APPENDIX

Air Emissions Calculations and Methodology

Prepared for

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Appendix K Air Emissions Calculations and Methodology is currently being updated to incorporate the refined project design envelope described in Section 3 of this COP. This includes:

- The reduction in the number of foundations, from 242 to 176;
- The removal of the minimum sized wind turbine; and
- The removal of the piled jacket foundation as an option to support wind turbines.

An updated assessment will be completed and submitted to BOEM in August 2021.

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ATTACHMENTS

Attachment K-1 Emission Calculations



ACRONYMS AND ABBREVIATIONS

AQCR Air Quality Control Region

BOEM Bureau of Ocean Energy Management

Btu British thermal units

CFR Code of Federal Regulations

CH₄ methane

CMV commercial marine vessels

CO carbon monoxide CO₂ carbon dioxide

CO₂e carbon dioxide equivalents

EPA U.S. Environmental Protection Agency

Empire Offshore Wind LLC

EW Empire Wind

gal gallons

g/hp-hr grams per horsepower hour
g/kW-hr grams per kilowatt hour
GHG greenhouse gas emissions
GWP Global Warming Potential
HAP Hazardous Air Pollutant

hp horsepower

ICF ICF International

kW kilowatt

Lease Area designated Renewable Energy Lease Area OCS-A 0512

L/cyl liters per cylinder

lb pounds

MMBtu one million British Thermal Units
MOVES Motor Vehicle Emission Simulator
NEPA National Environmental Policy Act

 $\begin{array}{ll} \text{nm} & \text{nautical mile} \\ \text{NO}_X & \text{nitrogen oxides} \\ \text{N}_2\text{O} & \text{nitrous oxide} \end{array}$

O&M operations and maintenance

OCS Outer Continental Shelf

OGV ocean-going vessels



ppmw part per million by weight

PM particulate matter

 $PM_{2.5}$ particulate matter 2.5 micrometers in diameter PM_{10} particulate matter 10 micrometers in diameter

Project The offshore wind project for OCS A-0512 proposed by Empire Offshore

Wind LLC consisting of Empire Wind 1 (EW 1) and Empire Wind 2 (EW 2).

Project Area The area associated with the build out of the Lease Area, submarine export

cable routes, interarray cables, and all onshore Project facilities.

SBMT South Brooklyn Marine Terminal

SF₆ sulfur hexafluoride

SO₂ sulfur dioxide

ULSD ultra-low sulfur diesel

VOC volatile organic compound

K.1 INTRODUCTION

Empire Offshore Wind LLC (Empire) proposes to construct and operate an offshore wind facility, to be located in the designated Renewable Energy Lease Area OCS-A 0512 (Lease Area). The Lease Area covers approximately 79,350 acres (32,112 hectares) and is located approximately 12 nautical miles (nm, 22 kilometers [km]) south of Long Island, New York and 16.9 nm (31.4 km) east of Long Branch, New Jersey (**Figure K-1**).

Empire proposes to develop the Lease Area in two wind farms, known as Empire Wind (EW) 1 and Empire Wind 2 (EW 2), collectively referred to hereafter as the Project. EW 1 and EW 2 are covered in this Construction and Operations Plan (COP). EW 1 and EW 2 will be electrically isolated and independent from each other. Each wind farm will connect via offshore substations to separate Points of Interconnection (POIs) at onshore locations by way of export cable routes and onshore substations. In this respect, the Project includes two onshore locations in New York where the renewable electricity generated will be transmitted to the electric grid.

This report describes the methodology applied to calculate the anticipated air emissions associated with construction and operation of the Project,¹ as well as the results of the emissions calculations, which are detailed in **Attachment K-1, Emission Calculations²**. Vessel specifications and durations have been selected to represent a maximum design scenario with respect to the potential emissions associated with construction and operation of the Project. Actual vessels to be employed during construction and operations activities are subject to change. There are seven categories of sources for which emissions were calculated:

- Commercial marine vessels (CMVs);
- Helicopters;
- Stationary diesel generator engines;
- Portable diesel generator engines;
- Gas-insulated switchgear;
- Nonroad engines; and
- On-road vehicles.

The specific air pollutants estimated from the listed source categories consist of criteria air pollutants, hazardous air pollutants (HAPs), and greenhouse gases (GHGs). Specific pollutants in each group are as follows:

- Criteria Air Pollutants:
 - o Nitrogen oxides (NO_X);
 - o Volatile organic compounds (VOCs);
 - o Carbon monoxide (CO);
 - o Total particulate matter (PM);
 - o Particulate matter with aerodynamic diameter 10 micrometers or less (PM_{10}) ;
 - o Particulate matter with aerodynamic diameter 2.5 micrometers or less (PM_{2.5}); and
 - o Sulfur dioxide (SO₂).

² This assessment is currently being revised to incorporate the refined PDE, as described in Section 3 of the COP, consisting of up to 174 wind turbines and 2 offshore substations, removal of the minimum-sized wind turbine (10 MW), and inclusion of the O&M Base.



¹ Emissions associated with decommissioning of the Project will be addressed in a future OCS air permit application.

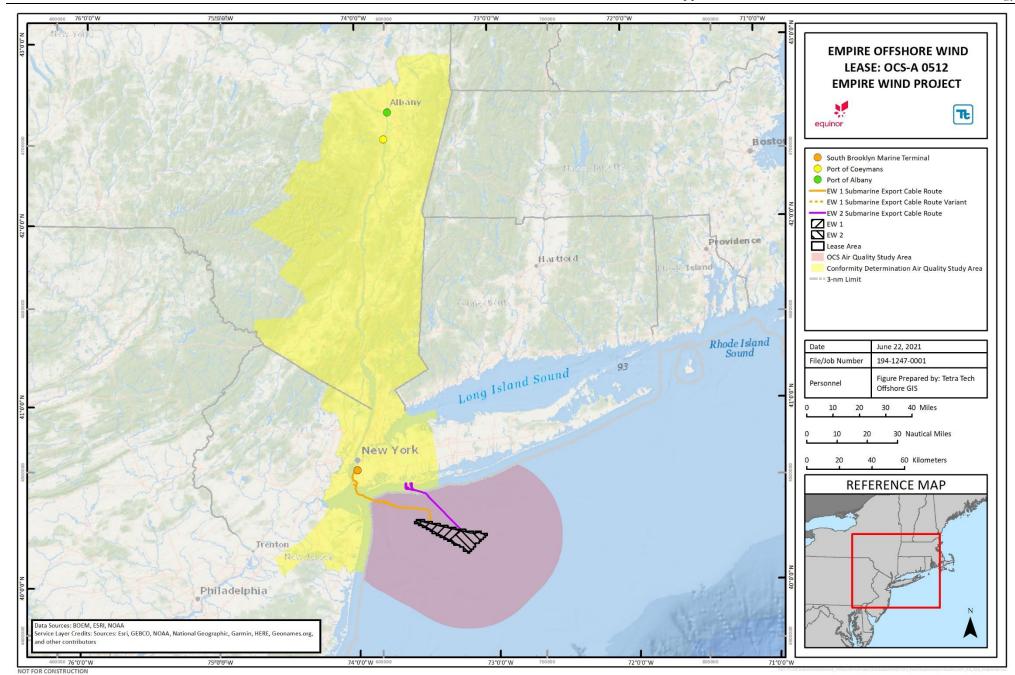


Figure K-1 Project Overview

- HAPs, which include but are not limited to:
 - o Formaldehyde;
 - o Acetaldehyde;
 - o Benzene;
 - o Naphthalene;
 - o Acrolein;
 - o 1,3-Butadiene;
 - o Ethylbenzene; and
 - o Polycyclic Organic Matter.
- GHGs:
 - o Carbon dioxide (CO₂);
 - o Methane (CH₄);
 - o Nitrous oxide (N2O); and
 - o Sulfur hexafluoride (SF₆).

For the purposes of this analysis, emissions of PM_{2.5}, PM₁₀, and PM are conservatively assumed to be the same.

K.2 EMISSION CALCULATION METHODS

Methods for calculating criteria pollutant emissions for the respective emission source categories are summarized in Sections K.2.1 through K.2.5. Additionally, Section K.2.6 discusses the methodology for estimating the total GHG emissions for each of the source categories. GHG emissions are presented as "CO₂ equivalent" or (CO₂e), because the different GHG constituents have different heat absorption capacities.

K.2.1 Commercial Marine Vessels

The calculations presented in **Attachment K-1** are based on assumed typical vessels representative of the types, configurations, and sizes that the Project anticipates will be employed during the construction and operations phases of the Project. Vessel specifications have been selected to represent a maximum design scenario with respect to the potential emissions of the identified vessel category. Actual vessels to be employed during construction and operations activities are subject to change. Vessel operating durations are based on anticipated schedules provided by the Project and may also be subject to change. However, the durations presented within have been selected to represent a maximum design scenario with respect to potential emissions (i.e., conservative estimates).

K.2.1.1 Emission Factors

ICF International (ICF) was contracted by the U.S. Environmental Protection Agency (EPA) to produce a guidance document for estimating CMV emissions, "Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories" (ICF International 2009). This document categorizes most vessels, including tugboats, crew boats, etc. as "harbor craft," and categorizes ships with larger engines as "ocean-going vessels" (OGVs). Emission factors from this report have been used to estimate marine vessel emissions for activities related to a number of offshore wind projects, and have formed the basis of approved Outer Continental Shelf (OCS) air permits in several different EPA regions. The ICF report factors that were selected for estimating emissions from harbor craft and OGVs are presented below in **Table K-1**.



Table K-1 Summary of Harbor Craft and OGV Emission Factors

					Emission Facto	or (g/kW-hr)			
Mini	mum Power (kW)	NO _X	VOC	СО	PM ₁₀ /PM _{2.5}	SO ₂	CO ₂	CH₄	N ₂ O
Harbor Craf	ft – Maximum Rate for T	Tier 1 and Tier	2 Engines						
	37-75 kW	9.8	0.27	5	0.77	0.0065	690	0.09	0.02
	75 – 130 kW	9.8	0.27	5	0.34	0.0065	690	0.09	0.02
	130 – 225 kW	9.8	0.27	5	0.34	0.0065	690	0.09	0.02
Category 1	225 – 450 kW	9.8	0.27	5	0.26	0.0065	690	0.09	0.02
	450 – 560 kW	9.8	0.27	5	0.26	0.0065	690	0.09	0.02
	560 – 1000 kW	9.8	0.27	5	0.26	0.0065	690	0.09	0.02
	1,000+ kW	9.8	0.27	5	0.26	0.0065	690	0.09	0.02
Category 2	All sizes	9.8	0.5	5	0.62	0.0065	690	0.09	0.02
Ocean-goin	g Vessels								
Category 3	Main Engines	13.2	0.50	1.10	0.19	0.397	646.08	0.004	0.031
	Auxiliary Engines	13.9	0.40	1.10	0.18	0.424	690.71	0.004	0.031

a/ Category 1 engines are main or auxiliary engines rated at less than 1,000 kW, Category 2 engines are those rated at 1,000 kW or greater with a displacement less than 30 liters per cylinder, and Category 3 engines are those with a displacement equal to or greater than 30 liters per cylinder.

b/ The PM₁₀ emission factors presented for Category 1 and 2 engines have had an adjustment factor applied, as recommended in Section 3.4.2 of the ICF report (ICF International 2009) and presented in Table 3-8 of the ICF report. These factors were adjusted for the now-required 15 parts per million by weight sulfur content in ultra-low sulfur diesel fuel (ULSD), by multiplying the emission factors by 0.86.

c/ The emission factors for the Category 3 engines were based on a medium-speed diesel vessel using marine diesel oil fuel. The PM₁₀ emission factors for Category 3 engines are based on the formulas provided in Section 2.6 of the ICF report and assumed use of marine diesel oil fuel with 0.1 percent sulfur content.



Vessel engines were classified as either Category 1, Category 2 or Category 3 based on the following size ranges:

- Category 1: Main or auxiliary engines rated at less than 1,000 kW;
- Category 2: Main or auxiliary engines rated at 1,000 kW or greater (but with a displacement of less than 30 liters per cylinder); and
- Category 3: Main or auxiliary engines with a displacement equal to or greater than 30 liters per cylinder.

Most of the marine vessels used for construction and operations of the Project are assumed to be equipped with either Category 1 or Category 2 engines and will qualify as harbor craft. These categories of engines will use only ultra-low sulfur diesel (ULSD) fuel, which has a sulfur content of 15 parts per million by weight. Some of the larger installation vessels will be equipped with Category 3 main engines, and these vessels have been assumed to use marine diesel oil with a sulfur content of 0.1 percent by weight.

The harbor craft emission factors for PM₁₀ originally presented in Table 3-8 of the ICF report are based on a fuel sulfur content of 1.5 percent. To adjust these emission factors to reflect the now-required use of ULSD fuel, they were multiplied by an adjustment factor of 0.86, as recommended in Table 3-9 of the ICF report. For other criteria pollutants, the emission factors for harbor vessels are based on EPA marine engine emissions standards (i.e., Tier 0 to Tier 3 based on cylinder displacement) and their respective EPA engine categories for CMV main propulsion engines and auxiliary engines.

The EPA established a tier structure for emission standards based on the age of the engine and cylinder displacement. Tier 0 (baseline), Tier 1, or Tier 2 apply to engines built prior to 2009. Stricter Tier 3 emission standards apply to engines built starting in 2009. However, for the purpose of estimating CMV emissions during the construction and operations phases of the Project, during which harbor craft with older engines might be utilized, the maximum Tier 1 or Tier 2 emission factors were used to provide a conservative estimate.

Only several of the largest construction vessels were assumed to be equipped with Category 3 engines, including the main generator engines and/or main propulsion engines on the following vessels:

- Heavy lift vessel;
- Heavy transport vessel;
- Fall pipe vessel;
- Monopile supply vessel;
- Wind turbine installation vessel;
- Wind turbine supply vessel;
- Export cable lay vessel; and
- Dredger.

For these Category 3 engines, the ICF emission factors for OGVs were used, as presented in Table 2-9 of the ICF report. The emission factors for OGVs are based on a 2002 analysis of emission data prepared by Entec (2002). For PM₁₀, the OGV emission factors originally presented in Table 2-9 of the ICF report are based on a fuel sulfur content of 1.0 percent. These factors were adjusted to comply with the International Maritime Organization's North America Sulfur Emissions Control Area requirements, which limit fuel sulfur content to 0.1 percent sulfur by weight. For these vessels, factors for PM₁₀ were calculated using the formulas provided in Section 2.6 of the ICF report, assuming the use of marine diesel oil, and using the appropriate values for brake specific fuel consumption provided in Table 2-9 (main engines) and Table 2-16 (auxiliary engines).



For all engine categories, SO₂ emission factors are based on a mass balance calculation for the appropriate fuel sulfur content of each fuel: 0.1 percent sulfur for MARPOL-compliant marine fuel, and 0.0015 percent for ULSD fuel. The fuel consumption rate for each engine type was converted to a mass of fuel using an assumed fuel density of 853 kg/m³ (7.11 lb/gal).

Emission factors for HAPs from commercial marine vessels were determined using the methodology identified by EPA for the 2017 National Emissions Inventory (NEI). The emission factors for individual HAP compounds are provided as percentages of the PM_{2.5} or VOC emissions from the CMVs. These are tabulated in **Attachment K-1**.

K.2.1.2 Load Factors

For all marine vessel construction and operations activities, including construction activities and transits to and from shore, average engine load factors for each vessel type were estimated based on assumed average daily fuel use rates provided by the Project.

K.2.1.3 Calculation of Emissions

The basic equation used to estimate annual emissions from each CMV engine and activity is:

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E = kW \times Act \times LF \times EF
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Where:

E = emission, grams/year kW = kilowatts (engine rating) Act = activity, hours/year

LF = engine load factor (for the activity)

EF = emission factor, g/kW-hr

The calculated emissions were converted to tons per year by dividing the emissions by the conversion factor from grams to pounds (453.6 g/lb) and by the conversion factor from pounds to tons (2,000 lb/ton).

The CO₂e (GHG) emissions for the CMVs were calculated based on the methodology presented in Section K.2.6.

K.2.2 Stationary Engines

K.2.2.1 Offshore Substation and Onshore Substation Generator Engines

The offshore substation platform for both EW 1 and EW 2 is assumed to be equipped with one diesel generator engine rated at 600 kW mechanical output. Each onshore substation is also assumed to be equipped with one diesel generator engine rated at 600 kW mechanical output. The offshore and onshore substation generator engines are assumed to be used only for emergency generation, as well as for readiness testing and maintenance purposes. For both the offshore substation and onshore substation engines, potential emissions were estimated by conservatively assuming up to 500 operating hours per year for each engine.

Emissions of NO_X, CO, VOC, and PM from these engines were assumed to meet the corresponding EPA Tier 2 emission standards in Table 1 of 40 Code of Federal Regulations (CFR) § 89.112 for emergency generator engines of the appropriate size category. Emissions of SO₂ were based on a mass balance assuming a fuel sulfur content of 0.0015 percent by weight, and 100 percent conversion of fuel sulfur to SO₂. Emissions of HAPs for the engines were based on factors presented in EPA's AP-42 Compilation of Air Pollutant Emission Factors



(AP-42) Section 3.4 for large diesel engines (EPA 1996). Emissions for GHG pollutants (CO₂, CH₄, and N₂O) were based on the emission factors presented in 40 CFR § 98 Tables C-1 and C-2.

Emission rates provided in g/kWh were multiplied by the engine's assumed power rating (kW) and by the total annual operating hours (assumed to be 500 hours per year for each engine). The calculated emissions were converted to tons per year by dividing the emissions by the conversion factor from grams to pounds (453.6 g/lb) and by the conversion factor from pounds to ton (2,000 lb/ton).

Emissions calculated using AP-42 emission factors (lb/million British thermal units [MMBtu]) were multiplied by the heat input rate (MMBtu/hr) (calculated from generator's fuel consumption (gallons) and the diesel fuel's heat content (Btu/gal)), and by the total annual operating hours, converting from pounds to ton (2,000 lb/ton).

K.2.3 Portable Diesel Generator Engines

A number of portable diesel generator engines will be required during construction and commissioning of the Project, as well as during potential unplanned emergency events during operations and maintenance of the Project, including the following tasks:

- Providing power for welding machines, lighting, and other tasks during installation of each offshore substation topside structure (one 50-kW engine operating for approximately 15 days at each offshore substation);
- Providing power during commissioning of each offshore substation topside structure (one 500-kW engine operating for approximately 120 days at each offshore substation);
- Providing power during installation of each wind turbine (one 1,200-kW engine operating for approximately 9 hours at each wind turbine);
- Providing power during commissioning of each wind turbine (one 150-kW engine operating for approximately 72 hours at each wind turbine);
- Providing power to pull the interarray cables into each wind turbine tower, and into each offshore substation topside structure (one 15-kW engine operating for approximately 50 hours at each wind turbine, and for approximately four days at each offshore substation);
- Providing power to pull the submarine export cable into each offshore substation topside structure (one 25-kW engine operating for approximately four days at each offshore substation); and
- Providing emergency power at individual wind turbine towers during operations and maintenance (up to sixteen 150-kW engines, operating for approximately six days each, estimated to occur separately at EW 1 or EW 2, up to once every 10 years per EW 1 and per EW 2).

Each of the portable diesel generators (with the exception of the 1,200-kW wind turbine installation engine and the 500-kW offshore substation commissioning engine) will be hoisted onto each offshore substation or wind turbine platform prior to use, and will be retrieved from each platform after use. The 1,200-kW wind turbine installation engine and the 500-kW offshore substation commissioning engine will each be located on the deck of a marine vessel, with power supplied through a cable while the vessel is tied up to the structure. It is also possible that a marine vessel's own generator engine could be used to provide power for the wind turbine installation and offshore substation commissioning tasks.

For the portable diesel generators that will be hoisted onto an offshore substation or wind turbine platform, emissions of NO_X, CO, VOC, and PM were assumed to meet the corresponding post-2014 nonroad emission standards in Table 1 of 40 CFR § 1039.101 for generator sets of the appropriate size category. Emissions of SO₂ were based on a mass balance assuming a fuel sulfur content of 0.0015 percent by weight, and 100 percent conversion of fuel sulfur to SO₂. Emissions of HAPs for the engines were based on factors presented in AP-



42 Section 3.3 for small diesel engines (EPA 1996). Emissions for GHG pollutants (CO₂, CH₄, and N₂O) were based on the emission factors presented in 40 CFR § 98 Tables C-1 and C-2.

Since the 1,200-kW wind turbine installation engine and the 500-kW offshore substation commissioning engine could potentially be a marine vessels' own generator engine, emissions for all pollutants from these engines were conservatively estimated using the emission factors described in Section K.2.1 for Category 2 marine engines.

K.2.4 Non-road Engines

Emissions factors for mobile source, non-road engines to be used during the construction of the onshore substation, onshore export cable, and interconnection cables for EW 1 and EW 2 (including cranes, forklifts, excavators, front end loaders, generators, HDD drill rigs, and other construction equipment) were calculated using the EPA's Motor Vehicle Emission Simulator (MOVES2014b) emission factor modeling system (EPA 2014). To calculate emission factors for the Project, a run was conducted for a conservatively assumed construction start year of 2023, using the national database and inventory mode.

Emission factors from the EPA's MOVES2014b emission model are provided in units of g/hp-hr, so emissions were estimated by multiplying the emission factor by the non-road engine's assumed power rating (hp), the total operating hours, and the load factor for each different type of machine. Typical load factors for various equipment types were based on Appendix A of EPA's "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling" (EPA 2010). The calculated emissions were converted to tons per year by dividing the resultant emissions in grams per year by the conversion factor from grams to pounds (453.6 g/lb) and by the conversion factor from pounds to ton (2,000 lb/ton). Emission of HAPs are based on factors from ERG (2003, as cited in EPA 2005) Appendix D, Tables D-1 through D-3. Emissions for CH₄ and N₂O are based on EPA emission factors for construction equipment in Table B-8 of the EPA report on "Direct Emissions from Mobile Combustion Sources" (0.57 g CH₄/gal fuel and 0.26 g N₂O/gal fuel, respectively) (EPA 2016). Fuel consumption for each type of equipment was estimated based on CO₂ emission factor (g/hp-hr) generated from the MOVES2014b model and the emission factor for the mass of CO₂ generated per gallon of diesel fuel (10.21 kg CO₂/gal fuel), as presented in Table A-1 of the EPA (2016) report.

Therefore, CH₄ and N₂O emissions were calculated based on the following equation:

 $E = FC \times \rho \times EF \times 0.4536 \text{ (kg/lb)} \times Eng. \text{ Rating x Act x LF } / 453.6 \text{ (g/lb)} / 2,000 \text{ (lb/ton)}$

Where:

E = Emissions, tons/year
FC = Fuel consumption, gal/hp-hr

ρ = Density, lb/gal
EF = Emission Factor, g (CH₄ or N₂O)/kg fuel
Eng. Rating = Engine Rating, hp
Act = Activity, hours/year
LF = Load Factor

The CO₂e (GHG) emissions were calculated based on the methodology presented in Section K.2.5.

K.2.5 On-road Vehicles

MOVES2014b was used to estimate emissions associated with on-road engines used during construction of the onshore substation, onshore export cable, and interconnection cable for EW 1 and EW 2, for a conservatively



assumed construction start year of 2023. This emission modeling system estimates emissions for a broad range of pollutants from mobile sources such as cars, trucks, and motorcycles, and allows multiple scale analysis.

Emission factors (in pounds per vehicle mile traveled) for VOC, NOx, CO, PM, SO2, and CO2e were calculated for 2020 using the most current database files input into MOVES2014b. Input values were provided by the New York State Department of Environmental Conservation for each county in which the onshore construction would occur, including:

- Kings County (EW 1 onshore substation, Operations and Maintenance (O&M) Base, and interconnection cables); and
- Nassau County (EW 2 onshore substation, onshore export cables, and interconnection cables).

K.2.6 Helicopter Emissions

One helicopter is currently assumed to be used to perform crew transfers during the foundation installation, wind turbine generator, and submarine export cable installation tasks for both EW 1 and EW 2. The Bureau of Ocean Energy Management (BOEM) has produced a technical document, "BOEM Offshore Wind Energy Facilities Emission Estimating Tool - Technical Documentation" (BOEM 2017), to assist in estimating emissions for construction and operations of offshore wind energy facilities, including emissions from helicopters. Table 4 of the BOEM document provides default emission factors for VOC, NO_x, CO, PM, SO₂, CO₂, CH₄, and N₂O, as well as default fuel consumption rates in gallons/hour, based on four categories of helicopter size. Table 9 of the BOEM document provides default airspeeds for each category of helicopter size. Emissions of HAPs for the helicopter engines were based on factors presented in EPA's AP-42 Compilation of Air Pollutant Emission Factors (AP-42) Section 3.4 for large diesel engines.

Emissions for helicopter crew transfers during construction were estimated assuming a large twin-engine helicopter capable of carrying 20-30 passengers. The "Twin Heavy" helicopter category was selected from the BOEM document, with a default airspeed of 188.2 miles/hour. Although the airport for helicopter flights has not been selected, travel distances and durations were estimated using JFK International Airport as the assumed departure location. Emissions were based on two round trips per week for the duration of foundation installation, wind turbine generator installation, and submarine export cable installation tasks for EW 1 and EW 2, with a round trip duration of 30 minutes per flight.

K.2.7 Gas-Insulated Switchgear

The offshore substation platforms, wind turbine towers, and onshore substations will all be equipped with high-voltage circuit breakers ("switchgear") that use sulfur hexafluoride gas (SF₆) as an insulating material. SF₆ is a GHG that slowly leaks form the sealed switchgear housings into the air. The offshore substation platforms and onshore substations are still being designed, and information about the proposed switchgear will be included in a future supplement to the COP. Emissions of SF₆ from the wind turbine switchgear were estimated using the switchgear counts and storage quantities provided by the Project, and assuming an annual leakage rate of 0.5 percent by weight per year (IEC 2004, as cited in EPA 2017).

K.2.8 Global Warming Potentials

The GHG emissions from the Project are a result of the combustion of diesel fuel that produces emissions of CO₂, CH₄, and N₂O, as well as leakage of SF₆ from gas-insulated switchgear. GHGs (CO₂, CH₄, N₂O, and SF₆) are typically presented as CO₂ equivalent or "CO₂e", based on the specific Global Warming Potential (GWP) for each gas.



Each GHG constituent has a different heat trapping capability. The corresponding GWP has been calculated by the EPA to reflect how long the gas remains in the atmosphere, on average, and how strongly it absorbs energy compared to CO₂. Gases with a higher GWP absorb more energy, per pound, than gases with a lower GWP.

Factors used to calculate CO₂e (GWP) were taken from Table A-1 of 40 CFR § 98, Subpart A. The GWPs are 25 for CH₄, 298 for N₂O, and 22,800 for SF₆.

Therefore, the equation to calculate CO₂e for each source is:

$$\begin{aligned} \text{CO2e} = \left[\text{CO2} \frac{\text{tons}}{\text{yr}} \text{ x CO2 GWP(1)}\right] + \left[\text{CH4} \frac{\text{tons}}{\text{yr}} \text{ x CH4 GWP(25)}\right] + \left[\text{N2O} \frac{\text{tons}}{\text{yr}} \text{ x N20 GWP(298)}\right] + \\ \left[\text{SF6} \frac{\text{tons}}{\text{yr}} \text{ x SF6 GWP(22,800)}\right] \end{aligned}$$

K.3 GEOGRAPHIC ALLOCATION OF EMISSIONS

Some of the CMVs will make a number of round trips to and from shore during the construction and operations phases of the Project. Trips to and from shore will be made for multiple purposes, including loading of construction materials and equipment, refueling and restocking of supplies, crew transfers, and other purposes. Vessel transits will be made between the Project Area and an onshore port location(s). Therefore, portions of the vessel emissions from each transit will occur in distinct geographic areas for the purposes of regulatory applicability.

For example, transit emissions within 25 nm (46 km) of the Lease Area will be assigned to the OCS source potential emissions inventory. Transit emissions occurring in state waters will be assigned to the General Conformity potential emissions inventory for the specific nonattainment or maintenance area in which they occur, or to the attainment area potential emissions inventory for the purpose of addressing National Environmental Policy Act (NEPA) requirements. Those areas that are within 25 nm (46 km) of the Lease Area but also within state waters are not under the jurisdiction of the OCS air regulations, and will only be considered for General Conformity and NEPA review. Those portions of the transit emissions that occur in waters located beyond 3 nm from shore and also beyond 25 nm (46 km) from the Lease Area (chiefly consisting of transits from overseas ports) have not been included in either potential emissions inventory.

Empire has assumed that the South Brooklyn Marine Terminal (SBMT) will be the local port and staging area for all purposes during construction and operations of the Project, with the following exceptions:

- Port of Coeymans on the Hudson River in upstate New York is assumed to be the starting point for the transit of the Gravity Base Structure (GBS) foundations (if this foundation design option is used);
- Port of Albany, also on the Hudson River in upstate New York, is assumed to be the starting point for
 the transit of the transition pieces for each turbine foundation (if a GBS or piled jacket foundation
 design is used)³, as well as for the wind turbine towers themselves (regardless of foundation design
 option);
- A yet-to-be-determined port in the Hampton Roads/Norfolk, Virginia area is assumed to be the starting point for transporting the GBS foundation pillars (if needed) to a local staging area at SBMT, from which they will be transported to their installation locations in the Lease Area;

³ Empire is currently considering more than one design approach for the GBS foundation solution, where supporting ports would be determined based on the final design selected.



- A yet-to-be-determined port in the Corpus Christi, Texas area is assumed to be the starting point for transporting the offshore substation topside for EW 1 and EW 2, to its installation location in the Lease Area. These will be brought directly to their offshore construction locations by a heavy transport vessel; and
- Halifax, Nova Scotia is assumed to be the starting point for the transit of scour protection rock and gravel (although a local U.S. port could be selected instead as construction planning continues). Rock and gravel will be brought directly to the offshore construction locations by a fall pipe vessel.

Empire is also considering the use of Howland Hook Marine Terminal on Staten Island in New York. Howland Hook Marine Terminal could be used in the event that the GBS foundation is selected for EW 1 and/or EW 2. Howland Hook Marine Terminal would be the manufacturing port for the GBS foundation, and would therefore be the starting point for GBS transit. As the transit duration is significantly less under this scenario than it would be if Port of Coeymans were selected, the inventory presented herein assumes the use of Port of Coeymans. The inventory and any associated OCS air permits for the Project will be updated as additional detail is available, subject to Empire's contracting commitments.

K.3.1 Vessel Transits to Shore

To determine the maximum potential transit emissions for General Conformity and NEPA review purposes, the following one-way transit distances from the Lease Area to SBMT, from a Virginia port to SBMT, and from a Texas port to the Lease Area, were used to allocate vessel transit emissions by geographic area. Assuming an average transit speed of 5 knots (9 km/hr) for tugs and barges, and 10 (18.5 km/hr) knots for all other vessels:

- SBMT to center of the Lease Area (each way):
 - o Kings County, NY: 7.8 nm (14.5 km)
 - O Queens County, NY: 3.0 nm (5.5 km)
 - o Monmouth County, NJ: 2.7 nm (5 km)
 - o Inside OCS radius: 30 nm (55.6 km)
 - TOTAL: 43.5 nm (80.5 km)
- Virginia port to local staging area at SBMT (each way):
 - O State waters within Hampton Roads AQCR, Virginia: 30.0 nm (55.6 km)
 - o Non-OCS federal waters: 250 nm (463.0 km)
 - o Monmouth County, NJ: 2.7 nm (5 km)
 - O Queens County, NY: 3.0 nm (5.5 km)
 - o Kings County, NY: 7.8 nm (14.5 km)
 - TOTAL: 293.5 nm (543.6 km)
- Texas port to center of the Lease Area (one-way transit):
 - o State waters within Corpus Christi-Victoria AQCR, Texas: 30.0 nm (55.6 km)
 - o Non-OCS federal waters: 1,940 nm (3,592.9 km)
 - o Inside OCS radius: 30 nm (55.6 km)
 - TOTAL: 2,000 nm (3,704 km)

Emissions for all transits located within the 25-nm (46-km) OCS source perimeter are inventoried for the OCS air permit.



Emissions for all transits located within state waters are inventoried either for the General Conformity assessments (if within a designated nonattainment or maintenance area) or for NEPA purposes (if located outside a designated nonattainment or maintenance area).

Emissions for those portions of transits that are outside the 25-nm (46-km) OCS source perimeter (and are also outside state waters) have not been inventoried, with the exception of the foundation pillar heavy transport vessel, and the offshore substation topside transits, from Virginia and Texas, respectively. Generally, this results in exclusion of most of the ocean-crossing transit distance from overseas ports to SBMT, or from overseas ports directly to the offshore construction area.

K.3.2 GBS Foundation Transport

If one of the GBS foundation options is used for the wind turbine foundations, Empire may transport GBS foundations down the Hudson River from the Port of Coeymans or Howland Hook Marine Terminal⁴. While emissions from the transport of the GBS foundations have been considered in this analysis, any emissions associated with fabrication of the GBS foundations will be addressed in the relevant air permits issued to the port owners for operation of the required manufacturing facilities. For all other foundation design options (monopile wind turbine foundation and piled jacket offshore substation foundation), it has been assumed that all foundation structures and pilings would be manufactured at another location (outside the U.S.) and would be staged for assembly at SBMT. Foundation structures and pilings could also potentially be directly supplied to the field for installation.

If the GBS foundation is selected, each GBS structure could be towed by tugboats (potentially on barges) from the Port of Coeymans directly to the offshore installation location, or alternatively, to a temporary mooring location in New York harbor, and then to the offshore installation location. One design alternative being considered by Empire would involve a two-component GBS foundation; with the foundation bases being transported from Port of Coeymans, and the foundation pillars being transported from a Virginia port. This GBS design solution would then result in assembly at SBMT prior to being transported to the offshore installation location. For the purpose of estimating transit emissions, the total distance for each GBS transit has been assumed to be the sum of the distance from Port of Coeymans to SBMT (or from a Virginia port to SBMT, in the case of the two-component GBS foundation solution), plus the distance from SBMT to the center of the Lease Area:

- Southbound counties along the Hudson River (Port of Coeymans to SBMT):
 - o Albany County, NY: 1.3 nm (2.4 km)
 - o Greene County, NY: 22.7 nm (42.0 km)
 - O Ulster County, NY: 33.5 nm (62.0 km)
 - Orange County, NY: 18.0 nm (33.3 km)
 - o Rockland County, NY: 21.6 nm (40.0 km)
 - o Bergen County, NJ: 12.7 nm (23.5 km)
 - o Hudson County, NJ: 7.5 nm (13.9 km)
 - Tradeon sound, right to min (1815 in
 - o Kings County, NY: 2.0 nm (3.7 km)
 - TOTAL: 119.3 nm (220.8 km)

⁴ As the transit duration is significantly less under this scenario than it would be if Port of Coeymans were selected, the inventory presented herein assumes the use of Port of Coeymans. The inventory and any associated OCS air permits for the Project will be updated as additional detail is available, subject to Empire's contracting commitments.



- Northbound counties along the Hudson River (SBMT to Port of Coeymans):
 - o Albany County, NY: 0.1 nm (0.2 km)
 - o Rensselaer County, NY: 1.2 nm (2.2 km)
 - o Columbia County, NY: 26.0 nm (48.1 km)
 - O Dutchess County, NY: 39.9 nm (73.9 km)
 - o Putnam County, NY: 8.2 nm (15.2 km)
 - o Westchester County, NY: 27.0 nm (50.0 km)
 - o Bronx County, NY: 2.2 nm (4.0 km)
 - O New York County, NY: 12.9 nm (23.9 km)
 - o Kings County, NY: 1.8 nm (3.3 km)
 - TOTAL: 119.3 nm (220.8 km)
- Virginia port to local staging area at SBMT (each way):
 - o Virginia state waters: 30.0 nm (55.6 km)
 - o Non-OCS federal waters: 250 nm (463.0 km)
 - o Monmouth County, NJ: 2.7 nm (5 km)
 - O Queens County, NY: 3.0 nm (5.5 km)
 - o Kings County, NY: 7.8 nm (14.5 km)
 - TOTAL: 293.5 nm (543.6 km)
- SBMT to center of Lease Area (each way):
 - o Kings County, NY: 7.8 nm (14.5 km)
 - O Queens County, NY: 3.0 nm (5.5 km)
 - o Monmouth County, NJ: 2.7 nm (5.0 km)
 - o Inside OCS radius: 30 nm (55.6 km)
 - TOTAL: 43.5 nm (80.6 km)

K.3.3 Transition Piece and Wind Turbine Tower Transport

If the GBS option is used for the wind turbine foundations, Empire may transport the transition pieces for each wind turbine generator tower down the Hudson River from the Port of Albany. Empire may also use the Port of Albany to transport the wind turbine generator towers themselves. Similar to the method used for the GBS foundations, tugs and barges would be used to move the transition pieces from the Port of Albany directly to the offshore installation location. Tugs and barges would first move the wind turbine towers to SBMT, and then continue moving them to the offshore installation location. For the purpose of estimating transit emissions, the total distance for each transit has been assumed to be the sum of the distance from Port of Albany to SBMT, plus the distance from SBMT to the center of the Lease Area:

- Southbound counties along the Hudson River (Port of Albany to SBMT):
 - o Albany County, NY: 10.3 nm (19.1 km)
 - o Greene County, NY: 22.7 nm (42.0 km)
 - O Ulster County, NY: 33.5 nm (62.0 km)
 - Orange County, NY: 18.0 nm (33.3 km)
 - o Rockland County, NY: 21.6 nm (40.0 km)
 - o Bergen County, NJ: 12.7 nm (23.5 km)
 - o Hudson County, NJ: 7.5 nm (13.9 km)
 - o Kings County, NY: 2.0 nm (3.7 km)
 - TOTAL: 128.3 nm (237.6 km)



- Northbound counties along the Hudson River (SBMT to Port of Albany):
 - o Albany County, NY: 0.1 nm (0.2 km)
 - o Rensselaer County, NY: 10.2 nm (18.9 km)
 - o Columbia County, NY: 26.0 nm (48.1 km)
 - O Dutchess County, NY: 39.9 nm (73.9 km)
 - o Putnam County, NY: 8.2 nm (15.2 km)
 - o Westchester County, NY: 27.0 nm (50.0 km)
 - o Bronx County, NY: 2.2 nm (4.0 km)
 - New York County, NY: 12.9 nm (23.9 km)
 - o Kings County, NY: 1.8 nm (3.3 km)
 - TOTAL: 128.3 nm (237.6 km)
- SBMT to center of Lease Area (each way):
 - o Kings County, NY: 7.8 nm (14.5 km)
 - O Queens County, NY: 3.0 nm (5.5 km)
 - o Monmouth County, NJ: 2.7 nm (5.0 km)
 - o Inside OCS radius: 30 nm (55.6 km)
 - TOTAL: 43.5 nm (80.6 km)

K.3.4 Submarine Export Cable Construction

Emissions from construction of the submarine export cable and export cable landfall for EW 1 and EW 2 will occur along an export cable route from the Lease Area to each onshore POI. A portion of each export cable route is located within 25 nm (46 km) of the Lease Area (and these construction emissions will be part of the OCS source potential to emit). The remainder of each cable route is located in New York state waters.

For all vessels used in construction of each submarine export cable, the air emissions were divided proportionally into each geographic area as follows:

- EW 1 export cable landfall to Lease Area (each way):
 - o Kings County, NY: 8.0 nm (15 km)
 - O Queens County, NY: 6.5 nm (12 km)
 - o Inside OCS radius: 25.5 nm (47.2 km)
 - TOTAL: 40.0 nm (74.1 km)
- EW 2 export cable landfall to Lease Area (each way):
 - o Nassau County, NY: 7.0 nm (13 km)
 - o Inside OCS radius: 18.0 nm (33.3 km)
 - TOTAL: 25.0 nm (46.3 km)

K.3.5 All Other Vessel Activities

With the exception of transits to and from ports (such as SBMT, Port of Coeymans, Port of Albany, Texas or Virginia ports, and transits from overseas ports), and the portions of each submarine export cable route located in state waters, emissions from all other vessel activities during construction and operations of the Project were assumed to occur within 25 nm (46 km) of the Lease Area and are therefore part of the OCS source potential to emit.



K.3.6 Helicopter Transits

For the purpose of allocating emissions to geographic areas, helicopter flights were treated in a similar manner to vessel transits, with all flights assumed to originate from JFK International Airport.

For the foundation and wind turbine generator installation tasks, distances were based on a straight-line route to the center of the Lease Area. Travel distances across each of the jurisdictional areas were calculated to be as follows:

- JFK International Airport to center of Lease Area (each way):
 - O Queens County, NY: 1.5 statute miles (2.4 km)
 - o Nassau County, NY: 8.5 statute miles (13.7 km)
 - o Inside OCS radius: 20 statute miles (32.2 km)
 - TOTAL: 30.0 statute miles (48.3 km)

For the submarine export cable installation task, distances vary depending on which segment of the submarine export cable route is being visited. Travel distances for each export cable were estimated as follows:

- JFK International Airport to each submarine export cable route (each way):
 - o For the EW 1 submarine export cable route, one-way distance was estimated to average 14 statute miles (22.5 km), varying from 10 to 24 statute miles (16.1 to 38.6 km), with total mileage distributions of 30% in Kings County, 27% in Queens County, 9% in Nassau County, and 34% inside the OCS radius.
 - o For the EW 2 submarine export cable route, one-way distance was estimated to average 20 statute miles (32.2 km), varying from 8 to 32 statute miles (12.9 to 51.5 km), with total mileage distributions of 6% in Queens County, 41% in Nassau County, and 53% inside the OCS radius.

K.4 ONSHORE CONSTRUCTION AND OPERATION

Emissions from EW 1 and EW 2 of construction and operations of the O&M Base, onshore substation, onshore export cable, and interconnection cable will occur in the following geographic locations:

- EW 1: Kings County, New York (onshore substation, O&M Base (used by both EW 1 and EW 2), onshore staging and assembly of wind turbine generator components (used by both EW 1 and EW 2), onshore export cables, and interconnection cables); and
- EW 2: Nassau County, New York (onshore substation, onshore export cables, and interconnection cables).

K.5 SUMMARY OF EMISSIONS BY GEOGRAPHIC AREA

Potential emissions have been estimated for the construction, operations, and maintenance of both EW 1 and EW 2.

Under the construction schedule, EW 1 and EW 2 both begin construction of onshore facilities in 2023, followed by the commencement of construction for the EW 1 offshore facilities in 2024, and for the EW 2 offshore facilities in 2025, with EW 1 having a total construction duration of four years, and EW 2 having a total construction duration of five years. Construction emissions would begin in calendar year 2023 (start of EW 1 and EW 2) and continue through calendar year 2026 (completion of EW 2).



Emissions from operations and maintenance would begin as EW 1 was completed and would be concurrent with construction emissions from EW 2. It was assumed that the following tasks would occur in each year of activity:

- Year 1: Onshore substation construction (EW 1 and EW 2), and O&M Base construction (shared facility for both EW 1 and EW 2);
- Year 2: Onshore substation construction (EW 1 and EW 2), wind turbine foundation installation (EW 1 only), submarine export cable installation (EW 1 only), temporary mooring of foundations, onshore export and interconnection cables (EW 1 only), and export cable landfall construction (EW 1 only);
- Year 3: Onshore substation construction (EW 1 and EW 2), wind turbine foundation installation (EW 1 and EW 2), submarine export cable installation (EW 1 and EW 2), interarray cable installation (EW 1 only), offshore substation topside and foundation installation (EW 1 and EW 2), temporary mooring of foundations, wind turbine installation and offshore commissioning (EW 1 only), onshore export and interconnection cables (EW 1 and EW 2), and export cable landfall construction (EW 1 and EW 2);
- Year 4: Wind turbine foundation installation (EW 2 only), interarray cable installation (EW 2 only), offshore substation topside and foundation installation (EW 2 only), temporary mooring of foundations, wind turbine installation and offshore commissioning (EW 2 only), onshore export and interconnection cables (EW 2 only), export cable landfall construction (EW 2 only), and normal operations and maintenance (EW 1 only);
- Year 5: Wind turbine installation and offshore commissioning (EW 2 only), and normal operations and maintenance (EW 1 only); and
- Year 6: Normal operations and maintenance (EW 1 and EW 2).

Table K-2 through **Table K-7** present the potential emissions for both EW 1 and EW 2, by calendar year for each geographic area considered. The emissions in each area include total emissions from construction (both onshore and offshore) and operations and maintenance, including vessel transits.



Table K-2 Calendar Year 2023 Potential Emissions (tons)

Geographic Area	VOC	NO _x	CO	PM/ PM ₁₀	PM _{2.5}	SO ₂	HAP	GHG (CO ₂ e)
Inside OCS radius	0	0	0	0	0	0	0	0
Albany County, NY	0	0	0	0	0	0	0	0
Greene County, NY	0	0	0	0	0	0	0	0
Ulster County, NY	0	0	0	0	0	0	0	0
Orange County, NY	0	0	0	0	0	0	0	0
Rockland County, NY	0	0	0	0	0	0	0	0
Bergen County, NJ	0	0	0	0	0	0	0	0
Hudson County, NJ	0	0	0	0	0	0	0	0
Rensselaer County, NY	0	0	0	0	0	0	0	0
Columbia County, NY	0	0	0	0	0	0	0	0
Dutchess County, NY	0	0	0	0	0	0	0	0
Putnam County, NY	0	0	0	0	0	0	0	0
Westchester County, NY	0	0	0	0	0	0	0	0
Bronx County, NY	0	0	0	0	0	0	0	0
New York County, NY	0	0	0	0	0	0	0	0
Kings County, NY	0.44	3.40	1.18	0.14	0.14	6.82E-03	0.10	1,230.5
Queens County, NY	0	0	0	0	0	0	0	0
Monmouth County, NJ	0	0	0	0	0	0	0	0
Nassau County, NY	0	0	0	0	0	0	0	0
Ozone NAA (NY-NJ-CT)	0.44	3.40						
PM ₁₀ NAA (New York County, NY)				0				
PM _{2.5} Maintenance Area (1997 Annual, NY-NJ-CT)		3.40			0.14	6.82E-03		
PM _{2.5} Maintenance Area (2006 24-hour, NY-NJ-CT)	0	3.40			0.14	6.82E-03		
C0 Maintenance Area (NY-NJ-CT)			1.18					
Non-OCS federal waters	0	0	0	0	0	0	0	0
Virginia state waters (Hampton Roads AQCR)	0	0	0	0	0	0	0	0
Texas state waters (Corpus Christi-Victoria AQCR)	0	0	0	0	0	0	0	0
TOTAL, ALL AREAS	0.44	3.40	1.18	0.14	0.14	6.82E-03	0.10	1,231

a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_x and SO₂) that are precursors for more than one General Conformity pollutant.



Table K-3 Calendar Year 2024 Potential Emissions (tons)

Geographic Area	voc	NO _x	СО	PM/ PM ₁₀	PM _{2.5}	SO ₂	HAP	GHG (CO₂e)
Inside OCS radius	189.11	4,709.84	915.11	118.83	115.26	110.59	17.58	256,692
Albany County, NY	0.06	1.23	0.63	0.08	0.08	8.19E-04	6.65E-03	87.4
Greene County, NY	0.64	12.53	6.40	0.79	0.77	8.36E-03	0.07	893.1
Ulster County, NY	0.94	18.50	9.44	1.17	1.13	1.23E-02	0.10	1,318.0
Orange County, NY	0.51	9.94	5.07	0.63	0.61	6.63E-03	0.05	708.2
Rockland County, NY	0.61	11.93	6.09	0.75	0.73	7.96E-03	0.06	849.8
Bergen County, NJ	0.36	7.01	3.58	0.44	0.43	4.68E-03	0.04	499.6
Hudson County, NJ	0.21	4.14	2.11	0.26	0.25	2.76E-03	0.02	295.1
Rensselaer County, NY	0.06	1.12	0.57	0.07	0.07	7.45E-04	6.05E-03	79.6
Columbia County, NY	0.73	14.36	7.33	0.91	0.88	9.58E-03	0.08	1,022.9
Dutchess County, NY	1.12	22.03	11.24	1.39	1.35	1.47E-02	0.12	1,569.8
Putnam County, NY	0.23	4.53	2.31	0.29	0.28	3.02E-03	0.02	322.6
Westchester County, NY	0.76	14.91	7.61	0.94	0.91	9.95E-03	0.08	1,062.2
Bronx County, NY	0.06	1.21	0.62	0.08	0.07	8.11E-04	6.58E-03	86.6
New York County, NY	0.36	7.12	3.63	0.45	0.44	4.75E-03	0.04	507.5
Kings County, NY	17.85	438.48	58.42	8.40	8.15	11.69	1.77	25,511.1
Queens County, NY	2.09	48.71	12.24	1.61	1.56	0.94	0.20	2,846.5
Monmouth County, NJ	0.24	4.78	2.41	0.29	0.28	0.04	0.02	338.8
Nassau County, NY	0.02	0.21	5.08E-03	4.96E-03	4.96E-03	1.31E-02	4.29E-04	41.6
Ozone NAA (NY-NJ-CT)	22.56	538.51						
PM ₁₀ NAA (New York County, NY)				0.45				
PM _{2.5} Maintenance Area (1997 Annual, NY-NJ-CT)		548.45			13.45	12.73		
PM _{2.5} Maintenance Area (2006 24-hour, NY-NJ-CT)		548.45			13.45	12.73		
CO Maintenance Area (NY-NJ-CT)			88.22					
Non-OCS federal waters	4.42	116.81	9.73	1.64	1.59	3.51	0.39	5,800.2
Virginia state waters (Hampton Roads AQCR)	0.53	14.02	1.17	0.20	0.19	0.42	0.05	696.0
Texas state waters (Corpus Christi-Victoria AQCR)	0	0	0	0	0	0	0	0
TOTAL, ALL AREAS	220.92	5,463.42	1,065.70	139.22	135.04	127.30	20.73	301,228

a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_x and SO₂) that are precursors for more than one General Conformity pollutant.



Table K-4 Calendar Year 2025 Potential Emissions (tons)

Geographic Area	VOC	NO _x	СО	PM/ PM ₁₀	PM _{2.5}	SO ₂	HAP	GHG (CO₂e)
Inside OCS radius	526.84	13,074.36	2,484.39	328.43	318.58	308.71	48.99	711,308
Albany County, NY	0.19	3.65	1.86	0.23	0.22	2.44E-03	0.02	260.1
Greene County, NY	1.58	30.97	15.80	1.95	1.90	0.02	0.17	2,206.3
Ulster County, NY	2.33	45.70	23.32	2.89	2.80	0.03	0.25	3,255.9
Orange County, NY	1.25	24.56	12.53	1.55	1.50	0.02	0.13	1,749.5
Rockland County, NY	1.50	29.47	15.03	1.86	1.80	0.02	0.16	2,099.3
Bergen County, NJ	0.88	17.33	8.84	1.09	1.06	1.16E-02	0.09	1,234.3
Hudson County, NJ	0.52	10.23	5.22	0.65	0.63	6.83E-03	0.06	728.9
Rensselaer County, NY	0.17	3.38	1.72	0.21	0.21	2.25E-03	0.02	240.7
Columbia County, NY	1.81	35.47	18.10	2.24	2.17	0.02	0.19	2,527.0
Dutchess County, NY	2.78	54.43	27.77	3.44	3.33	0.04	0.29	3,878.0
Putnam County, NY	0.57	11.19	5.71	0.71	0.69	7.46E-03	0.06	797.0
Westchester County, NY	1.88	36.83	18.79	2.33	2.26	0.02	0.20	2,624.2
Bronx County, NY	0.15	3.00	1.53	0.19	0.18	2.00E-03	0.02	213.8
New York County, NY	0.90	17.60	8.98	1.11	1.08	1.17E-02	0.10	1,253.8
Kings County, NY	36.50	921.71	114.25	16.76	16.26	25.29	3.45	50,421.5
Queens County, NY	2.58	58.91	16.42	2.13	2.07	1.08	0.25	3,258.3
Monmouth County, NJ	0.69	14.46	6.32	0.77	0.75	0.17	0.07	976.8
Nassau County, NY	4.83	114.54	31.29	3.81	3.69	1.96	0.47	6,857.5
Ozone NAA (NY-NJ-CT)	50.44	1,224.07						
PM ₁₀ NAA (New York County, NY)				1.11				
PM _{2.5} Maintenance Area (1997 Annual, NY-NJ-CT)		1,248.63			31.29	28.59		
PM _{2.5} Maintenance Area (2006 24-hour, NY-NJ-CT)		1,248.63			31.29	28.59		
CO Maintenance Area (NY-NJ-CT)			205.32					
Non-OCS federal waters	12.03	317.66	26.47	4.46	4.33	9.55	1.06	15,772.7
Virginia state waters (Hampton Roads AQCR)	1.24	32.71	2.73	0.46	0.45	0.98	0.11	1,624.0
Texas state waters (Corpus Christi-Victoria AQCR)	0.03	0.70	0.06	9.79E-03	9.50E-03	0.02	2.33E-03	34.6
TOTAL, ALL AREAS	601.25	14,858.84	2,847.13	377.28	365.96	347.97	56.16	813,592

a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_X and SO₂) that are precursors for more than one General Conformity pollutant.



Table K-5 Calendar Year 2026 Potential Emissions (tons)

Geographic Area	VOC	NO _x	СО	PM/ PM ₁₀	PM _{2.5}	SO ₂	HAP	GHG (CO₂e)
Inside OCS radius	315.23	7,751.23	1,603.03	206.36	200.17	170.72	29.58	432,562
Albany County, NY	0.18	3.57	1.82	0.22	0.22	2.38E-03	0.02	254.6
Greene County, NY	0.73	14.37	7.33	0.90	0.88	9.59E-03	0.08	1,023.9
Ulster County, NY	1.08	21.21	10.82	1.33	1.29	1.42E-02	0.11	1,511.1
Orange County, NY	0.58	11.40	5.81	0.72	0.69	7.60E-03	0.06	811.9
Rockland County, NY	0.69	13.68	6.98	0.86	0.83	9.12E-03	0.07	974.3
Bergen County, NJ	0.41	8.04	4.10	0.50	0.49	5.36E-03	0.04	572.8
Hudson County, NJ	0.24	4.75	2.42	0.30	0.29	3.17E-03	0.03	338.3
Rensselaer County, NY	0.17	3.45	1.76	0.22	0.21	2.30E-03	0.02	245.6
Columbia County, NY	0.84	16.46	8.40	1.03	1.00	1.10E-02	0.09	1,172.8
Dutchess County, NY	1.28	25.26	12.89	1.59	1.54	0.02	0.14	1,799.7
Putnam County, NY	0.26	5.19	2.65	0.33	0.32	3.46E-03	0.03	369.9
Westchester County, NY	0.87	17.09	8.72	1.07	1.04	1.14E-02	0.09	1,217.9
Bronx County, NY	0.07	1.39	0.71	0.09	0.08	9.29E-04	7.51E-03	99.2
New York County, NY	0.41	8.17	4.17	0.51	0.50	5.45E-03	0.04	581.9
Kings County, NY	9.94	240.58	32.96	4.70	4.56	6.39	0.95	14,482.0
Queens County, NY	0.78	18.19	5.41	0.66	0.64	0.31	80.0	1,106.4
Monmouth County, NJ	0.70	16.32	4.86	0.59	0.57	0.27	0.07	987.3
Nassau County, NY	0.90	21.43	10.82	1.04	1.01	0.03	0.09	1,557.4
Ozone NAA (NY-NJ-CT)	15.02	349.65						
PM ₁₀ NAA (New York County, NY)				0.51				
PM _{2.5} Maintenance Area (1997 Annual, NY-NJ-CT)		361.04			10.70	7.05		
PM _{2.5} Maintenance Area (2006 24-hour, NY-NJ-CT)		361.04			10.70	7.05		
CO Maintenance Area (NY-NJ-CT)			69.30					
Non-OCS federal waters	3.29	86.89	7.24	1.22	1.18	2.61	0.29	4,314.6
Virginia state waters (Hampton Roads AQCR)	0.35	9.35	0.78	0.13	0.13	0.28	0.03	464.0
Texas state waters (Corpus Christi-Victoria AQCR)	5.28E-03	0.14	1.16E-02	1.96E-03	1.90E-03	4.19E-03	4.67E-04	6.9
TOTAL, ALL AREAS	339.02	8,298.16	1,743.68	224.36	217.63	180.73	31.92	466,455

a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_x and SO₂) that are precursors for more than one General Conformity pollutant.



Table K-6 Calendar Year 2027 Potential Emissions (tons)

Geographic Area	VOC	NO _x	CO	PM/ PM ₁₀	PM _{2.5}	SO ₂	HAP	GHG (CO ₂ e)
Inside OCS radius	147.16	3,544.20	920.72	110.10	106.80	63.95	14.09	212,480
Albany County, NY	0.18	3.54	1.81	0.22	0.21	2.36E-03	0.02	252.4
Greene County, NY	0.39	7.73	3.95	0.48	0.47	5.16E-03	0.04	551.0
Ulster County, NY	0.58	11.41	5.82	0.71	0.69	7.61E-03	0.06	813.1
Orange County, NY	0.31	6.13	3.13	0.38	0.37	4.09E-03	0.03	436.9
Rockland County, NY	0.37	7.36	3.75	0.46	0.44	4.91E-03	0.04	524.3
Bergen County, NJ	0.22	4.33	2.21	0.27	0.26	2.89E-03	0.02	308.3
Hudson County, NJ	0.13	2.56	1.30	0.16	0.15	1.70E-03	1.37E-02	182.0
Rensselaer County, NY	0.18	3.47	1.77	0.22	0.21	2.32E-03	0.02	247.6
Columbia County, NY	0.45	8.86	4.52	0.55	0.53	5.91E-03	0.05	631.1
Dutchess County, NY	0.69	13.59	6.94	0.85	0.82	9.07E-03	0.07	968.4
Putnam County, NY	0.14	2.79	1.43	0.17	0.17	1.86E-03	1.49E-02	199.0
Westchester County, NY	0.46	9.20	4.69	0.57	0.56	6.14E-03	0.05	655.3
Bronx County, NY	0.04	0.75	0.38	0.05	0.05	5.00E-04	4.01E-03	53.4
New York County, NY	0.22	4.39	2.24	0.27	0.27	2.93E-03	0.02	313.1
Kings County, NY	2.81	51.16	13.36	1.61	1.56	0.92	0.21	3,720.3
Queens County, NY	0.83	20.44	5.45	0.62	0.60	0.36	0.08	1,208.7
Monmouth County, NJ	0.74	18.37	4.90	0.55	0.54	0.32	0.07	1,082.7
Nassau County, NY	0.27	2.02	1.16	0.07	0.07	1.24E-02	2.57E-03	1,092.1
Ozone NAA (NY-NJ-CT)	6.10	120.58						
PM ₁₀ NAA (New York County, NY)				0				
PM _{2.5} Maintenance Area (1997 Annual, NY-NJ-CT)		126.71			4.86	1.64		
PM _{2.5} Maintenance Area (2006 24-hour, NY-NJ-CT)		126.71			4.86	1.64		
CO Maintenance Area (NY-NJ-CT)			30.80					
Non-OCS federal waters	0	0	0	0	0	0	0	0
Virginia state waters (Hampton Roads AQCR)	0	0	0	0	0	0	0	0
Texas state waters (Corpus Christi-Victoria AQCR)	0	0	0	0	0	0	0	0
TOTAL, ALL AREAS	156.15	3,722.32	989.53	118.31	114.76	65.63	14.91	225,719

a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_x and SO₂) that are precursors for more than one General Conformity pollutant.



