GHG emissions by Sector for Maryland.

Specifically looking at the individual GHGs, CO_2 accounts for approximately 85.9% of Maryland's GHG emissions as depicted in **Figure 1-2.** While fluorinated gases and methane (CH_4) comprise 5.6% and 5.5% respectively. Nitrous oxide (N_2O) accounts for the lowest contribution in Maryland at 3.0%.

1.2 Greenhouse Gas Emissions

Climate change refers to any substantial change in measure of climate, such as temperature or precipitation, lasting for decades or longer. Natural factors have caused the climate to change, however human activities are the main cause of climate changes that are currently being observed. Increasing emissions from human activities worldwide, such as the burning of fossil fuels, have led to a substantial increase in atmospheric concentration of GHGs, especially CO_2. Other contributing major GHGs emitted to the atmosphere include CH_4, N_2O, and fluorinated gases (EPA, 2024).

Increasing concentrations of GHGs in the Earth's atmosphere trap excessive heat which leads to higher temperatures near the Earth's surface, altering weather patters and raising the temperature of the oceans. This action is known as the 'Greenhouse Effect,' where incoming solar radiation (i.e., energy from the sun) that is absorbed by the Earth's surface has difficulty radiating back into the atmosphere due to absorption from GHGs. Many of the major GHGs (i.e., CO_2, CH_4, N_2O, and fluorinated gases) can remain in the atmosphere for tens to thousands of years after being released

(EPA, 2024). Their emissions are often measured in CO_2 equivalents which account for the gas' global warming potential (GWP).

Sources of GHGs are produced entirely by human activity or a combination of natural sources and human activities. As identified in **Section 1.1**, the sources from human activities include the combustion of fossil fuels for electricity, transportation, and heat as well as agricultural (e.g., synthetic fertilizers and livestock digestion) and industrial processes including landfilling.

1.3 Regulations

Consistent with Executive Order (EO) 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis* the Council on Environmental Quality (CEQ) issued interim National Environmental Policy Act (NEPA) Guidance on Consideration of GHG Emissions and Climate Change (CEQ,2023). This guidance builds upon and updates the CEQ's 2016 *Final Guidance for Federal Departments and Agencies on Consideration of GHG Emissions and the Effects of Climate Change in NEPA Reviews* to assist Federal agencies in the consideration of the effects of GHG emissions and climate change when evaluating proposed major Federal actions in accordance with NEPA. The goal of the GHG emissions analysis is to quantify anticipated GHG emissions in order to determine whether the Project has potential for positive or negative GHG impacts based on type of construction proposed, extent of activities impacting GHG emissions, and potential positive impacts on GHG emissions (i.e. GHG sequestration) associated with ecosystem restoration.

On 16 August 2024, the USACE issued an Engineering and Construction Bulletin (ECB) with Guidance for Incorporating GHG Emissions Analysis in NEPA reviews. The ECB applies to any USACE action that requires NEPA compliance, including actions under supplemental NEPA documents with the objective of enhancing the USACE analysis of GHG emissions for planned, new, and existing projects.

1.3.1 State of Maryland Regulations

In 2009, the state of Maryland adopted the Greenhouse Gas Emissions Reduction Act (GGRA), which required the State to reduce GHG emissions 25% from the 2006 baseline by 2020. The law was amended in 2016 and set a new benchmark requiring a 40% reduction of emissions from 2006 levels by 2030 ("40 by 30") to ensure continued progress after 2020 toward the State's long-term GHG reduction goals (MDOT, 2024).

In 2022 the State passed into law the Climate Solutions Act Now (CSNA) which sets an even stronger benchmark by requiring the State to reduce its GHG emissions 60% from 2006 levels by 2-31 and achieve net-zero emissions by 2045. The CSNA, however, does not outline a dedicated funding source to implement the plan (MDE, 2023).