Table K-7	Calendar Year 2028 and Onward Potential Emissions (tons	3)
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Geographic Area	VOC	NO _x	co	PM/ PM ₁₀	PM _{2.5}	SO ₂	HAP	GHG (CO₂e)
Inside OCS radius	29.54	759.07	246.97	23.12	22.43	10.37	2.82	51,871
Kings County, NY	0.55	9.82	5.08	0.32	0.31	1.26E-02	0.04	1,502.3
Queens County, NY	0.09	2.91	1.46	0.09	0.09	3.64E-03	9.00E-03	205.9
Monmouth County, NJ	0.08	2.62	1.31	0.08	0.08	3.27E-03	8.10E-03	185.3
Nassau County, NY	0.26	1.85	1.16	0.07	0.06	2.18E-03	2.24E-03	1,059.7
Ozone NAA (NY-NJ-CT)	0.98	17.20						
PM ₁₀ NAA (New York County, NY)				0				
PM _{2.5} Maintenance Area (1997 Annual, NY-NJ-CT)		17.20			0.54	0.02		
PM _{2.5} Maintenance Area (2006 24-hour, NY-NJ-CT)		17.20			0.54	0.02		
CO Maintenance Area (NY-NJ-CT)			7.70					
TOTAL, ALL AREAS	30.52	776.26	255.98	23.68	22.97	10.39	2.88	54,824

a/ Total for all areas will differ from the subtotals shown above because it includes emissions for counties not subject to General Conformity, and also only counts emissions a single time for pollutants (such as NO_X and SO₂) that are precursors for more than one General Conformity pollutant.

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ATTACHMENT K-1 EMISSION CALCULATIONS

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS Calendar Year Emission Summary

2023 (Construction of EW 1 and EW 2)

Emissions by geographic area	voc	NO_X	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N ₂ O	CO ₂ e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0	0	0	0	0	0	0	0	0	0	0
Non-OCS federal waters	0	0	0	0	0	0	0	0	0	0	0
Albany County, NY	0	0	0	0	0	0	0	0	0	0	0
Greene County, NY	0	0	0	0	0	0	0	0	0	0	0
Ulster County, NY	0	0	0	0	0	0	0	0	0	0	0
Orange County, NY	0	0	0	0	0	0	0	0	0	0	0
Rockland County, NY	0	0	0	0	0	0	0	0	0	0	0
Bergen County, NJ	0	0	0	0	0	0	0	0	0	0	0
Hudson County, NJ	0	0	0	0	0	0	0	0	0	0	0
Rensselaer County, NY	0	0	0	0	0	0	0	0	0	0	0
Columbia County, NY	0	0	0	0	0	0	0	0	0	0	0
Dutchess County, NY	0	0	0	0	0	0	0	0	0	0	0
Putnam County, NY	0	0	0	0	0	0	0	0	0	0	0
Westchester County, NY	0	0	0	0	0	0	0	0	0	0	0
Bronx County, NY	0	0	0	0	0	0	0	0	0	0	0
New York County, NY	0	0	0	0	0	0	0	0	0	0	0
Kings County, NY	0.44	3.40	1.18	0.14	0.14	6.82E-03	0.10	1,221.1	0.05	0.03	1,230.5
Queens County, NY	0	0	0	0	0	0	0	0	0	0	0
Monmouth County, NJ	0	0	0	0	0	0	0	0	0	0	0
Nassau County, NY	0	0	0	0	0	0	0	0	0	0	0
Inside OCS radius	0	0	0	0	0	0	0	0	0	0	0
Ozone NAA (NY-NJ-CT)	0.44	3.40									
PM10 NAA (New York County)				0							
CO Maintenance Area (NY-NJ-CT)			1.18								
PM2.5 Maintenance Area (1997 Annual, NY-NJ-CT)		3.40			0.14	6.82E-03					
PM2.5 Maintenance Area (2006 24-hour, NY-NJ-CT)		3.40			0.14	6.82E-03					
TOTAL, ALL AREAS	0.44	3.40	1.18	0.14	0.14	6.82E-03	0.10	1,221	0.05	0.03	1,231

2024 (Construction of EW 1 and EW 2)

Emissions by geographic area	voc	NO _X	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH₄	N ₂ O	CO₂e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0.53	14.02	1.17	0.20	0.19	0.42	0.05	686.1	4.25E-03	0.03	696.0
Non-OCS federal waters	4.42	116.81	9.73	1.64	1.59	3.51	0.39	5,717.5	0.04	0.27	5,800.2
Albany County, NY	0.06	1.23	0.63	0.08	0.08	8.19E-04	6.65E-03	86.4	1.13E-02	2.50E-03	87.4
Greene County, NY	0.64	12.53	6.40	0.79	0.77	8.36E-03	0.07	882.6	0.12	0.03	893.1
Ulster County, NY	0.94	18.50	9.44	1.17	1.13	1.23E-02	0.10	1,302.5	0.17	0.04	1,318.0
Orange County, NY	0.51	9.94	5.07	0.63	0.61	6.63E-03	0.05	699.8	0.09	0.02	708.2
Rockland County, NY	0.61	11.93	6.09	0.75	0.73	7.96E-03	0.06	839.8	0.11	0.02	849.8
Bergen County, NJ	0.36	7.01	3.58	0.44	0.43	4.68E-03	0.04	493.8	0.06	1.43E-02	499.6
Hudson County, NJ	0.21	4.14	2.11	0.26	0.25	2.76E-03	0.02	291.6	0.04	8.45E-03	295.1
Rensselaer County, NY	0.06	1.12	0.57	0.07	0.07	7.45E-04	6.05E-03	78.6	1.03E-02	2.28E-03	79.6
Columbia County, NY	0.73	14.36	7.33	0.91	0.88	9.58E-03	0.08	1,010.9	0.13	0.03	1,022.9
Dutchess County, NY	1.12	22.03	11.24	1.39	1.35	1.47E-02	0.12	1,551.3	0.20	0.04	1,569.8
Putnam County, NY	0.23	4.53	2.31	0.29	0.28	3.02E-03	0.02	318.8	0.04	9.24E-03	322.6
Westchester County, NY	0.76	14.91	7.61	0.94	0.91	9.95E-03	0.08	1,049.7	0.14	0.03	1,062.2
Bronx County, NY	0.06	1.21	0.62	0.08	0.07	8.11E-04	6.58E-03	85.5	1.12E-02	2.48E-03	86.6
New York County, NY	0.36	7.12	3.63	0.45	0.44	4.75E-03	0.04	501.5	0.07	1.45E-02	507.5
Kings County, NY	17.85	438.48	58.42	8.40	8.15	11.69	1.77	25,176.1	0.65	1.07	25,511.1
Queens County, NY	2.09	48.71	12.24	1.61	1.56	0.94	0.20	2,809.4	0.19	0.11	2,846.5
Monmouth County, NJ	0.24	4.78	2.41	0.29	0.28	0.04	0.02	334.8	0.04	9.87E-03	338.8
Nassau County, NY	0.02	0.21	5.08E-03	4.96E-03	4.96E-03	1.31E-02	4.29E-04	41.2	1.18E-03	1.36E-03	41.6
Inside OCS radius	189.11	4,709.84	915.11	118.83	115.26	110.59	17.58	253,222	13.10	10.74	256,692
Ozone NAA (NY-NJ-CT)	22.56	538.51	-	-	-	-	-	-			
PM10 NAA (New York County)	-	-	-	0.45	-	-	-	-			
CO Maintenance Area (NY-NJ-CT)		-	88.22	-	-	-	-	-		-	
PM2.5 Maintenance Area (1997 Annual, NY-NJ-CT)		548.45	-	-	13.45	12.73	-	-		-	
PM2.5 Maintenance Area (2006 24-hour, NY-NJ-CT)	-	548.45			13.45	12.73					
TOTAL, ALL AREAS	220.92	5,463.42	1,065.70	139.22	135.04	127.30	20.73	297,180	15.22	12.50	301,228

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS Calendar Year Emission Summary

2025 (Construction of EW 1 and EW 2)

Emissions by geographic area	VOC	NO _x	CO	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH₄	N ₂ O	CO₂e
Texas state waters	0.03	0.70	0.06	9.79E-03	9.50E-03	0.02	2.33E-03	34.1	2.11E-04	1.64E-03	34.6
Virginia state waters	1.24	32.71	2.73	0.46	0.45	0.98	0.11	1,600.9	9.91E-03	0.08	1,624.0
Non-OCS federal waters	12.03	317.66	26.47	4.46	4.33	9.55	1.06	15,548.0	0.10	0.75	15,772.7
Albany County, NY	0.19	3.65	1.86	0.23	0.22	2.44E-03	0.02	257.1	0.03	7.45E-03	260.1
Greene County, NY	1.58	30.97	15.80	1.95	1.90	0.02	0.17	2,180.3	0.28	0.06	2,206.3
Ulster County, NY	2.33	45.70	23.32	2.89	2.80	0.03	0.25	3,217.7	0.42	0.09	3,255.9
Orange County, NY	1.25	24.56	12.53	1.55	1.50	0.02	0.13	1,728.9	0.23	0.05	1,749.5
Rockland County, NY	1.50	29.47	15.03	1.86	1.80	0.02	0.16	2,074.7	0.27	0.06	2,099.3
Bergen County, NJ	0.88	17.33	8.84	1.09	1.06	1.16E-02	0.09	1,219.8	0.16	0.04	1,234.3
Hudson County, NJ	0.52	10.23	5.22	0.65	0.63	6.83E-03	0.06	720.4	0.09	0.02	728.9
Rensselaer County, NY	0.17	3.38	1.72	0.21	0.21	2.25E-03	0.02	237.9	0.03	6.89E-03	240.7
Columbia County, NY	1.81	35.47	18.10	2.24	2.17	0.02	0.19	2,497.3	0.33	0.07	2,527.0
Dutchess County, NY	2.78	54.43	27.77	3.44	3.33	0.04	0.29	3,832.4	0.50	0.11	3,878.0
Putnam County, NY	0.57	11.19	5.71	0.71	0.69	7.46E-03	0.06	787.6	0.10	0.02	797.0
Westchester County, NY	1.88	36.83	18.79	2.33	2.26	0.02	0.20	2,593.3	0.34	0.08	2,624.2
Bronx County, NY	0.15	3.00	1.53	0.19	0.18	2.00E-03	0.02	211.3	0.03	6.12E-03	213.8
New York County, NY	0.90	17.60	8.98	1.11	1.08	1.17E-02	0.10	1,239.0	0.16	0.04	1,253.8
Kings County, NY	36.50	921.71	114.25	16.76	16.26	25.29	3.45	49,738.1	1.11	2.20	50,421.5
Queens County, NY	2.58	58.91	16.42	2.13	2.07	1.08	0.25	3,483.0	0.26	0.13	3,528.3
Monmouth County, NJ	0.69	14.46	6.32	0.77	0.75	0.17	0.07	965.1	0.11	0.03	976.8
Nassau County, NY	4.83	114.54	31.29	3.81	3.69	1.96	0.47	6,769.2	0.49	0.26	6,857.5
Inside OCS radius	526.84	13,074.36	2,484.39	328.43	318.58	308.71	48.99	701,683	34.83	29.83	711,308
Ozone NAA (NY-NJ-CT)	50.44	1,224.07	-	-	-	-	-	-	-	-	
PM10 NAA (New York County)			-	1.11	-	-	-	-	-	-	
CO Maintenance Area (NY-NJ-CT)			205.32	-	-	-	-	-	-	-	
PM2.5 Maintenance Area (1997 Annual, NY-NJ-CT)		1,248.63		-	31.29	28.59		-	-	-	
PM2.5 Maintenance Area (2006 24-hour, NY-NJ-CT)		1,248.63	-	-	31.29	28.59					
TOTAL, ALL AREAS	601.25	14,858.84	2,847.13	377.28	365.96	347.97	56.16	802,619	39.88	33.93	813,592

2026 (Construction of EW 1 and EW 2, plus EW 1 O&M)

Emissions by geographic area	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH₄	N ₂ O	CO ₂ e
Texas state waters	5.28E-03	0.14	1.16E-02	1.96E-03	1.90E-03	4.19E-03	4.67E-04	6.8	4.23E-05	3.28E-04	6.9
Virginia state waters	0.35	9.35	0.78	0.13	0.13	0.28	0.03	457.4	2.83E-03	0.02	464.0
Non-OCS federal waters	3.29	86.89	7.24	1.22	1.18	2.61	0.29	4,253.1	0.03	0.20	4,314.6
Albany County, NY	0.18	3.57	1.82	0.22	0.22	2.38E-03	0.02	251.6	0.03	7.29E-03	254.6
Greene County, NY	0.73	14.37	7.33	0.90	0.88	9.59E-03	0.08	1,011.9	0.13	0.03	1,023.9
Ulster County, NY	1.08	21.21	10.82	1.33	1.29	1.42E-02	0.11	1,493.3	0.19	0.04	1,511.1
Orange County, NY	0.58	11.40	5.81	0.72	0.69	7.60E-03	0.06	802.4	0.10	0.02	811.9
Rockland County, NY	0.69	13.68	6.98	0.86	0.83	9.12E-03	0.07	962.8	0.13	0.03	974.3
Bergen County, NJ	0.41	8.04	4.10	0.50	0.49	5.36E-03	0.04	566.1	0.07	0.02	572.8
Hudson County, NJ	0.24	4.75	2.42	0.30	0.29	3.17E-03	0.03	334.3	0.04	9.69E-03	338.3
Rensselaer County, NY	0.17	3.45	1.76	0.22	0.21	2.30E-03	0.02	242.7	0.03	7.04E-03	245.6
Columbia County, NY	0.84	16.46	8.40	1.03	1.00	1.10E-02	0.09	1,159.0	0.15	0.03	1,172.8
Dutchess County, NY	1.28	25.26	12.89	1.59	1.54	0.02	0.14	1,778.6	0.23	0.05	1,799.7
Putnam County, NY	0.26	5.19	2.65	0.33	0.32	3.46E-03	0.03	365.5	0.05	1.06E-02	369.9
Westchester County, NY	0.87	17.09	8.72	1.07	1.04	1.14E-02	0.09	1,203.5	0.16	0.03	1,217.9
Bronx County, NY	0.07	1.39	0.71	0.09	0.08	9.29E-04	7.51E-03	98.1	1.28E-02	2.84E-03	99.2
New York County, NY	0.41	8.17	4.17	0.51	0.50	5.45E-03	0.04	575.0	0.08	0.02	581.9
Kings County, NY	9.94	240.58	32.96	4.70	4.56	6.39	0.95	13,746.5	0.35	0.58	14,482.0
Queens County, NY	0.78	18.19	5.41	0.66	0.64	0.31	0.08	1,092.3	0.09	0.04	1,106.4
Monmouth County, NJ	0.70	16.32	4.86	0.59	0.57	0.27	0.07	974.7	0.08	0.04	987.3
Nassau County, NY	0.90	21.43	10.82	1.04	1.01	0.03	0.09	1,539.1	0.20	0.04	1,557.4
Inside OCS radius	315.23	7,751.23	1,603.03	206.36	200.17	170.72	29.58	425,182	22.70	17.55	432,562
Ozone NAA (NY-NJ-CT)	15.02	349.65	-		-		-	-	-		-
PM10 NAA (New York County)			-	0.51	-		-	-	-		-
CO Maintenance Area (NY-NJ-CT)			69.30		-		-	-	-		-
PM2.5 Maintenance Area (1997 Annual, NY-NJ-CT)		361.04			10.70	7.05					
PM2.5 Maintenance Area (2006 24-hour, NY-NJ-CT)		361.04			10.70	7.05					
TOTAL, ALL AREAS	339.02	8,298.16	1,743.68	224.36	217.63	180.73	31.92	458,097	24.86	18.80	466,455

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS Calendar Year Emission Summary

2027 (Construction of EW 2, plus EW 1 O&M)

Emissions by geographic area	voc	NO _X	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH₄	N ₂ O	CO ₂ e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0	0	0	0	0	0	0	0	0	0	0
Non-OCS federal waters	0	0	0	0	0	0	0	0	0	0	0
Albany County, NY	0.18	3.54	1.81	0.22	0.21	2.36E-03	0.02	249.5	0.03	7.23E-03	252.4
Greene County, NY	0.39	7.73	3.95	0.48	0.47	5.16E-03	0.04	544.5	0.07	0.02	551.0
Ulster County, NY	0.58	11.41	5.82	0.71	0.69	7.61E-03	0.06	803.5	0.10	0.02	813.1
Orange County, NY	0.31	6.13	3.13	0.38	0.37	4.09E-03	0.03	431.8	0.06	1.25E-02	436.9
Rockland County, NY	0.37	7.36	3.75	0.46	0.44	4.91E-03	0.04	518.1	0.07	0.02	524.3
Bergen County, NJ	0.22	4.33	2.21	0.27	0.26	2.89E-03	0.02	304.6	0.04	8.83E-03	308.3
Hudson County, NJ	0.13	2.56	1.30	0.16	0.15	1.70E-03	1.37E-02	179.9	0.02	5.21E-03	182.0
Rensselaer County, NY	0.18	3.47	1.77	0.22	0.21	2.32E-03	0.02	244.7	0.03	7.09E-03	247.6
Columbia County, NY	0.45	8.86	4.52	0.55	0.53	5.91E-03	0.05	623.6	0.08	0.02	631.1
Dutchess County, NY	0.69	13.59	6.94	0.85	0.82	9.07E-03	0.07	957.1	0.12	0.03	968.4
Putnam County, NY	0.14	2.79	1.43	0.17	0.17	1.86E-03	1.49E-02	196.7	0.03	5.70E-03	199.0
Westchester County, NY	0.46	9.20	4.69	0.57	0.56	6.14E-03	0.05	647.6	0.08	0.02	655.3
Bronx County, NY	0.04	0.75	0.38	0.05	0.05	5.00E-04	4.01E-03	52.8	6.88E-03	1.53E-03	53.4
New York County, NY	0.22	4.39	2.24	0.27	0.27	2.93E-03	0.02	309.4	0.04	8.97E-03	313.1
Kings County, NY	2.81	51.16	13.36	1.61	1.56	0.92	0.21	3,128.6	0.19	0.11	3,720.3
Queens County, NY	0.83	20.44	5.45	0.62	0.60	0.36	0.08	1,193.1	0.08	0.05	1,208.7
Monmouth County, NJ	0.74	18.37	4.90	0.55	0.54	0.32	0.07	1,068.7	0.08	0.04	1,082.7
Nassau County, NY	0.27	2.02	1.16	0.07	0.07	1.24E-02	2.57E-03	261.6	1.02E-02	2.93E-03	1,092.1
Inside OCS radius	147.16	3,544.20	920.72	110.10	106.80	63.95	14.09	205,047	13.93	7.88	212,480
Ozone NAA (NY-NJ-CT)	6.10	120.58	-								
PM10 NAA (New York County)		-	-	0			-				
CO Maintenance Area (NY-NJ-CT)			30.80								
PM2.5 Maintenance Area (1997 Annual, NY-NJ-CT)		126.71	-		4.86	1.64	-				
PM2.5 Maintenance Area (2006 24-hour, NY-NJ-CT)		126.71	-		4.86	1.64	-				
TOTAL, ALL AREAS	156.15	3,722.32	989.53	118.31	114.76	65.63	14.91	216,763	15.09	8.25	225,719

2028 Onward (O&M for EW 1 and EW 2)

2028 Oliwaru (Octivi for Lw 1 and Lw 2)											
Emissions by geographic area	VOC	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH₄	N ₂ O	CO ₂ e
Kings County, NY	0.55	9.82	5.08	0.32	0.31	1.26E-02	0.04	940.7	0.08	0.02	1,502.3
Queens County, NY	0.09	2.91	1.46	0.09	0.09	3.64E-03	9.00E-03	203.5	0.03	5.95E-03	205.9
Monmouth County, NJ	0.08	2.62	1.31	0.08	0.08	3.27E-03	8.10E-03	183.1	0.02	5.36E-03	185.3
Nassau County, NY	0.26	1.85	1.16	0.07	0.06	2.18E-03	2.24E-03	229.5	9.31E-03	1.86E-03	1,059.7
Inside OCS radius	29.54	759.07	246.97	23.12	22.43	10.37	2.82	46,543	3.98	1.65	51,871
Ozone NAA (NY-NJ-CT)	0.98	17.20	-		-			-	-	-	
PM10 NAA (New York County)			-	0	-			-	-	-	
CO Maintenance Area (NY-NJ-CT)			7.70		-			-	-	-	
PM2.5 Maintenance Area (1997 Annual, NY-NJ-CT)		17.20	-		0.54	0.02		-	-	-	
PM2.5 Maintenance Area (2006 24-hour, NY-NJ-CT)		17.20			0.54	0.02		-	-		
TOTAL, ALL AREAS	30.52	776.26	255.98	23.68	22.97	10.39	2.88	48,100	4.12	1.68	54,824

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Emission Summary

Year 1

Emissions by geographic area	voc	NO _X	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH₄	N ₂ O	CO ₂ e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0	0	0	0	0	0	0	0	0	0	0
Non-OCS federal waters	0	0	0	0	0	0	0	0	0	0	0
Albany County, NY	0	0	0	0	0	0	0	0	0	0	0
Greene County, NY	0	0	0	0	0	0	0	0	0	0	0
Ulster County, NY	0	0	0	0	0	0	0	0	0	0	0
Orange County, NY	0	0	0	0	0	0	0	0	0	0	0
Rockland County, NY	0	0	0	0	0	0	0	0	0	0	0
Bergen County, NJ	0	0	0	0	0	0	0	0	0	0	0
Hudson County, NJ	0	0	0	0	0	0	0	0	0	0	0
Rensselaer County, NY	0	0	0	0	0	0	0	0	0	0	0
Columbia County, NY	0	0	0	0	0	0	0	0	0	0	0
Dutchess County, NY	0	0	0	0	0	0	0	0	0	0	0
Putnam County, NY	0	0	0	0	0	0	0	0	0	0	0
Westchester County, NY	0	0	0	0	0	0	0	0	0	0	0
Bronx County, NY	0	0	0	0	0	0	0	0	0	0	0
New York County, NY	0	0	0	0	0	0	0	0	0	0	0
Kings County, NY	0.18	1.30	0.47	0.06	0.06	2.89E-03	0.04	507.4	0.02	1.15E-02	511.3
Queens County, NY	0	0	0	0	0	0	0	0	0	0	0
Monmouth County, NJ	0	0	0	0	0	0	0	0	0	0	0
Nassau County, NY	0	0	0	0	0	0	0	0	0	0	0
Inside OCS radius	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0.18	1.30	0.47	0.06	0.06	2.89E-03	0.04	507	0.02	1.15E-02	511

Vear 2

Year 2									•		
Emissions by geographic area	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N ₂ O	CO₂e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0.53	14.02	1.17	0.20	0.19	0.42	0.05	686.1	4.25E-03	0.03	696.0
Non-OCS federal waters	4.42	116.81	9.73	1.64	1.59	3.51	0.39	5,717.5	0.04	0.27	5,800.2
Albany County, NY	0.06	1.23	0.63	0.08	0.08	8.19E-04	6.65E-03	86.4	1.13E-02	2.50E-03	87.4
Greene County, NY	0.64	12.53	6.40	0.79	0.77	8.36E-03	0.07	882.6	0.12	0.03	893.1
Ulster County, NY	0.94	18.50	9.44	1.17	1.13	1.23E-02	0.10	1,302.5	0.17	0.04	1,318.0
Orange County, NY	0.51	9.94	5.07	0.63	0.61	6.63E-03	0.05	699.8	0.09	0.02	708.2
Rockland County, NY	0.61	11.93	6.09	0.75	0.73	7.96E-03	0.06	839.8	0.11	0.02	849.8
Bergen County, NJ	0.36	7.01	3.58	0.44	0.43	4.68E-03	0.04	493.8	0.06	1.43E-02	499.6
Hudson County, NJ	0.21	4.14	2.11	0.26	0.25	2.76E-03	0.02	291.6	0.04	8.45E-03	295.1
Rensselaer County, NY	0.06	1.12	0.57	0.07	0.07	7.45E-04	6.05E-03	78.6	1.03E-02	2.28E-03	79.6
Columbia County, NY	0.73	14.36	7.33	0.91	0.88	9.58E-03	0.08	1,010.9	0.13	0.03	1,022.9
Dutchess County, NY	1.12	22.03	11.24	1.39	1.35	1.47E-02	0.12	1,551.3	0.20	0.04	1,569.8
Putnam County, NY	0.23	4.53	2.31	0.29	0.28	3.02E-03	0.02	318.8	0.04	9.24E-03	322.6
Westchester County, NY	0.76	14.91	7.61	0.94	0.91	9.95E-03	0.08	1,049.7	0.14	0.03	1,062.2
Bronx County, NY	0.06	1.21	0.62	0.08	0.07	8.11E-04	6.58E-03	85.5	1.12E-02	2.48E-03	86.6
New York County, NY	0.36	7.12	3.63	0.45	0.44	4.75E-03	0.04	501.5	0.07	1.45E-02	507.5
Kings County, NY	17.32	434.28	57.01	8.24	7.99	11.69	1.65	23,748.7	0.60	1.04	24,072.5
Queens County, NY	2.09	48.71	12.24	1.61	1.56	0.94	0.20	2,809.4	0.19	0.11	2,846.5
Monmouth County, NJ	0.24	4.78	2.41	0.29	0.28	0.04	0.02	334.8	0.04	9.87E-03	338.8
Nassau County, NY	0.02	0.21	5.08E-03	4.96E-03	4.96E-03	1.31E-02	4.29E-04	41.2	1.18E-03	1.36E-03	41.6
Inside OCS radius	189.11	4,709.84	915.11	118.83	115.26	110.59	17.58	253,222	13.10	10.74	256,692
TOTAL	220.39	5,459.22	1,064.29	139.06	134.88	127.29	20.61	295,753	15.17	12.47	299,790

Phase 1 Summary 4 of 66 Empire AQ emissions 04-14-21.xlsx

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Emission Summary

Year 3

Emissions by geographic area	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH₄	N ₂ O	CO₂e
Texas state waters	0.02	0.42	0.03	5.87E-03	5.70E-03	1.26E-02	1.40E-03	20.5	1.27E-04	9.83E-04	20.8
Virginia state waters	0.18	4.67	0.39	0.07	0.06	0.14	0.02	228.7	1.42E-03	1.10E-02	232.0
Non-OCS federal waters	2.50	65.99	5.50	0.93	0.90	1.98	0.22	3,230.1	0.02	0.15	3,276.8
Albany County, NY	0.06	1.20	0.61	0.07	0.07	7.98E-04	6.43E-03	84.2	1.10E-02	2.44E-03	85.2
Greene County, NY	0.30	5.90	3.01	0.37	0.36	3.93E-03	0.03	415.2	0.05	1.20E-02	420.1
Ulster County, NY	0.44	8.70	4.44	0.55	0.53	5.81E-03	0.05	612.7	0.08	0.02	620.0
Orange County, NY	0.24	4.68	2.39	0.29	0.29	3.12E-03	0.03	329.2	0.04	9.54E-03	333.1
Rockland County, NY	0.29	5.61	2.86	0.35	0.34	3.74E-03	0.03	395.1	0.05	1.15E-02	399.8
Bergen County, NJ	0.17	3.30	1.68	0.21	0.20	2.20E-03	0.02	232.3	0.03	6.73E-03	235.0
Hudson County, NJ	0.10	1.95	0.99	0.12	0.12	1.30E-03	1.05E-02	137.2	0.02	3.98E-03	138.8
Rensselaer County, NY	0.06	1.14	0.58	0.07	0.07	7.64E-04	6.15E-03	80.6	1.05E-02	2.34E-03	81.5
Columbia County, NY	0.34	6.75	3.45	0.42	0.41	4.51E-03	0.04	475.5	0.06	1.38E-02	481.2
Dutchess County, NY	0.53	10.36	5.29	0.65	0.63	6.92E-03	0.06	729.8	0.10	0.02	738.5
Putnam County, NY	0.11	2.13	1.09	0.13	0.13	1.42E-03	1.15E-02	150.0	0.02	4.35E-03	151.8
Westchester County, NY	0.36	7.01	3.58	0.44	0.43	4.68E-03	0.04	493.8	0.06	1.43E-02	499.7
Bronx County, NY	0.03	0.57	0.29	0.04	0.03	3.81E-04	3.09E-03	40.2	5.25E-03	1.17E-03	40.7
New York County, NY	0.17	3.35	1.71	0.21	0.20	2.24E-03	0.02	235.9	0.03	6.84E-03	238.8
Kings County, NY	13.24	329.11	50.86	6.85	6.64	8.27	1.29	18,606.6	0.62	0.79	18,856.0
Queens County, NY	2.06	48.63	11.24	1.50	1.46	0.98	0.20	2,754.6	0.16	0.11	2,791.3
Monmouth County, NJ	0.23	5.27	1.67	0.21	0.20	0.09	0.02	319.6	0.03	1.15E-02	323.7
Nassau County, NY	1.16E-02	0.15	3.57E-03	3.49E-03	3.49E-03	9.20E-03	3.01E-04	28.9	8.28E-04	9.59E-04	29.2
Inside OCS radius	156.45	3,884.12	741.76	97.20	94.29	89.72	14.58	209,942	10.12	8.84	212,810
TOTAL	177.88	4,401.03	843.42	110.70	107.38	101.25	16.67	239,543	11.53	10.04	242,804

Year 4

Year 4											
Emissions by geographic area	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO_2	CH ₄	N ₂ O	CO₂e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0	0	0	0	0	0	0	0	0	0	0
Non-OCS federal waters	0	0	0	0	0	0	0	0	0	0	0
Albany County, NY	0.08	1.57	0.80	0.10	0.10	1.05E-03	8.43E-03	110.9	1.45E-02	3.21E-03	112.2
Greene County, NY	0.17	3.44	1.75	0.21	0.21	2.29E-03	0.02	242.0	0.03	7.01E-03	244.9
Ulster County, NY	0.26	5.07	2.59	0.32	0.31	3.38E-03	0.03	357.1	0.05	1.04E-02	361.4
Orange County, NY	0.14	2.73	1.39	0.17	0.16	1.82E-03	1.46E-02	191.9	0.03	5.56E-03	194.2
Rockland County, NY	0.16	3.27	1.67	0.20	0.20	2.18E-03	0.02	230.3	0.03	6.67E-03	233.0
Bergen County, NJ	0.10	1.92	0.98	0.12	0.12	1.28E-03	1.03E-02	135.4	0.02	3.92E-03	137.0
Hudson County, NJ	0.06	1.14	0.58	0.07	0.07	7.58E-04	6.08E-03	80.0	1.04E-02	2.32E-03	80.9
Rensselaer County, NY	0.08	1.54	0.79	0.10	0.09	1.03E-03	8.26E-03	108.7	1.42E-02	3.15E-03	110.0
Columbia County, NY	0.20	3.94	2.01	0.25	0.24	2.63E-03	0.02	277.2	0.04	8.03E-03	280.5
Dutchess County, NY	0.30	6.04	3.08	0.38	0.36	4.03E-03	0.03	425.4	0.06	1.23E-02	430.4
Putnam County, NY	0.06	1.24	0.63	0.08	0.07	8.28E-04	6.64E-03	87.4	1.14E-02	2.53E-03	88.5
Westchester County, NY	0.21	4.09	2.09	0.25	0.25	2.73E-03	0.02	287.8	0.04	8.34E-03	291.3
Bronx County, NY	0.02	0.33	0.17	0.02	0.02	2.22E-04	1.78E-03	23.5	3.06E-03	6.80E-04	23.7
New York County, NY	0.10	1.95	1.00	0.12	0.12	1.30E-03	1.05E-02	137.5	0.02	3.99E-03	139.2
Kings County, NY	1.35	26.13	7.63	0.84	0.81	0.41	0.13	1,969.0	0.11	0.06	2,543.7
Queens County, NY	0.36	8.76	2.25	0.26	0.26	0.16	0.03	508.6	0.03	0.02	515.3
Monmouth County, NJ	0.32	7.86	2.03	0.24	0.23	0.14	0.03	453.8	0.03	0.02	459.8
Nassau County, NY	9.83E-03	0.13	3.02E-03	2.95E-03	2.95E-03	7.77E-03	2.55E-04	24.5	7.00E-04	8.10E-04	24.7
Inside OCS radius	61.42	1,472.47	378.31	45.90	44.52	26.84	5.88	85,013	5.71	3.27	87,753
TOTAL	65.39	1,553.62	409.75	49.62	48.13	27.59	6.27	90,664	6.24	3.45	94,023

Year 5 Onward (O&M)

Emissions by geographic area	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH₄	N ₂ O	CO ₂ e
Kings County, NY	0.37	4.60	2.49	0.15	0.15	6.57E-03	0.02	498.2	0.03	9.40E-03	1,054.8
Queens County, NY	0.03	0.98	0.49	0.03	0.03	1.50E-03	3.03E-03	68.3	8.73E-03	2.01E-03	69.1
Monmouth County, NJ	0.03	0.88	0.44	0.03	0.03	1.35E-03	2.73E-03	61.5	7.86E-03	1.81E-03	62.2
Nassau County, NY	0	0	0	0	0	0	0	0	0	0	0
Inside OCS radius	10.16	258.99	83.59	7.81	7.57	3.62	0.96	15,871	1.33	0.56	17,693
TOTAL	10.58	265.45	87.01	8.02	7.78	3.63	0.98	16,499	1.38	0.58	18,879

Phase 1 Summary 5 of 66 Empire AQ emissions 04-14-21.xlsx

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Emission Summary

Year 1

Emissions by geographic area	VOC	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH₄	N ₂ O	CO ₂ e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0	0	0	0	0	0	0	0	0	0	0
Non-OCS federal waters	0	0	0	0	0	0	0	0	0	0	0
Albany County, NY	0	0	0	0	0	0	0	0	0	0	0
Greene County, NY	0	0	0	0	0	0	0	0	0	0	0
Ulster County, NY	0	0	0	0	0	0	0	0	0	0	0
Orange County, NY	0	0	0	0	0	0	0	0	0	0	0
Rockland County, NY	0	0	0	0	0	0	0	0	0	0	0
Bergen County, NJ	0	0	0	0	0	0	0	0	0	0	0
Hudson County, NJ	0	0	0	0	0	0	0	0	0	0	0
Rensselaer County, NY	0	0	0	0	0	0	0	0	0	0	0
Columbia County, NY	0	0	0	0	0	0	0	0	0	0	0
Dutchess County, NY	0	0	0	0	0	0	0	0	0	0	0
Putnam County, NY	0	0	0	0	0	0	0	0	0	0	0
Westchester County, NY	0	0	0	0	0	0	0	0	0	0	0
Bronx County, NY	0	0	0	0	0	0	0	0	0	0	0
New York County, NY	0	0	0	0	0	0	0	0	0	0	0
Kings County, NY	0.26	2.10	0.71	0.08	0.08	3.94E-03	0.06	713.7	0.03	0.02	719.3
Queens County, NY	0	0	0	0	0	0	0	0	0	0	0
Monmouth County, NJ	0	0	0	0	0	0	0	0	0	0	0
Nassau County, NY	0	0	0	0	0	0	0	0	0	0	0
Inside OCS radius	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0.26	2.10	0.71	0.08	0.08	3.94E-03	0.06	714	0.03	0.02	719

Vear 2

Year 2											
Emissions by geographic area	VOC	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N ₂ O	CO ₂ e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0	0	0	0	0	0	0	0	0	0	0
Non-OCS federal waters	0	0	0	0	0	0	0	0	0	0	0
Albany County, NY	0	0	0	0	0	0	0	0	0	0	0
Greene County, NY	0	0	0	0	0	0	0	0	0	0	0
Ulster County, NY	0	0	0	0	0	0	0	0	0	0	0
Orange County, NY	0	0	0	0	0	0	0	0	0	0	0
Rockland County, NY	0	0	0	0	0	0	0	0	0	0	0
Bergen County, NJ	0	0	0	0	0	0	0	0	0	0	0
Hudson County, NJ	0	0	0	0	0	0	0	0	0	0	0
Rensselaer County, NY	0	0	0	0	0	0	0	0	0	0	0
Columbia County, NY	0	0	0	0	0	0	0	0	0	0	0
Dutchess County, NY	0	0	0	0	0	0	0	0	0	0	0
Putnam County, NY	0	0	0	0	0	0	0	0	0	0	0
Westchester County, NY	0	0	0	0	0	0	0	0	0	0	0
Bronx County, NY	0	0	0	0	0	0	0	0	0	0	0
New York County, NY	0	0	0	0	0	0	0	0	0	0	0
Kings County, NY	0.53	4.20	1.41	0.17	0.16	7.87E-03	0.12	1,427.4	0.05	0.03	1,438.5
Queens County, NY	0	0	0	0	0	0	0	0	0	0	0
Monmouth County, NJ	0	0	0	0	0	0	0	0	0	0	0
Nassau County, NY	0	0	0	0	0	0	0	0	0	0	0
Inside OCS radius	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0.53	4.20	1.41	0.17	0.16	7.87E-03	0.12	1,427	0.05	0.03	1,439

Phase 2 Summary 6 of 66 Empire AQ emissions 04-14-21.xlsx

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Emission Summary

Year 3

Emissions by geographic area	voc	NO _X	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH ₄	N ₂ O	CO ₂ e
Texas state waters	1.06E-02	0.28	0.02	3.92E-03	3.80E-03	8.38E-03	9.33E-04	13.7	8.45E-05	6.55E-04	13.8
Virginia state waters	1.06	28.04	2.34	0.39	0.38	0.84	0.09	1,372.2	8.50E-03	0.07	1,392.0
Non-OCS federal waters	9.53	251.67	20.97	3.53	3.43	7.56	0.84	12,317.9	0.08	0.59	12,495.9
Albany County, NY	0.13	2.45	1.25	0.16	0.15	1.64E-03	0.01	172.8	0.02	5.01E-03	174.9
Greene County, NY	1.28	25.07	12.79	1.58	1.54	0.02	0.14	1,765.1	0.23	0.05	1,786.1
Ulster County, NY	1.89	37.00	18.88	2.34	2.27	0.02	0.20	2,604.9	0.34	0.08	2,635.9
Orange County, NY	1.01	19.88	10.14	1.26	1.22	1.33E-02	0.11	1,399.7	0.18	0.04	1,416.3
Rockland County, NY	1.22	23.86	12.17	1.51	1.46	0.02	0.13	1,679.6	0.22	0.05	1,699.6
Bergen County, NJ	0.72	14.03	7.16	0.89	0.86	9.36E-03	0.08	987.5	0.13	0.03	999.3
Hudson County, NJ	0.42	8.28	4.23	0.52	0.51	5.53E-03	0.04	583.2	0.08	0.02	590.1
Rensselaer County, NY	0.11	2.23	1.14	0.14	0.14	1.49E-03	1.21E-02	157.3	0.02	4.56E-03	159.1
Columbia County, NY	1.47	28.71	14.65	1.81	1.76	0.02	0.16	2,021.7	0.26	0.06	2,045.8
Dutchess County, NY	2.25	44.07	22.48	2.78	2.70	0.03	0.24	3,102.6	0.40	0.09	3,139.5
Putnam County, NY	0.46	9.06	4.62	0.57	0.56	6.04E-03	0.05	637.6	0.08	0.02	645.2
Westchester County, NY	1.52	29.82	15.21	1.88	1.83	0.02	0.16	2,099.5	0.27	0.06	2,124.5
Bronx County, NY	0.12	2.43	1.24	0.15	0.15	1.62E-03	1.32E-02	171.1	0.02	4.96E-03	173.1
New York County, NY	0.73	14.25	7.27	0.90	0.87	9.51E-03	0.08	1,003.1	0.13	0.03	1,015.0
Kings County, NY	23.25	592.60	63.39	9.92	9.62	17.02	2.17	31,131.5	0.50	1.42	31,565.5
Queens County, NY	0.52	10.28	5.18	0.63	0.61	0.09	0.05	728.4	0.09	0.02	737.1
Monmouth County, NJ	0.46	9.19	4.66	0.57	0.55	0.08	0.05	645.4	0.08	0.02	653.1
Nassau County, NY	4.82	114.39	31.29	3.80	3.69	1.95	0.47	6,740.3	0.49	0.25	6,828.3
Inside OCS radius	370.39	9,190.24	1,742.63	231.23	224.29	218.99	34.41	491,741	24.71	20.99	498,498
TOTAL	423.37	10,457.81	2,003.71	266.58	258.58	246.72	39.49	563,076	28.36	23.89	570,788

Year 4

Year 4											
Emissions by geographic area	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH₄	N ₂ O	CO ₂ e
Texas state waters	5.28E-03	0.14	1.16E-02	1.96E-03	1.90E-03	4.19E-03	4.67E-04	6.8	4.23E-05	3.28E-04	6.9
Virginia state waters	0.35	9.35	0.78	0.13	0.13	0.28	0.03	457.4	2.83E-03	0.02	464.0
Non-OCS federal waters	3.29	86.89	7.24	1.22	1.18	2.61	0.29	4,253.1	0.03	0.20	4,314.6
Albany County, NY	0.10	2.00	1.02	0.13	0.12	1.33E-03	1.08E-02	140.8	0.02	4.08E-03	142.4
Greene County, NY	0.56	10.93	5.58	0.69	0.67	7.30E-03	0.06	769.9	0.10	0.02	779.0
Ulster County, NY	0.82	16.14	8.23	1.02	0.99	1.08E-02	0.09	1,136.2	0.15	0.03	1,149.7
Orange County, NY	0.44	8.67	4.42	0.55	0.53	5.79E-03	0.05	610.5	0.08	0.02	617.7
Rockland County, NY	0.53	10.40	5.31	0.66	0.64	6.94E-03	0.06	732.6	0.10	0.02	741.3
Bergen County, NJ	0.31	6.12	3.12	0.39	0.37	4.08E-03	0.03	430.7	0.06	1.25E-02	435.8
Hudson County, NJ	0.18	3.61	1.84	0.23	0.22	2.41E-03	0.02	254.4	0.03	7.37E-03	257.4
Rensselaer County, NY	0.10	1.90	0.97	0.12	0.12	1.27E-03	1.02E-02	134.0	0.02	3.88E-03	135.6
Columbia County, NY	0.64	12.52	6.39	0.79	0.76	8.36E-03	0.07	881.8	0.12	0.03	892.3
Dutchess County, NY	0.98	19.22	9.81	1.21	1.17	1.28E-02	0.10	1,353.2	0.18	0.04	1,369.3
Putnam County, NY	0.20	3.95	2.02	0.25	0.24	2.64E-03	0.02	278.1	0.04	8.06E-03	281.4
Westchester County, NY	0.66	13.01	6.64	0.82	0.79	8.68E-03	0.07	915.7	0.12	0.03	926.6
Bronx County, NY	0.05	1.06	0.54	0.07	0.06	7.07E-04	0.01	74.6	9.73E-03	2.16E-03	75.5
New York County, NY	0.32	6.21	3.17	0.39	0.38	4.15E-03	0.03	437.5	0.06	1.27E-02	442.7
Kings County, NY	8.59	214.45	25.33	3.86	3.74	5.98	0.83	11,777.5	0.24	0.52	11,938.3
Queens County, NY	0.42	9.43	3.15	0.39	0.38	0.15	0.04	583.7	0.05	0.02	591.2
Monmouth County, NJ	0.38	8.46	2.83	0.35	0.34	0.13	0.04	520.8	0.05	0.02	527.5
Nassau County, NY	0.89	21.31	10.81	1.03	1.00	0.02	0.09	1,514.7	0.20	0.04	1,532.7
Inside OCS radius	253.81	6,278.76	1,224.72	160.46	155.65	143.88	23.70	340,169	17.00	14.28	344,810
TOTAL	273.63	6,744.54	1,333.93	174.74	169.50	153.14	25.65	367,432	18.62	15.34	372,431

Phase 2 Summary 7 of 66 Empire AQ emissions 04-14-21.xlsx

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Emission Summary

Year 5

Emissions by geographic area	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N ₂ O	CO₂e
Texas state waters	0	0	0	0	0	0	0	0	0	0	0
Virginia state waters	0	0	0	0	0	0	0	0	0	0	0
Non-OCS federal waters	0	0	0	0	0	0	0	0	0	0	0
Albany County, NY	0.18	3.54	1.81	0.22	0.21	2.36E-03	0.02	249.5	0.03	7.23E-03	252.4
Greene County, NY	0.39	7.73	3.95	0.48	0.47	5.16E-03	0.04	544.5	0.07	0.02	551.0
Ulster County, NY	0.58	11.41	5.82	0.71	0.69	7.61E-03	0.06	803.5	0.10	0.02	813.1
Orange County, NY	0.31	6.13	3.13	0.38	0.37	4.09E-03	0.03	431.8	0.06	1.25E-02	436.9
Rockland County, NY	0.37	7.36	3.75	0.46	0.44	4.91E-03	0.04	518.1	0.07	0.02	524.3
Bergen County, NJ	0.22	4.33	2.21	0.27	0.26	2.89E-03	0.02	304.6	0.04	8.83E-03	308.3
Hudson County, NJ	0.13	2.56	1.30	0.16	0.15	1.70E-03	1.37E-02	179.9	0.02	5.21E-03	182.0
Rensselaer County, NY	0.18	3.47	1.77	0.22	0.21	2.32E-03	0.02	244.7	0.03	7.09E-03	247.6
Columbia County, NY	0.45	8.86	4.52	0.55	0.53	5.91E-03	0.05	623.6	0.08	0.02	631.1
Dutchess County, NY	0.69	13.59	6.94	0.85	0.82	9.07E-03	0.07	957.1	0.12	0.03	968.4
Putnam County, NY	0.14	2.79	1.43	0.17	0.17	1.86E-03	1.49E-02	196.7	0.03	5.70E-03	199.0
Westchester County, NY	0.46	9.20	4.69	0.57	0.56	6.14E-03	0.05	647.6	0.08	0.02	655.3
Bronx County, NY	0.04	0.75	0.38	0.05	0.05	5.00E-04	4.01E-03	52.8	6.88E-03	1.53E-03	53.4
New York County, NY	0.22	4.39	2.24	0.27	0.27	2.93E-03	0.02	309.4	0.04	8.97E-03	313.1
Kings County, NY	2.44	46.56	10.87	1.45	1.41	0.92	0.19	2,630.4	0.16	0.10	2,665.5
Queens County, NY	0.80	19.46	4.96	0.59	0.57	0.36	0.08	1,124.8	0.08	0.04	1,139.6
Monmouth County, NJ	0.71	17.49	4.46	0.53	0.51	0.32	0.07	1,007.2	0.07	0.04	1,020.5
Nassau County, NY	0.27	2.02	1.16	0.07	0.07	1.24E-02	2.57E-03	261.6	1.02E-02	2.93E-03	1,092.1
Inside OCS radius	137.00	3,285.21	837.12	102.29	99.23	60.34	13.13	189,176	12.60	7.31	194,786
TOTAL	145.57	3,456.87	902.52	110.29	106.98	62.00	13.93	200,264	13.70	7.68	206,840

Year 6 Onward (O&M)

Emissions by geographic area	VOC	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH₄	N ₂ O	CO ₂ e
Kings County, NY	0.18	5.22	2.59	0.16	0.16	6.03E-03	0.02	442.6	0.05	1.26E-02	447.5
Queens County, NY	0.06	1.93	0.97	0.06	0.06	2.13E-03	5.97E-03	135.2	0.02	3.94E-03	136.8
Monmouth County, NJ	0.05	1.74	0.87	0.05	0.05	1.92E-03	5.37E-03	121.7	0.02	3.55E-03	123.1
Nassau County, NY	0.26	1.85	1.16	0.07	0.06	2.18E-03	2.24E-03	229.5	9.31E-03	1.86E-03	1,059.7
Inside OCS radius	19.38	500.07	163.37	15.32	14.86	6.75	1.86	30,672	2.65	1.09	34,178
TOTAL	19.93	510.81	168.97	15.66	15.19	6.77	1.89	31,601	2.74	1.11	35,945

Phase 2 Summary 8 of 66 Empire AQ emissions 04-14-21.xlsx

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Cobra GBS Design)

																							Total Em	nissions (Non-	Transit)				
	No. of	1. DP		Dimensions (ft)	Emission Factor	Engine Fuel	Assumed fuel	Assumed fuel	Transit Round	Transit Duration	Non-OCS Operating	OCS Operating	Non-Transit Operating	Non-Transit Total Operatin		Non-Transit Average	Transit Fuel Usage	Non-Transit Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	СН₄	N ₂ O	CO₂e
Vessels/Equipment	Engines		ed le	ength x width x depth (draft)	Used (see EFs worksheet)	Rating Type (hp)	rate (kg per vessel per day)	density (kg/gal)	Trips	(hrs/round trip)	Days	Days	Hours (hrs/day)	Hours (hrs)	load (%)	load (%)	Gallons (per vessel)	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
Helicopter - Twin-Engine Heavy		N/A			worksneet)																								
Main	Engines 2				164	1,400 Jet fuel	N/A	N/A	76	0.5					100%	0%	11.960		0	0	0	0	0	0	0	0	0	0	l i
Heavy Lift Vessel - Foundation Pillars (from VA)	Eligilles 2	1	715	5 x 184 x 41 (32)	104	1,400 Jet luei	IN/F	N/A	70	0.5	,	,	, .		100%	0%	11,900	, ,	U	U	U	U	U	U	U	U	U	U	
-Main	Engines 4			` '	3	9,651 Diesel	50,000	3.18	20	59	100) (24	2,400	37%	37%	773,061	1,572,327	14.09	371.90	30.99	5.22	5.06	11.18	1.24	18,203.04	0.11	0.87	18,466.14
Heavy Lift Vessel - Foundation installation	Engines 6	1	663	1 x 290 x 162 (43)	3	6,568 Diesel	80,000	3.18	1			188	2/	4,512	29%	29%	6,289	4,729,560	21.33	563.18	46.93	7.91	7.67	16.93	1.88	27,564.90	0.17	1.32	27,963.30
	Engines 4				3	6,032 Diesel	80,000	3.16	1		5	188		4,512		29%		4,723,300	13.06	344.80	28.73	4.84	4.70		1.15	,	0.10		
-Main	Engines 2				3	7,373 Diesel			1	. (5 (188	3 24	4,512		29%			7.98	210.71	17.56	2.96	2.87	6.33	0.70		0.06		
Heavy Lift Vessel - TP installation	Engines 6	1	600	0 x 154 x 60 (44)	•	4,500 Diesel	E0.000	3.18	1			265		6.360	53%	53%	3,931	4,166,667	37.33	985.55	82.13	13.83	13.42	29.63	3.30	48,238.07	0.30	2.31	48,935.27
Fall Pipe Vessel - Seabed filter layer	Engines 6	1	520	0 x 118 x 44 (31)	3	4,500 Diesei	50,000	3.18	1			203	24	0,300	55%	55%	3,931	4,166,667	37.33	985.55	82.13	13.83	13.42	29.03	3.30	48,238.07	0.30	2.31	48,935.27
-Main Ger				` '	3	6,032 Diesel	50,000	3.18	80	0	5	268		6,432		72%		4,213,836	34.40	908.03	75.67	12.75	12.36	27.29	3.04	44,444.04	0.28	2.13	45,086.40
-Aux. Ge					2 1	1,609 Diesel 660 Diesel			80		5	268	24	6,432	72%				3.06	59.92	30.57	3.79	3.67	0.04	0.32	4,219.14	0.55	0.12	4,269.34
-Emergency Ge Fall Pipe Vessel - Solid ballast	enerator 1	1	520	0 x 118 x 44 (31)	1	bou Diesei			U	'	, ,	, ,	, .		0%	0%			U	U	U	U	U	U	U	0	U	U	
-Main Ger	nerators 3	_			3	6,032 Diesel	50,000	3.18	80		5	170		4,080	72%	72%	314,465	2,672,956	21.82	575.99	48.00	8.09	7.84	17.31	1.93	28,192.11	0.17	1.35	
-Aux. Ge					2	1,609 Diesel			80		5	170	24	4,080		72%			1.94	38.01	19.39	2.40	2.33	0.03	0.21	2,676.32	0.35	0.08	2,708.16
-Emergency Ge Fall Pipe Vessel - Scour protection	enerator 1	1	520	0 x 118 x 44 (31)	1	660 Diesel			Ü) () () () (C	0%	0%			0	0	0	0	0	0	0	0	0	0	
-Main Ger	nerators 3	1	320	0 x 110 x 44 (31)	3	6,032 Diesel	50,000	3.18	80		5	268	24	6,432	72%	72%	314,465	4,213,836	34.40	908.03	75.67	12.75	12.36	27.29	3.04	44,444.04	0.28	2.13	45,086.40
-Aux. Ge					2	1,609 Diesel			80) (5	268	3 24	6,432					3.06	59.92	30.57	3.79	3.67	0.04	0.32	4,219.14	0.55	0.12	4,269.34
-Emergency Ge	enerator 1	N/A	1.44	6 v 46 v 35 /31\	1	660 Diesel			0) () () (0	C	0%	0%			0	0	0	0	0	0	0	0	0	0	
Tug 1 for GBS Bases (from Coeymans) -Main	Engines 2	N/A	140	6 x 46 x 25 (21)	2	5,440 Diesel	10,000	3.18	40	65	5	180	24	4,320	24%	24%	340,671	566,038	4.62	90.48	46.16	5.72	5.55	0.06	0.49	6,370.42	0.83	0.18	6,446.22
-Harbor Ge					1	456 Diesel	,,,,,		0) ()	0	C	0%	0%			0	0	0	0	0	0	0	0	0	0	, ,
-Emergency Ge	enerator 1				1	168 Diesel			0) () () (0	C	0%	0%			0	0	0	0	0	0	0	0	0	0	
Tug 2 for GBS Bases (from Coeymans)	Engines 2	N/A	146	6 x 46 x 25 (21)	2	5,440 Diesel	10,000	3.18	40	65		180	2/	4,320	24%	24%	340,671	566,038	4.62	90.48	46.16	5.72	5.55	0.06	0.49	6,370.42	0.83	0.18	6,446.22
-Harbor Ge					1	456 Diesel	10,000	3.10	0) () 100	0	4,320	0%			300,030	0	0	0.10	0	0	0.00	0.43	0,370.42	0.03	0.10	1 0,440.22
-Emergency Ge	enerator 1				1	168 Diesel			0) () () () (С	0%	0%			0	0	0	0	0	0	0	0	0	0	(
Tug 3 for GBS Bases (from Coeymans)	Farina 2	N/A	146	6 x 46 x 25 (21)	2	5,440 Diesel	10,000	3.18	40	65		180		4 220	24%	240/	340,671	566,030	4.62	00.40	46.16	F 72		0.00	0.40	6,370.42	0.83	0.18	6,446.22
-Main -Harbor Ge	Engines 2 enerator 1				1	456 Diesel	10,000	3.18	40) () 180) 24	4,320	0%	24% 0%	340,671	566,038	4.62	90.48	46.16	5.72	5.55 0	0.06	0.49	0,370.42	0.83	0.18	0,446.22
-Emergency Ge					1	168 Diesel			0) () () (0	C	0%	0%			0	0	0	0	0	0	0	0	0	0	(
Tug 4 for GBS Bases (from Coeymans)	5	N/A	146	6 x 46 x 25 (21)	2	5.440 8:	40.000	2.40	40			100		4 220	2.40/	240/	240.674	566 020	4.60	00.40	45.45	5.70		0.00	0.40	6 270 42	0.00	0.40	
-Main -Harbor Ge	Engines 2				2 1	5,440 Diesel 456 Diesel	10,000	3.18	40) 6:		180) 24	4,320	24%	24% 0%	,-	566,038	4.62	90.48	46.16 0	5.72	5.55	0.06	0.49	6,370.42	0.83	0.18	6,446.22
-Emergency Ge					1	168 Diesel			0					C	0%	0%			0	0	0	0	0	0	0	o	0	0	, (
GBS Base Barge 1				0 x 105 x 25																									1
GBS Base Barge 2	N/A	N/A		0 x 105 x 25	N/A	N/A N/A	(N/A	40	18	3 (180	24	4,320	N/A	N/A	N/A	N/A											
GDS base barge 2	N/A	N/A	400	0 X 103 X 25	N/A	N/A N/A	(N/A	40	18	3	180	24	4,320	N/A	N/A	N/A	N/A											İ
Tug 1 for Transition Pieces (from Albany)		N/A	146	6 x 46 x 25 (21)																									1
	Engines 2				2	5,440 Diesel	10,000	3.18	8	69		365	24	8,760	24%	24% 0%		1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
-Harbor Ge -Emergency Ge					1	456 Diesel 168 Diesel			0						0%	0%			0	0	0	0	0	0	0	0	0	0	
Tug 2 for Transition Pieces (from Albany)		N/A	146	6 x 46 x 25 (21)	·	300 3.000															,						-		-
	Engines 2				2	5,440 Diesel	10,000	3.18	8	69		365	24	8,760				1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
-Harbor Ge -Emergency Ge					1	456 Diesel 168 Diesel			0						0%	0% 0%			0	0	0	0	0	0	0	0	0	0	i (
Transition Piece Barge			400	0 x 105 x 25		100 Die361				,	,		,		0/6	0/6			0	0	Ü	0	0	0	Ü	3	U	0	
	N/A	N/A			N/A	N/A N/A	(N/A	8	69) (365	24	8,760	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1	Engines 2	N/A	65	x 17 x 5	1	1,000 Diesel	4,000	3.18	52		,	365	24	8,760	51%	51%	24,528	459,119	1.97	71.47	36.47	1.88	1.83	0.05	0.20	5,032.21	0.66	0.15	5,092.08
-Main Ger					1	27 Diesel	4,000	3.18	52			365		8,760		51%		433,119	0.05	1.92	0.98	0.05	0.05		5.30E-03	134.91	0.02		
Safety Vessel 1		N/A	65	x 17 x 5										-,,,,,															
	Engines 2				1	660 Diesel	5,000	3.18	12 12			365		8,760		95%		573,899	2.43	88.15	44.98	2.32	2.25		0.24	6,206.77	0.81		
-Main Ger	ieracors 2				1	27 Diesel			12		1 (365	24	8,760	95%	95%			0.10 234.19	3.58 5,920.03	1.83 942.33	0.09 128.71	0.09 124.85		9.90E-03	252.12	0.03 11.13		

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Virginia port to local staging area at SBMT: 293.5 nm (30 nm in VA state waters, 250 nm in non-OCS federal waters, and 13.5 nm in NY/NJ state waters)

 Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)

 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:

- 1 round trip to/from overseas port for each heavy lift vessel.

 80 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).

 20 round trips from Virginia port to local staging area at SBMT for GBS pillar supply vessel, based on assumed capacity to transport components for four positions per trip (for 80 total positions).
- 40 round trips to/from Coeymans for each GBS base tow tug (for 80 total positions). 8 round trips to/from Port of Albany for each TP barge tug (for 80 total positions).
- Weekly round trips to/from port for crew transfer vessels.
- Monthly round trips to/from port for safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. CO_2e emission rates use the following carbon equivalence factors: 25 for $CH_{\!\!H}$, and 298 for N_2O .

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Cobra GBS Design)

																							Total	Emissions (Tra	nsit)				
Vessels/Equipment	No. of Engines per vessel	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO ₂ e tons
Helicopter - Twin-Engine Heavy		N/A		worksneetj																									
-Main Engines	2			164	1.400	Jet fuel	N/A	N/A	76	5 0.5		1	0	0	100%	0%	11,960	0	0.05	0.66	0.02	0.02	0.02	0.04	1.31E-03	126.17	3.61E-03	4.18E-03	127.50
Heavy Lift Vessel - Foundation Pillars (from VA)		1	715 x 184 x 41 (32)					,	,	0.5				, ,															
-Main Engines Heavy Lift Vessel - Foundation installation	4	1	661 x 290 x 162 (43)	3	9,651	Diesel	50,000	3.18	20	59	10	0	24	2,400	37%	37%	773,061	1,572,327	6.93	182.85	15.24	2.57	2.49	5.50	0.61	8949.83	5.54E-02	0.43	9,079.19
-Main Engines	6	1	001 X 230 X 102 (43)	3	6,568	Diesel	80,000	3.18	1	1 6	,	188	24	4,512	29%	29%	6,289	4,729,560	0.03	0.75	0.06	1.05E-02	1.02E-02	0.02	2.51E-03	36.66	2.27E-04	1.76E-03	37.19
-Main Engines	4			3		Diesel			1	1 6		188	24	4,512	29%	29%			0.02	0.46	0.04	6.44E-03	6.24E-03		1.53E-03	22.44		1.08E-03	
-Main Engines Heavy Lift Vessel - TP installation	2	1	600 x 154 x 60 (44)	3	7,373	Diesel			1	1 6	1	188	24	4,512	29%	29%			1.06E-02	0.28	0.02	3.93E-03	3.82E-03	8.42E-03	9.37E-04	13.71	8.49E-05	6.58E-04	13.91
-Main Engines	6	-	555 X 15 1 X 55 (11)	3	4,500	Diesel	50,000	3.18	1	1 6		265	24	6,360	53%	53%	3,931	4,166,667	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.17
Fall Pipe Vessel - Seabed filter layer	-	1	520 x 118 x 44 (31)		6.000	8:1	50,000	2.40	00			250	2.4	6 422	720/	720/	244465	4 242 026	2.57	67.76	5.65	0.05	0.00	204	0.22	2246.72	0.00	0.46	2 254 55
-Main Generators -Aux. Generator	3 1			3 2		Diesel Diesel	50,000	3.18	80			268	24	6,432 6,432	72% 72%	72% 72%	314,465	4,213,836	2.57 0.23	67.76 4.47	5.65 2.28	0.95 0.28	0.92 0.27	2.04 2.98E-03	0.23	3316.72 314.86		0.16 9.13E-03	
-Emergency Generator	1			1		Diesel			(0		0 0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Fall Pipe Vessel - Solid ballast	-	1	520 x 118 x 44 (31)		6.000	B: I	50.000	2.40	0.0			470	24	4.000	720/	720/	244 465	2 672 056	2.57	67.76	5.65	0.05	0.00	204	0.22	2246.72	0.00	0.46	2 254 55
-Main Generators -Aux. Generator	1			3 2		Diesel Diesel	50,000	3.18	80			170 170	24	4,080 4,080	72% 72%	72% 72%		2,672,956	2.57 0.23	67.76 4.47	5.65 2.28	0.95 0.28	0.92 0.27		0.23	3316.72 314.86		0.16 9.13E-03	
-Emergency Generator	1			1		Diesel			(0 0	1	0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
Fall Pipe Vessel - Scour protection -Main Generators	2	1	520 x 118 x 44 (31)	3	6.027	Diesel	50,000	3.18	or			268	24	6 422	72%	72%	314,465	4,213,836	2.57	67.76	5.65	0.95	0.92	2.04	0.23	3316.72	0.02	0.16	3,364.66
-Aux. Generator	1			2		Diesel	30,000	5.16	80			268	24	6,432 6,432		72%		4,213,030	0.23	4.47	2.28	0.93	0.92		0.23	314.86		9.13E-03	
-Emergency Generator	1			1		Diesel			(0 0	1	0 0	0	0	0%				0	0	0	0	0	0	0	0	0	0	0
Tug 1 for GBS Bases (from Coeymans)	2	N/A	146 x 46 x 25 (21)	2	5 440	Diesel	10,000	3.18	40	. 65		180	24	4,320	24%	24%	340,671	566,038	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Main Engines -Harbor Generator	1			1		Diesel	10,000	3.16	40			0 0	0	4,320	0%	0%	340,071	300,038	0	0	0	0	3.34	0.04	0.30	3834.03	0.30	0.11	3,873.07
-Emergency Generator	1			1	168	Diesel			() (1	0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
Tug 2 for GBS Bases (from Coeymans) -Main Engines	2	N/A	146 x 46 x 25 (21)	2	5 440	Diesel	10,000	3.18	40	n 65		180	24	4,320	24%	24%	340,671	566,038	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor Generator	1			1		Diesel	10,000	3.16	40	0		0 0	0	4,320	0%	0%	340,071	300,038	0	0	0	0	3.34	0.04	0.30	3834.03	0.30	0.11	0
-Emergency Generator	1			1	168	Diesel			() (1	0 0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 3 for GBS Bases (from Coeymans) -Main Engines	2	N/A	146 x 46 x 25 (21)	2	5.440	Diesel	10,000	3.18	40	n 65		180	24	4,320	24%	24%	340,671	566,038	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor Generator	1			1		Diesel	10,000	5.10	(0		0 0	0	0	0%	0%	340,071	300,030	0	0	0	0	0.54	0.04	0.50	0	0.50	0.11	3,073.07
-Emergency Generator	1			1	168	Diesel			() (1	0 0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
Tug 4 for GBS Bases (from Coeymans) -Main Engines	2	N/A	146 x 46 x 25 (21)	2	5 440	Diesel	10,000	3.18	40) 65		180	24	4,320	24%	24%	340,671	566,038	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor Generator	1			1		Diesel	10,000	5.10	(0		0 0	0	0	0%	0%	340,071	300,030	0	0	0	0	0.54	0.04	0.50	0	0.50	0.11	0,075.07
-Emergency Generator	1			1	168	Diesel			(0 0	1	0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
GBS Base Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	40	18		180	24	4,320	N/A	N/A	N/A	N/A											, !
GBS Base Barge 2		,	400 x 105 x 25	1471	,	,		,,,		- 10		100		1,520	.,,,,	.,,,,	,	.,,,,											
	N/A	N/A	446 46 25 (24)	N/A	N/A	N/A	0	N/A	40	18	1	180	24	4,320	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany) -Main Engines	2	N/A	146 x 46 x 25 (21)	2	5.440	Diesel	10,000	3.18	8	8 69		365	24	8,760	24%	24%	72,327	1,147,799	0.59	11.56	5.90	0.73	0.71	0.01	0.06	814.00	0.11	0.02	823.68
-Harbor Generator	1			1	456	Diesel		5.25	(0 0		0	0	0	0%	0%	,	_, ,	0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	1	N1/A	146 46 25 (24)	1	168	Diesel			(0 0	1	0	0	0	0%	0%			0	0	0	0		0	0	0	0	0	0
Tug 2 for Transition Pieces (from Albany) -Main Engines	2	N/A	146 x 46 x 25 (21)	2	5,440	Diesel	10,000	3.18	8	8 69		365	24	8,760	24%	24%	72,327	1,147,799	0.59	11.56	5.90	0.73	0.71	0.01	0.06	814.00	0.11	0.02	823.68
-Harbor Generator	1			1	456	Diesel			(0		0	0	0	0%	0%	,	, , ,	0	0	0	0	C	0	0	0	0	0	0
-Emergency Generator	1		400 × 105 × 25	1	168	Diesel			(0 0	1	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Transition Piece Barge	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	8	8 69		365	24	8,760	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1	· ·	N/A	65 x 17 x 5					,,																					
-Main Engines	2			1		Diesel	4,000	3.18	52	2 9	1 :	365	24	8,760 8,760	51% 51%	51% 51%	24,528	459,119	0.11 2.82E-03	3.82 0.10	1.95 0.05	0.10 2.70E-03	0.10 2.61E-03		1.06E-02 2.83E-04	268.84 7.21	0.04 9.40E-04	7.79E-03 2.09E-04	
-Main Generators Safety Vessel 1	2	N/A	65 x 17 x 5	1	21	Diesel			52	2 9	1	305	24	8,760	51%	51%	1		2.82E-U3	0.10	0.05	2./UE-U3	2.01E-U3	0.835-05	2.83E-04	7.21	9.40E-04	2.U9E-U4	7.29
-Main Engines	2			1		Diesel	5,000	3.18	12			365	24	8,760	95%	95%		573,899	0.03	1.09	0.55	0.03	0.03		3.01E-03	76.52		2.22E-03	
-Main Generators	2	1		1	27	Diesel			12	2 9		365	24	8,760	95%	95%			1.22E-03	0.04 648.63	0.02	1.16E-03	1.13E-03	2.95E-05	1.22E-04	3.11	4.05E-04 2.50	9.01E-05 1.45	

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Virginia port to local staging area at SBMT: 293.5 nm (30 nm in VA state waters, 250 nm in non-OCS federal waters, and 13.5 nm in NY/NJ state waters)

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- 3. The number of transits for each vessel are based on the following assumptions:

- 1 round trip to/from overseas port for each heavy lift vessel.

 80 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).

 20 round trips from Virginia port to local staging area at SBMT for GBS pillar supply vessel, based on assumed capacity to transport components for four positions per trip (for 80 total positions).
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- Monthly round trips to/from port for safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. CO_2e emission rates use the following carbon equivalence factors: 25 for CH, and 298 for N_2O .

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Aker GBS Design, Lift-Install Option)

																						Total Em	nissions (Non-1	Transit)				
Vessels/Equipment	No. of Engine per vess		Dimensions (ft) d length x width x dep (draft)	Emission Factor oth Used (see EFs worksheet)	Engine Fuel Rating Type (hp)	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)			Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N ₂ O tons	CO₂e tons
Helicopter - Twin-Engine Heavy		N/A		worksneety																								
-Main	Engines 2			164	1,400 Jet fuel	N/A	A N/A	76	5 0.	5	0 0	0	0	100%	0%	11,960	0	0	0	0	0	0	0	0	О	0	0	(
Heavy Lift Vessel - Foundation installation		1	661 x 290 x 162 (43)																									
-Main -Main				3	6,568 Diesel 6,032 Diesel	80,000	0 3.18	1	1	6	0 188 0 188		4 4,512 4 4,512		29% 29%		4,729,560	21.33 13.06	563.18 344.80	46.93 28.73	7.91 4.84	7.67 4.70		1.88 1.15		0.17 0.10	1.32 0.81	27,963.30 17,120.39
-Main -Main				3	7,373 Diesel			1	1	6	0 188							7.98		28.73 17.56	2.96	2.87		0.70		0.10		
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																						·			
-Main Fall Pipe Vessel - Seabed filter layer	ingines 6	1	520 x 118 x 44 (31)	3	4,500 Diesel	50,000	0 3.18	1	1	6	0 265	5 2	4 6,360	53%	53%	3,931	4,166,667	37.33	985.55	82.13	13.83	13.42	29.63	3.30	48,238.07	0.30	2.31	48,935.27
-Main Gen	erators 3	1	320 X 118 X 44 (31)	3	6,032 Diesel	50,000	0 3.18	80	0	6	0 268	3 2	4 6,432	72%	72%	314,465	4,213,836	34.40	908.03	75.67	12.75	12.36	27.29	3.04	44,444.04	0.28	2.13	45,086.40
-Aux. Ge				2	1,609 Diesel			80	0	6	0 268	3 2	4 6,432		72%			3.06	59.92	30.57	3.79	3.67	0.04	0.32	4,219.14	0.55	0.12	4,269.34
-Emergency Ge	nerator 1	1	520 110 11 (21)	1	660 Diesel			C	0	0	0 (0	0 (0%	0%	ó		0	0	0	0	0	0	0	0	- 0	0	(
Fall Pipe Vessel - Solid ballast -Main Gen	erators 3	1	520 x 118 x 44 (31)	3	6,032 Diesel	50,000	0 3.18	80	0	6	0 170	2	4 4,080	72%	72%	314,465	2,672,956	21.82	575.99	48.00	8.09	7.84	17.31	1.93	28,192.11	0.17	1.35	28,599.58
-Aux. Ge				2	1,609 Diesel	33,533	-	80		6	0 170	2	4 4,080	72%	72%		_,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1.94		19.39		2.33		0.21		0.35		
-Emergency Ge	nerator 1			1	660 Diesel			C)	0	0 (0	0 (0%	0%	6		0	0	0	0	0	0	0	0	0	0	(
Fall Pipe Vessel - Scour protection -Main Gen	orator 3	1	520 x 118 x 44 (31)	2	6,032 Diesel	50,000	0 3.18	0.0	2	c	0 268	2 2	4 6,432	72%	72%	314,465	4,213,836	34.40	908.03	75.67	12.75	12.26	27.29	3.04	44,444.04	0.28	2 12	45,086.40
-Aux. Ge				2	1,609 Diesel	50,000	5.10	80	2	6	0 268						4,213,636	3.06		30.57	12.75 3.79	12.36 3.67		0.32		0.55	2.13 0.12	
-Emergency Ge				1	660 Diesel			0	5	0	0 0	5	0 (0%				0	0	0	0	0	0	0	0	0	0	,,(
Tug 1 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main				2	5,440 Diesel 456 Diesel	10,000	3.18	40	5 6	5	0 180	2	4 4,320		24% 0%		566,038	4.62	90.48	46.16	5.72	5.55	0.06	0.49	6,370.42	0.83	0.18	6,446.22
-Harbor Ge -Emergency Ge				1	168 Diesel				0	0	0 0	0	0	0%				0	0	0	0	0	ا ا	0	. 0	0	0	
Tug 2 for GBS Tow		N/A	146 x 46 x 25 (21)							-								_	-									
-Main				2	5,440 Diesel	10,000	3.18	40	6	5	0 180	2	4 4,320				566,038	4.62	90.48	46.16	5.72	5.55	0.06	0.49	6,370.42	0.83	0.18	6,446.22
-Harbor Ge				1	456 Diesel 168 Diesel			C	0	0	0 0	0	0	0%				0	0	0	0	0	0	0	0	0	0	(
-Emergency Ge Tug 3 for GBS Tow	nerator 1	N/A	146 x 46 x 25 (21)	1	108 Diesei				J	U	0 (J	0 (0%	0%	0		U	U	U	U	U		- 0		- 0	U	
	Engines 2	,		2	5,440 Diesel	10,000	0 3.18	40	6	5	0 180	2	4,320	24%	24%	340,671	566,038	4.62	90.48	46.16	5.72	5.55	0.06	0.49	6,370.42	0.83	0.18	6,446.22
-Harbor Ge				1	456 Diesel			C	0	0	0 (0	0	0%				0	0	0	0	0	0	0	0	0	0	(
-Emergency Ge	nerator 1	NI/A	146 46 25 (21)	1	168 Diesel			C	0	0	0 (0	0 (0%	0%	ó		0	0	0	0	0	0	0	0	- 0	0	(
Tug 4 for GBS Tow -Main	ngines 2	N/A	146 x 46 x 25 (21)	2	5,440 Diesel	10,000	0 3.18	40	0 6	5	0 180	2	4 4,320	24%	24%	340,671	566,038	4.62	90.48	46.16	5.72	5.55	0.06	0.49	6,370.42	0.83	0.18	6,446.22
-Harbor Ge				1	456 Diesel	10,000	5.20		5	0	0 0	5	0 1,520	0%			300,030	0	0	0	0	0	0.00	0	0,576.12	0.00	0.10	0,110.22
-Emergency Ge	nerator 1			1	168 Diesel			C	0	0	0 (0	0 (0%	0%	6		0	0	0	0	0	0	0	0	0	0	(
Tug 1 for Ballast Barge		N/A	136 x 36 x 19 (17)		3 500 8:1	40.000	2.40						4 22	250/	250		566.000	4.50	20.45	44.00		F 40		0.40	6 206 62	0.04	0.40	6 200 46
-Main -Aux.				2	3,600 Diesel 95 Diesel	10,000	0 3.18	40		8	0 180 0 180		4 4,320 4 4,320		35% 35%	. ,	566,038	4.50 0.06	88.15 2.33	44.98 1.19	5.57 0.06	5.40 0.06	0.06 1.55E-03	0.48 6.43E-03	6,206.63 163.79	0.81 0.02	0.18 4.75E-03	6,280.48 165.73
Tug 2 for Ballast Barge	-iigiiies - L	N/A	136 x 36 x 19 (17)	-	33 516361				-		100	_	,52.	3370	337			0.00	2.55	1.13	0.00	0.00	1.552 05	0.152 05	105.75	0.02	11752 05	105.75
-Main				2	3,600 Diesel	10,000	3.18	40	1	8	0 180		4 4,320		35%		566,038	4.50	88.15	44.98	5.57	5.40		0.48	6,206.63	0.81	0.18	6,280.48
-Aux.	Engines 2		400 405 25	1	95 Diesel			40) 1	8	0 180) 2	4 4,320	35%	35%	ó		0.06	2.33	1.19	0.06	0.06	1.55E-03	6.43E-03	163.79	0.02	4.75E-03	165.73
GBS Ballast Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A N/A		0 N/A	40	1	8	0 180	2	4 4,320	N/A	N/A	N/A	N/A											
GBS Ballast Barge 2	.,,,	.,,,	400 x 105 x 25		.,	1					100	1	.,520	.41	,,,	,										$\overline{}$		
	N/A	N/A		N/A	N/A N/A	(0 N/A	40) 1	8	0 180	2	4 4,320	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany)	Engines 3	N/A	146 x 46 x 25 (21)	2	5,440 Diesel	10,000	0 3.18		R 6	0	0 365	,	4 8,760	24%	24%	72,327	1,147,799	9.36	183.47	93.61	11 50	11 34	0.13	0.99	12,917.80	1.68	0.37	13,071.50
-Main -Harbor Ge				1	456 Diesel	10,000	3.18	Č		0	0 0	o ź	0 0,760	0 0%	0%		1,147,799	9.36	103.47	10.66	11.59 0	11.24 0	0.12	0.99	12,917.00	0	0.37	15,0/1.50
-Emergency Ge				1	168 Diesel			C	0	0	0 0	0	0	0%	0%	6		0	Ó	0	0	0	0	0	0	0	0	(
Tug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)		5.446											,			4						42.047.55			40.000
-Main -Harbor Ge				2	5,440 Diesel 456 Diesel	10,000	0 3.18	8	s 6	0	0 365	2	4 8,760	24%	24% 0%		1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
-Emergency Ge				1	168 Diesel			0	ő	0	o c	ő	o o	0%				0	0	0	0	0	0	0	ő	0	0	
Transition Piece Barge			400 x 105 x 25																									
O. T. G. W. o.ld	N/A	N/A	65 47 5	N/A	N/A N/A	(0 N/A	8	8 6	9	0 365	5 2	4 8,760	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1 -Main	ngines 2	N/A	65 x 17 x 5	1	1,000 Diesel	4,000	0 3.18	52	,	9	0 365	,	4 8,760	51%	51%	24,528	459,119	1.97	71.47	36.47	1.88	1.83	0.05	0.20	5,032.21	0.66	0.15	5,092.08
-Main Gen				1	27 Diesel	4,000	3.16	52		9	0 365						.55,119	0.05		0.98		0.05				0.00		
Safety Vessel 1		N/A	65 x 17 x 5																									
-Main	Engines 2		Ì	1	660 Diesel	5,000	0 3.18	12	2	9	0 365		4 8,760	95%	95%	7,075	573,899	2.43	88.15	44.98	2.32	2.25	0.06	0.24	6,206.77	0.81	0.18	
-Main Gen				-	27 Diesel						0 365		4 8,760	95%	95%	,	1	0.10	3 58	1.83	0.09	0.09	2.39E-03	9.90E-03	252.12	0.03	7.31E-03	

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for each heavy lift vessel.

 80 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
- 40 round trips to/from Coeymans for each GBS tow tug (for 80 total positions).
 40 round trips to/from SBMT for each ballast barge tug (for 80 total positions).
 8 round trips to/from Port of Albany for each TP barge tug (for 80 total positions).
- Weekly round trips to/from port for crew transfer vessels. Monthly round trips to/from port for safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.
 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂ and 298 for N₂O.

EW 1 GBS Aker 1 11 of 66

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Aker GBS Design, Lift-Install Option)

																							Total	Emissions (Tra	ınsit)				
Vessels/Equipment	No. o Engin per ve:			Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Fuel Rating Type (hp)	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operatin Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N ₂ O tons	CO₂e tons
Helicopter - Twin-Engine Heavy		N/	Ά		worksneet)																								
-Mai	Engines 2				164	1,400 Jet fuel	N/A	N/A	76	0.	5	0		0	100%	0%	11,960	0	0.05	0.66	0.02	0.02	0.02	0.04	1.31E-03	126.17	3.61E-03	4.18E-03	127.50
Heavy Lift Vessel - Foundation installation		1	. 6	561 x 290 x 162 (43)						_																			
	Engines 6 Engines 4				3	6,568 Diesel 6,032 Diesel	80,000	3.18	:	1	6	188		4,512 4,512		29% 29%		4,729,560	0.03	0.75 0.46	0.06 0.04	1.05E-02 6.44E-03	1.02E-02 6.24E-03	0.02 1.38E-02	2.51E-03 1.53E-03	36.66 22.44	2.27E-04 1.39E-04	1.76E-03 1.08E-03	37.19 22.7
	Engines 2				3	7,373 Diesel				1	6	188				29%			1.06E-02	0.28	0.02	3.93E-03	3.82E-03		9.37E-04	13.71	8.49E-05	6.58E-04	13.9
Heavy Lift Vessel - TP installation		1	. 6	600 x 154 x 60 (44)																									
-Mai Fall Pipe Vessel - Seabed filter layer	Engines 6	1		520 x 118 x 44 (31)	3	4,500 Diesel	50,000	3.18		l .	6	265	24	6,360	53%	53%	3,931	4,166,667	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.17
-Main G	nerators 3	,	·	320 X 118 X 44 (31)	3	6,032 Diesel	50,000	3.18	80)	6	268	24	6,432	72%	72%	314,465	4,213,836	2.57	67.76	5.65	0.95	0.92	2.04	0.23	3316.72	0.02	0.16	3,364.66
-Aux. G	enerator 1				2	1,609 Diesel			80)	6	268		6,432		72%			0.23	4.47	2.28	0.28	0.27	2.98E-03	0.02	314.86	0.04	9.13E-03	
-Emergency (enerator 1			-20 440 44 (24)	1	660 Diesel			()	0	0	(0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
Fall Pipe Vessel - Solid ballast -Main G	nerators 3	1		520 x 118 x 44 (31)	3	6,032 Diesel	50,000	3.18	80)	6	170	24	4,080	72%	72%	314,465	2,672,956	2.57	67.76	5.65	0.95	0.92	2.04	0.23	3316.72	0.02	0.16	3,364.66
	enerator 1				2	1,609 Diesel	30,000	3.10	80		6	170	24	4,080		72%		2,072,330	0.23	4.47	2.28	0.28	0.27		0.02	314.86	0.02		
-Emergency C	enerator 1				1	660 Diesel			()	0	0	(0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Fall Pipe Vessel - Scour protection		1	. 5	520 x 118 x 44 (31)	2	6.022 811	50.000	240				250		6 422	720/	720/	244.465	4 242 026	2.57	67.76	5.65	0.05	0.00	204	0.22	2246 72	0.00	0.46	2 264 66
-Main G	enerator 1				2	6,032 Diesel 1,609 Diesel	50,000	3.18	80	ו	6	268		6,432 6,432		72% 72%		4,213,836	2.57 0.23	67.76 4.47	5.65 2.28	0.95 0.28	0.92 0.27	2.04 2.98E-03	0.23 0.02	3316.72 314.86	0.02 0.04	0.16 9.13E-03	3,364.66 318.6
-Emergency C					1	660 Diesel			(Ó	0	0	-	0,132	0%				0.25	0	0	0	0.27	0	0.02	0	0.01	0	510.0
Tug 1 for GBS Tow		N/	'A 1	146 x 46 x 25 (21)																									
	Engines 2				2	5,440 Diesel 456 Diesel	10,000	3.18	40	6	5	180	24	4,320		24%		566,038	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor G -Emergency G					1 1	168 Diesel			(1	0			0	0% 0%				0	0	0	0	0	0	0	0	0	0	
Tug 2 for GBS Tow	circiatoi 2	N/	'A 1	146 x 46 x 25 (21)	-	200 516361									0,0	070	1			-	Ĭ	-		, i					· · · · · · · · · · · · · · · · · · ·
-Mai	Engines 2				2	5,440 Diesel	10,000	3.18	40	6	5	180	24	4,320				566,038	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor G					1	456 Diesel			()	0	0	(0	0%				0	0	0	0	0	0	0	0	0	0	(
-Emergency C Tug 3 for GBS Tow	enerator 1	N/	'Δ 1	146 x 46 x 25 (21)	1	168 Diesel			()	0	0	(0	0%	0%			0	0	0	0	0	0	0	0	0	0	
	Engines 2	14/	^	140 % 40 % 25 (21)	2	5,440 Diesel	10,000	3.18	40	6	5	180	24	4,320	24%	24%	340,671	566,038	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor G	enerator 1				1	456 Diesel			()	0	0	(0	0%				0	0	0	0	0	0	0	0	0	0	
-Emergency (enerator 1			145 45 25 (24)	1	168 Diesel			()	0	0	(0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
Tug 4 for GBS Tow	Engines 2	N/	Α 1	146 x 46 x 25 (21)	2	5,440 Diesel	10,000	3.18	40	6	5	180	2/	4,320	24%	24%	340,671	566,038	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor G					1	456 Diesel	10,000	3.10	(0	0	-	0	0%			300,030	0	0	0	0	0	0.04	0.50	0	0.50	0.11	3,073.01
-Emergency C					1	168 Diesel			()	0	0	(0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Tug 1 for Ballast Barge	5	N/	'A 1	136 x 36 x 19 (17)		2 500 8:	40.000	2.40				400		4 220	250/	250/	04.240	566 000	0.75	44.50	7.50	0.00	0.00	0.005.00	0.00	402444	0.43	0.00	4.046.7
	Engines 2 Engines 2				2	3,600 Diesel 95 Diesel	10,000	3.18	40		8	180		4,320 4,320		35% 35%	. ,	566,038	0.75 1.07E-02	14.69 0.39	7.50 0.20	0.93 1.02E-02	0.90 9.90E-03	9.80E-03 2.59E-04	0.08 1.07E-03	1034.44 27.30	0.13 3.56E-03	0.03 7.91E-04	1,046.75 27.62
Tug 2 for Ballast Barge	Eligines 2	N/	'A 1	136 x 36 x 19 (17)	-	33 Diesei				, .		100		7,320	3370	3370			1.072 02	0.55	0.20	1.021 02	J.JOE 03	2.552 04	1.07 £ 03	27.50	3.302 03	7.512 04	27.02
	Engines 2				2	3,600 Diesel	10,000	3.18	40	1	8	180		4,320		35%		566,038	0.75	14.69	7.50	0.93	0.90	9.80E-03	0.08	1034.44	0.13	0.03	1,046.75
	Engines 2			100 105 35	1	95 Diesel			40	1	8	180	24	4,320	35%	35%			1.07E-02	0.39	0.20	1.02E-02	9.90E-03	2.59E-04	1.07E-03	27.30	3.56E-03	7.91E-04	27.62
GBS Ballast Barge 1	N/A	N/		400 x 105 x 25	N/A	N/A N/A	0	N/A	40	1	8	180	24	4,320	N/A	N/A	N/A	N/A											
GBS Ballast Barge 2	1477	,		400 x 105 x 25	,	1977		1477				100	-	1,520	.47.	, / .	.,,,,	1475											
	N/A				N/A	N/A N/A	0	N/A	40	1	8	180	24	4,320	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany)	Engines 3	N/	'A 1	146 x 46 x 25 (21)	2	5,440 Diesel	10,000	3.18		3 6	0	365	2	8,760	24%	24%	72,327	1,147,799	0.59	11.56	5.90	0.73	0.71	0.01	0.06	814.00	0.11	0.02	823.68
-Wai	Engines 2 enerator 1				1	456 Diesel	10,000	3.10	(0	0 0	22	0,760	0%	0%		1,147,799	0.59	0	0.90	0.73	0.71	0.01	0.06	014.00	0.11	0.02	023.00
-Emergency (1	168 Diesel			()	0	0	(0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
Tug 2 for Transition Pieces (from Albany)		N/	'A 1	146 x 46 x 25 (21)																									
-Mai -Harbor G	Engines 2 enerator 1				2 1	5,440 Diesel 456 Diesel	10,000	3.18	8	6	0	365	24	8,760	24% 0%	24% 0%		1,147,799	0.59	11.56	5.90	0.73	0.71	0.01	0.06	814.00	0.11	0.02	823.68
-Emergency C					1	168 Diesel			(0	0		0	0%				0	0	0	0	0	0	0	0	0	0	
Transition Piece Barge				400 x 105 x 25																									
Co. Tours Would	N/A				N/A	N/A N/A	0	N/A	8	3 6	9	365	24	8,760	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1	Engines 2	N/	Ά 6	55 x 17 x 5	1	1,000 Diesel	4,000	3.18	52	,	9	365	2/	8,760	51%	51%	24,528	459,119	0.11	3.82	1.95	0.10	0.10	2.55E-03	1.06E-02	268.84	0.04	7.79E-03	272.04
-Main G					1	27 Diesel	4,300	3.10	52		9	365						.55,115	2.82E-03	0.10	0.05		2.61E-03		2.83E-04	7.21	9.40E-04		7.29
Safety Vessel 1		N/	Ά 6	55 x 17 x 5																									
	Engines 2	1			1	660 Diesel	5,000	3.18	12)	91	365	1 2	8,760	95%	95%	7,075	573,899	0.03	1.09	0.55	0.03	0.03	7.25E-04	3.01E-03	76.52	9.98E-03	2.22E-03	77.43
-Mai -Main G					1	27 Diesel	-,				0	365						373,033	1.22E-03	0.04	0.02	1.16E-03	1.13E-03		1.22E-04	3.11	4.05E-04	9.01E-05	3.1

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for each heavy lift vessel.

 80 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
- 40 round trips to/from Coeymans for each GBS tow tug (for 80 total positions).
 40 round trips to/from SBMT for each ballast barge tug (for 80 total positions).
 8 round trips to/from Port of Albany for each TP barge tug (for 80 total positions).
- Weekly round trips to/from port for crew transfer vessels. Monthly round trips to/from port for safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.
 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂ and 298 for N₂O.

EW 1 GBS Aker 1 12 of 66

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Aker GBS Design, Self-Install Option)

																							Total En	nissions (Non-	Transit)				
Vessels/Equipment	No. o Engine per ves	chored	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Fotal Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH₄ tons	N ₂ O tons	CO ₂ e tons
Helicopter - Twin-Engine Heavy		N/A		Worksheety																									
	-Main Engines 2			164	1.400	Jet fuel	N/A	N/A	76	0.5		0		0	100%	0%	11,960	0	0	0	0	0	0	0	0	0	0	0	0
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)				<i>'</i>	,	,,,	0.5		, ,													Ü				
Fall Pipe Vessel - Seabed filter layer	-Main Engines 6	1	520 x 118 x 44 (31)	3	4,500	Diesel	50,000	3.18	1	6	5	265	24	6,360	53%	53%	3,931	4,166,667	37.33	985.55	82.13	13.83	13.42	29.63	3.30	48,238.07	0.30	2.31	48,935.27
	lain Generators 3	1	320 X 118 X 44 (31)	3	6,032	Diesel	50,000	3.18	80	6	5	268	24	6,432	72%	72%	314,465	4,213,836	34.40	908.03	75.67	12.75	12.36	27.29	3.04	44,444.04	0.28	2.13	45,086.40
	Aux. Generator 1			2		Diesel			80	6	5	268	24	6,432	72%	72%			3.06	59.92	30.57	3.79	3.67	0.04	0.32	4,219.14	0.55	0.12	4,269.34
Fall Pipe Vessel - Solid ballast	ency Generator 1	1	520 x 118 x 44 (31)	1	bbl	Diesel			0	U	'	0	U	0	0%	0%			0	U	0	0	0	0	0	0	U	0	0
-M	lain Generators 3		, ,	3		Diesel	50,000	3.18	80	6	6	170		4,080	72%	72%	314,465	2,672,956		575.99	48.00		7.84	17.31	1.93				
	Aux. Generator 1 ency Generator 1			2		Diesel Diesel			80	6		170	24	4,080	72% 0%	72%			1.94	38.01	19.39	2.40	2.33	0.03	0.21	2,676.32	0.35	0.08	2,708.16
Fall Pipe Vessel - Scour protection	ency deficiation 1	1	520 x 118 x 44 (31)	-							,					070						Ů			Ŭ				
	lain Generators 3 Aux. Generator 1			3 2		Diesel	50,000	3.18	80 80	6	i	268		6,432 6,432	72% 72%	72% 72%		4,213,836	34.40 3.06	908.03 59.92	75.67 30.57		12.36 3.67	27.29 0.04	3.04 0.32	44,444.04			
	Aux. Generator 1 ency Generator 1			1		Diesel Diesel			0	0		0 0	0	0,432	0%	0%			0	0	0.57	3.79 0	0.67	0.04	0.32	4,219.14 0	0.55	0.12	4,269.54
Tug 1 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Ha	-Main Engines 2 rbor Generator 1			2		Diesel Diesel	10,000	3.18	40	65		365	24	8,760 0	24% 0%	24%	340,671	1,147,799	9.36	183.47 0	93.61 0	11.59 0	11.24	0.12	0.99	12,917.80 0	1.68	0.37	13,071.50 0
-Emerg	ency Generator 1			1		Diesel			0	O)	0	O	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 2 for GBS Tow/Installation	-Main Engines 2	N/A	146 x 46 x 25 (21)	2	5.440	Diesel	10,000	3.18	40	65		365	2/	8,760	24%	24%	340,671	1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
-Ha	rbor Generator 1			1		Diesel	10,000	3.10	0	0		0 0	0	0	0%	0%	340,071	1,147,733	0	0	0	0	0	0.12	0.55	0	0	0.57	0
	ency Generator 1		145 45 25 (24)	1	168	Diesel			0	0)	0 0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 3 for GBS Tow/Installation	-Main Engines 2	N/A	146 x 46 x 25 (21)	2	5,440	Diesel	10,000	3.18	40	65	;	365	24	8,760	24%	24%	340,671	1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
	rbor Generator 1			1	456	Diesel	,,,,,		0	C)	0	C	0	0%			, , ,	0	0	0	0	0	0	0	0	0	0	0
-Emergi Tug 4 for GBS Tow/Installation	ency Generator 1	N/A	146 x 46 x 25 (21)	1	168	Diesel			0	0		0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
	-Main Engines 2			2		Diesel	10,000	3.18	40	65	5	365	24	8,760	24%	24%	340,671	1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
	rbor Generator 1 ency Generator 1			1 1		Diesel Diesel			0	0		0	0	0	0% 0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 1 for Ballast Barge	ency denerator 1	N/A	136 x 36 x 19 (17)	1	100	Diesei					,	, ,		U	078	070			U	0		0		U	U		0	0	0
	-Main Engines 2			2		Diesel	10,000	3.18	40	18	3	180		4,320	35%	35%		566,038	4.50	88.15	44.98		5.40	0.06	0.48	6,206.63			
Tug 2 for Ballast Barge	-Aux. Engines 2	N/A	136 x 36 x 19 (17)	1	95	Diesel			40	18		180	24	4,320	35%	35%			0.06	2.33	1.19	0.06	0.06	1.55E-03	6.43E-03	163.79	0.02	4.75E-03	165.73
	-Main Engines 2		, ,	2		Diesel	10,000	3.18	40	-	3	180		4,320	35%	35%	94,340	566,038	4.50	88.15	44.98		5.40	0.06	0.48	6,206.63			
GBS Ballast Barge 1	-Aux. Engines 2		400 x 105 x 25	1	95	Diesel			40	18	3	180	24	4,320	35%	35%			0.06	2.33	1.19	0.06	0.06	1.55E-03	6.43E-03	163.79	0.02	4.75E-03	165.73
	N/A	N/A	100 X 103 X 23	N/A	N/A	N/A	0	N/A	40	18	3	180	24	4,320	N/A	N/A	N/A	N/A											
GBS Ballast Barge 2	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	40	10	,	180	24	4.320	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany)		,	146 x 46 x 25 (21)	N/A	IN/A	IN/A	0	N/A	40	10	'	180	24	4,320	IN/A	N/A	N/A	N/A											
	-Main Engines 2			2		Diesel	10,000	3.18	8	69		365	24	8,760	24% 0%	24%	72,327	1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
	rbor Generator 1 ency Generator 1			1 1		Diesel Diesel			0	0		0 0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)																										
-Ha	-Main Engines 2 rbor Generator 1			2		Diesel Diesel	10,000	3.18	8	69		365	24	8,760 0	24% 0%	24% 0%	72,327	1,147,799	9.36	183.47 0	93.61 0	11.59 0	11.24	0.12	0.99	12,917.80 0	1.68	0.37	13,071.50 0
	ency Generator 1			1		Diesel			0	C)	0	C	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Transition Piece Barge	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	۰	60		365	24	8,760	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1	N/A	 •	65 x 17 x 5	19/75	18/75	IN/A		IN/A		09	'	303	24	5,760	14/74	N/A	IN/A	19/75											
	-Main Engines 2			1		Diesel	4,000	3.18	52	9		365		8,760	51%	51%		459,119	1.97	71.47	36.47		1.83	0.05	0.20	5,032.21			
Safety Vessel 1	lain Generators 2	N/A	65 x 17 x 5	1	27	Diesel			52	9	1	365	24	8,760	51%	51%			0.05	1.92	0.98	0.05	0.05	1.28E-03	5.30E-03	134.91	0.02	3.91E-03	136.52
	-Main Engines 2	•		1		Diesel	5,000	3.18	12			365		8,760	95%	95%		573,899	2.43	88.15	44.98		2.25	0.06	0.24	6,206.77			
-M	lain Generators 2			1	27	Diesel			12	9	9	365	24	8,760	95%	95%		1	0.10	3.58	1.83	0.09	0.09	2.39E-03	9.90E-03	252.12	0.03		255.12 282,040

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area) 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for the heavy lift vessel.
- 80 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
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- 40 round trips to/from SBMT for each ballast barge tug (for 80 total positions).
- 8 round trips to/from Port of Albany for each TP barge tug (for 80 total positions). Weekly round trips to/from port for the crew transfer vessels.
- Monthly round trips to/from port for the construction support vessels and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
 The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Aker GBS Design, Self-Install Option)

																							Total	Emissions (Tra	insit)				
Vessels/Equipment Eng	gines	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO₂e tons
Helicopter - Twin-Engine Heavy		N/A		Worksheety																									
-Main Engines	2			164	1.40	0 Jet fuel	N/A	N/A	76	0.5		n	0		100%	0%	11,960	0	0.05	0.66	0.02	0.02	0.02	0.04	1.31E-03	126.17	3.61E-03	4.18E-03	127.50
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)	104	1,40	o jet idei	N/A	IN/A	70	0		o .	0	, 0	10076	076	11,500	0	0.03	0.00	0.02	0.02	0.02	0.04	1.511-05	120.17	3.01L-03	4.101-03	127.50
-Main Engines	6		1	3	4,50	0 Diesel	50,000	3.18	1	(5	0 26	5 24	6,360	53%	53%	3,931	4,166,667	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.17
Fall Pipe Vessel - Seabed filter layer	3	1	520 x 118 x 44 (31)	2	6.03	2 Diesel	50,000	3.18	00		_	0 26	0 2/	6 433	720/	720/	214 465	4 242 026	2.57	67.76	F 6F	0.05	0.00	3.04	0.22	2246 72	0.02	0.16	3,364.66
-Main Generators -Aux. Generator	1			3 2		9 Diesel	50,000	3.18	80 80		5	0 26		6,432	72% 72%	72% 72%		4,213,836	2.57 0.23	4.47	5.65 2.28		0.92 0.27		0.23 0.02	3316.72 314.86		0.16 9.13E-03	3,364.66
-Emergency Generator	1			1		0 Diesel			0	()	0	0 (0	0%				0	0	0	0		0	0	0	0	0	0
Fall Pipe Vessel - Solid ballast		1	520 x 118 x 44 (31)	_																									
-Main Generators -Aux. Generator	3 1			3 2		2 Diesel 9 Diesel	50,000	3.18	80 80		5	0 17 0 17		4,080	72% 72%	72% 72%		2,672,956	2.57 0.23	67.76 4.47	5.65 2.28		0.92 0.27		0.23 0.02	3316.72 314.86		0.16 9.13E-03	3,364.66 318.61
-Emergency Generator	1			1		0 Diesel			0			0	0 (0 4,000	0%				0.25	0	0	0.20	0.27	0	0.02	0	0.04	0.132 03	310.01
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																										
	3 1			3 2		2 Diesel	50,000	3.18			5	0 26 0 26		6,432	72%	72%		4,213,836		67.76	5.65		0.92		0.23	3316.72		0.16	3,364.66 318.61
-Aux. Generator -Emergency Generator	1			1		9 Diesel 0 Diesel			80)	0 26	0 (6,432	72% 0%				0.23	4.47	2.28	0.28	0.27	2.98E-03	0.02	314.86 0	0.04	9.13E-03 0	318.61
Tug 1 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)						-													-			-				
	2			2		0 Diesel	10,000	3.18	40	65	5	36	5 24	8,760	24%		340,671	1,147,799	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor Generator -Emergency Generator	1			1		6 Diesel 8 Diesel			0)	0	0 0		0% 0%	0%			0	0	0	0	(0	0	0	0	0
Tug 2 for GBS Tow/Installation	1	N/A	146 x 46 x 25 (21)	-	10	lo Diesei			0	,	,	J.	0	,	078	076	,		0	U	- 0	0		, ,	0	0	U	U	
-Main Engines	2		, ,	2		0 Diesel	10,000	3.18	40	65	5	36	5 24	8,760	24%	24%	340,671	1,147,799	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
	1			1		6 Diesel 8 Diesel			0	(0	0 (0	0% 0%	0%			0	0	0	0	(0	0	0	0	0	0
-Emergency Generator Tug 3 for GBS Tow/Installation	1	N/A	146 x 46 x 25 (21)	1	10	o Diesei			U		,	U	U (, 0	U%	0%)		0	U	U	U		, ,	U	U	U	U	U
	2			2	5,44	0 Diesel	10,000	3.18	40	65	5	36	5 24	8,760	24%		340,671	1,147,799	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
	1			1		6 Diesel			0	()	0	0 (0	0%		5		0	0	0	0	C	0	0	0	0	0	0
-Emergency Generator Tug 4 for GBS Tow/Installation	1	N/A	146 x 46 x 25 (21)	1	16	8 Diesel			0	()	0	0 (0	0%	0%			0	0	0	0	(0	0	0	0	0	0
-Main Engines	2	14/75	140 % 40 % 25 (21)	2	5,44	0 Diesel	10,000	3.18	40	65	5	36	5 24	8,760	24%	24%	340,671	1,147,799	2.78	54.45	27.78	3.44	3.34	0.04	0.30	3834.05	0.50	0.11	3,879.67
-Harbor Generator	1			1		6 Diesel			0	()	0	0 (0	0%	0%	S		0	0	0	0	C	0	0	0	0	0	0
-Emergency Generator	1	NI/A	126 v 26 v 10 (17)	1	16	8 Diesel			0	()	0	0 (0	0%	0%	5		0	0	0	0	C	0	0	0	0	0	0
Tug 1 for Ballast Barge -Main Engines	2	N/A	136 x 36 x 19 (17)	2	3.60	0 Diesel	10,000	3.18	40	18	3	0 18	0 24	4,320	35%	35%	94,340	566,038	0.75	14.69	7.50	0.93	0.90	9.80E-03	0.08	1034.44	0.13	0.03	1,046.75
-Aux. Engines	2			1		5 Diesel	-5,000	0.20	40	18	3	18		4,320	35%	35%		010,100	1.07E-02	0.39	0.20		9.90E-03		1.07E-03	27.30		7.91E-04	27.62
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)	_							_																		
-Main Engines -Aux. Engines	2			2		0 Diesel 5 Diesel	10,000	3.18	40	18	3	0 18 0 18		4,320 4.320	35% 35%	35% 35%		566,038	0.75 1.07E-02	14.69 0.39	7.50 0.20		0.90 9.90E-03		0.08 1.07E-03	1034.44 27.30		0.03 7.91E-04	1,046.75 27.62
GBS Ballast Barge 1			400 x 105 x 25	-	,	J DICSCI			40		,	J 10	0 2-	4,320	3370	3370	1		1.072 02	0.55	0.20	1.021 02	J.JOE 03	2.552 04	1.071 03	27.50	3.302 03	7.512 04	27.02
	I/A	N/A		N/A	N/A	N/A	0	N/A	40	18	3	0 18	0 24	4,320	N/A	N/A	N/A	N/A											
GBS Ballast Barge 2	I/A	N/A	400 x 105 x 25	N/A	N1/A	N/A		N/A	40	11		0 18	0 24	4 220	N/A	N/A	N1/A	N/A											
Tug 1 for Transition Pieces (from Albany)	I/A	N/A	146 x 46 x 25 (21)	N/A	N/A	N/A	0	N/A	40	10	3	18	0 22	4,320	N/A	N/A	N/A	N/A											
-Main Engines	2		` '	2		0 Diesel	10,000	3.18	8	69	9	36	5 24	8,760	24%	24%	72,327	1,147,799	0.59	11.56	5.90	0.73	0.71	0.01	0.06	814.00	0.11	0.02	823.68
	1			1		6 Diesel			0	()	0	0 (0	0%	0%	5		0	0	0	0	(0	0	0	0	0	0
-Emergency Generator Tug 2 for Transition Pieces (from Albany)	1	N/A	146 x 46 x 25 (21)	1	16	8 Diesel			0	()	U	0 (0	0%	0%			0	0	0	0	(0	0	0	0	0	0
	2	.,,,,		2		0 Diesel	10,000	3.18	8	69	9	36	5 24	8,760	24%	24%	72,327	1,147,799	0.59	11.56	5.90	0.73	0.71	0.01	0.06	814.00	0.11	0.02	823.68
-Harbor Generator	1			1	45	6 Diesel			0	()	0	0	0	0%	0%	S		0	0	0	0	C	0	0	0	0	0	0
-Emergency Generator Transition Piece Barge	1		400 x 105 x 25	1	16	8 Diesel			0	(J	U	U (0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
	I/A	N/A	-00 V 103 V 53	N/A	N/A	N/A	0	N/A	8	69	9	0 36	5 24	8,760	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1		N/A	65 x 17 x 5					Í							•														
-Main Engines	2			1		0 Diesel	4,000	3.18	52	9	9	36		8,760	51%	51%		459,119		3.82	1.95		0.10		1.06E-02	268.84		7.79E-03	272.04
-Main Generators Safety Vessel 1	2	N/A	65 x 17 x 5	1	2	7 Diesel			52	9	9	0 36	5 24	8,760	51%	51%			2.82E-03	0.10	0.05	2.70E-03	2.61E-03	6.83E-05	2.83E-04	7.21	9.40E-04	2.09E-04	7.29
	2	.4/5		1	66	0 Diesel	5,000	3.18	12		9	0 36	5 24	8,760	95%	95%	7,075	573,899	0.03	1.09	0.55	0.03	0.03	7.25E-04	3.01E-03	76.52	9.98E-03	2.22E-03	77.43
-Main Generators	2			1	2	7 Diesel			12	ģ	Э	36			95%		S		1.22E-03	0.04	0.02		1.13E-03		1.22E-04	3.11	4.05E-04	9.01E-05	3.15
																TOTALS	2,686,908	24,319,182	22.42	494.45	164.77	20.96	20.33	6.37	2.24	30,510	2.72	1.07	30,89

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area) 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for the heavy lift vessel.
- 80 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
 40 round trips to/from Coeymans for each GBS tow tug (for 80 total positions).
- 40 round trips to/from SBMT for each ballast barge tug (for 80 total positions).
- 8 round trips to/from Port of Albany for each TP barge tug (for 80 total positions). Weekly round trips to/from port for the crew transfer vessels.
- Monthly round trips to/from port for the construction support vessels and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
 The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. CO_2 e emission rates use the following carbon equivalence factors: 25 for CH_2 , and 298 for N_2O .

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Pre-Piled Jacket Design)

																							Total Emi	ssions (Nor	-Transit)				
				Emission					Transit	Transit	Non-OCS	ocs		Non-Transit		Non-Transit		Non-Transit											
		DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operatin		Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N ₂ O	CO ₂ e
Vessels/Equipment		Anchored Spuds	length x width x depth (draft)	Used (see EFs worksheet)	Rating (hp)	Туре	rate (kg per vessel per day)	density (kg/gal)	Trips	(hrs/round trip)	Days	Days	Hours (hrs/day)	Hours (hrs)	load (%)	load (%)	(per vessel)	Gallons (per vessel)	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
Helicopter - Twin-Engine Heavy		N/A																									-		
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	104	0.5	(0	C	0	100%	0%	16,366	0	0	0	0	0	0	0	0	0	0	0	0
Heavy Lift Vessel - Piling Transport from Europe		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	10	6	(70	24	1,680	37%	37%	39,308	1,100,629	9.86	260.33	21.69	3.65	3.54	7.83	0.87	12,742.13	0.08	0.61	12,926.30
Heavy Lift Vessel - Piling Installation		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	1	6	(156	24	3,744	37%	37%	3,931	2,452,830	21.98	580.17	48.35	8.14	7.90	17.44	1.94	28,396.75	0.18	1.36	28,807.18
Heavy Lift Vessel - Transport and Install Jackets	_	1	715 x 184 x 41 (32)	_						_																			
-Main Engines	4			3	9,651	Diesel	50,000	3.18	10	6	(365	24	8,760	37%	37%	39,308	5,738,994	51.42	1357.45	113.12	19.06	18.48	40.80	4.54	66,441.11	0.41	3.19	67,401.41
Fall Pipe Vessel - Seabed filter layer		1	520 x 118 x 44 (31)	2	5 000	n: 1	50,000	2.40		_		250	2.6	5 422	720/	720	244455	4 242 026	24.40	000.00	75.67	40.75	42.26	27.20	201		0.25	2.42	45 000 40
-Main Generators	3			3	6,032		50,000	3.18	80	6		268		6,432		72%		4,213,836	34.40	908.03	75.67	12.75		27.29	3.04		0.28	2.13	45,086.40 4,269.34
-Aux. Generator -Emergency Generator	1			2	1,609	Diesel			80	6		208	24	6,432	72% 0%	72% 0%			3.06	59.92	30.57	3.79	3.67	0.04	0.32	4,219.14	0.55	0.12	4,269.34
ů ,	1	1	520 x 118 x 44 (31)	1	000	Diesei			U	U	,	J U	·	U	0%	0%	0		U	U	U	U	U	U	U	U		U	U
Fall Pipe Vessel - Scour protection -Main Generators	2	1	320 X 116 X 44 (31)	2	6,032	Diocal	50,000	3.18	90	6	,	268	24	6,432	72%	72%	314.465	4.213.836	34.40	908.03	75.67	12.75	12.36	27.29	3.04	44.444.04	0.28	2.13	45,086.40
-Aux. Generator	1			2	1,609		30,000	3.10	90	6		268		6,432		72%		4,213,630	3.06	59.92		3.79		0.04	0.32		0.55	0.12	4,269.34
-Aux. Generator	1			1		Diesel			00	0	1	200	24	0,432	0%	0%			3.00	39.92	30.37	3.79	3.07	0.04	0.32	4,219.14	0.55	0.12	4,209.54
Tug 1 for Transition Pieces (from Albany)	-	N/A	146 x 46 x 25 (21)	-	000	Diesei				·	,	, ,			070	070			0				· ·	Ū		- O		Ü	
-Main Engines	2	14/7	140 / 40 / 25 (21)	2	5.440	Diesel	10,000	3.18	Q	69	,	365	2/	8,760	24%	24%	72,327	1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
-Harbor Generator	1			1		Diesel	10,000	5.10	0	0		0 0		0,700	0%	0%		1,147,733	0.50	103.47	0 33.01	11.55	11.24	0.12	0.55	12,517.00	1.00	0.57	13,071.30
-Emergency Generator	1			1		Diesel			0	0		0		0	0%	0%			0	0	i o	0	0	0	0	0	0	0	0
Tug 2 for Transition Pieces (from Albany)	-	N/A	146 x 46 x 25 (21)	-	100	Diesei				Ĭ		•		·	0,0	07.			, i		1		ŭ						
-Main Engines	2	,	,	2	5,440	Diesel	10,000	3.18	8	69	(365	24	8,760	24%	24%	72,327	1,147,799	9.36	183.47	93.61	11.59	11.24	0.12	0.99	12,917.80	1.68	0.37	13,071.50
-Harbor Generator	1			1		Diesel	,,,,,		0	0	(0	C	0	0%	0%		, , ,	0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	1			1	168	Diesel			0	0	(0	C	0	0%	0%	6		0	0	0	0	0	0	0	0	0	0	0
Transition Piece Barge			400 x 105 x 25																										
	N/A	N/A		N/A	N/A	N/A	0	N/A	8	69	(365	24	8,760	N/A	N/A	N/A	N/A											
Bubble Curtain Vessel		N/A	150 x 36 x 10																										
-Main Engines	2			1		Diesel	4,000	3.18	5	9	(156		3,744		50%		196,226	0.62	22.50		0.59		1.50E-02			0.21	4.59E-02	1,603.08
-Aux. Generator	1			1		Diesel			5	9	(156		3,744		50%			5.50E-02	2.00	1.02	5.25E-02	5.09E-02	1.33E-03	5.52E-03		1.83E-02	4.07E-03	142.14
-Bow Thruster Engine	1			1		Diesel			0	0	(156		3,744	0%	50%			0.13	4.88	2.49	1.28E-01		3.25E-03	1.35E-02		4.48E-02	9.95E-03	347.33
-Aux. Engine	1			1	133	Diesel			0	0	(156	24	3,744	0%	50%	6		5.50E-02	2.00	1.02	5.25E-02	5.09E-02	1.33E-03	5.52E-03	140.47	1.83E-02	4.07E-03	142.14
Crew Transfer Vessel 1		N/A	65 x 17 x 5																										
-Main Engines	2			1	1,000		4,000	3.18	52	9	(365		8,760		51%		459,119	1.97	71.47		1.88		0.05	0.20		0.66	0.15	5,092.08
-Main Generators	2			1	27	Diesel			52	9	(365	24	8,760	51%	51%	6		0.05	1.92	0.98	0.05	0.05	1.28E-03	5.30E-03	134.91	0.02	3.91E-03	136.52
Safety Vessel 1		N/A	65 x 17 x 5																										
-Main Engines	2			1		Diesel	5,000	3.18	12	9	(365		8,760		95%		573,899	2.43	88.15		2.32		0.06	0.24		0.81		6,280.63
-Main Generators	2			1	27	Diesel			12	9	(365	24	8,760	95%	95%			0.10	3.58		0.09		2.39E-03	9.90E-03		0.03	7.31E-03	255.12
																TOTALS	906,461	21,244,969	182.30	4,697.30	683.11	92.28	89.51	121.12	16.61	244,576	7.49	10.82	247,988

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
 South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
 10 round trips to/from overseas port for each heavy lift transport vessel.
- 1 round trip to/from overseas port for the heavy lift installation vessel.
- 80 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
 80 round trips to/from SBMT for each TP barge tug (for 80 total positions).
- 80 round trips to/from SBMT for TP barge tug (for 80 total positions).
- 8 round trips to/from Port of Albany for each TP barge tug (for 80 total positions). Weekly round trips to/from port for crew transfer vessels.
- Monthly round trips to/from port for bubble curtain vessel and safety vessels. 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM25 or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)

 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.

 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₄, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Pre-Piled Jacket Design)

																						Total Er	nissions (T	ransit)				
				Emission				Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of	1. DP	Dimensions (ft)	Factor	Engine Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2,5}	SO ₂	HAPs	CO2	CH ₄	N ₂ O	CO ₂ e
Vessels/Equipment I	Engines	2.Anchored	length x width x depth	Used	Rating Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	er vessel		(draft)	(see EFs	(hp)	vessel per day)			trip)	.,		(hrs/day)	(hrs)		,	(per vessel)	(per vessel)											
		•	` '	worksheet)	` ` ' '				• • •				` '															
Helicopter - Twin-Engine Heavy		N/A		,																								
-Main Engines	2			164	1,400 Jet fuel	N/A	N/A	104	0.5	0	0	0	0	100%	0%	16,366	0	0.07	0.90	0.02	0.02	0.02	0.05	1.80E-03	172.65	4.94E-03	5.72E-03	174.48
Heavy Lift Vessel - Piling Transport from Europe		1	715 x 184 x 41 (32)																									
-Main Engines	4			3	9,651 Diesel	50,000	3.18	10	6	0	70	24	1,680	37%	37%	39,308	1,100,629	0.35	9.30	0.77	0.13	0.13	0.28	0.03	455.08	2.82E-03	0.02	461.65
Heavy Lift Vessel - Piling Installation		1	715 x 184 x 41 (32)																									
-Main Engines	4			3	9,651 Diesel	50,000	3.18	1	6	0	156	24	3,744	37%	37%	3,931	2,452,830	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.17
Heavy Lift Vessel - Transport and Install Jackets		1	715 x 184 x 41 (32)																									
-Main Engines	4			3	9,651 Diesel	50,000	3.18	10	6	0	365	24	8,760	37%	37%	39,308	5,738,994	0.35	9.30	0.77	0.13	0.13	0.28	0.03	455.08	2.82E-03	0.02	461.65
Fall Pipe Vessel - Seabed filter layer		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032 Diesel	50,000	3.18	80	6	0	268	24	6,432	72%	72%	314,465	4,213,836	2.57	67.76	5.65	0.95	0.92	2.04	0.23	3316.72	0.02	0.16	3,364.66
-Aux. Generator	1			2	1,609 Diesel			80	6	0	268	24	6,432	72%				0.23	4.47	2.28	0.28	0.27	0.00	0.02	314.86	0.04	9.13E-03	318.61
-Emergency Generator	1			1	660 Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032 Diesel	50,000	3.18	80	6	0	268	24	6,432	72%	72%	314,465	4,213,836	2.57	67.76	5.65	0.95	0.92	2.04	0.23	3316.72	0.02	0.16	3,364.66
-Aux. Generator	1			2	1,609 Diesel			80	6	0	268	24	6,432	72%				0.23	4.47	2.28	0.28	0.27	2.98E-03	0.02	314.86	0.04	9.13E-03	318.61
-Emergency Generator	1			1	660 Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 1 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440 Diesel	10,000	3.18	8	69	0	365	24	8,760	24%	24%		1,147,799	0.59	11.56	5.90	0.73	0.71	0.01	0.06	814.00	0.11	0.02	823.68
-Harbor Generator	1			1	456 Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	1			1	168 Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440 Diesel	10,000	3.18	8	69	0	365	24	8,760	24%		72,327	1,147,799	0.59	11.56	5.90	0.73	0.71	0.01	0.06	814.00	0.11	0.02	823.68
-Harbor Generator	1			1	456 Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	1			1	168 Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Transition Piece Barge			400 x 105 x 25																									
	N/A	N/A		N/A	N/A N/A	(N/A	8	69	0	365	24	8,760	N/A	N/A	N/A	N/A											
Bubble Curtain Vessel	_	N/A	150 x 36 x 10	_				_	_	_																		
-Main Engines	2			1	750 Diesel	4,000	3.18	5	9	0	156	24	3,744	64%	50%		196,226	9.54E-03	0.35 3.07E-02	0.18	9.12E-03	8.84E-03	2.31E-04	9.58E-04	24.38			24.67
-Aux. Generator	1			1	133 Diesel 325 Diesel			5	9		156 156	24	3,744	64%	50%			8.46E-04	3.07E-02	1.57E-02	8.08E-04	7.84E-04	2.05E-05	8.49E-05	2.16	2.82E-04	6.27E-05	2.19
-Bow Thruster Engine	1			1				0	U	0	156 156	24	3,744 3.744	0%				0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1	N1/A	CF 17 F	1	133 Diesel			0		0	156	24	3,/44	0%	50%			U	0	0	U	U	0	U	0	U	0	U
Crew Transfer Vessel 1	2	N/A	65 x 17 x 5	1	1 000 Dias-1	4.000	3.18	52			305	3.4	0.700	E40/	E40/	24 520	459,119	0.11	2 02	1.05	0.10	0.10	2 555 02	1.065.03	260.04	0.04	7 705 03	272.04
-Main Engines	2			1	1,000 Diesel 27 Diesel	4,000	3.18	52	9		365 365	24	8,760 8,760	51% 51%			459,119	0.11 2.82E-03	3.82 0.10	1.95	0.10 2.70E-03	0.10	2.55E-03	1.06E-02	268.84			272.04 7.29
-Main Generators Safety Vessel 1	2	N/A	65 x 17 x 5	1	27 Diesei		1	52	9	0	365	24	8,760	51%	51%			2.82E-U3	0.10	0.05	2.70E-03	2.61E-03	6.83E-05	2.83E-04	7.21	9.40E-04	2.09E-04	7.29
1 .	2	IN/A	02 4 1 / 4 2	1	660 Diosal	5,000	3.18	12			365	24	8,760	95%	95%	7,075	573,899	0.03	1.09	0.55	0.03	0.03	7.25E-04	3.01E-03	76.52	9.98E-03	2.22E-03	77.43
-Main Engines -Main Generators	2			1	660 Diesel 27 Diesel	5,000	3.18	12	9] ,	365	24	8,760 8,760	95% 95%		7,075	3/3,699	1.22E-03	0.04	0.55	1.16E-03	1.13E-03	7.25E-04 2.95E-05	1.22E-04	3.11			3.15
-iviaiii Generators	۷.			1	Z/ Diesei			12	9	1 0	505	24	0,700	95%	TOTALS	906,461		7.73	193.45		4.37	1.13E-03 4.24	2.95E-05 4.74	0.71		4.05E-04 0.40	9.01E-05 0.45	10,545

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
 South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
 10 round trips to/from overseas port for each heavy lift transport vessel.
- 1 round trip to/from overseas port for the heavy lift installation vessel.
- 80 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
 80 round trips to/from SBMT for each TP barge tug (for 80 total positions).
- 80 round trips to/from SBMT for TP barge tug (for 80 total positions).
- 8 round trips to/from Port of Albany for each TP barge tug (for 80 total positions). Weekly round trips to/from port for crew transfer vessels.
- Monthly round trips to/from port for bubble curtain vessel and safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM25 or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)

 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.