1.3.2 State of Delaware Regulations

In 2023, the state of Delaware passed the Climate Change Solutions Act. The Act follows the State's Climate Action Plan in 2021 by establishing a statutory target of GHG emission reductions to mitigate the adverse effects of climate change due to anthropogenic GHG emissions on the State. The Act establishes a series of emission reduction goals – 50% net reduction by 2030, and net-zero by 2050, and among others requires State agencies to consider climate change in decision-making, rulemaking, and procurement (State of Delaware).

1.4 Determining Significant Effects

The GHG emissions calculated during this analysis will be compared against the Federal 2050 net zero emissions goal which was laid out in the 2021, Federal Sustainability Plan (Office of the Federal Chief Sustainability Officer, 2021). At this time there are no numerical thresholds associated with this goal, so it will be used as a metric to qualitatively assess if the GHG emissions from the Alternative will prevent the Federal 2050 Net Zero Emissions Goal from being met. If so, the Alternative will result in a determination of significant impact.

Due to the lack of numerical thresholds in the Federal 2050 Net Zero Emissions Goal, the Alternative GHG emissions will also be evaluated against State of Maryland and State of Delaware specific thresholds. Based on the State of Maryland's 2030 GGRA Plan, predicted GHG emissions values for 2025 are roughly 60 million metric tons (MMT) of carbon dioxide equivalents. The Climate Change Solutions Act of 2023 for the State of Delaware is predicting that their GHG emissions for this time period will be around 18 MMT carbon dioxide equivalents. These values are being provided for transparency of review and are not being formally adopted as the USACE standard for determining significant impact. This determination will still be based on comparison to the Federal 2050 Net Zero Emissions Goal.

2 GHG EFFECTS ANALYSIS

2.1 Metric for Significant Effect

The GHG emissions calculate during this analysis will be compared against the Federal 2050 net zero emissions goal which was laid out in the 2021, Federal Sustainability Plan (Office of the Federal Chief Sustainability Officer, 2021). This goal involves achieving net-zero carbon emissions across Federal operations by 2050 and will be used as a metric to evaluate the Alternative's GHG emissions.

If GHG emission from the Alternative prevent the Federal 2050 Net Zero Emissions Goal from being met, it would result in a determination of significant impacts.

2.2 GHG Analysis

This Section presents the GHG analysis and supporting calculations for the short-term, direct project emissions from construction equipment used for the Alternative. As identified in **Section 1**, no GHG emissions are anticipated under the No Federal Action Alternative.

2.2.1 Methodology

Due to the relative project size (i.e., medium-large) and construction timespan of less than one year, the Fuel Volume Method was used to produce this GHG emissions analysis (USACE, 2024). The Fuel Volume Method involves calculating GHG emissions from the Alternative using fuel emissions factors to convert from a unit volume of fuel to GHG quantities. These quantities were calculated using the fuel emission factors (FEF) from the "Emission Factors for Greenhouse Gas Inventories" (EPA's GHG Emission Factors Hub,2025) as inputs into **Equation 1**, the Fuel Volume Emissions Equation. The total GHG emissions for the Alternative was calculated using **Equation 2** However, as noted above there are no anticipated GHG emissions from the No Federal Action Alternative. Therefore, the net emissions for the Alternative equaled the total emissions for the Alternative in this analysis. **Equations 3** and **Equations 4** were used to determine the total carbon dioxide equivalents and provide a social cost to the Alternative's short-term, direct construction emissions, respectively.

Equation 1: Fuel Volume Emissions Equation

$$\text{GHG Emissions} = FV * FEF$$

Where:

Emissions = metric tons of a unique GHG (i.e. CO_2, CH_4, N_2O, etc.)
FV = Fuel Volume = gallons for how much fuel is used
FEF = Fuel Emissions Factor = grams, kilograms, pounds, or metric tons of emissions by GHG type per unit of fuel volume. EPA's GHG Emission Factors Hub (https://www.epa.gov/climateleadership/ghgemissionfactors-hub) provides regularly updated default emission factors (EFs) for a variety of fuel types for both mobile and stationary equipment

For example, the total number of metric tons of CO_2 generated from 222,902 gallons of diesel by Marine equipment was calculated using the following equation:

$$CO_2 \text{ Emissions (grams)} = 222,902 \text{ gallons} * 10,210 \text{ (grams of emissions per gallons of fuel)}$$

A conversion factor of $1x10^{-6}$ was used to convert grams to metric tons. To determine the annual emissions, the result was divided by the number of years for construction. Due to the scope of the Alternative, this project is not expected to last longer than one year.