 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₄, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Monopile Design)

																							Total Emi	sions (Non	-Transit)				
				Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of	1. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operatir	Average	Average	Fuel Usage	Fuel Usage	voc	NOx	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH₄	N ₂ O	CO ₂ e
Vessels/Equipment	Engines	2.Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	per vessel	3.Spuds	(draft)	(see EFs	(hp)	.,,,-	vessel per day)	, (8, 8)		trip)	,-	,-	(hrs/day)	(hrs)	,		(per vessel)									10.12			
			(* · · ,	worksheet)									, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	, ,			,	u,								1	ļ		
Helicopter - Twin-Engine Heavy		N/A																											
																										1	ļ		
-Main Engines	2			164	1,400 J	et fuel	N/A	N/A	56	0.5	() (0 0	100%	6 09	6 8,81	3 0	0	0	0	0	0	0	0	0	0	0	0
Heavy Lift Vessel - Monopile and TP Transport		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	20	6	(140	2	4 3,360	37%	379	78,61	6 2,201,258	19.72	520.67	43.39	7.31	7.09	15.65	1.74	25,484.26	0.16	1.22	25,852.60
Heavy Lift Vessel - Monopile and TP Installation		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	1	6	(198	2	4 4,752	37%	379	6 3,93	1 3,113,208	27.89	736.37	61.36	10.34	10.03	22.13	2.46	36,042.03	0.22	1.73	36,562.96
Fall Pipe Vessel - Seabed filter layer		1	520 x 118 x 44 (31)																										
-Main Generators	3			3	6,032	Diesel	50,000	3.18	16	6	(268	2	4 6,432	72%	729	62,89	3 4,213,836	34.40	908.03	75.67	12.75	12.36	27.29	3.04	44,444.04	0.28	2.13	45,086.40
-Aux. Generator	1			2	1,609				16	6	(268	2	4 6,432	72%	729	6		3.06	59.92	30.57	3.79	3.67	0.04	0.32	4,219.14	0.55	0.12	4,269.34
-Emergency Generator	1			1	660	Diesel			C	0	(0)	0 0	0%	6 09	6		0	0	0	0	0	0	0	0	0	0	0
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																							1	ļ		
-Main Generators	3			3	6,032		50,000	3.18	16	6	(268		4 6,432				3 4,213,836	34.40	908.03		12.75	12.36	27.29	3.04		0.28	2.13	45,086.40
-Aux. Generator	1			2	1,609				16	6	(268	2	4 6,432	72%	729	6		3.06	59.92	30.57	3.79	3.67	0.04	0.32	4,219.14	0.55	0.12	4,269.34
-Emergency Generator	1			1	660	Diesel			C	0	(0)	0 (0%	6 09	6		0	0	0	0	0	0	0	0	0	0	0
Bubble Curtain Vessel		N/A	150 x 36 x 10																							1	ļ		
-Main Engines	2			1	750		4,000	3.18	7	9	(198	2	4 4,752				249,057	0.79	28.56	14.57	0.75	0.73	1.91E-02				5.83E-02	2,034.67
-Aux. Generator	1			1	133				7	9	(198	2	4 4,752	64%				6.98E-02	2.53	1.29	6.67E-02	6.47E-02	1.69E-03	7.00E-03	178.29	2.33E-02	5.17E-03	180.41
-Bow Thruster Engine	1			1	325				C	0	(198		4 4,752	0%				0.17	6.19		1.63E-01	1.58E-01	4.13E-03	1.71E-02		5.68E-02	1.26E-02	440.85
-Aux. Engine	1			1	133 [Diesel			C	0	(198	2	4 4,752	2 0%	509	6		6.98E-02	2.53	1.29	6.67E-02	6.47E-02	1.69E-03	7.00E-03	178.29	2.33E-02	5.17E-03	180.41
Crew Transfer Vessel 1		N/A	65 x 17 x 5																							1	ļ		
-Main Engines	2			1	1,000		4,000	3.18	52	9	(365		-,				8 459,119		71.47		1.88	1.83	0.05	0.20		0.66		5,092.08
-Main Generators	2			1	27 [Diesel			52	9	(365	2	4 8,760	51%	519	6		0.05	1.92	0.98	0.05	0.05	1.28E-03	5.30E-03	134.91	0.02	3.91E-03	136.52
Safety Vessel 1		N/A	65 x 17 x 5									1														1	ļ		
-Main Engines	2			1	660		5,000	3.18	12	9	(365		4 8,760				573,899		88.15	44.98	2.32	2.25	0.06	0.24		0.81		6,280.63
-Main Generators	2			1	27 [Diesel			12	9	(365	2	4 8,760	95%				0.10	3.58	1.83	0.09	0.09	2.39E-03	9.90E-03		0.03		255.12
																TOTAL	252.05	2 15.024.214	128.17	3.397.88	421.80	56.11	54.42	92.59	11.50	173.282	3.91	7.88	175,728

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)

 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 20 round trips to/from overseas port for the heavy lift transport vessel.

 1 round trip to/from overseas port for the heavy lift installation vessel.
- 16 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 5 foundations per cargo). Weekly round trips to/from port for crew transfer vessels.

- weekly round trips to/from port for crew transfer vessels.

 Monthly round trips to/from port for bubble curtain vessel and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.

- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM25 or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages) 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₄, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Foundation Construction Emissions (Monopile Design)

																						Total Er	nissions (T	ransit)				
				Emission				Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of	1. DP	Dimensions (ft)	Factor	Engine Fue	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating To	tal Operatin	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH ₄	N ₂ O	CO ₂ e
Vessels/Equipment	Engines	2.Anchored	length x width x depth	Used	Rating Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	per vessel	3.Spuds	(draft)	(see EFs	(hp)	vessel per day)			trip)			(hrs/day)	(hrs)			(per vessel)	(per vessel)											
				worksheet)																								
Helicopter - Twin-Engine Heavy		N/A																										
	_									_	_		_				_											
-Main Engines	2		745 404 44 (22)	164	1,400 Jet fuel	N/s	A N/A	56	0.5	0		0	0	100%	0%	8,813	0	0.04	0.49	0.01	0.01	0.01	0.03	9.68E-04	92.97	2.66E-03	3.08E-03	93.95
Heavy Lift Vessel - Monopile and TP Transport -Main Engines		1	715 x 184 x 41 (32)	3	9,651 Diesel	50,00	0 3.18	20		0	140		2.200	270/	37%	78,616	2,201,258	0.70	10.00	4.55	0.26	0.25	0.50	0.06	910.15	5.63E-03	0.04	923.31
Heavy Lift Vessel - Monopile and TP Installation	4	1	715 x 184 x 41 (32)	3	9,651 Diesei	50,00	0 3.18	20	В	U	140	24	3,360	37%	3/%	78,010	2,201,258	0.70	18.60	1.55	0.26	0.25	0.56	0.06	910.15	5.63E-03	0.04	923.31
-Main Engines	4	1	/13 X 104 X 41 (32)	3	9.651 Diesel	50.00	0 3.18	1	6	0	198	3 24	4.752	37%	37%	3.931	3.113.208	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.17
Fall Pipe Vessel - Seabed filter layer	4	1	520 x 118 x 44 (31)	3	9,031 Diesei	30,00	0 5.16			- 0	190	24	4,732	3776	3/76	3,931	3,113,206	0.04	0.93	0.08	1.51E-02	1.276-02	0.03	3.11E-U3	45.51	2.02E-04	2.10E-03	40.17
-Main Generators	2	-	320 X 110 X 44 (31)	3	6.032 Diesel	50,00	0 3.18	16	6	0	268	24	6,432	72%	72%	62,893	4.213.836	0.51	13.55	1.13	0.19	0.18	0.41	0.05	663.34	4.11E-03	0.03	672.93
-Aux. Generator	1			2	1.609 Diesel	30,00	5.10	16	6	0	268		6.432	72%	72%		4,213,030	0.05	0.89	0.46	0.06	0.05	5.97E-04	4.85E-03	62.97	8.21E-03	1.83E-03	63.72
-Emergency Generator	1			1	660 Diesel			0	0	0	0	0	0,132	0%	0%			0.03	0.03	0.10	0.00	0.05	0.572.01	0	02.37	0.212 00	0	05.72
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)	_															_	-						-		
-Main Generators	3		(,,	3	6,032 Diesel	50,00	0 3.18	16	6	0	268	24	6,432	72%	72%	62,893	4,213,836	0.51	13.55	1.13	0.19	0.18	0.41	0.05	663.34	4.11E-03	0.03	672.93
-Aux. Generator	1			2	1,609 Diesel			16	6	0	268	24	6,432	72%	72%			0.05	0.89	0.46	0.06	0.05	5.97E-04	4.85E-03	62.97	8.21E-03	1.83E-03	63.72
-Emergency Generator	1			1	660 Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Bubble Curtain Vessel		N/A	150 x 36 x 10																									
-Main Engines	2			1	750 Diesel	4,00	0 3.18	7	9	0	198	24	4,752	64%	50%	3,302	249,057	1.34E-02	0.48	0.25	1.28E-02	1.24E-02	3.23E-04	1.34E-03	34.13	4.45E-03	9.89E-04	34.54
-Aux. Generator	1			1	133 Diesel			7	9	0	198	24	4,752	64%	50%			1.18E-03	4.30E-02	2.19E-02	1.13E-03	1.10E-03	2.87E-05	1.19E-04	3.03	3.95E-04	8.77E-05	3.06
-Bow Thruster Engine	1			1	325 Diesel			0	0	0	198	24	4,752	0%	50%			0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1			1	133 Diesel			0	0	0	198	3 24	4,752	0%	50%			0	0	0	0	0	0	0	0	0	0	0
Crew Transfer Vessel 1		N/A	65 x 17 x 5																									
-Main Engines	2			1	1,000 Diesel	4,00	0 3.18	52	9	0	365	24	8,760		51%	24,528	459,119	0.11	3.82	1.95		0.10	2.55E-03		268.84		7.79E-03	272.04
-Main Generators	2			1	27 Diesel			52	9	0	365	24	8,760	51%	51%			2.82E-03	0.10	0.05	2.70E-03	2.61E-03	6.83E-05	2.83E-04	7.21	9.40E-04	2.09E-04	7.29
Safety Vessel 1		N/A	65 x 17 x 5		cco 8: 1	5.00		4.0			265		0.750	050/	050/	7.075	573.000	0.00	4.00	0.55	0.00	0.00	7.055.04	2 04 5 02	76.50	0.005.00	2 225 62	77.41
-Main Engines -Main Generators	2			1	660 Diesel 27 Diesel	5,00	0 3.18	12	9	0	365 365	24	8,760 8,760	95% 95%	95% 95%	7,075	573,899	0.03 1.22E-03	1.09 0.04	0.55 0.02	0.03 1.16E-03	0.03 1.13E-03	7.25E-04 2.95E-05	3.01E-03 1.22E-04	76.52 3.11	9.98E-03 4.05E-04	2.22E-03 9.01E-05	77.43
-Main Generators				1	27 Diesei			12	9	0	365	24	8,760	95%		252.052	45.004.044											3.15
															TOTALS	252,052	15,024,214	2.05	54.48	7.66	0.93	0.90	1.44	0.18	2,894	0.08	0.13	2,934

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)

 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 20 round trips to/from overseas port for the heavy lift transport vessel.

 1 round trip to/from overseas port for the heavy lift installation vessel.
- 16 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 5 foundations per cargo). Weekly round trips to/from port for crew transfer vessels.

- weekly round trips to/from port for crew transfer vessels.

 Monthly round trips to/from port for bubble curtain vessel and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.

- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM25 or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages) 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₄, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Cobra GBS Design)

																							Total En	nissions (Non-	Transit)				
Vessels/Equipment	No. of Engines per vessel	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N ₂ O tons	CO ₂ e tons
Helicopter - Twin-Engine Heavy		N/A																											
-Main Engines	2			164	1.400	Jet fuel	N/A	N/A	104	0.5		0	0	0	100%	0%	16.366	. 0	0	0	0	0	0	0	0	0	0	0	. 0
Heavy Lift Vessel - Foundation Pillars (from VA)		1	715 x 184 x 41 (32)				·										.,				<u>-</u>		<u></u>						
-Main Engines Heavy Lift Vessel - Foundation installation	4	1	661 x 290 x 162 (43)	3	9,651	Diesel	50,000	3.18	40	59	20	0	24	4,800	37%	37%	1,546,122	3,144,654	28.17	743.81	61.98	10.44	10.13	22.36	2.49	36,406.09	0.23	1.75	36,932.28
-Main Engines	6	_	(10,	3		Diesel	80,000	3.18	1	. 6	,	376	24	9,024	29%	29%		9,459,119	42.66	1126.35	93.86		15.34		3.77	55,129.79	0.34	2.65	
-Main Engines -Main Engines	4			3		Diesel Diesel			1	. 6		376 376	24	9,024 9,024	29% 29%	29% 29%			26.12 15.96	689.60 421.42	57.47 35.12		9.39 5.74		2.31 1.41	33,752.93 20,626.79	0.21 0.13	1.62 0.99	
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)	3					-						2570	23%							3.7 .	12.07	2.12			0.55	
-Main Engines Fall Pipe Vessel - Seabed filter layer	6	1	520 x 118 x 44 (31)	3	4,500	Diesel	50,000	3.18	1	. 6	1	530	24	12,720	53%	53%	3,931	8,333,333	74.66	1971.09	164.26	27.67	26.84	59.25	6.59	96,476.14	0.60	4.63	97,870.54
-Main Generators	3	1	320 X 118 X 44 (31)	3	6,032	Diesel	50,000	3.18	160	6	,	536	24	12,864	72%	72%	628,931	8,427,673	68.79	1816.06	151.34	25.49	24.73	54.59	6.08	88,888.07	0.55	4.26	90,172.80
-Aux. Generator	1			2		Diesel Diesel			160	6		536	24	12,864	72% 0%				6.11	119.85	61.15	7.57	7.35	0.08	0.65	8,438.28	1.10	0.24	8,538.68
-Emergency Generator Fall Pipe Vessel - Solid ballast	1	1	520 x 118 x 44 (31)	1	DDL	Diesei			U		'	J 0	U	U	U%	0%			U	U	U	U	·	, ,	U	U	U	U	
-Main Generators	3			3		Diesel	50,000	3.18	160	6		340	24	8,160	72%	72%	628,931	5,345,912	43.64	1151.98	96.00		15.69		3.85	56,384.22	0.35	2.71	
-Aux. Generator -Emergency Generator	1 1			2		Diesel Diesel			160 0			340	24	8,160 0	72% 0%				3.88	76.02 0	38.79 0	4.80 0	4.66 0	0.05	0.41	5,352.64 0	0.70 0	0.16 0	5,416.33 0
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																										
-Main Generators -Aux. Generator	3 1			3 2		Diesel Diesel	50,000	3.18	160 160	6		536	24	12,864 12,864	72% 72%	72% 72%	628,931	8,427,673	68.79 6.11	1816.06 119.85	151.34 61.15		24.73 7.35		6.08 0.65	88,888.07 8,438.28	0.55 1.10	4.26 0.24	
-Emergency Generator	1			1		Diesel			0	· c		0 0	C	0	0%				0	0	0	0	0	0	0	0	0	0	0
Tug 1 for GBS Bases (from Coeymans) -Main Engines	2	N/A	146 x 46 x 25 (21)	2	5 440	Diesel	10,000	3.18	80	65		360	24	8,640	24%	24%	681,342	1,132,075	9.23	180.96	92.32	11.43	11.09	0.12	0.98	12,740.84	1.66	0.37	12,892.44
-Harbor Generator	1			1	456	Diesel	10,000	5.10	0	0.00		0 0	0	0,010	0%	0%	001,012	1,132,073	0	0	0	0	0	0	0	0	0	0.57	0
-Emergency Generator Tug 2 for GBS Bases (from Coeymans)	1	N/A	146 x 46 x 25 (21)	1	168	Diesel			0	C	1	0 0	С	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Main Engines	2	IN/A	140 / 40 / 23 (21)	2	5,440	Diesel	10,000	3.18	80	65		360	24	8,640	24%	24%	681,342	1,132,075	9.23	180.96	92.32	11.43	11.09	0.12	0.98	12,740.84	1.66	0.37	12,892.44
-Harbor Generator	1			1		Diesel Diesel			0			0	0	0	0% 0%	0% 0%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator Tug 3 for GBS Bases (from Coeymans)	1	N/A	146 x 46 x 25 (21)	1	108	Diesei			U			J 0	U	U	U%	0%			U	U	U	U		0	U	U	U	U	
-Main Engines	2			2		Diesel	10,000	3.18	80	65		360	24	8,640	24%	24%	681,342	1,132,075	9.23	180.96	92.32	11.43	11.09	0.12	0.98	12,740.84	1.66	0.37	12,892.44
-Harbor Generator -Emergency Generator	1 1			1		Diesel Diesel			0			0 0	0	0	0% 0%	0% 0%			0	0	0	0	0	0	0	0	0	0	. 0
Tug 4 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																										
-Main Engines -Harbor Generator	2 1			2 1		Diesel Diesel	10,000	3.18	80	65		360	24	8,640 0	24% 0%	24% 0%	681,342	1,132,075	9.23	180.96 0	92.32	11.43	11.09	0.12	0.98	12,740.84 0	1.66	0.37	12,892.44 0
-Emergency Generator	1			1		Diesel			0	· c		0	O	0	0%				0	0	0	0	C	0	0	0	0	0	0
GBS Base Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	80	18		360	24	8,640	N/A	N/A	N/A	N/A											
GBS Base Barge 2			400 x 105 x 25					,						5,5 1.5	·	•													
Tug 1 for Transition Pieces (from Albany)	N/A	N/A N/A	146 x 46 x 25 (21)	N/A	N/A	N/A	0	N/A	80	18	1	360	24	8,640	N/A	N/A	N/A	N/A											
-Main Engines	2	.,		2		Diesel	10,000	3.18	16	69		730	24	17,520	24%	24%	144,654	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Harbor Generator -Emergency Generator	1			1		Diesel Diesel			0			0	0	0	0% 0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)	1								5 0			078	0/6			0	U	0	0		, 0	U		U	U	
-Main Engines -Harbor Generator	2 1			2 1		Diesel Diesel	10,000	3.18	16	69		730	24	17,520	24% 0%	24%	144,654	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Emergency Generator	1			1		Diesel			0			0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	. 0
Transition Piece Barge	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A		N/A		-]	730	-	17,520	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1	IN/A	N/A N/A	65 x 17 x 5	N/A	N/A	N/A	0	, IN/A	16	65	1	/30	24	17,520	IN/A	IN/A	IN/A	IV/A											-
-Main Engines	2			1		Diesel	4,000	3.18	52	9		365	24	8,760	51%	51%		459,119	1.97	71.47	36.47		1.83	0.05	0.20	5,032.21	0.66	0.15	
-Main Generators Safety Vessel 1	2	N/A	65 x 17 x 5	1	27	Diesel			52	9	1	365	24	8,760	51%	51%	1		0.05	1.92	0.98	0.05	0.05	1.28E-03	5.30E-03	134.91	0.02	3.91E-03	136.52
-Main Engines	2			1		Diesel	5,000	3.18	12		,	365	24	8,760	95%	95%		573,899	2.43	88.15	44.98		2.25		0.24	6,206.77	0.81		
-Main Generators	2	1		1	27	Diesel			12	9	'	365	24	8,760	95%	95% TOTALS		53,290,881	0.10 463.83	3.58 11,674.94	1.83 1,800.42		0.09 245.48		9.90E-03 42.64	252.12 613,042	0.03 20.75	7.31E-03 26.82	

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Virginia port to local staging area at SBMT: 293.5 nm (30 nm in VA state waters, 250 nm in non-OCS federal waters, and 13.5 nm in NY/NJ state waters)

 Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for each heavy lift vessel.

 160 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
- 80 round trips from Virginia port to local staging area at SBMT for GBS pillar supply vessel, based on assumed capacity to transport components for four positions per trip (for 160 total positions).
- 80 round trips to/from Coeymans for each GBS base tow tug (for 160 total positions). 16 round trips to/from Port of Albany for each TP barge tug (for 160 total positions).
- Weekly round trips to/from port for crew transfer vessels.
- Monthly round trips to/from port for safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. CO_2e emission rates use the following carbon equivalence factors: 25 for CH, and 298 for N_2O .

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Cobra GBS Design)

																							Total	Emissions (Tra	nsit)				
Vessels/Equipment	No. of Engines per vessel	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH₄ tons	N ₂ O tons	CO ₂ e tons
Helicopter - Twin-Engine Heavy		N/A		Worksheety																									
-Main Engines	2			164	1 400	Jet fuel	N/A	N/A	104	0.5			0	0	100%	0%	16,366		0.07	0.90	0.02	0.02	0.02	0.05	1.80E-03	172.65	4.94E-03	5.72E-03	174.48
Heavy Lift Vessel - Foundation Pillars (from VA)		1	715 x 184 x 41 (32)					,	104	0.5				Ů															
-Main Engines Heavy Lift Vessel - Foundation installation	4	1	661 x 290 x 162 (43)	3	9,651	Diesel	50,000	3.18	40	59	20	0	24	4,800	37%	37%	1,546,122	3,144,654	13.85	365.71	30.48	5.13	4.98	10.99	1.22	17899.66	1.11E-01	0.86	18,158.37
-Main Engines	6	1	001 X 290 X 102 (43)	3	6,568	Diesel	80,000	3.18	1	. 6	,	376	24	9,024	29%	29%	6,289	9,459,119	0.03	0.75	0.06	1.05E-02	1.02E-02	0.02	2.51E-03	36.66	2.27E-04	1.76E-03	37.19
-Main Engines	4			3		Diesel Diesel			1	. 6		376	24	9,024	29%	29%			0.02	0.46	0.04		6.24E-03		1.53E-03	22.44		1.08E-03	
-Main Engines Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)	3	7,373	Diesei			1		1	376	24	9,024	29%	29%)		1.06E-02	0.28	0.02	3.93E-03	3.82E-03	8.42E-03	9.37E-04	13.71	8.49E-05	6.58E-04	13.91
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	. 6		530	24	12,720	53%	53%	3,931	8,333,333	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.17
Fall Pipe Vessel - Seabed filter layer -Main Generators	3	1	520 x 118 x 44 (31)	3	6.033	Diesel	50,000	3.18	160			536	24	12,864	72%	72%	628,931	8,427,673	5.13	135.53	11.29	1.90	1.85	4.07	0.45	6633.44	0.04	0.32	6,729.31
-Aux. Generator	1			2	1,609	Diesel	30,000	5.10	160			536	24	12,864	72%	72%		0,427,075	0.46	8.94	4.56		0.55		0.05	629.72		1.83E-02	
-Emergency Generator	1	1	E20 v 110 v 44 (21)	1	660	Diesel			0	C)	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Fall Pipe Vessel - Solid ballast -Main Generators	3	1	520 x 118 x 44 (31)	3	6,032	Diesel	50,000	3.18	160	6	,	340	24	8,160	72%	72%	628,931	5,345,912	5.13	135.53	11.29	1.90	1.85	4.07	0.45	6633.44	0.04	0.32	6,729.31
-Aux. Generator	1			2		Diesel			160	6		340	24	8,160	72%	72%			0.46	8.94	4.56	0.57	0.55	5.97E-03	0.05	629.72	0.08	1.83E-02	637.21
-Emergency Generator Fall Pipe Vessel - Scour protection	1	1	520 x 118 x 44 (31)	1	660	Diesel			0	(1	0	0	0	0%	0%)		0	0	0	0		- 0	0	0	0	0	0
-Main Generators	3		, ,	3		Diesel	50,000	3.18	160	6		536	24	12,864	72%	72%	628,931	8,427,673	5.13	135.53	11.29		1.85	4.07	0.45	6633.44	0.04	0.32	
-Aux. Generator -Emergency Generator	1			2		Diesel Diesel			160	6		536	24	12,864	72% 0%				0.46	8.94	4.56	0.57	0.55	5.97E-03	0.05	629.72	0.08	1.83E-02	637.21
Tug 1 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)									, ,				070	1		,	,	Ü	0							
-Main Engines	2 1			2		Diesel Diesel	10,000	3.18	80	65		360	24	8,640	24% 0%	24%	681,342	1,132,075	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.34
-Harbor Generator -Emergency Generator	1			1		Diesel			0			0 0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	ا ٥
Tug 2 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																										
-Main Engines -Harbor Generator	2 1			2 1		Diesel Diesel	10,000	3.18	80	65		360	24	8,640 0	24% 0%	24%	681,342	1,132,075	5.56	108.91	55.57 0	6.88	6.67	0.07	0.59	7668.10 0	1.00	0.22	7,759.34 0
-Emergency Generator	1			1		Diesel			0	C)	0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
Tug 3 for GBS Bases (from Coeymans) -Main Engines	2	N/A	146 x 46 x 25 (21)	2	5 440	Diesel	10,000	3.18	90	65		360	24	8,640	24%	24%	681,342	1,132,075	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.34
-Harbor Generator	1			1	456	Diesel	10,000	5.10	0	0.5		0	0	0,040	0%	0%	001,542	1,132,073	0	0	0	0.00	0.07	0.07	0.55	0	0	0.22	0
-Emergency Generator	1	21/2	446 46 25 (24)	1	168	Diesel			0	C	1	0	0	0	0%	0%	i		0	0	0	0	0	0	0	0	0	0	0
Tug 4 for GBS Bases (from Coeymans) -Main Engines	2	N/A	146 x 46 x 25 (21)	2	5,440	Diesel	10,000	3.18	80	65		360	24	8,640	24%	24%	681,342	1,132,075	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.34
-Harbor Generator	1			1	456	Diesel			0	C	,	0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
-Emergency Generator GBS Base Barge 1	1		400 x 105 x 25	1	168	Diesel			0	(1	0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
	N/A	N/A	100 X 103 X 23	N/A	N/A	N/A	0	N/A	80	18	;	360	24	8,640	N/A	N/A	N/A	N/A											
GBS Base Barge 2	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A		N/A	90	10		360	24	8,640	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany)	11/75	N/A	146 x 46 x 25 (21)	N/A	IN/A	IN/A		N/A	80	10	'		24	8,040	IN/A	N/A	NA	N/A											
-Main Engines	2			2		Diesel	10,000	3.18	16	69		730	24	17,520	24% 0%	24%	144,654	2,295,597	1.18	23.12	11.80	1.46	1.42	0.02	0.13	1628.00	0.21	0.05	1,647.37
-Harbor Generator -Emergency Generator	1 1			1		Diesel Diesel			0			0 0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	ا ٥
Tug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)																										
-Main Engines -Harbor Generator	2 1			2 1		Diesel Diesel	10,000	3.18	16	69		730	24	17,520 0	24% 0%	24%	144,654	2,295,597	1.18	23.12	11.80	1.46	1.42	0.02	0.13	1628.00 0	0.21	0.05	1,647.37 0
-Emergency Generator	1			1		Diesel			0	C)	0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
Transition Piece Barge	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A		N/A	16] .	730	24	17,520	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1	N/A	N/A	65 x 17 x 5	IN/A	18/75	IV/A		IN/A	10	03	'	, /30	24	17,520	14/74	N/A	IN/A	19/75						+					
-Main Engines	2			1		Diesel	4,000	3.18	52	9		365	24	8,760	51%	51%		459,119	0.11	3.82	1.95	0.10	0.10		1.06E-02	268.84	0.04	7.79E-03	
-Main Generators Safety Vessel 1	2	N/A	65 x 17 x 5	1	27	Diesel	+		52	9	'	365	24	8,760	51%	51%)		2.82E-03	0.10	0.05	2.70E-03	2.61E-03	6.83E-05	2.83E-04	7.21	9.40E-04	2.09E-04	7.29
-Main Engines	2			1		Diesel	5,000	3.18	12		1	365	24	8,760	95%	95%		573,899	0.03	1.09	0.55		0.03		3.01E-03	76.52		2.22E-03	
-Main Generators	2	1		1	27	Diesel		l	12	9	1	365	24	8,760	95%	95% TOTALS		53,290,881	1.22E-03 55.51	0.04 1,289.37	0.02 326.70		1.13E-03 41.88		1.22E-04 5.36	3.11 74,264		9.01E-05 2.87	

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EW 2 GBS Cobra

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Virginia port to local staging area at SBMT: 293.5 nm (30 nm in VA state waters, 250 nm in non-OCS federal waters, and 13.5 nm in NY/NJ state waters)

 Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for each heavy lift vessel.

 160 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
- 80 round trips from Virginia port to local staging area at SBMT for GBS pillar supply vessel, based on assumed capacity to transport components for four positions per trip (for 160 total positions).
- 80 round trips to/from Coeymans for each GBS base tow tug (for 160 total positions). 16 round trips to/from Port of Albany for each TP barge tug (for 160 total positions).
- Weekly round trips to/from port for crew transfer vessels.
- Monthly round trips to/from port for safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. CO_2e emission rates use the following carbon equivalence factors: 25 for CH, and 298 for N_2O .

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Aker GBS Design, Lift-Install Option)

																						Total Em	nissions (Non-1	Transit)				
Vessels/Equipment	No. of Engine per vess		Dimensions (ft) I length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Fuel Rating Type (hp)	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operatin Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N ₂ O tons	CO₂e tons
Helicopter - Twin-Engine Heavy		N/A		worksneetj																								
-Main E	ingines 2			164	1,400 Jet fuel	N/A	N/A	104	0.	5	0 0	C	0	100%	0%	16,366	6 0	0	0	0	0	0	0	0	О	0	0	(
Heavy Lift Vessel - Foundation installation		1	661 x 290 x 162 (43)																									
-Main E -Main E				3	6,568 Diesel 6,032 Diesel	80,000	3.18	1		6	0 376 0 376		9,024 9,024		29% 29%		9,459,119	42.66 26.12	1126.35 689.60	93.86 57.47	15.81 9.68	15.34 9.39		3.77 2.31		0.34 0.21	2.65 1.62	55,926.60 34,240.78
-Main E				3	7,373 Diesel			1	L	6	0 376		9,024					15.96		35.12	5.92	5.74		1.41		0.21	0.99	20,924.92
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)										,															
-Main E Fall Pipe Vessel - Seabed filter layer	ingines 6	1	520 x 118 x 44 (31)	3	4,500 Diesel	50,000	3.18	1	L	6	0 530	24	12,720	53%	53%	3,931	1 8,333,333	74.66	1971.09	164.26	27.67	26.84	59.25	6.59	96,476.14	0.60	4.63	97,870.54
-Main Gene	erators 3	1	520 X 110 X 44 (51)	3	6,032 Diesel	50,000	3.18	160		6	536	24	12,864	72%	72%	628,931	1 8,427,673	68.79	1816.06	151.34	25.49	24.73	54.59	6.08	88,888.07	0.55	4.26	90,172.80
-Aux. Ger				2	1,609 Diesel			160)	6	536	24	12,864		72%			6.11	119.85	61.15	7.57	7.35	0.08	0.65	8,438.28	1.10	0.24	8,538.68
-Emergency Ger Fall Pipe Vessel - Solid ballast	nerator 1	1	520 x 118 x 44 (31)	1	660 Diesel			0)	0	0 0	C	0	0%	0%	5		0	0	0	0	0	0	0	0	0	0	(
-Main Gene	erators 3	1	520 X 118 X 44 (31)	3	6,032 Diesel	50,000	3.18	160		6	0 340	24	8,160	72%	72%	628,931	1 5,345,912	43.64	1151.98	96.00	16.17	15.69	34.63	3.85	56,384.22	0.35	2.71	57,199.16
-Aux. Ger				2	1,609 Diesel			160		6	340	24	8,160	72%			.,,.	3.88		38.79	4.80	4.66		0.41		0.70	0.16	5,416.33
-Emergency Ger	nerator 1			1	660 Diesel			0)	0	0 0	C	0	0%	0%	S		0	0	0	0	0	0	0	0	0	0	(
Fall Pipe Vessel - Scour protection -Main Gene	arators 3	1	520 x 118 x 44 (31)	3	6,032 Diesel	50,000	3.18	160		6	0 536	2/	12,864	72%	72%	628,931	1 8,427,673	68.79	1816.06	151.34	25.49	24.73	54.59	6.08	88,888.07	0.55	4.26	90,172.80
-Aux. Ger				2	1,609 Diesel	30,000	5.10	160		6	536		12,864				0,427,073	6.11		61.15		7.35		0.65		1.10		
-Emergency Ger	nerator 1			1	660 Diesel			0)	0	0 0	C	0	0%	0%	S		0	0	0	0	0	0	0	0	0	0	(
Tug 1 for GBS Tow -Main E	inginos 2	N/A	146 x 46 x 25 (21)	2	5,440 Diesel	10,000	3.18	80	6	5	360	24	8,640	24%	24%	681,342	1,132,075	9.23	180.96	92.32	11.43	11.09	0.12	0.98	12,740.84	1.66	0.37	12,892.44
-Harbor Ger				1	456 Diesel	10,000	3.16	0		0	0 0	24	8,040	0%	0%		1,132,073	0	0	0	0	0	0.12	0.38	0	0.00	0.57	12,032.44
-Emergency Ger				1	168 Diesel			0)	0	0 0	C	0	0%	0%	S		0	0	0	0	0	0	0	0	0	0	(
Tug 2 for GBS Tow		N/A	146 x 46 x 25 (21)																				1					
-Main E -Harbor Ger				2	5,440 Diesel 456 Diesel	10,000	3.18	80	6	0	0 360	24	8,640	24%			1,132,075	9.23	180.96	92.32	11.43	11.09	0.12	0.98	12,740.84	1.66	0.37	12,892.44
-Emergency Ger				1	168 Diesel			0		0	0 0	d	0	0%				0	0	0	0	0	0	0	o	0	0	
Tug 3 for GBS Tow		N/A	146 x 46 x 25 (21)																				i I					
-Main E -Harbor Ger				2	5,440 Diesel 456 Diesel	10,000	3.18	80	6	5	360	24	8,640	24%	24%		1,132,075	9.23	180.96	92.32	11.43	11.09	0.12	0.98	12,740.84	1.66	0.37	12,892.44
-Emergency Ger				1	168 Diesel			0		0			0	0%	0%			0	0	0	0	0	1 0	0	0	0	0	(
Tug 4 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main E				2	5,440 Diesel	10,000	3.18	80	6	5	360	24	8,640				1,132,075	9.23	180.96	92.32	11.43	11.09	0.12	0.98	12,740.84	1.66	0.37	12,892.44
-Harbor Ger -Emergency Ger				1	456 Diesel 168 Diesel			0		0	0 0		0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
Tug 1 for Ballast Barge		N/A	136 x 36 x 19 (17)										-											-		-	-	
-Main E				2	3,600 Diesel	10,000	3.18	80	1	8	360		8,640		35%	,	1,132,075	9.00	176.30	89.95	11.14	10.81		0.96	12,413.27	1.62	0.36	12,560.97
-Aux. E Tug 2 for Ballast Barge	ingines 2	N/A	136 x 36 x 19 (17)	1	95 Diesel			80	1	8	0 360	24	8,640	35%	35%	5		0.13	4.65	2.37	0.12	0.12	3.10E-03	1.29E-02	327.57	0.04	9.49E-03	331.47
-Main E	ingines 2	14/7	130 x 30 x 13 (17)	2	3,600 Diesel	10,000	3.18	80	1	8	360	24	8,640	35%	35%	188,679	1,132,075	9.00	176.30	89.95	11.14	10.81	0.12	0.96	12,413.27	1.62	0.36	12,560.97
-Aux. E				1	95 Diesel			80	1	8	0 360		8,640	35%	35%	S		0.13	4.65	2.37	0.12	0.12	3.10E-03	1.29E-02	327.57	0.04	9.49E-03	331.47
GBS Ballast Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A N/A		N/A	0.0			0 360		8,640	N/A	N/A	N/A	N/A						r L					
GBS Ballast Barge 2	N/A	IN/A	400 x 105 x 25	IN/A	N/A N/A		IN/A	00	, 1	0	300	24	8,040	IN/A	IN/A	IN/A	N/A						-					
	N/A	N/A		N/A	N/A N/A	C	N/A	80	1	8	360	24	8,640	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)	2	F 440 DiI	10.000	3.10	10	6		720		17.530	24%	2.40/	144.054	2 205 507	10.70	200.04	107.21	22.10	22.40	0.24	1.00	25 625 50	2.27	0.75	26 142 06
-Main E -Harbor Ger				2	5,440 Diesel 456 Diesel	10,000	3.18	16		0	0 730 0 0	24	17,520 0	0%	24%	,	2,295,597	18.72 0	366.94 0	187.21 0	23.18	22.49 0	0.24	1.99 0	25,835.59 0	3.37 0	0.75 0	26,143.00
-Emergency Ger				1	168 Diesel			0		0	0 0	C	0	0%	0%	S		0	0	0	0	0	0	0	0	0	0	(
Tug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)	2	5 440 8:	46.000							47				2 205 555	40.70	255.0	407.51	22.62	22	0.51	4.00	25 025 56	2.55	0	26 445 55
-Main E -Harbor Ger				2	5,440 Diesel 456 Diesel	10,000	3.18	16	6	0	0 730	24	17,520	24%	24%		2,295,597	18.72	366.94	187.21	23.18	22.49 0	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Emergency Ger				1	168 Diesel					0	0		0	0%				0	0	0	0	0	0	0	0	0	0	
Transition Piece Barge			400 x 105 x 25																			-						
Crow Transfer Voscal 1	N/A	N/A	65 v 17 v 5	N/A	N/A N/A	C	N/A	16	6	9	0 730	24	17,520	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1 -Main E	ingines 2	N/A	65 x 17 x 5	1	1,000 Diesel	4,000	3.18	52	2	9	365	24	8,760	51%	51%	24,528	3 459,119	1.97	71.47	36.47	1.88	1.83	0.05	0.20	5,032.21	0.66	0.15	5,092.08
-Main Gene				1	27 Diesel	,,,,,		52		9	0 365							0.05		0.98		0.05		5.30E-03		0.02		
Safety Vessel 1		N/A	65 x 17 x 5		550 81								0				572.000	2	00.45		2	2	0.55	0.5.	6 206 77	0.61	0	6 206 55
-Main E -Main Gene				1	660 Diesel 27 Diesel	5,000	3.18	12		9	0 365 0 365		8,760 8,760		95% 95%		5 573,899	2.43 0.10	88.15 3.58	44.98 1.83	2.32 0.09	2.25 0.09		0.24 9.90E-03		0.81	0.18 7.31E-03	6,280.63 255.12

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for each heavy lift vessel.

 160 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
- 80 round trips to/from Coeymans for each GBS tow tug (for 160 total positions).
 80 round trips to/from SBMT for each ballast barge tug (for 160 total positions).
 16 round trips to/from Port of Albany for each TP barge tug (for 160 total positions).
- Weekly round trips to/from port for crew transfer vessels.

 Monthly round trips to/from port for safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂ and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Aker GBS Design, Lift-Install Option)

																						Total I	Emissions (Tra	ınsit)				
Vessels/Equipment	No. of Engines per vessel	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Fuel Rating Type (hp)	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operatin Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO ₂ e tons
Helicopter - Twin-Engine Heavy		N/A		worksneet)																								
-Main Engine	es 2			164	1,400 Jet fuel	N/A	A N/A	104	1 0.5	5 (0	C	0	100%	0%	16,366	0	0.07	0.90	0.02	0.02	0.02	0.05	1.80E-03	172.65	4.94E-03	5.72E-03	174.4
Heavy Lift Vessel - Foundation installation		1	661 x 290 x 162 (43)																									
-Main Engine -Main Engine				3	6,568 Diesel 6,032 Diesel	80,000	3.18	1	1	6 (376		9,024 9,024		29% 29%		9,459,119	0.03	0.75 0.46	0.06 0.04	1.05E-02 6.44E-03	1.02E-02 6.24E-03	0.02 1.38E-02	2.51E-03 1.53E-03	36.66 22.44	2.27E-04 1.39E-04	1.76E-03 1.08E-03	37.1 22.7
-Main Engine				3	7,373 Diesel			1	i	6	376		9,024		29%			1.06E-02	0.48	0.04	3.93E-03	3.82E-03		9.37E-04	13.71	8.49E-05	6.58E-04	13.9
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engine Fall Pipe Vessel - Seabed filter layer	es 6	1	520 x 118 x 44 (31)	3	4,500 Diesel	50,000	3.18	1	1 1	6 (530	24	12,720	53%	53%	3,931	8,333,333	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.1
-Main Generato	rs 3	1	320 X 110 X 44 (31)	3	6,032 Diesel	50,000	3.18	160		6 (536	24	12,864	72%	72%	628,931	8,427,673	5.13	135.53	11.29	1.90	1.85	4.07	0.45	6633.44	0.04	0.32	6,729.3
-Aux. Generato				2	1,609 Diesel			160)	6	536		12,864	72%	72%		.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	0.46	8.94	4.56	0.57	0.55		0.05		0.08		637.2
-Emergency Generate	or 1		520 440 44 (24)	1	660 Diesel			C) (0 (0	C	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Fall Pipe Vessel - Solid ballast -Main Generato	rs 3	1	520 x 118 x 44 (31)	3	6,032 Diesel	50,000	3.18	160)	6 (340	24	8,160	72%	72%	628,931	5,345,912	5.13	135.53	11.29	1.90	1.85	4.07	0.45	6633.44	0.04	0.32	6,729.3
-Aux. Generate				2	1,609 Diesel	30,000	5.10	160		6	340	24	8,160		72%		3,3 13,312	0.46	8.94	4.56	0.57	0.55		0.05		0.08	1.83E-02	
-Emergency Generate	or 1			1	660 Diesel			C) (0 (0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Fall Pipe Vessel - Scour protection -Main Generato	2	1	520 x 118 x 44 (31)	2	6,032 Diesel	50,000	3.18	160			536	24	12,864	72%	72%	628,931	8,427,673	F 12	135.53	11.20	1.90	1.85	4.07	0.45	6633.44	0.04	0.32	6,729.3
-Aux. Generato				2	1,609 Diesel	30,000	3.10	160		6 (536		12,864				0,427,073	5.13 0.46	8.94	11.29 4.56	0.57	0.55		0.45		0.04		
-Emergency Generate	or 1			1	660 Diesel			C)	0	0	C	0	0%				0	0	0	0	0	0	0	0	0	0	
Tug 1 for GBS Tow		N/A	146 x 46 x 25 (21)	_																								
-Main Engine -Harbor Generato				2 1	5,440 Diesel 456 Diesel	10,000	3.18	80	6:	0 1	360	24	8,640	24% 0%	24%	681,342	1,132,075	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.3
-Emergency Generate				1	168 Diesel			Ċ		0	0	ď	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Tug 2 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engine				2 1	5,440 Diesel 456 Diesel	10,000	3.18	80	6:	5 (360	24	8,640	24% 0%	24% 0%	,	1,132,075	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.3
-Harbor Generato -Emergency Generato				1	168 Diesel					0 0) 0		0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Tug 3 for GBS Tow		N/A	146 x 46 x 25 (21)	_				-				-	-	4,1					-	_								
-Main Engine				2	5,440 Diesel	10,000	3.18	80	6	5 (360	24	8,640		24%		1,132,075	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.3
-Harbor Generato -Emergency Generato				1	456 Diesel 168 Diesel			(0 () 0		0	0% 0%	0% 0%			0	0	0	0	0	0	0	0	0	0	
Fug 4 for GBS Tow	, 1	N/A	146 x 46 x 25 (21)	-	100 Diesei				,	,			U	076	076			U	U	U	U	0	0	0	0	0	U	
-Main Engine				2	5,440 Diesel	10,000	3.18	80	6	5 (360	24	8,640		24%		1,132,075	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.3
-Harbor Generate				1	456 Diesel 168 Diesel			C		0 (0	0	0	0% 0%	0%			0	0	0	0	0	0	0	0	0	0	
-Emergency Generate Fug 1 for Ballast Barge	or 1	N/A	136 x 36 x 19 (17)	1	168 Diesei			·	, ,) (U	0%	0%			0	U	U	U	U	U	0	U	0	0	
-Main Engine	es 2	,	150 X 50 X 15 (17)	2	3,600 Diesel	10,000	3.18	80	1	8 (360	24	8,640	35%	35%	188,679	1,132,075	1.50	29.38	14.99	1.86	1.80	1.96E-02	0.16	2068.88	0.27	0.06	2,093.4
-Aux. Engine	es 2			1	95 Diesel			80	1	3 (360	24	8,640	35%	35%			2.14E-02	0.78	0.40	2.04E-02	1.98E-02	5.17E-04	2.14E-03	54.60	7.12E-03	1.58E-03	55.2
Fug 2 for Ballast Barge -Main Engine	os 2	N/A	136 x 36 x 19 (17)	2	3,600 Diesel	10,000	3.18	80	11		360	24	8,640	35%	35%	188,679	1,132,075	1.50	29.38	14.99	1.86	1.80	1.96E-02	0.16	2068.88	0.27	0.06	2,093.4
-Aux. Engine				1	95 Diesel	10,000	3.16	80	1	8 (360		8,640		35%		1,132,073	2.14E-02	0.78	0.40		1.98E-02		2.14E-03	54.60	7.12E-03		55.2
GBS Ballast Barge 1			400 x 105 x 25																									
CRC Rollact Rargo 2	N/A	N/A	400 x 105 x 25	N/A	N/A N/A	C	N/A	80) 1	8 (360	24	8,640	N/A	N/A	N/A	N/A											
GBS Ballast Barge 2	N/A	N/A	400 X 103 X 23	N/A	N/A N/A	C	N/A	80	1	8 (360	24	8,640	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)											-	,													
-Main Engine				2	5,440 Diesel	10,000	3.18	16	6	9 (730	24	17,520		24%	144,654	2,295,597	1.18	23.12	11.80	1.46	1.42	0.02	0.13	1628.00	0.21	0.05	1,647.3
-Harbor Generato -Emergency Generato				1 1	456 Diesel 168 Diesel					0) 0		0	0% 0%	0% 0%			0	0	0	0	0	0	0	0	0	0	
Fug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)	-	100 516361					,			Ū	0,0	0,0			ŭ		Ĭ	Ů							
-Main Engine				2	5,440 Diesel	10,000	3.18	16	6	9 (730	24	17,520		24%		2,295,597	1.18	23.12	11.80	1.46	1.42	0.02	0.13	1628.00	0.21	0.05	1,647.3
-Harbor Generate				1	456 Diesel 168 Diesel			0		0 (0	0	0	0% 0%	0% 0%			0	0	0	0	0	0	0	0	0	0	
-Emergency Generate Fransition Piece Barge	J. I	1	400 x 105 x 25	1	TOO DIEZEI				1	'			U	0%	U%			U	U	U	U	U	U	U	U	U	U	
	N/A	N/A		N/A	N/A N/A	C	N/A	16	6	9 (730	24	17,520	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1	3	N/A	65 x 17 x 5		1 000 0:!	4.000	3.50		,		300		0.700	E40/	E40/	24 520	450 110	0.11	2.02	1.05	0.10	0.10	2 555 02	1.005.03	200.04	0.04	7 705 02	272.0
-Main Engine -Main Generato				1	1,000 Diesel 27 Diesel	4,000	3.18	52 52		9 1	365		8,760 8,760		51% 51%		459,119	0.11 2.82E-03	3.82 0.10	1.95 0.05	0.10 2.70E-03	0.10 2.61E-03	2.55E-03 6.83E-05	1.06E-02 2.83E-04	268.84 7.21	0.04 9.40E-04	7.79E-03 2.09E-04	7.2
Safety Vessel 1	1 -	N/A	65 x 17 x 5							<u> </u>			3,700	31/0	32/0				0.20	0.03	02 03	22	5.552 05		7,22			
-Main Engine	es 2			1	660 Diesel	5,000	3.18	12	2	9 (365		8,760	95%	95%	7,075	573,899	0.03	1.09	0.55	0.03	0.03	7.25E-04	3.01E-03	76.52	9.98E-03	2.22E-03	77.4 3.1
-Main Generato					27 Diesel						365	24	8,760	95%	95%		1	1.22E-03	0.04	0.02	1.16E-03	1.13E-03	2.95E-05	1.22E-04	3.11	4.05E-04	9.01E-05	

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for each heavy lift vessel.

 160 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).
- 80 round trips to/from Coeymans for each GBS tow tug (for 160 total positions).
 80 round trips to/from SBMT for each ballast barge tug (for 160 total positions).
 16 round trips to/from Port of Albany for each TP barge tug (for 160 total positions).
- Weekly round trips to/from port for crew transfer vessels.

 Monthly round trips to/from port for safety vessels.
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.
 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂ and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Aker GBS Design, Self-Install Option)

																							Total Er	nissions (Non-	Transit)				
Vessels/Equipment	No. of Engines per vessel	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Gallons	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N ₂ O tons	CO₂e tons
Helicopter - Twin-Engine Heavy		N/A																											
-Main Er	ngines 2			164	1 400	Jet fuel	N/A	N/A	104	0.5		0	0	0	100%	0%	16,366		0	0	0	0		0	0	0	0	0	0
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)					-											-	-					_				
-Main Er Fall Pipe Vessel - Seabed filter layer	ngines 6	1	520 x 118 x 44 (31)	3	4,500	Diesel	50,000	3.18	1	. 6	i	0 530	24	12,720	53%	53%	3,931	8,333,333	74.66	1971.09	164.26	27.67	26.84	59.25	6.59	96,476.14	0.60	4.63	97,870.54
-Main Gene	erators 3	_	320 X 118 X 44 (31)	3		Diesel	50,000	3.18	160	6		0 536	24	12,864	72%	72%	628,931	8,427,673	68.79	1816.06	151.34	25.49	24.73	54.59	6.08	88,888.07	0.55	4.26	
-Aux. Gene				2		Diesel Diesel			160	6		0 536	24	12,864	72% 0%				6.11	119.85	61.15	7.57	7.35	0.08	0.65	8,438.28	1.10	0.24	8,538.68
-Emergency Gene Fall Pipe Vessel - Solid ballast	ierator 1	1	520 x 118 x 44 (31)	1	660	Diesei			U	·	1	0 0	U	U	U%	0%			U	U	·	0		, 0	U	U	U	U	U
-Main Gene				3		Diesel	50,000	3.18	160	6		0 340	24	8,160	72%	72%	628,931	5,345,912	43.64	1151.98	96.00		15.69		3.85	56,384.22		2.71	
-Aux. Gene -Emergency Gen				2		Diesel Diesel			160 0	6		0 340	24	8,160	72% 0%				3.88	76.02 0	38.79 0	4.80	4.66	0.05	0.41	5,352.64 0	0.70	0.16 0	5,416.33 0
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																										
-Main Gene -Aux. Gene				3 2		Diesel Diesel	50,000	3.18	160 160			0 536 0 536		12,864 12,864	72% 72%	72% 72%		8,427,673	68.79 6.11	1816.06 119.85	151.34 61.15		24.73 7.35		6.08 0.65	88,888.07 8,438.28		4.26 0.24	
-Emergency Gen				1		Diesel			0	0		0 0	0	0	0%				0	0	0	0	(0	0	0	0	0	0
Tug 1 for GBS Tow/Installation -Main Er	ngines 2	N/A	146 x 46 x 25 (21)	2	5 440	Diesel	10,000	3.18	90	65		0 730	24	17,520	24%	24%	681,342	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Harbor Gen				1		Diesel	10,000	3.10	0	0		0 0	0	0	0%	0%	001,542	2,233,337	0	0	107.21	0	22.43	0.24	0	25,055.55	0	0.73	0
-Emergency Gen	nerator 1	N1/A	146 46 25 (24)	1	168	Diesel			0	C		0 0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
Tug 2 for GBS Tow/Installation -Main Er	ingines 2	N/A	146 x 46 x 25 (21)	2	5,440	Diesel	10,000	3.18	80	65		0 730	24	17,520	24%	24%	681,342	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Harbor Gen	nerator 1			1		Diesel			0	0		0 0	0	0	0%				0	0	0	0	0	0	0	0	0	0	0
-Emergency General Tug 3 for GBS Tow/Installation	nerator 1	N/A	146 x 46 x 25 (21)	1	168	Diesel				0		0 0	0	0	0%	0%			0	0		0	(0	0		0	0	0
-Main Er			,	2		Diesel	10,000	3.18	80	65		0 730	24	17,520	24%		681,342	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Harbor Gene -Emergency Gene				1		Diesel Diesel			0	0		0 0	0	0	0% 0%				0	0	0	0	(0	0	0	0	0	0
Tug 4 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)	-								0 0		, ,						Ŭ		, ,			Ŭ				
-Main Er -Harbor Gen	ingines 2 nerator 1			2 1		Diesel Diesel	10,000	3.18	80	65		0 730	24	17,520	24% 0%	24%	681,342	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Emergency Gen				1		Diesel			0	0		0 0	0	0	0%	0%			0	0	0	0	(0	0	0	0	0	0
Tug 1 for Ballast Barge		N/A	136 x 36 x 19 (17)	2	2 500	D'	10.000	3.40		4.0		250		0.540	250/	250	400.676	4 422 075	0.00	476.20	20.05		40.04	0.43	0.05	42 442 27	4.62	0.26	42 550 07
-Main Er -Aux. Er				2 1		Diesel Diesel	10,000	3.18	80	18 18		0 360 0 360		8,640 8,640	35% 35%	35% 35%		1,132,075	9.00 0.13	176.30 4.65	89.95 2.37		10.81 0.12		0.96 1.29E-02	12,413.27 327.57		0.36 9.49E-03	
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																										
-Main Er -Aux. Er				2 1		Diesel Diesel	10,000	3.18	80 80			0 360 0 360		8,640 8,640	35% 35%	35% 35%	188,679	1,132,075	9.00 0.13	176.30 4.65	89.95 2.37		10.81 0.12		0.96 1.29E-02	12,413.27 327.57		0.36 9.49E-03	
GBS Ballast Barge 1			400 x 105 x 25																				-						
GBS Ballast Barge 2	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	80	18	1	0 360	24	8,640	N/A	N/A	N/A	N/A											
	N/A	N/A		N/A	N/A	N/A	0	N/A	80	18		0 360	24	8,640	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany) -Main Er	ingines 2	N/A	146 x 46 x 25 (21)	2	5.440	Diesel	10,000	3.18	16	69		0 730	24	17,520	24%	24%	144,654	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Harbor Gene				1	456	Diesel	10,000	3.10	0	0		0 750	0	0	0%	0%	144,034	2,233,337	0	0	07.21	0	(0.24	0	25,055.55	0	0.73	0
-Emergency Gen	nerator 1	N/A	146 v 46 v 25 (21)	1	168	Diesel			0	C		0 0	С	0	0%	0%			0	0	0	0	C	0	0	0	0	0	0
Tug 2 for Transition Pieces (from Albany) -Main Er	ingines 2	N/A	146 x 46 x 25 (21)	2	5,440	Diesel	10,000	3.18	16	69		0 730	24	17,520	24%	24%	144,654	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Harbor Gen	nerator 1			1		Diesel			0	0		0 0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Gene Transition Piece Barge	ierator 1		400 x 105 x 25	1	168	Diesel			0	0		0	U	0	0%	0%	1		0	0	U	0	·	0	0	0	0	0	0
	N/A	N/A		N/A	N/A	N/A	0	N/A	16	69		0 730	24	17,520	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1 -Main Er	ngines 2	N/A	65 x 17 x 5	1	1,000	Diesel	4,000	3.18	52	q		0 365	24	8,760	51%	51%	24,528	459,119	1.97	71.47	36.47	1.88	1.83	0.05	0.20	5,032.21	0.66	0.15	5,092.08
-Main Gene				1		Diesel	.,	2.20	52	9		0 365	24	8,760	51%			,	0.05	1.92	0.98		0.05		5.30E-03	134.91			
Safety Vessel 1 -Main Er	ingines 2	N/A	65 x 17 x 5	1	660	Diesel	5,000	3.18	12	c		0 365	2/	8,760	95%	95%	7,075	573,899	2.43	88.15	44.98	2.32	2.25	0.06	0.24	6,206.77	0.81	0.18	6,280.63
-Main Gene				1		Diesel	3,000	3.10	12			0 365			95%			3,3,833	0.10	3.58	1.83		0.09		9.90E-03	252.12			

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area) 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for the heavy lift vessel.
- 160 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo). 80 round trips to/from Coeymans for each GBS tow tug (for 160 total positions).

- 80 round trips to/from SBMT for each ballast barge tug (for 160 total positions).

 16 round trips to/from Port of Albany for each TP barge tug (for 160 total positions).

 Weekly round trips to/from port for the crew transfer vessels.
- Monthly round trips to/from port for the construction support vessels and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
 The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. CO_2 e emission rates use the following carbon equivalence factors: 25 for CH_2 , and 298 for N_2O .