Equation 2: Net Emissions

The total proposed action emissions were determined based on the following equation:

$$E_{Net} = A_E - NA_E$$

Where:

E_{Net} = net emissions for the proposed action (grams, pounds, metric tons)

A_E = total emissions for the proposed action (subtracting sequestered emissions)

NA_E = total emissions for the no action alternative.

As discussed in Section 1, the total emissions for the No Federal Action Alternative are assumed to be zero based on no anticipated changes occurring to visitor behavior.

Again, using CO_2 as an example, the calculated net emissions for the Alternative generated from 2,275.8 metric tons of CO_2 emissions is based on the following equation:

$$E_{Net}\,(\text{metric tons}) = 2{,}275.8 - 0 = 2275.8$$

Equation 3: Carbon Dioxide Equivalents (CO2e)

As identified in **Section 1.2**, GHG emissions are often measured in CO_2 equivalents (CO_{2e}) to account for the gas' GWP. The conversion of individual GHG emissions (e.g., CO_2, N_2O, CH_4) for a specific fuel type to total CO_{2e} were computed using the following equation:

$$CO_2e = X * CO2 + Y * N2O + Z * CH4$$

Where:

X = 100 Year Global Warming Potential for CO_2 = 1

Y = 100 Year Global Warming Potential for N_2O = 298

Z = 100 Year Global Warming Potential for CH_4 = 25.

CFR Title 40 Chapter I Subchapter C Part 98: Table A-1 Global Warming Potential

For example, based on the calculations using **Equation 1** for the marine diesel equipment, the total metric tons of emissions for CO_2, N_2O, and CH_4 were 2,275.8, 1.45, and 0.04, respectively. The CO_{2e} for equipment using marine diesel based on these values were determined by the following equation:

$$CO_2e\ (metric\ tons) = 2{,}275.8 \times 1 + 0.04 * 298 + 25 \times 1.45 = 2{,}324$$

Equation 4: The Social Cost of Greenhouse Gas

The Social Cost of Greenhouse Gas is a measure used to estimate the economic damages associated with a small increase in greenhouse gas emissions. It represents a monetary value of the net harm to society from emitting GHG. The SCGHG was calculated for the Alternative using the below equation for each year in which emissions are anticipated. The Alternative is anticipated to be completed within one year.

$$SCGHG = \sum_{I}^{J} CO_2 \ x \ SCCO_2 + \sum_{I}^{J} N_2O \ x \ SCN_2O + \sum_{I}^{J} CH_4 \ x \ SCCH_4$$

Where:

period I to J represents the project lifetime
SCGHG = total social costs of all GHGs in dollars
CO_2 = metric tons of carbon dioxide
$SCCO_2$ = social cost of carbon dioxide specific for each year in period I to J
N_2O = metric tons of nitrous oxide for each year in period I to J
SCN_2O = social cost of nitrous oxide specific for each year in period I to J
CH_4 = metric tons of methane for each year in period I to J
$SCCH_4$ = social cost of methane specific for each year in period I to J

Based on the emissions presented under **Equation 3** as an example for the marine diesel equipment and the 2025, 3% average social cost of CO_2, CH_4, and N_2O ($56, $1,700, and $21,000, respectively), the total SCGHG was calculated as:

$$SCGGHG = \sum_{0}^{1} 2275.83 \ tons \ x \ \$56 + \sum_{0}^{1} 0.04 \ tons \ x \ \$1{,}700 + \sum_{0}^{1} 1.45 \ tons \ x \ \$21{,}000 = \$157{,}964.48$$

Aquatic Habitat Greenhouse Gas Emissions Equations:

The construction activities for the Alternative, involves dredging and placement of material along the shoreline in the State of Maryland and the State of Delaware. No area of wetlands or aquatic habitat will be created in response to this action. Therefore, no values were calculated for the Aquatic Habitat Carbon Dioxide Sequestration, Aquatic Habitat Methane Production, and the Aquatic Habitat Nitrous Oxide Production.