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Aker GBS Design, Self-Install Option)

																							iotai	Emissions (Tra	insit)				
Vessels/Equipment	No. of Engines per vessel		Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N ₂ O tons	CO ₂ e tons
Helicopter - Twin-Engine Heavy		N/A		worksneed																									
-Main Engin	2			164	1 400	Jet fuel	N/A	N/A	104	0.5		0	0	0	100%	0%	16,366	0	0.07	0.90	0.02	0.02	0.02	0.05	1.80E-03	172.65	4.94E-03	5.72E-03	3 174.48
Heavy Lift Vessel - TP installation	ies z	1	600 x 154 x 60 (44)	104	1,400	Jet luei	IN/A	NA	104	0.5	,	0		U	10076	0/0	10,300	0	0.07	0.50	0.02	0.02	0.02	0.03	1.001-03	172.03	4.541-05	J./2L-03	174.40
-Main Engin	nes 6		1	3	4,500	Diesel	50,000	3.18	1	6	(530	24	12,720	53%	53%	3,931	8,333,333	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	3 46.17
Fall Pipe Vessel - Seabed filter layer	ors 3	1	520 x 118 x 44 (31)	2	6.022	Diesel	50,000	3.18	160			536	24	12.064	720/	720/	620 021	0 427 672	E 12	135.53	11 20	1.00	1 05	4.07	0.45	6622.44	0.04	0.22	6 720 2
-Main Generato -Aux. Generat				3 2		Diesel	50,000	3.18	160	6		536	24	12,864 12,864	72% 72%	72% 72%		8,427,673	5.13 0.46	8.94	11.29 4.56		1.85 0.55	4.07 5.97E-03	0.45 0.05	6633.44 629.72		0.32 1.83E-02	
-Emergency Generat				1		Diesel			0	Ċ		0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0) (
Fall Pipe Vessel - Solid ballast		1	520 x 118 x 44 (31)																										
-Main Generato -Aux. Generat				3 2		Diesel Diesel	50,000	3.18	160 160	6		340	24	8,160 8,160	72% 72%	72% 72%	628,931	5,345,912	5.13 0.46	135.53 8.94	11.29 4.56		1.85 0.55		0.45 0.05	6633.44 629.72		0.32 1.83E-02	
-Aux. Generat				1		Diesel			0	(0 0	0	8,160	0%	0%			0.46	0.94	4.30	0.57	0.55	3.97E-03	0.03	029.72	0.08	1.03E-02) 037.21
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)	1	000	Diesei									0,0	070			-		ŭ	ŭ						ŭ	
-Main Generato				3		Diesel	50,000	3.18	160	6	(536	24	12,864	72%	72%	628,931	8,427,673	5.13	135.53	11.29		1.85		0.45	6633.44		0.32	
-Aux. Generat				2		Diesel Diesel			160	6	9	536	24	12,864	72% 0%	72% 0%			0.46	8.94	4.56	0.57	0.55	5.97E-03	0.05	629.72	0.08	1.83E-02	637.21
-Emergency Generat Tug 1 for GBS Tow/Installation	tor 1	N/A	146 x 46 x 25 (21)	1	660	Diesei			0	(,	0	0	U	0%	0%			0	U	U	0	U	0	U	0	U U	U	
-Main Engin	nes 2	IV/A	140 x 40 x 25 (21)	2	5,440	Diesel	10,000	3.18	80	65		730	24	17,520	24%	24%	681,342	2,295,597	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.34
-Harbor Generat	tor 1			1		Diesel			0	C		0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	, (
-Emergency Generat	tor 1			1	168	Diesel			0	C	(0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Tug 2 for GBS Tow/Installation -Main Engin	2	N/A	146 x 46 x 25 (21)	2	5.440	Diesel	10,000	3.18	90	65		730	24	17,520	24%	24%	681,342	2,295,597	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.34
-Harbor Generat				1		Diesel	10,000	3.10	0	0.		0 0	0	17,320	0%	0%	001,342	2,233,337	0.50	0	0	0.88	0.07	0.07	0.59	7008.10	1.00	0.22) 7,733.34
-Emergency Generat				1		Diesel			0	Ċ	(0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0) (
Tug 3 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engin				2 1		Diesel	10,000	3.18	80	65	9	730	24	17,520	24% 0%	24% 0%	681,342	2,295,597	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.34
-Harbor Generat -Emergency Generat				1		Diesel Diesel			0	(0	0	0	0%	0%			0	0	0	0	0	0	0	0		0	,
Tug 4 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)	1	100	Diesei								Ü	070	070			Ĭ		Ů	Ů			Ŭ			ŭ	
-Main Engin				2		Diesel	10,000	3.18	80	65		730	24	17,520	24%	24%	681,342	2,295,597	5.56	108.91	55.57	6.88	6.67	0.07	0.59	7668.10	1.00	0.22	7,759.34
-Harbor Generat				1		Diesel			0	((0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	
-Emergency Generat Tug 1 for Ballast Barge	tor 1	N/A	136 x 36 x 19 (17)	1	168	Diesel			0	((0	0	0	0%	0%			0	0	0	0	C	0	0	0	0	0	
-Main Engin	nes 2	IV/A	130 x 30 x 13 (17)	2	3,600	Diesel	10,000	3.18	80	18		360	24	8,640	35%	35%	188,679	1,132,075	1.50	29.38	14.99	1.86	1.80	1.96E-02	0.16	2068.88	0.27	0.06	2,093.49
-Aux. Engin				1		Diesel	·		80	18	(360	24	8,640	35%	35%			2.14E-02	0.78	0.40		1.98E-02		2.14E-03	54.60		1.58E-03	
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																										
-Main Engin				2		Diesel Diesel	10,000	3.18	80	18	9	360 360	24	8,640 8.640	35% 35%	35% 35%		1,132,075	1.50 2.14E-02	29.38 0.78	14.99 0.40		1.80 1.98E-02	1.96E-02 5.17E-04	0.16 2.14E-03	2068.88 54.60		0.06 1.58E-03	
-Aux. Engin GBS Ballast Barge 1	ies z		400 x 105 x 25	1	93	Diesei			80	10	,	360	24	8,040	3370	3370			2.146-02	0.78	0.40	2.04E-02	1.900-02	3.17E-04	2.146-05	34.00	7.12E-03	1.30E-03	33.24
	N/A	N/A		N/A	N/A	N/A	0	N/A	80	18		360	24	8,640	N/A	N/A	N/A	N/A											
GBS Ballast Barge 2			400 x 105 x 25																										
Tue 1 fee Tanachies Dieses (fees Albert)	N/A	N/A	146 46 25 (21)	N/A	N/A	N/A	0	N/A	80	18	(360	24	8,640	N/A	N/A	N/A	N/A											
Tug 1 for Transition Pieces (from Albany) -Main Engin	nes 2	N/A	146 x 46 x 25 (21)	2	5,440	Diesel	10,000	3.18	16	69		730	24	17,520	24%	24%	144,654	2,295,597	1.18	23.12	11.80	1.46	1.42	0.02	0.13	1628.00	0.21	0.05	1,647.37
-Harbor Generat				1		Diesel		0.20	0	0		0	0	0	0%	0%	2,	_,,	0	0	0	0	0	0	0	0	0	0)
-Emergency Generat	tor 1			1	168	Diesel			0	C	(0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	1 (
Tug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)			Diago	40.555	2] .			47.500	2	2.55	444.65	2 205 55-		22.42	44.00			2.22	0.40	1620.65	22.	2.5-	
-Main Engin -Harbor Generat				2 1		Diesel Diesel	10,000	3.18	16 0	69) :	730	24 n	17,520 0	24% 0%	24%	144,654	2,295,597	1.18	23.12	11.80	1.46	1.42	0.02	0.13	1628.00 0	0.21	0.05	1,647.37
-Emergency Generat				1		Diesel			0	(0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	,
Transition Piece Barge			400 x 105 x 25																										
C. T. C. V. L.	N/A	N/A	65 47 5	N/A	N/A	N/A	0	N/A	16	69	(730	24	17,520	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1 -Main Engin	105 7	N/A	65 x 17 x 5	1	1 000	Diesel	4,000	3.18	ED	,		365	24	8,760	51%	51%	24,528	459,119	0.11	3.82	1.95	0.10	0.10	2.55E-03	1.06E-02	268.84	0.04	7.79E-03	3 272.04
-Main Engin				1		Diesel	4,000	5.18	52	5		365	24	8,760	51% 51%	51%		455,119	2.82E-03	0.10	0.05		2.61E-03		2.83E-04	7.21		2.09E-04	
Safety Vessel 1	_	N/A	65 x 17 x 5		2,				- 52	-		303		2,. 00	22/0	31/0			2.522 30	2.20	2.05			5.555 55			51.52.01		1.23
-Main Engin -Main Generato				1		Diesel	5,000	3.18	12	9		365	24	8,760	95%	95%		573,899	0.03	1.09	0.55		0.03		3.01E-03	76.52		2.22E-03	
				1 4	27	Diesel	i i		12			365	24	8,760	95%	95%			1.22E-03	0.04	0.02	1.16E-03	1.13E-03	2.95E-05	1.22E-04	3.11	4.05E-04	9.01E-05	3.15

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- Port of Coeymans to South Brooklyn Marine Terminal: 119.3 nm Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area) 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for the heavy lift vessel.
- 160 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo). 80 round trips to/from Coeymans for each GBS tow tug (for 160 total positions).

- 80 round trips to/from SBMT for each ballast barge tug (for 160 total positions).

 16 round trips to/from Port of Albany for each TP barge tug (for 160 total positions).

 Weekly round trips to/from port for the crew transfer vessels.
- Monthly round trips to/from port for the construction support vessels and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
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- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. CO_2 e emission rates use the following carbon equivalence factors: 25 for CH_2 , and 298 for N_2O .

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Pre-Piled Jacket Design)

																							Total Emis	sions (Nor	-Transit)				
				Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of 1.	DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	Total Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N ₂ O	CO ₂ e
	-	Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
pr	er vessel 3.9	Spuds	(draft)	(see EFs	(hp)		vessel per day)			trip)			(hrs/day)	(hrs)			(per vessel)	(per vessel)									l.		
		***		worksheet)																									
Helicopter - Twin-Engine Heavy		N/A																									Į.		
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	104	0.5	C	0	0	0	100%	0%	16,366	0	0	0	0	0	0	0	0	0	0	0	0
Heavy Lift Vessel - Piling Transport from Europe		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	20	6	C	140	24	3,360	37%	37%	78,616	2,201,258	19.72	520.67	43.39	7.31	7.09	15.65	1.74	25,484.26	0.16	1.22	25,852.60
Heavy Lift Vessel - Piling Installation		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	1	6	C	312	24	7,488	37%	37%	3,931	4,905,660	43.95	1160.34	96.70	16.29	15.80	34.88	3.88	56,793.50	0.35	2.73	57,614.35
Heavy Lift Vessel - Transport and Install Jackets		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	20	6	C	730	24	17,520	37%	37%	78,616	11,477,987	102.84	2714.90	226.24	38.11	36.97	81.61	9.08	132,882.23	0.82	6.38	134,802.82
Fall Pipe Vessel - Seabed filter layer -Main Generators	2	1	520 x 118 x 44 (31)	2	C 022	D:I	50,000	2.10	100	_			24	12,864	720/	720/	620.024	0.427.672	CO 70	1016.06	151.24	25.40	24.72	5450	6.00	00 000 07	٥٠٠٠	4.26	90,172.80
	3			2	6,032 1,609		50,000	3.18	160 160	6		536 536	24	12,864	72% 72%	72%		8,427,673	68.79 6.11	1816.06 119.85	151.34	25.49 7.57		54.59 0.08	6.08 0.65	-	0.55		8,538.68
-Aux. Generator -Emergency Generator	1			1		Diesel Diesel			100	0		536	24	12,864	72% 0%				6.11	119.85	61.15	7.57	7.35	0.08	0.65	8,438.28	1.10	0.24	8,538.68
Fall Pipe Vessel - Scour protection	1	1	520 x 118 x 44 (31)	-	000	Diesei			0	U		, 0	0	0	0/8	076	1		· ·	0	U	- 0	0	U	0	U		0	0
-Main Generators	3	1	320 X 118 X 44 (31)	3	6,032	Diesel	50,000	3.18	160	6		536	24	12,864	72%	72%	628,931	8.427.673	68.79	1816.06	151.34	25.49	24.73	54.59	6.08	88,888.07	0.55	4.26	90,172.80
-Aux. Generator	1			2	1,609		30,000	5.10	160	6		536	24	12,864	72%			0,127,075	6.11	119.85		7.57		0.08	0.65	-	1.10		8,538.68
-Emergency Generator	1			1		Diesel			0	0		0	0	0	0%	0%			0.11	0	01.13	0	0	0.00	0.03	0,130.20	0.10	0.21	0,550.00
Tug 1 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)	_						-	_				0,1													_	_
-Main Engines	2	· ·	, ,	2	5,440	Diesel	10,000	3.18	16	69	c	730	24	17,520	24%	24%	144,654	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Harbor Generator	1			1	456	Diesel			0	0	c	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	1			1	168	Diesel			0	0	C	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 2 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440		10,000	3.18	16	69	C	730	24	17,520	24%	24%	144,654	2,295,597	18.72	366.94	187.21	23.18	22.49	0.24	1.99	25,835.59	3.37	0.75	26,143.00
-Harbor Generator	1			1	456	Diesel			0	0	C	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	1			1	168	Diesel			0	0	C	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Transition Piece Barge			400 x 105 x 25																										
	N/A	N/A		N/A	N/A	N/A	0	N/A	16	69	C	730	24	17,520	N/A	N/A	N/A	N/A											
Bubble Curtain Vessel		N/A	150 x 36 x 10	.		n: 1				_	_							202 :	4.31	45.55	22.55			2 005	4.045.51	2 4 5 2		0.405	2 200 :-
-Main Engines	2			1		Diesel	4,000	3.18	10	9		312	24	7,488		50%		392,453	1.24	45.00		1.18		3.00E-02			0.41		3,206.15
-Aux. Generator -Bow Thruster Engine	1			1		Diesel Diesel			10	9		312 312	24	7,488 7,488	64% 0%	50% 50%			1.10E-01 0.27	3.99 9.75		1.05E-01 2.57E-01		2.66E-03	1.10E-02 2.70E-02		3.66E-02 8.95E-02		284.28 694.67
_	1			1		Diesel			0	0		312	24	7,488	0%	50%			1.10E-01	3.99		1.05E-01		6.51E-03 2.66E-03	1.10E-02		3.66E-02		284.28
-Aux. Engine Crew Transfer Vessel 1	1	N/A	65 x 17 x 5	1	133	Diesei			U	U	,	312	24	7,488	0%	50%	1		1.10E-01	3.99	2.04	1.05E-01	1.02E-01	2.66E-U3	1.10E-02	280.94	3.00E-UZ	8.14E-U3	284.28
-Main Engines	2	13/75	03 / 1 / / 3	1	1,000	Diesel	4.000	3.18	52	۵	,	365	24	8,760	51%	51%	24,528	459,119	1.97	71.47	36.47	1.88	1.83	0.05	0.20	5,032.21	0.66	0.15	5,092.08
-Main Generators	2			1		Diesel	4,000	5.10	52	٥		365	24	8,760				455,115	0.05	1.92		0.05		1.28E-03	5.30E-03	-	0.00		136.52
Safety Vessel 1	-	N/A	65 x 17 x 5	-	21	J. (3C)	1		32	,		303	24	5,700	51/6	31/0			0.03	1.32	0.36	0.03	0.03	1.201 03	J.JUL 03	154.51	0.02	3.511-03	150.52
-Main Engines	2	,		1	660	Diesel	5,000	3.18	12	9		365	24	8,760	95%	95%	7,075	573,899	2.43	88.15	44.98	2.32	2.25	0.06	0.24	6,206.77	0.81	0.18	6,280.63
-Main Generators	2			1		Diesel	3,000	5.20	12	9	d	365	24	8,760	95%	95%		270,033	0.10	3.58	1.83	0.09		2.39E-03	9.90E-03		0.03		255.12
							1				-					TOTALS	1.761.021	41,456,918	360.04	9,229.47		180.21		242.12	32.76		13.47		

- Notes:
 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Port of Coeymans to South Brooklyn Marine Terminal: 119.3 mm

- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
 South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
 20 round trips to/from overseas port for each heavy lift transport vessel.
- 1 round trip to/from overseas port for the heavy lift installation vessel.
- 160 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).

 16 round trips to/from Port of Albany for each TP barge tug (for 80 total positions).
- Weekly round trips to/from port for crew transfer vessels.

- Monthly round trips to/from port for bubble curtain vessel and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).
- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.

 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM_{2.5} or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for $\rm CH_4$, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Pre-Piled Jacket Design)

May Not company May Not company May Not company May Not																								Total E	missions (T	ransit)				
New					Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
Second Process Seco		No. of	1. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operatin	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH ₄	N ₂ O	CO ₂ e
Margare - Interface Free Composition Free Com							Type		density (kg/gal)	Trips		Days	Days			load (%)	load (%)			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
Proceedings Procedure Pr		per vessel	3.Spuds	(draft)		(hp)		vessel per day)			trip)			(hrs/day)	(hrs)			(per vessel	(per vessel)											
Man Engree 2 1 1 25 184 4 (12) 3 9 5.5 Decid 95.00 1.1 2 0 0 1 1 2 0 0 1 1 2 0 0 1 1 1 2 0 0 1 1	Halicantar - Twin Engine Heavy		N/A		worksneet)																									
May Not company May Not company May Not company May Not	Helicopter - I will-Eligilie Heavy		IN/A																											
Asia Fagure 4	-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	104	0.5	(0	C	0	100%	0%	16,36	6 0	0.07	0.90	0.02	0.02	0.02	0.05	1.80E-03	172.65	4.94E-03	5.72E-03	174.48
Heavy Mark Secure Freely Provided - Nation Mark Sequence August Freely Provided - Nation F	Heavy Lift Vessel - Piling Transport from Europe		1	715 x 184 x 41 (32)																										
Main tegros 4 = 1 5 5,000 cm 5 5,000	-Main Engines	4			3	9,651	Diesel	50,000	3.18	20	6	(140	24	3,360	37%	37%	78,61	6 2,201,258	0.70	18.60	1.55	0.26	0.25	0.56	0.06	910.15	5.63E-03	0.04	923.31
Part			1	715 x 184 x 41 (32)																										
Main Engine Vessel: Schale filter layer Filt Pige Vessel: Schale filter layer Fil		4			3	9,651	Diesel	50,000	3.18	1	6	(312	24	7,488	37%	37%	6 3,93	1 4,905,660	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.17
Fall Pipe Vesser - Seaber differ layer 1 20 21 18 44 [13] 3 6,631 Dates 50,000 3 18 16 6 6 536 24 12,86 778 778 778			1	715 x 184 x 41 (32)	-	0.054	n: 1	50,000	2.40	20	-		720	2.0	47.500	270/	270	70.54		0.70	40.50		0.20	0.25	0.56	0.05	040.45	5 625 01		022.24
Main Generation 3 3 0,002 Direct 50,000 2.18 100 6 0 536 24 12,064 72% 72% 72% 528,931 8,477,679 5.11 135,81 12.09 1.00 1.80 4.07 0.46 683,44 0.04 0.02 637,24 0.02 637,24 0.02 637,24 0.02 0.05 637,24 0.02 0.05	ÿ	4		F20 440 44 (24)	3	9,651	Diesei	50,000	3.18	20	ь	(/30	24	17,520	3/%	3/%	6 /8,61	6 11,477,987	0.70	18.60	1.55	0.26	0.25	0.56	0.06	910.15	5.63E-03	0.04	923.31
Aux Generator 1		2	1	520 X 118 X 44 (31)	2	6.022	Diocol	50,000	2 10	160	6	,	526	24	12 964	72%	729/	629.02	1 0 427 672	5 12	125 52	11 20	1 00	1 05	4.07	0.45	6622 44	0.0/	0.22	6 720 21
Energency Generator 1		1			2			30,000	3.10										0,427,073											
Fall Pipe Vessel - Scour protection 1 50 x 118 x 44 (21) 3 6,032 (lesel 50,000 3.18 10 6 0 536 24 11,864 7756 7756 638,931 8,477,67 5.13 135,53 11,0 10 18,8 4.07 0.45 633,44 0.04 0.33 6,793 3.18 3.19 0 0 0 0 0 0 0 0 0		1								0	0		0 0		12,004					0.40	0.54	1.50	0.57	0.55	0.01	0.03	025.72	0.00	0	037.21
	, , , , , , , , , , , , , , , , , , ,		1	520 x 118 x 44 (31)	_						_				_	0,1						1					_			
		3		, ,	3	6,032	Diesel	50,000	3.18	160	6	(536	24	12,864	72%	72%	628,93	1 8,427,673	5.13	135.53	11.29	1.90	1.85	4.07	0.45	6633.44	0.04	0.32	6,729.31
Tug 1 for Transition Pieces (from Albary)	-Aux. Generator	1			2	1,609	Diesel			160	6	(536	24	12,864	72%	72%	6		0.46	8.94	4.56	0.57	0.55	5.97E-03	0.05	629.72	90.0	1.83E-02	637.21
## Affine Represed 1	-Emergency Generator	1			1	660	Diesel			0	0	(0	C	0	0%	0%	6		0	0	0	0	0	0	0	0	0	0	0
Harbor Generator 1 1 1 556 Diesel 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Tug 1 for Transition Pieces (from Albany)		N/A	146 x 46 x 25 (21)																										
Emergency Generator 1		2						10,000	3.18	16	69	(730	24	17,520				4 2,295,597	1.18	23.12	11.80	1.46	1.42	0.02	0.13	1628.00	0.21	0.05	1,647.37
Tug 2 for Transition Pieces (from Albany)		1								0	0	(0	C	0					0	0	0	0	0	0	0	0	0	0	0
Main Engines 2 S,440 Diesel 10,000 3.18 16 69 0 730 24 17,520 24% 24% 245,545 24,555 24,555 1.18 23.12 11.80 1.46 1.42 0.02 0.13 1628.00 0.21 0.05 1,647.37		1			1	168	Diesel			0	0	(0	C	0	0%	0%	6		0	0	0	0	0	0	0	0	0	0	0
Harbor Generator 1	, ,,	_	N/A	146 x 46 x 25 (21)	_							_																		
-Emergency Generator 1		2						10,000	3.18	16	69	(/30	24	17,520				4 2,295,597	1.18	23.12	11.80	1.46	1.42	0.02	0.13	1628.00	0.21	0.05	1,647.37
Transition Piece Barge		1								0	0				0					0	0		0		0	0	0	0	0	0
N/A		1		400 v 105 v 25	1	100	Diesei				U				U	076	070			U	U	, 0	U	0	U	U	U		U	U
Bubble Curtain Vessel	Transition Fiece Burge	N/A	N/A	100 X 103 X 23	N/A	N/A	N/A	0	N/A	16	69		730	24	17.520	N/A	N/A	N/A	N/A											
-Main Engines 2 - Main	Bubble Curtain Vessel	,/,	,	150 x 36 x 10	.47.	,,,	.471		,			`	750		17,520	,,,,	,,,,	1471												
-Aux. Generator 1		2			1	750	Diesel	4,000	3.18	10	9	(312	24	7,488	64%	50%	6 4,71	7 392,453	1.91E-02	0.69	0.35	1.82E-02	1.77E-02	4.62E-04	1.92E-03	48.76	6.36E-03	1.41E-03	49.34
-Aux. Engine 1	-Aux. Generator	1			1	133	Diesel			10	9	(312	24	7,488	64%	50%	6		1.69E-03	6.14E-02	3.13E-02	1.62E-03	1.57E-03	4.10E-05	1.70E-04	4.32	5.64E-04	1.25E-04	4.38
Crew Transfer Vessel 1 -Main Engines 2 -Main Generators 2 -Main Engines 2 -Main Engines 2 -Main Engines 2 -Main Generators 2 -Main Engines 2 -Main Engine	-Bow Thruster Engine	1			1	325	Diesel			0	0	C	312	24	7,488	0%	50%	6		0	0	0	0	0	0	0	0	0	0	0
-Main Engines 2	-Aux. Engine	1			1	133	Diesel			0	0	(312	24	7,488	0%	50%	6		0	0	0	0	0	0	0	0	0	0	0
-Main Generators 2	Crew Transfer Vessel 1		N/A	65 x 17 x 5																										
Safety Vessel 1		2						4,000	3.18		-	(8 459,119											
-Main Engines 2 1 660 Diesel 5,000 3.18 12 9 0 365 24 8,760 95% 95% 7,075 573,899 0.03 1.09 0.55 0.03 0.03 7.25E-04 3.01E-03 76.52 9.98E-03 2.22E-03 77.43 -Main Generators 2 1 2 7 Diesel 12 9 0 365 24 8,760 95% 95% 0.04 0.02 1.16E-03 1.13E-03 2.95E-05 1.22E-04 3.11 4.05E-04 9.01E-05 3.15		2			1	27	Diesel	1		52	9	(365	24	8,760	51%	51%	6		2.82E-03	0.10	0.05	2.70E-03	2.61E-03	6.83E-05	2.83E-04	7.21	9.40E-04	2.09E-04	7.29
-Main Generators 2 1 27 Diesel 12 9 0 365 24 8,760 95% 95% 1.22E-03 0.04 0.02 1.16E-03 1.13E-03 2.95E-05 1.22E-04 3.11 4.05E-04 9.01E-05 3.15		_	N/A	65 x 17 x 5	_					_	_]	_] _]								
		2						5,000	3.18	12	9	(573,899											
TOTALS 1,761,021 41,456,918 15.21 380.01 61.47 8.57 8.31 9.40 1.40 20,230 0.74 0.87 20,509	-Main Generators	2			1	27	niesei	1		12	. 9	(365	24	8,760	95%		-	44 456 040		0.04 380.01		1.16E-03 8.57		2.95E-05 9.40	1.22E-04 1.40		4.05E-04 0.74		20,509

- Notes:
 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Port of Coeymans to South Brooklyn Marine Terminal: 119.3 mm
- Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
 South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
 20 round trips to/from overseas port for each heavy lift transport vessel.
- 1 round trip to/from overseas port for the heavy lift installation vessel.
- 160 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 1 foundation per cargo).

 16 round trips to/from Port of Albany for each TP barge tug (for 80 total positions).
- Weekly round trips to/from port for crew transfer vessels.

- Monthly round trips to/from port for bubble curtain vessel and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

- 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.

 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM_{2.5} or VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 9. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for $\rm CH_4$, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Monopile Design)

																						Total Emis	sions (Non	-Transit)				
				Emission				Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of	1. DP	Dimensions (ft)	Factor	Engine Fu	el Assumed fue	I Assumed fue	l Round	Duration	Operating	Operating	Operating To	tal Operatin	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH₄	N ₂ O	CO ₂ e
Vessels/Equipment	Engines	2.Anchored	length x width x depth	Used	Rating Ty	e rate (kg per	density (kg/ga	ıl) Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	per vessel	3.Spuds	(draft)	(see EFs	(hp)	vessel per da	1)		trip)			(hrs/day)	(hrs)			(per vessel)	(per vessel)											
				worksheet)																								
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400 Jet fuel	N	/A N	/A 104	4 0.5	0	(0	0	100%	0%	16,366	0	0	0	0	0	0	0	0	0	0	0	0
Heavy Lift Vessel - Monopile and TP Transport		1	715 x 184 x 41 (32)																									
-Main Engines	4	_	745 404 44 (22)	3	9,651 Diesel	50,0	00 3.	18 40	0 6	0	280	24	6,720	37%	37%	157,233	4,402,516	39.44	1041.33	86.78	14.62	14.18	31.30	3.48	50,968.53	0.32	2.45	51,705.19
Heavy Lift Vessel - Monopile and TP Installation		1	715 x 184 x 41 (32)	2	0.554.0: 1	50.0					201		0.504	270/	270/	2.024	6 226 445	55.70	4 4 7 2 7 4	400.70	20.57	20.05	44.07	4.00	72 004 00	0.45	2.46	72 425 04
-Main Engines Fall Pipe Vessel - Seabed filter layer	4	1	520 x 118 x 44 (31)	3	9,651 Diesel	50,0	00 3.	18	1 6	0	396	24	9,504	37%	37%	3,931	6,226,415	55.79	1472.74	122.73	20.67	20.05	44.27	4.93	72,084.06	0.45	3.46	73,125.91
-Main Generators	2	1	320 X 116 X 44 (31)	2	6,032 Diesel	50,0	00 3.	10 2		0	536	24	12,864	72%	72%	125,786	8,427,673	68.79	1816.06	151.34	25,49	24.73	54.59	6.08	88.888.07	0.55	4.26	90,172.80
-Aux. Generator	1			3	1,609 Diesel	30,0	3.	10 3	2 6	0	536		12,864		72%	123,780	8,427,073	6.11	119.85	61.15	7.57	7.35	0.08	0.65	8.438.28	1.10	0.24	8,538.68
-Emergency Generator	1			1	660 Diesel			3,	0	0	330	24	12,804	0%	0%			0.11	113.83	01.13	7.57	7.33	0.08	0.03	0,430.20	1.10	0.24	0,558.08
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)	-	ooo bicsei				-		`	1		0,0	0,0			ŭ		-	ŭ		•	ŭ				
-Main Generators	3	_	520 x 110 x 11 (51)	3	6,032 Diesel	50,0	00 3.	18 3:	2 6	0	536	24	12,864	72%	72%	125,786	8,427,673	68.79	1816.06	151.34	25.49	24.73	54.59	6.08	88,888.07	0.55	4.26	90,172.80
-Aux. Generator	1			2	1,609 Diesel			33	2 6	0	536	24	12,864	72%	72%	.,	., ,.	6.11	119.85	61.15	7.57	7.35	0.08	0.65	8,438.28	1.10	0.24	8,538.68
-Emergency Generator	1			1	660 Diesel				0 0	0	C	0	. 0	0%	0%			0	0	0	0	0	0	0	. 0	0	0	0
Bubble Curtain Vessel		N/A	150 x 36 x 10																									
-Main Engines	2			1	750 Diesel	4,0	00 3.	18 14	4 9	0	396	24	9,504	64%	50%	6,604	498,113	1.57	57.12	29.14	1.50	1.46	3.81E-02	1.58E-01	4,021.50	0.52	1.17E-01	4,069.35
-Aux. Generator	1			1	133 Diesel			14	4 9	0	396	24	9,504	64%	50%			1.40E-01	5.06	2.58	1.33E-01	1.29E-01	3.38E-03	1.40E-02	356.57	4.65E-02	1.03E-02	360.82
-Bow Thruster Engine	1			1	325 Diesel				0 0	0	396		9,504		50%			0.34	12.38	6.31	3.26E-01	3.16E-01	8.26E-03	3.42E-02	871.32	1.14E-01	2.53E-02	881.69
-Aux. Engine	1			1	133 Diesel			(0 0	0	396	24	9,504	0%	50%			1.40E-01	5.06	2.58	1.33E-01	1.29E-01	3.38E-03	1.40E-02	356.57	4.65E-02	1.03E-02	360.82
Crew Transfer Vessel 1		N/A	65 x 17 x 5																									
-Main Engines	2			1	1,000 Diesel	4,0	00 3.	18 57	2 9	0	365	24	8,760		51%	24,528	459,119	1.97	71.47	36.47	1.88	1.83	0.05	0.20	5,032.21		0.15	5,092.08
-Main Generators	2			1	27 Diesel			52	2 9	0	365	24	8,760	51%	51%			0.05	1.92	0.98	0.05	0.05	1.28E-03	5.30E-03	134.91	0.02	3.91E-03	136.52
Safety Vessel 1	_	N/A	65 x 17 x 5	_					_ _	_																		
-Main Engines	2			1	660 Diesel 27 Diesel	5,0	00 3.	18 17	2 9	0	365	24	8,760		95%	7,075	573,899	2.43	88.15	44.98	2.32	2.25	0.06	0.24	6,206.77	0.81	0.18	6,280.63
-Main Generators	2			1	27 Diesel			1.	2 9	0	365	24	8,760	95%	95%			0.10	3.58	1.83	0.09	0.09	2.39E-03	9.90E-03	252.12	0.03	7.31E-03	255.12
															TOTALS	467,310	29,015,409	251.78	6,630.64	759.35	107.87	104.63	185.07	22.54	334,937	6.31	15.42	339,691

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)

 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 40 round trips to/from overseas port for the heavy lift transport vessel.

 1 round trip to/from overseas port for the heavy lift installation vessel.
- 32 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 5 foundations per cargo). Weekly round trips to/from port for crew transfer vessels.

- weekly round trips to/from port for crew transfer vessels.

 Monthly round trips to/from port for bubble curtain vessel and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.

- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM25 or VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages) 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₄, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Foundation Construction Emissions (Monopile Design)

				Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of 1.	. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operatin	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N ₂ O	CO₂e
Vessels/Equipment	Engines 2.	.Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	per vessel 3.5	.Spuds	(draft)	(see EFs	(hp)		vessel per day)			trip)			(hrs/day)	(hrs)			(per vessel)	(per vessel)											
				worksheet)																									
Helicopter - Twin-Engine Heavy		N/A																											
-Main Engines	2			164	1,400 J	let fuel	N/A	N/A	104	0.5	0	0	C	0	100%	0%	16,366	0	0.07	0.90	0.02	0.02	0.02	0.05	1.80E-03	172.65	4.94E-03	5.72E-03	174.48
Heavy Lift Vessel - Monopile and TP Transport		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	40	6	0	280	24	4 6,720	37%	37%	157,233	4,402,516	1.41	37.19	3.10	0.52	0.51	1.12	0.12	1820.30	1.13E-02	0.09	1,846.61
Heavy Lift Vessel - Monopile and TP Installation		1	715 x 184 x 41 (32)																										
-Main Engines	4			3	9,651	Diesel	50,000	3.18	1	6	0	396	24	9,504	37%	37%	3,931	6,226,415	0.04	0.93	0.08	1.31E-02	1.27E-02	0.03	3.11E-03	45.51	2.82E-04	2.18E-03	46.17
Fall Pipe Vessel - Seabed filter layer		1	520 x 118 x 44 (31)																										
-Main Generators	3			3	6,032	Diesel	50,000	3.18	32	6	0	536	24	12,864	72%	72%	125,786	8,427,673	1.03	27.11	2.26	0.38	0.37	0.81	0.09	1326.69	8.21E-03	0.06	1,345.86
-Aux. Generator	1			2	1,609				32	6	0	536	24	12,864	72%	72%			0.09	1.79	0.91	0.11	0.11	1.19E-03	9.69E-03	125.94	1.64E-02	3.65E-03	127.44
-Emergency Generator	1			1	660 [Diesel			0	0	0	0	(0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																										
-Main Generators	3			3	6,032		50,000	3.18	32	6	0	536	24	12,864			.,	8,427,673	1.03	27.11	2.26	0.38	0.37	0.81	0.09	1326.69	8.21E-03	0.06	1,345.86
-Aux. Generator	1			2	1,609				32	6	0	536	24	12,864	72%				0.09	1.79	0.91	0.11	0.11	1.19E-03	9.69E-03	125.94	1.64E-02	3.65E-03	127.44
-Emergency Generator	1			1	660 [Diesel			0	0	0	0	C	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Bubble Curtain Vessel		N/A	150 x 36 x 10																										
-Main Engines	2			1	750		4,000	3.18	14	9	0	396	24	9,504				498,113	2.67E-02	0.97		2.55E-02	2.48E-02	6.47E-04	2.68E-03	68.27	8.90E-03	1.98E-03	69.08
-Aux. Generator	1			1	133 [14	9	0	396	24	9,504					2.37E-03	8.60E-02	4.39E-02	2.26E-03	2.20E-03	5.74E-05	2.38E-04	6.05	7.90E-04	1.75E-04	6.13
-Bow Thruster Engine	1			1	325				0	0	0	396	24	9,504					0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1			1	133 [Diesel			0	0	0	396	24	9,504	0%	50%			0	0	0	0	0	0	0	0	0	0	0
Crew Transfer Vessel 1		N/A	65 x 17 x 5																										
-Main Engines	2			1	1,000		4,000	3.18	52	9	0	365	24	4 8,760				459,119	0.11	3.82		0.10	0.10	2.55E-03		268.84	0.04	7.79E-03	272.04
-Main Generators	2			1	27 [Diesel			52	9	0	365	24	4 8,760	51%	51%			2.82E-03	0.10	0.05	2.70E-03	2.61E-03	6.83E-05	2.83E-04	7.21	9.40E-04	2.09E-04	7.29
Safety Vessel 1		N/A	65 x 17 x 5																										
-Main Engines	2			1		Diesel	5,000	3.18	12	9	0	365	24	4 8,760	95%	95%		573,899	0.03	1.09	0.55	0.03	0.03	7.25E-04	3.01E-03	76.52	9.98E-03	2.22E-03	77.43
-Main Generators	2			1	27 [Diesel			12	9	0	365	24	4 8,760	95%				1.22E-03	0.04	0.02	1.16E-03	1.13E-03	2.95E-05	1.22E-04	3.11	4.05E-04	9.01E-05	3.15
																TOTALS	467,310	29,015,409	3.92	102.92	12.66	1.70	1.65	2.84	0.35	5,374	0.12	0.24	5,449

- Notes:

 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)

 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- 3. The number of transits for each vessel are based on the following assumptions:
- 40 round trips to/from overseas port for the heavy lift transport vessel.

 1 round trip to/from overseas port for the heavy lift installation vessel.
- 32 round trips to/from overseas port for each fall pipe vessel (based on assumed capacity to treat 5 foundations per cargo). Weekly round trips to/from port for crew transfer vessels.

- weekly round trips to/from port for crew transfer vessels.

 Monthly round trips to/from port for bubble curtain vessel and safety vessels.

 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.

- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM25 or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages) 8. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₄, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 OSS Topside and Foundation Installation Emissions (per Phase)

																						Total Em	nissions (Non-	Transit)				
Vessels/Equipment	No. of Engines per vessel	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Fuel Rating Type (hp)	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH₄ tons	N ₂ O tons	CO₂e tons
eavy Transport Vessel (transit from TX)		3	484 x 138 x 36	,																								-
-Main Engines	6			3	6,394 Diesel	45,000	3.18	1	200	() 4.	5 24	1,080	33%	33%	117,92	636,792	5.71	150.62	12.55	2.11	2.05	4.53	0.50	7,372.23	0.05	0.35	7,478.79
eavy Lift Vessel - Foundation installation		1	661 x 290 x 162 (43)																									
-Main Engines	6			3	6,568 Diesel	80,000	3.18	1	. 6	(0 4	5 24	1,080	29%	29%	6,289	1,132,075	5.11	134.80	11.23	1.89	1.84	4.05	0.45	6,597.98	0.04	0.32	6,693.34
-Main Engines	4			3	6,032 Diesel			1	. 6	(0 4	5 24	1,080	29%	29%	S		3.13	82.53	6.88	1.16	1.12	2.48	0.28	4,039.58	0.03	0.19	4,097.97
-Main Engines	2			3	7,373 Diesel			1	. 6		4	24	1,080	29%	29%	S		1.91	50.44	4.20	0.71	0.69	1.52	0.17	2,468.63	0.02	0.12	2,504.31
all Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032 Diesel	50,000	3.18	1	. 6	(1 24	96	72%	72%		62,893	0.51	13.55	1.13	0.19	0.18	0.41	0.05		4.11E-03	0.03	672.93
-Aux. Generator	1			2	1,609 Diesel			1	. 6	(1 24	96	72%	72%	S		0.05	0.89	0.46	0.06	0.05	5.97E-04	4.85E-03	62.97	8.21E-03	1.83E-03	63.72
-Emergency Generator	1			1	660 Diesel			0	0	(0	0	0	0%	0%	S		0	0	0	0	0	0	0	0	0	0	C
ubble Curtain Vessel		N/A	150 x 36 x 10																									-
-Main Engines	2			1	750 Diesel	4,000	3.18	1	. 9	(4	5 24	1,080	64%	50%	47	56,604	0.18	6.49	3.31	0.17	0.17	4.33E-03	1.79E-02	456.99	0.06	1.32E-02	462.43
-Aux. Generator	1			1	133 Diesel			1	9	() 4	5 24	1,080	64%	50%	S		1.59E-02	0.58	0.29	1.52E-02	1.47E-02	3.84E-04	1.59E-03	40.52	5.29E-03	1.17E-03	41.00
-Bow Thruster Engine	1			1	325 Diesel			0	0	(4	5 24	1,080	0%	50%	S		0.04	1.41	0.72	3.70E-02	3.59E-02	9.38E-04	3.89E-03	99.01	1.29E-02	2.87E-03	100.19
-Aux. Engine	1			1	133 Diesel			0	0	() 4	5 24	1,080	0%	50%	S		1.59E-02	0.58	0.29	1.52E-02	1.47E-02	3.84E-04	1.59E-03	40.52	5.29E-03	1.17E-03	41.00
SS Installation Generator Engine																												
-	1	N/A	N/A	255	67 Diesel	235	3.18	0	0	(1	5 24	360	0%	100%	3	1,108	1.15E-02	0.08	0.10	5.96E-04	5.78E-04	2.98E-05	2.92E-04	3.24	1.31E-04	2.63E-05	3.25
SS Commissioning Generator Engine																												
-	1	N/A	N/A	2	670 Diesel	2,350	3.18	0	0	(12	24	2,880	0%	91%	5	88,679	0.72	14.17	7.23	0.90	0.87	0.01	0.08	998.03	0.13	0.03	1,009.91
·															TOTALS	128,610	1,978,153	17.39	456.14	48.40	7.25	7.04	13.00	1.55	22.843.05	0.35	1.06	23.168.84

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:

 Texas port to center of OCS lease area: 2,000 nm (30 nm in TX state waters, 1,940 nm in non-OCS federal waters, and 30 nm within OCS radius)
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area) 3. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from overseas port for the heavy transport vessel and heavy lift vessel.

 1 round trips to/from overseas port for the fall pipe vessel.
- 1 round trip to/from port for bubble curtain vessel.
- 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.

 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 7. OSS installation generator engine will be a portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 8. OSS commissioning generator engine could be a vessel engine connected directly to OSS platform; emissions based on factors for Category 2 marine engines.
 9. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.

- 10. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 OSS Topside and Foundation Installation Emissions (per Phase)

																							Total Er	nissions (T	ransit)				
Vessels/Equipment	No. of Engines per vessel	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N ₂ O tons	CO₂e tons
Heavy Transport Vessel (transit from TX)		3	484 x 138 x 36																										
-Main Engines	6			3	6,394 Die	sel	45,000	3.18	1	1 200	C	45	24	1,080	33%	33%	117,925	636,792	1.06	27.89	2.32	0.39	0.38	0.84	0.09	1365.23	8.45E-03	0.07	1,384.96
Heavy Lift Vessel - Foundation installation		1	661 x 290 x 162 (43)																										
-Main Engines	6			3	6,568 Die		80,000	3.18	1	1 6	C	45	24	1,080	29%		6,289	1,132,075		0.75		1.05E-02	1.02E-02	0.02		36.66		1.76E-03	
-Main Engines	4			3	6,032 Die	sel			1	1 6	C	45	24	1,080	29%	29%			0.02	0.46	0.04	6.44E-03	6.24E-03	1.38E-02	1.53E-03	22.44	1.39E-04	1.08E-03	22.77
-Main Engines	2			3	7,373 Die	sel			1	1 6	C	45	24	1,080	29%	29%			1.06E-02	0.28	0.02	3.93E-03	3.82E-03	8.42E-03	9.37E-04	13.71	8.49E-05	6.58E-04	13.91
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																										
-Main Generators	3			3	6,032 Die	sel	50,000	3.18	1	1 6	C	4	. 24	4 96	72%	72%	3,931	62,893		0.85		1.19E-02	1.15E-02	0.03	2.83E-03	41.46		1.99E-03	
-Aux. Generator	1			2	1,609 Die				1	1 6	C	4	. 24	4 96	72%	72%			2.85E-03	0.06	0.03	3.53E-03	3.43E-03	3.73E-05	3.03E-04	3.94	5.13E-04	1.14E-04	3.98
-Emergency Generator	1			1	660 Die	sel			(0	C	0	(0 0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Bubble Curtain Vessel		N/A	150 x 36 x 10																										
-Main Engines	2			1	750 Die		4,000	3.18	1	1 9	C	45	24	1,080	64%		472	56,604		0.07		1.82E-03		4.62E-05		4.88		1.41E-04	
-Aux. Generator	1			1	133 Die				1	1 9	C	45	24	1,080	64%	50%			1.69E-04	6.14E-03	3.13E-03	1.62E-04	1.57E-04	4.10E-06	1.70E-05	0.43	5.64E-05	1.25E-05	0.44
-Bow Thruster Engine	1			1	325 Die	sel			(0	C	45	24	1,080	0%	50%			0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1			1	133 Die	sel			(0	C	45	24	4 1,080	0%	50%			0	0	0	0	0	0	0	0	0	0	0
OSS Installation Generator Engine																													
	1	N/A	N/A	255	67 Die	sel	235	3.18	(0	C	15	24	4 360	0%	100%	0	1,108	0	0	0	0	0	0	0	0	0	0	0
OSS Commissioning Generator Engine																													
	1	N/A	N/A	2	670 Die	sel	2,350	3.18	(0	C	120	24	4 2,880	0%	91%	0	88,679		0	0	0	0	0	0	0	0	0	0
																TOTALS	128,616	1,978,153	1.15	30.36	2.59	0.43	0.42	0.91	0.10	1,488.74	0.01	0.07	1,510.24

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: Texas port to center of OCS lease area: 2,000 nm (30 nm in TX state waters, 1,940 nm in non-OCS federal waters, and 30 nm within OCS radius)
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
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- 1 round trip to/from overseas port for the heavy transport vessel and heavy lift vessel.

 1 round trips to/from overseas port for the fall pipe vessel.
- 1 round trip to/from port for bubble curtain vessel.

- 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.

 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 7. OSS installation generator engine will be a portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 8. OSS commissioning generator engine could be a vessel engine connected directly to OSS platform; emissions based on factors for Category 2 marine engines.
 9. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.

- 10. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Cable Installation Emissions

																								Total Em	issions (Non-	Transit)				
		No. of	1. DP	Dimensions (ft)	Emission Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Transit Round	Transit Duration	Non-OCS Operating	OCS Operating	Non-Transit Operating	Non-Transit	Transit Average	Non-Transit Average	Transit M	Ion-Transit Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2,5}	SO ₂	HAPs	CO2	СН₄	N ₂ O	CO₂e
Vessels/Equipme			2.Anchored	length x width x depth		Rating				Trips	(hrs/round		Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
vessels/Equipme		er vessel		(draft)	(see EFs	(hp)	Type	rate (kg per vessel per day)	density (kg/gal)	irips	trip)	Days	Days	(hrs/day)	(hrs)	ioau (%)	ioau (%)		(per vessel)	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	۲	CI VC33CI	3.5puus	(drait)	worksheet)	()		vesser per day,			crip,			(III3) day)	(1113)			(per vesser)	(per vesser)											
Helicopter - Twin-Engine Heavy			N/A																											
	-Main Engines	2			164	1.40	0 Jet fuel	N/A	N/A	60	0.5		0	0	0	100%	0%	9,442	0	0	0	0	0	0	0	0	0	0	0	0
Export Cable Lay Vessel	Widin Engines		1	459 x 97 x 36 (24)	104	1,40	o secraci	N/A	111/75	00	0.5	, .				10070	070	3,442			-	Ü			Ü		Ü	-	U	
Export cubic tay vesser	-Main Generators	6	1	433 X 37 X 30 (24)	3	3,00	3 Diesel	15,000	3.18	2	9	9 0	212	24	5,088	24%	24%	3,538	1,000,000	8.96	236.53	19.71	3.32	3.22	7.11	0.79	11,577.14	0.07	0.56	11,744.46
Installation Support Vessel 1			1	243 x 56 x 26 (21)																										
	-Main Generators	2			2		6 Diesel	15,000	3.18	2	9	9 0	212	24		45%	45%		1,000,000		91.34	46.60	5.77	5.60		0.49	6,431.09	0.84	0.19	6,507.61
	-Main Generators	2			2		0 Diesel			2	9	9	212	24	5,088	45%	45%			3.50	68.51	34.95	4.33	4.20	0.05	0.37	4,823.32	0.63	0.14	4,880.71
	-Emergency Generator	1			1	38.	2 Diesel			0	() 0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Inter-Array Cable Lay Vessel	-Main Generators	4	1	313 x 71 x 29 (24)	2	2,60	6 Diesel	15,000	3.18	2		9 0	106	24	2,544	37%	37%	3,538	500,000	4.08	79.92	40.78	5.05	4.90	0.05	0.43	5,627.20	0.73	0.16	5,694.16
Installation Support Vessel 2			1	243 x 56 x 26 (21)																										
	-Main Generators	2	_	(,	2	2.46	6 Diesel	15,000	3.18	2		9 0	106	24	2,544	45%	45%	3,538	500,000	2.33	45.67	23.30	2.89	2.80	0.03	0.25	3,215.55	0.42	0.09	3,253.81
	-Main Generators	2			2		0 Diesel		0.20	2	9	9 0	106	24		45%	45%		,	1.75	34.25	17.48	2.16	2.10		0.19		0.31	0.07	2,440.35
	-Emergency Generator	1			1	38	2 Diesel			0		0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	. 0
Fall Pipe Vessel - Scour protection			1	520 x 118 x 44 (31)																										
	-Main Generators	3			3	6,03	2 Diesel	50,000	3.18	16		5 0	268	24	6,432	72%	72%	62,893	4,213,836	34.40	908.03	75.67	12.75	12.36	27.29	3.04	44,444.04	0.28	2.13	45,086.40
	-Aux. Generator	1			2		9 Diesel			16		5 0	268	24	6,432	72%	72%			3.06	59.92	30.57	3.79	3.67	0.04	0.32	4,219.14	0.55	0.12	4,269.34
	-Emergency Generator	1			1	66	0 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Pre-Sweep Dredger/Tug Combination	1		N/A	480 x 92 x 36 (30)																										
	-Tugboat Main Engines	2			3		1 Diesel	15,000	3.18	1	. 9	9 0	12	24	288	27%	17%	1,769	56,604	0.31	8.17	0.68	0.11	0.11	0.25	0.03	399.95	2.48E-03	0.02	405.73
	boat Harbor Generator	1			1		9 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
	t Emergency Generator	1			1		7 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
	-Dredger Pump Engines	2			3		0 Diesel			0	(0	12	24	288	0%	17%			0.20	5.22	0.43	0.07	0.07	0.16	0.02	255.36	1.58E-03	1.23E-02	259.05
	edger Harbor Generator	1			2	1,220	0 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Pre-Trenching Barge			N/A	401 x 110 x 25 (18)						_																				
	-Main Generators	4			2		2 Diesel	20,000	3.18	1	18	3	9	24	216	98% 0%	89%		56,604		8.22	4.19	0.52	0.50		0.04	578.81	0.08	0.02	585.70
	-Crane Engine	1			1		6 Diesel 1 Diesel			0			9	24	216	0%	89% 0%			0.02	0.83	0.42	0.02	0.02	5.52E-04	2.29E-03	58.23	7.60E-03	1.69E-03	58.92
Pre-Trenching Tug 1	-Emergency Generator		N/A	98 x 31 x 10 (8)	1	30.	Diesei			U			U	U	U	0%	0%			U	U	U	U	U	U	U	U	U	U	U
Pre-Trenching rug 1	-Main Engines	2	IN/A	30 X 31 X 10 (0)	2	1 26	0 Diesel	2,500	3.18	1	10	, ,	۵	24	216	22%	22%	590	7,075	0.05	0.96	0.49	0.06	0.06	6.40E-04	5.20E-03	67.59	8.82E-03	1.96E-03	68.39
	-Aux. Generator	1			1		9 Diesel	2,300	3.10	1	18	3	9	24		22%	22%		7,073	4.71E-03	0.17	0.49	4.50E-03	4.37E-03		4.73E-04	12.04		3.49E-04	12.19
	-Emergency Generator	1			1		7 Diesel			0	1		0	0	0	0%	0%			0	0.17	0.03	502 05	0.072.03	0	,52 01	0	0	0.152 01	0
Pre-Trenching Tug 2			N/A	98 x 31 x 10 (8)	_					_			-		-											-				
3 3 3	-Main Engines	2	,		2	1,260	0 Diesel	2,500	3.18	1	18	3 0	9	24	216	22%	22%	590	7,075	0.05	0.96	0.49	0.06	0.06	6.40E-04	5.20E-03	67.59	8.82E-03	1.96E-03	68.39
	-Aux. Generator	1			1	44	9 Diesel			1	18	3 0	9	24		22%	22%		·	4.71E-03	0.17	0.09	4.50E-03	4.37E-03		4.73E-04	12.04		3.49E-04	12.19
	-Emergency Generator	1			1	8	7 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Pre-Lay Grapnel Run Vessel			N/A	150 x 36 x 10																										
	-Main Engines	2			1		0 Diesel	4,000	3.18	2	9	9 0	18	24	432	64%	50%		22,642		2.60	1.32	0.07	0.07	1.73E-03	7.18E-03	182.80		5.30E-03	184.97
	-Aux. Generator	1			1		3 Diesel		1	2	9	9 0	18	24	432	64%	50%			6.34E-03	0.23	0.12	6.06E-03	5.88E-03		6.37E-04	16.21		4.70E-04	16.40
	-Bow Thruster Engine	1			1		5 Diesel		1	0		0	18	24		0%	50%			0.02	0.56	0.29	1.48E-02	1.44E-02	3.75E-04	1.56E-03	39.61	5.17E-03	1.15E-03	40.08
	-Aux. Engine	1			1	13:	3 Diesel			0	(0	18	24	432	0%	50%			6.34E-03	0.23	0.12	6.06E-03	5.88E-03	1.54E-04	6.37E-04	16.21	2.11E-03	4.70E-04	16.40
Safety Vessel 1		_	N/A	65 x 17 x 5						_																				
	-Main Engines	2			1		0 Diesel	5,000	3.18	3	9		106	24	2,544	95%	95%		166,667	0.71	25.60	13.06	0.67	0.65	1.71E-02	0.07	1,802.52	0.24	0.05	1,823.96
Cafata Manada 2	-Main Generators	2	21/2	CF 17 F	1	2	7 Diesel		1	3	9	9 C	106	24	2,544	95%	95%			0.03	1.04	0.53	0.03	0.03	6.94E-04	2.88E-03	73.22	9.55E-03	2.12E-03	74.09
Safety Vessel 2	Main Factors	2	N/A	65 x 17 x 5			0 0:!	F 000	2.40	_	1 .		100		2544	0564	0524	1 700	100.007	0.74	25.60	12.00	0.67	0.55	1 715 63	0.07	1 002 53	0.24	0.05	1 022 00
	-Main Engines -Main Generators	2			1		0 Diesel 7 Diesel	5,000	3.18	3	1 3		106 106	24 24	-,	95% 95%	95% 95%	1,769	166,667	0.71 0.03	25.60 1.04	13.06 0.53	0.67 0.03	0.65 0.03		0.07 2.88E-03	1,802.52 73.22	0.24 9.55E-03	0.05 2.12E-03	1,823.96 74.09
	-iviain Generators	2			1		/ piesei	1	1	3	1 5	ا د	106	24	2,544	95%	95%			0.03	1.04	0.53	0.03	0.03	0.94E-U4	2.88E-03	/3.22	9.55E-U3	2.12E-03 3.63	

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Emissions for the route preparation vessels (pre-lay grapnel run, pre-sweep dredging, and pre-trenching) are based on the total EW 1 cable length of 300 nm (260 nm for interarray cables and 40 nm for export cable).
- 3. Emissions for the fall pipe vessel assume scour protection will be required for 10% of the total EW 1 cable length of 300 nm (260 nm for interarray cables and 40 nm for export cable route).
- 4. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- The number of transits for each vessel are based on the following assumptions:
 1 round trip to/from port for pre-sweep dregding and pre-trenching vessels.
- 2 round trips to/from port for export cable lay vessel, interarray cable lay vessel, support vessels, and pre-lay grapnel run vessel.
- 16 round trips to/from overseas port for the fall pipe vessel (based on volume required to install scour protection for 10% of total cable length).
- Monthly round trips to/from port for safety vessels.
- 6. Helicopter transits to the export cable lay vessel assume two round trips per week, with a duration of 30 minutes per round trip based on travel from JFK Int'l Airport.

 One-way distance estimated to average 14 mi along the EW 1 export cable route (varies from 10 to 24 mi, with total mileage distributions of 30% in Kings County, 27% in Queens County, 9% in Nassau County, and 34% inside OCS radius).
- 7. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 8. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 9. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 11. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Cable Installation Emissions

																								Total	Emissions (Tra	ansit)				
Vessels/Equipmer		No. of Engines	1. DP 2.Anchored	Dimensions (ft) length x width x depth	Emission Factor n Used	Engine Rating	Fuel Type	Assumed fuel rate (kg per	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours	Non-Transit Total Operating Hours	Transit Average load (%)	Non-Transit Average load (%)	Transit I Fuel Usage Gallons	Non-Transit Fuel Usage Gallons	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂	CH ₄ tons	N ₂ O tons	CO ₂ e tons
	p	er vessel	3.Spuds	(draft)	(see EFs	(hp)		vessel per day)			trip)			(hrs/day)	(hrs)			(per vessel)	(per vessel)											
Helicopter - Twin-Engine Heavy			N/A		worksheet)																									
	-Main Engines	2			164	1.40	0 Jet fuel	N/A	N/A	60	0.5	5 0	0	0	0	100%	0%	9,442	0	0.04	0.52	1.23E-02	1.20E-02	1.20E-02	0.03	1.04E-03	99.61	2.85E-03	3.30E-03	100.66
Export Cable Lay Vessel			1	459 x 97 x 36 (24)				.,,.,	.,,					-				5,112											0.000	
	-Main Generators	6			3	3,00	3 Diesel	15,000	3.18	2		9 0	212	24	5,088	24%	24%	3,538	1,000,000	0.03	0.84	0.07	1.17E-02	1.14E-02	2.52E-02	2.80E-03	40.96	2.54E-04	1.97E-03	41.55
Installation Support Vessel 1			1	243 x 56 x 26 (21)																										
	-Main Generators	2			2		6 Diesel	15,000	3.18	2		9 0	212	24		45%	45%		1,000,000		0.32	0.16		1.98E-02		1.75E-03	22.75	2.97E-03	6.59E-04	23.02
	-Main Generators	2			2		0 Diesel 2 Diesel			2		9	212	24	5,088	45% 0%	45% 0%			1.24E-02	0.24	0.12	1.53E-02	1.49E-02	1.62E-04	1.31E-03	17.06	2.23E-03	4.95E-04	17.2
Inter-Array Cable Lay Vessel	Emergency Generator	1	1	313 x 71 x 29 (24)	1	38.	2 Diesei			U) (0	U	U	0%	0%			U	U	0	U	0	U	U	U	U	U	
iliter-Array Cable Lay Vessel	-Main Generators	4	1	313 % / 1 % 2.9 (24)	2	2,60	6 Diesel	15,000	3.18	2	9	9 0	106	24	2,544	37%	37%	3,538	500,000	0.03	0.57	0.29	0.04	0.03	3.77E-04	0.00	39.82	5.19E-03	1.15E-03	40.29
Installation Support Vessel 2			1	243 x 56 x 26 (21)																										
	-Main Generators	2			2		6 Diesel	15,000	3.18	2	9	e c	106	24		45%	45%		500,000		0.32	0.16		1.98E-02		1.75E-03	22.75		6.59E-04	23.02
	-Main Generators	2			2		0 Diesel			2	9	9 0	106	24	2,544	45%	45%			1.24E-02	0.24	0.12	1.53E-02	1.49E-02	1.62E-04	1.31E-03	17.06	2.23E-03	4.95E-04	17.27
	Emergency Generator	1		()	1	38.	2 Diesel			0	() 0	0	0	0	0%	0%	5		0	0	0	0	0	0	0	0	0	0	0
Fall Pipe Vessel - Scour protection	-Main Generators	2	1	520 x 118 x 44 (31)	3	6.03	2 Diesel	50,000	3.18	16			268	24	6 422	720/	720/	62,893	4,213,836	0.51	13.55	1 12	0.10	0.10	0.41	0.05	663.34	4.11E-03	0.03	672.93
	-Aux. Generator	1			2		9 Diesel	30,000	5.10	16			268	24	-, -	72% 72%	72% 72%		4,213,630	0.51 0.05	13.55 0.89	1.13 0.46	0.19 0.06	0.18 0.05		0.05 4.85E-03	62.97	8.21E-03	1.83E-03	63.72
_	Emergency Generator	1			1		0 Diesel			10			0	0	0,432	0%	0%			0.03	0.05	0.40	0.00	0.03	0.572.04	4.032 03	02.57	0.212 03	0.032	03.72
Pre-Sweep Dredger/Tug Combination			N/A	480 x 92 x 36 (30)	_					-			_		-								-		1		-	_		
	Tugboat Main Engines	2		, ,	3	7,83	1 Diesel	15,000	3.18	1		9 0	12	24	288	27%	17%	1,769	56,604	0.02	0.42	0.03	5.87E-03	5.70E-03	1.26E-02	1.40E-03	20.48	1.27E-04	9.83E-04	20.77
	oat Harbor Generator	1			1		9 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
	Emergency Generator	1			1		7 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
	Dredger Pump Engines	2			3		0 Diesel			0	(0	12	24	288	0%	17%			0	0	0	0	0	0	0	0	0	0	0
	lger Harbor Generator	1	N/A	401 x 110 x 25 (18)	2	1,220	0 Diesel			0	() 0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Pre-Trenching Barge	-Main Generators	4	IN/A	401 X 110 X 25 (16)	2	1 22	2 Diesel	20,000	3.18	1	19	, ,	9	24	216	98%	89%	4,717	56,604	0.04	0.75	0.38	0.05	0.05	5.03E-04	4.09E-03	53.09	6.92E-03	1.54E-03	53.72
	-Crane Engine	1			1		6 Diesel	20,000	3.16	0	1		9	24		0%	89%		30,004	0.04	0.75	0.38	0.03	0.03	0.031-04	4.031-03	03.03	0.321-03	1.546-03	33.72
_	Emergency Generator	1			1		1 Diesel			0			0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Pre-Trenching Tug 1	· ·		N/A	98 x 31 x 10 (8)																										
	-Main Engines	2			2		0 Diesel	2,500	3.18	1	18	3 0	9	24	216	22%	22%		7,075	4.08E-03	0.08	0.04	5.05E-03	4.90E-03		4.33E-04	5.63		1.63E-04	5.70
	-Aux. Generator	1			1		9 Diesel			1	18	3 0	9	24	216	22%	22%			3.93E-04	1.43E-02	7.27E-03	3.75E-04	3.64E-04	9.51E-06	3.94E-05	1.00	1.31E-04	2.91E-05	1.02
	Emergency Generator	1			1	8	7 Diesel			0	() 0	0	0	0	0%	0%	5		0	0	0	0	0	0	0	0	0	0	0
Pre-Trenching Tug 2	-Main Engines	2	N/A	98 x 31 x 10 (8)	2	1 26	0 Diesel	2,500	3.18	1	18	,		24	216	22%	22%	590	7,075	4.08E-03	0.08	0.04	5.05E-03	4.90E-03	5.34E-05	4.33E-04	5.63	7.35E-04	1.63E-04	5.70
	-Aux. Generator	1			1		9 Diesel	2,500	3.18	1	15	-	٥	24		22%	22%		7,075	3.93E-04		7.27E-03		4.90E-03 3.64E-04		4.33E-04 3.94E-05			2.91E-05	1.02
_	Emergency Generator	1			1		7 Diesel			0	1		ő	0	0	0%	0%			0.552.04	0	7.272 03	0	0.042.04	0.512 00	0.542	0	0	2.512 05	1.02
Pre-Lay Grapnel Run Vessel			N/A	150 x 36 x 10						-																				
	-Main Engines	2			1		0 Diesel	4,000	3.18	2	9	9 0	18	24	432	64%	50%		22,642		0.14	0.07	3.65E-03	3.54E-03		3.83E-04	9.75		2.83E-04	9.87
	-Aux. Generator	1			1		3 Diesel			2		9 0	18	24		64%	50%			3.38E-04	1.23E-02	6.27E-03	3.23E-04	3.14E-04	8.19E-06	3.40E-05	0.86	1.13E-04	2.51E-05	0.88
	-Bow Thruster Engine	1			1		5 Diesel			0	(0	18	24		0%	50%			0	0	0	0	0	0	0	0	0	0	0
C.S.L. Married	-Aux. Engine	1	21/2	CE 47 E	1	13	3 Diesel	+		0	() (18	24	432	0%	50%			0	0	0	0	0	0	0	0	0	0	0
Safety Vessel 1	Main Engine	2	N/A	65 x 17 x 5	1		O Diocol	5,000	3.18	,			100	3.4	2544	050/	050/	1 700	166,667	7.49E-03	0.37	014	7.155.03	6 04E 03	1 015 04	7 515 04	10.13	3 505 03	5.55E-04	10.20
	-Main Engines -Main Generators	2			1		0 Diesel 7 Diesel	5,000	3.18	3		, C	106 106	24	2,544 2.544	95% 95%	95% 95%		100,067	7.49E-03 3.04E-04	0.27 1.10E-02	0.14 5.63E-03	7.15E-03 2.91E-04	6.94E-03 2.82E-04		7.51E-04 3.05E-05	19.13 0.78		5.55E-04 2.25E-05	19.36 0.79
Safety Vessel 2	iviaiii Generaturs		N/A	65 x 17 x 5	1		, DIESCI			3	· ·		100	24	2,344	3370	3370	1		3.041-04	1.101-02	J.UJL-U3	2.31L-U4	2.021-04	7.30L-00	J.UJL-03	0.76	1.011-04	Z.ZJL-03	0.75
	-Main Engines	2	,		1	66	0 Diesel	5,000	3.18	3		9 0	106	24	2,544	95%	95%	1,769	166,667	7.49E-03	0.27	0.14	7.15E-03	6.94E-03	1.81E-04	7.51E-04	19.13	2.50E-03	5.55E-04	19.36
	-Main Generators	2			1		7 Diesel	,,,,,,		3		9 0	106	24		95%	95%		,	3.04E-04	1.10E-02	5.63E-03		2.82E-04		3.05E-05	0.78	1.01E-04	2.25E-05	0.79
									·							- 1	TOTALS		7,697,170			3.41		0.45		0.07	1,124		0.05	

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- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Emissions for the route preparation vessels (pre-lay grapnel run, pre-sweep dredging, and pre-trenching) are based on the total EW 1 cable length of 300 nm (260 nm for interarray cables and 40 nm for export cable).
- 3. Emissions for the fall pipe vessel assume scour protection will be required for 10% of the total EW 1 cable length of 300 nm (260 nm for interarray cables and 40 nm for export cable route).
- 4. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances: South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)
- The number of transits for each vessel are based on the following assumptions:
 1 round trip to/from port for pre-sweep dregding and pre-trenching vessels.
- 2 round trips to/from port for export cable lay vessel, interarray cable lay vessel, support vessels, and pre-lay grapnel run vessel.
- 16 round trips to/from overseas port for the fall pipe vessel (based on volume required to install scour protection for 10% of total cable length).
- Monthly round trips to/from port for safety vessels.
- 6. Helicopter transits to the export cable lay vessel assume two round trips per week, with a duration of 30 minutes per round trip based on travel from JFK Int'l Airport.