2.2.2 Assumptions

The following assumptions were used to calculate the GHG emissions for the Alternative. It is anticipated that the action will take place during the off-summer season in 2025.

- Based on previous dredging reports for similar activities from previous years, it is anticipated that an average amount of material dredged per day is **9,182.5 CY per day**.

- Using the total amount of material to be dredged of 900,000 CY and dividing by the average dredged per day, the total number of days for dredging was calculated to be **98**

days. This agrees with the initial provided schedule estimate of 3 months of field activities.

- Based on the provided dredge reports from previous years, the marine fuel consumption rate is 0.241 gallons per CY. Using the 900,000 CYs of material to be dredged, this equates to **216,900 gallons** of diesel fuel consumed by the dredge boat over the length of the project.

- Assume crews travel to/from the dredging location using the crew boats Bayou Chene (560 horsepower [HP]) and Captain Tom (600 HP). It is assumed that the boats travel approximately 2 hours per day, both boats support the proposed action, and the engines are shut off during dredging operations.

- Fuel consumption rate for marine diesel equipment is based on a 10% assumption of the engines HP in liters per hour. The conversion from liters to gallon of 0.264 was used to calculate a quantity of marine diesel fuel in gallons.

- The dozers and fork loaders are considered medium types of equipment. Therefore, fuel consumption rates for the dozer are assumed to be 8 gallons per hour (D-6 Caterpillar Dozer) and 6 gallons per hour (D-8 Caterpillar Dozer) based on the difference in HP ratings. Fuel consumption for the 972-Fork Loader is assumed to fall in the middle of these two pieces of equipment at 7 gallons per hour.

- Fuel consumption for the light plants was determined based on Bobcat specification for the PL65 Light Tower. It is anticipated that a similar type of equipment would be used on this project. The equipment has a usable fuel capacity of 52.4 gallons with 210 hours of runtime with 4 LED lights. This equates to a fuel consumption rate of 0.25 gallons per hour.

- As stated above, it is assumed that the work will take place during the Fall/Winter months where there is approximately 10 hours of daylight per day. Therefore, the light plants are assumed to operate for 14 hours per day for the duration of the project. It is assumed that three light plants will be used to illuminate the project area.

- It is anticipated that each delivery of land-based equipment will be escorted by a competent person in a utility terrain vehicle (UTV). It is assumed that the UTV will travel a total of 10 miles per load to the staging area. It is assumed that a load is considered 1 piece of equipment, therefore approximately 25 loads are anticipated. It is additionally assumed that the UTV will drive 16 miles a day, travelling the approximate length of the project site. These assumptions total to 1,593 miles driven by the UTV.
- Fuel consumption for the UTV is approximately 15 miles per gallon.

- Crews, in addition to two security guards during mobilization, will travel to the site using gasoline pick-up trucks.

- 5 crew personnel (working per shift, 2 shifts per day) for the duration of the project, in addition to two security guards present during mobilization estimated to take 21 days. These personnel will likely travel a total 20 miles each per day.

- As estimated above, dredging crews take the crew boats to the dredging location.

- Trucks delivering equipment are anticipated to be Class 8 trucks, assumed to travel approximately 250 miles (500 miles roundtrip). It is assumed that three deliveries will be made per truck at 5.7 miles per gallon (https://afdc.energy.gov/data/10310).

- Beach crews are assumed to work in 12-hour shifts, and dredge crews will work in 12-hour shifts for the duration of the Alternative action.