 One-way distance estimated to average 14 mi along the EW 1 export cable route (varies from 10 to 24 mi, with total mileage distributions of 30% in Kings County, 27% in Queens County, 9% in Nassau County, and 34% inside OCS radius).
- 7. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 8. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 9. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 11. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for N₂O.

EW 1 Cable Installation

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Cable Installation Emissions

																								Total Em	nissions (Non-	Transit)				
Vessels/Equipn		No. of Engines per vessel	1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit Total Operating Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Fuel Usage Gallons	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO₂e tons
Helicopter - Twin-Engine Heavy			N/A																											
	-Main Engines	2			164	1,400) Jet fuel	N/A	N/A	38	0.5		0	0	0	100%	0%	5,980	0	0	0	0	0	0	0	0	0	0	0	0
Export Cable Lay Vessel	_		1	459 x 97 x 36 (24)																										
	-Main Generators	6			3	3,003	3 Diesel	15,000	3.18	2	9	9	133	24	3,192	24%	24%	3,538	627,358	5.62	148.39	12.37	2.08	2.02	4.46	0.50	7,263.01	0.04	0.35	7,367.99
Installation Support Vessel 1			1	243 x 56 x 26 (21)																										
	-Main Generators	2			2		Diesel	15,000	3.18	2	9) (133	24	3,192	45%	45%		627,358		57.30	29.24	3.62	3.51	0.04	0.31	4,034.60	0.53	0.12	4,082.61
	-Main Generators	2			2		Diesel			2	9	9 0	133	24	3,192	45%	45%			2.19	42.98	21.93	2.72	2.63	0.03	0.23	3,025.95	0.39	0.09	3,061.95
	-Emergency Generator	1			1	382	2 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Inter-Array Cable Lay Vessel			1	313 x 71 x 29 (24)																										
	-Main Generators	4			2	2,606	Diesel	15,000	3.18	2	9	9	212	24	5,088	37%	37%	3,538	1,000,000	8.16	159.85	81.55	10.10	9.80	0.11	0.87	11,254.41	1.47	0.33	11,388.32
Installation Support Vessel 2			1	243 x 56 x 26 (21)																										
	-Main Generators	2	_		2	2.466	Diesel	15,000	3.18	2) (212	24	5,088	45%	45%	3.538	1,000,000	4.66	91.34	46.60	5.77	5.60	0.06	0.49	6,431.09	0.84	0.19	6,507.61
	-Main Generators	2			2		Diesel	-5,555		2	9		212			45%	45%	-,	_,,	3.50	68.51	34.95		4.20		0.37	4,823.32		0.14	4,880.71
	-Emergency Generator	1			1		2 Diesel			0	() (0	o	0	0%	0%			0	0	0	0	0	0	0	0	0	0	. 0
Fall Pipe Vessel - Scour protection			1	520 x 118 x 44 (31)																										
	-Main Generators	3			3	6,032	2 Diesel	50,000	3.18	29	6	6	487	24	11,688	72%	72%	113,994	7,657,233	62.50	1650.04	137.50	23.16	22.47	49.60	5.52	80,762.11	0.50	3.88	81,929.39
	-Aux. Generator	1			2		Diesel			29	6	6	487	24	11,688	72%	72%			5.56	108.89	55.56	6.88	6.67	0.07	0.59	7,666.87	1.00	0.22	7,758.09
	-Emergency Generator	1			1	660	Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Pre-Sweep Dredger/Tug Combination			N/A	480 x 92 x 36 (30)																										
	-Tugboat Main Engines	2			3		1 Diesel	15,000	3.18	1	9	9	22	24	528	27%	17%		103,774	0.57	14.98	1.25	0.21	0.20	0.45	0.05	733.24	4.54E-03	0.04	743.84
	ugboat Harbor Generator	1			1		Diesel			0			0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugbo	oat Emergency Generator				1		7 Diesel			0	9		0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
_	-Dredger Pump Engines	2			3		Diesel			0	9		22	24	528	0%	17%			0.36	9.57	0.80	0.13	0.13	0.29	0.03	468.16	2.90E-03	2.25E-02	474.93
	Oredger Harbor Generator	1	N/A	404 440 25 /40\	2	1,220	Diesel			0		, ,	U	U	U	0%	0%	1		0	U	U	0	0	U	0	0	0	0	0
Pre-Trenching Barge	-Main Generators	4	N/A	401 x 110 x 25 (18)	2	1 222	Diesel	20,000	3.18	1	10		16	24	384	98%	89%	4,717	100,629	0.75	14.61	7.46	0.92	0.90	9.75E-03	0.08	1,029.00	0.13	0.03	1,041.24
	-Crane Engine				1		Diesel	20,000	3.10	1	10		16	24		0%	89%		100,629	0.73	1.47	0.75		0.90		4.07E-03			3.00E-03	1,041.24
	-Emergency Generator	1			1		1 Diesel			0			10	24	384	0%	0%			0.04	1.47	0.73	0.04	0.04	9.812-04	4.071-03	103.52	1.331-02	3.00L-03	104.73
Pre-Trenching Tug 1	Emergency denerator		N/A	98 x 31 x 10 (8)	-	301	Diesei			·	`				-	0,0	070				-			0			·			
	-Main Engines	2	.,,		2	1.260	Diesel	2,500	3.18	1	18		16	24	384	22%	22%	590	12,579	0.09	1.71	0.87	0.11	0.10	1.14E-03	9.25E-03	120.15	1.57E-02	3.48E-03	121.58
	-Aux. Generator	1			1		Diesel	,		1	18	3	16	24		22%	22%		,-	8.38E-03	0.30	0.16		7.77E-03		8.41E-04	21.41		6.21E-04	21.67
	-Emergency Generator	1			1		7 Diesel			0	() (0	o	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Pre-Trenching Tug 2			N/A	98 x 31 x 10 (8)																										
	-Main Engines	2			2	1,260	Diesel	2,500	3.18	1	18	3 0	16	24	384	22%	22%	590	12,579	0.09	1.71	0.87	0.11	0.10	1.14E-03	9.25E-03	120.15	1.57E-02	3.48E-03	121.58
	-Aux. Generator	1			1		Diesel			1	18	3	16	24	384	22%	22%			8.38E-03	0.30	0.16	8.01E-03	7.77E-03	2.03E-04	8.41E-04	21.41	2.79E-03	6.21E-04	21.67
	-Emergency Generator	1			1	87	7 Diesel			0	() (0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Pre-Lay Grapnel Run Vessel			N/A	150 x 36 x 10																										
	-Main Engines	2			1		Diesel	4,000	3.18	2	9		33	24	792	64%	50%		41,509		4.76	2.43	0.13	0.12	3.18E-03	1.32E-02	335.12		9.71E-03	339.11
	-Aux. Generator	1			1		3 Diesel			2	9		33	24		64%	50%			1.16E-02	0.42	0.22		1.08E-02		1.17E-03	29.71		8.61E-04	30.07
	-Bow Thruster Engine	1			1		Diesel			0	(33	24	792	0% 0%	50% 50%	1		0.03	1.03	0.53	2.71E-02	2.63E-02	6.88E-04	2.85E-03	72.61		2.10E-03	73.47
Cafaba Manad 4	-Aux. Engine	1	N1/A	CF 17 F	1	133	3 Diesel			0	(, ,	33	24	792	0%	50%			1.16E-02	0.42	0.22	1.11E-02	1.08E-02	2.82E-04	1.17E-03	29.71	3.88E-03	8.61E-04	30.07
Safety Vessel 1	Main Engine	2	N/A	65 x 17 x 5	1		Diocal	5,000	2.40	-	,	,	242	2.4	E 000	05%	059/	4,127	222 222	1 44	E1 20	26.12	1 25	1 21	2 425 02	0.44	2 605 02	0.47	0.10	3,647.93
	-Main Engines -Main Generators	2			1 1		Diesel Diesel	5,000	3.18	/]	()	212 212	24	-,	95% 95%	95% 95%		333,333	1.41 0.06	51.20 2.08	26.12 1.06	1.35 0.05	1.31 0.05		0.14 5.75E-03	3,605.03 146.44		0.10 4.24E-03	
Safety Vessel 2	-iviain Generators	2	N/A	65 x 17 x 5	1	21	Diesei	+		/	3	,	212	24	5,088	95%	95%	1		0.06	2.08	1.06	0.05	0.05	1.39E-03	5./5E-U3	140.44	1.916-02	4.24E-03	148.18
Salety vessel 2	-Main Engines	2	IN/A	07 V T / Y 2	1	660	Diesel	5,000	3.18	7			212	24	5,088	95%	95%	4,127	333,333	1.41	51.20	26.12	1.35	1.31	3.42E-02	0.14	3,605.03	0.47	0.10	3,647.93
	-Main Generators	2			1		7 Diesel	3,000	3.10	7			212	24		95%	95%		333,333	0.06	2.08	1.06	0.05	0.05	1.39E-03	5.75E-03	146.44		4.24E-03	148.18
	Widin Generators		1				, Diesei			,	-	,	212		3,000	3370	TOTALS		11,849,686		2,485.15	489.76	63.18	61.28		9.38			5.63	

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Operating days for export cable vessels are scaled down from the EW 1 (Gowanus) cable route (40 nm), proportionate to the EW 2 (Oceanside) export cable length (25 nm).
- 3. Operating days for route preparation vessels (pre-lay grapnel run, pre-sweep dredging, and pre-trenching) are scaled up from the total EW 1 cable length (300 nm), proportionate to the total EW 2 cable length of 545 nm (520 nm for interarray cables and 25 nm for export cable).
- 4. Operating days for the fall pipe vessel assume scour protection will be required for 10% of the total EW 2 cable length of 545 nm, and are scaled up from the total EW 1 cable length of 300 nm.
 5. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- South Brooklyn Marine Terminal to senet vessel speed to 1 Shots on Usa and barges (and 10 knots for an other vessel by South Brooklyn Marine Terminal to senet of OCS lease area: 43.5 nm

 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)

 6. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from port for pre-sweep dregding and pre-trenching vessels.
- 2 round trips to/from port for export cable lay vessel, interarray cable lay vessel, support vessels, and pre-lay grapnel run vessel.
 29 round trips to/from overseas port for the fall pipe vessel (based on volume required to install scour protection for 10% of total cable length).
- Monthly round trips to/from port for safety vessels.

 7. Helicopter transits to the export cable lay vessel assume two round trips per week, with a duration of 30 minutes per round trip based on travel from JFK Int'l Airport.
- One-way distance estimated to average 20 mi along the EW 2 export cable route (varies from 8 to 32 mi, with total mileage distributions of 6% in Queens County, 41% in Nassau County, and 53% inside OCS radius).
- 8. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 9. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 10. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 11. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 12. ${\rm CO_2}e$ emission rates use the following carbon equivalence factors: 25 for ${\rm CH_2}$ and 298 for ${\rm N_2O}$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Cable Installation Emissions

																								Total	Emissions (Tra	ansit)				
Vessels/Equipme	ent	No. of Engines	1. DP 2.Anchored	Dimensions (ft) length x width x depth	Emission Factor Used	Engine Rating	Fuel Type	Assumed fuel rate (kg per	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours	Non-Transit Total Operating Hours	Transit Average load (%)	Non-Transit Average load (%)	Transit N Fuel Usage Gallons	Non-Transit Fuel Usage Gallons	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5}	SO ₂ tons	HAPs tons	CO ₂	CH ₄ tons	N₂O tons	CO ₂ e tons
	p	er vessel	3.Spuds	(draft)	(see EFs	(hp)		vessel per day)			trip)			(hrs/day)	(hrs)			(per vessel)	(per vessel)											
Helicopter - Twin-Engine Heavy			N/A		worksheet)																									
	-Main Engines	2			164	1 40	0 Jet fuel	N/A	N/A	38	0.5		0	0	0	100%	0%	5,980	0	0.03	0.33	7.79E-03	7.60E-03	7.60E-03	0.02	6.57E-04	63.08	1.81E-03	2.09E-03	63.75
Export Cable Lay Vessel	Well Engines		1	459 x 97 x 36 (24)	201	2,10	o secraci	.,,,,	14/1	50	0					10070	0,0	3,500		0.05	0.55	71.752 05	7.002 05	7.002 03	0.02	0.572 01	05.00	1.012 05	2.032 03	05.75
	-Main Generators	6			3	3,00	3 Diesel	15,000	3.18	2		9 0	133	24	3,192	24%	24%	3,538	627,358	0.03	0.84	0.07	1.17E-02	1.14E-02	2.52E-02	2.80E-03	40.96	2.54E-04	1.97E-03	41.55
Installation Support Vessel 1			1	243 x 56 x 26 (21)																										
	-Main Generators	2			2		6 Diesel	15,000	3.18	2	9	9 0	133	24	-, -	45%	45%		627,358		0.32	0.16		1.98E-02		1.75E-03	22.75	2.97E-03	6.59E-04	23.0
	-Main Generators	2			2		0 Diesel 2 Diesel			2		9	133	24	3,192	45% 0%	45% 0%			1.24E-02	0.24	0.12	1.53E-02	1.49E-02	1.62E-04	1.31E-03	17.06	2.23E-03	4.95E-04	17.2
Inter-Array Cable Lay Vessel	-Emergency Generator	1	1	313 x 71 x 29 (24)	1	38.	2 Diesei			U		, ,	U	U	U	U%	0%	1		U	U	U	U	U	U	U	U	U	U	
inter-Array Cable Lay Vessel	-Main Generators	4	1	313 x 71 x 29 (24)	2	2,60	6 Diesel	15,000	3.18	2	9	9 0	212	24	5,088	37%	37%	3,538	1,000,000	0.03	0.57	0.29	0.04	0.03	3.77E-04	0.00	39.82	5.19E-03	1.15E-03	40.2
Installation Support Vessel 2			1	243 x 56 x 26 (21)																										
	-Main Generators	2			2		6 Diesel	15,000	3.18	2	9	e c	212			45%	45%		1,000,000		0.32	0.16		1.98E-02		1.75E-03	22.75		6.59E-04	23.0
	-Main Generators	2			2		0 Diesel			2	9	9 0	212	24	5,088	45%	45%			1.24E-02	0.24	0.12	1.53E-02	1.49E-02	1.62E-04	1.31E-03	17.06	2.23E-03	4.95E-04	17.27
	-Emergency Generator	1			1	38:	2 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Fall Pipe Vessel - Scour protection	Main Congrators	2	1	520 x 118 x 44 (31)	,	6.03	2 Diesel	E0 000	2.10	20			487	24	11 600	720/	720/	112.004	7 657 222	0.03	24.56	2.05	0.24	0.22	0.74	0.00	1202 21	7 445 02	0.06	1,219.69
	-Main Generators -Aux. Generator	1			3 2		9 Diesel	50,000	3.18	29 29			487	24	,	72% 72%	72% 72%		7,657,233	0.93 0.08	24.56 1.62	2.05 0.83	0.34 0.10	0.33 0.10		0.08 8.78E-03	1202.31 114.14	7.44E-03 1.49E-02	3.31E-03	1,219.65
	-Emergency Generator	1			1		0 Diesel			23			487	0	11,088	0%	0%			0.08	0	0.83	0.10	0.10	1.081-03	0.761-03	0	1.491-02	3.311-03	113.30
Pre-Sweep Dredger/Tug Combination			N/A	480 x 92 x 36 (30)						-					-					-					_	_				
	-Tugboat Main Engines	2	,		3	7,83	1 Diesel	15,000	3.18	1		9 0	22	24	528	27%	17%	1,769	103,774	0.02	0.42	0.03	5.87E-03	5.70E-03	1.26E-02	1.40E-03	20.48	1.27E-04	9.83E-04	20.77
	gboat Harbor Generator	1			1		9 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
	at Emergency Generator	1			1		7 Diesel			0	(0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
	-Dredger Pump Engines	2			3		0 Diesel			0		0	22	24	528	0%	17%			0	0	0	0	0	0	0	0	0	0	(
	edger Harbor Generator	1	21/2	404 440 25 (40)	2	1,220	0 Diesel			0	() 0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	-
Pre-Trenching Barge	-Main Generators	4	N/A	401 x 110 x 25 (18)	2	1 22	2 Diesel	20,000	3.18	1	10		16	24	384	98%	89%	4,717	100,629	0.04	0.75	0.38	0.05	0.05	5.03E-04	4.09E-03	53.09	6.92E-03	1.54E-03	53.72
	-Crane Engine	1			1		6 Diesel	20,000	5.10	1	10		16	24		0%	89%		100,629	0.04	0.73	0.56	0.03	0.03	3.03E-04	4.09E-03	33.09	0.926-03	1.346-03	33.7.
	-Emergency Generator	1			1		1 Diesel			0			0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Pre-Trenching Tug 1			N/A	98 x 31 x 10 (8)			- 1333																			-	-			
	-Main Engines	2			2	1,260	0 Diesel	2,500	3.18	1	18	3 0	16	24	384	22%	22%	590	12,579	4.08E-03	0.08	0.04	5.05E-03	4.90E-03	5.34E-05	4.33E-04	5.63	7.35E-04	1.63E-04	5.70
	-Aux. Generator	1			1		9 Diesel			1	18	3 0	16	24	384	22%	22%			3.93E-04	1.43E-02	7.27E-03	3.75E-04	3.64E-04	9.51E-06	3.94E-05	1.00	1.31E-04	2.91E-05	1.0
	-Emergency Generator	1			1	8	7 Diesel			0	() 0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
Pre-Trenching Tug 2	Main Engineer	2	N/A	98 x 31 x 10 (8)	2	1 30	0 Diesel	2,500	3.40		44	,	10	3.4	384	220/	220/	590	12 570	4.095.03	0.08	0.04	5.05E-03	4 005 03	5.34E-05	4 225 04	5.03	7.255.04	1.63E-04	F 7/
	-Main Engines -Aux. Generator	1			1		9 Diesel	2,500	3.18	1	18		16	24		22% 22%	22% 22%		12,579	4.08E-03 3.93E-04		7.27E-03		4.90E-03 3.64E-04		4.33E-04 3.94E-05	5.63 1.00	7.35E-04 1.31E-04	2.91E-05	5.70 1.00
	-Emergency Generator	1			1		7 Diesel			0	1		0	0	0	0%	0%			3.932-04	0	7.271-03	3.732-04	3.041-04	9.511-00	3.346-03	0.00	1.312-04	2.511-03	1.02
Pre-Lay Grapnel Run Vessel	Emergency denerator		N/A	150 x 36 x 10	-		, biesei					-				0,0	070				-		Ü		-		Ů	,		`
,	-Main Engines	2			1	75	0 Diesel	4,000	3.18	2	9	9 0	33	24	792	64%	50%	943	41,509	3.82E-03	0.14	0.07	3.65E-03	3.54E-03	9.24E-05	3.83E-04	9.75	1.27E-03	2.83E-04	9.87
	-Aux. Generator	1			1		3 Diesel			2	9	9 0	33	24	792	64%	50%			3.38E-04	1.23E-02	6.27E-03	3.23E-04	3.14E-04	8.19E-06	3.40E-05	0.86	1.13E-04	2.51E-05	0.88
	-Bow Thruster Engine	1			1		5 Diesel			0	(0	33	24		0%	50%			0	0	0	0	0	0	0	0	0	0	
	-Aux. Engine	1			1	13:	3 Diesel			0	(0	33	24	792	0%	50%			0	0	0	0	0	0	0	0	0	0	1
Safety Vessel 1	Main Factors	2	N/A	65 x 17 x 5	,		0 0:1	F 000	3.40	_			242	3.4	F 000	050/	050/	4 4 2 7	222 222	4.755.00	0.63	0.22	1.675.00	1 (25 22	4 225 64	1 755 63	44.54	E 02E 02	1 205 02	45.45
	-Main Engines -Main Generators	2			1		0 Diesel 7 Diesel	5,000	3.18	'			212 212	24	5,088 5.088	95% 95%	95% 95%		333,333	1.75E-02 7.10E-04	0.63 2.58E-02	0.32 1.31E-02	1.67E-02 6.78E-04	1.62E-02 6.58E-04		1.75E-03 7.12E-05	44.64 1.81		1.29E-03 5.26E-05	45.17 1.83
Safety Vessel 2	-iviaiii Generators		N/A	65 x 17 x 5	1		/ Diesei			/	,		212	24	3,088	93%	35%	+		7.10E-04	2.30E-UZ	1.516-02	0.70E-U4	0.30E-U4	1.72E-05	/.12E-05	1.81	2.37E-U4	J.20E-U5	1.83
,	-Main Engines	2	,	/ // 0	1	66	0 Diesel	5,000	3.18	7		9 0	212	24	5,088	95%	95%	4,127	333,333	1.75E-02	0.63	0.32	1.67E-02	1.62E-02	4.23E-04	1.75E-03	44.64	5.82E-03	1.29E-03	45.17
	-Main Generators	2			1		7 Diesel	3,000	5.10	7		9 0	212	24		95%	95%		222,333	7.10E-04	2.58E-02	1.31E-02		6.58E-04		7.12E-05	1.81	2.37E-04	5.26E-05	1.83
·									·							-	TOTALS		11,849,686	1.26		5.08		0.66		0.11	1,730		0.07	

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Operating days for export cable vessels are scaled down from the EW 1 (Gowanus) cable route (40 nm), proportionate to the EW 2 (Oceanside) export cable length (25 nm).
- 3. Operating days for route preparation vessels (pre-lay grapnel run, pre-sweep dredging, and pre-trenching) are scaled up from the total EW 1 cable length (300 nm), proportionate to the total EW 2 cable length of 545 nm (520 nm for interarray cables and 25 nm for export cable).
- 4. Operating days for the fall pipe vessel assume scour protection will be required for 10% of the total EW 2 cable length of 545 nm, and are scaled up from the total EW 1 cable length of 300 nm.
 5. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- South Brooklyn Marine Terminal to senet vessel speed to 1 Shots on Usa and barges (and 10 knots for an other vessel kye.

 South Brooklyn Marine Terminal to senet of OCS lease area: 43.5 nm

 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)

 6. The number of transits for each vessel are based on the following assumptions:
- 1 round trip to/from port for pre-sweep dregding and pre-trenching vessels.
- 2 round trips to/from port for export cable lay vessel, interarray cable lay vessel, support vessels, and pre-lay grapnel run vessel.
 29 round trips to/from overseas port for the fall pipe vessel (based on volume required to install scour protection for 10% of total cable length).
- Monthly round trips to/from port for safety vessels.

 7. Helicopter transits to the export cable lay vessel assume two round trips per week, with a duration of 30 minutes per round trip based on travel from JFK Int'l Airport.

- One-way distance estimated to average 20 mi along the EW 2 export cable route (varies from 8 to 32 mi, with total mileage distributions of 6% in Queens County, 41% in Nassau County, and 53% inside OCS radius).
- 8. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 9. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 10. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 11. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 12. ${\rm CO_2}e$ emission rates use the following carbon equivalence factors: 25 for ${\rm CH_2}$ and 298 for ${\rm N_2O}$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 Landfall Marine Construction Emissions

LANDFALL MARINE INSTALLATION EQUIPMENT FOR EW	/ 1 (GOWANUS)																				Total En	nissions (Non-	Transit)				
	1 (6011711105)		Emission				Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of 1. DP	Dimensions (ft)	Factor	Engine Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N₂O	CO₂e
Vessels/Equipment	Engines 2.Ancho	ed length x width x dept	n Used	Rating Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	per vessel 3.Spuds	(draft)	(see EFs	(hp)	vessel per day)	7, 0.0 7	•	trip)	,		(hrs/day)	(hrs)	. ,	, ,	(per vessel)	(per vessel)											ı
		, , ,	worksheet)	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \							, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	` '			,	u ,											ı
Channel Area Dredger/Tug Combination	N/A	480 x 92 x 36 (30)																									
-Tugboat Main Engine	s 2	, ,	3	7,831 Diesel	15,000	3.18	1	. 3	: 0	122	24	4 2,928	279	6 179	6 59	575,472	3.15	83.07	6.92	1.17	1.13	2.50	0.28	4,066.14	0.03	0.20	4,124.9
-Tugboat Harbor Generato	r 1		1	979 Diesel			C) c) (0		0 0	09	6 09	6		0	0	0	0	0	0	0	0	0	0	· I
-Tugboat Emergency Generato	r 1		1	737 Diesel			C			0		0	09	6 09	6		0	0	0	0	0	0	0	0	0	0	ı
-Dredger Pump Engine			3	5,000 Diesel			C	o c		122	24	2,928	09	6 179	6		2.01	53.04	4.42	0.74	0.72	1.59	0.18	2,596.18	0.02	0.12	2,633.7
-Dredger Harbor Generato	r 1		2	1,220 Diesel			C			0		0 0	09	6 09	6		0	0	0	0	0	0	0	0	0	0	
Pier Area Dredger/Tug Combination	N/A	480 x 92 x 36 (30)																									
-Tugboat Main Engine	s 2	, ,	3	7,831 Diesel	15,000	3.18	1	. 3	: 0	62	24	1,488	279	6 179	6 59	292,453	1.60	42.22	3.52	0.59	0.57	1.27	0.14	2,066.40	1.28E-02	0.10	2,096.2
-Tugboat Harbor Generato	r 1		1	979 Diesel	·		C) c		0		0 0	09	6 09	6	1 1	0	0	0	0	0	0	0	0	0	0	
-Tugboat Emergency Generato	r 1		1	737 Diesel			C) c) (0		0 0	09	6 09	6		0	0	0	0	0	0	0	0	0	0	ı
-Dredger Pump Engine			3	5,000 Diesel			C			62	24	1,488	09	6 179	6		1.02	26.96	2.25	0.38	0.37	0.81	0.09	1,319.37	8.17E-03	0.06	1,338.4
-Dredger Harbor Generato			2	1,220 Diesel			C) c) (0		0 0	09	6 09	6		0	0	0	0	0	0	0	0	0	0	· I
Tug for O&M Base Pilings	N/A	98 x 31 x 10 (8)																									
-Main Engine	s 2		2	1,260 Diesel	1,500	3.18	C) c		90		4 360	09	6 799	6	42,453	0.29	5.76	2.94	0.36	0.35	3.84E-03	0.03	405.52	0.05	1.18E-02	410.3
-Aux. Generato	r 1		1	449 Diesel			C) c) (90		4 360	09	6 799	6		0.03	1.03	0.52	0.03	0.03	6.85E-04	2.84E-03	72.26	9.43E-03	2.09E-03	
-Emergency Generato	r 2		1	87 Diesel			C) c) (0		0 0	09	6 09	6		0	0	0	0	0	0	0	0	0	0	ı
O&M Base Piling Barge	2	400 x 105 x 25																									
-Station-keeping Engine	1		1	200 Diesel	1,000	3.18	C) c) (180	13	2,160	09	6 569	6	28,302	0.05	1.94	0.99	0.05	0.05	1.29E-03	5.36E-03	136.51	1.78E-02	3.96E-03	138.1
- Piling Rig Engine			1	800 Diesel			C) c		90		720	09	6 569	6		0.07	2.59	1.32		0.07	1.72E-03	7.15E-03	182.01	0.02	5.28E-03	184.1
Tug for Cable Landfall and Bulkhead		98 x 31 x 10 (8)																									
-Main Engine	s 2		2	1,260 Diesel	1,500	3.18	C) c		240		960	09	6 799	6	113,208	0.78	15.36	7.84	0.97	0.94	1.02E-02	0.08	1,081.39	0.14	0.03	1,094.2
-Aux. Generato	r 1		1	449 Diesel			C) c) (240		960	09	6 799	6		0.08	2.74	1.40	0.07	0.07	1.83E-03	7.57E-03	192.69	0.03	5.59E-03	194.9
-Emergency Generato	r 2		1	87 Diesel			C	i c		0		0 0	09	6 09			0	0	0	0	0	0	0	0	0	0	ı
Cable Landfall and Bulkhead Barge	2	400 x 105 x 25																									
-Station-keeping Engine	1		1	200 Diesel	1,000	3.18	C) c		210		1,050	09	6 849	6	66,038	0.04	1.43	0.73	0.04	0.04	9.52E-04	3.94E-03	100.43	1.31E-02	2.91E-03	101.6
- Piling Rig Engine			1	800 Diesel			C) c		210		1,680	09	6 849	6	o l	0.25	9.13	4.66	0.24	0.23	6.09E-03	0.03	642.78	0.08	0.02	650.4
		•			•			•				то	TALS FOR FW	1 (GOWANUS) 1.17	938,679	9.37	245.25	37.50	4.71	4.57	6.20	0.85	12,861.68	0.43		

NDFALL MARINE INSTALLATION EQUIPMENT FOR EW	2 (OCEANS	IDE)																					Total Emi	ssions (Non	-Transit)				
-				Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of	1. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH ₄	N ₂ O	CO₂e
Vessels/Equipment	Engines	2.Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	per vessel	3.Spuds	(draft)	(see EFs	(hp)		vessel per day)			trip)			(hrs/day)	(hrs)			(per vessel)	(per vessel)											
				worksheet)																									
ug for Cofferdam Barge		N/A	98 x 31 x 10 (8)																										
-Main Engines	2			2	1,260 Die	sel	5,000	3.18	4	6	0	120	24	2,880	44%	44%	1,572	188,679	1.31	25.60	13.06	1.62	1.57	0.02	0.14	1,802.32	0.24	0.05	1,823
-Aux. Generator	1			1	449 Die	sel			4	6	0	120	24	2,880	44%	44%	6		0.13	4.56	2.33	0.12	0.12	3.04E-03	1.26E-02	321.16	0.04	9.31E-03	324
-Emergency Generator	2			1	87 Die	sel			0	0	0	0	0	0	0%	0%	6		0	0	0	0	0	0	0	0	0	0	
offerdam Barge		2	400 x 105 x 25																										
-Station-keeping Engine	1			1	200 Die	sel	2,000	3.18	1	6	0	120	24	2,880	0%	52%	6 0	75,472	0.07	2.41	1.23	0.06	0.06	1.61E-03	6.67E-03	169.88	0.02	4.92E-03	171
- Piling Rig Engine	1			1	800 Die	sel			1	6	0	120	24	2,880	0%	52%	6 0		0.27	9.65	4.92	0.25	0.25	6.44E-03	0.03	679.51	0.09	0.02	687
					•								•	TO'	TALS FOR EW 2	(OCEANSIDE)	1,572	264,151	1.76	42.22	21.54	2.06	1.99	0.03	0.18	2,973	0.39	0.09	3,/

- Notes:

 1. Non-transit activity durations were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:

 Overseas port to South Brooklyn Marine Terminal to EW 2 (Oceanside) landfall site: 27 nm (Kings: 7.8 nm; Queens: 3 nm; Nassau: 16.2 nm)

 3. The number of transits for each vessel are based on the following assumptions:

 One round trip to/from overseas port for the dredger.

 Monthly round trips to/from SBMT for the cofferdam barge tug.

 One round trip to/from SBMT for the cofferdam barge.

 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.

 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI): i.e., they are calculated.
- 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
 7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 8. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₄, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 Landfall Marine Construction Emissions

LANDFALL MARINE INSTALLATION EQUIPMENT FOR EW	1 (GOWANUS)																				Total	Emissions (Tra	nsit)				
	1 (0011711105)		Emission				Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
	No. of 1. DP	Dimensions (ft)	Factor	Engine Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO ₂	CH ₄	N ₂ O	CO ₂ e
Vessels/Equipment	Engines 2.Anchor	ed length x width x depth	Used	Rating Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	per vessel 3.Spuds	(draft)	(see EFs	(hp)	vessel per day)	,,,,,,,	•	trip)			(hrs/day)	(hrs)		, ,	(per vessel)	(per vessel)											1
		, ,	worksheet)									' '															1
Channel Area Dredger/Tug Combination	N/A	480 x 92 x 36 (30)																									
-Tugboat Main Engine	2	, ,	3	7,831 Diesel	15,000	3.18	1	. 3	:	122	24	4 2,928	27%	6 179	6 59	575,472	0.01	0.14	0.01	1.96E-03	1.90E-03	4.19E-03	4.67E-04	6.83	4.23E-05	3.28E-04	6
-Tugboat Harbor Generator	1		1	979 Diesel			C) c)	o c		0 0	0%	6 09	6		0	0	0	0	0	0	0	0	0	0	1
-Tugboat Emergency Generato	1		1	737 Diesel			C			o c		0 0	0%	6 09	6		0	0	0	0	0	0	0	0	0	0	1
-Dredger Pump Engine			3	5,000 Diesel			C	o c		122	24	2,928	0%	6 179	6		0	0	0	0	0	0	0	0	0	0	I
-Dredger Harbor Generato	1		2	1,220 Diesel			C			o c		0 0	0%	6 09	6		0	0	0	0	0	0	0	0	0	0	1
Pier Area Dredger/Tug Combination	N/A	480 x 92 x 36 (30)		·																							
-Tugboat Main Engine	2	, ,	3	7,831 Diesel	15,000	3.18	1	. 3	:	62	24	1,488	27%	6 179	6 59	292,453	0.01	0.14	0.01	1.96E-03	1.90E-03	4.19E-03	4.67E-04	6.83	4.23E-05	3.28E-04	6.
-Tugboat Harbor Generator	1		1	979 Diesel			C) c)	o c		0 0	0%	6 09	6		0	0	0	0	0	0	0	0	0	0	1
-Tugboat Emergency Generato	1		1	737 Diesel			C			o c		0 0	0%	6 09	6		0	0	0	0	0	0	0	0	0	0	I
-Dredger Pump Engine	2		3	5,000 Diesel			C			62	24	1.488	0%	6 179	6		0	o	0	0	0	0	0	0	0	o ^l	1
-Dredger Harbor Generato			2	1,220 Diesel			C) c)	o c		0 0	0%	6 09	6		0	0	0	0	0	0	0	0	0	0	1
Tug for O&M Base Pilings	N/A	98 x 31 x 10 (8)																									
-Main Engines	2	. ,	2	1,260 Diesel	1,500	3.18	C) c)	90		4 360	0%	6 799	6	42,453	0	0	0	0	0	0	0	0	0	0	1
-Aux. Generator	1		1	449 Diesel	·		C			90		4 360	0%	6 799			0	0	0	0	0	0	0	0	0	0	I
-Emergency Generato	2		1	87 Diesel			C) c)	0 0		0 0	09	6 09	6		0	0	0	0	0	0	0	0	0	0	I
O&M Base Piling Barge	2	400 x 105 x 25																									
-Station-keeping Engine	1		1	200 Diesel	1,000	3.18	C			180	13	2,160	0%	6 569	6	28,302	0	0	0	0	0	0	0	0	0	0	1
- Piling Rig Engine			1	800 Diesel	·		C) c)	90		720	09	6 569	6		0	0	0	0	0	0	0	0	0	0	1
Tug for Cable Landfall and Bulkhead		98 x 31 x 10 (8)																									
-Main Engines	2	. ,	2	1,260 Diesel	1,500	3.18	C) c)	240		960	0%	6 799	6	113,208	0	0	0	0	0	0	0	0	0	0	1
-Aux. Generator	1		1	449 Diesel	·		C			240		960	0%	6 799	6		0	0	0	0	0	0	0	0	0	0	1
-Emergency Generato	2		1	87 Diesel			C			o		0 0	09	6 09			0	0	0	0	0	0	0	0	0	0	1
Cable Landfall and Bulkhead Barge	2	400 x 105 x 25																							_		
-Station-keeping Engine	1		1	200 Diesel	1,000	3.18	C) c		210		1,050	0%	6 849	6	66,038	0	0	0	0	0	0	0	0	0	0	1
- Piling Rig Engine			1	800 Diesel	, , , , , , , , , , , , , , , , , , , ,		C) (210		1,680	09	6 849			0	0	0	0	0	0	0	0	0	0	1
	1				1	1		1	1	-1		TO	TALS FOR EW	1 (GOWANUS) 1,17	938,679	1.06E-02	0.28	0.02	3.92E-03	3.80E-03	0.01	9.33E-04	13.65	8.45E-05	6.55E-04	13.

NDFALL MARINE INSTALLATION EQUIPMENT FOR	EW 2 (OCEAN	ISIDE)																					Total E	missions (T	ransit)				
	Ì			Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit		Non-Transit		Non-Transit											
	No. of	1. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operatin	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH ₄	N ₂ O	CO ₂ e
Vessels/Equipment	Engines	2.Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
	per vess	el 3.Spuds	(draft)	(see EFs	(hp)		vessel per day)			trip)			(hrs/day)	(hrs)			(per vessel)	(per vessel)										,	
	-	1		worksheet)																								ļ	
Tug for Cofferdam Barge		N/A	98 x 31 x 10 (8)																										
-Main Eng	ines 2			2	1,260 Die:	sel	5,000	3.18	4	6	0	120	24	2,880	44%	44%	1,572	188,679	1.09E-02	0.21	0.11	1.35E-02	1.31E-02	1.42E-04	1.16E-03	15.02	1.96E-03	4.35E-04	15.20
-Aux. Gener	ator 1			1	449 Die:	sel			4	6	0	120	24	2,880	44%	44%			1.05E-03	0.04	1.94E-02	1.00E-03	9.71E-04	2.54E-05	1.05E-04	2.68	3.49E-04	7.76E-05	2.71
-Emergency Gener	ator 2			1	87 Die	sel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	, ,
Cofferdam Barge		2	400 x 105 x 25																									-	
-Station-keeping En	gine 1			1	200 Die:	sel	2,000	3.18	1	6	0	120	24	2,880	0%	52%	0	75,472	0	0	0	0	0	0	0	0	0	0	, ,
- Piling Rig En				1	800 Die:	sel			1	6	0	120	24	2,880	0%	52%	0		0	0	0	0	0	0	0	0	0	0	/ (
		•	*	•										то	TALS FOR EW 2	(OCEANSIDE)	1.572	264.151	1.19E-02	0.25	0.13	1.45E-02	1.40E-02	1.68E-04	1.26E-03	17.70	2.31E-03	5.13E-04	17.91

- Notes:

 1. Non-transit activity durations were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:

 Overseas port to South Brooklyn Marine Terminal to EW 2 (Oceanside) landfall site: 27 nm (Kings: 7.8 nm; Queens: 3 nm; Nassau: 16.2 nm)

 3. The number of transits for each vessel are based on the following assumptions:

 One round trip to/from overseas port for the dredger.

 Monthly round trips to/from SBMT for the cofferdam barge tug.

 One round trip to/from SBMT for the cofferdam barge.

 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.

 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.

 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI): i.e., they are calculated.
- 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs. The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
 7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 8. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₄, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 WTG Installation Emissions

																								Total Em	issions (Non-	Transit)				
					Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
		No. of	1. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating To	otal Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH₄	N ₂ O	CO ₂ e
Vessels/Equipment		Engines	2.Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
, 4. 4.		per vesse		(draft)	(see EFs	(hp)	,,,	vessel per day)	7 (0.0)	•	trip)	.,.		(hrs/day)	(hrs)			(per vessel)	(per vessel)											1
				, ,	worksheet)	` ' '		,,,			,			, ., ,,	` ',			,	,											I.
Helicopter - Twin-Engine Heavy			N/A																											Ī
	-Main Engines	2			164	1.400	Jet fuel	N/A	N/A	-	78 0.5			0	0	100%	0%	12,275	0	0	0	0	c	0	0	0	0	0	0	1 ,
Main Installation Vessel			3	484 x 138 x 36		2,100		.,,.	.,.						-			,		-		-			-					
	-Main Engines	6			3	6.394	Diesel	45,000	3.18		1 6	;	293	3 24	7,032	33%	33%	3,538	4,146,226	37.15	980.71	81.73	13.77	13.35	29,48	3.28	48,001.43	0.30	2.30	48,695.21
WTG Supply Vessel (transit from Europe)			1	568 x 138 x 39 (18)		- 7,11		-,							,			.,									-,			
	-Main Generators	2			3	2,880	Diesel	50,000	3.18	2	27	,	9:	3 24	2,352	98%	98%	159,198	1,540,881	5.47	144.46	12.04	2.03	1.97	4.34	0.48	7,070.77	0.04	0.34	7,172.97
	-Main Generators	2			3	3,840	Diesel			2	27		9:	3 24	2,352	98%	98%		,,	7.30		16.05				0.64	9,427.70	0.06	0.45	9,563.96
	-Aux. Generator	1			2	994	Diesel			2	27		98	3 24	2,352	98%	98%			0.94		9.44				0.10	1,303.15	0.17	0.04	1,318.65
-	Emergency Generator	1			2	601	Diesel				0 0) (0	0	0%	0%			0	0	0	C	0	0	0	0	0	0	, ,
WTG Installation Generator	Ŭ ,																													i
		1	N/A	N/A	2	1,609	Diesel	6,190	3.18		0 (1	30	24	720	0%	100.0%	0	58,396	0.36	6.96	3.55	0.44	0.43	4.65E-03	0.04	490.28	0.06	1.42E-02	496.12
WTG Commissioning Generators																														1
		3	N/A	N/A	257	201	Diesel	2,112	3.18		0 (1) 80	24	1,920	0%	100.0%	0	53,132	0.18	0.38	3.33	0.02	0.02	1.43E-03	0.01	155.24	6.30E-03	1.26E-03	155.77
Tug 1 for WTG Blades/Nacelles (from SBM)			N/A	146 x 46 x 25 (21)																										1
	-Main Engines	2			2	5,440		10,000	3.18	4	40 18	'	293	3 24	7,032	24%	24%	94,340	921,384	7.51	147.28	75.14	9.31	9.03	0.10	0.80	10,369.63	1.35	0.30	10,493.01
	-Harbor Generator	1			1		Diesel				0 (') (0	0	0%	0%			0	0	0	C	0	0	0	0	0	0	l c
	Emergency Generator	1			1	168	Diesel				0 (') (0	0	0%	0%			0	0	0	C	0	0	0	0	0	0	- 0
Tug 2 for WTG Blades/Nacelles (from SBM			N/A	146 x 46 x 25 (21)	_																									
	-Main Engines	2			2	5,440		10,000	3.18	2	40 18		293	3 24	7,032	24%	24%		921,384	7.51	147.28	75.14	9.31	9.03	0.10	0.80	10,369.63	1.35	0.30	10,493.01
	-Harbor Generator	1			1		Diesel Diesel				0	1			0	0%	0%			0	0	0		0	0	0	0	0	0	1
	Emergency Generator	1	21/2	400 405 25	1	168	Diesel				0 (1) (0	0	0%	0%			0	0	0	C	0	0	0	0	0	0	- 0
Cargo Barge 1 (for WTG Blades/Nacelles)			N/A	400 x 105 x 25					N/A				293		7,032	N/A	N/A	N/A												1
Cargo Barge 2 (for WTG Blades/Nacelles)			N/A	400 x 105 x 25				0	N/A		40 18	'	29:	3 24	7,032	N/A	N/A	N/A	N/A											
cargo barge 2 (for WTG blades/Nacelles)			IN/A	400 X 103 X 23					N/A	,	40 18		293	3 24	7.032	N/A	N/A	N/A	N/A											1
Tug 3 for WTG Towers (from Albany)			N/A	136 x 36 x 19 (17)				0	IN/A	· · ·	+0 10	'	23.	24	7,032	IN/A	IN/A	IN/A	N/A											
Tag 5 Tot WTO TOWERS (HOITI ADDITY)	-Main Engines	2	11/75	130 X 30 X 13 (17)	2	3,600	Diesel	10,000	3.18		27 69		293	24	7,032	35%	35%	244,104	921,384	7.32	143.49	73.21	9.07	8.79	0.10	0.78	10,103.02	1.32	0.29	10,223.23
	-Aux. Engines	2			1		Diesel	10,000	3.10	-	27 69		293		7,032	35%	35%	244,104	321,364	0.10		1.93	0.10			1.05E-02	266.61	0.03	7.73E-03	
Tug 4 for WTG Towers (from Albany)	Aux. Eligilles		N/A	136 x 36 x 19 (17)	1	95	Diesei				2, 03		23.	, 24	7,032	33/6	33/6			0.10	3.73	1.93	0.10	0.10	2.33L-03	1.03L-02	200.01	0.03	7.73L-03	203.78
ing it in the remains (from Albumy)	-Main Engines	2	11/7	150 % 50 % 15 (17)	2	3,600	Diesel	10,000	3.18		27 60		293	24	7,032	35%	35%	244,104	921,384	7.32	143.49	73.21	9.07	8.79	0.10	0.78	10,103.02	1.32	0.29	10,223.23
	-Aux. Engines	2			1		Diesel	10,000	3.10	5	27 69		293	24	7,032	35%	35%	244,104	321,334	0.10		1.93	0.10			1.05E-02	266.61	0.03	7.73E-03	269.78
Cargo Barge 2 (for WTG Towers)	, tax. Engines		N/A	400 x 105 x 25		1 33				-		· ·		24	.,552	3370	3370			0.10	3.73	1.55	3.10	3.10	2.552 05	1.032.02	200.01	5.05	,,,,,,,	205.70
								0	N/A	2	27 69		293	24	7,032	N/A	N/A	N/A	N/A											I.
	1		-1	1	T.	1 1		-				1			.,	,	TOTALS	851,898	9,484,170	81 28	1,932.76	426.71	57.07	55.36	40.02	7 73	107,927.08	6.05	4 35	109,374.72

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- Overseas port to local staging area at SBMT: 13.5 nm in NY/NJ state waters
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
 Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)

- 3. The number of transits for each vessel are based on the following assumptions: 1 round trip to/from overseas port for the main installation vessel.
- 27 round trips from overseas port to local staging area at SBMT for the turbine supply vessel, based on assumed capacity to transport components for three positions per trip (for 80 total positions).
- 40 round trips to/from SBMT for each WTG component tug (for 80 total positions). 27 round trips to/from Port of Albany for each WTG tower tug (for 80 total positions).
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)

 8. WTG installation generator could be a vessel engine connected directly to WTG tower; emissions based on factors for Category 2 marine engines.

 9. WTG commissioning generator will be a portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
- 10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 11. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for CH, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 WTG Installation Emissions

																								Total E	missions (Tr	ansit)				
					Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
		No. of	1. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating To	tal Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH ₄	N ₂ O	CO ₂ e
Vessels/Equipment		Engines	2.Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
		per vesse		(draft)	(see EFs	(hp)	,,,	vessel per day)	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		trip)	.,.	,	(hrs/day)	(hrs)			(per vessel)	(per vessel)											1
			· ·	, ,	worksheet)									, , , ,,	` ,			. ,	. ,											1
Helicopter - Twin-Engine Heavy			N/A																											
	-Main Engines	2			164	1,400	lot fuel	N/A	N/A	-	78 0.5	,			0	100%	0%	12,275	0	0.05	0.68	0.02	0.02	0.02	0.04	1.35E-03	129.49	3.71E-03	4.29E-03	130.86
Main Installation Vessel	-iviaiii Liigiiles		3	484 x 138 x 36	104	1,400	iet iuei	IN/A	19/75		78 0.2	,		0	U	100%	078	12,273	0	0.03	0.08	0.02	0.02	0.02	0.04	1.331-03	123.43	3.71L-03	4.23L-03	130.80
ivialii ilistaliatioli vessei	-Main Engines	6	3	404 X 136 X 30	3	6.394	Diesel	45,000	3.18		1 6		293	24	7,032	33%	33%	3,538	4,146,226	0.03	0.84	0.07	1.17E-02	1.14E-02	0.03	2.80E-03	40.96	2.54E-04	1.97E-03	41.55
WTG Supply Vessel (transit from Europe)	Widin Engines		1	568 x 138 x 39 (18)	3	0,334	Diesei	45,000	3.10		1 `	`	255	2-7	7,032	3370	3370	3,330	4,140,220	0.05	0.04	0.07	1.172 02	1.142 02	0.05	2.001 03	40.50	2.542 04	1.57 € 03	71.55
wild supply vessel (transit from Europe)	-Main Generators	2	-	308 X 138 X 39 (18)	3	2,880	Diesel	50,000	3.18	-	27 (0.0	24	2,352	98%	98%	159,198	1,540,881	0.57	14.93	1.24	0.21	0.20	0.45	0.05	730.53	4.52E-03	0.04	741.08
	-Main Generators	2			3	3,840		30,000	3.10	2	27] ;	95	24	2,352	98%			1,540,001	0.75		1.66		0.27	0.60	0.03	974.03	6.03E-03		
	-Aux. Generator	1			2	994				2	27		95	24	2,352	98%	98%			0.10		0.98		0.12	1.28E-03	1.04E-02	134.64	0.032 03	3.90E-03	
	Emergency Generator	1			2	601				-	,			2-7	2,332	0%	0%			0.10	1.51	0.50	0.12	0.12	1.202 05	1.042 02	154.04	0.02	3.302 03	130.24
WTG Installation Generator	emergency denerator				-	001	Diese.				1		`	1	ŭ	0,0	0,0			ŭ	Ü		Ü	Ü	ŭ	Ü	Ü	ŭ		
W 10 mistaliation deficiator		1	N/A	N/A	2	1.609	Diesel	6,190	3.18		0 (,	30	24	720	0%	100.0%	0	58.396	0	0	0	0	0	0	0	0	0	0	1 /
WTG Commissioning Generators			,	'		,		0,200										_	00,000				_	-		-				
· ·		3	N/A	N/A	257	201	Diesel	2,112	3.18		0 0		80	24	1,920	0%	100.0%	0	53,132	0	0	0	0	0	0	0	0	0	0	(
Tug 1 for WTG Blades/Nacelles (from SBMT)		N/A	146 x 46 x 25 (21)																										
	-Main Engines	2			2	5,440	Diesel	10,000	3.18	4	40 18		293	24	7,032	24%	24%	94,340	921,384	0.77	15.08	7.69	0.95	0.92	1.01E-02	0.08	1061.74	0.14	0.03	1,074.37
	-Harbor Generator	1			1	456					0 0			0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
-1	Emergency Generator	1			1	168	Diesel				0 0		(0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	١
Tug 2 for WTG Blades/Nacelles (from SBMT)		N/A	146 x 46 x 25 (21)																										
	-Main Engines	2			2	5,440		10,000	3.18	4	40 18		293	24	7,032	24%	24%	94,340	921,384	0.77	15.08	7.69	0.95	0.92	1.01E-02	0.08	1061.74	0.14	0.03	1,074.37
	-Harbor Generator	1			1	456					0 ((0	0	0%				0	0	0	0	0	0	0	0	0	0	, ,
	Emergency Generator	1			1	168	Diesel				0 (((0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Cargo Barge 1 (for WTG Blades/Nacelles)			N/A	400 x 105 x 25																										1
								0	N/A	4	40 18	(293	24	7,032	N/A	N/A	N/A	N/A											
Cargo Barge 2 (for WTG Blades/Nacelles)			N/A	400 x 105 x 25																										1
								0	N/A	4	40 18		293	24	7,032	N/A	N/A	N/A	N/A											
Tug 3 for WTG Towers (from Albany)			N/A	136 x 36 x 19 (17)	_																									
	-Main Engines	2			2	3,600		10,000	3.18	2	2/ 69		293		7,032	35%			921,384	1.94		19.40		2.33	2.54E-02	0.21	2676.61	0.35	0.08	
Tug 4 for WTG Towers (from Albany)	-Aux. Engines	2	NI/A	136 x 36 x 19 (17)	1	95	Diesel				27 69	(293	24	7,032	35%	35%			2.76E-02	1.00	0.51	2.64E-02	2.56E-02	6.69E-04	2.77E-03	70.63	9.21E-03	2.05E-03	71.47
rug 4 for WTG Towers (from Albany)	Main Engine	2	N/A	130 X 30 X 19 (17)	2	3,600	Diocal	10,000	3.18	-	27 66		293	34	7 022	350/	350/	244 104	921,384	1.94	20.02	10.40	2.40	2.22	2.54E-02	0.34	2676.64	0.35	0.00	2,708.46
	-Main Engines -Aux. Engines	2			1		Diesel	10,000	3.18	2	27 69	1 2	293	24	7,032 7,032	35% 35%	35% 35%		921,384	1.94 2.76E-02		19.40 0.51		2.33 2.56E-02	6.69E-04	0.21 2.77E-03	2676.61 70.63	0.35 9.21E-03	0.08 2.05E-03	2,708.46 71.47
Cargo Barge 2 (for WTG Towers)	-Aux. Eligines		N/A	400 x 105 x 25	1	95	DIESEI				27 05	'	293	24	7,032	35%	35%			2./0E-UZ	1.00	0.51	2.04E-UZ	2.30E-U2	0.09E-04	2.//E-U3	70.03	3.ZIE-03	2.U3E-U3	/1.4/
cargo barge 2 (for WTG TOWers)			IN/A	400 x 103 x 23				0	N/A	7	27 60	,	293	24	7.032	N/A	N/A	N/A	N/A											I.
				1	1	1			11/74			١	233	24	7,032	14/74	TOTALS	851,898	,,,,		146.45	59.17	7.40	7.18		0.71	9,627.60	1.03		9,746.45

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- Overseas port to local staging area at SBMT: 13.5 nm in NY/NJ state waters
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
 Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)

- 3. The number of transits for each vessel are based on the following assumptions: 1 round trip to/from overseas port for the main installation vessel.
- 27 round trips from overseas port to local staging area at SBMT for the turbine supply vessel, based on assumed capacity to transport components for three positions per trip (for 80 total positions).
- 40 round trips to/from SBMT for each WTG component tug (for 80 total positions). 27 round trips to/from Port of Albany for each WTG tower tug (for 80 total positions).
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)

 8. WTG installation generator could be a vessel engine connected directly to WTG tower; emissions based on factors for Category 2 marine engines.

 9. WTG commissioning generator will be a portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
- 10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 11. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for CH, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 WTG Installation Emissions

																								Total Em	issions (Non	-Transit)				
					Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
		No. of	1. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH₄	N ₂ O	CO₂e
Vessels/Equipment		Engines	2.Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
, 4. 4		per vesse		(draft)	(see EFs	(hp)	,,,	vessel per day)	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	•	trip)	.,.		(hrs/day)	(hrs)			(per vessel)	(per vessel)											1
				,,,,	worksheet)			,,,						, ,,,,,	` ',			,	,											
Helicopter - Twin-Engine Heavy			N/A																											
	-Main Engines	2			164	1.400	Jet fuel	N/A	N/A	c	1 0.5			0 0	0	100%	0%	14,321	0	0	0	0	0	0	0	0	0	0	0	J
Main Installation Vessel			3	484 x 138 x 36		2,100		.,,.	.,,.,					-	-			- 1,0		-			-				-		-	
	-Main Engines	6			3	6.394	Diesel	45,000	3.18		1 6	;	58	6 24	14,064	33%	33%	3,538	8,292,453	74.30	1961.43	163.45	27.53	26.71	58.96	6.56	96,002.86	0.59	4.61	97,390.42
WTG Supply Vessel (transit from Europe)			1	568 x 138 x 39 (18)		.,		-,							,			.,												
, , , , , , , , , , , , , , , , , , , ,	-Main Generators	2			3	2,880	Diesel	50,000	3.18	9	4	,	19	6 24	4,704	98%	98%	318,396	3,081,761	10.94	288.92	24.08	4.06	3.93	8.68	0.97	14,141.54	0.09	0.68	14,345.94
	-Main Generators	2			3	3,840	Diesel			5	4		19		4,704	98%			.,,	14.59						1.29	18,855.39	0.12	0.90	
	-Aux. Generator	1			2	994	Diesel			5	4 9		19	6 24	4,704	98%	98%			1.89				2.27		0.20	2,606.29	0.34		
	Emergency Generator	1			2	601	Diesel				0 0)	0 0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	1
WTG Installation Generator	,																													
		1	N/A	N/A	2	1,609	Diesel	6,190	3.18		0 ()	6	0 24	1,440	0%	100.0%	0	116,792	0.71	13.93	7.11	0.88	0.85	9.29E-03	0.08	980.56	0.13	2.84E-02	992.23
WTG Commissioning Generators																														
		3	N/A	N/A	257	201	Diesel	2,112	3.18		0 (1	16	0 24	3,840	0%	100.0%	0	106,264	0.36	0.76	6.66	0.04	0.04	2.86E-03	0.03	310.47	1.26E-02	2.52E-03	311.54
Tug 1 for WTG Blades/Nacelles (from SBM			N/A	146 x 46 x 25 (21)																										
	-Main Engines	2			2	5,440		10,000	3.18	8	18	'	58	6 24	14,064	24%	24%	188,679	1,842,767	15.03	294.56	150.28	18.61	18.05	0.20	1.60	20,739.26	2.71	0.60	20,986.02
	-Harbor Generator	1			1		Diesel				0 (')	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	۱ (
	Emergency Generator	1			1	168	Diesel				0 (1)	0 0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Tug 2 for WTG Blades/Nacelles (from SBM			N/A	146 x 46 x 25 (21)																										
	-Main Engines	2			2	5,440		10,000	3.18	8	18		58	5 24	14,064	24%		188,679	1,842,767	15.03	294.56	150.28	18.61	18.05	0.20	1.60	20,739.26	2.71	0.60	20,986.02
	-Harbor Generator	1			1		Diesel				0 0	')	0	0	0%				0	0	0	0	0	0	0	0	0	0	۱ '
	Emergency Generator	1			1	168	Diesel				0 (')	0 0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	
Cargo Barge 1 (for WTG Blades/Nacelles)			N/A	400 x 105 x 25					N/A				58		44.054	21/2	N/A													
Cargo Barge 2 (for WTG Blades/Nacelles)			N/A	400 x 105 x 25				0	N/A		18	'	58	b 24	14,064	N/A	N/A	N/A	N/A											
cargo barge 2 (for WTG blades/Nacelles)			IN/A	400 X 103 X 23					N/A	۶	15		58	6 24	14.064	N/A	N/A	N/A	N/A											
Tug 3 for WTG Towers (from Albany)			N/A	136 x 36 x 19 (17)				0	IN/A		10	'	30	24	14,064	IN/A	N/A	N/A	N/A											—
rug 3 for WTG Towers (Horri Albany)	-Main Engines	2	IV/A	130 x 30 x 13 (17)	2	3,600	Diesel	10,000	3.18		.4 60		58	5 24	14,064	35%	35%	488,208	1,842,767	14.64	286.98	146.42	18.13	17.59	0.19	1.56	20,206.04	2.64	0.59	20,446.46
	-Aux. Engines	2			1		Diesel	10,000	3.10	-	4 69		58		14.064	35%	35%	400,200	1,042,707	0.21						2.09E-02	533.22	0.07	1.55E-02	
Tug 4 for WTG Towers (from Albany)	Aux. Eligines		N/A	136 x 36 x 19 (17)	1	95	Diesei				- 03		, 36	24	14,004	3376	33/6			0.21	7.57	3.80	0.20	0.13	3.03L-03	2.03L-02	333.22	0.07	1.33L-02	339.30
ing it is it is is it is	-Main Engines	2	14/7	150 % 50 % 15 (17)	2	3,600	Diesel	10,000	3.18		4 60		58	5 24	14,064	35%	35%	488,208	1,842,767	14.64	286.98	146.42	18.13	17.59	0.19	1.56	20,206.04	2.64	0.59	20,446.46
	-Aux. Engines	2			1		Diesel	10,000	3.16	-	4 69		58		14,064	35%	35%	400,208	1,072,707	0.21						2.09E-02	533.22	0.07	1.55E-02	539.56
Cargo Barge 2 (for WTG Towers)	, take Englites	-	N/A	400 x 105 x 25		33						· ·	50	27	2.,504	3370	3370			0.21	,.57	5.00	3.20	5.13	5.032 03	2.032.02	555.22	3.07	1.552 02	333.30
			,					0	N/A	9	4 69		58	6 24	14,064	N/A	N/A	N/A	N/A											
	ı		1	1	1	1 1		1							,	7	TOTALS	1,690,028	18 968 340	162 55	3,865.52	853.43	114.14	110.72	80.05	15 47	215.854.16	12.10	8 70	218,749.45

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- Overseas port to local staging area at SBMT: 13.5 nm in NY/NJ state waters
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
 Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)

- 3. The number of transits for each vessel are based on the following assumptions: 1 round trip to/from overseas port for the main installation vessel.
- 54 round trips from overseas port to local staging area at SBMT for the turbine supply vessel, based on assumed capacity to transport components for three positions per trip (for 160 total positions).
- 80 round trips to/from SBMT for each WTG component tug (80 barge trips total for 160 total positions). 54 round trips to/from Port of Albany for each WTG tower tug (for 160 total positions).
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. WTG installation generator could be a vessel engine connected directly to WTG tower; emissions based on Category 2 marine engine.

 9. WTG commissioning generator will be portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
- 10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 11. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for CH, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 WTG Installation Emissions

																								Total E	missions (Tr	ansit)				
					Emission					Transit	Transit	Non-OCS	ocs	Non-Transit	Non-Transit	Transit	Non-Transit	Transit	Non-Transit											
		No. of	1. DP	Dimensions (ft)	Factor	Engine	Fuel	Assumed fuel	Assumed fuel	Round	Duration	Operating	Operating	Operating	otal Operating	Average	Average	Fuel Usage	Fuel Usage	voc	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	HAPs	CO2	CH ₄	N ₂ O	CO ₂ e
Vessels/Equipment		Engines	2.Anchored	length x width x depth	Used	Rating	Type	rate (kg per	density (kg/gal)	Trips	(hrs/round	Days	Days	Hours	Hours	load (%)	load (%)	Gallons	Gallons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons
, 4. 4.		per vesse		(draft)	(see EFs	(hp)	,,,	vessel per day)	7 (0.0)	•	trip)	.,.		(hrs/day)	(hrs)			(per vessel)	(per vessel)											1
				, ,	worksheet)			,,,						, ,,,,,,	` ',			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,											1
Helicopter - Twin-Engine Heavy			N/A																											[
	-Main Engines	2			164	1.400	Jet fuel	N/A	N/A		91 0.5			0 0	0	100%	0%	14,321	0	0.06	0.79	0.02	0.02	0.02	0.05	1.57E-03	151.07	4.32E-03	5.01E-03	152.67
Main Installation Vessel			3	484 x 138 x 36		2,100		.,,.	.,.					-	-		-		-										0.022	
	-Main Engines	6			3	6.394	Diesel	45,000	3.18		1	;	58	6 24	14,064	33%	33%	3,538	8,292,453	0.03	0.84	0.07	1.17E-02	1.14E-02	0.03	2.80E-03	40.96	2.54E-04	1.97E-03	41.55
WTG Supply Vessel (transit from Europe)			1	568 x 138 x 39 (18)		.,		-,							,			-,	., . ,											
, , , , , , , , , , , , , , , , , , , ,	-Main Generators	2			3	2,880	Diesel	50,000	3.18		54 9		19	6 24	4,704	98%	98%	318,396	3,081,761	1.13	29.85	2.49	0.42	0.41	0.90	0.10	1461.05	9.05E-03	0.07	1,482.17
	-Main Generators	2			3	3,840	Diesel				54		19		4,704	98%			.,,	1.51					1.20	0.13	1948.07	1.21E-02		1,976.23
	-Aux. Generator	1			2	994	Diesel				54 9		19	6 24	4,704	98%	98%	3		0.20	3.82	1.95		0.23	2.55E-03	2.07E-02	269.27	0.04	7.81E-03	272.48
-	Emergency Generator	1			2	601	Diesel				0 0			0 0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	(
WTG Installation Generator	Ŭ,																													i
		1	N/A	N/A	2	1,609	Diesel	6,190	3.18		0 ()	6	0 24	1,440	0%	100.0%	0	116,792	0	0	0	0	0	0	0	0	0	0	C
WTG Commissioning Generators																														1
		3	N/A	N/A	257	201	Diesel	2,112	3.18		0 (1	16	0 24	3,840	0%	100.0%	0	106,264	0	0	0	0	0	0	0	0	0	0	C
Tug 1 for WTG Blades/Nacelles (from SBM)			N/A	146 x 46 x 25 (21)																										1
	-Main Engines	2			2	5,440		10,000	3.18	8	80 18	'	58	6 24	14,064	24%	24%		1,842,767	1.54	30.16	15.39	1.91	1.85	2.01E-02	0.16	2123.47	0.28	0.06	2,148.74
	-Harbor Generator	1			1		Diesel				0 0	')	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
	Emergency Generator	1			1	168	Diesel				0 (1)	0 0	0	0%	0%	5		0	0	0	0	0	0	0	0	0	0	C
Tug 2 for WTG Blades/Nacelles (from SBM)			N/A	146 x 46 x 25 (21)																										1
	-Main Engines	2			2	5,440		10,000	3.18	8	80 18	'	58	6 24	14,064	24%			1,842,767	1.54	30.16	15.39	1.91	1.85	2.01E-02	0.16	2123.47	0.28	0.06	2,148.74
	-Harbor Generator	1			1		Diesel				0	'	2	0	0	0%				0	0	0	0	0	0	0	0	0	0	1 0
	Emergency Generator	1			1	168	Diesel				0 (')	0 0	0	0%	0%	5		0	0	0	0	0	0	0	0	0	0	0
Cargo Barge 1 (for WTG Blades/Nacelles)			N/A	400 x 105 x 25					N/A		00		58		44.054	21/2	N/A													1
Cargo Barge 2 (for WTG Blades/Nacelles)			N/A	400 x 105 x 25				0	N/A		80 18	'	58	b 24	14,064	N/A	N/A	N/A	N/A											
cargo barge 2 (for WTG blades/Nacelles)			IN/A	400 X 103 X 23					N/A		80 18		58	6 24	14.064	N/A	N/A	N/A	N/A											1
Tug 3 for WTG Towers (from Albany)			N/A	136 x 36 x 19 (17)				0	IN/A	•	00 10	'	361	5 24	14,064	IN/A	IN/A	IN/A	IN/A											
rug 3 for WTG Towers (from Albany)	-Main Engines	2	IN/A	130 X 30 X 19 (17)	2	3,600	Diocal	10,000	3.18		5.4 60		58	5 24	14,064	35%	35%	488,208	1,842,767	3.88	76.03	38.79	4.80	4.66	5.07E-02	0.41	5353.22	0.70	0.16	5,416.92
	-Aux. Engines	2			1		Diesel	10,000	3.10		54 69		58		14.064	35%	35%		1,042,707	5.53E-02		1.02			1.34E-03	5.55E-03	141.27	1.84E-02		
Tug 4 for WTG Towers (from Albany)	Aux. Eligilles		N/A	136 x 36 x 19 (17)		95	Diesei			•	54 0:		, 381	24	14,004	3376	33/0	1		J.JJL-02	2.01	1.02	3.28L-02	J.12L-02	1.54L-03	J.JJL-03	141.27	1.34L-02	4.03L-03	142.53
ing it in the remains (from Albumy)	-Main Engines	2	11/7	150 / 50 / 15 (17)	2	3,600	Diesel	10,000	3.18		54 69		58	5 24	14,064	35%	35%	488,208	1,842,767	3.88	76.03	38.79	4.80	4.66	5.07E-02	0.41	5353.22	0.70	0.16	5,416.92
	-Aux. Engines	2			1		Diesel	10,000	3.10		54 69		58		14,064	35%	35%		1,042,707	5.53E-02	2.01	1.02			1.34E-03	5.55E-03	141.27	1.84E-02	4.09E-03	142.95
Cargo Barge 2 (for WTG Towers)	, tax. Engines		N/A	400 x 105 x 25	-	33					0.	· ·	30		2.,504	3370	3370			3.332 02	2.01	1.02	5.252 62	5.122 02	1.5 . 2 . 0 . 0 . 0 . 0 . 0 . 0 . 0 . 0 . 0	3.332 03	1.1.27	2.0 .2 02		1.2.55
			,.,					0	N/A	9	54 69		58	6 24	14,064	N/A	N/A	N/A	N/A											I.
				-1	1	, ,									,	.,	TOTALS	1,690,028	18 968 340	13.87	291.50	118.25	14.77	14.33	2.31	1 42	19,106.34	2.05	0.62	19,342.30

- 1. Non-transit construction emissions were estimated based on the number of days of operation provided by the project.
 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances:
- Overseas port to local staging area at SBMT: 13.5 nm in NY/NJ state waters
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm)
 Port of Albany to South Brooklyn Marine Terminal: 128.3 nm
 Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area)

- 3. The number of transits for each vessel are based on the following assumptions: 1 round trip to/from overseas port for the main installation vessel.
- 54 round trips from overseas port to local staging area at SBMT for the turbine supply vessel, based on assumed capacity to transport components for three positions per trip (for 160 total positions).
- 80 round trips to/from SBMT for each WTG component tug (80 barge trips total for 160 total positions). 54 round trips to/from Port of Albany for each WTG tower tug (for 160 total positions).
- 4. Helicopter transit emissions assume two round trips per week, with a duration of 30 minutes per round trip, based on travel from JFK Int'l Airport (30 mi one-way distance, 1.5 mi over Queens County, 8.5 mi over Nassau County, and 20 mi inside OCS radius).

 5. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort.
- 6. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- 7. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PMor VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
- 8. WTG installation generator could be a vessel engine connected directly to WTG tower; emissions based on Category 2 marine engine.

 9. WTG commissioning generator will be portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
- 10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
- 11. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Commissioning Emissions

																								Total Emi	ssions (Nor	-Transit)				
Vessels/Equipme			1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit otal Operatir Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO ₂ e tons
Service Operations Vessel 1	-Main Generators	4	1 2	275 x 58 x 21	2	2212	Diesel	4,000	3.18	3	7 9	0	219	24	5,256	5 12%	12%	3,302	275,472	2.25	44.03	22.47	2.78	2.70	0.03	0.24	3,100.27	0.40	0.09	3,137.16
Service Operations Vessel 2	-Main Generators	4	1 2	275 x 58 x 21	2	2212	Diesel	4,000	3.18	3	1 9	0	30	24	720	12%	12%	472	37,736	0.31	6.03	3.08	0.38	0.37	4.02E-03	0.03	424.69	0.06	1.23E-02	429.75
Crew Transfer Vessel 1	-Main Engines -Main Generators	2 2	N/A 6	65 x 17 x 5	1 1		Diesel Diesel	3,000	3.18	3 3	1 9	0	219	24	5,256 5,256		38% 38%		206,604	0.89	32.16 0.86	16.41 0.44	0.85 0.02		0.02 5.75E-04	0.09 2.38E-03	2,264.49 60.71	0.30 7.92E-03	0.07 1.76E-03	2,291.4 61.4
Crew Transfer Vessel 2	-Main Engines -Main Generators	2 2	N/A 6	65 x 17 x 5	1 1		Diesel Diesel	3,000	3.18	3	4 9	0 0	30	24	720 720		38% 38%	1,415	28,302	0.12 3.25E-03	4.41 0.12	2.25	0.12 3.11E-03	0.11 3.02E-03	2.94E-03 7.88E-05	1.22E-02 3.27E-04	310.20 8.32	0.04 1.08E-03	8.99E-03 2.41E-04	313.9
Inter-array Cable Pulling Engine (at	t each WTG)	1	N/A	N/A	254	20	Diesel	70	3.18	3	0 0	0	167	7 24	4,008	3 0%	99.4%	5 (3,676		0.43	0.43	0.03		9.88E-05		10.74	4.36E-04		10.78
Inter-array Cable Pulling Engine (at Export Cable Pulling Engine (at OSS		1	N/A	N/A	254	20	Diesel	70	3.18	3	0 0	0	4	1 24	96	6 0%	99.4%	5 (88	1.47E-03	1.04E-02	1.04E-02	6.31E-04	6.12E-04	2.37E-06	2.32E-05	0.26	1.04E-05	2.09E-06	0.26
Export Cable Fulling Engine (at O53	ع)	1	N/A	N/A	255	34	Diesel	117	3.18	3	0 0	0	4	4 24	96	6 0%	99.7% TOTALS	`	147 5 552,025	1.53E-03 3.65	1.09E-02 88.07	1.32E-02 45.16			3.96E-06	3.88E-05 0.38	0.43 6.180.12	1.74E-05 0.81	3.49E-06 0.18	0.43 6,253.5 6

- Notes:

 1. Non-transit activity durations were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 10 knots, and the following one-way travel distances:
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) 3. The number of transits for each vessel are based on the following assumptions:
- Monthly round trips to/from port for the service operations vessels.
- Weekly round trips to/from port for the crew transfer vessels.

 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.
- 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- Emission factors for marine vessel engines are from ICI International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions inventories", April 2009.
 HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions inventory (NEI); i.e., they are calculated as percentages of the PMOr VOC emissions from the CMVs.
 The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
 Inter-array cable pulling engine (at each WTG) will be a portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Export cable pulling engine (at OSS) will be a portable generator lifted onto OSS platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Export cable pulling engine (at OSS) will be a portable generator lifted onto OSS platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.

- 11. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₃, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Commissioning Emissions

																								Total E	missions (T	ransit)				
Vessels/Equipme			1. DP 2.Anchored 3.Spuds	Dimensions (ft) red length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days		Non-Transit otal Operatin Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO ₂ e tons
Service Operations Vessel 1	-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel	4,000	3.18	7	9	C	219	24	5,256	12%	12%	3,302	275,472	0.03	0.53	0.27	0.03	0.03	3.52E-04	2.86E-03	37.16	4.85E-03	1.08E-03	37.60
Service Operations Vessel 2	-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel	4,000	3.18	1	. 9	C	30	24	720	12%	12%	472	37,736	3.85E-03	0.08	0.04	4.76E-03	4.62E-03	5.03E-05	4.09E-04	5.31	6.92E-04	1.54E-04	5.37
Crew Transfer Vessel 1	-Main Engines -Main Generators	2 2	N/A	65 x 17 x 5	1 1		Diesel Diesel	3,000	3.18	31	L 9	C	219	24	5,256 5,256		38% 38%		206,604	0.05 1.26E-03		0.87 0.02			1.14E-03 3.05E-05	4.72E-03 1.27E-04	120.20 3.22			121.63
Crew Transfer Vessel 2	-Main Engines -Main Generators	2 2	N/A	65 x 17 x 5	1 1		Diesel Diesel	3,000	3.18	2	1 9	C	30	24	720 720	38%	38% 38%		28,302	6.07E-03 1.63E-04		0.11 3.01E-03	5.80E-03 1.55E-04		1.47E-04 3.94E-06	6.09E-04 1.63E-05	15.51 0.42	2.02E-03 5.42E-05	4.50E-04 1.21E-05	15.69 0.42
Inter-array Cable Pulling Engine (at		1	N/A	N/A	254	20	Diesel	70	3.18	(0	C	167	24	4,008	0%	99.4%	C	3,676	0	0	0	0	0	0	0	0	0	0	(
Inter-array Cable Pulling Engine (at Export Cable Pulling Engine (at OSS)		1	N/A	N/A	254	20	Diesel	70	3.18	(0	C	4	24	96	0%	99.4%	C	88	0	0	0	0	0	0	0	0	0	0	
		1	N/A	N/A	255	34	Diesel	117	3.18	(0	C	4	24	96	0%	99.7% TOTALS		147 552,025	0.09	0 2.58	0 1.32	0.09	0.09	0.00	0 0.01	0 181.82	0.02	0.01	183.99

- Notes:

 1. Non-transit activity durations were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 10 knots, and the following one-way travel distances:
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) 3. The number of transits for each vessel are based on the following assumptions:
- Monthly round trips to/from port for the service operations vessels.
- Weekly round trips to/from port for the crew transfer vessels.

 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.
- 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- Emission factors for marine vessel engines are from ICI International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions inventories", April 2009.
 HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions inventory (NEI); i.e., they are calculated as percentages of the PMOr VOC emissions from the CMVs.
 The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
 Inter-array cable pulling engine (at each WTG) will be a portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Export cable pulling engine (at OSS) will be a portable generator lifted onto OSS platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Export cable pulling engine (at OSS) will be a portable generator lifted onto OSS platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.

- 11. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS **EW 2 Commissioning Emissions**

																								Total Emi	ssions (Nor	n-Transit)				
Vessels/Equipm			1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days		Non-Transit otal Operatin Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO ₂ e tons
Service Operations Vessel 1	-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel	4,000	3.18	14	1 9	0	438	24	10,512	12%	12%	6,604	550,943	4.49	88.07	44.93	5.56	5.40	0.06	0.48	6,200.54	0.81	0.18	6,274.32
Service Operations Vessel 2	-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel	4,000	3.18	2	2 9	0	60	24	1,440	12%	12%	943	75,472	0.62	12.06	6.15	0.76	0.74	8.05E-03	0.07	849.39	0.11	2.46E-02	859.50
Crew Transfer Vessel 1	-Main Engines -Main Generators	2 2	N/A	65 x 17 x 5	1 1		Diesel Diesel	3,000	3.18	62 62	2 9	0	438	24	10,512 10,512		38% 38%	21,934	413,208	1.77 0.05	64.32 1.72	32.82 0.88			0.04 1.15E-03	0.18 4.77E-03	4,528.99 121.42	0.59 1.58E-02	0.13 3.52E-03	4,582.8° 122.8
Crew Transfer Vessel 2	-Main Engines -Main Generators	2 2	N/A	65 x 17 x 5	1 1		Diesel Diesel	3,000	3.18	8	B 9	0	60	24	1,440 1.440		38% 38%	2,830	56,604	0.24 6.51E-03	8.81 0.24	4.50 0.12	0.23 6.22E-03	0.23 6.03E-03	5.88E-03 1.58E-04	2.44E-02 6.53E-04	620.41 16.63	0.08 2.17E-03	1.80E-02 4.82E-04	627.79 16.83
Inter-array Cable Pulling Engine (at	t each WTG)	1	N/A	N/A	254) Diesel	70	3.18	C	0	0	334	. 24	8,016	0%	99.4%	C	7,352	0.12	0.87	0.87	0.05	0.05	1.98E-04	1.94E-03		8.71E-04		21.55
Inter-array Cable Pulling Engine (at Export Cable Pulling Engine (at OSS		1	N/A	N/A	254	20	Diesel	70	3.18	C	0	0	4	24	96	0%	99.4%	C	88	1.47E-03	1.04E-02	1.04E-02	6.31E-04	6.12E-04	2.37E-06	2.32E-05	0.26	1.04E-05	2.09E-06	0.26
	,	1	N/A	N/A	255	34	Diesel	117	3.18	C	0	0	4	24	96	0%	99.7% TOTALS	32,311	147 1,103,814	1.53E-03 7.30	1.09E-02 176.11	1.32E-02 90.29			3.96E-06 0.12		0.43 12,359.55	1.74E-05 1.61	3.49E-06 0.36	0.43 12,506.4 2

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- Notes:

 1. Non-transit activity durations were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 10 knots, and the following one-way travel distances:
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) 3. The number of transits for each vessel are based on the following assumptions:
- Monthly round trips to/from port for the service operations vessels.
- Weekly round trips to/from port for the crew transfer vessels.

 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.
- 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- Emission factors for marine vessel engines are from ICI International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions inventories", April 2009.
 HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions inventory (NEI); i.e., they are calculated as percentages of the PMOr VOC emissions from the CMVs.
 The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
 Inter-array cable pulling engine (at each WTG) will be a portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Export cable pulling engine (at OSS) will be a portable generator lifted onto OSS platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Export cable pulling engine (at OSS) will be a portable generator lifted onto OSS platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.

- 11. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS **EW 2 Commissioning Emissions**

																								Total E	missions (T	ransit)				
Vessels/Equipmo			1. DP 2.Anchored 3.Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days		Non-Transit otal Operatin Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH₄ tons	N ₂ O tons	CO ₂ e tons
Service Operations Vessel 1	-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel	4,000	3.18	14	1 9	O	438	24	10,512	12%	12%	6,604	550,943	0.05	1.06	0.54	0.07	0.06	7.04E-04	5.72E-03	74.32	9.69E-03	2.15E-03	75.21
Service Operations Vessel 2	-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel	4,000	3.18	2	2 9	C	60	24	1,440	12%	12%	943	75,472	7.69E-03	0.15	0.08	9.53E-03	9.24E-03	1.01E-04	8.17E-04	10.62	1.38E-03	3.08E-04	10.74
Crew Transfer Vessel 1	-Main Engines -Main Generators	2 2	N/A	65 x 17 x 5	1 1		Diesel Diesel	3,000	3.18	62 62	2 9	0	438	24	10,512 10,512		38% 38%	21,934	413,208	0.09 2.52E-03	3.41 0.09	1.74 0.05			2.28E-03 6.11E-05	9.44E-03 2.53E-04	240.41 6.45	0.03 8.41E-04	6.97E-03 1.87E-04	243.2
Crew Transfer Vessel 2	-Main Engines -Main Generators	2 2	N/A	65 x 17 x 5	1 1		Diesel Diesel	3,000	3.18	8	9 9	0	60	24	1,440 1,440		38% 38%	2,830	56,604	1.21E-02 3.25E-04	0.44 1.18E-02	0.22 6.03E-03	1.16E-02 3.11E-04	1.13E-02 3.02E-04	2.94E-04 7.88E-06	1.22E-03 3.27E-05	31.02 0.83	4.05E-03 1.08E-04	8.99E-04 2.41E-05	31.39
Inter-array Cable Pulling Engine (at		1	N/A	N/A	254	20) Diesel	70	3.18	(0	0	334	. 24	8,016	0%	99.4%	C	7,352	0	0	0	0	0	0	0	0	0	0	(
Inter-array Cable Pulling Engine (at Export Cable Pulling Engine (at OSS		1	N/A	N/A	254	20	Diesel	70	3.18	(0 0	o c	4	24	96	0%	99.4%	С	88	0	0	0	0	0	0	0	0	0	0	
		1	N/A	N/A	255	34	Diesel	117	3.18	(0	C	4	24	96	0%	99.7% TOTALS	32,311	147 1,103,814	0 0.17	0 5.16	0 2.64	0.18	0.18	0.00	0 0.02	0 363.64	0.05	0 0.01	367.97

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- Notes:

 1. Non-transit activity durations were estimated based on the number of days of operation provided by the project.

 2. Transit emissions are based on an assumed vessel speed of 10 knots, and the following one-way travel distances:
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm) 3. The number of transits for each vessel are based on the following assumptions:
- Monthly round trips to/from port for the service operations vessels.
- Weekly round trips to/from port for the crew transfer vessels.

 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identifed for each installation activity are typical sizes for performing this effort.
- 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009.
- Emission factors for marine vessel engines are from ICI International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions inventories", April 2009.
 HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions inventory (NEI); i.e., they are calculated as percentages of the PMOr VOC emissions from the CMVs.
 The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages)
 Inter-array cable pulling engine (at each WTG) will be a portable generator lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Export cable pulling engine (at OSS) will be a portable generator lifted onto OSS platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Export cable pulling engine (at OSS) will be a portable generator lifted onto OSS platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs).
 Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.

- 11. CO₂e emission rates use the following carbon equivalence factors: 25 for CH₂, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 (Gowanus) Substation, O+M Base, and Onshore Cable Route - Construction Emissions

								Fuel Use						Emissions	3				
Construction Equipment	Source Category	HP per unit	Fuel Type	Emiss. Factor ID	hrs per day	Load Factor	Total Equip. Months	gal	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAP Tons	CO ₂	CH₄ tons	N ₂ O tons	CO ₂ e tons
Land-based Nonroad Equip.																			
SUBSTATION																			
Large Bulldozer	2270002069	800	diesel	105	8	59%	9	27,962	0.17	2.16	0.47	0.06	0.06	2.16E-03	0.04	421.85	1.31E-02	1.07E-02	425.38
All-Terrain Forklift	2270002057	150	diesel	103	8	59%	30	17,480	0.09	0.44	0.18	0.04	0.04	1.36E-03	2.06E-02	263.71	7.03E-03	6.72E-03	
Front End Loader	2270002060	200	diesel	104	8	59%	15	11,654	0.05	0.21	0.07	9.57E-03	9.28E-03	8.73E-04	1.28E-02	175.82	4.42E-03	4.48E-03	177.26
Medium Crane	2270002045	400	diesel	102	8	43%	12	13,442	0.07	0.54	0.15	0.02	0.02	1.09E-03	0.02	202.79	5.21E-03	5.16E-03	204.46
Medium Aerial Lift	2270003010	20	diesel	106	8	21%	48	1,713	0.05	0.20	0.19	0.03	0.03	1.74E-04	1.12E-02	25.85	1.60E-03	6.58E-04	26.08
Medium Excavator	2270002036	200	diesel	101	8	59%	12	9,324	0.04	0.10	0.04	3.66E-03	3.55E-03	6.82E-04	9.85E-03	140.66	3.42E-03	3.58E-03	141.81
Piling Rig	2270002033	200	diesel	100	8	43%	3	1,680	1.19E-02	0.12	0.03	5.72E-03	5.55E-03	1.44E-04	2.86E-03	25.34	6.63E-04	6.45E-04	25.55
Generator	2270006005	150	diesel	107	8	43%	15	6,297	0.05	0.47	0.13	0.03	0.03	5.51E-04	1.20E-02	95.00	2.62E-03	2.42E-03	95.79
ONSHORE CABLE																			1
Onshore Cable Route HDD Drill Rig	2270002033	200	diesel	100	8	43%	3	1,680	1.19E-02	0.12	0.03	5.72E-03	5.55E-03	1.44E-04	2.86E-03	25.34	6.63E-04	6.45E-04	25.55
Onshore Cable Route Compressor	2270006015	150	diesel	108	8	43%	3	1,260	6.41E-03	0.04	1.09E-02	2.49E-03	2.42E-03	1.00E-04	1.54E-03	19.01	5.17E-04	4.84E-04	1 19.17
Onshore Cable Route Excavator	2270002036	200	diesel	101	8	59%	6	4,662	2.05E-02	0.05	0.02	1.83E-03	1.77E-03	3.41E-04	4.92E-03	70.33	1.71E-03	1.79E-03	70.91
Onshore Cable Route Tractor	2270002075	450	diesel	105.1	8	59%	3	5.244	0.02	0.16	0.06	8.84E-03	8.58E-03				2.00E-03		
O&M BASE								- '											
250T Shore Crane	2270002045	400	diesel	102	8	43%	5	5,601	0.03	0.22	0.06	9.31E-03	9.03E-03	4.56E-04	6.66E-03	84.50	2.17E-03	2.15E-03	85.19
5T Forklift	2270002057	115	diesel	103	6	59%	6	2.010	9.86E-03	0.05	0.02		4.17E-03				8.08E-04		
All-Terrain Forklift	2270002057	150	diesel	103	8	59%	10	5.827	0.03	0.15	0.06	1.25E-02	1.21E-02	4.53E-04	6.87E-03		2.34E-03		88.63
Front End Loader	2270002060	200	diesel	104	8	59%	10	7.769	0.04	0.14	0.05	6.38E-03	6.19E-03	5.82E-04	8.53E-03	117.21	2.95E-03	2.98E-03	
Medium Crane	2270002045	400	diesel	102	8	43%	10	11,202	0.06	0.45	0.12	1.86E-02	0.02	9.12E-04	1.33E-02		4.34E-03		170.39
Medium Aerial Lift	2270003010	20	diesel	106	8	21%	10	357	9.67E-03	0.04	0.04	5.40E-03	5.23E-03	3.63E-05	2.32E-03		3.34E-04		5.43
Medium Excavator	2270002036	200	diesel	101	8	59%	10	7.770	0.03	0.08	0.03	3.05E-03	2.95E-03	5.69E-04	8.21E-03	117.22	2.85E-03	2.98E-03	118.18
Piling Rig	2270002033	200	diesel	100	8	43%	1	560	3.97E-03	0.04	9.16E-03	1.91E-03	1.85E-03	4.81E-05	9.54E-04	8.45	2.21E-04	2.15E-04	8.52
CABLE LANDFALL AND BULKHEAD																			
250T Shore Crane	2270002045	400	diesel	102	8	43%	7	7.841	0.04	0.31	0.08	1.30E-02	1.26E-02	6.38E-04	9.32E-03	118.30	3.04E-03	3.01E-03	119.27
Large excavator	2270002036	350	diesel	101	12	59%	8	16.316	0.07	0.17	0.06	6.40E-03	6.20E-03	1.19E-03	0.02	246.15	5.98E-03	6.27E-03	3 248.17
Medium Bulldozer	2270002069	390	diesel	105	6	59%	8	9.088	0.05	0.70	0.15	0.02	0.02	7.02E-04	1.31E-02	137.10	4.25E-03	3.49E-03	138.25
5T Forklift	2270002057	115	diesel	103	6	59%	6	2.010	9.86E-03	0.05	0.02	4.30E-03	4.17E-03			30.33			
Onroad Vehicles								,											
Semi-Truck		-	diesel	131	-	-	9	1.878	4.77E-03	0.04	0.02	1.36E-03	1.25E-03	1.77E-04	6.17E-04	21.14	2.02E-03	8.13E-05	21.21
Work Truck		-	diesel	133	-	-	15	1.391	7.19E-03	0.02	0.06	8.75E-04	8.05E-04	1.32E-04	9.63E-04	15.65			15.76
Refuse Truck	1		diesel	132	-	-	9	2.387	2.28E-03	0.03	1.18E-02	9.76E-04	8.98E-04			26.87	1.49E-03		
Dump Truck	1		diesel	131	-	-	68	14.191	0.04	0.27	0.13		9.45E-03		4.66E-03	159.71			
Concrete Truck			diesel	131	-	-	9	1.878		0.04			1.25E-03				2.02E-03		
Worker Commute	1	l -					Ů	.,510	50	3.34	0.02							552 00	†
Light Commercial Truck	1	-	diesel	134		<u> </u>	60	4.274	1.21E-02	0.05	0.10	1.35E-03	1 25F-03	4.02E-04	2 17F-03	48 10	9.68E-03	2.97E-04	48.43
Passenger Truck	1	-	gasoline	135			36	2.020		8.27E-03		3.92E-04	3.46E-04			19.55			
. accongor ridon	1		gaoomic	100			Total	206,768	1.04	7.46	2.56	0.33	0.32			3,008.82			7 3,032.48

- 1. Equipment assumptions based on information provided by the project.
- 2. Calculations assume equipment is used 5 days/wk i.e. 21 days/month.
- 3. Calculations conservatively assume that onroad vehicles travel approximately 50 miles per day, since emission factors from the MOVES2014 model for onroad vehicles are based on miles traveled.
- 4. Calculations conservatively assume workers average daily round trip commute is approximately 40 miles per day, since emission factors from the MOVES2014 model for onroad vehicles are based on miles traveled.
- 5. Nonroad emission factors for criteria pollutants and GHG were estimated using EPA's MOVES2014b emission model for an assumed construction year of 2022.
- 6. Nonroad emission factors for HAPs were estimated using ERG, "Documentation for Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory," Volume 1 Methodology, October 7, 2003.
- 7. Onroad vehicle emission factors (lb/VMT) for VOC, NOx, CO, PM10, SO2, HAP and CO2e, were estimated using the MOVES2014b emission model for an assumed construction year of 2022.
- 8. Footprint for onshore substation is assumed to be 11.5 acres.
- 9. Length of onshore transmission cable is assumed to be 4.2 miles.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 (Oceanside) Substation and Onshore Cable Route - Construction Emissions

								Fuel Use						Emissions	3				
Construction Equipment	Source Category	HP per unit	Fuel Type	Emiss. Factor ID	hrs per day	Load Factor	Total Equip. Months	gal	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAP Tons	CO ₂ tons	CH₄ tons	N₂O tons	CO₂e tons
Land-based Nonroad Equip.																			
SUBSTATION																			
Large Bulldozer	2270002069	800	diesel	115	8	59%	18	55,925	0.34	4.31	0.94	0.12	0.11	4.32E-03	0.08	843.70	0.03	0.02	850.76
All-Terrain Forklift	2270002057	150	diesel	113	8	59%	30	17,480	0.09	0.44	0.18	0.04	0.04	1.36E-03	0.02	263.71	7.03E-03	6.72E-03	265.88
Front End Loader	2270002060	200	diesel	114	8	59%	30	23,308	0.11	0.42	0.14	0.02	0.02	1.75E-03	0.03	351.63	8.84E-03	8.95E-03	354.52
Medium Crane	2270002045	400	diesel	112	8	43%	12	13,442	0.07	0.54	0.15	0.02	0.02	1.09E-03	0.02	202.79	5.21E-03	5.16E-03	204.46
Medium Aerial Lift	2270003010	20	diesel	116	8	21%	48	1,713	0.05	0.20	0.19	0.03	0.03	1.74E-04	1.12E-02	25.85	1.60E-03	6.58E-04	26.08
Medium Excavator	2270002036	200	diesel	111	8	59%	36	27,971	0.12	0.29	0.11	1.10E-02	1.06E-02	2.05E-03	0.03	421.98	1.03E-02	1.07E-02	425.43
Piling Rig	2270002033	200	diesel	110	8	43%	3	1,680	1.19E-02	0.12	0.03	5.72E-03	5.55E-03	1.44E-04	2.86E-03	25.34	6.63E-04	6.45E-04	25.55
Generator	2270006005	150	diesel	117	8	43%	15	6,297	0.05	0.47	0.13	0.03	0.03	5.51E-04	1.20E-02	95.00	2.62E-03	2.42E-03	95.79
ONSHORE CABLE																			
Landfall/Onshore HDD Drill Rig	2270002033	200	diesel	110	8	43%	10	5,599	0.04	0.38	0.09	0.02	0.02	4.81E-04	9.54E-03	84.46	2.21E-03	2.15E-03	85.16
Landfall/Onshore HDD Compressor	2270006015	150	diesel	118	8	43%	10	4,201	0.02	0.13	0.04	8.31E-03	8.07E-03	3.34E-04	5.14E-03	63.37	1.72E-03	1.61E-03	63.90
Landfall/Onshore HDD Shaker	2270002081	100	diesel	115.2	8	59%	10	3,884	0.02	0.12	0.05	1.07E-02	1.03E-02	3.08E-04	4.76E-03	58.60	1.60E-03	1.49E-03	59.08
Landfall/Onshore HDD Excavator	2270002036	200	diesel	111	8	59%	10	7,770	0.03	0.08	0.03	3.05E-03	2.95E-03	5.69E-04	8.21E-03	117.22	2.85E-03	2.98E-03	118.18
Landfall/Onshore HDD Tractor	2270002075	450	diesel	115.1	8	59%	10	17,481	0.08	0.52	0.21	0.03	0.03	1.38E-03	0.02	263.72	6.67E-03	6.72E-03	265.89
Onshore Cable Route Excavator	2270002036	200	diesel	111	8	59%	36	27,971	0.12	0.29	0.11	1.10E-02	1.06E-02	2.05E-03	0.03	421.98	1.03E-02	1.07E-02	425.43
Onroad Vehicles																			
Semi-Truck		-	diesel	141	-	-	24	3,180	1.10E-02	0.08	0.04	3.15E-03	2.90E-03	3.01E-04	1.31E-03	35.79	3.74E-03	1.23E-04	35.92
Work Truck		-	diesel	143	-	-	24	1,802	0.02	0.05	0.16	2.02E-03	1.86E-03	1.73E-04	2.14E-03	20.28	4.97E-03	9.36E-05	20.43
Refuse Truck		-	diesel	142	-	-	24	4,913	9.46E-03	0.15	0.05	6.39E-03	5.88E-03	4.68E-04	9.76E-04	55.30	2.32E-03	1.01E-04	55.39
Dump Truck		-	diesel	141	-	-	60	7,950	0.03	0.19	0.10	7.87E-03	7.24E-03	7.53E-04	3.28E-03	89.47	9.36E-03	3.07E-04	89.79
Concrete Truck		-	diesel	141	-	-	12	1,590	5.50E-03	0.04	0.02	1.57E-03	1.45E-03	1.51E-04	6.57E-04	17.89	1.87E-03	6.13E-05	17.96
Worker Commute																			
Light Commercial Truck		-	diesel	144	-	-	60	3,112	1.48E-02	0.05	0.10	1.32E-03	1.21E-03	2.94E-04	2.18E-03	35.02	8.12E-03	1.68E-04	35.13
Passenger Truck		-	gasoline	145	-	-	36	1,461	9.69E-03	9.62E-03	0.15	3.94E-04	3.49E-04	2.03E-04	8.97E-04	14.14	5.25E-04	4.26E-04	14.28
•	•	•				•	Total	238,728	1.24	8.88	3.00	0.37	0.36	0.02	0.29	3,507.24	0.12	0.08	3,535.02

- 1. Equipment assumptions based on information provided by the project.
- 2. Calculations assume equipment is used 5 days/wk i.e. 21 days/month.
- 3. Calculations conservatively assume that onroad vehicles travel approximately 50 miles per day, since emission factors from the MOVES2014 model for onroad vehicles are based on miles traveled.
- 4.Calculations conservatively assume workers average daily round trip commute is approximately 40 miles per day, since emission factors from the MOVES2014 model for onroad vehicles are based on miles traveled.
- 5. Nonroad emission factors for criteria pollutants and GHG were estimated using EPA's MOVES2014b emission model for an assumed construction year of 2022.
- 6. Nonroad emission factors for HAPs were estimated using ERG, "Documentation for Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory," Volume 1 Methodology, October 7, 2003.
- 7. Onroad vehicle emission factors (Ib/VMT) for VOC, NOx, CO, PM10, SO2, HAP and CO2e, were estimated using the MOVES2014b emission model for an assumed construction year of 2022.
- 8. Footprint for onshore substation is assumed to be 11.5 acres.
- 9. Length of onshore transmission cable is assumed to be 3.8 miles.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS

EW 1 Onshore Staging and Assembly at O+M Base - Construction Emissions

						Emissions	3												
Construction Equipment	Source Category	HP per unit	Fuel Type	Emiss. Factor ID	hrs per day	Load Factor	Total Equip. Months	gal	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAP Tons	CO ₂ tons	CH₄ tons	N₂O tons	CO₂e tons
Land-based Nonroad Equip.																			
24-Axle SPMT (Transport)	N/A	N/A	electric	N/A	12	N/A	20	0	0	0	0	0	0	0	0	0	0	0	0
12-Axle SPMT (Transport)	N/A	N/A	electric	N/A	12	N/A	20	0	0	0	0	0	0	0	0	0	0	0	0
Main Loading Crane	2270002045	900	diesel	102	12	43%	12	45,367	0.22	1.81	0.49	7.54E-02	7.31E-02	3.69E-03	5.39E-02	684.43	1.76E-02	1.74E-02	690.06
300T Crawler Crane	2270002045	500	diesel	102	8	43%	12	16,803	0.08	0.67	0.18	2.79E-02	2.71E-02	1.37E-03	2.00E-02	253.49	6.51E-03	6.46E-03	255.58
16T Forklift	2270002057	160	diesel	103	4	59%	10	3,108	0.02	0.08	0.03	6.65E-03	6.45E-03	2.42E-04	3.66E-03	46.88	1.25E-03	1.19E-03	47.27
5T Forklift	2270002057	115	diesel	103	4	59%	10	2,234	1.10E-02	0.06	0.02	4.78E-03	4.64E-03	1.74E-04	2.63E-03	33.70	8.98E-04	8.58E-04	33.97
20T Hydraulic Cherrypicker	2270003010	100	diesel	106	6	21%	10	1,339	0.04	0.16	0.15	2.02E-02	1.96E-02	1.36E-04	8.72E-03	20.19	1.25E-03	5.14E-04	20.38
	•						Total	68,850	0.37	2.77	0.88	0.13	0.13	5.61E-03	0.09	1,038.69	0.03	0.03	1,047.26

- 1. Equipment assumptions based on information provided by the project.
- 2. Calculations assume equipment is used 5 days/wk i.e. 21 days/month.
- 3. Nonroad emission factors for criteria pollutants and GHG were estimated using EPA's MOVES2014b emission model for an assumed construction year of 2022.
- 4. Nonroad emission factors for HAPs were estimated using ERG, "Documentation for Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory," Volume 1 Methodology, October 7, 2003.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS

EW 2 Onshore Staging and Assembly at O+M Base - Construction Emissions

		Fuel Use						Emissions	3										
Construction Equipment	Source Category	HP per unit	Fuel Type	Emiss. Factor ID	hrs per day	Load Factor	Total Equip. Months	gal	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAP Tons	CO ₂ tons	CH₄ tons	N₂O tons	CO₂e tons
Land-based Nonroad Equip.																			
24-Axle SPMT (Transport)	N/A	N/A	electric	N/A	12	N/A	40	0	0	0	0	0	0	0	0	0	0	0	0
12-Axle SPMT (Transport)	N/A	N/A	electric	N/A	12	N/A	40	0	0	0	0	0	0	0	0	0	0	0	0
Main Loading Crane	2270002045	900	diesel	102	12	43%	24	90,735	0.45	3.62	0.98	1.51E-01	1.46E-01	7.39E-03	1.08E-01	1368.86	3.52E-02	3.49E-02	1380.12
300T Crawler Crane	2270002045	500	diesel	102	8	43%	24	33,606	0.17	1.34	0.36	5.59E-02	5.42E-02	2.74E-03	3.99E-02	506.98	1.30E-02	1.29E-02	511.16
1300T Ring Crane	2270002045	500	diesel	102	8	43%	3	4,201	0.02	0.17	0.05	6.98E-03	6.77E-03	3.42E-04	4.99E-03	63.37	1.63E-03	1.61E-03	63.89
16T Forklift	2270002057	160	diesel	103	4	59%	20	6,215	0.03	0.16	0.07	1.33E-02	1.29E-02	4.83E-04	7.33E-03	93.76	2.50E-03	2.39E-03	94.54
5T Forklift	2270002057	115	diesel	103	4	59%	20	4,467	2.19E-02	0.11	0.05	9.56E-03	9.28E-03	3.47E-04	5.27E-03	67.39	1.80E-03	1.72E-03	67.95
20T Hydraulic Cherrypicker	2270003010	100	diesel	106	6	21%	20	2,677	0.07	0.31	0.29	4.05E-02	3.93E-02	2.72E-04	1.74E-02	40.39	2.50E-03	1.03E-03	40.76
							Total	141,900	0.76	5.71	1.80	0.28	0.27	1.16E-02	0.18	2,140.76	0.06	0.05	2,158.42

- 1. Equipment assumptions based on information provided by the project.
- 2. Calculations assume equipment is used 5 days/wk i.e. 21 days/month.
- 3. Nonroad emission factors for criteria pollutants and GHG were estimated using EPA's MOVES2014b emission model for an assumed construction year of 2022.
- 4. Nonroad emission factors for HAPs were estimated using ERG, "Documentation for Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory," Volume 1 Methodology, October 7, 2003.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 Offshore Operations Emissions

																							Total Em	issions (Nor	n-Transit)				
Vessels/Equip	•	No. of Engines per vesse	2.Anchore	Dimensions (ft) ed length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Assumed fu Type rate (kg pe vessel per d	r density (kg/gal	Transit Round) Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)		Transit Average load (%)	Non-Transit Average load (%)	Fuel Usage Fuel Gallons Ga	Transit Usage Ilons vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO₂e tons
Service Operations Vessel 1	-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel 4,	3.1	3 2	6	9 (328.5	24	7,884	12%	12%	12,264	413,208	3.37	66.05	33.70	4.17	4.05	0.04	0.36	4,650.41	0.61	0.13	4,705.74
Crew Transfer Vessel 1			N/A	65 x 17 x 5																									i T
	-Main Engines	2			1	1000	Diesel 4,	000 3.1	3 12	0	9 (240.9	24	5,782	51%	51%	56,604	303,019	1.30	47.17	24.07	1.24	1.20	3.15E-02	0.13	3,321.26	0.43	0.10	3,360.77
	-Main Generators	2			1	27	Diesel		12	0	9 (240.9	24	5,782	51%	51%			0.03	1.26	0.65	0.03	0.03	8.44E-04	3.50E-03	89.04	1.16E-02	2.58E-03	90.10
Crew Transfer Vessel 2			N/A	65 x 17 x 5																									i
	-Main Engines	2			1	1000	Diesel 4,	000 3.1	3 12	0	9 (240.9	24	5,782	51%	51%	56,604	303,019	1.30	47.17	24.07	1.24	1.20	3.15E-02	0.13	3,321.26		0.10	3,360.7
	-Main Generators	2			1	27	Diesel		12	0	9 (240.9	24	5,782	51%	51%			0.03	1.26	0.65	0.03	0.03	8.44E-04	3.50E-03	89.04	1.16E-02	2.58E-03	90.10
Crew Transfer Vessel 3			N/A	65 x 17 x 5																									1
	-Main Engines	2			1	1000	Diesel 4,	000 3.1	3 12	0	9 (240.9	24	5,782	51%	51%	56,604	303,019	1.30	47.17	24.07	1.24	1.20	3.15E-02	0.13	3,321.26			3,360.7
	-Main Generators	2			1	27	Diesel		12	0	9 (240.9	24	5,782	51%	51%			0.03	1.26	0.65	0.03	0.03	8.44E-04	3.50E-03	89.04	1.16E-02	2.58E-03	90.10
Crew Transfer Vessel 4			N/A	65 x 17 x 5																									1
	-Main Engines	2			1	1000	Diesel 4,	000 3.1	3 12	0	9 (240.9	24	5,782	51%	51%	56,604	303,019	1.30	47.17	24.07	1.24	1.20	3.15E-02	0.13	3,321.26	0.43	0.10	3,360.7
	-Main Generators	2			1	27	Diesel		12	0	9 (240.9	24	5,782	51%	51%			0.03	1.26	0.65	0.03	0.03	8.44E-04	3.50E-03	89.04	1.16E-02	2.58E-03	90.10
Survey Vessel (every year)			N/A	180 x 39 x 14																									
	-Main Engine	1			2	2131	Diesel 3,	3.1	В	1	9 (60	24	1,440	27%	27%	354	56,604	0.34	6.57	3.35	0.42	0.40	4.38E-03	0.04	462.51	0.06	0.01	468.03
	-Main Generators	2			1	402	Diesel			1	9 (60	24	1,440	27%	27%			0.07	2.48	1.26	0.07	0.06	1.65E-03	6.86E-03	174.53	2.28E-02	5.06E-03	176.61
	•						•				-	-	-			TOTALS	239,033 1,6	681,887	9.11	268.84	137.16	9.75	9.46	0.18	0.94	18.928.64	2.47	0.55	19,153.87

- ${\bf 1.}\ Non-transit\ activity\ durations\ were\ estimated\ based\ on\ the\ number\ of\ days\ of\ operation\ provided\ by\ the\ project$
- 2. Transit emissions are based on an assumed vessel speed of 10 knots, and the following one-way travel distances
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm
- 3. The number of transits for each vessel are based on the following assumptions $\label{eq:control_eq} \begin{tabular}{ll} \$
- Bi-weekly round trips to/from port for the service operations vessel. Weekly round trips to/from port for crew transfer vessels.
- One annual round trip for the survey vessel.
- 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort
- 5. Emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM_S or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages
- 7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project
- 8. WTG temporary blackout generators will be portable generators lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs
- 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH_t, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 Offshore Operations Emissions

																		Total Emissions (Transit)											
Vessels/Equip	•	No. of Engines per vesse	2.Anchore	Dimensions (ft) I length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Assumed fue Type rate (kg per vessel per da	density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit otal Operatin Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Non-T Fuel Usage Fuel Gallons Gal (per vessel) (per v	Jsage VC ons to	^	CO		PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH₄ tons	N₂O tons	CO₂e tons	
Service Operations Vessel 1	-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel 4,0	00 3.18	20	5	9 (328.5	24	7,884	12%	12%	12,264 4	13,208	0.10 1	96	1.00 0	12 0.1	2 1.31E-03	1.06E-02	138.03	0.02	4.00E-03	139.67	
Crew Transfer Vessel 1			N/A	65 x 17 x 5																									
	-Main Engines	2			1	1000	Diesel 4,0	00 3.18	120)	9 (240.9	24	5,782	51%	51%	56,604 3	03,019	0.24 8	81	4.50 0	23 0.2	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79	
	-Main Generators	2			1	27	Diesel		120)	9 (240.9	24	5,782	51%	51%		6.5	1E-03 0	24	0.12 6.22E	03 6.03E-0	3 1.58E-04	6.53E-04	16.63	2.17E-03	4.82E-04	16.83	
Crew Transfer Vessel 2			N/A	65 x 17 x 5																									
	-Main Engines	2			1	1000	Diesel 4,0	00 3.18	120)	9 (240.9	24	5,782	51%	51%	56,604 3	03,019	0.24 8	81	4.50 0	23 0.2	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79	
	-Main Generators	2			1	27	Diesel		120)	9 (240.9	24	5,782	51%	51%		6.5	1E-03 0	24	0.12 6.22E	03 6.03E-0	3 1.58E-04	6.53E-04	16.63	2.17E-03	4.82E-04	16.83	
Crew Transfer Vessel 3			N/A	65 x 17 x 5																									
	-Main Engines	2			1	1000	Diesel 4,0	00 3.18	120)	9 (240.9	24	5,782	51%	51%	56,604 3	03,019	0.24 8	81	4.50 0	23 0.2	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79	
	-Main Generators	2			1	27	Diesel		120)	9 (240.9	24	5,782	51%	51%		6.5	1E-03 0	24	0.12 6.22E	03 6.03E-0	3 1.58E-04	6.53E-04	16.63	2.17E-03	4.82E-04	16.83	
Crew Transfer Vessel 4			N/A	65 x 17 x 5																									
	-Main Engines	2			1	1000	Diesel 4,0	00 3.18	120)	9 (240.9	24	5,782	51%	51%	56,604 3	03,019	0.24 8	81	4.50 0	23 0.2	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79	
	-Main Generators	2			1	27	Diesel		120)	9 (240.9	24	5,782	51%	51%		6.5	1E-03 0	24	0.12 6.22E	03 6.03E-0	3 1.58E-04	6.53E-04	16.63	2.17E-03	4.82E-04	16.83	
Survey Vessel (every year)			N/A	180 x 39 x 14																									
	-Main Engine	1			2	2131	Diesel 3,0	00 3.18	:	1	9 (60	24	1,440	27%	27%	354	6,604	0.00	04	0.02 0	0.0	2.74E-05	2.22E-04	2.89	0.00	8.38E-05	2.93	
	-Main Generators	2			1	402	Diesel			1	9 (60	24	1,440	27%	27%		4.2	7E-04 0	02	0.01 4.08E	04 3.96E-0	4 1.03E-05	4.28E-05	1.09	1.42E-04	3.16E-05	1.10	
	•			•			•				-	-	-		-	TOTALS	239,033 1,6	31,887	1.10 38	21 1	9.49 1	08 1.0	0.03	0.11	2,690.18	0.35	0.08	2,722.18	

- ${\bf 1.}\ Non-transit\ activity\ durations\ were\ estimated\ based\ on\ the\ number\ of\ days\ of\ operation\ provided\ by\ the\ project$
- 2. Transit emissions are based on an assumed vessel speed of 10 knots, and the following one-way travel distances
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm
- 3. The number of transits for each vessel are based on the following assumptions $\label{eq:control_eq} \begin{tabular}{ll} \$
- Bi-weekly round trips to/from port for the service operations vessel. Weekly round trips to/from port for crew transfer vessels.
- One annual round trip for the survey vessel.
- 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort
- 5. Emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM_S or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages
- 7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project
- 8. WTG temporary blackout generators will be portable generators lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs
- 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH_t, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 Offshore Maintenance Emissions

																		Total Em	nissions (No	n-Transit)										
Vessels/Equipment	No. Engi per v		DP Anchored Spuds	Dimensions (ft) length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)	Non-Transit otal Operatin Hours (hrs)		Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO₂e tons
Heavy Lift Vessel (every year)	Engines 6		3	484 x 138 x 36	2	6 204	Diesel	45.000	3.18		,		20	24	720	33%	33%	3,538	424,528	3.80	100.41	8.37	1.41	1 27	3.02	0.34	4,914.82	0.03	0.24	4,985.86
Tug 1 (every year)	crigines c	<u> </u>	N/A	136 x 36 x 19 (17)	3	0,334	Diesei	43,000	3.10		'	,	30	24	720	33/	33/0	3,330	424,320	3.00	100.41	6.37	1.41	1.37	3.02	0.34	4,314.02	0.03	0.24	4,363.60
-Main E	Engines 2	,	14/75	130 x 30 x 13 (17)	2	3.600	Diesel	10,000	3.18		1 1		30	24	720	35%	35%	2,358	94,340	0.75	14.69	7.50	0.93	0.90	0.01	0.08	1,034.44	0.13	0.03	1,046.75
-Aux. E	-				1	-,	Diesel	,	1		1 1	3	30	24	720	35%	35%	_,	.,	0.01	0.39	0.20	0.01		2.59E-04		27.30			
Tug 2 (every year)			N/A	136 x 36 x 19 (17)																										
-Main E	Engines 2	!			2	3,600	Diesel	10,000	3.18	:	1 18	3 0	30	24	720	35%	35%	2,358	94,340	0.75	14.69	7.50	0.93	0.90	0.01		1,034.44	0.13	0.03	1,046.75
-Aux. E	Engines 2	!			1	95	Diesel			:	1 1	3 0	30	24	720	35%	35%			0.01	0.39	0.20	0.01	0.01	2.59E-04	1.07E-03	27.30	0.00	7.91E-04	27.62
Cargo Barge (every year)			N/A	400 x 105 x 25				0	N/A		1 1:	3 0	30	24	720	N/A	N/A	N/A	N/A											
Inter-Array Cable Lay Vessel (every year) -Main Gen	nerators 4	,	1	313 x 71 x 29 (24)	2	2,606	Diesel	15,000	3.18	:	1 !) (14	1 24	336	37%	37%	1,769	66,038	0.54	10.56	5.39	0.67	0.65	0.01	. 0.06	743.22	0.10	0.02	752.06
Export Cable Lay Vessel (once per 10 yrs) -Main Gen	nerators 6	;	1	459 x 97 x 36 (24)	3	3,003	Diesel	15,000	3.18	:	1 !) (14	1 24	336	24%	24%	1,769	66,038	0.59	15.62	1.30	0.22	0.21	. 0.47	0.05	764.53	0.00	0.04	775.58
WTG Temporary Generators (once per 10 yrs)	10	6	N/A	N/A	257	201	Diesel	11,270	3.18	() () 6	5 24	144	0%	100.0%	(21,264	0.07	0.15	1.33	0.01	0.01	5.72E-04	0.01	62.13	2.52E-03	5.04E-04	62.34
																	TOTALS	11,792	766,547	6.53	156.90	31.78	4.18	4.06	3.52	0.61	8.608.17	0.41	0.36	8,724.58

- ${\bf 1.}\ Non-transit\ activity\ durations\ were\ estimated\ based\ on\ the\ number\ of\ days\ of\ operation\ provided\ by\ the\ project$
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area
- 3. The number of transits for each vessel are based on the following assumptions
- One annual round trip each for heavy lift vessel, tugs and barge, and interarray cable lay vessel
- One round trip every 10 years (estimated) for export cable lay vessel.
- 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort
- 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2005
- 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM₅ or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages
- 7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project
- 8. WTG temporary blackout generators will be portable generators lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs
- 9. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for $\rm CH_1$, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS **EW 1 Offshore Maintenance Emissions**

																			Total Emissions (Transit)											
Vessels/Equipment	En	o. of 1. DP gines 2.Anchore vessel 3.Spuds	Dimensions (ft) ed length x width x depth (draft)	Emission Factor Used (see EFs worksheet	Engine Rating (hp)		Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)		Transit Average load (%)	Non-Transit Average load (%)	Fuel Usage Gallons	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH₄ tons	N₂O tons	CO₂e tons	
Heavy Lift Vessel (every year)		3	484 x 138 x 36																											
-Main Engir	nes	6		3	6,3	94 Diesel	45,000	3.18	1	. 6	C	30	0 24	720	33%	33%	3,538	424,528	0.03	0.84	0.07	1.17E-02	1.14E-02	0.03	2.80E-03	40.96	2.54E-04	1.97E-03	41.55	
Tug 1 (every year)		N/A	136 x 36 x 19 (17)																											
-Main Engir	nes	2		2	3,6	00 Diesel	10,000	3.18	1	. 18	C	30	0 24	720	35%	35%	2,358	94,340	0.02	0.37	0.19	0.02	0.02	2.45E-04	0.00	25.86	0.00	0.00	26.17	
-Aux. Engir	nes	2		1		95 Diesel			1	. 18	C	30	0 24	720	35%	35%			2.67E-04	0.01	0.00	2.55E-04	2.48E-04	6.47E-06	2.68E-05	0.68	8.90E-05	1.98E-05	0.69	
Tug 2 (every year)		N/A	136 x 36 x 19 (17)																											
-Main Engir	nes	2		2	3,6	00 Diesel	10,000	3.18	1	. 18	C	30	0 24	720	35%	35%	2,358	94,340	0.02	0.37	0.19	0.02	0.02	2.45E-04	0.00	25.86	0.00	0.00	26.17	
-Aux. Engir	nes	2		1		95 Diesel			1	. 18	C	30	0 24	720	35%	35%			2.67E-04	0.01	0.00	2.55E-04	2.48E-04	6.47E-06	2.68E-05	0.68	8.90E-05	1.98E-05	0.69	
Cargo Barge (every year)		N/A	400 x 105 x 25				(N/A	1	. 18	(30	0 24	720	N/A	N/A	N/A	N/A												
Inter-Array Cable Lay Vessel (every year)		1	313 x 71 x 29 (24)																											
-Main Generate	ors	4		2	2,6	06 Diesel	15,000	3.18	1	. 9	C	14	4 24	336	37%	37%	1,769	66,038	0.01	0.28	0.14	0.02	0.02	1.89E-04	0.00	19.91	2.60E-03	5.77E-04	20.14	
Export Cable Lay Vessel (once per 10 yrs)		1	459 x 97 x 36 (24)																											
-Main Generat	ors	6		3	3,0	03 Diesel	15,000	3.18	1	. 9	C	14	4 24	336	24%	24%	1,769	66,038	0.02	0.42	0.03	5.87E-03	5.70E-03	1.26E-02	1.40E-03	20.48	1.27E-04	9.83E-04	20.77	
WTG Temporary Generators (once per 10 yrs)																														
		16 N/A	N/A	257	2	01 Diesel	11,270	3.18	(0	C) 6	5 24	144	0%	100.0%	(21,264	0	0	0	0	0	0	0	0	0	0	0	
																TOTALS	11.79	766.547	0.10	2.29	0.63	0.08	0.08	0.04	9.77E-03	134.43	9.90E-03	5.06E-03	136.19	