- The fuel types for the marine equipment (i.e., dredges and support boats) is diesel. The fuel type for earth moving equipment and hauling trucks is diesel. The fuel type for the passenger pick-up trucks used by the work crew to get to the site is gasoline.

2.2.3 GHG Emissions

The Alternative equipment list was pared down to determine which equipment was anticipated to have emissions associated with its use. The identified equipment is included in Table 2-1, below. This table also identified the fuel consumption rates used for each type of equipment based on the assumptions identified above and uses those values to determine an overall fuel consumption value in gallons for the Alternative.

Table 2-1: Total Fuel Volumes by Alternative Equipment

Alternative Equipment	Fuel Type	Power Rating	Fuel Consumption	Fuel Volume (gallons)
Marine Equipment				
Hopper Dredge(s) BE Lindholm and R.N. Weeks	Marine Diesel	-	-	216,900
Crew boat Bayou Chene	Marine Diesel	560 HP	14.784 gal/hr	2,898
Captain Tom	Marine Diesel	600 HP	15.84 gal/hr	3,104
Land Equipment				
D-6 Caterpillar Dozer	Diesel	215 HP	8 gal/hr	6,272
D-8 Caterpillar Dozer	Diesel	363 HP	6 gal/hr	4,704
972 Fork Loaders	Diesel	339 HP	7 gal/hr	1,176
Light Plants	Diesel	6 kW	0.2495 gal/hr	1,027
Four Passenger UTV's	Diesel	25 HP	15 miles/gal	106
On Road Equipment				
Pick-up Truck	Gasoline	-	23 miles/gal	1,230
Similar to a Class 8 truck	Diesel	-	5.7 miles/gal	263

Table 2-2: Total Fuel Volumes by Fuel Type

Fuel Type	Fuel Volume (gallons)
Marine Diesel	222,902
Diesel Land Equipment	13,285
On-road Diesel	263
On-road Gasoline	1,230

Using the fuel volume method and equations presented in **Section 2.2.1**, the total volumes of fuel for the Alternative equipment presented in **Table 2-2** were used to estimate the GHG emissions for the proposed action.

Tables 2-3 through 2-6 present the GHG volume emissions analysis for the Alternative based on the equipment fuel type.

Table 2-3: Fuel Volume Emissions Analysis for Alternative: Marine Equipment

Calculation of Emissions Using Fuel Volumes					**Total Emissions from Fuel Volumes**		
Diesel Marine Equipment	GHG	Fuel Volume (Gallons)	Emissions Factor (Grams of Emissions/ Gallons of Fuel)	Emissions (grams)	Emissions Total (grams)	Emissions Total (pounds)	Emissions Total (Metric Tons)
	CO_2	222,902	10210	2,275,829,420	2,275,829,420	5,017,349.12	2,275.83
	CH_4	222,902	6.51	1,451,092.02	1,451,092	3199.11	1.45
	N_2O	222,902	0.17	37,893.34	37,893	83.54	0.04

Table 2-4: Fuel Volume Emissions Analysis for Alternative: Land Equipment

Calculation of Emissions Using Fuel Volumes					**Total Emissions from Fuel Volumes**		
Diesel Land Equipment	GHG	Fuel Volume (Gallons)	Emissions Factor (Grams of Emissions/ Gallons of Fuel)	Emissions (grams)	Emissions Total (grams)	Emissions Total (pounds)	Emissions Total (Metric Tons)
	CO_2	13,285	10.21	135,639.85	135,640	299.035	0.136
	CH_4	13,285	1.01	13,417.85	13,418	29.581	0.013
	N_2O	13,285	0.94	12,487.9	12,488	27.531	0.012

Note: CO_2 EF values come from Table 1 of EPA's GHG Emission Factors Hub.