- ${\bf 1.}\ Non-transit\ activity\ durations\ were\ estimated\ based\ on\ the\ number\ of\ days\ of\ operation\ provided\ by\ the\ project$
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area
- 3. The number of transits for each vessel are based on the following assumptions
- One annual round trip each for heavy lift vessel, tugs and barge, and interarray cable lay vessel
- One round trip every 10 years (estimated) for export cable lay vessel.
- 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort
- 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2005

 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventoriey (NEI); i.e., they are calculated as percentages of the PM₅ or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages
- 7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project
- 8. WTG temporary blackout generators will be portable generators lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs
- 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH_t, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 2 Offshore Maintenance Emissions

																								Total Em	nissions (No	n-Transit)				
Vessels/Equipment	E		1. DP 2.Anchored 3.Spuds	Dimensions (ft) I length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Rating (hp)	Fuel Type	Assumed fuel rate (kg per vessel per day)	Assumed fuel density (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days		Non-Transit Operating Hours (hrs/day)	Non-Transit otal Operatin Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N₂O tons	CO₂e tons
Heavy Lift Vessel (every year)	n Engines	6	3	484 x 138 x 36	2	6 204	Diesel	45.000	3.18		2	s (24	1.440	33%	. 33%	7.075	849.057	7.61	200.83	16.74	2.82	2 72	6.04	0.67	9,829.64	0.06	0.47	9,971.72
Tug 1 (every year)	II Eligilles	0	N/A	136 x 36 x 19 (17)	3	0,354	Diesei	43,000	3.10	,			5 00	24	1,440	33/0	3370	7,073	043,037	7.01	200.65	10.74	2.02	2.73	0.04	0.07	3,023.04	0.00	0.47	9,971.72
	n Engines	2	,	150 x 50 x 15 (17)	2	3,600	Diesel	10,000	3.18		2 1	8 (60	24	1,440	35%	35%	4,717	188,679	1.50	29.38	14.99	1.86	1.80	0.02	0.16	2,068.88	0.27	0.06	2,093.49
	x. Engines	2			1	95	Diesel	,			2 1	8 (60	24	1,440	35%	35%			0.02	0.78	0.40	0.02	0.02	5.17E-04	2.14E-03	54.60	0.01	1.58E-03	
Tug 2 (every year)			N/A	136 x 36 x 19 (17)																										
	n Engines	2			2		Diesel	10,000	3.18		2 1	8 (60	24	1,440		35%	4,717	188,679	1.50	29.38	14.99	1.86		0.02		2,068.88		0.06	,
	x. Engines	2			1	95	Diesel				2 1	8 () 60	24	1,440	35%	35%			0.02	0.78	0.40	0.02	0.02	5.17E-04	2.14E-03	54.60	0.01	1.58E-03	55.24
Cargo Barge (every year)			N/A	400 x 105 x 25				0	N/A		2 1	8 (5 60	24	1,440	N/A	N/A	N/A	N/A								ļ			
Inter-Array Cable Lay Vessel (every year) -Main C	enerators	4	1	313 x 71 x 29 (24)	2	2,606	Diesel	15,000	3.18	:	2	9 (28	3 24	672	37%	37%	3,538	132,075	1.08	21.11	10.77	1.33	1.29	0.01	. 0.11	1,486.43	0.19	0.04	1,504.12
Export Cable Lay Vessel (once per 10 yrs) -Main C	enerators	6	1	459 x 97 x 36 (24)	3	3,003	Diesel	15,000	3.18		1	9 () 14	1 24	336	24%	24%	1,769	66,038	0.59	15.62	1.30	0.22	0.21	. 0.47	0.05	764.53	0.00	0.04	775.58
WTG Temporary Generators (once per 10 yr		16	N/A	N/A	257	201	Diesel	11,270	3.18		0	0 () (5 24	144	0%	100.0%	0	21,264	0.07	0.15	1.33	0.01	0.01	5.72E-04	0.01	62.13	2.52E-03	5.04E-04	62.34
		•															TOTALS	21,816	1,445,792	12.39	298.03	60.92	8.13	7.89	6.56	1.17	16.389.68	0.82	0.68	16,611.23

- ${\bf 1.}\ Non-transit\ activity\ durations\ were\ estimated\ based\ on\ the\ number\ of\ days\ of\ operation\ provided\ by\ the\ project$
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area
- 3. The number of transits for each vessel are based on the following assumptions $% \left(1\right) =\left(1\right) \left(1\right)$
- One annual round trip each for heavy lift vessel, tugs and barge, and interarray cable lay vessel
- One round trip every 10 years (estimated) for export cable lay vessel.
- 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort
- 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2005
- 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM₅ or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages
- 7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project
- 8. WTG temporary blackout generators will be portable generators lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs
- 9. $\rm CO_2e$ emission rates use the following carbon equivalence factors: 25 for $\rm CH_1$, and 298 for $\rm N_2O$.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS **EW 2 Offshore Maintenance Emissions**

																			Total Emissions (Transit)											
Vessels/Equipment	E	No. of 1. DP ngines 2.Anchore r vessel 3.Spuds	Dimensions (ft) ed length x width x depth (draft)	Emission Factor Used (see EFs worksheet)	Engine Fu Rating Ty (hp)	pe ra		Assumed fuel ensity (kg/gal)	Transit Round Trips	Transit Duration (hrs/round trip)	Non-OCS Operating Days	OCS Operating Days	Non-Transit Operating Hours (hrs/day)			load (%)	Fuel Usage Gallons	Non-Transit Fuel Usage Gallons (per vessel)	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAPs tons	CO ₂ tons	CH ₄ tons	N ₂ O tons	CO₂e tons	
Heavy Lift Vessel (every year)		3	484 x 138 x 36																											
-Main E	ngines	6		3	6,394 Diesel		45,000	3.18	2	6	C	60	24	1,440	33%	33%	7,075	849,057	0.06	1.67	0.14	2.35E-02	2.28E-02	0.05	5.60E-03	81.91	5.07E-04	3.93E-03	83.10	
Tug 1 (every year) -Main E	oginos	N/A	136 x 36 x 19 (17)	,	3,600 Diesel		10,000	3.18	-	10	,		24	1,440	35%	35%	4,717	188,679	0.04	0.73	0.27	0.05	0.05	4.90E-04	0.00	51.72	0.01	0.00	52.34	
-Main El	-	2		2			10,000	3.10	2	10		0	24			35%	4,/1/	100,079	5.34E-04			5.10E-04				1.36				
	ngines	N/A	125 25 10 (17)	1	95 Diesel					10	U	00	J 24	1,440	3370	33%			5.54E-U4	0.02	0.01	5.1UE-U4	4.95E-04	1.29E-03	5.30E-U3	1.30	1./6E-04	3.96E-05	1.38	
Tug 2 (every year) -Main E		N/A	136 x 36 x 19 (17)		2 500 Dissel		10,000	2.40						1 110	250/	250/	4 747	400.670	0.04	0.72	0.27	0.05	0.05	4.005.04	0.00	F4 73	1 001	0.00	F2 2/	
	_	2		2	3,600 Diesel		10,000	3.18	2	18	u u	60	24	1,440		35%	4,717	188,679	0.04	0.73		0.05	0.05	4.90E-04		51.72			52.34	
-Aux. Ei	ngines	2		1	95 Diesel				2	18	U) 60) 24	1,440	35%	35%			5.34E-04	0.02	0.01	5.10E-04	4.95E-04	1.29E-05	5.36E-05	1.36	1.78E-04	3.96E-05	1.38	
Cargo Barge (every year)		N/A	400 x 105 x 25				0	N/A	2	18	c	60	24	1,440	N/A	N/A	N/A	N/A					.				1			
Inter-Array Cable Lay Vessel (every year)		1	313 x 71 x 29 (24)											-					i i											
-Main Gene	rators	4		2	2,606 Diesel		15,000	3.18	2	9	С	28	3 24	672	37%	37%	3,538	132,075	0.03	0.57	0.29	0.04	0.03	3.77E-04	0.00	39.82	5.19E-03	1.15E-03	40.29	
Export Cable Lay Vessel (once per 10 yrs)		1	459 x 97 x 36 (24)																								$\overline{}$			
-Main Gene	rators	6		3	3,003 Diesel		15,000	3.18	1	. 9	С	14	4 24	336	24%	24%	1,769	66,038	0.02	0.42	0.03	5.87E-03	5.70E-03	1.26E-02	1.40E-03	20.48	1.27E-04	9.83E-04	20.77	
WTG Temporary Generators (once per 10 yrs)		46 81/4		25-	204 5: 1		44.070	2.10					24			100.00/		24.254												
		16 N/A	N/A	257	201 Diesel		11,270	3.18	C	0) 6	24	144	0%	100.0%	C	21,264	0	0	0	0	0	0	0	0	0	0	0	
																TOTALS	21,816	1,445,792	0.18	4.17	1.23	0.16	0.15	0.06	1.81E-02	248.38	1.97E-02	9.14E-03	251.60	

- ${\bf 1.}\ Non-transit\ activity\ durations\ were\ estimated\ based\ on\ the\ number\ of\ days\ of\ operation\ provided\ by\ the\ project$
- 2. Transit emissions are based on an assumed vessel speed of 5 knots for tugs and barges (and 10 knots for all other vessel types), and the following one-way travel distances
- South Brooklyn Marine Terminal to center of OCS lease area: 43.5 nm (Kings: 7.8 nm; Queens: 3 nm; Monmouth: 2.7 nm; OCS radius: 30 nm
- Overseas port to center of OCS lease area: 30.0 nm (only includes portion of transit within 25 nm of the OCS lease area
- 3. The number of transits for each vessel are based on the following assumptions
- One annual round trip each for heavy lift vessel, tugs and barge, and interarray cable lay vessel
- One round trip every 10 years (estimated) for export cable lay vessel.
- 4. The specific vessels for each operation have not been finalized at this time; however, the vessels identified for each installation activity are typical sizes for performing this effort
- 5. Emission factors for marine vessel engines are from ICF International report to the US EPA "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2005

 6. HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the latest (2017) National Emissions Inventoriey (NEI); i.e., they are calculated as percentages of the PM₅ or VOC emissions from the CMVs.
- The HAP emissions for nonroad engines were based on EPA's AP-42 Volume 1, Chapters 3.3 and 3.4 for small and large diesel engines. (see HAP emission factor summary pages
- 7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project
- 8. WTG temporary blackout generators will be portable generators lifted onto WTG platform; emissions based on nonroad factors in Table 1 of 40 CFR 1039.101, AP-42 Table 3.3-2 (HAPs), and 40 CFR 98 (GHGs
- 9. CO₂e emission rates use the following carbon equivalence factors: 25 for CH_t, and 298 for N₂O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 O+M Base - Operating Emissions

								Fuel Use						Emissions					
Construction Equipment	Source Category	HP per unit	Fuel Type	Emiss. Factor ID	hrs per day	Load Factor	Total Equip. Months	gal	VOC tons	NO _x tons	CO tons	PM ₁₀ tons	PM _{2.5} tons	SO ₂ tons	HAP Tons	CO ₂	CH₄ tons	N₂O tons	CO₂e tons
Land-based Nonroad Equip.																			
250T Shore crane	2270002045	400	diesel	102	4	43%	12	6,721	0.03	0.27	0.07	1.12E-02	1.08E-02	5.47E-04	7.99E-03	101.40	2.60E-03	2.58E-03	102.23
5T Forklift	2270002057	115	diesel	103	8	59%	12	5,361	2.63E-02	0.14	0.06	1.15E-02	1.11E-02	4.17E-04	6.32E-03	80.87	2.15E-03	2.06E-03	81.54
							Total	12,082	0.06	0.40	0.13	0.02	0.02	9.64E-04	1.43E-02	182.27	4.76E-03	4.64E-03	183.77

- Equipment assumptions based on information provided by the project.
 Calculations assume equipment is used 5 days/wk i.e. 21 days/month.
- 3. Nonroad emission factors for criteria pollutants and GHG were estimated using EPA's MOVES2014b emission model for an assumed construction year of 2022.
- 4. Nonroad emission factors for HAPs were estimated using ERG, "Documentation for Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory," Volume 1 Methodology, October 7, 2003.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 OSS Generator Emissions (per Phase)

Generator Engine Data

Generator Manufacturer	TBD		
Model	TBD		
Engine Type	TBD		
Rated engine output	kW	600	
Rated engine output	bhp	804	
Engine speed	rpm	1800	
Fuel consumption at 100% load	gal/hr	40.2	
Number of generators	engines	1	
Annual operating hours per generator	hr/yr	500	
Annual Fuel Usage per generator	gal/yr	20,107	

Fuel Data

Fuel type	Ultra low sulfur diesel		
Fuel heat content	Btu/lb (LHV) 18,3		
Fuel heat content	Btu/lb (HHV)	19,326	
Fuel density	lb/gal	7.01	
Fuel sulfur content	% weight	0.0015	
Conversion factor	LHV/HHV	0.95	

Tetra Tech assumptions/calculations

Engine load	%	100
Heat input rate	MMBtu/hr (HHV)	5.63

Engine Emission Factors

NOx	g/kWh	5.61
СО	g/kWh	3.5
HC (VOC)	g/kWh	0.79
PM/PM10	g/kWh	0.20
PM2.5	g/kWh	0.19
SO2	lb/MMBtu (HHV)	0.0016
НАР	lb/MMBtu (HHV)	0.0016
CO2	lb/MMBtu (HHV)	163.1
CH4	lb/MMBtu (HHV)	0.007
N2O	lb/MMBtu (HHV)	0.001

Engine Emission Estimates

NOx	lb/hr (per engine)	7.4
CO	lb/hr (per engine)	4.6
VOC	lb/hr (per engine)	1.05
PM10	lb/hr (per engine)	0.26
PM2.5	lb/hr (per engine)	0.26
SO2	lb/hr (per engine)	8.74E-03
HAP	lb/hr (per engine)	8.96E-03
CO2	lb/hr (per engine)	918.0
CH4	lb/hr (per engine)	3.72E-02
N2O	lb/hr (per engine)	7.45E-03
CO2e	lb/hr (per engine)	921.1

	Short Term Emissions (lb/hr per engine)	Annual Emissions (tons/yr per engine)
NOx	7.42	1.85
СО	4.63	1.16
VOC	1.05	0.26
PM10	0.26	0.07
PM2.5	0.26	0.06
SO2	8.74E-03	2.18E-03
HAP	8.96E-03	2.24E-03
CO2	918.0	229
CH4	0.04	0.01
N2O	7.45E-03	1.86E-03
CO2e	921.1	230

- 1. Engine power rating is based on project assumption.
- 2. It is assumed that each engine will only be used for emergency purposes, limited to no more than 500 hours per year to include maintenance and testing.
- 3. Emission factors for NOx, CO, VOC, and PM are based on EPA Tier 2 standards from Table 1 of 40 CFR 89.112.
- 4. NOx+NMHC limit is 6.4 g/kWh; split into NOx and VOC based on Tier 1 limits of 9.2 g/kWh (NOx) and 1.3 g/kWh (VOC).
- 5. All particulate (PM) is assumed to be ≤ to 10 μm (PM10) and 97% of the PM is assumed to be smaller than 2.5 μm (PM2.5) based on US EPA Report Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling Compression-Ignition, No. NR-0009d, July 2010.
- 6. SO2 emission factor calculated from mass balance for 0.0015% by weight ULSD, assuming 100% conversion of fuel sulfur to SO2.
- 7. Emission factors used to calculate emission rates for CO2 (73.96 kg/MMBtu), CH4 (0.003 kg/MMBtu) and N2O (0.0006 kg/MMBtu) were based on Tables C-1 and C-2 of 40 CFR Part 98 Mandatory Greenhouse Gas Reporting, Subpart C General Stationary Fuel Combustion Sources.
- 8. CO2e emission rates use the following carbon equivalence factors: 25 for CH4, and 298 for N2O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 Onshore Substation Generator Emissions (per Phase)

Generator Engine Data

Generator Manufacturer	TBD		
Model	TBD		
Engine Type	TBD		
Rated engine output	kW	600	
Rated engine output	bhp	804	
Engine speed	rpm	1800	
Fuel consumption at 100% load	gal/hr	40.2	
Number of generators	engines	1	
Annual operating hours per generator	hr/yr	500	
Annual Fuel Usage per generator	gal/yr	20,107	

Fuel Data

Fuel type	Ultra low sulfur diesel		
Fuel heat content	Btu/lb (LHV) 18,3		
Fuel heat content	Btu/lb (HHV)	19,326	
Fuel density	lb/gal	7.01	
Fuel sulfur content	% weight	0.0015	
Conversion factor	LHV/HHV	0.95	

Tetra Tech assumptions/calculations

Engine load	%	100
Heat input rate	MMBtu/hr (HHV)	5.63

Engine Emission Factors

NOx g/kWh 5.61 CO g/kWh 3.5 HC (VOC) g/kWh 0.79 PM/PM10 g/kWh 0.20 PM2.5 g/kWh 0.19 SO2 lb/MMBtu (HHV) 0.0016 HAP lb/MMBtu (HHV) 0.0016 CO2 lb/MMBtu (HHV) 163.1 CH4 lb/MMBtu (HHV) 0.007 N2O lb/MMBtu (HHV) 0.001			
HC (VOC) g/kWh 0.79 PM/PM10 g/kWh 0.20 PM2.5 g/kWh 0.19 SO2 lb/MMBtu (HHV) 0.0016 HAP lb/MMBtu (HHV) 0.0016 CO2 lb/MMBtu (HHV) 163.1 CH4 lb/MMBtu (HHV) 0.007	NOx	g/kWh	5.61
PM/PM10 g/kWh 0.20 PM2.5 g/kWh 0.19 SO2 lb/MMBtu (HHV) 0.0016 HAP lb/MMBtu (HHV) 0.0016 CO2 lb/MMBtu (HHV) 163.1 CH4 lb/MMBtu (HHV) 0.007	СО	g/kWh	3.5
PM2.5 g/kWh 0.19 SO2 lb/MMBtu (HHV) 0.0016 HAP lb/MMBtu (HHV) 0.0016 CO2 lb/MMBtu (HHV) 163.1 CH4 lb/MMBtu (HHV) 0.007	HC (VOC)	g/kWh	0.79
SO2 Ib/MMBtu (HHV) 0.0016 HAP Ib/MMBtu (HHV) 0.0016 CO2 Ib/MMBtu (HHV) 163.1 CH4 Ib/MMBtu (HHV) 0.007	PM/PM10	g/kWh	0.20
HAP lb/MMBtu (HHV) 0.0016 CO2 lb/MMBtu (HHV) 163.1 CH4 lb/MMBtu (HHV) 0.007	PM2.5	g/kWh	0.19
CO2 Ib/MMBtu (HHV) 163.1 CH4 Ib/MMBtu (HHV) 0.007	SO2	lb/MMBtu (HHV)	0.0016
CH4 lb/MMBtu (HHV) 0.007	HAP	lb/MMBtu (HHV)	0.0016
. , ,	CO2	lb/MMBtu (HHV)	163.1
N2O Ib/MMBtu (HHV) 0.001	CH4	lb/MMBtu (HHV)	0.007
	N2O	lb/MMBtu (HHV)	0.001

Engine Emission Estimates

NOx	lb/hr (per engine)	7.4
СО	lb/hr (per engine)	4.6
VOC	lb/hr (per engine)	1.05
PM10	lb/hr (per engine)	0.26
PM2.5	lb/hr (per engine)	0.26
SO2	lb/hr (per engine)	8.74E-03
HAP	lb/hr (per engine)	8.96E-03
CO2	lb/hr (per engine)	918.0
CH4	lb/hr (per engine)	3.72E-02
N2O	lb/hr (per engine)	7.45E-03
CO2e	lb/hr (per engine)	921.1

	Short Term Emissions (lb/hr per engine)	Annual Emissions (tons/yr per engine)
NOx	7.4	1.85
СО	4.6	1.16
VOC	1.05	0.26
PM10	0.26	6.61E-02
PM2.5	0.26	6.42E-02
SO2	8.74E-03	2.18E-03
HAP	8.96E-03	2.24E-03
CO2	918.0	229
CH4	3.72E-02	9.31E-03
N2O	7.45E-03	1.86E-03
CO2e	921.1	230

- 1. Engine power rating is based on project assumption.
- 2. It is assumed that each engine will only be used for emergency purposes and limited to no more than 500 hours per year to include maintenance and testing.
- 3. Emission factors for NOx, CO, VOC, and PM are based on EPA Tier 2 standards from Table 1 of 40 CFR 89.112.
- 4. NOx+NMHC limit is 6.4 g/kWh; split into NOx and VOC based on Tier 1 limits of 9.2 g/kWh (NOx) and 1.3 g/kWh (VOC).
- 5. All particulate (PM) is assumed to be ≤ to 10 μm (PM10) and 97% of the PM is assumed to be smaller than 2.5 μm (PM2.5) based on US EPA Report Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling Compression-Ignition, No. NR-0009d, July 2010.
- 6. SO2 emission factor calculated from mass balance for 0.0015% by weight ULSD, assuming 100% conversion of fuel sulfur to SO2.
- 7. Emission factors used to calculate emission rates for CO2 (73.96 kg/MMBtu), CH4 (0.003 kg/MMBtu) and N2O (0.0006 kg/MMBtu) were based on Tables C-1 and C-2 of 40 CFR Part 98 Mandatory Greenhouse Gas Reporting, Subpart C General Stationary Fuel Combustion Sources.
- 8. CO2e emission rates use the following carbon equivalence factors: 25 for CH4, and 298 for N2O.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS EW 1 and EW 2 Switchgear SF6 Emissions

Circuit Breaker SF ₆ ¹ Fugitive Emissi	ons	EW 1 OSS	EW 2 OSS	EW 1 WTGs	EW 2 WTGs	EW 1 Onshore Substation	EW 2 Onshore Substation
SF ₆ Storage Capacity per Switch ²	lbs	5,512	8,818	286.6	286.6	9,700	14,550
Number of Switches	units	N/A	N/A	80	160	N/A	N/A
SF ₆ Leak Rate (by weight) ³	% per year	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
SF ₆ Emissions	lbs/year	27.56	44.09	114.64	229.28	48.50	72.75
SF ₆ Emissions	tons/year	0.0138	0.0220	0.0573	0.1146	0.0243	0.0364
Annual GHG emissions (CO ₂ e) ⁴	tons/year	314.16	502.65	1306.89	2613.77	552.91	829.37

- 1. SF₆ = Sulfur Hexafluoride
- 2. Storage capacity based on estimate provided by the project.
- 3. Leak rate for the SF6 is based on the International Electrotechnical Commission Standard 62271-1, 2004, as presented in the U.S. EPA technical paper, "SF6 Leak Rates from High Voltage Circuit Breakers U.S. EPA Investigates Potential Greenhouse Gas Emissions Source."
- 4. CO₂e emission rates use the following carbon equivalence factors based on

Table A-1 to Subpart A of 40 CFR Part 98—Global Warming Potentials: 22,800 for SF6.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS Emission Factors

Commercial Marine Vessels (CMVs)

				Commo	ercial Marine	Vessel Emiss	sion Factors	(g/hp-hr)/	a		Fuel Cons.
					PM/						
	Engine Type		NO _x	со	PM ₁₀ / <u>b</u> , / <u>c</u>	PM _{2.5} / <u>b</u>	SO ₂ / <u>d</u>	CO ₂	CH ₄	N ₂ O	(gal/hp-hr)/ <u>e</u>
1	Category 1 engines < 1000 kW	0.20	7.3	3.73	0.19	0.19	0.0049	515	0.067	0.015	0.050
2	Category 2 engines	0.37	7.3	3.73	0.46	0.45	0.0049	515	0.067	0.015	0.050
3	Category 3 engines (MSD using MDO) (>30L/cyl.)	0.37	9.8	0.82	0.14	0.13	0.296	482	0.003	0.023	0.046
4	All Categories aux. engines (MSD using MDO)	0.30	10.4	0.82	0.14	0.13	0.316	515	0.003	0.023	0.049

- /a Emission factors for Category 1 and 2 engines are from Table 3-8 and Category 3 engines are from Tables 2-9, 2-13, and 2-16 from ICF International report to the U.S. EPA, "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories", April 2009 (converted from g/kW-hr to g/hp-hr by multiplying by 0.746 kW/hp). Assumed all Category 1 and 2 engines to be used for for CVOW are certified to meet EPA Tier 1 and 2 marine engine standards respectively (providing conservative estimate for Category 1 engines); therefore the Tier 1 and 2 emission factors in Table 3-8 from the ICF International report was used.
- /b_All PM is assumed to less than 10 µm in diameter; therefore, PM emission factor is equivalent to PM₁₀ emission factor. PM_{2.5} is estimated to be 97 % of PM₁₀ per EPA guidance in "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling Compression-Ignition," EPA420-R-10-018/NR-009d, July 2010.
- /c_PM₁₀ Emission factors for Category 1 and 2 engines presented in Table 3-8 of the ICF report (ICF International 2009) are based on a fuel sulfur content of 1.5 percent. These factors were adjusted for two potential fuel sulfur contents that could be used by marine vessels: 0.1 percent sulfur MARPOL-compliant marine fuel, and 0.0015 percent ultra-low sulfur distillate (ULSD) fuel oil. The ICF factors were adjusted for each fuel sulfur content following the approach used in Section 3.4.2 of the ICF Report. For 0.1 percent sulfur MARPOL-compliant marine fuel, the ICF factors were multiplied by 1.00 for PM10. For 0.0015 percent sulfur ULSD fuel oil, the ICF factors were multiplied by 0.86 for PM10.
- /d SO2 emission factors for all marine engine categories are based on a mass balance calculation for the appropriate fuel sulfur content of each fuel: 0.1 percent sulfur MARPOL-compliant marine fuel, and 0.0015 percent ultra-low sulfur distillate (ULSD) fuel oil. The fuel consumption rate for each engine type was converted to a mass of fuel using an assumed fuel density of 853 kg/m3 (7.11 lb/gal).
- /e Fuel consuption rate for category 1 and 2 marine engines was estimated based on CO₂ emission factor (g/hp-hr) and the emission factor for the mass of CO₂ generated per gallon of fuel (10.21 kg CO₂/gal fuel) as presented in Table A-1 of the EPA report, "Direct Emissions from Mobile Combustion Sources, U.S. EPA Center for Corporate Leadership Greenhouse Gas Inventory Guidance," EPA430-K-16-004, January 2016. Fuel consumption for Category 3 marine engines was based on the BSFC (g/kW-hr) in the ICF International report.

Land-based Nonroad Engines and Other Equipment (Kings County, NY)

						NONRO	AD Emission	Climate Leaders (g/kWh)/ <u>b</u>		NONROAD				
		NONROAD Source Category		Exhaust+ Crankcase	Exhaust	Exhaust	Exhaust	Exhaust	Exhaust	Exhaust	Exhaust	Exhaust	Fuel Consumption	Default
	SCC	Description	Engine Size (hp)	VOC	NO _x	CO	PM ₁₀	PM _{2.5}	SO ₂	CO ₂	CH ₄	N ₂ O	gal/kWh /c	Load Factor
		& Mining Subcategory (*002*)												
100	2270002033	Diesel Bore/Drill Rigs	175 < HP <= 300	0.25	2.42	0.58	0.12	0.12	0.003	530	0.014	0.014	0.052	43%
101	2270002036	Diesel Excavators	175 < HP <= 300	0.16	0.37	0.14	0.01	0.01	0.003	536	0.013	0.014	0.053	59%
102	2270002045	Diesel Cranes	300 < HP <= 600	0.17	1.40	0.38	0.06	0.06	0.003	531	0.014	0.014	0.052	43%
103	2270002057	Diesel Rough Terrain Forklifts	100 < hp <= 175	0.17	0.90	0.38	0.08	0.07	0.003	536	0.014	0.014	0.053	59%
104	2270002060	Diesel Rubber Tire Loaders	175 < hp <= 300	0.16	0.65	0.21	0.03	0.03	0.003	536	0.013	0.014	0.053	59%
105	2270002069	Diesel Crawler Tractor/Dozers	750 < hp <= 1000	0.21	2.74	0.60	0.07	0.07	0.003	536	0.017	0.014	0.053	59%
105.1	2270002075	Diesel Off-Highway Tractor	300 < HP <= 600	0.16	1.07	0.43	0.06	0.06	0.003	536	0.014	0.014	0.053	59%
105.2	2270002081	Diesel Other Construction Equip.	100 < hp <= 175	0.18	1.07	0.45	0.10	0.09	0.003	536	0.015	0.014	0.053	59%
	Industrial Equ	ipment Subcategory (*003*)												
106	2270003010	Diesel Aerial Lifts	16 < hp <= 25	1.24	5.36	5.02	0.69	0.67	0.005	692	0.043	0.018	0.068	21%
	Commercial E	mercial Equipment Subcategory (*006*)										•		
107	2270006005	Diesel Generator Sets	100 < HP <= 175	0.28	2.61	0.72	0.16	0.15	0.003	530	0.015	0.014	0.052	43%
108	2270006015	Diesel Air Compressors	100 < HP <= 175	0.18	1.07	0.30	0.07	0.07	0.003	531	0.014	0.014	0.052	43%

- /a Emission factors for the land-based nonroad engines were estimated using EPA's MOVES2014b emission model for an assumed construction year of 2022.
- /b Emission factors for N₂O are based on Table B-8 of the EPA report, "Direct Emissions from Mobile Combustion Sources, U.S. EPA Center for Corporate Leadership Greenhouse Gas Inventory Guidance," EPA430-K-16-004, January 2016. (0.57 g CH4/gal fuel and 0.26 g N2O/gal fuel, respectively)
- /c Fuel consumption for each type of equipment was estimated based on CO2 emission factor (g/hp-hr) generated from the MOVES2014b model and the emission factor for the mass of CO2 generated per gallon of fuel (10.21 kg CO₂/gal fuel) as presented in Table A-1 of the EPA report, "Direct Emissions from Mobile Combustion Sources, U.S. EPA Center for Corporate Leadership Greenhouse Gas Inventory Guidance," EPA430-K-16-004, January 2016.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS Emission Factors

Land-based Nonroad Engines and Other Equipment (Nassau County, NY)

						NONRO	AD Emission		Climate Leaders (g/kWh)/ <u>b</u>		NONROAD			
		NONROAD Source Category		Exhaust+ Crankcase	Exhaust	Exhaust	Exhaust	Exhaust	Exhaust	Exhaust	Exhaust	Exhaust	Fuel Consumption	Default
	SCC	Description	Engine Size (hp)	VOC	NO _x	со	PM ₁₀	PM _{2.5}	SO ₂	CO ₂	CH ₄	N ₂ O	gal/kWh/ <u>c</u>	Load Factor
	Construction	& Mining Subcategory (*002*)												
110	2270002033	Diesel Bore/Drill Rigs	175 < HP <= 300	0.25	2.42	0.58	0.12	0.12	0.003	530	0.014	0.014	0.052	43%
111	2270002036	Diesel Excavators	175 < HP <= 300	0.16	0.37	0.14	0.01	0.01	0.003	536	0.013	0.014	0.053	59%
112	2270002045	Diesel Cranes	300 < HP <= 600	0.17	1.40	0.38	0.06	0.06	0.003	531	0.014	0.014	0.052	43%
113	2270002057	Diesel Rough Terrain Forklifts	100 < hp <= 175	0.17	0.90	0.38	0.08	0.07	0.003	536	0.014	0.014	0.053	59%
114	2270002060	Diesel Rubber Tire Loaders	175 < hp <= 300	0.16	0.65	0.21	0.03	0.03	0.003	536	0.013	0.014	0.053	59%
115	2270002069	Diesel Crawler Tractor/Dozers	750 < hp <= 1000	0.21	2.74	0.60	0.07	0.07	0.003	536	0.017	0.014	0.053	59%
115.1	2270002075	Diesel Off-Highway Tractor	300 < HP <= 600	0.16	1.07	0.43	0.06	0.06	0.003	536	0.014	0.014	0.053	59%
115.2	2270002081	Diesel Other Construction Equip.	100 < hp <= 175	0.18	1.07	0.45	0.10	0.09	0.003	536	0.015	0.014	0.053	59%
		ipment Subcategory (*003*)												
116	2270003010	Diesel Aerial Lifts	16 < hp <= 25	1.24	5.36	5.02	0.69	0.67	0.005	692	0.043	0.018	0.068	21%
	Commercial E	quipment Subcategory (*006*)		-			-				-			
117	2270006005	Diesel Generator Sets	100 < HP <= 175	0.28	2.61	0.72	0.16	0.15	0.003	530	0.015	0.014	0.052	43%
118	2270006015	Diesel Air Compressors	100 < HP <= 175	0.18	1.07	0.30	0.07	0.07	0.003	531	0.014	0.014	0.052	43%

[/]a Emission factors for the land-based nonroad engines were estimated using EPA's MOVES2014b emission model for an assumed construction year of 2022.

On-road Vehicles (Kings County, NY)

						MOVES20	14b Emissio	on factors in	lb/VMT/a				
		VOC	NO _x	CO	PM ₁₀	PM2.5	SO ₂	HAP	CO ₂	CH ₄	N ₂ O	CO2e	mi/gal
131	Diesel Single Unit Short-haul Truck	0.00101	0.00759	0.00362	0.00029	0.00026	0.00004	0.00013	4.47360	0.00043	0.00002	4.48575	5.03
132	Diesel Refuse Truck	0.00048	0.00686	0.00249	0.00021	0.00019	0.00005	0.00007	5.68676	0.00031	0.00002	5.69804	3.96
133	Diesel Light Commercial Truck	0.00091	0.00311	0.00771	0.00011	0.00010	0.00002	0.00012	1.98729	0.00041	0.00001	1.99466	11.33
134	Diesel Passenger Truck	0.00048	0.00210	0.00385	0.00005	0.00005	0.00002	0.00009	1.90868	0.00038	0.00001	1.91577	11.79
135	Gasoline Passenger Truck	0.00064	0.00055	0.00986	0.00003	0.00002	0.00002	0.00006	1.29294	0.00003	0.00003	1.30114	14.97

[/]a Emission factors (lb/VMT) for VOC, NOx, CO, PM10, SO2, HAP and CO2e, were derived using the MOVES2014 model and inputs for calendar year 2022 using the latest input files for calendar year 2020 from the New York State Department of Environmental Conservation.

On-road Vehicles (Nassau County, NY)

							MOVES20	14b Emissio	on factors in	lb/VMT/a				L
			VOC	NO _x	СО	PM ₁₀	PM2.5	SO ₂	HAP	CO ₂	CH ₄	N ₂ O	CO2e	mi/gal
141		Diesel Single Unit Short-haul Truck	0.00087	0.00602	0.00329	0.00025	0.00023	0.00002	0.00010	2.84028	0.00030	0.00001	2.84685	7.92
142		Diesel Refuse Truck	0.00075	0.01157	0.00379	0.00051	0.00047	0.00004	0.00008	4.38876	0.00018	0.00001	4.39449	5.13
143		Diesel Light Commercial Truck	0.00154	0.00428	0.01240	0.00016	0.00015	0.00001	0.00017	1.60958	0.00039	0.00001	1.61536	13.98
144		Diesel Passenger Truck	0.00059	0.00184	0.00398	0.00005	0.00005	0.00001	0.00009	1.38976	0.00032	0.00001	1.39405	16.20
145]	Gasoline Passenger Truck	0.00064	0.00064	0.00983	0.00003	0.00002	0.00001	0.00006	0.93536	0.00003	0.00003	0.94460	20.69

[/]a Emission factors (lb/VMT) for VOC, NOx, CO, PM10, SO2, HAP and CO2e, were derived using the MOVES2014 model and inputs for calendar year 2022 using the latest input files for calendar year 2020 from the New York State Department of Environmental Conservation.

[/]b Emission factors for N2O are based on Table B-8 of the EPA report, "Direct Emissions from Mobile Combustion Sources, U.S. EPA Center for Corporate Leadership – Greenhouse Gas Inventory Guidance," EPA430-K-16-004, January 2016. (0.57 g CH4/gal fuel and 0.26 g N2O/gal fuel, respectively)

[/]c Fuel consumption for each type of equipment was estimated based on CO2 emission factor (g/hp-hr) generated from the MOVES2014b model and the emission factor for the mass of CO2 generated per gallon of fuel (10.21 kg CO₂/gal fuel) as presented in Table A-1 of the EPA report, "Direct Emissions from Mobile Combustion Sources, U.S. EPA Center for Corporate Leadership – Greenhouse Gas Inventory Guidance," EPA430-K-16-004, January 2016.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) - OCS AIR EMISSION CALCULATIONS Emission Factors

Helicopters

ſ	161	
I	162	
I	163	
I	164	

			Emission Factors (lb/hr) / <u>a</u>										
Helicopter Type	Default Speed (mph)	VOC	NO _x	СО	PM/PM10	PM _{2.5}	SO ₂	CO ₂	CH ₄	N ₂ O	Fuel Use (gal/hr)		
Single	157.5	1.89	2.32	0.07	0.07	0.07	0.3	956.92	0.03	0.03	45.36		
Twin Light	177	4.3	3.1	0.10	0.09	0.09	0.5	1589.69	0.04	0.05	75.35		
Twin Medium	182.6	3.5	7.2	0.20	0.20	0.20	0.78	2459.92	0.1	0.1	116.59		
Twin Heavy	188.2	2.67	34.66	0.82	0.80	0.80	2.11	6640.46	0.19	0.22	314.74		

[/]a Emission factors for VOC, NOx, CO, PM, SO2, CO2, CH4, and N2O are from "BOEM Offshore Wind Energy Facilities Emission Estimating Tool - Technical Documentation," OCS Study BOEM 2017-079, August 1, 2017 (https://www.boem.gov/Technical-Documentation-stakeholder/). Table 4 in this document provides default emission factors and gal/hr fuel consumption rates based on helicopter type. Table 9 provides default speeds based on helicopter type.

Land-Based Stationary Diesel Engines, Excluding Fire Pumps (<= 2,237 kW and Displacement < 10 L/cylinder)

ı	254
	255
	256
	257
	258
	259

		Sub	part IIII stan	dards (g/kV	Vh) / <u>a</u>	(g/kWh)/b	Other I	Fuel Cons.			
					PM/						
Stationary Source Category	Engine Size (kW)	VOC	NO _x	co	PM ₁₀	PM _{2.5}	SO ₂	CO ₂	CH ₄	N ₂ O	(gal/kWh)/ <u>e</u>
Non-Emergency Engines	kW < 19	0.93	6.57	6.6	0.40	0.39	0.0015	163.1	0.007	0.001	0.067
Subject to Tier 4 Standards	19 <= kW < 56	0.58	4.12	5.0	0.03	0.03	0.0015	163.1	0.007	0.001	0.067
(2015 model year and later)	56 <= kW < 130	0.19	0.40	5.0	0.02	0.02	0.0015	163.1	0.007	0.001	0.067
(2013 filodel year and later)	130 <= kW <= 560	0.19	0.4	3.5	0.02	0.02	0.0015	163.1	0.007	0.001	0.067
Gensets	kW > 560	0.19	0.67	3.5	0.03	0.03	0.0015	163.1	0.007	0.001	0.067
All except gensets	KVV > 300	0.19	3.5	3.5	0.04	0.04	0.0015	163.1	0.007	0.001	0.067

/a Values are from Table 1 of 40 CFR 1039.101, except as follows:

For highlighted cells, a combined standard was provided (NMHC+NOx). Values for NMHC+NOx were apportioned into NOx and VOC rates based on the ratio of Tier 1 limits (9.2 g/kWh NOx and 1.3 g/kWh HC).

/b_All PM is assumed to less than 10 µm in diameter; therefore, PM emission factor is equivalent to PM₁₀ emission factor. PM₂₅ is estimated to be 97 % of PM₁₀ per EPA guidance in "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition." EPA420-R-10-018/NR-009d, July 2010.

/CSO2 emission factor based on typical mass balance for 0.0015% by weight ULSD, assuming 100% conversion of fuel sulfur to SO2.

 $\label{eq:maission} $$ /\underline{d}$ Emission factors used to calculate emission rates for CO2 (73.96 kg/MMBtu), CH4 (0.003 kg/MMBtu) and N2O (0.0006 kg/MMBtu) were based on the contraction of the contraction$

Tables C-1 and C-2 of 40 CFR Part 98 - Mandatory Greenhouse Gas Reporting, Subpart C - General Stationary Fuel Combustion Sources.

/e Fuel consumption rate is on a higher heating value (HHV) basis per unit of engine output, assuming the AP-42 specific consumption rate of 7,000 Btu/hp-hr, and a fuel heat content of 140,000 Btu/gal.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) MOVES Emission Factor Summary

	Kings County, NY													
Innut Vees	Fuel	Vahiala Tima					Emissi	on Factor lb	s/VMT					
Input Year	Fuei	Vehicle Type	voc	NOx	со	PM10	PM2.5	SO2	HAPS	CO2	CH4	N2O	CO2e	
		Combination Long-haul Truck	0.00124	0.01452	0.00438	0.00052	0.00048	0.00005	0.00017	6.26592	0.00061	0.00001	6.28520	
		Combination Short-haul Truck	0.00066	0.00840	0.00274	0.00030	0.00027	0.00005	0.00009	5.92943	0.00031	0.00002	5.94088	
		Single Unit Long-haul Truck	0.00061	0.00568	0.00252	0.00017	0.00015	0.00004	0.00009	4.45192	0.00036	0.00002	4.46429	
	Diesel	Single Unit Short-haul Truck	0.00101	0.00759	0.00362	0.00029	0.00026	0.00004	0.00013	4.47360	0.00043	0.00002	4.48575	
	Βĕ	Refuse Truck	0.00048	0.00686	0.00249	0.00021	0.00019	0.00005	0.00007	5.68676	0.00031	0.00002	5.69804	
		Light Commercial Truck	0.00091	0.00311	0.00771	0.00011	0.00010	0.00002	0.00012	1.98729	0.00041	0.00001	1.99466	
		Passenger Truck	0.00048	0.00210	0.00385	0.00005	0.00005	0.00002	0.00009	1.90868	0.00038	0.00001	1.91577	
2022		Passenger Car	0.00042	0.00023	0.00448	0.00001	0.00001	0.00001	0.00007	0.88278	0.00033	0.00000	0.88534	
7		Combination Short-haul Truck	0.00294	0.00459	0.04556	0.00008	0.00007	0.00008	0.00031	5.68020	0.00003	0.00003	5.69062	
		Single Unit Long-haul Truck	0.00213	0.00358	0.04945	0.00005	0.00004	0.00006	0.00021	3.85693	0.00005	0.00006	3.87547	
	oline	Single Unit Short-haul Truck	0.00161	0.00295	0.04627	0.00004	0.00003	0.00006	0.00016	3.86101	0.00006	0.00006	3.87888	
		Refuse Truck	0.00340	0.00494	0.04550	0.00010	0.00009	0.00008	0.00036	5.50689	0.00007	0.00006	5.52320	
	ë	Light Commercial Truck	0.00059	0.00053	0.00920	0.00002	0.00002	0.00002	0.00006	1.31347	0.00004	0.00003	1.32221	
		Passenger Truck	0.00064	0.00055	0.00986	0.00003	0.00002	0.00002	0.00006	1.29294	0.00003	0.00003	1.30114	
		Passenger Car	0.00086	0.00054	0.00983	0.00003	0.00003	0.00001	0.00009	1.02051	0.00003	0.00003	1.02738	

Note: Emission factors (lb/VMT) for VOC, NOx, CO, PM10, SO2, HAP and CO2e, were derived using the MOVES2014 model and inputs for calendar year 2022 using the latest input files for calendar year 2020 from the New York State Department of Environmental Conservation.

	Nassau County, NY												
Input Year	Fuel	Vehicle Type	Emission Factor lbs/VMT										
input rear			VOC	NOx	СО	PM10	PM2.5	SO2	HAPS	CO2	CH4	N2O	CO2e
	Diesel	Combination Long-haul Truck	0.00103	0.01212	0.00378	0.00034	0.00032	0.00004	0.00015	4.35553	0.00057	0.00001	4.37123
		Combination Short-haul Truck	0.00039	0.00627	0.00197	0.00020	0.00019	0.00003	0.00005	4.03462	0.00015	0.00001	4.03948
		Single Unit Long-haul Truck	0.00041	0.00350	0.00187	0.00012	0.00011	0.00002	0.00006	2.56280	0.00021	0.00001	2.56867
		Single Unit Short-haul Truck	0.00087	0.00602	0.00329	0.00025	0.00023	0.00002	0.00010	2.84028	0.00030	0.00001	2.84685
		Refuse Truck	0.00075	0.01157	0.00379	0.00051	0.00047	0.00004	0.00008	4.38876	0.00018	0.00001	4.39449
		Light Commercial Truck	0.00154	0.00428	0.01240	0.00016	0.00015	0.00001	0.00017	1.60958	0.00039	0.00001	1.61536
7		Passenger Truck	0.00059	0.00184	0.00398	0.00005	0.00005	0.00001	0.00009	1.38976	0.00032	0.00001	1.39405
202		Passenger Car	0.00054	0.00038	0.00509	0.00001	0.00001	0.00001	0.00008	0.64176	0.00034	0.00000	0.64414
	Gasoline	Combination Short-haul Truck	0.00739	0.01249	0.23011	0.00053	0.00047	0.00006	0.00077	4.00483	0.00035	0.00017	4.05264
		Single Unit Long-haul Truck	0.00151	0.00318	0.04959	0.00007	0.00006	0.00004	0.00016	2.51162	0.00005	0.00005	2.52408
		Single Unit Short-haul Truck	0.00148	0.00296	0.05316	0.00006	0.00005	0.00004	0.00015	2.66765	0.00007	0.00007	2.68509
		Refuse Truck	0.00225	0.00456	0.03411	0.00010	0.00009	0.00006	0.00024	4.30993	0.00004	0.00006	4.32644
		Light Commercial Truck	0.00107	0.00110	0.01571	0.00004	0.00003	0.00002	0.00010	1.05180	0.00005	0.00004	1.06565
		Passenger Truck	0.00064	0.00064	0.00983	0.00003	0.00002	0.00001	0.00006	0.93536	0.00003	0.00003	0.94460
		Passenger Car	0.00091	0.00063	0.01004	0.00003	0.00003	0.00001	0.00009	0.74467	0.00003	0.00002	0.75269

Note: Emission factors (lb/VMT) for VOC, NOx, CO, PM10, SO2, HAP and CO2e, were derived using the MOVES2014 model and inputs for calendar year 2022 using the latest input files for calendar year 2020 from the New York State Department of Environmental Conservation.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) EPA NEI HAP emission factors for Commercial Marine Vessels

HAP emission factors for commercial marine vessels were determined using the methodology identified by US EPA for the 2017 National Emissions Inventory (NEI); i.e., they are calculated as percentages of the PM2.5 or VOC emissions from the CMVs.

Pollutant	HAP?*	Fraction of	Fraction (All engines Cat 1/2/3, all fuel types, all operating modes)
Ammonia	No	PM2.5	0.019247
Antimony	Yes	PM2.5	0.000615
Arsenic	Yes	PM2.5	2.59E-05
Benz[a]Anthracene	Yes	PM2.5	8.82E-06
Benzo(g,h,i)Perylene	Yes	PM2.5	0.000132
Benzo[a]Pyrene	Yes	PM2.5	4.18E-06
Benzo[b]Fluoranthene	Yes	PM2.5	8.35E-06
Benzo[k]Fluoranthene	Yes	PM2.5	4.18E-06
Cadmium	Yes	PM2.5	0.000236
Chromium (VI)	Yes	PM2.5	7.24E-09
Chrysene	Yes	PM2.5	1.63E-05
Dibenzo[a,h]anthracene	Yes	PM2.5	8.65E-06
Fluoranthene	Yes	PM2.5	8.97E-05
Indeno[1,2,3-c,d]Pyrene	Yes	PM2.5	8.35E-06
Lead	Yes	PM2.5	0.000125
Manganese	Yes	PM2.5	3.22E-06
Mercury	Yes	PM2.5	4.18E-08
Nickel	Yes	PM2.5	0.000687
Polychlorinated Biphenyls	Yes	PM2.5	4.18E-07
Pyrene	Yes	PM2.5	3.37E-05
Selenium	Yes	PM2.5	4.38E-08
Total HA	P (ratioe	d to PM2.5)	0.0213
1,3-Butadiene	Yes	VOC	0.001013
2,2,4-Trimethylpentane	Yes	VOC	0.00712
Acenaphthene	Yes	VOC	5.09E-05
Acenaphthylene	Yes	VOC	0.000118
Acetaldehyde	Yes	VOC	0.009783
Acrolein	Yes	VOC	0.001848
Anthracene	Yes	VOC	0.000344
Benzene	Yes	VOC	0.004739
Ethyl Benzene	Yes	VOC	0.000439
Fluorene	Yes	VOC	0.000164
Formaldehyde	Yes	VOC	0.042696
Hexane	Yes	VOC	0.00279
Naphthalene	Yes	VOC	0.00273
o-Xylene	Yes	VOC	0.000513
Phenanthrene	Yes	VOC	0.001356
Propionaldehyde	Yes	VOC	0.001517
Toluene	Yes	VOC	0.002035
Xylenes (Mixed Isomers)	Yes	VOC	0.001422
Total I	IAP (rati	oed to VOC)	0.0807

^{*}For completeness, all of the pollutants in EPA's database are shown, but not all are HAP as defined in Section 112 of the Clean Air Act and as updated in 40 CFR 63 Subpart C.

<u>Reference:</u> US EPA, "2017 National Emissions Inventory (NEI)," April 2020, available from https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.

HAP speciation profiles for Category 1 and 2 engines are from Table 8 of the 2017 NEI "Methodology Documentation for EPA's Commercial Marine Emissions Estimates" for Category 1 and 2 vessels. HAP speciation profiles for Category 3 and 2 engines are from Table 15 of the "Methodology Documentation for EPA's Commercial Marine Emissions Estimates" for Category 3 vessels. Both documents are available from

https://www.epa.gov/sites/production/files/2019-11/cmv_methodology_documentation.zip.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2)

HAP Emission Factor Calculation Sheet

Small Diesel Engines

			F!	C
	F.,		Emission	Source
		nission Factor	Factor Rating	(AP-42
Pollutant	((lb/MMBtu) ^a		Table)
Organic Compounds				
Benzene ^b		9.33E-04	E	3.3-2
Toluene ^b		4.09E-04	E	3.3-2
Xylene ^b		2.85E-04	E	3.3-2
1,3 Butadiene	<	3.91E-05	E	3.3-2
Propylene		2.58E-03	E	3.3-2
Formaldehyde ^b		1.18E-03	E	3.3-2
Acetaldehyde ^b		7.67E-04	E	3.3-2
Acrolein ^b	<	9.25E-05	E	3.3-2
PAH				
Naphthalene ^b		8.48E-05	E	3.3-2
Acenaphthylene ^b	<	5.06E-05	E	3.3-2
Acenaphthene ^b	<	1.42E-06	E	3.3-2
Fluorene ^b		2.92E-05	E	3.3-2
Phenanthrene ^b		2.94E-05	E	3.3-2
Anthracene ^b		1.87E-06	E	3.3-2
Fluoranthene ^b		7.61E-06	E	3.3-2
Pyrene ^b		4.78E-06	E	3.3-2
Benzo(a)anthracene ^b		1.68E-06	E	3.3-2
Chrysene ^b		3.53E-07	E	3.3-2
Benzo(b)fluoranthene ^b	<	9.91E-08	E	3.3-2
Benzo(k)fluoranthene ^b	<	1.55E-07	E	3.3-2
Benzo(a)pyrene ^b	<	1.88E-07	E	3.3-2
Indeno(1,2,3-cd)pyrene ^b	<	3.75E-07	E	3.3-2
Dibenz(a,h)anthracene ^b	<	5.83E-07	E	3.3-2
Benzo(g,h,i)perylene ^b	<	4.89E-07	E	3.3-2
TOTAL PAH		1.68E-04	E	3.3-2
Metals and inorganics ^c				
Arsenic ^b		4.62E-08		
Cadmium ^b		5.13E-09		
Chromium ^b		1.24E-05		
Chromium VI ^{b, d}		2.24E-06		
Lead ^b		7.69E-07		
Mercury ^b		1.03E-08		
Nickel ^b		1.48E-06		
Selenium ^b		2.56E-07		

Total for substances identified as HAP ^e	< 3.89E-03

^a Values preceded by "<" are based on method detection limits.

^b Specifically listed as a "Hazardous Air Pollutant" (HAP) in the Clean Air Act, or a component of Polycyclic Organic Matter, which is also listed as a HAP.

^c Metal emissions are based on the paper *Survey of Ultra-Trace Metals in Gas Turbine Fuels*, 11th Annual International Petroleum Conference, Oct 12-15, 2004. Where trace metals were detected in any of 13 samples, the average result is used. Where no metals were detected in any of 13 samples, the detection limit is used.

d Hexavalent chrome was not detected in any fuel oil samples (in the note c reference study). However, to allow for potential hex chrome emissions formed during combustion, 18% of the total chrome emissions were assumed to be hex chrome (per EPA 453/R-98-004a)

^e Total calculated using the TOTAL PAH emission factor instead of factors for individual PAH.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2)

HAP Emission Factor Calculation Sheet

Large Stationary Diesel Engines

			Emission	Source
	Fn	nission Factor	Factor	(AP-42
Pollutant		lb/MMBtu) ^a	Rating	Table)
Organic Compounds	,	ιογινιινίσταγ	Hatting	rubicj
Benzene ^b		7.76E-04	E	3.4-3
Toluene ^b		2.81E-04	E	3.4-3
Xylene ^b		1.93E-04	E	3.4-3
Propylene		2.79E-03	E	3.4-3
Formaldehyde ^b		7.89E-05	E	3.4-3
Acetaldehyde ^b		2.52E-05	E	3.4-3
Acrolein ^b		7.88E-06	Е	3.4-3
PAH				
Naphthalene ^b		1.30E-04	Е	3.4-4
Acenaphthylene ^b		9.23E-06	Е	3.4-4
Acenaphthene ^b		4.68E-06	Е	3.4-4
Fluorene ^b		1.28E-05	Е	3.4-4
Phenanthrene ^b		4.08E-05	Е	3.4-4
Anthracene ^b		1.23E-06	Е	3.4-4
Fluoranthene ^b		4.03E-06	Е	3.4-4
Pyrene ^b		3.71E-06	Е	3.4-4
Benz(a)anthracene ^b		6.22E-07	E	3.4-4
Chrysene ^b		1.53E-06	E	3.4-4
Benzo(b)fluoranthene ^b		1.11E-06	E	3.4-4
Benzo(k)fluoranthene ^b	<	2.18E-07	Е	3.4-4
Benzo(a)pyrene ^b	<	2.57E-07	E	3.4-4
Indeno(1,2,3-cd)pyrene ^b	<	4.14E-07	E	3.4-4
Dibenz(a,h)anthracene ^b	<	3.46E-07	E	3.4-4
Benzo(g,h,i)perylene ^b	<	5.56E-07	E	3.4-4
TOTAL PAH	<	2.12E-04	E	3.4-4
Metals and inorganics ^c				
Arsenic ^b		4.62E-08		
Cadmium ^b		5.13E-09		
Chromium ^b		1.24E-05		
Chromium VI ^{b, d}		2.24E-06		
Lead ^b		7.69E-07		
Mercury ^b		1.03E-08		
Nickel ^b		1.48E-06		
Selenium ^b		2.56E-07		

Total for substances identified as HAP ^e	< 1.59E-03	
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^a Values preceded by "<" are based on method detection limits.

^b Specifically listed as a "Hazardous Air Pollutant" (HAP) in the Clean Air Act, or a component of Polycyclic Organic Matter, which is also listed as a HAP.

^c Metal emissions are based on the paper Survey of Ultra-Trace Metals in Gas Turbine Fuels, 11th Annual International Petroleum Conference, Oct 12-15, 2004. Where trace metals were detected in any of 13 samples, the average result is used. Where no metals were detected in any of 13 samples, the detection limit is used.

d Hexavalent chrome was not detected in any fuel oil samples (in the note f reference study). However, to allow for potential hex chrome emissions formed during combustion, 18% of the total chrome emissions were assumed to be hex chrome (per EPA 453/R-98-004a)

^e Total calculated using the TOTAL PAH emission factor instead of factors for individual PAH.

EMPIRE OFFSHORE WIND: EMPIRE WIND PROJECT (EW 1 and EW 2) EPA NEI HAP emission factors for Nonroad Diesels

HAP emission factors for nonroad diesels (below) were obtained from ERG, "Documentation for Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory," Volume I - Methodology, October 7, 2003 (available from http://www.epa.gov/ttn/chief/net/1999inventory.html#final3haps), Appendix D, Tables D-1 through D-3. This is the reference cited by EPA's National Inventory Model (NMIM), i.e., US EPA, "EPA's National Inventory Model (NMIM), A Consolidated Emissions Modeling System for MOBILE6 and NONROAD", EPA420-R-05-024, December 2005 (available from http://www.epa.gov/otaq/models/nmim/420r05024.pdf), pp. 19-21.

Pollutant	Fraction of	Emissions Factor %
1,3-butadiene	VOC - Exhaust	0.0018616
formaldehyde	VOC	0.11815
benzene	VOC	0.020344
acetaldehyde	VOC	0.05308
ethylbenzene	VOC - Exhaust	0.0031001
styrene	VOC - Exhaust	0.00059448
acrolein	VOC	0.00303
toluene	VOC	0.014967
hexane	VOC	0.0015913
propionaldehyde	VOC	0.011815
2,2,4-trimethylpentane	VOC	0.000719235
2,3,7,8-TCDD TEQ **	tons TEQ/gal	1.90705E-14
xylenes	VOC	0.010582
Total I	HAP (ratioed to VOC)	0.239834715
PAH		
benz[a]anthracene	PM10	0.0000071
benzo[a]pyrene	PM10	0.00000035
benzo[b]fluoranthene	PM10	0.00000049
benzo[k]fluoranthene	PM10	0.00000035
chrysene	PM10	0.0000019
dibenzo[a,h]anthracene	PM10	2.9E-09
indeno[1,2,3-c,d]pyrene	PM10	0.00000079
acenaphthene	PM10	0.0001
acenaphthylene	PM10	0.000084
anthracene	PM10	0.00000043
benzo[g,h,i]perylene	PM10	0.00000019
fluoranthene	PM10	0.000017
fluorene	PM10	0.0001
naphthalene	PM10	0.00046
phenanthrene	PM10	0.00026
pyrene	PM10	0.0000029
Total HA	AP (ratioed to PM10)	0.001034792
chromium	ug/bhp-hr	0.03
manganese	ug/bhp-hr	1.37
nickel	ug/bhp-hr	2.035
Total HAI	(Metals ug/bhp-hr)	3.435

^{**} Note: the emission rate for 2,3,7,8-TCDD TEQ is significantly lower than any other HAP and therefore, was not factored into the total HAP emission factor.