Table 2-5: Fuel Volume Emissions Analysis for Alternative: On Road Diesel Trucks

Calculation of Emissions Using Fuel Volumes					**Total Emissions from Fuel Volumes**		
On Road Diesel Trucks	GHG	Fuel Volume (Gallons)	Emissions Factor (Grams of Emissions/ Gallons of Fuel)	Emissions (grams)	Emissions Total (grams)	Emissions Total (pounds)	Emissions Total (Metric Tons)
	CO_2	263	10,210	2,685,230	2,685,230	5,919.924	2.6852
	CH_4	263	0.009	2.367	2	0.0052	0.0000
	N_2O	263	0.005	1.315	1	0.0029	0.0000

Note: Note CH4 and N2O values are taken from EPA's GHG Emission Factors Hub.

Table 2-6: Fuel Volume Emissions Analysis for Alternative: On Road Gas Trucks

Calculation of Emissions Using Fuel Volumes					**Total Emissions from Fuel Volumes**		
On Road Gas Trucks	GHG	Fuel Volume (Gallons)	Emissions Factor (Grams of Emissions/ Gallons of Fuel)	Emissions (grams)	Emissions Total (grams)	Emissions Total (pounds)	Emissions Total (Metric Tons)
	CO_2	1,230	8,780	10,799,400	10,799,400	23,808.621	10.799
	CH_4	1,230	0.0079	9.717	10	0.021	0.000
	N_2O	1,230	0.0012	1.476	1	0.003	0.000

The emission totals in metric tons for each GHG and equipment type were used in Table 2-7 below to calculate carbon dioxide equivalences. As stated above, there are not expected emissions from the no action alternative and carbon sequestration which would have been subtracted from these total values due to the nature of the Alternative action.

Table 2-7: Emissions Summary Table for Gross and Net Total Emissions

	Gross Emissions		Net Emissions	
No Action	*Pounds*	*Metric Tons*	*Pounds*	*Metric Tons*
Carbon Dioxide(CO_2)	0	0	0	0
Methane (CH_4)	0	0	0	0
Nitrous Oxide (N_2O)	0	0	0	0
CO_{2eq}	0	0	0	0
Alternative: Marine Equipment	*Pounds*	*Metric Tons*	*Pounds*	*Metric Tons*
Carbon Dioxide(CO_2)	5,017,349	2,276	5,017,349	2,276
Methane (CH_4)	3,199	2	3,199	2
Nitrous Oxide (N_2O)	84	0.04	84	0.04
CO_{2eq}	5,122,222	2,324	5,122,222	2,324
Alternative: Land Equipment	*Pounds*	*Metric Tons*	*Pounds*	*Metric Tons*
Carbon Dioxide(CO_2)	299	0.136	299	0.136
Methane (CH_4)	30	0.013	30	0.013
Nitrous Oxide (N_2O)	28	0.012	28	0.012
CO_{2eq}	9,243	4	9,243	4
Alternative: On Road Diesel Trucks	*Pounds*	*Metric Tons*	*Pounds*	*Metric Tons*
Carbon Dioxide(CO_2)	5,920	3	5920	3
Methane (CH_4)	0.0052	0	0.0052	0
Nitrous Oxide (N_2O)	0.0029	0	0.0029	0
CO_{2eq}	5,921	3	5,921	3
Alternative: On Road Gas Trucks	*Pounds*	*Metric Tons*	*Pounds*	*Metric Tons*
Carbon Dioxide(CO_2)	23,809	11	23,809	11
Methane (CH_4)	0	0	0	0
Nitrous Oxide (N_2O)	0	0	0	0
CO_{2eq}	23810	11	23810	11
Green shaded cells denote net negative emissions are expected which is advantageous for the environment Red shaded cells denote net positive emissions are expected which is disadvantageous for the environment				

Using Equation 4, presented in **Section 2.2.1**, the social cost of the GHG emissions for the Alternative were determined based on the total metric tons calculated in Tables 2-3 through 2-6, and summarized in **Table 2-7**, above. The total social cost of the Alternative is summarized in **Table 2-8**, below.

Table 2-8: Social Cost of GHG for the Alternative

	Social Cost of GHG Emissions
No Action	$0
Marine Equipment	$157.964.48
Land Equipment	$301.02
On Road Diesel Trucks	$150.37
On Road Gas Trucks	$604.74
Total Sum of SCGHG Cost:	**$159,020.61**

2.3 Summary of Results

Based on the GHG analysis presented in **Section 2.2**, the total GHG emissions in carbon dioxide equivalents for the Alternative is 2,342 metric tons. Approximately 99% of the Alternative GHG emissions are from the marine diesel equipment used during dredging operations.

Looking at the total GHG emissions by gas type for the Alternative, CO_2 has the highest total emissions at approximately 2,290 metric tons, followed by CH_4 at 2.013 metric tons, and N_2O at 0.052 metric tons.

The total calculated social cost of the GHG emissions for the Alternative is $159,020. 61.

2.4 Effects Determination

The calculated GHG emissions for the Alternative were compared against the Federal 2050 Net Zero Emissions Goal laid out in the 2021, Federal Sustainability Plan (Office of the Federal Chief Sustainability Officer, 2021). This goal involves achieving net-zero carbon emissions across Federal operations by 2050.

The results of the GHG analysis indicate that short-term, direct project GHG emissions could reach roughly 2,342 metric tons of carbon dioxide equivalents. **Figure 2-1** identifies the reduction in CO_2 emissions by sector to reach the 2050 Federal Net Zero Goal. Emissions are presented in gigatons or roughly 1,000,000,000 metric tons. CO_2 emissions from the Alternative reach only a fraction of the percent of the total energy emissions. Therefore, the Alternative is not expected to prevent the Federal 2050 Net Zero Goal of being met and therefore not expected to result in a determination of significant impact.

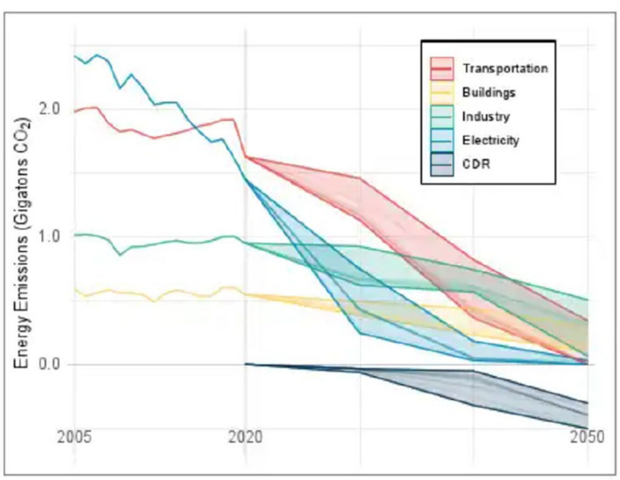

Figure 2. 2050 Federal Net Zero Goal Reductions by Sector

For comparison purposes only, the Alternative was compared to the State of Maryland and State of Delaware predicted emissions for 2025, i.e., 60 MMT CO_{2e} and 18 MMT CO_{2e}, respectively. The GHG emissions estimated for the Alternative was 2,342 metric tons CO_{2e}. Calculated GHG emissions in CO_{2e} is roughly 0.004% of the overall State of Maryland emissions goal for 2025 and 0.013% of the State of Delaware Emissions goal for 2025. These percentages assume that the entire Alternative takes place in either the State of Maryland or the State of Delaware. However, project emissions will occur between both States resulting in a lower percentage.

2.5 Mitigation Measures

Options for managing GHG emissions for the Alternative include using the cleanest available fuels for construction equipment. Due to the size of this equipment, it is not anticipated that electric powered equipment would be a viable option. However, reducing runtimes of equipment, idling engines from the marine engines or carpooling between personnel should be considered in order to reduce GHG emissions from the Alternative action.

3 CONCLUSIONS

The direct, short-term GHG emissions calculated for the Alternative are not expected to prevent the Federal 2050 Net Zero Goal of being met. Therefore, the Alternative emissions are not considered to result in a determination of significant impact.

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